FINAL TECHNICAL REPORT

Klamath Hydroelectric Project
(FERC Project No. 2082)

Terrestrial Resources

PacifiCorp
Portland, Oregon

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PREFACE

In the course of study and in the interim between the draft technical report and this final technical report, PacifiCorp made a few changes to the proposed Klamath Hydroelectric Project (Project). The newly proposed Project begins at the J.C. Boyle Development and continues downstream to the Iron Gate Development. The Spring Creek diversion is now included in the Fall Creek Development. The East Side, West Side, and Keno developments are no longer part of the Project. Keno dam will remain in operation, but is not included in the Federal Energy Regulatory Commission (FERC) Project because the development does not have generation facilities, and its operation does not substantially benefit generation at PacifiCorp's downstream hydroelectric developments.

LIST OF ABBREVIATIONS AND ACRONYMS

ACEC	Area of Critical Environmental Concern
ac-ft	acre-feet
ACHP	Advisory Council on Historic Preservation
ACS	Aquatic Conservation Strategy
AD	accretion/depletion
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ADCP	Acoustic Doppler Current Profiler
AINW	Archaeological Investigations Northwest
AMS	accelerator mass spectrometry
ANOVA	analysis of variants
APE	area of potential effect
ARPA	Archaeological Resources Protection Act
ATV	all-terrain vehicle
AUM	animal unit month
AW	American Whitewater
AWG	Aquatics Work Group
BAOT	boats at one time
BIA	Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMF	bedrock milling feature
BMTS	Bird Mortality Tracking System
BNRR	Burlington Northern Railroad
BO	Biological Opinion
BOD	biochemical oxygen demand
B.P.	before present
BSL	Bureau of Labor Statistics
BVNWR	Bear Valley National Wildlife Refuge
°C	degrees Centigrade
CALTRANS	California Department of Transportation

CCS	cryptocrystalline silicate
CDBW	California Department of Boating and Waterways
CDF	California Department of Finance
CDFG	California Department of Fish and Game
CDO	community development ordinance
CDP	census designated place
CDPR	California Department of Parks and Recreation
CDSOD	California Division of Safety of Dams
CDWR	California Department of Water Resources
CEII	Critical Energy Infrastructure Information
CES	constant effort stations
CFM	constant fractional marking
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHRIS	California Historical Resources Information System
CLBP	California Lentic Bioassessment Procedure
CLNP	Crater Lake National Park
cm	centimeter
cms	cubic meters per second
CNDDB	California Natural Diversity Database
COC	chain of custody
COPCO	California Oregon Power Company
CPRC	Center for Population Research and Census
CPUE	catch per unit effort
CRC	Confluence Research and Consulting
CRM	cultural resources management
CRWG	Cultural Resources Work Group
CS	culturally sensitive
CSBP	California Stream Bioassessment Procedure
C shasta	*Ceratomyxa shasta* (a fish disease)
CSWRCB	California State Water Resources Control Board
CWHRS	California Wildlife Habitat Relations System
CWP	coarse woody debris

CWT	coded wire tag
DCA	detrended correspondence analysis
dbh	diameter at breast height
DO	dissolved oxygen
DTM	Digital Terrain Model
DTR	Draft Technical Report
EC	electrical conductivity; existing conditions
EDT	Ecosystem Diagnosis and Treatment, a fish production modeling program
E_H	redox potential
EIS	environmental impact statement
ELV	elevation
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPT	ephemeroptera, plecoptera, and trichopera
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
ESU	evolutionarily significant unit
E/W	east/west
°F	degrees Fahrenheit
FEAM	Fishery Economic Assessment Model
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFA	Flood Frequency Analysis
FGDC	Federal Geographic Data Committee
FIC	field inventory corridor
FL	fork length
FLA	final license application
FLIR	forward-looking infrared
FLPMA	Federal Land Policy and Management Act
FLRMP	Forest Land and Resource Management Plan

FNF	Fremont National Forest
FPA	Federal Power Act
FPC	Federal Power Commission
FPD	fire protection district
fpm	feet per mile
fps	feet per second
FR	Federal Register
FSCD	First Stage Consultation Document
ft^2	square feet
$ft\text{-}lb/s/ft^3$	foot-pounds per second per cubic foot
FTR	Final Technical Report
FTS	fisheries technical subcommittee
FTU	formazin turbidity unit
FYLF	foothill yellow-legged frog
GDP	gross domestic product
GIS	geographic information system
GLO	General Land Office
GMU	grazing management unit
GPS	global positioning system
GSG	geomorphology subgroup
ha	hectare
HBI	Hilsenhoff Biotic Index
HDPE	high-density polyethylene
HEC	Hydrologic Engineering Center
HPMP	Historic Properties Management Plan
HRA	Historical Research Associates
HRWA	Horseshoe Ranch Wildlife Area
HSC	habitat suitability criteria
HSI	Habitat Stability Index
I-5	Interstate 5

I&E	interpretation and education
IFG	Instream Flow Group (now called U.S. Geological Survey [USGS] Aquatic Systems and Technology Application Group)
IFG-4	empirical log and log formula developed by the IFG
IFIM	instream flow incremental methodology
IK	inflatable kayak
IQR	interquartile range
KBAO	Klamath Basin Area Office
KBO	Klamath Bird Observatory
KCF	Klamath County Flycasters
KCSO	Klamath County Sheriff's Office
KFNWR	Klamath Forest National Wildlife Refuge
KFRA	Klamath Falls Resource Area
KFWTP	Klamath Falls Wastewater Treatment Plant
kHz	kilohertz
KlamRas	a fish production modeling program
km	kilometer
KMC	Klamath Mixed Conifer
KMZ	Klamath Management Zone
KNF	Klamath National Forest
KOP	key observation point
KRBFTF	Klamath River Basin Fisheries Task Force
KRITFWC	Klamath River Inter-Tribal Fish and Water Commission
KRP	Klamath River Project
KSD	Klamath Straits Drain
KSWR	Klamath State Wildlife Refuge
kV	kilovolt
kW	kilowatt
KWA	Klamath Wildlife Area
kWh	kilowatt-hour
LAC	limits of acceptable change
lb	pound

LBNM	Lava Beds National Monument
LDD3	Land Development Desktop 3
LKNWR	Lower Klamath National Wildlife Refuge
LRDC	Lost River Diversion Channel
LWCFA	Land and Water Conservation Fund Act
LWD	large woody debris
µg/L	microgram(s) per liter
µS/cm	microSiemen(s) per centimeter
m	meter
MANSQ	a channel conveyance method
MAR	mean annual runoff
MASCA	Museum Applied Science Center of Archaeology
mb	millibar
mgd	million gallon(s) per day
mg/L	milligram(s) per liter
MHO	Montane Hardwood Oak
MHOC	Montane Hardwood Oak-Conifer
MHOJ	Montane Hardwood Oak-Juniper
MHz	megahertz
mm	millimeter
MNI	minimum number of individuals
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mph	miles per hour
MPS	Multiple Property Submission
m/s	meters per second
msl	mean sea level
mv	millivolt
MW	megawatt
MWh	megawatt-hour
NAD	North American Datum

NAGPRA	Native American Graves Protection and Repatriation Act
NCASI	National Council for Air and Stream Improvement
NCCP	Natural Community Conservation Planning
NCRWQCB	North Coast Regional Water Quality Control Board
NEC	New Earth Company
NEPA	National Environmental Policy Act
NGO	nongovernment organization
NHPA	National Historic Preservation Act
NISP	number of individual species
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRA	National Recreation Area
NRHP	National Register of Historic Places
NRPA	National Recreation and Parks Association
N/S	north/south
NTU	nephelometric turbidity unit
NWFP	Northwest Forest Plan
NWI	National Wetland Inventory
NWSRA	National Wild and Scenic Rivers Act
NWSRS	National Wild and Scenic Rivers Study
O&CR	Oregon and California Railroad
O&M	operations and maintenance
OAR	Oregon Administrative Rule
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODWR	Oregon Department of Water Resources
OHP	Office of Historic Preservation
OHV	off-highway vehicle
ONHP	Oregon Natural Heritage Program

OPRD	Oregon Parks and Recreation Department
ORP	oxidation reduction potential
ORS	Oregon Revised Statute
ORV	outstanding remarkable value
OSMB	Oregon State Marine Board
OSSW	Oregon State Scenic Waterway
OSU	Oregon State University
OWRD	Oregon Water Resources Department
PA	Programmatic Agreement
PAH	polyaromatic hydrocarbon
PAOT	people at one time
PCB	polychlorinated biphenyl
PCR	polymerase chain reaction
PCT	Pacific Crest National Scenic Trail
PFMC	Pacific Fishery Management Council
PFO	Palustrine Forested Wetland
PG&E	Pacific Gas and Electric Company
PGT	Pacific Gas Transmission
ph	powerhouse
pH	hydrogen (ion) concentration
PHABSIM	Physical Habitat Simulation
PM&E	protection, mitigation, and enhancement
PPL	Pacific Power and Light
P-R	Pittman-Robertson [Act]
PRIA	Public Rangelands Improvement Act
PVC	polyvinyl chloride
PWC	personal watercraft
PWHMA	Pokegama Wildlife Habitat Management Area
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control

RA	resource area
rcy	radiocarbon years
RD	recreation day
RERP	Raptor Electrocution Reduction Program
RFS	Riparian Focal Species
RHABSIM	River Habitat Simulation
RHJV	Riparian Habitat Joint Venture
RL	reporting limit
RM	Riparian Mixed Deciduous-Coniferous Habitat; river mile
RMA	recreation management area
RMP	resource management plan
ROD	record of decision
ROI	Rapid Ornithological Inventories
ROR	run-of-river
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
RRA	Redding Resource Area
RRMP	recreation resource management plan
RV	recreational vehicle
RVD	recreation visitor days
RWG	Recreation Work Group
S/C	side channel
SCORP	South Central Oregon Regional Partnership [as defined in the Land Use, Visual, and Aesthetic Resources FTR]
SCORP	Statewide Comprehensive Outdoor Recreation Plan [as defined in the Recreation Resources FTR]
SCR	sensitive cultural resources
SCS	Soil Conservation Service
SCWQCP	State of California Water Quality Control Plan
SF	steady flow
SHPO	State Historic Preservation Office
SIAM	System Impact Assessment Model
SL	standard length

SLOM	System Landscape Options Matrix
S/M	survey and manage
SMET	stream margin edge types
SMP	shoreline management plan
SOD	sediment oxygen demand
SONC	southern Oregon/northern California
SOP	standard operating procedure
SPC	specific conductance; split channels
spp.	species
SPRR	Southern Pacific Railroad
SR	state route
SRMA	Special Resource Management Area
SRNF	Six Rivers National Forest
SSD	South Suburban Sanitation District
STU	subsurface testing
SV	screening value
SWDU	Statements of Water Diversion and Use
SWG	socioeconomic work group
SWRCB	State Water Resources Control Board
SZF	stage-at-zero-flow

TAF	thousand acre-feet
TCL	traditional cultural landscape
TCP	traditional cultural properties
TCR	traditional cultural riverscape
TDG	total dissolved gas
TDML	total maximum daily load
TDS	total dissolved solids
TES	threatened, endangered, or sensitive
THPO	Tribal Heritage Preservation Officer
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TPLA	Topsy/Pokegama Landscape Analysis

TRPA	Thomas R. Payne and Associates
TRWG	Terrestrial Resources Work Group
TSS	total suspended solids
UGB	urban growth boundary
UKL	Upper Klamath Lake
UKNWR	Upper Klamath National Wildlife Refuge
U of O	University of Oregon
UPL	Utah Power and Light
URDC	Urban Research Development Corporation
USACE	U.S. Army Corp of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	universal transverse Mercator
VAF	velocity adjustment factor
VAOT	vehicles at one time
VES	visual encounter survey
VQO	visual quality objective
VRM	visual resource management
VRMC II	visual resource management class II
WDF	Washington Department of Fisheries (renamed as WDFW in 1996)
WDFW	Washington Department of Fish and Wildlife
WNF	Winema National Forest
WOP I	without-Project I scenario
WOP II	without-Project II scenario
WQRRS	Water Quality for River-Reservoir Systems (a model)
WQS	Water Quality Standards

W&SR	Wild and Scenic River
WSE	water surface elevation
WSEL	water surface elevation
WTA	wild trout area
WTP	wild trout program
WUA	weighted usable area
XRF	x-ray fluorescence
YOY	young-of-the-year
YTHPO	Yurok Tribal Heritage Preservation Officer

GLOSSARY

Abandonment	The loss of water rights through nonuse.
Abutment	Part of a valley or canyon wall against which a dam is constructed. Right and left abutments are those on respective sides of an observer looking downstream.
Acre-foot	The amount of water required to cover 1 acre to a depth of 1 foot. An acre-foot equals 326,851 gallons or 43,560 cubic feet. This volume measurement is used to describe a quantity of storage in a reservoir.
Affecting	Means "will or may have an effect on," as defined by 40 Code of Federal Regulations (CFR) 1508.3.
Afterbay	A channel for conducting water away from a power plant after it has passed through it.
Aggradation	The raising of a riverbed because of sediment deposited.
Allocation	The amount of water guaranteed to a jurisdiction under an agreement.
Alluvium	Sediments deposited by erosional processes, usually by streams.
Alternatives	A given agency's duty is to consider "alternatives as they exist and are likely to exist" (CEQ No. 8, 1981). <u>Range of alternatives</u> Includes all reasonable alternatives, which must be rigorously explored and objectively evaluated, as well as other alternatives, which are eliminated from detailed study with a brief discussion of the reasons for eliminating them. (40 CFR 1502.14) <u>Reasonable alternatives</u> Alternatives that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant. (CEQ No. 2a, 1981) <u>No Action Alternative</u> 40 CFR 1502.14(d) requires the alternatives analysis in an environmental assessment (EA) or environmental impact statement (EIS) to "include the alternative of no action." There are two distinct interpretations of "no action" that must be considered. The first situation addresses plans and continuing actions. The second is relative to where "no action" would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward (CEQ No. 3, 1981).

Anadromous	Type of fish that ascend rivers from the sea to spawn (lay their eggs). Fish that hatch in freshwater, migrate to the ocean, mature there, and return to freshwater to spawn. Salmon and steelhead are examples.
Annual operating plan	A yearly plan for operating reservoirs on the Columbia River. Such a plan is specifically required by the Columbia River Treaty and by the Pacific Northwest Coordination Agreement.
Approach velocities	Water velocities at or near the face of a fish screen.
Appropriate	To authorize the use of a quantity of water to an individual requesting it.
Appropriation	<u>Doctrine of Prior</u> With respect to water, refers to the system western states use to assign and distribute quantifiable amounts of water, in the form of water rights; system operates on a first-in-time, first-in-right basis. <u>Process Water</u> Refers to the system a state has established to issue and keep track of water rights. Applies only to states that have adopted the doctrine of prior appropriation of water rights.
Appropriative rights	Those rights to the use of water that result from the doctrine of prior appropriation of water rights.
Appurtenant	Existing as part of a broader property right. For instance, a surface water right may exist as part of the rights associated with ownership of land bordering a body of water.
Aquatic microphyte	A plant living in water, large enough to be seen with the naked eye.
Aquatic plants	Plants that grow in water either floating on the surface, growing up from the bottom of the body of water, or growing under the surface of the water.
Aquifer	A porous layer of rock that can hold water within it.
Arch dam	A dam construction method used in sites where the ratio of width to height between abutments is not great and where the foundation at the abutment is solid rock capable of resisting great forces. The arch provides resistance to movement. When combined with the weight of concrete (arch-gravity dam), both the weight and shape of the structure provide great resistance to the pressure of water.
Armored riverbed	A riverbed from which easily removed sediment has been eroded, leaving a surface of cobbles or boulders.

Attraction	Drawing fish to dam fishways or spillways through the use of water flows.
Augmentation (of streamflow)	Increasing streamflow under normal conditions, by releasing storage water from reservoirs.
Average megawatt (aMW)	The average amount of energy (in megawatts) supplied or demanded over a specified period of time; equivalent to the energy produced by the continuous operation of 1 megawatt of capacity over the specified period.
Average streamflow	The rate at which water passes a given point in a stream, usually expressed in cubic feet per second (cfs).
Bank	The margins or sides of a river. Banks are called right or left as viewed when facing in the direction of the flow.
Bank storage	Water that is absorbed and stored in the soil cover of the bed and banks of a watercourse and is returned to the watercourse in whole or in part as the water level falls.
Barrel	A liquid measure defined as 42 U.S. gallons.
Barrier	A physical block or impediment to the movement or migration of fish, such as a waterfall (natural barrier) or a dam (human-made barrier).
Base load	In a demand sense, a load that varies only slightly in level over a specified time period. In a supply sense, a plant that operates most efficiently at a relatively constant level of generation.
Base river flow	Also referred to as minimum flow. The minimum river flow required to sustain aquatic life. Often prescribed in Federal Energy Regulatory Commission (FERC) license articles.
Basin	A land area having a common outlet for its surface water runoff.
Beneficial use	Traditionally, the use of water for such utilitarian benefits as agriculture, mining, power development, and domestic water supply.
Benefit-cost analysis	An accounting framework designed to characterize the expected economic outcomes of a decision to allocate scarce economic resources, in the form of benefits and costs to each component part of the economy, and summed to determine whether or not total benefits exceed total costs.
Benefit-cost ratio	The ratio of the present value of the benefit stream to the present value of the project cost stream used in economic analysis.

Benthic region	The bottom of a body of water. This region supports the benthos, a type of life that not only lives on, but also contributes to the character of the bottom.
Benthos	The plant and animal life whose habitat is the bottom of a sea, lake, or river.
Best management practices	State-of-the-art practices that are efficient and effective, practical, economical, and environmentally sound.
Biome	An area that has a certain kind of community of plants and animals.
Biota	All the species of plants and animals occurring within a certain area.
Blackout	The disconnection of the source of electricity from all the electrical loads in a certain geographical area brought about by an emergency forced outage or other fault in the generation, transmission, or distribution system serving the area.
Blocked areas	Areas in the Columbia River Basin where hydroelectric projects have created permanent barriers to anadromous fish runs. These include the areas above Chief Joseph and Grand Coulee dams, the Hell's Canyon complex, and other smaller locations.
Bonneville Power Administration	The sole federal power marketing agency in the northwest and the region's major wholesaler of electricity. Created by Congress in 1937, Bonneville sells power to public and private utilities, direct service customers, and various public agencies in the states of Washington, Oregon, Idaho, Montana west of the Continental Divide (and parts of Montana east of the Divide), and smaller adjacent areas of California, Nevada, Utah, and Wyoming. The Northwest Power Act charges Bonneville with additional duties related to energy conservation, resource acquisition, and fish and wildlife.
Breach	A break or opening in a dam.
British thermal unit (Btu)	A standard unit for measuring the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.
Brownout	The partial reduction of electrical voltages. A brownout results in lights dimming and motor-driven devices slowing down.
Bus	A conductor or group of conductors that serves as a common connection for two or more circuits. In power plants, bus work consists of the three rigid single-phase connectors that interconnect the generator and the step-up transformer(s).

Buttress dam	A dam consisting of a watertight upstream face supported at intervals on the downstream side by a series of buttresses. They are usually in the form of flat decks or multiple arches. Many were built in the 1930s.
Bypass reach	That section of a river from which water is removed to generate hydropower. Water is often diverted from the river at the dam, transported through channels or penstocks downstream, and released back in the river at the powerhouse. Bypass reaches can be as short as a few hundred feet to as long as several miles.
Bypass system	A channel or conduit in a dam that provides a route for fish to move through or around the dam without going through the turbine units.
Canal	A constructed open channel for transporting water.
Capacity	The production level for which an electrical generating unit or other electrical apparatus is rated, either by the user or manufacturer. Capacity is also used synonymously with capability. Dependable capacity—the load-carrying ability of a station or system under adverse conditions for a specified time period. Installed capacity—the total manufacturer rated capacities of such kinds of equipment as turbines, generators, condensers, transformers, and other system components. Peaking capacity—the maximum sustainable capacity of generating equipment intended for operation only during the hours of highest daily, weekly, or seasonal loads. Reserve generating capacity—extra generating capacity available to meet peak or abnormally high demands for power and to generate power during scheduled or unscheduled outages.
Capillary Fringe	The unsaturated zone immediately above the water table containing water in direct contact with the water table.
Catadromous	Fish that mature in freshwater but migrate to seawater to spawn (lay their eggs). The American eel is an example.
Catchment	(1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught.
Channel	An open conduit either naturally or artificially created which periodically or continuously contains moving water or forms a connecting link between two bodies of water. River, creek, run, and tributary are among the terms used to describe natural channels. Canal and floodway are among the terms used to describe artificial channels.

Check dam	A small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel erosion, promote deposition of sediment, and divert water from a channel.
Circuit breaker	Any switching device that is capable of closing or interrupting an electrical circuit.
Clean Water Act	Common name for the Federal Water Pollution Control Act, as amended. Its purpose is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters," whether on public or private land. It authorizes the U.S. Environmental Protection Agency (EPA) to set water quality criteria for states to use to establish water quality standards.
Climatic year	The 12-month period used in collection of precipitation data. Climatic years begin July 1 and end the following June 30, and are designated by the calendar year in which the water year ends.
Code of Federal Regulations (CFR)	A compilation of the general and permanent rules of the executive departments and agencies of the federal government as published in the Federal Register. The Code is divided into 50 titles that represent broad areas subject to federal regulation. Title 18 contains the FERC regulations. FERC regulations are cited as 18 CFR (FERC).
Collection and bypass system	A system at a dam that collects and holds the fish approaching the dam for later transportation or moves them through or around the dam without going through the turbine units.
Computable General Equilibrium (CGE) Model	A general equilibrium mathematical representation of an economy; a formulation of the interrelationships of the various sectors of an economy that depends on well-functioning markets (no surplus or shortages) and where responses to market price changes are accounted for.
Conservation	The care and protection of natural resources. Also used in energy conservation management plans to describe increasing the efficiency of energy and water use, production, or distribution.
Consulting team	Scientific consultants retained by licensees. The consulting team serves as a source of scientific expertise to appropriate work groups.
Consumer surplus	The difference between the amount of money one would be willing to pay for a given quantity of a good or service and the price required by the market, hence the fullest measure of the benefit one receives from having or consuming the good or service.
Consumptive use	Nonreusable withdrawal of water where the water is evaporated, transpired by plants, incorporated into products or crops, or consumed by humans or animals.
Coordinated	The operation of two or more interconnected electrical systems to achieve

operation	greater reliability and economy. As applied to hydropower resources, the operation of a group of hydropower plants to obtain optimal power benefits with due consideration to all other uses.
Coordination	The practice by which two or more interconnected electric power systems augment the reliability of bulk electric power supply by establishing planning and operating standards; by exchanging pertinent information regarding additions, retirements, and modifications to the bulk electric power supply system; and by joint review of these changes to assure that they meet the predetermined standards.
Creek	A small stream of water which serves as the natural drainage course for a drainage basin of nominal or small size. The term is relative to size. Some creeks in a humid region might be called rivers if they occur in an arid region.
Crest	(1) The highest stage or level of a flood wave as it passes a point; (2) The top of a dam, dike, spillway, or weir, to which water must rise before passing over the structure.
Critical areas	Areas of ecological significance. This term is frequently used as a modifier to describe government programs that concentrate on the conservation and protection of natural resources that are fragile or sensitive to development, and that are of great importance in overall state efforts to conserve and protect the natural resource environment.
Cryptogam	Plant that reproduces by spores, not by flowers or seeds. For example, ferns.
Cubic feet per second (cfs)	A measurement of water flow representing 1 cubic foot of water (7.48 gallons) moving past a given point in 1 second. One cfs equals about 2 acre-feet per day.
Cumulative impact	The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR 1508.7)
Cupules	Small (1 to 3 inches in diameter), round depressions that have been pecked into the surface of a rock with a hammerstone. They are typically ½ inch to 1 inch deep.
Cycling	Power plant operation to meet the intermediate portion of the load (9 to 14 hours per day).
Dam	A concrete or earthen barrier constructed across a river and designed to

	control water flow or create a reservoir.
Dam failure	Event characterized by the sudden, rapid, and uncontrolled release of impounded water because of a breach in the dam.
Dead storage	That part of a reservoir that lies beneath the elevation of the bottom of the dam's lowest outlet.
Decommissioning	The act of retiring or dismantling a dam.
Deflector screens/ diversion screens	Wire mesh screens placed at the point where water is diverted from a stream or river. The screens keep fish from entering the diversion channel or pipe.
Degradation	The lowering of a riverbed because of erosion.
Delta	An alluvial deposit, often in the shape of the Greek letter "delta," which is formed where a stream drops its debris load on entering a body of water (lake or ocean).
Demand	The rate at which electric energy is delivered to or by a system, part of a system, or a piece of equipment. It is expressed in kilowatts, kilovoltamperes, or other suitable units at a given instant or averaged over any designated period of time. The primary source of "demand" is the power-consuming equipment of the customers.
Descaling	A condition in which a fish has lost a certain percentage of scales.
Design head	The head at which the full gate of the turbine equals the manufacturer-rated generator capacity.
Designated	Given formal statutory recognition, as in a federal or state river system.
Dewatering	Elimination of water from a lake, river, stream, reservoir, or containment.
Dike	(1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee; (2) A low wall that can act as a barrier to prevent a spill from spreading; (3) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of adjacent rocks or cuts massive rocks.
Direct effects	Caused by the action and occurring at the same time and place.
Discharge	Volume of water released from a dam or powerhouse at a given time, usually expressed in cubic feet per second. Discharge is often used interchangeably with streamflow.
Discount rate	The rate at which future economic values are reduced to make them economically equivalent to today's value; a rate used to convert a future

	value to present value.
Dissolved gas concentrations	The amount of chemicals normally occurring as gases, such as nitrogen and oxygen, that are held in solution in water, expressed in units such as milligrams of the gas per liter of liquid. Supersaturation occurs when these solutions exceed the saturation level of the water (beyond 100 percent).
Dissolved oxygen (DO)	The amount of oxygen in the water available to aquatic organisms measured in mg/L or percent saturation.
Diversion	The taking of water from a stream or other body of water into a canal, pipe, or other conduit.
Diversion dam	A barrier built to divert part or all of the water from a stream into a different course.
Docket	A formal record of a FERC proceeding. Dockets are available for inspection and copying by the public. Dockets for hydroelectric projects can be accessed through the FERC CIPS website.
Downstream slope	The slope or face of the dam away from the reservoir water. This slope requires some kind of protection from the erosive effects of rain or surface flow.
Draft	Release of water from a storage reservoir.
Drawdown	The lowering of a reservoir's surface elevation and water volume by releasing (spilling or generating) the reservoir's water at a rate that is greater than the rate of water flowing into the reservoir. Typically used for power generation, flood control, irrigation, or other water management activity.
Drift	The phenomenon of aquatic insects drifting downstream each evening.
Earthfill or earth dam	An embankment dam in which more than 50 percent of the total volume is formed of compacted, fine-grained material. A homogeneous earthen dam is constructed of similar earthen material throughout. This is the most common type of dam because its construction involves using materials in the natural state, requiring little processing.
Easement	Limited right of ownership of one's land conveyed by deed to another for a special purpose.
Ecological impact	The total effect of an environmental change, either natural or human-made, on the ecology of the area.
Ecology	The interrelationships of living things to one another and to their environment or the study of such interrelationships.

Ecosystem	The interacting system of a biological community and its nonliving environment.
Ecotone	Border between two biomes, where the plants and animals of those biomes mingle.
Ecotourism	Tourism that focuses on the enjoyment of wildlife and other ecological resources.
Effects	Effects and impacts as used in the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations are synonymous. Effects are ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial. (CEQ regulations, 40 CFR 1508.9)
Efficiency	The ratio of useful energy output to total energy input, usually expressed as a percent.
Effluent	Treated wastewater discharged from sewage treatment plants.
Electric Consumers Protection Act of 1986	The Electric Consumers Protection Act of 1986 (ECPA) brought about significant changes and imposed new requirements to both procedural and substantive aspects of project licensing and relicensing under the Federal Power Act (FPA). The FPA was amended to require FERC to give equal consideration to energy conservation, fish and wildlife protection, enhancement and preservation of recreational opportunities, and other aspects of environmental quality. These requirements are described in the discussion of the Federal Power Act below.
Electric magnetic field (EMF)	An electric or magnetic field, or a combination of the two, as in an electromagnetic wave.
Electric power system	Physically connected electric generating, transmission, and distribution facilities operated as a unit under one control.
Elevation	Height in feet above sea level.
Embankment	Fill material, usually earth or rock, placed with sloping sides and usually with length greater than height.
Embankment dam	A dam structure constructed of fill material, usually earth or rock, placed with sloping sides and usually with a length greater than its height.
Emergency Action	Predetermined plan of action for reducing the potential for property damage and loss of life in an area affected by a dam break or excessive

Plan (EAP) spillway. Required for certain licensed FERC projects.

Eminent Domain — Governmental power to take private property for a public use, usually government acquisition of land for such purposes as parks, roads, schools, or public buildings.

Endangered Species — An animal, plant, or insect species whose numbers are so low, compared to historical levels, that it is in danger of extinction, and that is awarded protection under the federal Endangered Species Act. (See Public Law [P.L.] 93-205 for legal definition, Endangered Species Act, sec. 3(6).)

Energy — The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. Electrical energy is usually measured in kilowatt-hours, while heat energy is usually measured in British thermal units. Energy is measured in calories, joules, kilowatt-hours (kWh), BTUs, megawatt-hours (MW-hours), and average megawatts (MWs).

Energy conservation — The more efficient use of energy resources. Energy conservation seeks to reduce energy invested per unit of product output, service performed, or benefit received through waste reduction.

Energy content curves (ECC) — A set of curves that establishes limits on the amount of reservoir drawdown permitted to produce energy in excess of firm energy load carrying capability (FELCC).

Entrainment — The incidental trapping of fish and other aquatic organisms in the water—for example, used for cooling electrical power plants or in waters being diverted for irrigation or similar purposes.

Environment — The sum of all external conditions and influences affecting the life, development, and, ultimately, the survival of an organism.

Environmental Assessment — (a) A concise public document for which a federal agency is responsible that serves to:

Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact

Aid an agency's compliance with the Act when no environmental impact statement is necessary

Facilitate preparation of an environmental impact statement when one is necessary

(b) Shall include brief discussions of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted. (CEQ regulations, 40 CFR 1508.9)

Because the EA is a concise document, it should not contain long descriptions or detailed data that the agency may have gathered. Rather it should contain a brief discussion of the need for the proposal, alternatives to the proposal, the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted. (40 CFR 1508.9(b))

Environmental Impact Statement	A detailed written statement as required by section 102(2)(C) of the National Environmental Policy Act. (CEQ regulations, 40 CFR 1508.10)
Ephemeral flow	When water flows in a channel only after precipitation.
Epilimnion	The surface area of a lake or reservoir.
Equal consideration	Does not mean treating all potential purposes equally or requiring that an equal amount of money be spent on each resource value, but it does mean that all values must be given the same level of reflection and thorough evaluation in determining that the project as licensed is best adapted. In balancing developmental and nondevelopmental objectives, the FERC will consider the relative value of the existing power generation, flood control, and other potential developmental objectives in relation to present and future needs for improved water quality, recreation, fish, wildlife, and other aspects of environmental quality.
Erosion	The wearing away of the land surface by wind or water. Erosion occurs naturally from weather or runoff but is often intensified by land-clearing practices.
Estuarine waters	Deepwater tidal habitats and tidal wetlands that are usually enclosed by land but have access to the ocean and are at least occasionally diluted by freshwater runoff from the land (such as bays, mouths of rivers, salt marshes, and lagoons).
Estuarine zone	The area near the coastline that consists of estuaries and coastal saltwater wetlands.
Estuary	The thin zone along a coastline where freshwater systems and rivers meet and mix with a salty ocean (such as a bay, mouth of a river, salt marsh, or lagoon).
Eutrophication	The process by which a body of water is enriched by nutrients.

Evaporation	The physical process by which a liquid (or a solid) is transformed to the gaseous state. In hydrology, evaporation is vaporization that takes place at a temperature below the boiling point.
Evapotranspiration	Water transmitted to the atmosphere by a combination of evaporation from the soil and transpiration from plants.
Face	The external surface of a structure, such as the surface of a dam.
Facilitator	An independent third party whose role is to help participants reach lasting agreement (among as many of participants as possible on as many issues as possible.) The facilitator can help participants to identify goals, identify issues, develop and maintain critical paths, accomplish creative problem solving, and resolve issues (facilitate and mediate as necessary).
Federal Emergency Management Agency (FEMA)	An agency of the federal government responsible for hazard mitigation. FEMA also administers the National Flood Insurance Program.
Federal Energy Regulatory Commission (FERC)	A quasi-judicial independent regulatory commission established in 1977 (replacing the Federal Power Commission) within the U.S. Department of Energy. FERC issues and regulates licenses for construction and operation of nonfederal hydroelectric projects and advises federal agencies on the merits of proposed federal multipurpose water development projects. FERC is composed of five commissioners appointed by the President. No more than three can be from any one political party.
Federal Power Act	Enacted in 1920, the FPA, as amended in 1935, consists of three parts. The first part incorporated the Federal Water Power Act administered by the former Federal Power Commission. It confined FPC activities almost entirely to licensing nonfederal hydroelectric projects. With passage of the Public Utility Act, which added parts II and III, the Commission's jurisdiction was extended to include regulating the interstate transmission of electric energy and rates for its sale at wholesale in interstate commerce. <u>Section 4(c)</u> Authorizes FERC to cooperate with state and federal agencies in its activities, and directs federal departments and agencies to furnish records and information to FERC when requested (16 U.S.C. 797 (c)). <u>Section 4(e)</u> As stated in the act of March 3, 1921 (41 Stat. 1353)), authorizes FERC to issue licenses to citizens of the United States, or to any association of such citizens, or to any corporation organized under the laws of the United States or any State thereof, or to any State or municipality for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, power houses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation and for the development, transmission, and utilization of

power across, along, from or in any of the streams or other bodies of water over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States, or upon any part of the public lands and reservations of the United States (including the Territories), or for the purpose of utilizing the surplus water or water power from any Government dam, except as herein provided: Provided, that licenses shall be issued within any reservation only after a finding by the Commission that the license will not interfere or be inconsistent with the purpose for which such reservation was created or acquired, and shall be subject to and contain such conditions as the Secretary of the department under whose supervision such reservation falls shall deem necessary for the adequate protection and utilization of such reservation.

Section 10(a)
Under Section 10(a), FERC is required to ensure that a hydropower project is "best adapted" to a comprehensive plan for improving or developing a waterway or waterways, for the use or benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat), and for other beneficial public uses (including irrigation, flood control, water supply, and recreational and other purposes)(16 U.S.C. 803(a)). To ensure a project is best adapted, under Section 10(a)(2), FERC must consider the extent to which the project is consistent with a comprehensive plan (where one exists) for improving, developing, or conserving a waterway or waterways affected by the project, and the recommendations of federal and state agencies exercising administration over relevant resources and recommendations of Indian tribes affected by the project. Section 10(a)(3) states that upon receipt of an application for a license, the Commission shall solicit recommendations from the agencies and Indian tribes charged with the authority to prepare comprehensive plans and exercising administration over flood control, navigation, irrigation, recreation, cultural and other relevant resources of the state in which the project is located, and the recommendations (including fish and wildlife recommendations) of Indian tribes affected by the project.

Section 10(j)
Under Section 10(j), in each hydropower license issued, FERC must include recommended conditions for the protection, mitigation and enhancement of fish and wildlife resources (16 U.S.C. 803(j). Such conditions shall be based on recommendations received pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) from the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), and state fish and wildlife agencies. FERC must base license conditions on these agency recommendations unless it finds that the recommendations may be inconsistent with the purposes or requirements of the FPA or other applicable law. In cases where FERC and the agencies disagree on specific license conditions submitted under

10(j), these entities will attempt to resolve the inconsistency, giving due weight to the recommendation, expertise, and statutory responsibility of the federal or state resource agency in question. If a compromise cannot be reached and FERC decides to use its own recommendations, it must demonstrate that the agency recommendation is inconsistent with the FPA or other applicable laws and that FERC's recommended mitigation measures will adequately protect the fish and wildlife resources of concern.

In Order 533-A, issued November 22, 1991, FERC adopted a six-step consultation procedure:

- Submittal of fish and wildlife recommendations supported by a statement of the agency's "understanding of the resource issues presented by the proposed facilities and the evidentiary basis for the recommended terms and conditions."
- Clarification of recommendations.
- FERC issues preliminary determination of any inconsistency with applicable law and provides a 45-day comment period.
- Agency and other party respond to determination.
- Meetings with agencies and affected parties. These meetings, with the exception of extraordinary circumstances, are to take place within 75 days of the date that FERC issues its preliminary determination of any inconsistency with applicable law (30 days after agency comment due).
- Issuance of license, including terms and conditions.

<u>Section 18</u>
Under Section 18, FERC must provide for the construction, operation, and maintenance of any mandatory "fishway" prescribed by the Secretary of the Interior (through the U.S. Fish and Wildlife Service) or the Secretary of Commerce (through the National Marine Fisheries Service) for the safe and timely upstream and downstream passage of fish (16 U.S.C. 811). As with Section 4(e), the fishway conditions submitted by the relevant resource agency must be supported on the record before FERC with substantial evidence. FERC must include the Secretary's prescription for fishway as conditions in a license, if a license is issued.

This section applies to any project that may impact the life stages or passage of any fish species present in a project area and where a project may affect passage of a species planned for introduction in the area. Also applicable to fishway prescriptions in both upstream and downstream passage; not limited to anadromous or other migratory species. (P.L. 102-

	486, 1701(b)(1992))
Federal project operators and regulators	Federal agencies that operate or regulate hydroelectric projects in the Columbia River basin. They include the Bonneville Power Administration, the Bureau of Indian Affairs, the Bureau of Reclamation, the U.S. Army Corps of Engineers, and FERC.
Fill dam	Any dam constructed of excavated natural materials or industrial wastes.
Final Order	A final ruling by FERC which terminates an action, decides some matter litigated by the parties, operates to divest some right, or completely disposes of the subject matter.
Finding of No Significant Impact (FONSI)	A document by a federal agency briefly presenting the reasons why an action, not otherwise excluded (Sec. 1508.4), will not have a significant effect on the human environment and for which an environmental impact statement therefore will not be prepared. It shall include the environmental assessment or a summary of it and shall note any other environmental documents related to it (Sec 1501.7(a)(5)). If the assessment is included, the finding need not repeat any of the discussion in the assessment but may incorporate it by reference. (CEQ regulations, 40 CFR 1508.13)
Firm energy	The amount of energy that can be generated given the region's worst historical water conditions. It is energy produced on a guaranteed basis.
Firm energy load carrying capability (FELCC)	Firm energy load carrying capability is the amount of energy the region's generating system, or an individual utility or project, can be called on to produce on a firm basis during actual operations. FELCC is made up of both hydro and nonhydro resources, including power purchases.
Fish and wildlife agencies	The U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the state agency in charge of administrative management over fish and wildlife resources of the state in which a proposed hydropower project is located. (FERC regulations, 18 CFR 4.30(b)(9)(i))
Fish and Wildlife Coordination Act (FWCA)	The Fish and Wildlife Coordination Act, as amended, requires federal agencies granting a license or permit for the control, impoundment, or modification of streams and waterbodies to first consult with the U. S. Department of the Interior, U.S. Fish and Wildlife Service, and the appropriate state fish agencies regarding conservation of these resources (16 U.S.C. 661-667e). Under the FWCA, the Secretary of the Interior is authorized to provide assistance to, and cooperate with federal, state, and public or private agencies and organizations in developing, protecting, and stocking all wildlife and their habitat; controlling losses from disease; minimizing damages from overabundant species; and carrying out other necessary measures. The act also provides that wildlife conservation receives equal consideration with other features of water resource devel-

opment through planning, development, maintenance, and coordination.

Under the requirements of the Electric Consumers Protection Act of 1986, (ECPA), FERC is directed to not only consult with the FWS and the state agencies but also to include in each license conditions for the protection, mitigation, and enhancement of fish and wildlife. Those conditions are to be based on recommendations received pursuant to the FWCA from the NMFS, the USFWS, and state fish and wildlife agencies.

Fish and wildlife recommendations	Recommendation designed to protect, mitigate damages to, or enhance any wild member of the animal kingdom, including any migratory or nonmigratory mammal, fish, bird, amphibian, reptile, mollusk, crustacean, or other invertebrate, whether or not bred, hatched, or born in captivity, and includes any egg or offspring thereof, related breeding or spawning grounds and habitat. A "fish and wildlife recommendation" includes a request for a study which cannot be completed prior to licensing, but does not include a request that the proposed project not be constructed or operated, a request for additional prelicensing studies or analysis or, as the term is used in 4.34(e)(2) and 4.34(f)(3), a recommendation for facilities, programs, or other measures to benefit recreation or tourism. (FERC regulations, 18 CFR 4.30(b)(9)(ii))
Fish flows	Artificially increased flows in the river system called for in the fish and wildlife program to quickly move the young fish down the river during their spring migration period. (See also water budget.)
Fish guidance efficiency (FGE)	The proportion of juvenile fish passing into the turbine intakes that are diverted away from the turbines and into bypass facilities.
Fish ladder	A structure that enables fish to swim upstream, either around or over a dam.
Fish passage	Features of a dam that enable fish to move around, through, or over a dam without harm. Typically an upstream fish ladder or a downstream bypass system.
Fish Passage Center	Part of the water budget program, the center plans and implements the annual smolt monitoring program; develops and implements flow and spill requests; and monitors and analyzes research results to assist in implementing the water budget. (See also water budget.)
Fish passage efficiency (FPE)	The proportion of juvenile fish passing a project through the spillway, sluiceway, or juvenile bypass system, as opposed to passing through the turbines.
Fish passage facilities	Features of a dam that enable fish to move around, through, or over without harm. Generally an upstream fish ladder or a downstream bypass system.

Fish passage managers	Located at the Fish Passage Center, the two fish passage managers are responsible for the specific planning, implementation, and monitoring activities of the center aimed at helping fish on their migratory routes in the Columbia River basin. One manager is designated by a majority of the federal and state fish and wildlife agencies, and the other manager is designated by a majority of the Columbia River basin Indian tribes. (See also Fish Passage Center.)
Fish screen	A screen across the turbine intake of a dam, designed to divert the fish into the bypass system.
Fishway	A device made up of a series of stepped pools, similar to a staircase, that enables adult fish to migrate up the river past dams.
Fixed drawdown period	The late summer and fall when the volume of the next spring runoff is not yet known, and reservoir operations are guided by fixed rule curve based on historical streamflow patterns.
Flash flood	A flood which follows within a few hours (usually less than 6 hours) of heavy or excessive rainfall. A dam or levee failure, or the sudden release of water impounded by an ice jam, is also considered a flash flood.
Flashboards	Temporary structures installed at the crest (top) of dams, gates, or spillways for the purpose of temporarily raising the water surface elevation, and hence the gross head of a hydroelectric generating plant, thus increasing power output. Normally, flashboards are removed either at the end of the water storage season or during periods of high streamflow, or for the purpose of temporarily increasing flood control.
Flood	The inundation of a normally dry area caused by high flow, or overflow of water in an established watercourse (such as a river, stream, or drainage ditch), or ponding of water at or near the point where the rain fell. This is a duration type event with a slower onset than flash flooding, normally greater than 6 hours.
Flood cropping	Farming dependent on the moisture and nutrients from floods.
Flood management	(1) Reducing risk by building dams or embankments or altering the river channel. (2) Reducing flood risk by actions such as discouraging flood-plain development, establishing flood warning systems, protecting urban areas, and allowing the most flood-prone areas to remain as wetlands.
Flood stage	Height at which a watercourse overtops its banks and begins to cause damage to any portion of the river valley. Flood stage is usually higher than or equal to bankfull stage.
Floodplain	The land area of a river valley that becomes inundated with water during a flood.

Floodwall	A long, narrow concrete, or masonry embankment usually built to protect land from flooding. If built of earth the structure is usually referred to as a levee. Floodwalls and levees confine streamflow within a specified area to prevent flooding.
Floodway	That portion of a natural floodplain that is regularly inundated during the normal annual flood cycles of a river or stream.
Floodway fringe	That portion of the natural floodplain that is above the floodway in elevation, but still floods during the highest of regular floods at a frequency of once every 1 to 5 years.
Flow	The volume of water passing a given point per unit of time.
Flow augmentation	Water released from a storage reservoir added to increase river flow, particularly to aid fish migration.
Flume	(1) A narrow gorge, usually with a stream flowing through it; (2) An open artificial channel or chute carrying a stream of water, as for furnishing power, conveying logs, or as a measuring device.
Forced outage	The occurrence of a component failure or other condition which requires that a unit be removed from service immediately, in contrast to a planned or scheduled outage.
Forebay	The impoundment immediately above (upstream from) a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of-river, and pumped storage).
Forebay guidance net	A large net placed in the forebay of a dam to guide juvenile fish away from the powerhouse.
Fossil fuel plant	A plant using coal, oil, gas, or other fossil fuel as its source of energy.
Fossil fuels	Materials found in the earth's crust and formed from organic matter as a result of geological processes occurring over many millions of years. The conventional forms of energy in wide use today—coal, petroleum, and natural gas—are all fossil fuels.
Freedom of Information Act (FOIA)	Under FOIA, the public may request and obtain Commission documents that may otherwise be inaccessible. Certain internal working documents and other data may be exempt, under the law, from disclosure. Documents of other agencies may also be obtained under FOIA.
Free-flowing	Undammed and unchannelized, as defined by the National Wild and Scenic Rivers Act.
Fry	The brief transitional stage of recently hatched fish that spans from absorption of the yolk sac through several weeks of independent feeding.

Full pool	The maximum level of a reservoir under its established normal operating range.
Gallery	(1) A passageway within the body of a dam or abutment; hence the terms grouting gallery, inspection gallery, and drainage gallery; (2) A long and rather narrow hall, hence the following terms for a power plant: valve gallery, transformer gallery, and busbar gallery.
Gallons per minute (gpm)	A unit used to measure water flow.
Gas supersaturation	The overabundance of gases in turbulent water, such as at the base of a dam spillway. Can cause a fatal condition in fish similar to the bends.
Gaseous supersaturation	The condition of higher levels of dissolved gases in water owing to entrainment, pressure increases, or heating.
Gate	A device that is moved across a waterway from an external position to control or stop flow.
General equilibrium analysis	An economic analysis of a particular market where effects on related markets are fully accounted for.
Generation	(1) The process of producing electric energy by transforming other forms of energy; (2) the amount of electric energy produced, expressed in kilowatt-hours.
Generator	A machine that changes water power, steam power, or other kinds of mechanical energy into electricity.
Gigawatt (GW)	One billion watts.
Gigawatt-hour (Gwh)	One billion watt-hours.
Global warming	The possible result of an increase in atmospheric concentrations of carbon dioxide, methane, chlorofluorocarbons, and other “greenhouse gases” that trap additional heat in the atmosphere. The increase in greenhouse gases is caused by the combustion of fossil fuels (coal, petroleum, and natural gas), land use modification, and the release of agricultural and industrial gases into the atmosphere.
Gravity dam	A dam constructed of concrete or masonry that relies on its weight for stability.
Gravity feed system	A system that provides flow in a channel or conduit through the use of gravity.
Gross generation	The total amount of electric energy produced by a generating station or

	stations, measured at the generator terminals.
Groundwater	Water within the earth that supplies wells and springs; water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table. The supply of freshwater under the earth's surface in an aquifer or soil that forms the natural reservoir for human use.
Habitat	The sum total of environmental conditions of a specific place that is occupied by an organism, a population, or a community.
Hard water	A water quality parameter that indicates the level of alkaline salts, principally calcium and magnesium, and expressed as equivalent calcium carbonate. Hard water is commonly recognized by the increased quantities of soap, detergent, or shampoo necessary to raise a lather.
Head	The vertical height of water in a reservoir above the turbine. The more head, the more power that is exerted on the turbine by the force of gravity.
Headgate	The gate that controls water flow into irrigation canals and ditches. A watermaster regulates the headgates during water distribution and posts headgate notices declaring official regulations.
Head pond	The reservoir behind a run-of-river dam.
Headwaters	Streams at the source of a river.
Headworks	A flow control structure on an irrigation canal.
Horsepower	A unit for measuring the rate of work (or power) equivalent to 33,000 foot-pounds per minute or 746 watts.
Human environment	Interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. (See also effects.) (CEQ regulations, 40 CFR 1508.14)
Hydraulic head	The vertical distance between the surface of the reservoir and the surface of the river immediately downstream from the dam.
Hydro	Electric power produced by flowing water.
Hydroelectric energy	The production of electricity from kinetic energy in flowing water.
Hydroelectricity (hydroelectric power)	The production of electric power through use of the gravitational force of falling water.
Hydroelectric plant	A plant in which turbine generators are driven by falling water.

Hydrograph	A graph showing the water level (stage), discharge, or other property of a river volume with respect to time. For example, an annual hydrograph charts the varying river levels over the course of 1 year.
Hydrologic budget	An accounting of the inflow to, outflow from, and storage in, a hydrologic unit (such as a drainage basin, aquifer, soil zone, lake, reservoir, or irrigation project).
Hydrologic cycle	The natural pathway water follows as it changes between liquid, solid, and gaseous states.
Hydrology	The applied science concerned with the waters of the earth and their occurrences, distribution, and circulation through the unending hydrologic cycle of evaporation, transpiration, precipitation, infiltration, storage, and runoff.
Hydropower	The harnessing of flowing water to produce mechanical or electrical energy.
Hydropower system	The hydroelectric dams on the Columbia River and its tributaries.
Hypolimnion	Pertaining to the lower, colder portion of a lake, separated from the upper, warmer portion (epilimnion).
Impacts	See definition of effects.
Impoundment	A body of water, such as a pond, confined by a dam, dike, floodgate, or other barrier.
Indian tribe	In reference to a proposal to apply for a license or exemption for a hydropower project, an Indian tribe which is recognized by treaty with the United States, by federal statute, or by the U. S. Department of the Interior in its periodic listing of tribal governments in the Federal Register in accordance with 25 CFR 83.6(b), and whose legal rights as a tribe may be affected by the development and operation of the hydropower project proposed (as where the operation of the proposed project could interfere with the management and harvest of anadromous fish or where the project works would be located within the tribe's reservation). (FERC regulations, 18 CFR 4.30(b)(10))
Indirect effects	Effects that are caused by an action but occur later in time or farther removed in distance, yet are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. (CEQ regulations, 40 CFR 1508.8(b))
Inflow	Water that flows into a reservoir or forebay during a specified period.

Initial license	The first license issued for a water power project under either the Federal Water Power Act of 1920 or the Federal Power Act of 1935.
In-lieu energy	Energy provided by a reservoir owner instead of water to which a downstream party is entitled.
Input-output model	A special form of a general equilibrium mathematical representation of an economy; a formulation of the interrelationships of the various sectors of an economy that depends on well-functioning markets (no surplus or shortages) but where responses to market price changes are not accounted for.
Instream flow	The water flowing in a riverbed, which excludes water diverted from the river for human use.
Instream right	A water right in which water is kept in a stream and not removed and for which the legally required "beneficial use" is identified as fish and wildlife, riparian habitat, recreation, or some related protection.
Instream use	The use of water that does not require withdrawal or diversion from its natural watercourse; for example, the use of water for navigation, recreation, and support of fish and wildlife.
Intake	The entrance to a turbine at a dam, diversion works, or pumping station.
Intake traveling screens	See definition of turbine intake screens.
Interested parties	People or entities that are interested in the relicensing of a hydroelectric project. To the extent desired by an individual interested party, the interested parties will remain informed about and provide input regarding the relicensing process.
Interim spill	The spilling of water over a dam.
Interruptible demands	Those demands that, by contract, can be interrupted in the event of a capacity deficiency on the supplying system.
Intervenor	A person, institution, or organization admitted as a participant to a proceeding.
Inundation map	A map that delineates the areas that would be flooded by particular flood events.
Irrigation	The controlled application of water to arable lands to supply water requirements not satisfied by rainfall.
Just compensation	Payment for the full value of land or other property taken for public use by the government.

Juvenile	The early stage in the life cycle of anadromous fish when they migrate downstream to the ocean.
Juvenile transportation	Collecting migrating juvenile fish and transporting them around the dams using barges or trucks.
KAF	A thousand acre-feet, same as .504 thousand second-foot days.
kcfs	A measurement of water flow equivalent to 1,000 cubic feet of water passing a given point for an entire second.
kcfs-month	One kcfs-month is a flow of 1,000 cubic feet per second for 1 month or 0.0595 million acre-feet.
Key observation point (KOP)	An important location from which project facilities or operations are visible to the public, based on frequency of use and other factors.
Kilowatt (kW)	A unit of power equal to 1,000 watts or 1.3414 horsepower. It is a measure of electrical power or heat flow rate and equals 3,413 Btu per hour. An electric motor rated at 1 horsepower uses electric energy at a rate of about 3/4 kilowatt.
Kilowatt-hour (kWh)	1,000 watts of electrical energy, operating for 1 hour. Electrical energy is commonly sold by the kilowatt-hour.
Kjeldahl nitrogen	Organic nitrogen as determined by the Kjeldahl method, which entails quantitative analysis of organic compounds to determine nitrogen content by interaction with concentrated sulfuric acid; ammonia is distilled from the NH_4SO_4 formed.
KSFD	A volume of water equal to 1,000 cubic feet of water flowing past a point for an entire day. Same as 1.98 FAF.
Levee	A long, narrow, earthen embankment usually built to protect land from flooding. If built of concrete or masonry, the structure is referred to as a floodwall. Levees and floodwalls confine streamflow within a specified area to prevent flooding.
License	Authorization by FERC to construct, operate, and maintain nonfederal hydro projects for a period of up to 50 years.
Licensee	Any person, state, or municipality licensed under the provisions of section 4 of the Federal Power Act, and any assignee or successor in interest thereof. (Federal Power Act, Sec. 3 (5))
Littoral zone	The area on or near the shore of a body of water.
Live storage	That part of a reservoir that lies above the elevation of the bottom of the dam's lowest outlet.

Load	The amount of electric power or gas delivered or required at any point on a system. Load originates primarily at the energy consuming equipment of the customers.
Load factor	The ratio of average load to peak load for a specified period, usually expressed as a percentage.
Load factoring operation	A hydropower project operation that uses the generating equipment and reservoir impoundment capacity to store water and then provide power during daily, weekly, or seasonal periods of peak power demand.
Load shaping	The adjustment of storage releases so that generation and load are continuously in balance.
Lock	A chambered structure on a waterway closed off with gates for the purpose of raising or lowering the water level within the lock chamber so ships, boats, and tugs or barges can move from one elevation to another along the waterway.
Losing stream	A stream reach in which the water table adjacent to the stream is lower than the water surface in the stream, causing infiltration from the stream channel, recharging the groundwater aquifer, and decreasing the stream flow.
Low-head dam	A dam at which the water in the reservoir is not high above the turbine units.
MAF	Million acre-feet. The equivalent volume of water that will cover an area of 1 million acres to a depth of 1 foot. One MAF equals 1,000 KAF.
Mainstem	The principal river in a basin, as opposed to the tributary streams and smaller rivers that feed into it.
Mainstem passage	The movement of salmon and steelhead around or through the dams and reservoirs in the Columbia and Snake rivers.
Mainstem survival	The proportion of anadromous fish that survive passage through the dams and reservoirs while migrating in the Columbia and Snake rivers.
Maintenance expenses	That portion of operating expenses consisting of labor, materials, and other direct and indirect expenses incurred for preserving the operating efficiency or physical condition of utility plants used for power production, transmission, and distribution of energy.
Maintenance outage	The removal of a unit from service to perform work on specific components which could have been postponed past the next weekend.
Major hydro project	Those projects with a capacity greater than 1.5 megawatts (MW).
Mandatory	The authority of resource agencies to impose conditions on a FERC-

conditions	licensed project. See also the definition of Federal Power Act, where mandatory conditioning authority is identified in boldface at definitions of pertinent sections.
Mano	A stone used as the upper millstone for grinding foods by hand in a metate (see definition of metate).
Masonry dam	A dam constructed mainly of stone, brick, or concrete blocks that may or may not be joined with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.
Mean annual flood	The arithmetic mean of the highest peak discharge during each year of record.
Mechanical bypass systems	See definition of bypass system.
Megawatt	A unit of electrical power equal to 1 million watts or 1 thousand kilowatts. A megawatt will typically serve about 1,000 people. The Dalles Dam produces an average of about 1,000 megawatts.
Megawatt-hour (MWh)	A unit of electrical energy that equals 1 megawatt of power used for 1 hour.
Metate	A stone with a concave upper surface used as the bottom millstone for grinding foods.
Microcatchments	Small basins used to collect rainwater.
Mid-Columbia dams	Dams owned by the mid-Columbia Public Utility Districts. They include Wells, Rocky Reach, Rock Island, Wanapum and Priest Rapids dams.
Mid-Columbia Public Utility Districts (PUDs)	Public Utility District No. 1 of Grant County, Public Utility District No. 2 of Chelan County, and Public Utility District No. 1 of Douglas County.
Mill	A monetary cost and billing unit used by utilities; it is equal to 1/1,000 of the U.S. dollar (equivalent to 1/10 of one cent).
Minimum flow	The minimum river flow sufficient to support fish and other aquatic life, to minimize pollution, or to maintain other instream uses such as recreation and navigation.. Often required at a hydroelectric dam as a condition of the dam owner's operating license.
Minimum operating pool	The lowest water level of an impoundment at which navigation locks can still operate.
Mitigation	The act of alleviating or making less severe. Generally refers to efforts to alleviate the impacts of hydropower development to the Columbia Basins

salmon and steelhead runs.

1. Avoiding the impact altogether by not taking a certain action or parts of an action.

2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

5. Compensating for the impact by replacing or providing substitute resources or environments. (CEQ regulations, 40 CFR 1508.20)

Mitigation measures — A. Mitigation measures discussed in a NEPA document must cover the range of impacts of the proposal. Mitigation measures must be considered even for impacts that by themselves would not be considered "significant." Once the proposal itself is considered as a whole to have significant effects, all of its specific effects on the environment (whether or not "significant") must be considered, and mitigation measures must be developed where it is feasible to do so. (40 CFR 1502.14(f), 1502.16(h), 1508.14)

B. All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency or the cooperating agencies, and thus would not be committed as part of the Records of Decision (RODs) of these agencies (40 CFR 1502.16(h), 1502.2(c)). This will serve to alert agencies or officials who can implement these extra measures, and will encourage them to do so (46 FR 18032).

Monitor — To systematically and repeatedly measure conditions in order to track changes.

Mortality — The number of fish lost or the rate of loss.

Multipurpose dam — A barrier constructed for two or more purposes such as storage, flood control, navigation, power generation, or recreation.

Multipurpose reservoir — A reservoir that can be used for more than one purpose, such as flood control, hydroelectric power development, and recreation.

Navigability — The ability of a body of water to be traveled by water craft.

Navigable Waters — Those parts of streams or other bodies of water over which Congress has jurisdiction to regulate commerce with foreign nations and among the

	several states, and which either in their natural or improved condition notwithstanding interruptions between the navigable parts of such streams or waters by falls, shallows, or rapids compelling land carriage, are used or suitable for use for the transportation of persons or property in interstate or foreign commerce, including therein all such interrupting falls, shallows, or rapids, together with such other parts of streams as shall have been authorized by Congress for improvement by the United States or shall have been recommended to Congress for such improvement after investigation under its authority. (Federal Power Act, Sec. 3(8))
NEPA	National Environmental Policy Act, as amended (42 U.S.C. 4321, et. seq.).
Net environmental benefit analysis	An assessment of the impact of an economic decision on flow of ecological services provided by natural resources.
New license	Any license, except an annual license issued under section 15 of the Federal Power Act, for a water power project that is issued after the initial license for that project. (FERC regulations – 18 CFR 4.30(b)(19))
Nitrogen supersaturation	A condition of water in which the concentration of dissolved nitrogen exceeds the saturation level of water. Excess nitrogen can harm the circulatory system of fish.
Nondegradation	A term in the Clean Water Act that indicates a standard of water quality for which certain water bodies are to be managed so as to prevent any degradation.
Nonpoint Source Pollution	A term in the Clean Water Act also called “polluted runoff,” water pollution produced by diffuse land-use activities. Occurs when runoff carries fertilizer, animal wastes, and other pollution into rivers, streams, lakes, reservoirs, and other bodies of water.
Northwest Power Act	The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (16 U.S.C. 839 et seq.), which authorized the creation of the Northwest Power Planning Council and directed it to develop this program to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat on the Columbia River and its tributaries.
Northwest Power Pool Coordinating Group	An operating group made up of Bonneville Power Administration, the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and public and private generating utilities in the northwest. One of the group’s functions is administering the Pacific Northwest Coordination Agreement.
Nutrient cycling	Circulation or exchange of elements such as nitrogen and carbon between nonliving and living portions of the environment.

Nutrients	Animal, vegetable, or mineral substance that sustains individual organisms and ecosystems.
Off-highway vehicle (OHV)	A vehicle commonly used for traversing terrain other than paved roads.
Off-peak energy	Electric energy supplied during periods of relatively low system demands.
Off-peak hours	Period of relatively low demand for electrical energy, as specified by the supplier (such as the middle of the night).
On-peak energy	Electric energy supplied during periods of relatively high system demands.
Operating year	The 12-month period from August 1 through July 31.
Opportunity costs	The value of the opportunity foregone by the chosen economic decision, such as the value of the job given up (foregone) when choosing one's current job.
Original cost	The cost of the property at the time it was first placed in public service.
Outage	The period during which a generating unit, transmission line, or other facility is out of service. Forced outage—the shutdown of a generating unit, transmission line, or other facility, for emergency reasons Scheduled outage—the shutdown of a generating unit, transmission line, or other facility, for inspection or maintenance, in accordance with an advance schedule
Outflow	The water that is released from a project during the specified period.
Overdraft	Pumping of groundwater for consumptive use in excess of safe yield.
Oviposition	Egg laying; egg deposition; egg dropping. Typically used in reference to a specific behavioral trait or adaptation that a species employs when depositing its eggs.
Pacific Northwest Utilities Conference Committee (PNUCC)	A group formed by Pacific Northwest utilities officials in order to coordinate policy on Pacific Northwest power supply issues and activities. PNUCC lacks contractual authority, but it plays a major role in regional power planning through its Policy; Steering; Fish and Wildlife; and Lawyers committees, and the Technical Coordination Group. PNUCC publishes the Northwest Regional Forecast, containing information on regional loads and resources.
Paedomorphic	Characteristic of certain amphibians: becoming sexually mature and active in the aquatic (larval) form before metamorphosing into the

	terrestrial (adult) form.
Partial equilibrium analysis	An economic analysis of a particular market where effects on related markets are ignored.
Participants	Individuals or parties who have chosen to be actively involved in the relicensing process (by participating at meetings, working to collaboratively develop solutions, providing written comments, or otherwise providing input). Includes PacifiCorp, FERC, state and federal resource agencies, Indian tribes, and nongovernmental organizations actively involved in the filing activities for the project.
Passage	The movement of migratory fish through, around, or over dams, reservoirs, and other obstructions in a stream or river.
Peak flow	Refers to a specific period of time when the discharge of a stream or river is at its highest point.
Peak load	The maximum demand for electrical power that determines the generating capacity required by a public utility.
Peaking facilities	Hydroelectric plants that typically increase project discharge to maximize generation during highest electric demand.
Penstock	A conduit used to convey water under pressure to the turbines of a hydroelectric plant.
Perennial flow	Year-round flow
Permeability	The ability of a material to transmit water though its pores when subjected to pressure.
Petroglyph	A carving or inscription on a rock.
Pictograph	An ancient or prehistoric drawing or painting on a rock wall.
Plant	A station at which are located prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, or nuclear energy into electric energy.
Plant factor	The ratio of the average load on the plant for the period of time considered to be the aggregate rating of all the generating equipment installed in the plant.
Pluvial	In hydrology, anything that is brought about directly by precipitation.
Point source pollution	Pollution into bodies of water from specific discharge points such as sewer outfalls or industrial-waste pipes.

Potable water	Water of a quality suitable for drinking.
Power	The rate at which work is done. The rate at which energy is transferred. The watt is a typical unit of power measured in units of work per unit of time.
Power peaking	The generation of electricity to meet maximum instantaneous power requirements; usually refers to daily peaks.
Powerhouse	A primary part of a hydroelectric dam where the turbines and generators are housed and where power is produced by falling water rotating turbine blades.
Prefiling consultation process	Includes activities performed in order to address FERC and other statutory and regulatory requirements in preparing the Applications for New Licenses. The prefiling period continues until the formal filing of the applications with the FERC.
Probable maximum flood	The largest flood considered reasonably possible at a site as a result of meteorological and hydrological conditions.
Producer surplus	The difference between the amount of money it would cost to produce a given quantity of a good or service and the price available in the market; hence, the fullest measure of the benefit one receives from producing the good or service.
Production (electric)	Act or process of producing electrical energy from other forms of energy; also, the amount of electrical energy produced expressed in kilowatt-hours.
Production expenses	Costs incurred in the production of electric power and conforming to the accounting requirements of the Operation and Maintenance Expense Accounts of the FERC Uniform System of Accounts.
Productivity	The quality of creating something of value.
Project outflow	The volume of water per unit of time released from a project.
Protection, Mitigation, and Enhancement (PM&E) measures	PM&E measures will be expressed in the new license in Articles that define the affected resources and describe measures to be taken during the term of the new license.
Public lands	Lands and interest in lands owned by the United States that are subject to private appropriation and disposal under public land laws. It shall not include “reservations,” as hereinafter defined. (Federal Power Act, Sec. 3(1))
Public review file	The formal written record of the prefiling consultation process.

Public trust doctrine	A legal, court-developed doctrine by which a state can hold and manage all lands in state ownership (including the lands underlying navigable waters) in trust for the citizens of that state.
Public utility	A private business organization, subject to government regulation, that provides an essential commodity or service, such as water, electricity, transportation, or communications, to the public.
Public utility district (PUD)	A government unit established by voters of a district to supply electric or other utility service.
Pumped storage plant	A hydroelectric power plant that generates electric energy to meet peak load by using water pumped up into an elevated storage reservoir during off-peak periods. Often associated with nuclear power plants or other generating facilities that have a high base load of power that cannot be fully used in off-peak periods. Pumped storage facilities allow storage of part of this excess power (less power needed to pump the water to the upper reservoir).
Quantification	Defining the amount and timing of a water right.
Rainwater Harvesting	A farming technique that conserves water by collecting rainwater run-off behind earth or rock embankments in small basins.
Ramping	The process by which streamflows are gradually increased or decreased to protect streambeds and stream life from erosion and downstream flushing.
Ramping rate	The maximum allowable rate of change in outflow from a power plant. The ramping rate is established to prevent undesirable effects resulting from rapid changes in loading or, in the case of hydroelectric plants, discharge.
Rating	A manufacturer's guaranteed performance of a machine, transmission line, or other such equipment, based on design features and test data. The rating will specify such limits as load voltage, temperature, and frequency. The rating is generally printed on a nameplate attached to equipment and is commonly referred to as the nameplate rating or nameplate capacity.
Reach	The distance between two specific points outlining a portion of a stream or river.
Recharge	To add water to an aquifer; also, the water added to an aquifer.
Regional Economic Impact Analysis	Economic analysis of individual economic regions, such as a county, city, or metropolitan area, made up of all the individual sectors of the economy, and accounting for the interrelationships among the sectors.

Regulated river	A river whose natural flow pattern is altered by a dam or dams.
Regulations	FERC carries out its regulatory functions, including procedures and practice, through rulemaking and adjudication. Under rulemaking, the Commission may propose a general rule or regulation change. By law, it must issue a notice of the proposed rule and a request for comments in the Federal Register, and publish any final decision. Alternatively, the Commission considers, on a case-by-case basis, applications submitted by regulated companies. If there is an objection to a particular proposal and a settlement cannot be reached, the proposal must, by law, be presented at a hearing presided over by an agency administrative law judge. A decision by a judge may be adopted, modified, or reversed by the Commission. An aggrieved party may petition for a rehearing, and may appeal a decision to the United States Court of Appeals and ultimately, to the United States Supreme Court.
Reliability	The probability that a device will function without failure during a specified time period or amount of usage.
Relicensing	The administrative proceeding in which FERC, in consultation with other federal and state agencies, decides whether and on what terms to issue a new license for an existing hydroelectric project at the expiration of the original license.
Reregulating facility	A dam and reservoir, located downstream from a hydroelectric peaking plant, with sufficient storage capacity to store the widely fluctuating discharges from the peaking plant and to release them in a relatively uniform manner downstream.
Reregulation	Storing erratic discharges of water from an upstream hydroelectric plant and releasing them uniformly from a downstream plant.
Reservation	National forest, tribal lands within Indian reservations, military reservations, and other lands and interests in lands owned by the United States, and withdrawn, reserved, or withheld from private appropriation and disposal under the public land laws; also lands and interests in lands acquired and held for any public purposes; but shall not include national monuments or national parks. (Federal Power Act, Sec. 3.(2) 16 U.S.C. 796.2)
Reservation of water right	At the state level, the reservation of a water right means that the state declares its authority to stop certain water diversions in the event that a river runs dangerously low.
Reservoir	A body of water collected in an artificial lake behind a dam and used for the storage, regulation, and control of water.
Resident fish	Fish species that reside in freshwater throughout their lives.

Resource agency	A federal, state, or interstate agency exercising administration over the areas of flood control, navigation, irrigation, recreation, fish and wildlife, water resource management (including water rights), or cultural or other relevant resources of the state or states in which a project is or will be located. (FERC regulations, 18 CFR 4.30(b)(27))
Riffles	Shallow, turbulent portions of a stream or river.
Riparian	Pertaining to a river (for example, the riparian zone).
Riparian habitat	The habitat found on streambanks and riverbanks, where semiaquatic and terrestrial organisms mingle.
Riparian zone	The habitat found on stream banks and river banks, where semiaquatic and terrestrial organisms mingle.
Riparian-use doctrine	Legal rights belonging to the owner of land bordering on a given stream. The riparian owner is entitled to the reasonable use of the water in the bordered stream provided that use does not unreasonably diminish the rights of downstream users.
River	A natural stream of water emptying into an ocean, lake, or another river.
River basin	The total area drained by a river and its tributaries.
River left	Left bank when facing downstream.
River mouth	The place where a river ends by flowing into another body of water such as a lake, ocean, or another river.
River right	Right bank when facing downstream.
Riverine ecosystem	The zone of biological and environmental influence of a river and its floodplain.
Rockfill dam	An embankment dam in which more than 50 percent of the total volume consists of compacted or dumped pervious natural or crushed rock.
Rolled-fill dam	An embankment dam of earth or rock in which the material is placed in layers and compacted by using rollers or rolling equipment.
Rule curves	Water levels, represented graphically as curves, that guide reservoir operations.

Rulemaking	The authority delegated to administrative agencies by Congress to make rules that have the force of law. Frequently, statutory laws passed by Congress that express broad terms of a policy and are implemented more specifically by administrative rules, regulations, and practices.
Runner	The rotating part of a turbine.
Runoff	Water in excess of what can be absorbed by the ground and which runs off the land into streams, rivers, or lakes.
Run-of-river	Hydroelectric facilities whose operation cannot be regulated for more than a few hours from storage at or above the site, but are controlled mainly by the volume of water flowing in the stream. These volumes must be used as they occur or be wasted.
Safe yield	The rate of surface water diversion or groundwater extraction from a basin for consumptive use over an indefinite period of time. Such a yield can be maintained without producing negative effects.
Salinization	The accumulation of salt in soil or water to a harmful level.
Scenic river	Defined in the National Wild and Scenic Rivers Act as "those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads."
Sector analysis	Economic analysis of individual components or sectors of the economy, such as agriculture, commercial fishing, or municipal water supply services.
Sediment	Particles of material that are transported and deposited by water, wind, or ice.
Sediment flushing	A method of reservoir operation in which the reservoir is temporarily lowered so that fast-flowing water can erode accumulated sediments on the reservoir bed.
Sediment load	The amount of sediment carried by a river.
Sediment sluicing	A method of reservoir operation in which the reservoir is lowered at the start of the flood season, speeding the movement of water through the reservoir and hence reducing its capacity to trap sediment.
Selective withdrawal structures	Devices which permit releases from a reservoir over a wide range of depths, temperatures, or water quality.

Service list	In FERC terms, this is the official list of parties to a proceeding once a formal filing has been made.
Settlement agreement	FERC encourages applicants to prepare and file settlement agreements. Most measures in settlement agreements are included in license articles; however, FERC cannot include measures that are in conflict with the Federal Power Act or other federal statutes.
Shaping	The scheduling and operation of generating resources to meet seasonal and hourly load variations.
Silt	Sediment composed of particles between 0.004 millimeters (mm) and 0.06 mm in diameter.
Sluice	A structure with a gate for stopping or regulating flow of water.
Sluiceway	An open channel inside a dam designed to collect and divert ice and trash in the river (e.g., logs) before they get into the turbine units and cause damage. (On several of the Columbia River dams, ice and trash sluiceways are being used as, or converted into, fish bypass systems.)
Smolt	A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.
Socioeconomic analysis	Analysis of the provision of public goods and services such as public schools, roads, and other government services that contribute to the economic well-being of the community, and of equity considerations in the distribution of economic benefits among various classes of people.
Spawning	The releasing and fertilizing of eggs by fish.
Specific yield	The fraction of the saturated bulk volume consisting of water which will drain by gravity when the water table drops.
Spill	Water passed over a dam without going through turbines to produce electricity. Spills can be forced, when there is no storage capability and flows exceed turbine capacity, or they can be planned—for example, during a powerhouse maintenance event.
Spillway	The channel or passageway around or over a dam through which excess water is released or “spilled” past the dam without going through the turbines. A spillway is a safety valve for a dam and, as such, must be capable of discharging major floods without damaging the dam, while maintaining the reservoir level below some predetermined maximum level.

Spillway crest elevation	The point at which the reservoir behind a dam is level with the top of the dam's spillway.
Spinning reserves	The unused capacity in an electric system in generator units that are not in operation but can be called on for immediate use in case of system problems or sudden load changes.
Standby reserves	The unused capacity in an electric system in machines that are not in operation but are available for immediate use if required.
Station use	Energy used in a generating plant for the production of electricity. It includes energy consumed for plant light, power, and auxiliaries regardless of whether such energy is produced at the plant or comes from another source.
Storage	The volume of water in a reservoir at a given time.
Storage plant	A hydroelectric plant with reservoir storage capacity for power use.
Storage reservoir	A reservoir that has space for retaining water—from springtime snowmelts, for example. Retained water is released as necessary for various uses, including power production, fish passage, irrigation, and navigation.
Stratification	Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature: epilimnion (top layer); metalimnion or thermocline (middle layer of rapid temperature change); and hypolimnion (bottom layer).
Stream adjudication	A judicial process to determine the extent and priority of the rights of all persons to use water in a river system.
Streambed	The channel or bottom of a river or stream.
Stream reach	A specific portion of the length of a stream.
Streamflow	The rate at which water passes a given point in a stream, usually expressed in cubic feet per second. This term is often used interchangeably with discharge.
Subimpoundment	An isolated body of water created by a dike within a reservoir or lake.
Submersible traveling screen	A wire mesh screen that acts like a conveyor belt when installed in the intakes of turbines at dams guiding and transporting juvenile fish into bypass channels.
Substation	An assemblage of equipment for the purposes of switching, changing, or regulating the voltage of electricity.

Supersaturation	See definition of dissolved gas concentrations.
Surface water	Water on the earth's surface exposed to the atmosphere as rivers, lakes, streams, and the oceans.
Tailrace	A pipe or channel through which water is returned from the powerhouse into a river or other receiving water.
Tailwater	The water surface immediately downstream from a dam or hydroelectric power plant.
Tainter gate	A spillway gate whose face is a section of a cylinder. The cylinder rotates on a horizontal axis downstream of the gate. With this design, the gate can be closed using its own weight.
Taking	The transfer of dominion or control of property from a private owner to the government against his or her consent.
Talus	Rock rubble at the bottom of slope or cliff.
Thermal pollution	A human-caused change in water temperature that results in damage to aquatic life.
Threatened species	Any species that has the potential of becoming endangered in the near future (See Endangered Species Act, P.L. 93-205 for legal definition, sec. 3(20)).
Transmission	The movement or transfer of electric energy over an interconnected group of lines and associated equipment. The movement or transfer occurs between points of supply and points at which the energy is transformed for delivery to consumers or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.
Trap and haul program	A program to collect fish at a given point, transport them to a different point, and release them.
Tributary	A stream or river that flows into another stream or river and contributes water to it.
Turbidity	A measure of the extent to which light passing through water is reduced owing to suspended materials.
Turbine	A machine for generating rotary mechanical power from the energy in a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

Turbine intake screens	Large screens, which may have moving or nonmoving parts, designed to be placed in a dam's turbine intake at an angle to deflect juvenile fish from the intakes into a bypass system.
Uncontracted water	A volume of water in a storage reservoir that is not assigned for other purposes, such as irrigation.
Underflow	Groundwater flow within a streambed below a surface stream.
Velocity barrier	A physical structure, such as a barrier dam or floating weir, built in the tailrace of a hydroelectric powerhouse, which blocks the tailrace from further adult salmon or steelhead migration to prevent physical injury or migration delay.
Wasteway	An open ditch or canal that discharges excess irrigation water or power plant effluent into the river channel.
Water banking	An administrative system for renting surplus water.
Water budget	A provision of the Columbia River Basin Fish and Wildlife Program that calls for increasing Columbia and Snake river flows during the spring fish migration with the intent of increasing downstream survival of migrating juvenile salmon and steelhead.
Water demand	The amount of water used over a period of time at a given price.
Water quality	The condition of water as determined by measurements of such factors as suspended solids, acidity, turbidity, dissolved oxygen, and temperature, and by the presence of organic matter or pollution chemicals.
Water quality criteria	The levels of pollutants that affect the suitability of water for a given use. Generally, water use classification includes public water supply; recreation; propagation of fish and other aquatic life; and agricultural and industrial use.
Water quality standard	Water quality standards are numeric criteria or narrative statements used to address: (1) the beneficial uses that water resources provide to people and the environment; (2) allowable concentrations of specific pollution or pollutants in a waterbody, established to protect the beneficial uses; (3) narrative statements of unacceptable conditions in and on the water; and (4) provisions for antidegradation of existing high-quality or unique waters.

Water rights	Priority claims to water. A legal right to use a specific amount of water from a natural or artificial body of surface water for general or specific purposes such as irrigation, mining, power, domestic use, or instream flow. In western states, water rights are based on the principle "first in time, first in right," meaning older claims take precedence over newer ones.
Water table	The upper level that groundwater reaches in an aquifer, or the surface of groundwater.
Water year	The 12-month period for which the U.S. Geological Survey (USGS) reports surface water supplies. Water years begin October 1 and end the following September 30, and are designated by the calendar year in which the water year ends.
Watercourse	A natural stream channel that, depending on the season, may or may not contain water.
Watershed	All the land drained by a given river and its tributaries. An entire drainage basin including all living and nonliving components of the system.
Watt	A measure of the rate at which energy is produced, exchanged, or consumed. The rate of energy transfer is equivalent to 1 ampere of current flowing at 1 volt at unity power factor. Ampere—the unit of measurement of electrical current produced in a circuit by 1 volt acting through a resistance of 1 ohm Ohm—the unit of measurement of electrical resistance. The resistance of a circuit in which a potential difference of 1 volt produces a current of 1 ampere. Volt—the unit of measurement of voltage, electrical force, or pressure. The electrical force that, if steadily applied to a circuit with a resistance of 1 ohm, will produce a current of 1 ampere.
Weir	(1) A low dam built across a stream to raise the upstream water level. Called a fixed-crest weir when uncontrolled. Other types of weirs include broad-crested, sharp-crested, drowned, and submerged; (2) A structure built across a stream or channel for the purpose of measuring flow (measuring or gauging weir).
Wetland	An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances supports, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (U.S. Army Corps of Engineers and EPA definition). Wetlands must have the following three attributes: (1) at least periodically, the land supports predominately hydrophytes; (2) the

	substrate is predominately undrained hydric soil; and (3) the substrate is on soil and is saturated with water or covered by shallow water at some time during the growing season of each year.
Wild and Scenic Rivers Act	1968 federal law (Public Law 90-542) establishing and setting forth the procedure for including outstanding river segments in a national system of free-flowing, protected rivers.
Wild River	Defined in the National Wild and Scenic Rivers Act as "those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, within watersheds or shorelines essentially primitive and water unpolluted. These represent vestiges of primitive America."
Winter's Doctrine	A legal document arising from the case "Winters v. U.S., U.S. Supreme Court, 1908, 207 US 564," that holds that, upon the creation of a federal reservation on the public domain, the reservation has appurtenant to it the right to divert as much water from streams within or bordering it as is necessary to serve the purposes for which the reservation was created.

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1.0 INTRODUCTION

1.1 SCOPE OF WORK

This Final Technical Report (FTR) documents the methods and findings of the terrestrial resources studies to provide technical support for the relicensing application for the PacifiCorp Klamath Hydroelectric Project (Project). The Project is located on the Upper Klamath River in southern Oregon and northern California (Figure 1.1-1).

The Project consists of seven mainstem hydroelectric facilities on the Upper Klamath River and one tributary facility on Fall Creek. The Project is owned and operated by PacifiCorp under a single license (No. 2082) issued in 1956 by the Federal Energy Regulatory Commission (FERC). The existing FERC license expires March 1, 2006.

Study plans were submitted for public review in fall 2001, winter 2001, and spring 2002, and revised through February 2003 to address stakeholder comments. This FTR describes the methods and documents the results of the terrestrial resource studies conducted through October 2003. Any changes in methodology compared to the final study plan are noted in the methods section.

The information in this report provides the foundation for the development of Exhibit E (Environmental Report) of the FERC relicensing application. This FTR is not intended to assess the impacts of the Project or recommend protection, mitigation, and enhancement (PM&E) measures. Its purpose is to serve as a reference to help agencies, tribes, and other interested parties understand Project operations as they relate to terrestrial resources.

1.2 OVERVIEW OF TERRESTRIAL RESOURCES

PacifiCorp is conducting the following nine relicensing studies relating to terrestrial resources:

- Vegetation Cover Type/Wildlife Habitat Inventory and Mapping
- Wetland and Riparian Plant Community Characterization
- Amphibian and Reptile Inventory
- Threatened, Endangered, and Sensitive (TES) Species Inventory
- Wildlife Movement/Connectivity Assessment
- Wildlife Habitat Association Assessment and Synthesis of Existing Wildlife Information
- Noxious Weed Inventory
- Grazing Analysis
- Spring-Associated Mollusk Inventory

The following sections describe the methods and results for each of these studies conducted in the Klamath River terrestrial resources study area (Figure 1.1-1).

Figure 1.1-1. Terrestrial resources study area.

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2.0 VEGETATION COVER TYPE/WILDLIFE HABITAT INVENTORY AND MAPPING

2.1 DESCRIPTION AND PURPOSE

The purpose of this study was to produce a vegetation cover type map for the Klamath River Hydroelectric Project, describe plant communities associated with the Project, and provide information needed to support other relicensing studies. This study produced a vegetation cover type map to meet a license application requirement to describe the existing environment (18 CFR 4.51).

2.2 OBJECTIVES

The objectives of this study were to:

- Provide baseline data on the overall abundance and distribution of the cover types in relationship to the various Project facilities.
- Provide a description of dominant plant species in herb, shrub, and tree layers; tree cover and size; and shrub cover and size in vegetation cover types associated with the Project.
- Collect quantitative data on the species composition and structural characteristics in a sample of cover type polygons to aid in describing the plant communities that are closely associated with the Project and to describe the habitat value for wildlife, particularly those species that are of concern to stakeholders.
- Provide information that, along with results from other studies, can be used to assess the continuing Project impacts on these habitats and identify measures to protect, enhance, and mitigate where necessary.

2.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

The vegetation cover type map delineates existing vegetation cover types/wildlife habitat on study area lands surrounding the Klamath River, and the Project's reservoirs and facilities. The vegetation cover type map can be used to determine how existing habitat conditions influence wildlife presence and distribution in the study area, and which habitat types are affected by Project facilities and operations.

2.4 METHODS AND GEOGRAPHIC SCOPE

The study area included: (1) the Klamath River from the Link River dam to the Shasta River; (2) the area within 0.25 mile of all Project facilities, reservoirs, and river reaches; (3) the land in the Klamath River canyon; and (4) all PacifiCorp land in the area, but outside the 0.25-mile (0.4-km) buffer (Figure 1.1-1). The methods described in the following sections are those presented in the Revised Study Plans that incorporate the comments of the Terrestrial Resources Work Group (TRWG) provided in comment letters and at meetings held on the following dates: January 17, March 28, April 18, April 24, June 6, and July 11, 2002, and August 5 and October 10, 2003.

2.4.1 Vegetation Characterization and Classification System

During the fall and winter of 2001-2002, PacifiCorp developed a vegetation classification system for creating a preliminary vegetation map. This classification system was based on the California Wildlife Habitat Relations System (CWHRS) (Mayer and Laudenslayer, 1988) and the National Wetland Inventory (NWI) (Cowardin et al. 1979) classification schemes. As requested by the TRWG, the system was flexible enough to categorize the vegetation based on the floristics specifically in the study area. At TRWG meetings, the stakeholders made it clear that the vegetation mapping of the Klamath study area should not be "forced" into an existing system because it might not adequately describe the resources.

Table 2.4-1 describes the classification system or scheme that was developed for the study area. This classification scheme has upper level vegetation groupings or habitats (e.g., Upland Tree Habitat, Riparian Habitat, etc.); under each group heading are cover type designations or names that include both vegetated and unvegetated cover types. PacifiCorp used the cover type names to label polygons on the Project vegetation map. The floristic component was assigned to the classification by identifying at least the dominant species in the tallest tree, shrub, or herb layer. For many polygons up to three dominant species were assigned in one or more of each of the tree, shrub, and herb layers in the polygon; typically, these polygons were assigned additional species data based on vegetation sampling described in Section 2.4.4. The classification scheme also included a structural component whereby polygons that are tree- or shrub-dominated are assigned to a size class and age class (Table 2.4-1).

The classification scheme required some modification during fieldwork in 2002. The Douglas-fir *(Pseudotsuga menziesii)* cover type remains a part of the Project classification scheme, but was mapped as Klamath mixed conifer. Pure Douglas-fir stands occur in some parts of the J.C. Boyle peaking reach and bypass reaches, but the proximity of other conifer species typically made delineation of the pure Douglas-fir pockets difficult. The rabbitbrush *(Chrysothamnus)* scrub cover type was added to the classification because of its abundance primarily around Keno reservoir. Also, the wedgeleaf ceanothus *(Ceanothus cuneatus)* cover type was lumped into the mixed chaparral cover type although the dominance of this species was noted in geographic information system (GIS) attributes data whenever there was confirmation that it was one of the dominant shrub layer species in the mixed chaparral cover type.

This Project-based floristic/structural vegetation classification scheme then can be compared with other classification schemes (Federal Geographic Data Committee [FGDC] system; Kovalchik, 1987; Christy, 1993; Sawyer and Keeler-Wolf, 1995) to put the study area into context with habitats and cover types in adjacent regions. A comparison among the different classification schemes is provided in Appendix 2A.

To the extent possible, the vegetation mapping using the Project classification scheme follows guidelines provided by the National Park Service (http://biology.usgs.gov/npsveg/):

- The system must be based on a sound scientific approach that is a logical progression from historical methods.

Table 2.4-1. Upper-level habitats and cover types for the Klamath Hydroelectric Project.[1]

	Cover Type Code
1 UPLAND TREE HABITATS: >10% total cover by tree species[2]	
1a Hardwood: >50 of total tree cover is hardwood	
1a1 Hardwood-Dominated Types: >50% of total cover is hardwood and <25% of total cover is conifer	
Aspen	**ASP**
Montane Hardwood—Black Oak/White Oak	**MHO**
Montane Hardwood—Alder	**MHA**
1a2 Hardwood-Conifer Types: >50% of total cover is hardwood and >25% but <50% of total cover is conifer:	
Montane Hardwood (oak)-Conifer (Ponderosa Pine or Juniper)	**MHOC, MHOJ**
Montane Hardwood (alder)-Conifer (Ponderosa Pine or Juniper)	**MHAC, MHAJ**
1b Conifer: >50% of total tree cover is conifer	
1b1 Single Conifer Species-Dominated Types: >50% of total cover is a single conifer species regardless of the number of conifer species in the overstory and has its own CWHSR habitat type	
Douglas-fir	**DF**
East Side Pine	**EP**
Jeffrey Pine	**JP**
Juniper	**J**
Lodgepole Pine	**LP**
Ponderosa Pine	**PP**
Red Fir	**RF**
White Fir	**WF**
1b2 Mixed Conifer Types: <=50% of total tree cover is a single conifer species,>=two species of conifer occur, and each species occurs in the overstory and has >=5% total cover	
Klamath Mixed Conifer (Douglas-fir/Ponderosa Pine/Incense Cedar/White Fir)	**KMC**
2 UPLAND SHRUB HABITATS: >10% total cover by shrub species and <10% total cover by tree species[2]	
2a Single Shrub Species-Dominated Types: Total cover is dominated (3) by a single shrub species regardless of the number of shrub species in the overstory	
Bitterbrush	**BB**
Low Sagebrush	**LS**
Wedgeleaf Ceanothus	**WC**
Buckbrush Ceanothus	**BC**
Whiteleaf Manzanita	**WM**
Sagebrush	**SB**
Rabbitbrush	**RB**
2b Multiple Shrub Species Types: Total cover is not dominated by a single shrub species and >=two species have >=5% cover	
Alpine Dwarf Shrub	**AD**
Mixed Chaparral	**MXC**
Montane Chaparral	**MC**

Table 2.4-1. Upper-level habitats and cover types for the Klamath Hydroelectric Project.[1]

3	**UPLAND HERBACEOUS HABITATS:** >=2% total cover by herbaceous species and <10% total cover of tree and/or shrub species[2]	
	Annual Grassland	**AGL**
	Perennial Grassland	**PGL**
4	**AGRICULTURAL AND DEVELOPED HABITATS:** >=2% total vegetation cover of non-wildland vegetation[2]	
4a	Agricultural Types: >=2% total vegetation cover of non-wildland plants grown for food/fiber	
	Dryland Grain Crops	**DGC**
	Deciduous Orchard	**DO**
	Irrigated Grain Crop	**IGC**
	Irrigated Row and Field Crops	**IRFC**
	Irrigated Hayfield	**PA**
	Pasture	**PA**
4b	Developed Types: >=2% total vegetation cover of non-wildland plants grown for landscaping	
	Residential	**RES**
	Recreational Development	**REC**
	Industrial	**IND**
5	**RIPARIAN COMMUNITIES** (see note)[2]	
	Riparian Deciduous	**RD**
	Riparian Coniferous	**RC**
	Riparian Mixed Deciduous/Coniferous	**RM**
	Riparian Shrub	**RS**
	Riparian Grass/Forb	**RG**
	Note: Type down to dominant plant species similar to Kovalchik communities or Manual of California Vegetation (MCV) *series.*	
6	**WETLANDS** (see note)[2]	
	Palustrine Emergent Wetland	**PEM**
	Palustrine Scrub-shrub Wetland	**PSS**
	Palustrine Forested Wetland	**PFO**
	Palustrine Aquatic Bed	**PAB**
	Lacustrine Aquatic Bed	**LAB**
	Note: Type down to dominant plant species similar to Christy (1993) communities or MCV series where possible.	
7	**BARREN HABITATS:** <2% total cover by herbaceous, desert, or non-wildland species and <10% cover by tree or shrub species[2]	
	Barren	**BA**
	Exposed Rock/Cliff	**ER**
	Talus	**RT**
8	**AQUATIC HABITATS:** Water dominated with <=2% vegetation cover on shore zone[2]	
	Lacustrine Unconsolidated Bottom--Limnetic	**LUB**
	Lacustrine Unconsolidated Shore--Littoral	**LUS**
	Riverine Unconsolidated Bottom	**RUB**
	Riverine Unconsolidated Shore	**RUS**

Table 2.4-1. Upper-level habitats and cover types for the Klamath Hydroelectric Project.[1]

Modifiers[1]			
Tree Size Class (dbh)	**Tree Canopy Closure**		
Seedling tree--<1”	Sparse cover	10-24%	
Sapling tree--1-6”	Open cover	25-39%	
Pole tree--6-11”	Moderate cover	40-59%	
Small--11-24”	Dense cover	60-100%	
Medium/large-->24”			
Multi-layered canopy (layers present will be noted)			
Shrub Size Class	**Shrub Closure Class**		**Ground Cover**
Seedling shrub	Sparse cover		10-24%
Young shrub	Open cover		25-39%
Mature shrub	Moderate cover		40-59%
Decadent shrub	Dense cover		60-100%
Subgroups from FDGC:			
Natural/seminatural			
Planted/cultivated			

1 Polygons were assigned to a floristic cover type; assigned vegetation modifiers to describe canopy cover, tree size, and shrub cover/size; and consolidated into these upper-level cover type groupings presented in the table.

2 Areas on transmission line rights-of-way (ROW) received a polygon modifier indicating their position on the ROW.

- The approach must be repeatable and based on standard field and data analysis methods.
- The system should be broadly accepted both nationally and internationally.
- The system must classify existing biological associations that repeat across the landscape.
- The classification units must be ecologically meaningful.
- The classification must be mappable from imagery.
- The classification system must be hierarchically organized such that it can be applied at multiple scales.
- The system must identify classification units that are appropriately scaled to meet objectives for biodiversity conservation, as well as resource and ecosystem management needs.
- The system must be flexible and open-ended such that it allows for additions, modifications, and continuous refinement.
- The system must be well documented.
- The system should be able to be translated to other frequently used systems.

2.4.2 Delineate, Verify, and Digitize Plant Communities

During the fall of 2001, PacifiCorp delineated polygons on Mylar overlays registered to: (1) 1:12,000 color aerial photos for the study area upstream of Iron Gate dam taken in 1994; (2) 1:2,400 color infrared photos of the J.C. Boyle bypass and peaking reaches taken in 1999; (3) Oregon State University aerial forward-looking infrared (FLIR) and corresponding natural color video frames of the river downstream of the Iron Gate dam; and (4) U.S. Geological Survey (USGS) digital orthoquads. Polygons were delineated within the effective area of the photos (i.e., portion with minimal radial distortion) with the aid of a stereoscope. The Project-based floristic/structural vegetation classification scheme or key (Table 2.4-1) was used to aid in consistently interpreting polygons. Available maps showing Project facilities, streams, roads, other base map data, soils, and NWI data were used as photo-interpretive aids.

The minimum mapping unit for upland types was approximately 1 acre (0.4 hectare [ha]). More unique types, such as riparian areas and wetlands, were delineated as small as possible (approximately 0.1 acre; 0.4 ha, respectively). Some unique habitats were delineated as linear features (e.g., riparian areas) or points (e.g., springs and caves) rather than as polygons if they were very small or narrow and not adjacent to Project features.

Three biologists spent 1 week in the field verifying polygon delineations in the study area and selected accessible areas beyond the study area. In particular, an effort was made to visit as much of the riparian and wetland habitat as safely possible to verify cover type mapping. Additionally, during various wildlife and botanical surveys conducted during the spring and summer of 2002, PacifiCorp biologists visited many polygons and further confirmed and revised vegetation mapping. Where necessary, polygon designations were modified and vegetation database attributes confirmed.

2.4.3 Compile and Digitize Data

During the winter of 2001-2002, PacifiCorp digitized the preliminary vegetation polygons using ArcView software and developed a GIS database of polygon attributes. To produce an accurate, geographically correct map, the vegetation cover type polygons on the aerial photos were digitized using “heads-up” or “on-screen” digitizing over digital orthophotos (USGS Digital Ortho Quads [DOQs]), Project features (roads, facilities, transmission lines, etc.), streams, NWI, soil survey, and forest/range resource background GIS coverages. The resulting ARC/INFO polygons contain a cover type attribute. GIS coverage was periodically updated as new data became available. Quality control (QC) maps were produced and checked against the aerial photos for data capture/digitizing accuracy.

2.4.4 Characterization Plots

To characterize botanical resources and describe the range of species composition and structural conditions that exist in each cover type, PacifiCorp selected polygons of each cover type to sample. Initially, 326 of the 2,900 polygons in the study area were randomly selected for sampling, stratified by section of the study area and number of polygons of each type present (with greater emphasis on the study area, wetland habitats, and riparian habitats). One revision of the methods compared to the study plan was that the number of plots sampled was reduced on the basis of revised vegetation mapping and access restrictions in the field. The total number of plots sampled was 295, compared to the planned 326 (Table 2.4-2). The Project sections are self-explanatory with the exception of the Iron Gate-Shasta section (the Klamath River reach below Iron Gate dam to the mouth of the Shasta River). The approximate rivermile (RM) for each Project section is as follows:

- Iron Gate-Shasta (IGS) RM 176.8 to 188.9

- Iron Gate reservoir (IG) RM 188.9 to 196.8
- Copco No. 2 bypass (C2) RM 196.8 to 198.7
- Fall Creek (FC) RM 0 to 1.5
- Copco reservoir (CR) RM 198.7 to 203.9
- J.C. Boyle peaking reach (RR) RM 203.9 to 220.2
- J.C. Boyle bypass (JB) RM 220.2 to 224.6
- J.C. Boyle reservoir (JR) RM 224.6 to 228.2
- Keno Canyon (KC) RM 228.2 to 233.3
- Keno reservoir (KR) RM 233.3 to 253.3
- Link River (LiR) RM 253.3 to 254.8

During August and September 2002, PacifiCorp botanists placed one circular 4,305 foot^2 (400 meters^2 [m^2]) plot in a representative location (as requested by the TRWG) within each selected polygon; plot shape was modified occasionally to fit smaller polygons (e.g., wetlands and riparian vegetation). At each plot, biologists visually estimated vegetation data. The types of data collected in each plot included areal foliar cover by cover class for each species in each of the vegetation layers (i.e., tree, shrub, and herb layer); the areal cover and height of each vegetation layer in the plot; the aspect; and the slope. The number of living trees was tallied and the tree diameters at breast height (dbh) were recorded. The amount of dead wood in the plot was assessed by collecting data on coarse woody debris (CWD), snags, and wood cover for pieces greater than 4 inches (10 centimeters [cm]) in diameter. Some general observations were made concerning how erosion, livestock, and recreation might be affecting habitat in the study area and which effects might be the result of Project operations. Substrate conditions were not assessed using USGS data as originally intended. The substrate maps provided by the USGS were generally too coarse, and the substrate type descriptions were too generalized to provide reliable data for the individual sample sites.

The data collection effort for the vegetation characterization began on August 11, 2002, and continued through August 22, 2002. During this period, data were collected at 244 plots throughout the study area. The remaining 51 plots were sampled September 9 to 13, 2002.

Analysis consisted of summarizing data with descriptive statistics and using GIS to calculate summary information. Data analyses were completed using Excel (Microsoft Inc.) and Statistix 7.0 software (Analytical Software). Twinspan was used to aid in identifying species groups within each section (Hill, 1979).

Table 2.4-2. Total number of vegetation plots sampled by cover type and section.

Cover Type	Iron Gate-Shasta	Iron Gate Reservoir	Copco No. 2 Bypass	Copco Reservoir	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Reservoir	Keno Canyon	Keno Reservoir	Link River	Total
Upland Tree Habitats												
Deciduous Forest												
Montane Hardwood-Oak	2	4	2	7	1	8	1					25
Deciduous/Conifer Forest												
Montane Hardwood-Oak/Conifer			2	1	3	10	1					17
Montane Hardwood-Oak/Juniper	1	5	4	2	1	6	1					20
Conifer Forest												
Ponderosa Pine						2	4	5	2	1		14
Lodgepole Pine							1					1
Juniper		2	1	1		3	2			1	1	11
Klamath Mixed Conifer				1		1	3	1				6
Upland Shrub Habitats												
Rabbitbrush										1	1	2
Sagebrush								3		1		4
Mixed Chaparral	4	3	2	4	2	6	3	2	3		1	30
Upland Herbaceous Habitats												
Annual Grassland	1	4	1	6	2	5	1			1		21
Perennial Grassland					1	4	2	1		5		13
Agriculture and Developed												
Irrigated Hayfield/Pasture	1			1		4				3		9
Wetland												
Emergent Wetland		3	1	5	2	6		2		6		25
Forested Wetland		9	2	7				1		1		20
Palustrine Scrub-Shrub Wetland		6		2	3			4		1		16
Riparian Habitats												
Riparian Deciduous	5		3		1	8					2	19
Riparian Grassland	2					4			4		2	12
Riparian Mixed Deciduous/Coniferous					4	1						5
Riparian Shrub	4					1	3		2		3	13
Barren Habitats												
Talus			0	1		3						4
Exposed Rock		1	1	1	1	1	1	0				6
Aquatic Habitats												
Riverine Unconsolidated Shore	2											2

Table 2.4-2. Total number of vegetation plots sampled by cover type and section.

Cover Type	Iron Gate-Shasta	Iron Gate Reservoir	Copco No. 2 Bypass	Copco Reservoir	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Reservoir	Keno Canyon	Keno Reservoir	Link River	Total
Grand Total	**22**	**37**	**19**	**39**	**21**	**73**	**23**	**19**	**11**	**21**	**10**	**295**

2.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

A vegetation cover type map is a FERC license application requirement (18 CFR 16.4.51). This study will aid PacifiCorp in addressing agency/stakeholder management objectives and resource issues related to botanical and terrestrial resources. Together with the wetland and riparian plant community characterization in Study Plan 2.2, this study will provide information needed by the U.S. Bureau of Land Management (BLM) to: (1) assess compliance with Aquatic Conservation Strategy (ACS) objectives under the Northwest Forest Plan Record of Decision (USFS and BLM, 1994, 2000, and 2001); (2) protect and manage BLM Sensitive and Survey and Manage (S/M) species; and (3) evaluate potential natural communities. The information also will be used in the license application to identify PM&E measures potentially needed for the protection of wildlife habitat affected by the Project. PacifiCorp will address potential effects to vegetation resources and wildlife habitat identified in the following regulations and resource agency management plans:

- Federal and state Endangered Species Act (ESA) regulations
- BLM Klamath Falls and Redding Resource Management Plans
- U.S. Forest Service (USFS) Land and Resource Management Plans
- USFS and BLM Northwest Forest Plan
- Oregon Department of Fish and Wildlife (ODFW) Fish and Wildlife Habitat Mitigation Policy
- Oregon Wildlife Diversity Plan
- ODFW Klamath Basin Fish Management Plan
- California Department of Fish and Game (CDFG) Management Goals

2.6 TECHNICAL WORK GROUP COLLABORATION

Work group meetings with stakeholders were held on January 17, March 28, April 18, June 6, and July 11, 2002, and February 6, 2003. At each of these meetings, PacifiCorp received comments that have been incorporated into the Final Study Plan.

2.7 STUDY OBSERVATIONS AND FINDINGS

The observations and findings of this study are presented in four sections: 2.7.1, Cover Type Mapping; 2.7.2, Vegetation Characterization; 2.7.3, Coarse Wood, Snags, and Small Wood Cover; and 2.7.4, Grazing, Recreation and Erosion.

2.7.1 Cover Type Mapping

The Project cover type map covers approximately 52,870 acres (21,451 ha) and presents 3,145 polygons grouped into 31 cover types (Figure 2.7-1). The 31 cover types primarily follow the Project classification scheme (Table 2.4-1).

The GIS database associated with the cover type map was updated to include the following attribute information: cover type labels; dominant plant species in the herb, shrub, and tree layers; tree cover and size; and shrub cover and size. Table 2.7-1 summarizes the degree to which GIS attribute data were recorded for polygons that have vegetation cover. The types of attributes discussed include the distribution of large diameter trees, the presence and distribution of wedgeleaf ceanothus and birchleaf mountain mahogany (*Cercocarpus betuloides*) in upland habitats, the presence and distribution of reed canarygrass (*Phalaris arundinacea*) in riparian areas and the dominance and distribution of Douglas-fir and ponderosa pine (*Pinus ponderosa*) in montane hardwood oak-conifer stands, Klamath mixed-conifer stands, and ponderosa pine stands.

The acreage for the cover types and the relative cover (percent) of each habitat type that occurs within each Project section are provided in Table 2.7-2. Approximately 54 percent or 28,317 acres (11,470 ha) of the study area was mapped as one of the forested cover types within the upland tree habitat. There are several other upper level habitat types that range in relative cover from 9.2 to 10.9 percent of the study area; these include upland shrub (5,042 acres [2,042 ha]), upland herbaceous (4,841 acres [1,961 ha]), agricultural (5,746 acres [2,327 ha]), and aquatic (5,077 acres [2,056]) habitats. Riparian communities (598 acres [242 ha]), wetlands (2,238 acres [907 ha]), and barren habitats (1,003 acres [406 ha]) are the least abundant upper level habitat types.

When comparing Project sections using cover type area, keep in mind that the Project sections have different sizes and shapes. For example, the Iron Gate-Shasta study section is narrower than most other sections and excludes many wooded and forested slopes, ravines and valleys found in other, wider Project river sections. Thus, the relative cover of upland tree-dominated stands would be under-represented, while riparian types make up a larger percentage. Similarly, the Link River is a small Project section with less acreage of all cover types. One should keep these examples in mind during the following comparisons.

Figure 2.7-1. Vegetation cover and sampling locations.

Eighteen 11X17 Maps – INSERT HERE

Figure 2.7-1 page 1

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Upland tree dominated stands occupy the greatest percentage of area (42 to 78 percent) in all sections except in Keno reservoir and the Iron Gate-Shasta section. The upland shrub cover type group has the smallest range in relative cover between Project sections, from a low of 7 percent or 478 acres (194 ha) around Iron Gate reservoir to 21 percent or 252 acres (102 ha) acres around Copco reservoir. The upland herbaceous habitat type is common along the Iron Gate-Shasta section, Iron Gate reservoir, and Copco reservoir, with relative coverage ranging from 16 to 26 percent. All other sections have less than 10 percent relative cover of upland herbaceous cover types.

Table 2.7-1. Number of polygons and percent of GIS polygon attribute data cells filled for the vegetation cover types.

Cover Types	Number of Polygons	GIS Attributes (%)									
		Tree Cover	Tree Size	Shrub Cover	Shrub Size	Tree Layer 1 Species	Tree Layer 2 Species	Shrub Layer 1 Species	Shrub Layer 2 Species	Herb Layer 1 Species	Herb Layer 2 Species
Upland Tree Habitats											
Montane Oak	270	97.4	96.3	43.3	44.8	99.3	22.2	46.7	24.4	64.1	62.2
Oak-Conifer	245	99.6	100	23.3	24.1	100	98.4	47.3	29.8	36.3	33.9
Oak-Juniper	233	95.3	95.7	35.6	36.5	98.7	95.7	53.6	24.9	48.5	48.1
Juniper	51	100	98	43.1	37.3	98	39.2	49	25.5	62.7	54.9
Mixed Conifer	32	81.3	81.3	28.1	25	59.4	59.4	43.8	25	43.8	34.4
Lodgepole Pine	2	0	100	0	0	0	0	0	0	0	0
Ponderosa Pine	110	100	100	51.8	46.4	100	19.1	72.7	31.8	77.3	75.5
Upland Shrub Habitats											
Mixed Chaparral	367	10.9	18.3	95.6	76.6	34.9	10.6	96.7	46.6	52	50.4
Rabbitbrush	19	0	5.3	73.7	63.2	5.3	0	100	10.5	94.7	100
Sagebrush	11	9.1	18.2	100	100	27.3	0	100	100	100	90.9
Upland Herb Habitats											
Annual Grassland	406	4.4	5.7	5.4	6.9	11.8	2.2	11.3	3	70.4	64.5
Perennial Grassland	55	1.8	5.5	1.8	1.8	5.5	0	16.4	14.5	70.9	65.5
Wetland Habitats											
Palustrine Emergent	223	0	0.9	0.9	2.2	1.3	0.4	7.6	7.2	53.4	48.9
Palustrine Shrub	58	48.3	50	81	79.3	53.4	5.2	84.5	31	84.5	79.3
Palustrine Forest	39	92.3	92.3	74.4	74.4	97.4	82.1	84.6	59	92.3	84.6
Riparian Habitats											
Riparian Grassland	116	1.7	1.7	8.6	12.1	3.4	0	25.9	2.6	87.9	29.3
Riparian Shrub	161	20.5	21.7	91.9	85.7	29.8	11.2	90.7	27.3	26.7	18
Riparian Deciduous	161	95.7	95.7	57.8	57.1	95	87	65.2	32.9	37.9	28.6
Riparian Mixed	13	92.3	100	61.5	61.5	100	84.6	76.9	76.9	69.2	61.5

GIS = Geographic information system.

Table 2.7-2. Acreage of cover types in each Project section of the Klamath River Hydroelectric Project study area.

	Project Section											
Cover Type	**Iron Gate-Shasta**	**Iron Gate Reservoir**	**Copco No. 2 Bypass**	**Fall Creek**	**Copco Reservoir**	**J.C. Boyle Peaking Reach**	**J.C. Boyle Bypass**	**J.C. Boyle Reservoir**	**Keno Canyon**	**Keno Reservoir**	**Link River**	**Grand Total**
Upland Tree Habitat												
Juniper	1.0	463.5	22.5	21.4	27.6	212.5	132.4			150.0	237.3	1,268.3
Mixed Conifer					8.8	98.4	581.6	10.8	134.0			833.5
Lodgepole Pine							55.2	9.2				64.4
Montane Hardwood Oak	101.1	1,424.4	162.8	88.0	1,254.9	1,971.8	68.0					5,070.8
Montane Hardwood Oak - Conifer			257.1	387.4	585.4	7,374.3	34.2					8,638.4
Montane Hardwood Oak - Juniper	33.0	1,584.6	196.2	195.3	1,282.3	5,619.5	57.4					8,968.1
Ponderosa Pine			75.8			124.4	536.4	1,116.8	1,465.4	154.6		3,473.4
Subtotal	**135.1**	**3,472.5**	**714.4**	**692.1**	**3,159.0**	**15,400.9**	**1,465.2**	**1,136.8**	**1,599.4**	**304.6**	**237.3**	**28,316.9**
Percent of section	**9.7%**	**52.7%**	**59.4%**	**74.6%**	**51.2%**	**75.3%**	**70.6%**	**59.1%**	**78.0%**	**3.2%**	**42.2%**	**53.6%**
Upland Shrub Habitat												
Mixed Chaparral	205.8	478.4	251.7	102.6	791.2	1,851.2	285.9	47.5	257.0	35.5	88.7	4,395.5
Rabbitbrush									2.3	536.2		538.4
Sagebrush								72.5		35.8		108.3
Subtotal	**205.8**	**478.4**	**251.7**	**102.6**	**791.2**	**1,851.2**	**285.9**	**120.0**	**259.3**	**607.5**	**88.7**	**5,042.2**
Percent of section	**14.8%**	**7.3%**	**20.9%**	**11.1%**	**12.8%**	**9.1%**	**13.8%**	**6.2%**	**12.6%**	**6.4%**	**15.8%**	**9.5%**
Upland Herbaceous Habitat												
Annual Grassland	353.5	1,381.1	80.4	27.8	962.5	1,624.2	12.9			32.3		4,474.6
Perennial Grassland		2.7		0.9		51.6	96.7	171.6	24.7	14.5	3.4	366.0
Subtotal	**353.5**	**1,383.8**	**80.4**	**28.7**	**962.5**	**1,675.8**	**109.6**	**171.6**	**24.7**	**46.8**	**3.4**	**4,840.6**
Percent of section	**25.5%**	**21.0%**	**6.7%**	**3.1%**	**15.6%**	**8.2%**	**5.3%**	**8.9%**	**1.2%**	**0.5%**	**0.6%**	**9.2%**
Wetland Habitat												
Palustrine Aquatic Bed		0.9		0.6		0.1		37.6		254.1		293.3
Palustrine Emergent	0.4	11.2	1.4	8.0	18.9	89.8	8.3	63.2	5.1	1,589.4	0.2	1,795.9
Palustrine Forested		38.8	3.1	2.2	57.1		5.0			9.5	2.9	118.6
Palustrine Scrub-Shrub	0.2	9.2		2.7	3.2		0.8	4.2		7.8	2.5	30.6
Subtotal	**0.6**	**60.1**	**4.5**	**13.5**	**79.2**	**89.9**	**14.1**	**105.1**	**5.1**	**1,860.8**	**5.6**	**2,238.5**

Table 2.7-2. Acreage of cover types in each Project section of the Klamath River Hydroelectric Project study area.

Cover Type	Project Section											
	Iron Gate-Shasta	**Iron Gate Reservoir**	**Copco No. 2 Bypass**	**Fall Creek**	**Copco Reservoir**	**J.C. Boyle Peaking Reach**	**J.C. Boyle Bypass**	**J.C. Boyle Reservoir**	**Keno Canyon**	**Keno Reservoir**	**Link River**	**Grand Total**
Percent of section	**0.0%**	**0.9%**	**0.4%**	**1.5%**	**1.3%**	**0.4%**	**0.7%**	**5.5%**	**0.2%**	**19.5%**	**1.0%**	**4.2%**
Aquatic Habitat												
Lacustrine Unconsolidated Bottom		940.5	5.3	0.8	999.5	4.6	0.0	299.4		2,072.8	10.6	4,333.5
Lacustrine Unconsolidated Shore		6.3									2.5	8.8
Riverine Unconsolidated Bottom	214.6	18.1	4.7	0.1		269.9	43.7		92.3	63.8	19.2	726.4
Riverine Unconsolidated Shore	3.9				0.1	2.6	1.8					8.4
Subtotal	**218.5**	**964.9**	**10.0**	**0.9**	**999.6**	**277.1**	**45.5**	**299.4**	**92.3**	**2,136.6**	**32.3**	**5077.1**
Percent of section	**15.8%**	**14.7%**	**0.8%**	**0.1%**	**16.2%**	**1.4%**	**2.2%**	**15.6%**	**4.5%**	**22.4%**	**5.7%**	**9.6%**
Riparian Habitat												
Riparian Deciduous	87.9	40.3	23.1	2.1	20.6	170.0	0.5			0.8	19.8	365.1
Riparian Grassland	6.9	0.0			2.2	13.8	20.2	0.4	13.4		2.7	59.6
Riparian Mixed				37.8	1.9	12.0						51.7
Riparian Shrub	56.3	1.5			0.9	32.5	11.4	0.4	6.9		11.3	121.1
Subtotal	**151.1**	**41.8**	**23.1**	**39.9**	**25.6**	**228.3**	**32.1**	**0.8**	**20.3**	**0.8**	**33.9**	**597.5**
Percent of section	**10.9%**	**0.6%**	**1.9%**	**4.3%**	**0.4%**	**1.2%**	**1.6%**	**0.0%**	**1.0%**	**0.0%**	**6.0%**	**1.1%**
Barren Habitat												
Rock Talus	5.6	35.8	14.5		47.2	428.8	27.5					559.3
Exposed Rock	11.8	27.3	68.1	38.3	14.2	116.2	68.5	10.2	12.3			366.9
Subtotal	**17.4**	**63.1**	**82.6**	**38.3**	**61.4**	**545.0**	**96.0**	**10.2**	**12.3**	**0.0**	**0.0**	**926.2**
Percent of section	**1.3%**	**1.0%**	**6.9%**	**4.1%**	**1.0%**	**2.7%**	**4.6%**	**0.5%**	**0.6%**	**0.0%**	**0.0%**	**1.7%**
Agricultural/Developed												
Developed/Residential	89.9	44.3	1.4	0.6	79.0	11.3	4.9	0.5	18.5	696.4	152.2	1,099.0
Barren-Disturbed	18.9	20.4	2.0	0.0	3.0	2.2	10.0	6.0		6.5	7.8	76.8
Industrial		27.9	32.1	11.1	0.0		12.6	1.8	4.7	640.1	1.0	731.3
Pasture/Irrigated Hayfield	164.2				13.7	365.6				3,138.9		3,682.4
Recreation	31.4	27.7			0.6	0.5	0.5	72.4	14.0	93.9		241.0
Subtotal	**304.4**	**120.3**	**35.5**	**11.7**	**96.3**	**379.6**	**28.0**	**80.7**	**37.2**	**4,575.8**	**161.0**	**5,830.5**

Table 2.7-2. Acreage of cover types in each Project section of the Klamath River Hydroelectric Project study area.

Cover Type	Project Section											
	Iron Gate-Shasta	**Iron Gate Reservoir**	**Copco No. 2 Bypass**	**Fall Creek**	**Copco Reservoir**	**J.C. Boyle Peaking Reach**	**J.C. Boyle Bypass**	**J.C. Boyle Reservoir**	**Keno Canyon**	**Keno Reservoir**	**Link River**	**Grand Total**
Percent of section	**22.0%**	**1.8%**	**3.0%**	**1.3%**	**1.6%**	**1.8%**	**1.3%**	**4.2%**	**1.8%**	**48.0%**	**28.6%**	**11.0%**
Totals Acres	**1,386.4**	**6,585.1**	**1,202.2**	**927.7**	**6,174.7**	**20,447.8**	**2,076.1**	**1,924.5**	**2,050.6**	**9,532.9**	**562.1**	**52,869.5**

The relative cover of agricultural habitat (excluding general grazing allotment areas) is more than 20 percent in the Iron Gate-Shasta section (285.5 acres [116 ha]), Keno reservoir (4,569 acres [1,851 ha]), and Link River (153.2 acres [62 ha]) sections. The relative cover of agricultural land use is less than 2 percent in all other Project sections. However, the agricultural cover type is still fairly abundant in the J.C. Boyle peaking reach (370 acres [150 ha]), Copco reservoir (93 acres [38 ha]), and Iron Gate reservoir (100 acres [41 ha]) sections. In these sections, agricultural land uses are generally under-represented on the Project map because they do not include long-established grazing allotments that occur in nearly every section.

The relative and absolute cover of wetlands is greatest around Keno reservoir, with nearly 20 percent or 1,861 acres (754 ha) of wetland habitat around the reservoir. The relative cover of wetland cover types in the other Project sections ranges from 0.2 percent or 5.1 acres (2.1 ha) in Keno Canyon to 5.5 percent or 105 acres (43 ha) at J.C. Boyle reservoir.

Project reservoirs account for the majority of aquatic habitats, while river reaches account for relatively small amounts of aquatic habitat.

The acreage of the Project cover types is summarized for the 11 Project sections in Table 2.7-2.

2.7.2 Vegetation Characterization

The vegetation characterization data summarized below are based on plot data collected in 295 stands or sample sites distributed among 23 cover types and 11 Project sections (Table 2.4-2; Figure 2.7-1). Each cover type is discussed in the context of its distribution among the Project sections. The cover type descriptions include: plant species composition and abundance; stand structure, as depicted by the areal cover and height measurements of the vegetation layer(s) and tree tally data; small woody debris cover; and coarse or large wood and snag data (see Section 2.7.3 for discussion of snags and logs). The areal cover of species and vegetation layers often is expressed as “cover” in the following descriptions. The percent frequency or constancy is used to describe the number of times a species occurs within a Project section or within a cover type. Many of the comparisons in the descriptions below are between species presence determined from different sample sizes. For some variables, there was only one sample taken; to make comparisons easier or more fluid, values based on a sample size of one sometimes are referred to as an average value. Please refer to the appendices or to tables for information on sample size and standard deviations of means. The plant species composition and cover/abundance data for each cover type are summarized in more detail in Appendix 2B. The summary of the remaining cover type descriptors is located in Appendix 2C. Tables 2.7-3, 2.7-4, and 2.7-5 refer to shrub and tree layer heights and cover for vegetation types described in the following sections. Scientific names for plants and their associated codes used throughout this FTR are provided in Appendix 2B.

2.7.2.1 Upland Tree Habitats

The following sections summarize the various upland tree habitat types.

Montane Hardwood Oak (MHO)

The MHO vegetation type is distributed over 5,071 acres (2,054 ha) or 9.6 percent of the study area (Table 2.7-2; Figure 2.7-1), from the confluence of the Klamath and Shasta rivers to the downstream parts of the J.C. Boyle bypass. The MHO cover type is most abundant around Iron Gate reservoir, Copco reservoir, and in the J.C. Boyle peaking reach. The MHO polygon size averaged 19.6 ± 74.3 acres (7.9 ± 30.1 ha). Most of the MHO occurs intermixed with MHOC, MHOJ, and AGL in highly complex mosaics that vary with slope, aspect, and soil conditions.

In total, nine tree, 16 shrub, and 109 herbaceous plant species were documented in the 25 MHO plots sampled in 2002. The average cover and height of the herb, shrub and tree layer(s) for each cover type are provided in Tables 2.7-3 through 2.7-5. The average cover and height of the herb, shrub, and tree layer(s) in each Project section are discussed below. The complete treatment of averages and standard deviations cover and height data can be found in Appendix 2C.

Tree cover averaged 53.1 ± 23.6 percent (Table 2.7-5). Oregon oak (*Quercus garryana*) is most often the only species in the tree layer. The areal cover for the Oregon oak tree layer in sampled stands ranged from 15 percent in Fall Creek to nearly 70 percent around Copco reservoir. Oak tree heights ranged from 19.7 feet (6.0 meters [m]) to 26.2 feet (8.0 m) in Fall Creek and J.C. Boyle bypass, respectively, to 44.3 feet (13.5 m) along the Iron Gate-Shasta section.

In two sampled MHO stands in the J.C. Boyle peaking reach, there was a sparse, taller tree layer that included ponderosa pine and Douglas-fir. Western juniper (*Juniperus occidentalis*) is frequently found in or near MHO stands throughout the study area (see Montane hardwood oak/juniper). Black oak (*Quercus kelloggii*) is present in more mesic MHO stands in the J.C. Boyle peaking reach and near Copco reservoir.

The tree tally data (Appendix 2C) revealed average tree diameters ranging from 7.1 inches (15.1 cm) in Fall Creek to 14.7 inches (31.2 cm) along the Iron Gate-Shasta section. The basal area averages for Project sections ranged from 23 feet^2/acre (5 m^2/ha) in the J.C. Boyle bypass to 108 feet^2/acre (25 m^2/ha) in the Copco No. 2 bypass. The average basal area per plot was 82.6 ± 38.9 feet^2/acre (19 ± 8.9 m^2/ha). MHO stands averaged 194 ± 113 trees per acre.

The shrub layer species composition varies somewhat erratically by Project section. Western juniper occurs as a shrub layer component in all but the J.C. Boyle bypass and Fall Creek sections. Overall, western juniper is the most frequent (40 percent) shrub layer species in sampled MHO stands. Oregon oak saplings had an overall frequency of 28 percent and occurred in sampled stands in four sections: Iron Gate reservoir (25 percent), Copco reservoir (14 percent), J.C. Boyle peaking reach (50 percent), and in the one sampled stand in J.C. Boyle bypass. Three-leaf sumac (*Rhus trilobata*) is present in 100 percent of the Iron Gate-Shasta section, 75 percent of Iron Gate reservoir, and 13 percent of the J.C. Boyle peaking reach stands. Deerbrush (*Ceanothus integerrimus*) is present in the Copco reservoir (14 percent) and J.C. Boyle peaking reach (25 percent) sections. Birchleaf mountain mahogany (*Cercocarpus betuloides*) is present in the MHO stands with rocky substrate in the Copco No. 2 bypass (50 percent) and J.C. Boyle peaking reach (25 percent) sections. Oregon ash (*Fraxinus latifolia*) is present in mesic stands in proximity to Copco and Iron Gate reservoirs. Wedgeleaf ceanothus occurs in 50 percent of the Iron Gate-Shasta section MHO stands. Copco reservoir, Copco No. 2 bypass, and Fall Creek each had one sampled stand with no shrub layer.

Table 2.7-3. Herbaceous vegetation cover (%) and height (feet) in each cover type.

		Herb Layer 1 Cover (%)			Herb Layer 2 Cover (%)		Total Herb Cover (%)		Herb Layer 1 Height (feet)		Herb Layer 2 Height (feet)	
	N	Mean	Standard Deviation	N	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Upland Tree Habitats												
Montane Hardwood Oak	25	54.9	22.9				54.9	22.9	1.4	0.5		
Oak-Conifer	17	31.6	23.5				31.6	23.5	1.4	0.7		
Oak-Juniper	20	66.4	17.6				66.4	17.6	1.2	0.6		
Juniper	11	52.3	22.6				52.3	22.6	1.2	0.8		
Mixed Conifer	6	21.4	22.2				21.4	22.2	1	0.5		
Lodgepole Pine	1	80	--				80		1			
Ponderosa Pine	14	29.9	21.3				29.9	21.3	1.6	0.9		
Upland Shrub Habitat												
Mixed Chaparral	30	59.6	24.9				59.6	24.9	1.2	0.6		
Rabbitbrush	2	60	7.1				60	7.1	1.3	0.5		
Sagebrush	4	19.3	9.8				19.3	9.8	1	0.3		
Upland Herb Habitats												
Annual Grassland	21	93	7.8				93	7.8	1.8	0.9		
Perennial Grassland	13	76.5	22.9	1	50	13.9	80.4	22.2	1.7	0.8	0.7	
Wetland Habitats												
Palustrine Emergent	25	93.6	11.1	4	27.5	33	98	17.3	3.4	2.1	7.5	1.5
Palustrine Shrub	16	53.4	34.5				53.4	34.5	2.7	1.9		
Palustrine Forest	20	59.9	28.3				59.9	28.3	2.8	2.8		
Riparian Habitats												
Riparian Grassland	12	89.3	13.1				89.3	13.1	4.5	2.6		
Riparian Shrub	13	62.2	29.5				62.2	29.5	3.8	2.2		
Riparian Deciduous	19	34.9	21.8	1	1		34.9	21.7	2.8	1.6	8.2	
Riparian Mixed	5	29	30.7				29	30.7	2.2	0.5		
Barren Habitats												
Rock Talus	4	7	12				7	12	0.8	0.7		
Exposed Rock	6	35	23.9				35	23.9	1.2	0.3		
Aquatic Habitats												
Riverine Unconsolidated Bottom	2	22.5	10.6				22.5	10.6	1.8	2.1		
Agriculture/Developed												
Pasture-Irrigated Hayfield	9	82.7	28.3	1	90	30	92.7	8.2	1.9	1.4	0.3	
Total	**295**	**59.3**	**31.2**	**7**	**35.9**	**36.3**	**60.1**	**31.9**	**2.1**	**1.7**	**5.6**	**3.6**

Table 2.7-4. Shrub cover (%) and height (feet) in each cover type.

	Shrub Layer 1 Cover (%)			Shrub Layer 2 Cover (%)			Total Shrub Cover (%)			Shrub Layer 1 Height (feet)			Shrub Layer 2 Height (feet)		
Cover Type	**N**	**Mean**	**Standard Deviation**	**N**	**Mean**	**Standard Deviation**	**N**	**Mean**	**Standard Deviation**	**N**	**Mean**	**Standard Deviation**	**N**	**Mean**	**Standard Deviation**
Upland Tree Habitats															
Montane Hardwood Oak	25	19.7	23.9				25	19.7	23.9	22	4.2	3.9			
Oak-Conifer	17	13.4	16.2	3	4	1.7	17	14.1	16.6	14	3.5	1.8	3	7.7	4.7
Oak-Juniper	20	15.9	16.1				20	15.9	16.1	20	3.2	1.7			
Juniper	11	24.8	24.2				11	24.8	24.2	9	5.1	3.4			
Mixed Conifer	6	24.3	16.9	1	15		6	26.8	16.3	6	4.1	1.8	1	8.2	
Lodgepole Pine	1	5					1	5		1	4.9				
Ponderosa Pine	14	18.9	13.2	2	2	2.8	14	19.1	13.1	14	3.5	2.1	1	8.2	
Upland Shrub Habitat															
Mixed Chaparral	30	48.3	23.7	4	21.3	4.8	30	51.2	23.8	30	4.8	1.6	4	11.5	4
Rabbitbrush	2	55	14.1				2	55	14.1	2	3.4	2.1			
Sagebrush	4	55	28				4	55	28	4	3.1	0.7			
Upland Herb Habitats															
Annual Grassland	21	0.7	2.2				21	0.7	2.2	6	3.8	0.8			
Perennial Grassland	13	1.8	5.5				13	1.8	5.5	4	3	1.8			
Wetland Habitats															
Palustrine Emergent	25	0.2	1				25	0.2	1	1	6.6				
Palustrine Shrub	16	43.8	36	5	38.8	31.8	16	55.9	44.7	16	8.3	4.5	5	16.1	1.8
Palustrine Forest	20	35.1	22.7				20	35.1	22.7	18	5.7	3.6			
Riparian Habitats															
Riparian Grassland	12	1.8	2.1				12	1.8	2.1	7	8.2	4.8			
Riparian Shrub	13	65.8	16.4				13	65.8	16.4	13	10.9	4.1			
Riparian Deciduous	19	51.2	28.1	2	42.5	53	19	55.6	25.8	19	8.1	10.3	2	11.5	2.3
Riparian Mixed	5	54	19.8				5	54	19.8	5	4.7	1.4			
Barren Habitats															
Rock Talus	4	13.8	10.9				4	13.8	10.9	4	4.6	1.6			
Exposed Rock	6	22	16.1				6	22	16.1	6	4.1	1.6			
Aquatic Habitats															
Riverine Unconsolidated Bottom	2	20	14.1				2	20	14.1	2	6.6	2.3			
Agriculture/Developed															
Pasture-Irrigated Hayfield	9	0	0				9	0	0						
Total	**295**	**24.7**	**27.5**	**17**	**23.2**	**26.2**	**295**	**26.1**	**29.1**	**223**	**5.4**	**4.5**	**16**	**11.8**	**4.3**

Table 2.7-5. Tree cover (%) and height (feet) in each cover type.

Cover Type	Tree Layer 1 Cover (%)			Tree Layer 2 Cover (%)			Total Tree Cover (%)			Tree Layer 1 Height (feet)			Tree Layer 2 Height (feet)		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation	N	Mean	Standard Deviation	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Upland Tree Habitats															
Montane Hardwood Oak	25	53.1	23.6	2	2	0	25	53.2	23.6	25	37.3	16.5	2	72.2	23.2
Oak-Conifer	17	40.1	18.4	14	31.4	22.2	17	65.9	30.6	17	38.9	13.1	14	76.4	23.9
Oak-Juniper	20	38.2	20.2	6	23	18.9	20	45.1	20.5	20	33.1	9.6	6	38.3	9
Juniper	11	20.3	19.9	2	6	1.4	11	21.4	20.2	11	31.5	13.9	2	57.4	11.6
Mixed Conifer	6	52.5	18.9	3	31.7	20.2	6	68.3	11.3	6	49.2	19.9	3	131.2	16.4
Lodgepole Pine	1	10					1	10		1	16.4				
Ponderosa Pine	14	40.1	26.6	2	62.5	3.5	14	49.1	21.7	14	65.9	28.5	2	90.2	20.9
Upland Shrub Habitat															
Mixed Chaparral	30	2.1	5.2				30	2.1	5.2	10	26.2	25.6			
Rabbitbrush	2	0	0				2	0	0						
Sagebrush	4	0	0				4	0	0						
Upland Herb Habitats															
Annual Grassland	21	0.2	0.6				21	0.2	0.6	2	32.8	13.9			
Perennial Grassland	13	0	0	1	0		13	0	0						
Wetland Habitats															
Palustrine Emergent	25	0	0				25	0	0						
Palustrine Shrub	16	36.8	39.5				16	36.8	39.5	14	32.2	14.1			
Palustrine Forest	20	61.5	22.8	3	28.3	10.4	20	65.8	22.7	20	36.9	14.7	3	19.7	5.7
Riparian Habitats															
Riparian Grassland	12	0	0				12	0	0						
Riparian Shrub	13	6.8	10.1				13	6.8	10.1	8	21.1	3.4			
Riparian Deciduous	19	54.2	25.6	2	7.5	3.5	19	54.9	26.3	19	47.7	16.9	2	78.7	4.6
Riparian Mixed	5	46	18.2	4	43.3	36.4	5	80.6	22.3	5	34.1	8.2	4	65.6	9.3
Barren Habitats															
Rock Talus	4	5.3	9.8				4	5.3	9.8	2	21.3	2.3			
Exposed Rock	6	2.8	6				6	2.8	6	2	25.4	5.8			
Aquatic Habitats															
Riverine Unconsolidated Bottom	2	0	0				2	0	0						
Agriculture/Developed															
Pasture-Irrigated Hayfield	9	0	0				9	0	0						
Total	**295**	**24.2**	**29.3**	**39**	**27.9**	**23.4**	**295**	**27.9**	**32.9**	**176**	**38**	**19.1**	**38**	**68.7**	**31.4**

Excluding Fall Creek and J.C. Boyle bypass, the average shrub layer areal cover is variable, ranging from 2 percent cover in Copco No. 2 bypass to 33 percent cover in the Iron Gate-Shasta section, although overall it averaged 19.7 ± 23.9 percent (Table 2.7-4). The minimum shrub cover varied from 0 to 5 percent and the maximum cover ranged from 30 to 70 percent. J.C. Boyle bypass had an unusually high shrub layer cover of 60 percent, while Fall Creek had no shrub layer cover. Only one stand was sampled in the latter two Project sections.

Shrub layer height averaged 4.2 ± 3.9 feet (1.2 ± 1.2 m) (Table 2.7-4), ranging from 2.3 feet (0.7 m) at Iron Gate reservoir to 16.4 feet (95.0 m) in J.C. Boyle bypass. The tallest shrub layers in MHO stands typically have one or more components of birchleaf mountain mahogany, Oregon oak saplings, and western juniper saplings.

The herb layer in MHO plots had an average cover of 54.9 ± 22.9 percent (Table 2.7-3). A core group of species with more than 40 percent but less than 68 percent overall frequency included: Oregon oak, bulbous bluegrass (*Poa bulbosa*), hairy brome (*Bromus japonicus*), hedge parsley (*Torilis nodosa*), Idaho fescue (*Festuca idahoensis*), blue wildrye (*Elymus glaucus*), and cheatgrass (*Bromus tectorum*). The invasive/exotic species yellow starthistle (*Centaurea solstitialis*) and medusahead (*Taeniatherum caput-medusae*) were present in 24 and 28 percent of sampled stands, respectively.

The average herb layer areal cover generally ranged from 44 to 79 percent. The average herb layer cover was generally much less variable (see Appendix 2B for standard deviations for averages) than the shrub layer in MHO stands. Fall Creek, however, had an herb layer cover of 90 percent. The high herb layer cover in the Fall Creek stands contrasts sharply with the absence of a shrub layer in this stand. Conversely, the J.C. Boyle bypass MHO stand has an herb layer cover of 1 percent and a correspondingly dense shrub cover of 60 percent.

<u>Montane Hardwood Oak-Conifer (MHOC)</u>

The MHOC vegetation type is distributed over 8,638 acres (3,499 ha) or 16.9 percent of the study area in six Project sections (Table 2.7-2; Figure 2.7-1). The MHOC cover type is by far the most abundant in the J.C. Boyle peaking reach (7,374 acres [2,946 ha]) followed by Copco reservoir, Fall Creek, Copco No. 2 bypass, and J.C. Boyle bypass sections. No MHOC occurred downriver of Copco reservoir or upstream of the J.C. Boyle bypass. The average MHOC polygon size was 36.9 ± 141.7 acres (14.9 ± 57.3 ha).

In total, six tree, 20 shrub, and 105 herbaceous plant species were documented in the 17 MHOC plots sampled in 2002. The average cover and height of the herb, shrub, and tree layer(s) in each Project section are discussed below. The complete treatment of averages and standard deviations for cover and height data can be found in Appendix 2C.

Ponderosa pine and Oregon oak were present in all 17 of the MHOC plots. Black oak is a common tree layer and occurs in 41 percent of sampled stands, typically in more mesic or shadier locations. Western juniper and incense cedar (*Calocedrus decurrens*) occurred in less than 12 percent of the sampled MHOC stands. Bigleaf maple (*Acer macrophyllum*) was present in one mesic stand in Copco No. 2 bypass.

The tree canopy in sampled stands often has a two-layered canopy, with the taller conifer trees overtopping the oak layer except around Copco reservoir. Total tree cover averaged 65.9 ±

30.6 percent (Table 2.7-5). The taller tree layer ranged in cover from 15 percent in the J.C. Boyle bypass to 55 percent in Copco No. 2 bypass. Both the minimum and maximum cover value in the taller tree layer occurs in the J.C. Boyle bypass. The shorter tree layer and single-layered tree canopies ranged in cover from 25 percent in Copco No. 2 bypass and J.C . Boyle bypass reaches to 65 percent cover around Copco reservoir.

Average tree diameters range from 6.5 inches (13.7 cm) in J.C. Boyle bypass to 11.1 inches (23.4 cm) in the J.C. Boyle peaking reach (Appendix 2C). The basal area averages for Project sections ranged from 23 feet^2/acre (5 m^2/ha) in the J.C. Boyle bypass to 161.3 feet^2/acre (37.0 m^2/ha) in the J.C. Boyle peaking reach. The average basal area per plot was 131.0 ± 95.8 feet^2/acre (30.1 ± 22.0 m^2/ha). MHOC stands averaged 224 ± 24 trees per acre.

Total shrub cover averaged 14.1 ± 16.6 percent (Table 2.7-4), while the main shrub layer averaged 3.5 ± 1.8 feet tall (1.1 ± 0.55 m) (Table 2.7-4). The sampled stands with one shrub layer range had an average areal cover of 13 percent in Fall Creek, 20 percent in Copco reservoir, and 30 percent in Copco No. 2 bypass sections; the shrub layer heights averaged 2.7 feet (1.1 m), 1.7 feet (0.7 m), and 4.7 feet (1.9 m) in these sections, respectively.

There was no single shrub layer species that occurred in all five Project sections. Western juniper and deerbrush both occurred in 53 percent of sampled stands. Western juniper was present from Copco No. 2 bypass upriver through the J.C. Boyle peaking reach, while deerbrush was present in the Fall Creek, J.C. Boyle peaking reach, and J.C. Boyle bypass sections. Western juniper and deerbrush were the only shrub layer species to occur at 100 percent frequency in, at most, one Project section. Western serviceberry (*Amelanchier alnifolia*) occurred in 41 percent of all sampled MHOC stands, but was present only in four Project sections from Copco reservoir to the J.C. Boyle bypass.

Oregon oak had an overall frequency of 24 percent and occurred in two of the five sections: Fall Creek (67 percent) and J.C. Boyle peaking reach (20 percent). Poison oak (*Toxicodendron diversilobum*) occurred in 18 percent of sampled stands in three Project sections: Copco No. 2 bypass (50 percent), Fall Creek (33 percent), and the J.C. Boyle peaking reach (10 percent). Birchleaf mountain mahogany occurred in 67 percent of Fall Creek stands and in the one sampled stand in the J.C. Boyle bypass. Snowberry (*Symphoricarpos alba*) occurred in 33 percent of stands in the J.C. Boyle peaking reach. All other shrub layer species occurred in less than 12 percent of sampled stands. Three sampled stands had no shrub layer.

Three stands, two in the J.C. Boyle peaking reach and one in the J.C. Boyle bypass, had a two-layered shrub canopy. Western serviceberry forms the tallest shrub layer in the two J.C. Boyle peaking reach stands. The taller shrub layers were 3.7 feet (1.5 m) tall and had areal cover of 2 and 5 percent. The shorter shrub layer in these stands was Oregon oak in one and snowberry in the other. The areal cover averaged 33 percent and the height averaged 1.2 feet (0.5 m) and had an average areal cover of 33 percent. The tallest shrub layer in the J.C. Boyle bypass stand was birchleaf mountain mahogany at 5 percent cover and a height of 9.9 feet (4.0 m). Snowberry and bitter cherry (*Prunus emarginata*) formed the shorter shrub layer at 15 percent cover and a height of 3.7 feet (1.5 m).

Oregon oak seedlings occurred in the herb layer in 94 percent or 16 of the sampled stands. It is the only herb layer species to occur in all Project sections. There were eight herb layer species that occurred in four of the five sampled Project sections: foxtail fescue (*Vulpia microstachya*), bulbous bluegrass, ponderosa pine, large-flowered collomia (*Collomia grandiflora*), western serviceberry, western juniper, Idaho fescue, and birchleaf mountain mahogany. The frequency of these species ranged from 29 to 79 percent. Blue wildrye, Oregon grape (*Berberis aquifolium*), and cheatgrass occurred in three of five Project sections and range in frequency from 35 to 59 percent.

The average herb layer areal cover averaged 31.6 ± 23.5 percent (Table 2.7-4) and generally ranged from 23 to 70 percent. The herb layer cover in the J.C. Boyle peaking reach ranged from 1 to 75 percent cover with an average cover of 25 percent. The one sampled stand in the Copco No. 2 bypass section had an herb layer cover of 70 percent. The areal cover in the remaining three sections ranged from 15 to 40 percent. Average herb height was 1.4 ± 0.7 feet (0.4 ± 0.2 m) (Table 2.7-4).

<u>Montane Hardwood Oak-Juniper (MHOJ)</u>

The MHOJ vegetation type is distributed over 8,968 acres (3,633 ha) or 17 percent of the study area (Table 2.7-2; Figure 2.7-1) in seven Project sections. Its distribution is similar to MHO stands. The MHOJ cover type is by far the most abundant in the J.C. Boyle peaking reach (5,620 acres [2,276 ha]) followed by Iron Gate reservoir, Copco reservoir, Copco No. 2 bypass, Fall Creek, J.C. Boyle bypass, and the Iron Gate-Shasta sections. The average MHOJ polygon size was 40.0 ± 106.5 acres (16.2± 43.1 ha).

In total, four tree, 12 shrub, and 94 herbaceous plant species were documented in the 20 MHOJ plots sampled in 2002.

Western juniper and Oregon oak were present in all 20 of the sampled MHOJ stands. Ponderosa pine and sugar pine (*Pinus lambertiana*) were present in the tree layer in one stand in the Fall Creek and J.C. Boyle peaking reach sections, respectively.

Some MHOJ stands had a two-layered tree canopy, with the taller conifer trees overtopping the oak layer in six of the sampled stands in three Project sections: Copco No. 2 bypass, Fall Creek, and the J.C. Boyle peaking reach sections. The average areal cover of the taller tree layer was 38.2 +/- 20.2 percent (Table 2.7-5). It was 5 percent in Copco No. 2 bypass, 35 percent in Fall Creek, and 24.5 percent in the J.C. Boyle peaking reach sections. The average height of the taller tree layers was 33.1 ± 9.6 feet (10.1 ± 2.9 m) (Table 2.7-5) overall and 26.2 feet (8.0 m), 39.4 feet (12.0 m), and 41.0 feet (12.5 m) in the Copco No. 2 bypass, Fall Creek, and J.C. Boyle peaking reach, respectively. The shorter tree layers and single-layered tree canopies ranged in cover from 22.5 percent in Copco No. 2 bypass to 80 percent areal cover in Fall Creek.

The tree tally data for the MHOJ stands and the MHO stands are similar (Appendix 2C). The average tree diameters range from 6 inches (13.7 cm) in the J.C. Boyle bypass to 15.2 inches (23.4 cm) along the Iron Gate-Shasta section. The basal area averages for Project sections ranged from 22.9 feet^2/acre (5.3 m^2/ha) in the J.C. Boyle bypass to 162.2 feet^2/acre (37.2 m^2/ha) in the Iron Gate-Shasta reach. The average basal area per plot was 62.9 ± 33.9 feet^2/acre (14.4 ± 7.8 m^2/ha). MHOJ stands averaged 135 ± 92.4 trees per acre.

All sampled stands had a shrub layer. This is interesting given the somewhat low frequencies for individual shrub layer species. The average areal cover for the shrub layer ranged from 5 percent around Copco reservoir and along the Iron Gate-Shasta section to 45 percent cover in the J.C. Boyle bypass. Overall, shrub cover averaged 15.9 ± 16.1 percent (Table 2.7-4).

Shrub layer heights ranged from roughly 1.6 feet (0.5 m) around Copco and Iron Gate reservoirs to 6.6 feet (2.0 m) in Fall Creek and the J.C. Boyle bypass and averaged 3.2 ± 1.7 feet (0.98 ± 0.52 m) overall (Table 2.7-4). The remaining three stands have shrub heights averaging from 3 feet (0.9 m) to 5 feet (1.5 m).

There was no single shrub layer species that occurred in all seven Project sections where MHOJ was sampled. Western juniper (shrub) occurs in six of the seven Project sections and had a frequency of 45 percent in sampled stands. Wedgeleaf ceanothus occurred in 53 percent of sampled stands, but only in four Project sections. Its frequency is especially high in the Iron Gate reservoir (80 percent) and Copco No. 2 bypass (100 percent) sections. Birchleaf mountain mahogany occurred in 40 percent of the stands in four Project sections. Birchleaf mountain mahogany occurred in all five Copco No. 2 bypass stands along with wedgeleaf ceanothus, and in 33 percent of the sampled stands in the J.C. Boyle peaking reach. Oregon oak, western serviceberry, and three-leaf sumac each occurred in three sections, with overall frequencies being fairly low at 30, 20, and 20 percent, respectively. Oregon oak shrubs were present in more than 60 percent of the sampled stands in the J.C. Boyle peaking reach.

The herb layer had a core group of species with more than 50 percent, but less than 90 percent, overall frequency: Oregon oak, bulbous bluegrass, hairy brome, Idaho fescue, squirreltail (*Elymus elymoides*), and large-flowered collomia. Bulbous bluegrass occurred in seven Project sections, while the other four species occurred in five Project sections. The invasive/exotic species yellow starthistle and medusahead were each present in 45 percent of stands primarily around Iron Gate reservoir, Copco reservoir, and Copco No. 2 bypass reach.

The average herb layer areal cover ranged from 44 to 79 percent and averaged 66.4 ± 17.6 percent (Table 2.7-3). The lowest cover value recorded for an herb layer was 26 percent in the J.C. Boyle bypass. The herb layer in other reaches ranged from 50 to 98 percent cover.

<u>Ponderosa Pine (PP)</u>

Ponderosa pine forests are distributed over 3,473 acres (1,407 ha) or 6.7 percent of the study area (Table 2.7-3; Figure 2.7-1) in five Project sections. The ponderosa pine cover type was most abundant in the J.C. Boyle reservoir (1,117 acres [452 ha]) and Keno Canyon (1,465 acres [593 ha]) sections. The distribution of ponderosa pine stands extends from the lower end of Keno reservoir downriver to the lower end of the J.C. Boyle peaking reach. Ponderosa pine stands became increasingly less abundant downriver and occurred only as small patches in mesic ravines around the upper end of Copco reservoir. The average polygon size of ponderosa pine stands on the Project vegetation map was 37.0 ± 77.3 acres (15.0 ± 31.3 ha).

In total, four tree, 17 shrub, and 75 herbaceous plant species were documented in the 14 ponderosa pine stands sampled in 2002.

Ponderosa pine was the only species present in all 14 of the sampled ponderosa pine stands. Other tree layer species occurred in less than 21 percent of sampled stands. Oregon oak was recorded in one sampled stand in the J.C. Boyle peaking reach along with small amounts of

Douglas-fir. Western juniper and Douglas-fir appeared infrequently in stands around J.C. Boyle reservoir and Keno Canyon.

The tree canopy was two-layered in only two of the sampled stands near J.C. Boyle reservoir and Keno Canyon. In both stands, the shorter tree layer was western juniper among the taller pines. The juniper tree layer in both stands was only 10 feet (3 m) to 13 feet (4 m) tall and had a meager cover of less than 2 percent. The taller tree canopies in two-tiered stands and the more typical single-layered tree canopies ranged in height from 50 feet (15 m) to 100 feet (30 m). Overall, tree height averaged 65.9 ± 28.5 feet (20.1 ± 8.7 m) (Table 2.7-5). Tree cover averaged 49.1 ± 21.7 percent. Tree layer cover in stands near Keno Canyon, Keno reservoir, and J.C. Boyle reservoir are somewhat open with areal cover ranging from 12 to 60 percent, primarily as a result of commercial thinning and logging. Pine canopies in the J.C. Boyle peaking reach ranged from 65 to 75 percent areal cover.

Average tree dbh numbers ranged from 13.2 inches (28 cm) in Keno Canyon to 24.5 inches (51.8 cm) dbh in one stand near the lower end of Keno reservoir (Appendix 2C). The basal area averages for Project sections ranged from 152 feet^2/acre (34.9 m^2/ha) around J.C. Boyle reservoir to 184 feet^2/acre (42.2 m^2/ha) in the J.C. Boyle bypass. The average basal area per plot was 156.5 ± 68.2 feet^2/acre (36.0 ± 15.7 m^2/ha). Ponderosa pine stands averaged 108.2 ± 46.2 trees per acre.

There was no single shrub layer species that occurred in all five of the Project sections where ponderosa pine stands were sampled. Ponderosa pine and snowberry both occurred in four of the five Project sections. Ponderosa pine and serviceberry occurred in 50 and 29 percent, respectively, of all sampled stands. Western serviceberry also occurred in 50 percent of sampled stands, but only in three of the Project sections. A variety of other shrub layer species were captured in the plot data, but occurred in less than 20 percent of the sampling plots. Douglas-fir, deerbrush, and Oregon oak were common in the J.C. Boyle peaking reach and bypass. Greenleaf manzanita (*Arctostaphylos patula*), Oregon grape, mock orange (*Philadelphus lewisii*), and gray rabbitbrush (*Chrysothamnus nauseosus*) were present in the J.C. Boyle bypass. Birchleaf mountain mahogany, western chokecherry (*Prunus virginiana*), and Sierra plum (*Prunus subcordata*) occur in pine stands near Keno Canyon.

The shrub layer in one of the Keno Canyon stands had a two-tiered shrub layer. Birchleaf mountain mahogany and western chokecherry formed a sparse shrub layer that was 8 feet (2.5 m) tall. The shrub layer height in sampled stands averaged from 1.5 feet (0.5 m) in the J.C. Boyle peaking reach to 5 feet (1.5 m) in the J.C. Boyle bypass and 3.5 ± 2.1 feet (1.1 ± 0.6 m) overall (Table 2.7-4). The average areal cover of the shrub layer was lowest near Keno reservoir (2 percent) and in the J.C. Boyle bypass (8.5 percent). The shorter shrub layer in the Keno Canyon pine stands averaged 15 percent areal cover. J.C. Boyle reservoir and the J.C. Boyle peaking reach had the highest shrub cover at 26 and 35 percent, respectively. Overall shrub cover was 19.1 ± 13.1 percent (Table 2.7-4).

The herb layer has a small core group of species with more than 40 percent, but less than 80 percent, overall frequency. The members of this group that also occur in four or more of the Project sections include western serviceberry, ponderosa pine seedlings, Kentucky bluegrass (*Poa pratensis*), blue wildrye, large-flowered collomia, squirreltail, and small-flowered collinsia (*Collinsia parviflora*).

The average herb layer cover ranged from 12 to 70 percent in the various sections. The lowest cover value recorded for any herb layer was only 2 percent in the J.C. Boyle bypass. The highest herb layer cover was recorded in the Keno reservoir stand where the tree and shrub canopies were sparse. The herb layers in other reaches ranged from 10 to 60 percent cover.

Juniper Woodland (J)

Juniper woodland is distributed over 1,268 acres (514 ha) or 2.3 percent of the study area (Table 2.7-2; Figure 2.7-1). Juniper woodland was mapped in all Project sections except J.C. Boyle reservoir and Keno Canyon. Juniper woodland is most abundant in the Link River (237 acres [96 ha]) and the J.C. Boyle peaking reach (213 acres [83 ha]) sections. The average polygon size of juniper stands on the Project vegetation map was 28.2 ± 45.2 acres (11.4 ± 18.3 ha).

In total, four tree, 17 shrub, and 86 herbaceous plant species were documented in the 11 juniper plots sampled in 2002.

Juniper is the most widespread tree in the study area and grows in all Project sections. In spite of this fact, juniper woodland is not that common. Juniper woodlands are often very open with areal cover of the tree layer barely reaching 10 percent. Overall, the average tree cover was 21.4 ± 20.2 percent (Table 2.7-5). Juniper woodland typically occupies habitats that are too harsh for other tree species to become dominant. However, one of the sampled stands in the Copco No. 2 bypass was growing in atypically good soil, had a higher density juniper trees tree, and had a dense tree layer.

Western juniper was the only tree layer species in all 11 of the sampled juniper woodlands. Oregon oak was a tree layer species in Copco No. 2 bypass (100 percent), the J. C. Boyle peaking reach (67 percent), and the J.C. Boyle bypass (100 percent). During field work, it became increasingly difficult to find good juniper woodlands to sample in these three sections. In fact, these stands are marginal juniper woodland and might best be called MHOJ. The sampled stands around Iron Gate reservoir, Copco reservoir, Keno reservoir, and Link River are better examples of the more open juniper woodland. Sugar pine occurred in one stand in the J.C. Boyle peaking reach, and ponderosa pine occurred in one stand in the J.C. Boyle bypass.

The tree canopy was two-layered in two of the sampled stands in the J.C. Boyle peaking and bypass reaches. In both stands, the shorter tree layer was western juniper among a few taller pines. The height of the short juniper layer was 16 feet (5 m) and 38 feet (11.5 m) in the two stands. The taller pine layer was 50 feet (15 m) and 66 feet (20 m) in the two stands. Overall, tree height averaged 31.5 ± 13.9 feet (9.6 ± 4.2 m) (Table 2.7-5). The areal cover of the taller tree was less than 5 percent in both stands. The average cover of the shorter tree layer and most of the single-layered tree canopies ranged from 5 to 25 percent. The Copco No. 2 bypass stand was unusual in that the areal cover of the tree layer was 70 percent. Tree heights in range from 21 feet to 25 feet (6.5 to 7.5 m) in stands at Iron Gate reservoir, Keno reservoir, and Link River. The site conditions for these stands are more harsh or severe; they are more exposed and drier at Iron Gate reservoir, and colder around Keno reservoir and Link River. The average tree heights for the stands in Copco No. 2 bypass, the J.C. Boyle peaking reach, and at Copco reservoir ranged from 30 to 42 feet (9 to 13 m). These stands occur in more protected locations that provide favorable growing conditions and thus larger trees.

The tree tally data (Appendix 2C) for Keno reservoir, Link River, and Iron Gate reservoir stands ranged from 6.6 inches (17 cm) dbh to 13 inches (33 cm) dbh. The basal area averages for these sections ranged from 4.8 to 12.3 feet^2/acre (1.1 to 2.8 m^2/ha). The average diameters for the other four Project sections ranged from 10 inches (25.4 cm) dbh in Copco No. 2 bypass to 19 inches (62 cm) dbh in the J.C. Boyle peaking reach. The basal area averages for these four sections ranged from 32.7 to 97 feet^2/acre (7.5 to 22.3 m^2/ha). The average basal area per plot was 49.8 ± 48.2 feet^2/acre (11.4 ± 11.1 m^2/ha). Juniper woodland averaged 43 ± 35 trees per acre.

There was no single shrub layer species that occurred in all seven of the Project sections in which juniper woodland occurred. Western juniper occupied the shrub layer in 45 percent of all stands in five of seven Project sections. Oregon oak occurred in the Copco No. 2 bypass and J.C. Boyle peaking reach and bypass, reflecting the distribution of Oregon oak in the tree layer. Poison oak occurred only in the Iron Gate reservoir and Copco No. 2 bypass stands. Three-leaf sumac occurred only in the Copco No. 2 bypass. Wedgeleaf ceanothus occurred only in Copco reservoir section. Mock orange occurred only in the J.C. Boyle peaking reach. Sierra plum occurred from the J.C. Boyle peaking reach up to the Link River. Birchleaf mountain mahogany and gray rabbitbrush occurred only in the J.C. Boyle peaking reach and bypass. Green rabbitbrush, ponderosa pine, greenleaf manzanita, and incense cedar occurred only in Keno Canyon. Antelope bitterbrush (*Purshia tridentata*) and western chokecherry occurred only in Link River stands. Western juniper demonstrates a high tolerance to changing habitat conditions when compared to the varied distribution of the various shrub species in the study area.

At Iron Gate reservoir, one of two sampled stands did not have a shrub layer. The shrub layer in the other stand was 1.6 feet (0.5 m) tall and had less than 2 percent areal cover. The stands in other sections had average heights ranging from 3.3 to 8.6 feet (1.0 to 2.6 m). The taller shrub layers were chokecherry, western serviceberry, and birchleaf mountain mahogany. The average areal cover of the shrub layer was variable between sections and ranged from 18 percent cover in the J.C. Boyle bypass to 70 percent cover at the Link River. Overall, shrub cover averaged 24.8 ± 24.2 percent (Table 2.7-4).

The herb layer has a small core group of species with more than 50 percent, but less than 85 percent, overall frequency. The members of this group that also occurred in five or more of the Project sections: cheatgrass (82 percent), willowherb (*Epilobium brachycarpum*) (64 percent), squirreltail (64 percent), bulbous bluegrass (64 percent), blue bunch wheatgrass (*Pseudoroegneria spicata*) (55 percent), and small-flowered collinsia.

The average herb layer cover was 52.3 ± 22.6 percent and ranged from 12 to 70 percent (Table 2.7-3). The lowest cover value recorded for an herb layer was 2 percent in the J.C. Boyle bypass. The highest herb layer cover was recorded in the Keno reservoir stand where the tree and shrub canopies were sparse. The herb layers in other reaches ranged from 10 to 60 percent cover.

Klamath Mixed Conifer (KMC)

KMC stands were distributed over 834 acres (338 ha) or 1.6 percent of the study area (Table 2.7-2; Figure 2.7-1) in five Project sections. Approximately 70 percent of the mixed conifer stands were in the J.C. Boyle bypass. The mixed conifer stands in Keno Canyon and the J.C. Boyle peaking reach extended over 144 acres (40 ha) and 98 acres (54 ha), respectively. Small amounts of mixed conifer also occurred around Copco reservoir and J.C. Boyle reservoir. The average polygon size of mixed conifer stands on the Project vegetation map was 26.9 ± 36.8 acres (10.9 ± 14.9 ha).

KMC is defined as having no single conifer species in the stand with more than 50 percent areal cover, but with two or more conifer species in the tree canopy with more than 5 percent cover. The mixed conifer stands as discussed in this section do not always meet these criteria. In the J.C. Boyle bypass, Douglas-fir was frequently the dominant tree layer species (more than 50 percent cover). However, ponderosa pine, incense cedar, and white fir (*Abies concolor*) were typically nearby, but they did not always have more than 5 percent cover in the tree canopy present in the stand.

In total, six tree, six shrub, and 50 herbaceous plant species were documented in the 14 KMC plots sampled in 2002.

Douglas-fir is the only tree layer species present in all 14 of the sampled KMC stands. It was the dominant tree layer conifer in all but two of the sampled stands. Ponderosa pine occurred in 67 percent of stands and was the dominant tree layer conifer in the sampled stand at J.C. Boyle reservoir. Incense cedar was the dominant conifer in the tree layer in the J.C. Boyle peaking reach stand and co-dominates the mixed conifer stand at Copco reservoir. White fir occurred in two of the three J.C. Boyle peaking reach stands, but had low areal cover in the tree layer. Black oak and Oregon oak were present in some stands.

Total tree cover averaged 68.3 ± 11.3 percent (Table 2.7-5). The tree canopy was two-layered in the J.C. Boyle peaking reach stand and in two of the three J.C. Boyle bypass stands. These taller tree layers ranged from 30 to 35 percent areal cover and are comprised of taller, older ponderosa pine and Douglas-fir ranging from 115 to 141 feet (35 to 43 m) in height. The second or shorter tree layer in the J.C. Boyle peaking reach stand was comprised of short conifers and oak only 23 feet (7 m) tall. The tree layer at the Copco reservoir stand had 50 percent cover of relatively short (30 feet [9.0 m]), young trees. The shorter tree layer and single-layered stands in the J.C. Boyle bypass and at J.C. Boyle reservoir were approximately 59 feet (18 m) tall and had 55 to 65 percent areal cover.

The tree tally data (Appendix 2C) revealed that average tree diameters are surprisingly low in the Copco reservoir (4.5 in [11.4 cm]) and J.C. Boyle peaking reach (5.0 in [17.7 cm]) sections; tree densities in these stands were fairly high at 220 and 250 trees per acre, respectively. Average tree diameters in the other two Project sections were also fairly low compared to other upland, tree-dominated stands. Average tree diameters in the J.C. Boyle bypass and J.C. Boyle reservoir stands was 11.2 inches (28.4 cm) dbh and 10.7 inches (27.2 cm) dbh, respectively. The basal area averages for Project sections were 24.4 feet^2/acre (5.6 m^2/ha) at Copco reservoir, 67.3 feet^2/acre (15.5 m^2/ha) in the J.C. Boyle peaking reach, 105 feet^2/acre (24.1 m^2/ha) in the J.C. Boyle bypass, and 43.4 feet^2/acre (10.0 m^2/ha) around J.C. Boyle reservoir. The average basal area per plot was 74.9 ± 35.8 feet^2/acre (17.2 ± 8.2 m^2/ha). Overall tree density for KMC stands averaged 167 ± 63 trees per acre.

There was no single shrub layer species that occurred in all five of the Project sections in which KMC was sampled. Only two shrub layer species—Oregon grape and western serviceberry—occurred in more than one of the four Project sections. Oregon grape occurred in stands sampled at Copco reservoir, J.C. Boyle bypass, and J.C. Boyle reservoir; its overall frequency of occurrence was 83 percent. Serviceberry occurred in 67 percent of all sampled mixed conifer stands, but only occurred in the Copco reservoir and J.C. Boyle bypass stands. Birchleaf mountain mahogany occurred in two stands, and Oregon oak occurred in one stand in the J.C. Boyle bypass. Incense cedar (shrubs) and deerbrush were present in the Copco reservoir stand.

Overall KMC shrub cover averaged 26.8 ± 16.3 percent (Table 2.7-4). The shrub layer in one of the Keno Canyon stands was two-tiered. Birchleaf mountain mahogany formed a sparse shrub layer that was 8 feet (2.5 m) tall with an areal cover of 15 percent. The Keno Canyon mixed conifer stand had a short, sparse layer of Oregon ash. The shrub layer height ranged from 3.3 feet (1 m) to 5.6 feet (1.7 m). Shrub cover in those stands ranged from 15 to 45 percent.

The herb layer had relatively poor constancy among Project sections. Small-flowered collinsia was the only species that occurred in 100 percent of sampled stands. Small shrubs of snowberry occurred in 67 percent of sampled stands, but only occurred in two Project sections – J.C. Boyle bypass and Copco reservoir. Bulbous bluegrass was fairly abundant in the Copco reservoir strand. The J.C. Boyle peaking reach stand had a dense overstory and little in the way of an herb layer. False solomons seal (*Smilacina racemosa*), Virginia strawberry (*Fragaria virginiana*), moerhingia (*Moerhingia grandiflora*), blue wildrye, and large-flowered collomia occurred in all three stands in the J.C. Boyle bypass. At J.C. Boyle reservoir, the most abundant herb layer species included low-growing snowberry, western serviceberry, Idaho fescue, and prostrate ceanothus (*Ceanothus prostratus*).

The herb layer cover ranged from 15 percent at J.C. Boyle reservoir to 65 percent in the J.C. Boyle peaking reach. The lowest cover value recorded for an herb layer was 1.5 percent in the J.C. Boyle bypass. The average herb cover was 21.4 ± 22.2 percent (Table 2.7-4). Herb layer heights were generally low, ranging from 10.2 inches (0.1 m) to 1.3 feet (0.4 m).

Lodgepole Pine (LP)

Lodgepole pine stands occur in the J.C . Boyle bypass reach and at J.C. Boyle reservoir as a result of replanting in timber harvest sites. They are distributed over 64.4 acres (26 ha) or 0.12 percent of the study area in those two Project sections. The trees in these young plantations are typically small, averaging 6 inches (13 cm) dbh in the two reaches.

The dominant tree species is always lodgepole pine and the tree layer cover was 10 percent in the one stand. The shrub layer cover was 5 percent and the most common shrub layer species were Bloom's ericameria *(Ericameria bloomeri)* and western serviceberry. The most common herb layer species include cheatgrass, bluebunch wheat grass, yarrow *(Achillea millefolium),* and blue wildrye. The herb layer cover was 80 percent under the sparse tree and shrub layers. There was no evidence of grazing or recreation use.

2.7.2.2 Upland Shrub Habitats

The following sections summarize the various upland shrub habitat types.

Mixed Chaparral (MXC)

MXC stands are distributed over 4,396 acres (1,781 ha) or 8.3 percent of the study area (Table 2.7-2; Figure 2.7-1) in 10 of the 11 Project sections. Approximately 60 percent of the MXC stands occur in the J.C. Boyle bypass (1,851 acres [750 ha]) and around Copco reservoir (791 acres [320 ha]). The MXC cover type requires that two or more shrub species occur in the stand and that they have 5 percent or more areal cover. The shrub-dominated stands described here meet those criteria most of the time. The one exception to the rule is that this type includes pure stands of wedgeleaf ceanothus, which are common from the slopes of the J.C. Boyle peaking reach downriver to the banks of the Iron Gate-Shasta section. The average polygon size of MXC stands on the vegetation map was 12.6 ± 23.0 acres (5.1 ± 9.3 ha).

In total, four tree, 16 shrub, and 133 herbaceous plant species were documented in the 30 MXC plots sampled in 2002. Shrub and tree layer(s) in each Project section are discussed below. The complete descriptive averages and standard deviations for cover and height data can be found in Appendix 2C.

Tree cover averaged 2.1 ± 5.2 percent (Table 2.7-5). Shrub cover averaged 51.2 ± 23.8 percent (Table 2.7-4). The widespread distribution of this cover type is distinctly divided among various shrub species (Table 2.7-6). There are 15 shrub layer species that range in frequency from 3 to 40 percent. Birchleaf mountain mahogany has the highest frequency at 40 percent and the widest distribution among six of the ten Project sections. Western juniper is also ubiquitous in its distribution in stands in five Project sections in the shrub layer of the MXC cover type (as well as the various tree-dominated cover types discussed above). Oregon oak is distributed among sampled stands in four of ten Project sections and has an overall frequency 23 percent. Oregon oak saplings are prevalent in many cover types from the J.C. Boyle bypass down to the Iron Gate-Shasta section.

Wedgeleaf ceanothus is most prevalent and abundant in the lower portions of the study area from the Iron Gate-Shasta reach up through the J.C. Boyle peaking reach. Pure stands of this species are common on the canyon slopes in the J.C. Boyle peaking reach and form larger stands, especially around Copco and Iron Gate reservoirs. Three-leaf sumac and poison oak form dense stands in many low-lying ravine bottoms along the Iron Gate-Shasta section, Iron Gate reservoir, and in Fall Creek. The shrub layer composition of MXC changes rather markedly in the J.C. Boyle peaking reach up to the Link River. Several species were sampled only in this portion of the study area including gray rabbitbrush, antelope bitterbrush, Sierra plum, poison oak, chokecherry, snowberry, and bitter cherry. Sierra plum in particular dominates stands in the Keno Canyon vicinity. Gray rabbitbrush is discussed further in the rabbitbrush shrub cover type description below.

Table 2.7-6. Shrub frequency (% of plots) in the mixed chaparral cover type in each Project section.

Shrub Species	**Project Sections**										
	Iron Gate-Shasta Section	**Iron Gate Reservoir**	**Copco No. 2 Bypass**	**Copco Reservoir**	**Fall Creek**	**J.C. Boyle Peaking Reach**	**J.C. Boyle Bypass**	**J.C. Boyle Reservoir**	**Keno Canyon**	**Link River**	**Total (% of plots)**
Number of Plots	**4**	**3**	**2**	**4**	**2**	**6**	**3**	**2**	**3**	**1**	
Birchleaf Mountain Mahogany		67	100		50	50	67		67		40
Wedgeleaf Ceanothus	50	67		50	100	33					33
Western Juniper	50			50		17		50	33	100	27
Sierra Plum						33	100		67	100	27
Oregon Oak		33		50		50	33				23
Western Serviceberry						33	33		67		17
Gray Rabbitbrush						33	33		33	100	17
Antelope Bitterbrush								100	33	100	13
Three-Leaf Sumac	75	33									13
Greenleaf Manzanita							33		33		7
Ponderosa Pine								100			7
Poison Oak			100								7
Chokecherry									33		3
Snowberry									33		3
Bittercherry							33				3

Shrub height averaged 4.8 ± 1.6 feet (1.5 ± 0.5 m) (Table 2.7-4). Five of the 12 sampled stands in the J.C. Boyle peaking reach upriver to Keno Canyon have a two-tiered shrub layer. Mountain mahogany, chokecherry, and, in one plot, western serviceberry form a distinctly taller layer ranging in height from 8.2 feet (2.5 m) to 18.0 feet (5.5 m). The taller layer ranged in cover from 15 to 25 percent in the five stands. The average height of the shorter shrub layer and the single-tiered shrub layers ranged from 4.6 feet (1.4 m) to 5.9 feet (1.8 m), with the exception of stands in Fall Creek and in the J.C. Boyle bypass. The average shrub height in the latter two stands was short by comparison at about 3.3 feet (1 m).

The most frequent herb layer species included cheatgrass, bulbous bluegrass, willowherb, squirreltail, yellow starthistle (*Centaurea solstitialis*) (especially downriver of J.C. Boyle bypass), hairy brome, large-flowered collomia, and wall bedstraw (*Galium parisiense*); the frequency of the species ranged from 77 to 40 percent in the order listed. The species composition of the herb layer changed in different portions of the study area depending in part on the adjacent cover types. In the lower portions of the study area (primarily below the J.C. Boyle peaking reach) Idaho fescue, annual carrot (*Daucus pusillus*), soft chess (*Bromus hordeaceous*), hedge parsley (*Torilis nodosa*), bur chervil (*Anthriscus cacaulis*), and medusahead became more common; many of these species are common and often abundant components of annual grasslands and oak woodland that often abut MXC stands. The vegetation in the J.C. Boyle peaking reach and upriver to Keno Canyon often contributed to the herb layer in the MXC, most notably blue wildrye, small-flowered collinsia, low-growing snowberry, Bloom's ericameria (*Ericameria bloomeri*), and variable-leaf phacelia (*Phacelia heterophylla*).

The average herb layer height tended to increase slightly moving upslope and up-canyon; the average herb layer height ranges from 0.7 to 1.0 feet (0.2 to 0.3 m) below the canyon and from 1.3 to 1.6 feet (0.4 to 0.6 m) in Fall Creek and above the J.C. Boyle peaking reach to Link River. There was no obvious pattern to average herb layer cover in the MXC stands; herb layer cover ranged from as low as 3 percent in the J.C. Boyle bypass to as high a 90 percent in Keno Canyon.

The four tree layer species in MXC stands included Oregon oak, western juniper, sugar pine, and ponderosa pine. Oregon oak occurred in six of the 30 sampled stands. The J.C. Boyle peaking reach and J.C. Boyle reservoir stands averaged 25 and 19 trees/acre, respectively. J.C. Boyle bypass, Keno Canyon, and the Iron Gate-Shasta section averaged seven or eight trees/acre.

<u>Sagebrush (SB)</u>

Sagebrush (*Artemisia tridentata*) was distributed over 108 acres (44 ha) or 0.2 percent of the study area (Table 2.7-2; Figure 2.7-1) in only two Project sections. There are approximately 73 acres (30 ha) and 36 acres (15 ha) of sagebrush scrub cover type mapped at J.C. Boyle reservoir and Keno reservoir, respectively. The average polygon size of polygons on the Project vegetation map was 9.8 ± 5.4 acres (4.0 ± 2.2 ha).

In total, five shrub and 19 herbaceous plant species were documented in the four sagebrush scrub plots sampled in 2002. No tree layer species were captured in the plot data.

Sagebrush and cheatgrass occurred in all four of the sampled stands. Green rabbitbrush occurred in the shrub layer in both Project sections, but in only 50 percent of sampled stands. Linear-leaf ericameria (*Ericameria linearifolia*) and ponderosa pine saplings occurred in the shrub layer in two of three stands sampled at J.C. Boyle reservoir. Juniper saplings were the only other shrub layer species at Keno reservoir.

Squirreltail, Kentucky bluegrass, lupine (*Lupinus* sp.), and the sub-shrub, Bloom's ericameria were abundant herb layer species, but only occurred in one or two of the J.C. Boyle reservoir stands. Squirreltail, one-sided bluegrass (*Poa secunda*), basin wildrye (*Leymus cinereus*), and low-growing plateau gooseberry (*Ribes velutinum*) were in the herb layer at Keno reservoir.

Shrub cover averaged 55.0 ± 28.0 percent and 3.1 ± 0.7 feet (0.9 ±0.2 m) tall (Table 2.7-4). The shrub layer height was 3.9 feet (1.2 m) at Keno reservoir and had a cover of approximately 20 percent. The average height of the shrub layer at J.C. Boyle reservoir was 3.0 feet (0.9 m) with an average cover of 66 percent. The herb layer at Keno reservoir was 1.3 feet (0.4 m) tall and had an areal cover of 25 percent. The average height of the herb layer at J.C. Boyle reservoir was 1.0 foot (0.3 m) with an average cover of 17 percent. Overall, the herb layer averaged 1.0 ± 0.3 foot (0.3 ± 0.09 m) tall (Table 2.7-3).

Rabbitbrush (RB)

Rabbitbrush stands were distributed over 538 acres (218 ha) or 1.0 percent of the study area (Table 2.7-2; Figure 2.7-1) in only two Project sections. This cover type was the dominant shrub cover type at Keno reservoir 526.2 acres (213 ha). A small amount of rabbitbrush was also mapped in Keno Canyon. The average polygon size of rabbitbrush scrub stands on the Project vegetation map was 0.8 ± 1.0 acres (0.3 ± 0.4 ha).

In total, two shrub and 21 herbaceous plant species were documented in the two rabbitbrush plots sampled in 2002. No tree layer species were captured in the plot data.

Gray rabbitbrush and cheatgrass occurred in both of the sampled stands. Oddly, the two sampled stands shared no other species. The Link River stand had Sierra plum in the shrub layer and elated buckwheat (*Eriogonum elatum*), hairy brome, phacelia (*Phacelia* sp.), and bluebunch wheatgrass in the herb layer. Sierra plum was actually the dominant shrub layer species in the stand, followed by rabbitbrush. The shrub layer cover was 65 percent and the height was 6 feet (1.5 m). The herb layer cover in this stand was 55 percent and the height was 1.6 feet (0.5 m).

The sampled Keno reservoir rabbitbrush stand had no shrub species other than rabbitbrush. The shrub layer cover was 45 percent and the height was 2 feet (0.6 m). This site was near Keno reservoir and appeared to be affected by the reservoir pool level given the presence of spikerush, an obligate wetland species. The herb layer was dominated by saltgrass. Other herb layer species included Baltic rush (*Juncus balticus*), narrow leaf pyrrocoma (*Pyrrocoma lanceolata*), and fescue (*Festuce varundinacea*). The herb layer cover in this stand was 60 percent and the height was 0.7 feet (0.2 m). Applegate's milkvetch (*Astragalus applegatei*), a Project TES plant species, grows at this site.

2.7.2.3 Upland Herbaceous

The following sections summarize the various upland herbaceous types.

Annual Grasslands (AGL)

AGL were distributed over 4,475 acres (1,813 ha) or 8.5 percent of the study area (Table 2.7-2; Figure 2.7-1) in eight of 11 Project sections. More than 88 percent or 3,968 acres (1,607 ha) of the AGL occurs around Iron Gate and Copco reservoirs and in the J.C. Boyle peaking reach. The AGL cover type gave way to the perennial grassland cover type both upslope and upriver. The geographical and floristic differences between the two cover types were not always clear, as discussed below. In general, AGL vegetation is the result of centuries of non-native plant species introductions and ground-disturbing land uses, including road building and livestock grazing. The average polygon size of AGL stands was 11.4 ± 25 acres (4.6 ± 10.1 ha).

In total, one tree, six shrub, and 82 herbaceous plant species were documented in the 21 AGL plots sampled in 2002. Total shrub cover was less than 1 percent (Table 2.7-4).

Nine of the 11 most frequent species in the sampled stands are introduced species; two of them are the exotic/invasive species—medusahead and yellow starthistle. The other seven species include bulbous bluegrass, hairy brome, wall bedstraw, cheatgrass, Spanish clover (*Lotus purshianus*), storksbill (*Erodium cicutarium*), and hedge parsley. The frequency of occurrence for these species ranges from 2 to 90 percent. The two native species were willowherb (67 percent) and lagophyllum (*Lagophyllum ramosissimum*) (38 percent).

Medusahead, hairy brome, and yellow starthistle dominated grasslands down river of J.C. Boyle peaking reach. Bulbous bluegrass, an early season dominant, was under-represented in terms of abundance because it had died back by sampling time. However, it was still the second most frequent species in the sampled AGL. Cheatgrass became relatively more abundant in AGL in the J.C. Boyle bypass and upriver to Keno reservoir, where it was often the only dominant herb layer species. Excluding bulbous bluegrass, perennial grass species occur in, at most, 14 percent of sampled stands.

AGL took on the floristic character of the adjacent habitat or cover type, especially near wetlands. The opposite is true as well. AGL species often dominated the herb layers of adjacent cover types, especially in disturbed oak woodland and riparian areas.

Overall herb cover averaged 93.0 ± 7.8 percent, and height averaged 1.8 ± 0.9 feet (0.5 ± 0.3 m) (Table 2.7-3). The average herb layer cover of AGL in the different Project sections ranged from 87 to 99 percent. Average herb layer height ranged from 1 to 1.6 feet (0.3 to 0.5 m) in all sections except the Iron Gate-Shasta section and the J.C. Boyle bypass. Herb layer heights in the latter two reaches were 3.4 feet (1.1 m) and 3.3 feet (1.0 m); some taller herbaceous species, such as black mustard (*Brassica nigra*) and tumble mustard (*Sisymbrium altissimum*), bumped up the average herb layer height in these two stands.

<u>Perennial Grasslands (PGL)</u>

PGL were distributed over 366 acres (148 ha) or 0.7 percent of the study area (Table 2.7-2; Figure 2.7-1) in eight of 11 Project sections. More than 87 percent or 320 acres (130 ha) of the PGL occurred in the J.C. Boyle peaking reach and bypass, and around J.C. Boyle reservoir. The species composition of the PGL cover type changed depending on the predominant land uses and cover types in the Project section(s). Low-lying areas around Keno reservoir are alkaline and adjacent to many irrigated hayfields. Many of the grasslands from Fall Creek and the J.C. Boyle peaking reach upriver to the J.C. Boyle reservoir had an abundant component of naturalized, upland perennial grass species planted as forage species for cattle production. In the J.C. Boyle peaking reach, PGL adjacent to irrigated pastures took on the species composition of pastures that are tolerant to drier, upland soil conditions. Some of the PGL might be better classified as pastures except for the presence of at least some widespread perennial, upland grass or graminoid species. The contribution of native, perennial grasses to PGL species composition appears to depend mostly on the history of disturbance and land use at the sample site. The average polygon size of PGL stands on the Project vegetation map was 7.3 ± 14 acres (3.0 ± 6.0 ha).

In total, two shrub and 85 herbaceous plant species were documented in the 13 PGL plots sampled in 2002. Shrub cover averaged 1.8 ± 5.5 percent (Table 2.7-4).

Sixteen species occurred in more than 20 percent of the sampled PGL stands. Bulbous bluegrass and hairy brome were the only two species that occurred in more than 50 percent of sampled grasslands. Ten of the 17 species occurred in three or more of the eight Project sections where PGL were sampled: bulbous bluegrass, hairy brome, willowherb, Kentucky bluegrass, cheatgrass, spiny lettuce (*Lactuca serriola*), lagophyllum, blue bunch wheatgrass, colonial bentgrass (*Agrostis capillaris*), and blue wildrye.

In total, 31 graminoid species occurred in the sampled stands – five introduced annuals, 11 introduced perennials, two native annuals, ten native perennials, one native rush, and two native sedges. The distribution of the perennial graminoid species are summarized in Table 2.7-7.

Table 2.7-7. Perennial grass, sedge, and rush species frequency (% of plots) in perennial grasslands in each Project section.

Species	Fall Creek (n=1)	J.C. Boyle Peaking Reach (n=4)	J.C. Boyle Bypass (n=2)	J.C. Boyle Reservoir (n=1)	Keno Reservoir (n=5)	Overall Frequency
Introduced Perennials						
Poa bulbosa	100	100	50	100		54
Poa pratensis		50	50		40	38
Holcus lanatus		50				15
Phleum pratense		50				15
Hordeum brachycarpum					40	15
Dactylis glomeratus		25				8
Elytrigia intermedia					20	8
Elytrigia pontica					20	8
Festuca arundinacea					20	8
Hordeum jubatum					20	8
Lolium perenne					20	8
Native Perennials						
Pseudoroegneria spicata		25	100		20	31
Agrostis capillaris		50			20	23
Elymus elymoides			50		40	23
Elymus glaucas	100			100	20	23
Disticlis spicata					40	15
Leymus triticoides					40	15
Panicum capillare					40	15
Festuca idahoense			50			8
Panicum occidentalis					20	8
Poa secunda					20	8
Juncus balticus					20	8
Carex nebrascensis		25				8
Carex praegracilis					20	8

The PGL sampled at Keno reservoir had a strong presence of native and non-native perennial grass species. Saltgrass and bearded wheatgrass (*Leymus triticoides*) were sampled in relatively undisturbed sites on islands in Keno reservoir. The grassland sampled along the perimeter of

Keno reservoir had a rather large complement of naturalized species planted as forage species for livestock production. Pasture grass species were also prevalent in the J.C. Boyle bypass. The presence of sedges, rushes, and some hydrophilic grass species including velvet grass (*Holcus lanatus*), colonial bentgrass, foxtail barley (*Hordeum jubatum*), and meadow barley (*Hordeum brachycarpum*) are indicative of the influence of irrigation on these grasslands. Bulbous bluegrass, Kentucky bluegrass, bluebunch wheatgrass, and blue wildrye are the most ubiquitous perennial grasses in sampled stands. The wide variety of non-Project influences that are encountered in the study area makes a more definitive description of the PGL cover type difficult.

Two PGL sampled at Keno reservoir had a short dense cover of saltgrass. One of these also had a tall herb layer comprised of beardless wildrye (*Leymus triticoides*) and intermediate wheatgrass (*Elytrigia intermedia*). The height of the taller herb layer at this site and the other grassland stands sampled ranged from 1 to 3 feet (0.3 to 1.0 m). Herb cover across all sampled stands ranged from 70 to 99 percent cover and averaged 80.4 ± 22.2 percent (Table 2.7-3).

2.7.2.4 Agriculture

<u>Pasture/Irrigated Hayfield (P/IH)</u>

Pastures and irrigated hayfields were distributed over 3,675 acres (1,488 ha) or 6.9 percent of the study area (Table 2.7-2; Figure 2.7-1) in four of 11 Project sections. More than 85 percent or 3,139 acres (1,312 ha) of the pasture/irrigated hayfields were mapped around Keno reservoir. The other two Project sections with substantial amounts of this cover type were J.C. Boyle peaking reach (358 acres [145 ha]) and the Iron Gate-Shasta section (164 acres [66 ha]). The average polygon size of P/IH stands on the Project vegetation map was 157 ± 368 acres (64.0 ± 149.0 ha) around Keno reservoir and 16.7 ± 17.2 acres (6.7 ± 7.0 ha) elsewhere.

In total, 65 herbaceous plant species were documented in the nine pastures sampled in 2002. The average cover and height of the herb layer for each cover type are provided in Table 2.7-3.

Yellow starthistle, prickly lettuce (*Lactuca serriola*), timothy (*Phleum pratense*), curly dock (*Rumex crispus*), common knotweed (*Polygonum arenasterum*), plantain (*Plantago lanceolata*), morning glory (*Convolvulus arvensis*), and bull thistle (*Cirsium vulgare*) were the most frequent pasture species. In general, the species and cover data for the sampled pastures under-represents graminoid species that were closely cropped because of grazing or hay cutting at the time of sampling. The most abundant species in drier pastures in the J.C. Boyle peaking and Iron Gate-Shasta reaches were yellow starthistle, medusahead, Idaho fescue, hedge parsley, perennial rye grass (*Lolium perenne*), and bulbous bluegrass. The species composition of a wet pasture sampled in the J.C. Boyle peaking reach was similar in some ways to species found in palustrine emergent wetlands; species found include spikerush, Nebraska sedge (*Carex nebrascensis*), and waterpepper (*Polygonum hydropiperoides*).

The species composition in pastures at Keno reservoir was similar to other sections in that bull thistle, prickly lettuce, curly dock, and plantain were common species. Keno reservoir pastures also had their own set of pasture species not observed as often in pastures downriver, including tall wheatgrass (*Elytrigia pontica*), intermediate wheatgrass, Canada thistle (*Cirsium arvonse)*, poison hemlock (*Conium maculatum*), and salt grass.

The herb layer cover in pastures is typically 75 to 100 percent. One dry, over-grazed pasture at Keno reservoir had an herb layer cover of only 10 percent; these types of "weedy" pastures were plentiful at Keno reservoir.

2.7.2.5 Wetland Habitat Types

The following discussion of wetland and riparian cover types provides a general description. Additional detail can be found in Section 3.0. The "wetland" cover types described below are habitats positioned away from the hydrological influence of the Project river reaches. These habitats include all isolated wetlands away from Project reservoirs and river reaches and wet habitats connected hydrologically to Project reservoirs. Conversely, the "riparian" cover types described in the next section are habitats positioned in the immediate hydrological influence of Project river reaches.

Palustrine Emergent Wetland (PEM)

PEM or wet meadows were distributed over 1,796 acres (727 ha) or 3.3 percent of the study area (Table 2.7-2; Figure 2.7-1) in all 11 Project sections. More than 88 percent or 1,589 acres (644 ha) of the PEM occurred adjacent to Keno reservoir. There were 63.2 acres (25.0 ha) of wetlands around J.C. Boyle reservoir and 90 acres (37 ha) of wetlands mapped in the J.C. Boyle peaking reach. The average polygon size of wet meadows on the Project vegetation map was 8.2 ± 48 acres (27 ± 157 ha).

In total, one tree, three shrub, and 114 herbaceous plant species were documented in the 25 wetlands plots sampled in 2002.

There were 12 species that occurred in five of the seven sampled Project sections: fringed willowherb (*Epilobium ciliatum*), curly dock, prickly lettuce, common rush (*Juncus effusus*), Kentucky bluegrass, hardstem bulrush (*Scirpus acutus*), seep monkeyflower (*Mimulus guttatus*), western goldenrod (*Eupatorium occidentalis*), Canada thistle, teasel (*Dipsacus fullonum*), wild mint (*Mentha arvense*), and waterpepper. The frequency of occurrence in sampled stands was generally low with only eight species occurring in more than 40 percent but less than 56 percent of sampled stands: colonial bentgrass, hardstem bulrush, Kentucky bluegrass, common rush, bull thistle, prickly lettuce, curly dock, and fringed willowherb. Overall herbaceous cover averaged 98.0 ± 17.3 percent (Table 2.7-3).

The wetlands in the study area (with the exception of some wetlands at Keno reservoir), were fairly small, often not much larger than the 0.1-acre (0.04-ha) sampling plots used in this study. Even the larger wetlands often changed species composition in response to ever-changing hydrological gradients. Many of the finer-scaled vegetation patterns observed in sampled wetlands were "blended" together in the rather large sampling plots. The more ubiquitous species listed above may or may not be one of the dominant species in any particular sampled meadow.

The three sampled wetlands at Iron Gate reservoir often had hardstem bulrush, waterpepper, and, occasionally, hornwort (*Ceratophyllum demersum*) at the reservoir margin. Upslope of the bulrush, there was a zone often dominated by rather weedy species such as narrow-leaf milkweed (*Asclepias fascicularis*), bird's foot trefoil (*Lotus corniculatus*), medusahead, teasel, dog fennel (*Anthemis cotula*), plaintain, and cocklebur (*Xantium strumarium*). The sampled wetland in Copco No. 2 bypass was highly disturbed by cattle and dries out during the summer.

The dominant species there included Baltic rush, dog fennel, yellow starthistle, and chicory (*Cichorium intybus*).

The five sampled wetlands at Copco reservoir were all located near the reservoir margin. These wetlands were similar to Iron Gate wetlands located in similar low-gradient shoreline positions. Bulrush and waterpepper were common at the water margin. The species in the more upland shoreline positions were similar to those found at Iron Gate reservoir, but also included stipitate sedge (*Carex stipitatus*), Himalayan blackberry (*Rubus discolor*), and willow-leaf dock (*Rumex salicifolia*). One sampled stand at the extreme upriver end of Copco reservoir had reed canarygrass.

The two sampled Fall Creek wetlands shared only six species: fringed willowherb, curly dock, Kentucky bluegrass, western goldenrod, timothy, and Canada thistle. Some abundant species in one of the Fall Creek wetlands included mat muhly (*Muhlenbergia richardsonis*), sword-leaf rush (*Juncus ensifolius*), beggarstick (*Bidens frondosa*), and Modoc eryngo (*Eryngium alismaefolium*). Abundant species in the other sampled stand included teasel, bird's foot trefoil, and bulrush.

The PEM wetlands in the J.C. Boyle peaking reach were diverse in terms of sites dominated by different species. Only fringed willowherb and colonial bentgrass were present in all six sampled wetlands. Common rush was present in five of six sampled wetlands. Seep monkeyflower, velvet grass, and timothy were present in four of the six sampled wetlands. However, none of these seven species formed the dominant cover in any of the six sampled plots.

The dominant species in wetter parts of the sampled meadows were often sedges including clustered field sedge (*Carex praegracilis*), woolly sedge (*Carex lanuginosa*), Nebraska sedge, short-beaked sedge (*Carex simulata*) as well as several other species of sedge that did not have mature perigynia when sampled and were not identified. Other species often associated with wetter sites include sword-leafed rush, straight-leaf rush (*Juncus orthophyllus*), Scouler's hypericum (*Hypericum formosum*), Bigelow's sneezeweed (*Helenium bigelovii*), bay forget-me-not (*Myosotus laxa*), pendulous bulrush (*Scirpus pendulous*), and fowl bluegrass (*Poa palustris*). Species growing in relatively drier meadows or portions of meadows include Baltic rush, Kentucky bluegrass, dense-flowered willowherb (*Epilobium densiflorum*), Gairdner's perideridia (*Perideridia gairdneri*), and Oregon checkerbloom (*Sidalcea oregana*).

Several of the sampled meadows in the J.C. Boyle peaking reach were adjacent to the river so that captured species were more closely associated with riparian habitats, at least in J.C. Boyle peaking reach; these species include reed canarygrass, hardstem bulrush, beggarstick, and rice cutgrass (*Leersia oryzoides*).

At J.C. Boyle reservoir, there were eight species that occurred in both sampled wetlands; these include fringed willowherb, bull thistle, common rush, colonial bentgrass, marsh spikerush, (*Eleocharis macrostachya*) foxtail barley, dandelion (*Taraxacum officionale*), and mullien (*Verbascum thapsus*). The most abundant species in one sampled meadow included Nebraska sedge, stipitate sedge, marsh spikerush, and common rush. The most abundant species in the other sampled meadow included marsh spikerush, colonial bentgrass, western goldenrod, wild mint, bugle hedgenettle (*Stachys ajugoides*), seep monkeyflower, and duckweed (*Lemna minor*).

The wetlands at Keno reservoir had no species that occurred in all six of the sampled stands. Prickly sowthistle (*Sonchus asper*) and spear saltbrush (*Atriplex patula*) occurred in four of six sampled meadows.

In two sampled meadows, the most frequent species were nitrophila (*Nitrophila occidentalis*), silver cinquefoil (*Potentilla anserina*), and short-podded thelypodium (*Thelypodium brachycarpum*). One of these meadows was dense with clustered field sedge. The other meadow had many more species, in addition to a much higher herb layer cover and a second, taller herb layer. This meadow was tucked into an area with a very steep hydrological gradient that supported two meadow types that are widespread and abundant at Keno reservoir. The first was the taller marsh vegetation that included hardstem bulrush, cattail (*Typha latifolia*), beggarstick, climbing nightshade (*Solanum dulcamera*), waterpepper, and broad-fruited bur-reed (*Sparganium eurycarpum*). The second meadow type was slightly shorter than the first and is often much “weedier” and disturbed. This meadow type occurred in areas slightly more upland; stinging nettle (*Urtica dioica*), western goldenrod, catnip (*Nepeta catipa*), prickly sowthistle, prickly lettuce, Eaton’s aster (*Aster* cf. *eatonii*), Canada thistle, poison hemlock, bull thistle, teasel, and Bigelow’s sneezeweed were among the most frequent species.

The taller meadow vegetation types were often adjacent to or inter-mingled with dense mats of saltgrass meadow or taller meadows of bearded wheatgrass. These species often formed a dense areal cover, preventing other species from invading. California rose (*Rosa californica*) (possibly, also *Rosa woodsii*) formed thickets in some areas adjacent to these meadows and the reservoir. Dense patches of introduced species, such as intermediate wheatgrass and tall wheatgrass, were not uncommon.

J.C. Boyle reservoir, Keno reservoir, and J.C. Boyle peaking reach each had one sampled stand with two distinctive herb layers. The taller herb layer in these meadows was mostly hardstem bulrush 5 to 8 feet (1.5 to 2.5 m) in height. The presence of two herb layers was not called out in sampled wetlands unless the two-tiered structure was a dominant aspect of the sampled stand. There were four herb layers that were very low growing, two each in both J.C. Boyle and Keno reservoirs; these include the two shorter herb layers in the two-tiered meadows and the single herb layer in two other sampled stands. The low-growing herb layers ranged from 0.3 to 1.0 foot (0.1 to 0.3 m). The shorter herb layer in the J.C. Boyle peaking reach stand (2.6 feet [0.8 m]) was comparable to the remaining one-tiered herb layers in other sampled stands, which ranged from 1.6 to 6.6 feet (0.5 to 2.5 m).

The average areal cover of the herb layer for all sampled stands was 98.0 ± 17.3 percent (Table 2.7-3). Total areal herb layer covers ranged from a low of 80 percent in one J.C. Boyle peaking reach stand to a high of 155 percent cover in one J.C. Boyle reservoir stand. The areal cover of the taller herb layers was variable: cover values were 5 percent in J.C. Boyle peaking reach, 25 percent at J.C. Boyle reservoir, and 75 percent at Keno reservoir.

Palustrine Shrub-Scrub Wetland (PSS)

PSS wetlands were distributed over 30 acres (12 ha) or 0.06 percent of the study area (Table 2.7-2; Figure 2.7-1) in 8 of 11 Project sections. More than 80 percent or 24.4 acres (10 ha) of the PSS wetlands occurred adjacent to the four Project reservoirs. The average polygon size of PSS wetlands on the Project vegetation map was 0.56 ± 0.67 acres (0.2 ± 0.3 ha).

In total, seven tree, 19 shrub, and 98 herbaceous plant species were documented in the 16 shrub-dominated wetland plots sampled in 2002. Average tree cover was 36.8 ± 39.6 percent (Table 2.7-5), while shrub cover averaged 55.9 ± 44.7 percent (Table 2.7-4).

Coyote willow (*Salix exigua*), Oregon ash, and arroyo willow (*Salix lasiolepis*) were the primary hydrophilic shrubs in PSS wetlands; they occurred in 75, 44, and 31 percent of sampled stands, respectively. Coyote willow often grows in dense stands with many stems per acre, especially at Iron Gate and Copco reservoirs. The distinction between the shrub and tree growth form of coyote willow often was not clear. Some of the PSS wetlands described here included a shrub layer comprised of both a multi-branched shrub layer and a taller, dense thicket of small-diameter, single-stemmed “trees” that frequently fall over and sprout numerous lateral branches into the shorter shrub layer. Coyote willow was the dominant shrub layer species in 75 percent of the sampled PSS wetlands from J.C. Boyle reservoir to Iron Gate reservoir. Oregon ash was a ubiquitous shrub layer species occurring in seven of 11 sampled wetlands in Fall Creek and at Iron Gate and Copco reservoirs, but not at J.C. Boyle reservoir and the Link River. Arroyo willow is more abundant upriver and upslope: this species was most frequent in sampled stands at Fall Creek, J.C. Boyle reservoir, and Keno reservoir.

Other shrub and tree layer species growing in PSS wetlands around Iron Gate reservoir included trees of Oregon ash, trees and saplings of shining willow (*Salix lucida* spp. *lasiandra*), and shrub growth forms of Himalayan blackberry, poison oak, three-leaf sumac, and Oregon oak. Additional shrub layer species in stands sampled at Copco reservoir included only western juniper saplings. The sampled stands in the Fall Creek reach also included shrub growth forms of arroyo willow, Himalayan blackberry, and three-leaf sumac, in addition to Oregon oak trees. The only shrub layer species in the Link River wetland was arroyo willow.

The PSS wetlands at J.C. Boyle reservoir along Spencer Creek were among the most diverse and had many species unique to the shrub layer. These wetlands were dominated by arroyo willow, coyote willow, dense-flowered spiraea (*Spiraea densiflora*), and red osier dogwood (*Cornus sericeus*). Two of the four sampled stands at the reservoir margin had a large complement of slightly more upland species including chokecherry, Sierra plum, western serviceberry, snowberry, and dense-flowered spiraea. These sites were not obviously wetlands, but the pool level was exerting at least some influence on the species composition of these shrub-rich sites. The fourth sampled stand had only arroyo willow, chokecherry, and mock orange in the shrub layer stands.

There were 11 herb layer species that occurred in three of the five sampled Project sections: teasel, bull thistle, western goldenrod, cheatgrass, hairy brome, Kentucky bluegrass, mullien, colonial bentgrass, gray rabbitbrush, prickly lettuce, and Canada thistle. Each of the sampled Project sections had at least some unique herb layer species. The relationship of herbaceous species in PSS wetlands throughout the study area will be more fully elucidated in the riparian/wetland characterization (see Section 3.0).

The vegetation layers at Copco and Iron Gate reservoirs and at two of three Fall Creek wetlands were the most structurally diverse. Ten of the 11 sampled stands in these Project section had a tall “tree” layer ranging in height from 21.6 to 32.8 feet (6.5 to 10 m) and a shorter, sparser shrub layer ranging in height from 6.6 to 16.4 feet (2 to 5 m). The two vegetation layers were comprised primarily of coyote willow with some Oregon ash. Three of these stands had another shorter shrub layer ranging in height from 4.3 to 6.6 feet (1.3 to 2.0 m). The shortest shrub layer consisted of any number of shrub layer species listed above. The third Fall Creek wetland had a tall, sparse Oregon oak layer above the shorter arroyo willow shrub layer.

Two of the four sampled PSS wetlands in J.C. Boyle reservoir were small in area and were surrounded by ponderosa pine forest. Pine trees approximately 33 to 66 feet (10 to 20 m) in height were recorded in these PSS plots. The shrub layer was two-tiered in one of the plots with chokecherry and western serviceberry that were 16 feet (5 m) in height. The shorter shrub layers in these plots were both 4.9 feet (1.5 m) tall with snowberry and spiraea. The other two sampled plots at J.C. Boyle reservoir had dense willow shrub layers 9.8 to 13.1 feet (3 to 4 m) in height.

The sampled PSS wetland at Link River had a sparse, tall tree layer of naturalized elm (*Ulmus* sp.) approximately 43 feet (13 m) in height. The single shrub layer of arroyo willow was 8.2 feet (2.5 m) tall.

Shrub layer cover ranged from 10 to 153 percent in sampled plots. The areal cover of the herb layer averaged 53.4 ± 34.5 percent. The herb layer cover varied inversely with shrub layer cover, except when the wetlands were small in area and light was able to penetrate horizontally into the herb layer. Herb layer heights were often low and matted in wetland with low light. Tall, weedy herbs often were present in any openings in the dense canopy.

Palustrine Forested Wetlands (PFO)

PFO wetlands are distributed over 118.5 acres (48 ha) or 0.2 percent of the study area (Table 2.7-2; Figure 2.7-1) in seven of 11 Project sections. More than 80 percent or 95.9 acres (38.8 ha) of the PFO wetlands occur adjacent to Copco and Iron Gate reservoirs. The average polygon size of PFO wetlands on the Project vegetation map was 3.2 ± 5.8 acres (1.3 ± 2.3 ha).

In total, ten tree, 15 shrub, and 104 herbaceous plant species were documented in the 20 tree-dominated wetland plots sampled in 2002.

Oregon ash, white alder (*Alnus rhombifolia*), coyote willow, and shining willow are the primary hydrophilic tree species in PFO wetlands; they occur in 60, 25, 25 and 25 percent of sampled stands, respectively. Weeping willow (*Salix babylonica*) was the dominant tree layer species in one of the Keno reservoir wetlands. Oregon oak, black oak, and bigleaf maple commonly occurred in the tree layer, especially downriver. The dominant tree layer species varied by Project section. The most consistently occurring species at Iron Gate and Copco reservoirs and at Copco No. 2 bypass were Oregon ash and Oregon oak. Shining willow and coyote willow also were sampled at Iron Gate reservoir. White alder occurred only in sampled stands at Iron Gate and Copco reservoirs. At Keno reservoir, the two sampled stands had different dominant tree layer species—shining willow and weeping willow.

The tree tally data (Appendix 2C) for the PFO wetlands revealed that the average tree diameters ranged from 4.6 to 21.5 inches (10.3 to 45.6 cm) dbh. The basal area averages for all sampled stands ranged from 10.8 feet^2/acre (2.5 m^2/ha) in one Copco No. 2 bypass stand to 638.9 feet^2/acre (146.6 m^2/ha) in one stand at Keno reservoir. The average basal area per plot was 118 ± 154.1 feet^2/acre (27.1 ± 35.4 m^2/ha). PFO wetlands averaged 171 ± 164 trees per acre.

PFO wetlands sampled at Copco and Iron Gate reservoirs shared the following shrub layer species: Oregon ash, three-leaf sumac, western juniper, coyote willow, Oregon oak, and poison oak. Brown dogwood (*Cornus glabrata*) and arroyo willow were the only shrub layer species in the two Copco No. 2 bypass wetlands. The two Keno reservoir wetlands had no shrub layer. Total shrub cover was 35.1 ± 22.7 percent (Table 2.7-4).

There were five herb layer species that occurred in more than 30 percent but less than 60 percent of the sampled stands: hedge parsley, blue wildrye, Oregon grape, curly dock, and cheatgrass. Six species occurred only at Iron Gate and Copco reservoirs and Copco No. 2 bypass: Oregon grape, bugle hedgenettle, medusahead, common rush, California grape (*Vitis californica*), and yarrow (*Achillea millefolium*). Eight herb layer species occurred from Keno reservoir to Iron Gate and Copco reservoirs; these included cheatgrass, stinging nettle, bur chervil, Canada thistle, morning glory, sweet clover (*Melilotus alba*), beggarstick; and broadleaf cattail (*Typha latifolia*).

The tree layer was two-tiered in three PFO stands at Iron Gate reservoir. The shorter tree layer in two stands consisted of coyote willow under a taller tree layer comprised of shining willow and Oregon ash. The shorter tree layer in the third PFO stand was shining willow and Oregon ash under a tall tree layer of white alder. The shorter tree layers ranged in height from 14.8 to 26 feet (4.5 to 8 m). The average height of taller tree layers and all one-tiered tree layers was 37.4 ± 14.8 feet (11.4 ± 4.5 m). The average areal cover for the tree layer was 65.8 ± 22.7 percent (Table 2.7-5).

2.7.2.6 Riparian Habitats

The description of riparian cover types in this section is brief in lieu of the more detailed descriptions provided in Section 3.0.

Riparian Grass Habitat (RG)

The riparian grass cover type was distributed over 59 acres (23.9 ha) or 0.001 percent of the study area (Table 2.7-2; Figure 2.7-1) in seven Project sections. There was some riparian grass mapped within reservoir sections as a result of the way the section boundaries are drawn on the Project maps. There were 6.9 acres (2.8 ha) of riparian grass mapped along the Iron Gate-Shasta section, 13.8 acres (5.6 ha) in the J.C. Boyle peaking reach, 20.2 acres (8.2 ha) in the J.C. Boyle bypass, 13.4 acres (1.4 ha) mapped in Keno Canyon, and 2.7 acres (1.1 ha) mapped in the Link River. The average polygon size of the riparian grass habitat on the Project vegetation map was 0.48 ± 0.54 acres (0.19 ± 0.22 ha).

In total, four shrub and 68 herbaceous plant species were documented in the 12 riparian grass plots sampled in 2002.

Reed canarygrass was the only herb layer species present in all four of the sampled river reaches: Iron Gate-Shasta section, J.C. Boyle peaking reach, Keno Canyon, and Link River. (There is no plot data for riparian grass habitats in the J.C. Boyle bypass). Six species occurred in 50 to 67 percent of sampled habitats; these species included hardstem bulrush, climbing nightshade, curly dock, rice cutgrass, and water smartweed (*Polygonum amphibium*). Total herbaceous cover averaged 89.3 ± 13.1 percent (Table 2.7-3).

Riparian Shrub Habitat (RS)

The riparian shrub habitats were distributed over 121.1 acres (49.0 ha) or 0.24 percent of the study area (Table 2.7-2; Figure 2.7-1) in eight of 11 Project sections. There was 56.3 acres (22.8 ha) of riparian grass mapped along the Iron Gate-Shasta section, 32.5 acres (13.2 ha) in the J.C. Boyle peaking reach, 11.4 acres (4.6 ha) in the J.C. Boyle bypass, 6.9 acres (2.8 ha) mapped in Keno Canyon, and 11.3 acres (4.6 ha) mapped in the Link River. The average polygon size of the riparian grass habitat on the Project vegetation map was 0.79 ± 1.0 acre (0.32 ± 0.42 ha).

In total, six tree, 14 shrub, and 80 herbaceous plant species were documented in the 13 shrub-dominated riparian plots sampled in 2002.

Coyote willow, arroyo willow, and Oregon ash saplings were the primary hydrophilic shrubs in riparian shrub habitats; they occurred in 62, 54, and 23 percent of sampled stands, respectively. Coyote willow often grew in dense stands with many stems per acre, especially on gravel bars in the Iron Gate-Shasta reach. As discussed above, the distinction between the shrub and tree growth form of coyote willow often was not clear. Coyote willow was the dominant shrub layer species in 85 percent of the sampled riparian shrub habitats from the Link River to the Iron Gate-Shasta section. Arroyo willow was more abundant than coyote willow in one stand each in both J.C. Boyle bypass and the Link River reach. Himalayan blackberry was abundant in stands in the Link River and the Iron Gate-Shasta section. Chokecherry was present in all sampled sections except the J.C. Boyle bypass.

Herb cover averaged 89.3 ± 13.1 percent (Table 2.7-3). Reed canarygrass was abundant in Keno Canyon, J.C. Boyle bypass, and Link River. Oddly, reed canarygrass was not picked up in the J.C. Boyle peaking reach plots, stressing the importance of Section 3.0, which will provide a more complete description of riparian shrub habitats.

Riparian Deciduous Habitat (RD)

Riparian deciduous habitats were distributed over 365.1 acres (147.8 ha) or 0.7 percent of the study area (Table 2.7-2; Figure 2.7-1) in nine of 11 Project sections. More than 70 percent or 257.9 acres (104 ha) of the riparian deciduous habitat occurred along the J.C. Boyle peaking reach and the Iron Gate-Shasta reach. There were 87.9 acres (35.6 ha) of riparian deciduous habitat mapped along the Iron Gate-Shasta section, 23.1 acres (9.4 ha) in the Copco No. 2 bypass, 2.1 acres (0.9 ha) in Fall Creek, 170.0 acres (68.8 ha) in the J.C. Boyle peaking reach, 0.5 acre (0.2 ha) in the J.C. Boyle bypass, 0.8 acre (0.3 ha) at Keno reservoir, and 19.8 acres (8.0 ha) mapped in the Link River reach. More than 16 percent or 60.9 acres (24.7 ha) of riparian deciduous habitat were mapped along major tributaries to Copco and Iron Gate reservoirs, including Jenny Creek, Scotch Creek, Dutch Creek, and Beaver Creek. The average polygon size of PFO wetlands on the Project vegetation map was 2.3 ± 6.8 acres (0.93 ± 2.8 ha).

In total, 12 tree, 20 shrub, and 137 herbaceous plant species were documented in the 19 tree-dominated riparian plots sampled in 2002.

Oregon ash, coyote willow, western birch (*Betula occidentalis*), and white alder were the primary hydrophilic trees in riparian deciduous forest; they occurred in 74, 26, 16, and 11 percent of sampled stands, respectively. Oregon oak was the second most frequent (31 percent) tree in sampled stands. Western birch was present only in the Copco No. 2 bypass and the Link

River reaches. Black oak, ponderosa pine, and bigleaf maple occurred infrequently in sampled stands. Shining willow is a dominant tree in some riparian forests particularly in the Iron Gate-Shasta reach, but was sampled in only one stand at the Link River.

The tree tally data (Appendix 2C) for the riparian deciduous habitats revealed that the average tree diameters ranged from 4.8 to 30.7 inches (1.9 to 12.4 cm) dbh. The basal area averages for all sampled stands ranged from 15.9 feet^2/acre (3.6 m^2/ha) in one Link River stand to 299.6 feet^2/acre (68.8 m^2/ha) in one stand at J.C. Boyle peaking reach. The average basal area per plot was 103.9 ± 67.5 feet^2/acre (23.8 ± 15.5 m^2/ha). Riparian deciduous habitats averaged 179 ± 134 trees per acre.

Shrub cover averaged 55.6 ± 25.8 percent (Table 2.7-4). There were only four shrub layer species that occurred in more than 23 percent and less than 58 percent of sampled habitats: Oregon ash saplings, three-leaf sumac, Himalayan blackberry, and brown dogwood. Oregon ash occurred in ten of 19 sampled stands and in all sampled sections excluding Link River. Himalayan blackberry occurred in seven of 19 sampled stands and was particularly abundant in many sites along the Iron Gate-Shasta section, J.C. Boyle peaking reach, and the Link River reach. Brown dogwood occurred in five of seven sampled stands in Copco No. 2 bypass, the peaking reach, and the Link River reach. Three-leaf sumac occurred in the three stands in the Iron Gate-Shasta reach, one stand in the Copco No. 2 bypass, and one stand in the J.C. Boyle peaking reach. It is difficult to summarize the shrub layer species because there is so much uneven overlap of shrub species within and between Project sections. The shrub layer species composition of riparian deciduous habitats took on the “local flavor” of shrubs species growing in adjacent cover types. The discussion of the MXC cover types helps shed some light on the shrub distribution in the study area.

There were nine herb layer species that occurred in more than 30 percent but less than 53 percent of the sampled stands: curly dock, bur chervil, reed canarygrass, ripgut brome (*Bromus diandrus*), blue wildrye, field pepperweed (*Lepidium campestris*), bugle hedgenettle, mullien, and velvet grass. The species composition of the herb layer of riparian deciduous habitats is similar to the herb layer for PFO wetlands. All of the following common herb layer species occur in both cover types, but in somewhat different proportions: Oregon grape, bugle hedgenettle, medusahead, common rush, California grape, yarrow, cheatgrass, stinging nettle, bur chervil, Canada thistle, morning glory, sweet clover, beggarstick, and broadleaf cattail.

The tree layer in two of the sampled riparian deciduous stands in the J.C. Boyle peaking reach had a two-tiered tree layer. The taller tree layers in both stands were large, thinly dispersed ponderosa pine trees. The shorter tree layer in one stand was Oregon ash and white alder. The shorter tree layer in the second stand was Oregon ash, Oregon oak, and black oak. Excluding the pine layers, the average height of the tree layer in riparian deciduous stands was 47.6 ± 16.7 feet (14.5 ± 5.1 m). The taller pine layers were both approximately 82 feet (25 m) in height. The average areal cover for the tree layer was 54.9 ± 26.3 percent (Table 2.7-5).

<u>Riparian Mixed Deciduous-Coniferous Habitat (RM)</u>

Riparian mixed deciduous-coniferous habitats are distributed over 51.7 acres (20.9 ha) or 0.10 percent of the study area (Table 2.7-2; Figure 2.7-1) in only three of 11 Project sections. There are 37.8 acres (15.3 ha) of RM habitat mapped at Fall Creek, 12.0 acres (4.9 ha) in the J.C. Boyle peaking reach, and 1.9 acres (0.8 ha) around the upstream end of Copco reservoir. The average polygon size of RM habitats on the Project vegetation map was 4.0 ± 5.4 acres (1.6 ± 2.2 ha).

In total, eight tree, 12 shrub, and 49 herbaceous plant species were documented in the five tree-dominated riparian plots sampled in 2002.

There were four RM stands sampled in Fall Creek and one in the J.C. Boyle peaking reach. The dominant tree layer species in all five stands were Douglas-fir and white alder. Oregon ash was in the tree layer of all sampled stands, but at low areal cover. The RM stands in Fall Creek occurred in a narrow strip along Fall Creek. Western birch was present in three stands. Oregon ash, black oak, and ponderosa pine were present in one or two stands. The sampled RM stand in the J.C. Boyle peaking reach had Oregon oak in the tree layer.

The tree tally data (Appendix 2C) for the riparian mixed deciduous-coniferous habitat revealed that the average tree diameters range from 5.9 to 12.6 inches (12.6 to 26.7 cm) dbh. The basal area averages for all sampled stands ranged from 61.6 feet^2/acre (14.1 m^2/ha) in the J.C. Boyle peaking reach to 280.5 feet^2/acre (64.4 m^2/ha) in one of the Fall Creek stands. The average basal area per plot was 141.8 ± 94.6 feet^2/acre (32.5 ± 21.7 m^2/ha). Riparian deciduous habitats averaged 284.0 ± 134 trees per acre.

Western serviceberry was present in all sampled stands. The Fall Creek stands all had white alder saplings, arroyo willow, dense-flowered spiraea, poison oak, ninebark (*Physocarpus capitatus*), and snowberry. The shrub layer species in the J.C. Boyle peaking reach stand were coyote willow, chokecherry, and ponderosa pine saplings. Total shrub cover in the riparian mixed deciduous-coniferous habitat plots averaged 54.0 ± 19.8 percent (Table 2.7-4).

Total herb cover averaged 29.0 ± 30.7 percent and height averaged 2.2 ± 0.5 feet (0.7 ±0.2 m) (Table 2.7-3). The herb layer species common to all sampled stands were Oregon grape, blue wildrye, and velvet grass. Some of the more abundant species in the Fall Creek stands were Oregon grape, low-growing snowberry, and red osier dogwood seedlings. Abundant herb layer species in the J.C. Boyle peaking reach stand were poison oak, California grape, Idaho fescue, and California lomatium (*Lomatium californicum*). A taller herb layer with reed canarygrass and beggarstick was present along the river.

The average height of the tall, coniferous tree layer in the Fall Creek stands was 65.6 ± 9.2 feet (20.0 ± 2.8 m). The J.C. Boyle stand did not have a two-tiered tree canopy. The average height of the tree layer in all stands excluding the taller tree layers was 34.1 ± 8.2 feet (10.4 ± 2.5 m). The average total tree layer cover was 80.6 ± 22.3 percent (Table 2.7-5).

2.7.2.7 Barren Habitats

The following sections describe the various non-vegetated cover types.

<u>Rock Talus (RT)</u>

Rock talus habitats were distributed over 559 acres (226 ha) or 1.1 percent of the study area (Table 2.7-2; Figure 2.7-1) in six of 11 Project sections. This habitat is particularly abundant in the J.C. Boyle peaking reach, covering 429 acres (174 ha). Most rock talus habitats are barren with small patches of vegetation where the talus is thin or at the margins of the talus patch. The average polygon size of tock talus habitats on the Project vegetation map was 4.9 ± 16.1 acres (2.0 ± 6.9 ha).

In total, two trees, seven shrub, and 23 herbaceous plant species were documented in the rock talus habitats sampled in 2002.

The one sampled stand at Copco reservoir had one clump of poison oak and a few scattered herb layer species. The areal cover of the shrub layer was less than 10 percent and the height was approximately 3.3 feet (1.0 m). Hedge parsley, woolly sunflower (*Eriophyllum lanatum*), squirreltail, cheatgrass, blue bunch wheatgrass, and orange honeysuckle (*Lonicera ciliosa*) were herb layer species. The cover of the herb layer in the Copco reservoir stands was less than 1 percent.

The three rock talus habitats sampled in the J.C. Boyle peaking reach were more species rich and had denser vegetation cover than the Copco reservoir plot. Oregon oak, deerbrush, and western serviceberry were present in two of the three sampled habitats. In one of these sites, there was also black oak in the tree layer and poison oak and mock orange in the shrub layer. The third sampled stand had Sierra plum in the shrub layer and a patchy cover of cheatgrass in the herb layer. Bulbous bluegrass and ciliate brome (*Bromus ciliatus*) were the most abundant herb layer species in the J.C. Boyle peaking reach.

The average shrub cover for the rock talus habitats was 13.8 ± 10.9 percent; the herb layer cover was 7.0 ± 12.0 percent and the tree layer cover was 5.3 ± 9.8 percent.

<u>Exposed Rock Habitats (ER)</u>

Exposed rock habitats were distributed over 367 acres (148 ha) or 0.71 percent of the study area (Table 2.7-2; Figure 2.7-1) in nine of 11 Project sections. This habitat was mapped in all Project sections, except at Keno reservoir and the Link River. Exposed rock is most abundant in the J.C. Boyle peaking reach (116.2 acres [47.1 ha]), the J.C. Boyle bypass (68.5 acres [27.7]), and Copco No. 2 bypass (68.1 acres [27.6 ha]). The average polygon size of exposed rock habitats on the Project vegetation map was 8.9 ± 15.0 acres (3.6 ± 6.1 ha).

In total, four trees, three shrub, and 51 herbaceous plant species were documented in the six exposed rock habitats sampled in 2002.

The most frequent species found on rock outcrops included cheatgrass (83 percent), bulbous bluegrass (83 percent), low-growing gray rabbitbrush (67 percent), and bluebunch wheatgrass (67 percent). However, a wide variety of species creep into the rock outcrop habitat from adjacent cover types. Some of the species that appear to be most clearly aligned with rock outcrop habitats include naked-stemmed buckwheat (*Eriogonum nudum*), woolly sunflower, spectacular penstemon (*Penstemon speciosa*), foxtail fescue, and variable-leaf phacelia. The principal shrub species found on rock outcrops included western juniper saplings, wedgeleaf ceanothus, and three-leaf sumac.

The average herb layer cover for the rock outcrop habitats was 35.0 ± 23.9 percent (Table 2.7-3); the shrub layer cover was 22.0 ± 16.1 percent (Table 2.7-4), and tree cover was less than 3 percent (Table 2.7-5).

2.7.2.8 Riverine Habitats (RUS)

Riverine unconsolidated shoreline or "gravel" bar habitats were sampled only in the Iron Gate-Shasta reach. The two sampled gravel bars have no species in common and are located in different positions on an elevation gradient relative to the river. The ecology of sites like these is fully investigated in Section 3.0.

2.7.3 Coarse Wood, Snags, Small Wood Cover

The importance of snags and down wood to wildlife is well documented (Butts and McComb, 2000; Bull et al. 1997). There are no specific standards for snags in the Northwest Forest Plan (USFS and BLM, 1994); however, the Klamath Falls Resource Area Resource Management Plan (BLM, 1995) calls for maintaining the number of snags needed to support at least 60 percent of the maximum biological potential of cavity-nesting species over time. Each of these species uses snags of different sizes and decay classes (Table 2.7-8). The pileated woodpecker (*Drycopus pileatus*), for example, requires large, hard snags, generally more than 25 inches (63.5 cm) dbh and in decay classes 1, 2, or 3.

To determine if the study area met the guidelines in the Klamath Falls Resource Management Plan (RMP) (BLM, 1995), snag data were grouped into the size categories and decay classes used by six primary cavity-nesting species known from the vicinity (Table 2.7-8). This exercise allowed snags of different decay classes and sizes to be combined to estimate the number available per 100 acres (40.5 ha) for each species.

Table 2.7-8. Snag requirements of cavity-nesting species in the Klamath River study area.

Species	Snag dbh (inches)	Snag Decay Class[1]	Maximum Avian Density (pairs/100 acres)	Number of Snags Needed/100 Acres[1]		BLM (1995) Snag Retention Goal[2]
				100 percent Maximum Population	60% Maximum Population[2]	
Red-Breasted Sapsucker *Sphyrapicus rubra*	15+	2-3	11.3	45	27	1.4 snags/acre on East Side and 1.9/acre on West Side (size class not indicated)
Downy Woodpecker *Picoides pubescens*	11+	4-5	2	16	10	
Hairy Woodpecker *P. villosus*	15+	4-5	16	192	115	
Acorn Woodpecker *Melanerpas formicivorus*	17+	1-3	12	70	42	
Lewis' Woodpecker *M. lewis*	17+	4-5		48	29	
Pileated Woodpecker *Drycopus pileatus*	25+	1-3	0.5	6	4	

1 Source: Nietro et al. (1985).

2 The standard for snags in the Klamath Falls Resource Management Plan (BLM, 1995) is the number required to support at least 60 percent of the maximum biological potential of cavity-nesting species over time.

The density of snags more than 11 inches (27.8 cm) dbh ranged from zero snags/acre in non-forested cover types to 10.1 ± 14.3 snags/acre in riparian mixed deciduous-coniferous forest, but overall, averaged 1.4 ± 5.2 snags/acre across all plots in all cover types (Table 2.7-9). The one lodgepole pine (*Pinus contortae*) stand sampled had an unusual number of large diameter snags, but these snags were highly decayed (decay stage 7 or more) and relatively short, being 4 to 5 feet (1.2 to 1.5 m) in height. The density of large snags more than 25 inches (62.5 cm) dbh was low in all cover types, except the Klamath mixed conifer, riparian mixed, and lodgepole pine forest. When extrapolated to 100 acres, the study area provides at least 60 percent of the maximum population needs for all six species. Riparian deciduous, riparian mixed, and riparian shrub types all greatly exceeded the amount needed to provide for 100 percent of the maximum biological potential for all species except acorn (*Melanerpas formicivorus*), pileated, and Lewis woodpeckers (*M. lewis*), which require large snags (Table 2.7-8). However, 20 forested wetlands met the 60 percent level for all species except the hairy woodpecker (*Picoides villosus*). Scrub-shrub wetlands had adequate snags for all species except pileated woodpecker.

Table 2.7-9. Density (number/acres) of snags of different minimum diameter in each cover type.

Cover Type	N	All Snags		>11 Inches		>15 Inches		>17 Inches		>21 Inches		>25 Inches	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Upland Tree Habitats													
Montane Oak	25	3.6	6.5	1.2	3.4	0.8	2.8	0.4	2	0	0	0	0
Oak-Conifer	17	8.3	12	5.4	8.1	4.2	6.3	3.6	6.1	2.4	5.7	1.2	3.4
Oak-Juniper	20	4	8.3	1	3.1	0.5	2.3	0.5	2.3	0.5	2.3	0	0
Juniper	11	3.7	12.2	2.8	9.2	2.8	9.2	1.8	6.1	0.9	3.1	0	0
Mixed Conifer	6	18.5	17.4	5.1	5.5	3.4	5.2	3.4	5.2	3.4	5.2	3.4	5.2
Lodgepole Pine	1	30.4		30.4		30.4		30.4		30.4		20.2	
Ponderosa Pine	14	6.5	10.9	2.9	6.2	2.2	4.3	1.4	3.7	0.7	2.7	0	0
Upland Shrub Habitat													
Mixed Chaparral	30	0.3	1.8	0	0	0	0	0	0	0	0	0	0
Rabbitbrush	2	0	0	0	0	0	0	0	0	0	0	0	0
Sagebrush	4	0	0	0	0	0	0	0	0	0	0	0	0
Upland Herb Habitats													
Annual Grassland	21	0	0	0	0	0	0	0	0	0	0	0	0
Perennial Grassland	13	0	0	0	0	0	0	0	0	0	0	0	0
Wetland Habitats													
Palustrine Emergent	25	0	0	0	0	0	0	0	0	0	0	0	0
Palustrine Shrub	16	1.9	5.5	1.3	5.1	1.3	5.1	1.3	5.1	0.6	2.5	0	0
Palustrine Forest	20	6.1	7.6	0.5	2.3	0.5	2.3	0.5	2.3	0.5	2.3	0.5	2.3
Riparian Habitats													
Riparian Grassland	12	0	0	0	0	0	0	0	0	0	0	0	0
Riparian Shrub	13	7.8	18.1	3.1	11.2	1.6	5.6	1.6	5.6	0.8	2.8	0	0
Riparian Deciduous	19	9.6	14.1	0.5	2.3	0.5	2.3	0	0	0	0	0	0
Riparian Mixed	5	16.2	18.4	10.1	14.3	4	5.5	4	5.5	4	5.5	4	5.5
Barren Habitats													
Rock Talus	4	0	0	0	0	0	0	0	0	0	0	0	0
Exposed Rock	6	0	0	0	0	0	0	0	0	0	0	0	0
Aquatic Habitats													
Riverine Unconsolidated Bottom	2	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Developed													
Pasture-Irrigated Hayfield	9	0	0	0	0	0	0	0	0	0	0	0	0
Total	**295**	**3.8**	**9.3**	**1.4**	**5.2**	**1**	**3.9**	**0.8**	**3.5**	**0.6**	**2.9**	**0.3**	**1.9**

N = Number.
S.D. = Standard deviation.

However, it should be noted that the Klamath Falls RMP standards and guidelines for snags are based on recommendations by Thomas et al. (1979) and Brown (1985), and more recent research indicates that greater numbers of snags are needed to provide for wildlife habitat needs and ecosystem function than were previously thought (Rose et al. 2001).

The Northwest Forest Plan calls for at least 120 linear feet (36 m) of logs greater than 16 inches (41 cm) diameter and 16 feet (4.9 m) in length per acre (0.4 ha) in matrix lands (USFS and BLM, 1994). This standard considers only logs of composition classes 1 and 2. The average total length of CWD per acre for decay class 1 logs was highest in the KMC stands (425.9 ± 745.1 feet/acre [329.0 ± 575.6 m/ha]) (Table 2.7-10). The average total length of CWD per acre for decay class 2 logs was highest for the ponderosa pine (90 ± 257.2 feet/acre [69.5 ± 198.7 m/ha]) cover type. However, the average total length of class 2 logs was similar to several other cover types, including riparian deciduous forest (84.9 ± 176.7 feet/acre [65.6 ± 136.5 m/ha]), montane hardwood oak-conifer (72.2 ± 213.9 feet/acre [55.8 ± 165.2 m/ha]), KMC (63.6 ± 155.8 feet/acre [49.1 ± 120.4 m/ha]), and riparian shrub (59.2 ± 135.9 feet/acre [45.7 ± 105.0 m/ha]).

The Klamath Falls RMP standard for CWD retention in matrix land on the West Side matches the Northwest Forest Plan; East Side management criteria call for a minimum of 50 feet (15.2 m) of logs per acre more than 12 inches (30.5 cm) in diameter (BLM, 1995) and 8 feet (2.4 m) long. There are six cover types that exceed these criteria as calculated for all decay classes combined (Table 2.7-11): KMC, riparian mixed forest, MHO-conifer woodland, ponderosa pine forest, juniper woodland, and MHO woodland. KMC forest exceeded the criteria only in classes 1, 2, and 3. Ponderosa pine exceeded the criteria only for class 4 logs. Riparian mixed forest exceeds the criteria in decay classes 3 and 4. MHO stands exceeded the criteria only in decay class 1. Juniper woodland did not exceed the criteria of having 50 feet (15.2 m) of logs more than 12 inches (30.1 cm) in diameter and 8 feet (2.4 m) in length in any of the decay classes, but managed to exceed the criteria in all four decay classes.

Down wood volumes are reported in a number of studies and are extremely variable, depending on seral stage, management, and forest type. A review of data from a number of forest types in montane mixed conifer habitats in Oregon and Washington indicates that average down wood volumes were 1,459, 1,608, and 2,837 feet^3/acre (102, 113, and 199 m^3/ha) for early-, mid-, and late-successional stands, respectively (Ohmann and Waddell as cited in Rose et al. 2001). More specifically, a study of managed, low elevation forests in western Oregon reported that volumes of down wood with more than 4 inches (10 cm) large-end diameter ranged from 200 to 12,284 feet^3/acre (14 to 859 m^3/ha) (Butts and McComb, 2000). In comparison, unmanaged stands in western Oregon with trees less than 80 years old averaged 3,546 feet^3/acre (248 m^3/ha) of down wood of more than 4-inch (10-cm) large-end diameter size; mature stands (80- to 120-year-old trees) averaged 2,116 feet^3/acre (148 m^3/ha); and old growth stands (400- to 500-year-old trees) averaged 4,475 feet^3/acre (313 m^3/ha) (Spies and Cline, 1988). In another study of unmanaged forests in Oregon and Washington, average down wood volume ranged from 1,773 feet^3/acre

Table 2.7-10. Total length of coarse woody debris per acre in each cover type and decay class.

Cover Type	N	Class 1		Class 2		Class 3		Class 4		Class Unknown		All Classes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Upland Tree Habitats													
Montane Oak	25	62.4	268	22.6	81.7	13.3	66.4	0	0	0	0	98.2	300
Oak-Conifer	17	31.2	129	72.2	214	57.6	135	87.8	225	0	0	249	322
Oak-Juniper	20	10	44.5	12.4	39.1	11.6	51.9	30.7	94.5	0	0	64.7	124
Juniper	11	0	0	21.1	70	45.3	101	0	0	0	0	66.4	154
Mixed Conifer	6	426	745	63.6	156	277	428	74.7	134	0	0	841	603
Lodgepole Pine	1	0		0		0		0		0		0	
Ponderosa Pine	14	71.1	192	90.1	257	66.4	186	59.3	222	0	0	287	348
Upland Shrub Habitat													
Mixed Chaparral	30	0	0	0	0	0	0	0	0	0	0	0	0
Rabbitbrush	2	0	0	0	0	0	0	0	0	0	0	0	0
Sagebrush	4	0	0	0	0	0	0	0	0	0	0	0	0
Upland Herb Habitats													
Annual Grassland	21	0	0	0	0	0	0	0	0	0	0	0	0
Perennial Grassland	13	0	0	0	0	0	0	0	0	0	0	0	0
Wetland Habitats													
Palustrine Emergent	25	34.5	173	0	0	12.6	63.1	25.9	86	0	0	73	201
Palustrine Shrub	16	65.3	184	0	0	22.8	91.3	0	0	0	0	88.1	198
Palustrine Forest	20	16.6	74.2	29.9	75.3	32.9	75.3	26.9	70.4	3.7	16.3	110	175
Riparian Habitats													
Riparian Grassland	12	0	0	0	0	0	0	0	0	0	0	0	0
Riparian Shrub	13	0	0	59.2	136	0	0	0	0	0	0	59.2	136
Riparian Deciduous	19	16.6	72.3	84.9	177	33.2	82	7	30.5	0	0	142	235
Riparian Mixed	5	0	0	0	0	126	182	179	401	0	0	305	562
Barren Habitats													
Rock Talus	4	0	0	0	0	0	0	0	0	0	0	0	0
Exposed Rock	6	0	0	0	0	0	0	0	0	0	0	0	0
Aquatic Habitats													
Riverine Unconsolidated Bottom	2	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Developed													
Pasture-Irrigated Hayfield	9	0	0	0	0	0	0	0	0	0	0	0	0
Total	**295**	**28.5**	**163**	**23.4**	**103**	**24.5**	**102**	**19**	**100**	**0.2**	**4.3**	**95.6**	**247**

S.D. = Standard deviation

Table 2.7-11. Length per acre of coarse woody debris more than 12 inches in diameter and 8 feet long in each cover type and decay class.

Cover Type	N	Class 1		Class 2		Class 3		Class 4		All Classes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Upland Tree Habitats											
Montane Oak	25	53.1	266	0	0	0	0	0	0	53.1	266
Oak-Conifer	17	31.2	129	54.7	155	42.9	126	76.1	224	205	273
Oak-Juniper	20	0	0	0	0	11.6	51.9	24.1	76.4	35.7	89.2
Juniper	11	0	0	21.1	70	45.3	101	0	0	66.4	154
Mixed Conifer	6	360	599	63.6	156	277	428	0	0	700	481
Lodgepole Pine	1	0		0		0		0		0	
Ponderosa Pine	14	40.3	104	49.8	127	19	71	59.3	222	168	243
Upland Shrub Habitat											
Mixed Chaparral	30	0	0	0	0	0	0	0	0	0	0
Rabbitbrush	2	0	0	0	0	0	0	0	0	0	0
Sagebrush	4	0	0	0	0	0	0	0	0	0	0
Upland Herb Habitats											
Annual Grassland	21	0	0	0	0	0	0	0	0	0	0
Perennial Grassland	13	0	0	0	0	0	0	0	0	0	0
Wetland Habitats											
Palustrine Emergent	25	34.5	173	0	0	3.3	16.6	0	0	37.8	173
Palustrine Shrub	16	24.9	99.6	0	0	22.8	91.3	0	0	47.7	131
Palustrine Forest	20	0	0	0	0	0	0	9.1	40.8	9.1	40.8
Riparian Habitats											
Riparian Grassland	12	0	0	0	0	0	0	0	0	0	0
Riparian Shrub	13	0	0	19.7	70.9	0	0	0	0	19.7	70.9
Riparian Deciduous	19	0	0	34.2	130	12.2	53.3	0	0	46.5	137
Riparian Mixed	5	0	0	0	0	126	182	179	401	305	562
Barren Habitats											
Rock Talus	4	0	0	0	0	0	0	0	0	0	0
Exposed Rock	6	0	0	0	0	0	0	0	0	0	0
Aquatic Habitats											
Riverine Unconsolidated Bottom	2	0	0	0	0	0	0	0	0	0	0
Agriculture/Developed											
Pasture-Irrigated Hayfield	9	0	0	0	0	0	0	0	0	0	0
Total	**295**	**19.8**	**138**	**10.7**	**64.8**	**15.9**	**87.4**	**12.5**	**92.3**	**58.9**	**199**

S.D. = Standard deviation

(124 m^3/ha) in mature forests (85- to 195-year-old trees) to 3,188 $feet^3$/acre (223 m^3/ha) in young stands (less than 85-year-old trees), to 3,804 $feet^3$/acre (266 m^3/ha) in old growth stands (more than 195-year-old trees) (Spies and Franklin, 1991).

The average percent cover of down wood more than 4 inches (10 cm) in diameter was highest in riparian mixed forest (3.3 ± 2.4 percent), KMC forest (1.7 ± 2.1 percent), ponderosa pine forest (1.3 ± 1.1 percent), riparian deciduous forest (1.2 ± 1.6 percent), MHO-conifer (1.2 ± 1.8 percent), and riparian shrub habitats (1.2 ± 2.7 percent) (Table 2.7-12). The herb-dominated cover types typically had less than 0.1 percent wood cover; the average line intercept lengths for all cover types can be found in Appendix 2C.

In terms of CWD volume, sampling in the study area found widely varying amounts of wood depending on cover type (Table 2.7-13). In many habitats, the volume of down wood appeared to be comparable to regional estimates. For example, in ponderosa pine forests, the CWD volume of 362 $feet^3$/acre (25.3 m^3/ha) was identical to the volume for all wood reported for Oregon and Washington for all successional stages combined (Ohmann and Waddell as cited in Rose et al. 2001). Juniper woodland habitat had 101 $feet^3$/acre (2.9 m^3/ha) compared to 106 $feet^3$/acre (3.0 m^3/ha) in the Northwest. The KMC forest plots had CWD volume that was between the volume estimates for total wood in early- and mid-successional stands of East Side mixed conifer in Oregon and Washington (Ohmann and Waddell as cited in Rose et al. 2001). The abundance of CWD in the MHO-conifer type was 475 $feet^3$/acre (33.2 m^3/ha) compared to 733 $feet^3$/acre (51.3 m^3/ha) for all West Side white-oak-Douglas-fir forests (Ohmann and Waddell as cited in Rose et al. 2001). Riparian habitats are important in providing wood to riverine habitat. In the Klamath River study area, riparian deciduous forests have low CWD volumes, while riparian mixed forests had much higher CWD availability.

2.7.4 Grazing, Erosion, and Recreation

Observations associated with evidence of grazing, erosion, and recreation land uses were made to describe the potential effects of these factors on the quality of habitats in the study area. The relationships between evidence of land uses, such as livestock grazing and recreation, and the evidence or observations of habitat degradation including signs of erosion, trampled or broken vegetation, and exotic/invasive plant species introductions are observational in nature and not the subject of rigorous evaluation. See Section 9.0 for in-depth treatment of grazing issues in the study area.

Table 2.7-12. Total wood cover (%) in each cover type by Project section.

Cover Type	Statistic	Iron Gate-Shasta Section	Iron Gate Res.	Copco No. 2 Bypass	Copco Res.	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Res.	Keno Canyon	Keno Res.	Link River	Total
Upland Tree Habitats													
Montane Oak	N	2	4	2	7	1	8	1	0	0	0	0	25
	Mean	0	0	0.4	0.3	0	1.6	0	M	M	M	M	0.6
	S.D.	0	0	0.6	0.5	M	3	M	M	M	M	M	1.8
Oak-Conifer	N	0	0	2	1	3	10	1	0	0	0	0	17
	Mean	M	M	0.4	0	0	1.4	5.8	M	M	M	M	1.2
	S.D.	M	M	0.6	M	0	1.6	M	M	M	M	M	1.8
Oak-Juniper	N	1	5	4	2	1	6	1	0	0	0	0	20
	Mean	0	0	2.1	0.1	0	1.6	0.9	M	M	M	M	1
	S.D.	M	0	2.9	0.2	M	3.4	M	M	M	M	M	2.3
Juniper	N	0	2	1	1	0	3	2	0	0	1	1	11
	Mean	M	0	0	0	M	0.1	1.1	M	M	0	0	0.2
	S.D.	M	0	M	M	M	0.3	1.6	M	M	M	M	0.7
Mixed Conifer	N	0	0	0	1	0	1	3	1	0	0	0	6
	Mean	M	M	M	1.1	M	0	2.5	1.3	M	M	M	1.7
	S.D.	M	M	M	M	M	M	3	M	M	M	M	2.1
Lodgepole Pine	N	0	0	0	0	0	0	1	0	0	0	0	1
	Mean	M	M	M	M	M	M	0.9	M	M	M	M	0.9
	S.D.	M	M	M	M	M	M	M	M	M	M	M	M
Ponderosa Pine	N	0	0	0	0	0	2	4	5	2	1	0	14
	Mean	M	M	M	M	M	1.6	1	1.9	0.7	0.4	M	1.3
	S.D.	M	M	M	M	M	0.3	0.7	1.6	0.9	M	M	1.1
Upland Shrub Habitat													
Mixed Chaparral	N	4	3	2	4	2	6	3	2	3	0	1	30
	Mean	0	0	0	0	0	0	0	0	0.3	M	0	0
	S.D.	0	0	0	0	0	0	0	0	0.5	M	M	0.2

Table 2.7-12. Total wood cover (%) in each cover type by Project section.

Cover Type	Statistic	Iron Gate-Shasta Section	Iron Gate Res.	Copco No. 2 Bypass	Copco Res.	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Res.	Keno Canyon	Keno Res.	Link River	Total
Rabbitbrush	N	0	0	0	0	0	0	0	0	0	1	1	2
	Mean	M	M	M	M	M	M	M	M	M	0	0	0
	S.D.	M	M	M	M	M	M	M	M	M	M	M	0
Sagebrush	N	0	0	0	0	0	0	0	3	0	1	0	4
	Mean	M	M	M	M	M	M	M	0	M	0	M	0
	S.D.	M	M	M	M	M	M	M	0	M	M	M	0
Upland Herb Habitats													
Annual Grassland	N	1	4	1	6	2	5	1	0	0	1	0	21
	Mean	0	0	0	0	0	0	0	M	M	0	M	0
	S.D.	M	0	M	0	0	0	M	M	M	M	M	0
Perennial Grassland	N	0	0	0	0	1	4	2	1	0	5	0	13
	Mean	M	M	M	M	0	0	0	0	M	0	M	0
	S.D.	M	M	M	M	M	0	0	M	M	0	M	0
Wetland Habitats													
Palustrine Emergent	N	0	3	1	5	2	6	0	2	0	6	0	25
	Mean	M	0	0	1.9	0	0	M	0	M	0	M	0.4
	S.D.	M	0	M	4.2	0	0	M	0	M	0	M	1.9
Palustrine Shrub	N	0	6	0	2	3	0	0	4	0	1	0	16
	Mean	M	1.6	M	3.6	0	M	M	0	M	0	M	1
	S.D.	M	1.5	M	5	0	M	M	0	M	M	M	2
Palustrine Forest	N	0	9	2	7	0	0	0	1	0	1	0	20
	Mean	M	0.8	0	1.7	M	M	M	0	M	0	M	1
	S.D.	M	1.7	0	1.7	M	M	M	M	M	M	M	1.6
Riparian Habitats													
Riparian Grassland	N	2	0	0	0	0	4	0	0	4	0	2	12
	Mean	0	M	M	M	M	0	M	M	0	M	0	0
	S.D.	0	M	M	M	M	0	M	M	0	M	0	0

Table 2.7-12. Total wood cover (%) in each cover type by Project section.

Cover Type	Statistic	Iron Gate-Shasta Section	Iron Gate Res.	Copco No. 2 Bypass	Copco Res.	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Res.	Keno Canyon	Keno Res.	Link River	Total
Riparian Shrub	N	4	0	0	0	0	1	3	0	2	0	3	13
	Mean	1.7	M	M	M	M	8	0	M	0.7	M	0	1.2
	S.D.	3.3	M	M	M	M	M	0	M	0.9	M	0	2.7
Riparian Deciduous	N	5	0	3	0	1	8	0	0	0	0	2	19
	Mean	2	M	0.1	M	1.8	1.3	M	M	M	M	0	1.2
	S.D.	2.9	M	0.3	M	M	0.8	M	M	M	M	0	1.6
Riparian Mixed	N	0	0	0	0	4	1	0	0	0	0	0	5
	Mean	M	M	M	M	2.7	5.8	M	M	M	M	M	3.3
	S.D.	M	M	M	M	2.2	M	M	M	M	M	M	2.4
Barren Habitats													
Rock Talus	N	0	0	0	1	0	3	0	0	0	0	0	4
	Mean	M	M	M	0	M	0.1	M	M	M	M	M	0.1
	S.D.	M	M	M	M	M	0.3	M	M	M	M	M	0.2
Exposed Rock	N	0	1	1	1	1	1	1	0	0	0	0	6
	Mean	M	0	0	0	0	0	0	M	M	M	M	0
	S.D.	M	M	M	M	M	M	M	M	M	M	M	0
Aquatic Habitats													
Riverine Unconsolidated Bottom	N	2	0	0	0	0	0	0	0	0	0	0	2
	Mean	0	M	M	M	M	M	M	M	M	M	M	0
	S.D.	0	M	M	M	M	M	M	M	M	M	M	0
Agriculture/Developed													
Pasture-Irrigated Hayfield	N	1	0	0	1	0	4	0	0	0	3	0	9
	Mean	0	M	M	0	M	0	M	M	M	0	M	0
	S.D.	M	M	M	M	M	0	M	M	M	0	M	0

Table 2.7-12. Total wood cover (%) in each cover type by Project section.

Cover Type	Statistic	Iron Gate-Shasta Section	Iron Gate Res.	Copco No. 2 Bypass	Copco Res.	Fall Creek	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Res.	Keno Canyon	Keno Res.	Link River	Total
Total	**N**	**22**	**37**	**19**	**39**	**21**	**73**	**23**	**19**	**11**	**21**	**10**	**295**
	Mean	**0.8**	**0.5**	**0.6**	**0.8**	**0.6**	**0.9**	**0.9**	**0.6**	**0.3**	**0**	**0**	**0.6**
	S.D.	**2**	**1.2**	**1.5**	**2**	**1.4**	**1.9**	**1.7**	**1.2**	**0.6**	**0.1**	**0**	**1.6**

M = Missing values.
N = Number of plots.
S.D. = Standard deviation.

The observations of erosion, grazing, and recreation are summarized by Project section in Table 2.7-14. Evidence of grazing was observed in 32.5 percent or 96 of the 295 polygons sampled during the vegetation characterization study. The various types of grazing observations included trampling, cropping and breakage of vegetation, cattle trails, grazing by wildlife, and grazing by horses. The highest percentage of grazed plots occurred in the Fall Creek (57 percent) and Iron Gate reservoir (51.4 percent) sections. There were no observations of grazing at sampled locations in the J.C. Boyle bypass or the Link River reaches.

Recreation uses, such as fishing trails, campgrounds, off-highway vehicle (OHV) trails, boating access, parking area, picnic areas, and dispersed campsites, were observed in 14.9 percent of sampled polygons. Link River and J.C. Boyle reservoir had the highest percentage of recreation observations, while there were no observations made in the 19 sampled polygons in the Copco No. 2 bypass. The J.C. Boyle peaking reach had the highest number of recreation observations (11); many riparian areas in the peaking reach, especially near fishing access points and campgrounds, are lined with fishing trails. Boater access points also contribute to the recreation observations, but their impacts are typically more intense and restricted in area.

Observations of naturally occurring erosion caused by steep slopes and loose or unstable substrates (five) or by river bank slumping (one) were made in just 2.0 percent of sampled polygons. Erosion observations that are potentially attributable to logging operations (one), livestock grazing (seven), roads (six), recreation trails (eight), as well as unknown causes of erosion (13) were made in 11.9 percent of sampled polygons. The Project sections with the highest percentage of erosion observations were the Link River (40 percent) and Keno Canyon (36.4 percent) sections.

Table 2.7-13. Volume (feet^3) of coarse woody debris per acre in each cover type and decay class.

Cover Type	N	Class 1		Class 2		Class 3		Class 4		Class Unknown		All Classes	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Upland Tree Habitats													
Montane Oak	25	129.4	641.3	4.4	19.1	2.9	14.7	0	0	0	0	136.7	640.4
Oak-Conifer	17	46	189.8	218.2	810.9	63.3	167.9	147.4	466.3	0	0	474.9	883.5
Oak-Juniper	20	0.7	2.9	0.6	1.8	11.9	53.4	35.3	109	0	0	48.5	117.2
Juniper	11	0	0	20.5	68	80.9	193.7	0	0	0	0	101.4	256.5
Mixed Conifer	6	375.4	736.9	37.8	92.7	342.6	566.4	23.8	43.6	0	0	779.6	698.9
Lodgepole Pine	1	0		0		0		0		0		0	
Ponderosa Pine	14	23.5	61.1	37.9	98.9	83.8	303.8	217.1	812.2	0	0	362.2	827.4
Upland Shrub Habitat													
Mixed Chaparral	30	0	0	0	0	0	0	0	0	0	0	0	0
Rabbitbrush	2	0	0	0	0	0	0	0	0	0	0	0	0
Sagebrush	4	0	0	0	0	0	0	0	0	0	0	0	0
Upland Herb Habitats													
Annual Grassland	21	0	0	0	0	0	0	0	0	0	0	0	0
Perennial Grassland	13	0	0	0	0	0	0	0	0	0	0	0	0
Wetland Habitats													
Palustrine Emergent	25	54.5	272.6	0	0	5.3	26.7	9.3	41.6	0	0	69.2	274
Palustrine Shrub	16	33.8	96.1	0	0	24.8	99.2	0	0	0	0	58.6	131.5
Palustrine Forest	20	2.3	10.2	4.1	10.7	10.6	30.9	58.1	226.2	3.4	15.3	78.5	255
Riparian Habitats													
Riparian Grassland	12	0	0	0	0	0	0	0	0	0	0	0	0
Riparian Shrub	13	0	0	13.3	34.1	0	0	0	0	0	0	13.3	34.1
Riparian Deciduous	19	1.2	5.3	26	68.8	14.7	50.4	0.5	2	0	0	42.4	81
Riparian Mixed	5	0	0	0	0	145.1	228.5	348.4	779.1	0	0	493.5	842.4
Barren Habitats													
Rock Talus	4	0	0	0	0	0	0	0	0	0	0	0	0
Exposed Rock	6	0	0	0	0	0	0	0	0	0	0	0	0
Aquatic Habitats													
Riverine Unconsolidated Bottom	2	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Developed													
Pasture-Irrigated Hayfield	9	0	0	0	0	0	0	0	0	0	0	0	0
Total	**295**	**29.1**	**235.4**	**18.9**	**198.6**	**24.6**	**130.6**	**32.3**	**241.6**	**0.2**	**4**	**105.1**	**408.7**

N = Number of plots.

S.D. = Standard deviation.

Table 2.7-14. Summary of observation of grazing, recreation, and erosion by Project section.

Project Section	Total Number of Plots	Grazed Plots	Percent Grazed	Recreation Plots	Percent Recreation	Erosion Plots	Percent Erosion
Iron Gate-Shasta Section	22	9	40.9	1	4.5	4	18.2
Iron Gate	37	19	51.4	2	5.4	5	13.5
Copco No. 2 Bypass	19	8	42.1	0	0.0	3	15.8
Copco Reservoir	39	11	28.2	1	2.6	4	10.3
Fall Creek	21	12	57.1	2	9.5	2	9.5
J.C. Boyle Peaking Reach	72	26	36.1	11	15.3	6	8.3
J.C. Boyle Bypass	22	0	0.0	4	18.2	3	13.6
J.C. Boyle Reservoir	21	3	14.3	10	47.6	3	14.3
Keno Canyon	11	1	9.1	3	27.3	4	36.4
Keno Reservoir	21	7	33.3	4	19.0	3	14.3
Link River	10	0	0.0	6	60.0	4	40.0
Total	**295**	**96**	**32.5**	**44**	**14.9**	**41**	**13.9**

The observations of erosion, grazing, and recreation land uses are summarized by cover type in Table 2.7-15. Evidence of grazing was observed in 38.4 percent or 63 of 164 sampled upland polygons. The AGL, MHOJ, MXC, and montane oak cover types are the most abundant upland cover types in the study area and had the some of the highest percentages of grazing observations at 85.7, 45.0, 36.7, and 36.0 percent, respectively. The PGL cover type is less abundant, but nevertheless had among the highest percentage of grazing observations in 38.5 percent or five of 13 sampled stands.

Evidence of grazing was observed in 23.6 percent or 26 of 110 sampled polygons in riparian and wetland habitats. Palustrine shrub-scrub wetlands, PEM, and riparian deciduous forest cover types had the highest percentage of grazing observation at 43.8, 36.0, and 26.3 percent, respectively.

Observations of recreation use in upland vegetation types were made in 13.4 percent or 22 of 110 sampled stands. The highest percentage was in the sagebrush-dominated cover type (100 percent) near recreation facilities at J.C. Boyle reservoir and in one sampled plot at Keno reservoir. Ponderosa pine stands, primarily at J.C. Boyle reservoir, have many campgrounds that attract firewood gatherers, hikers, and anglers that branch out into the surrounding forests that were sampled; observations of recreation uses were made in 43 percent of sampled ponderosa pine stands. Recreation observations in riparian and wetland cover types were recorded in 20 percent or 22 of 110 sampled stands; the highest percentage occurred in the riparian shrub-scrub habitat (61.5 percent). Recreation observations were made in 16.0 to 21.1 percent of sampled stands in riparian deciduous forest, PSS wetland, riparian grassland, and PFO.

Table 2.7-15. Summary of observation of grazing, recreation, and erosion by Project cover type.

Cover Types	Total Number of Plots	Grazed Plots	Percent Grazed	Recreation Plots	Percent Recreation	Erosion Plots	Percent Erosion
Upland Tree Habitats							
Montane Oak	25	9	36.0	1	4.0	2	8.0
Oak-Conifer	17	4	23.5	3	17.6	1	5.9
Oak-Juniper	20	9	45.0	0	0.0	1	5.0
Juniper	11	3	27.3	3	27.3	1	9.1
Mixed Conifer	6	0	0.0	1	16.7	0	0.0
Lodgepole Pine	1	0	0.0	0	0.0	0	0.0
Ponderosa Pine	14	1	7.1	6	42.9	1	7.1
Upland Shrub Habitat							
Mixed Chaparral	30	11	36.7	1	3.3	9	30.0
Rabbitbrush	2	1	50.0	0	0.0	0	0.0
Sagebrush	4	2	50.0	4	100.0	0	0.0
Upland Herb Habitats							
Annual Grassland	21	18	85.7	1	4.8	3	14.3
Perennial Grassland	13	5	38.5	2	15.4	2	15.4
Wetland Habitats							
Palustrine Emergent	25	9	36.0	4	16.0	0	0.0
Palustrine Shrub	16	7	43.8	3	18.8	2	12.5
Palustrine Forest	20	2	10.0	1	5.0	3	15.0
Riparian Habitats							
Riparian Grassland	12	1	8.3	2	16.7	2	16.7
Riparian Shrub	13	1	7.7	8	61.5	4	30.8
Riparian Deciduous	19	5	26.3	4	21.1	6	31.6
Riparian Mixed	5	1	20.0	0	0.0	0	0.0
Barren Habitats							
Rock Talus	4	0	0.0	0	0.0	0	0.0
Exposed Rock	6	0	0.0	0	0.0	3	50.0
Aquatic Habitats							
Riverine Unconsolidated Shore	2	1	50.0	0	0.0	0	0.0
Agriculture/Developed							
Pasture-Irrigated Hayfield	9	8	88.9	0	0.0	1	11.1
Total	**295**	**98**	**33.2**	**44**	**14.9**	**41**	**13.9**

Evidence of erosion in upland types was observed in 50 percent of exposed rock outcrop habitats and 30 percent of MXC habitats. The erosion in these habitats subjectively was determined to be caused by a combination of naturally occurring erosion on steep slopes and loose substrates, cattle grazing, OHV trails, and unknown causes. The riparian and wetland cover types with the highest incidence of erosion observations include riparian deciduous forest (31.6 percent) and riparian shrub habitat (30.8 percent). The erosion in the riparian habitat was subjectively determined to be caused primarily by recreation trails; other possible causes of the erosion were cattle trails, natural streambank slumping, and unknown causes.

2.8 DISCUSSION

The following section discusses the existing conditions of vegetation resources in the Project study area. This information will be used in coordination with other investigations to assess potential Project impacts on TES plants and wildlife.

2.8.1 Characterization of Existing Conditions

The following is a brief discussion of the current vegetation cover types; see Section 3.7 for a more detailed discussion on the riparian and wetland communities. The extreme patchiness of habitats in many portions of the study area exemplifies the high diversity in the study area.

In addition to being affected by the reduced flow levels in the Link River reach, riparian and wetland vegetation also is affected by the urban surroundings of the reach. People frequently use the urban trail that runs along the West Side canal, and well-established dirt paths run throughout the riparian vegetation. Many impromptu campsites occur in the thick riparian trees and shrubs. Among the dominant tree layer species in this reach are introduced and naturalized populations of elm, plum (*Prunus*), and apple (*Malus*). The East Side canal/flowline is associated with a higher level of ground disturbance and discontinuous vegetation; recent periodic maintenance activities resulted in some clearing of vegetation along the east side of the Link River reach.

Most of the wetlands at Keno reservoir are located at the Tule Smoke Hunt Club (locally referred to as the “Rat Club” duck hunting club) and at the ODFW State Wildlife Refuge. Currently, Keno reservoir has a significant influence on the hydrology of these wetlands particularly the undiked portions, although these naturally low-lying areas probably supported significant wetlands before formation of the reservoir. In some areas around Keno reservoir, the combination of a high water table and abandoned agricultural developments perpetuate marsh-like habitats with a thick spongy layer of organic matter and tall, emergent hardstem bulrush and stinging nettle. However, most of the reservoir margin has a narrow band of emergent wetland vegetation below steep-sided levies or berms created to permit industrial, commercial, or agricultural development. The tops of the berm and levies often are dominated by weedy species, such as poison hemlock and Canada thistle. The pool level at Keno reservoir fluctuates less than at the other Project reservoirs. This fact, together with the generally low-lying character of land around Keno reservoir, probably allows this reservoir to support much more wetland vegetation than the other Project reservoirs.

The Keno Canyon reach primarily supports intact, undisturbed riparian grass vegetation. The slopes of the canyon are steep, yet the riparian vegetation is fairly consistent in most areas along the reach. The transition from riparian to upland vegetation usually is uninterrupted, except at river access points that have heavily used angler access trails.

J.C. Boyle reservoir has several low-gradient areas abutting the reservoir. The marsh and wet meadow vegetation found there is some of the most botanically diverse and undisturbed in the study area, with the exception of some wetland habitats along the northwest shoreline that are highly disturbed by cattle grazing along the reservoir margin. Riparian and wetland vegetation at the mouth of Spencer Creek is particularly lush and intact, primarily because of the fence that protects this area. The Spencer Creek wetlands appear to be relatively uninfluenced by the reservoir pool level. Some portions of J.C. Boyle reservoir have patches of submerged aquatic vegetation.

The generally reduced flows in the J.C. Boyle bypass appear to support vegetation similar to the J.C. Boyle peaking reach. However, the reduced flows appear to be promoting some encroachment of riparian vegetation. The vegetated banks (which include some stream channel) are typically wider and appear to have a higher areal cover of riparian grass vegetation (predominantly reed canarygrass) among the large, coarse boulder substrate. One of the more obvious landmarks in the bypass reach is the canal and the long, steep slopes of the canal banks. The fill bank below the canal in some areas is not suitable riparian substrate although some trees are growing among the boulders. Another obvious feature of the bypass reach is the spillway at the end of the canal. The scour zone below the spillway is devoid of almost any vegetation because of periodic scouring flows.

Many of the wetlands and irrigated pastures abutting the river in the J.C. Boyle peaking reach occur on relatively wide benches above the bank full zone. These wetlands are fed by irrigation canals either intentionally or through leakage. These areas are used for hay production and pasture.

The section of river between the Oregon-California border and Copco reservoir has a generally lower gradient and many more sites with potential to support riparian vegetation. Some of the largest stands of shrub and tree-dominated riparian vegetation occur in this section of river. The riparian vegetation in the J.C. Boyle peaking reach is especially intact in many sites in the lower part of the canyon, particularly below the ranch at RM 204.5. The woody riparian vegetation between the Oregon-California border (RM 209) and the ranch are accessible to cattle grazing where there are few riparian fences. In some pastures, the blackberry thicket on the riparian vegetation edge is used as a pasture fence.

Most tree-dominated wetlands (PFO) or riparian habitats (riparian deciduous habitat and riparian mixed deciduous-coniferous habitat) along Iron Gate and Copco reservoirs are associated with the larger tributaries of Jenny, Scotch, Dutch, and Beaver creeks. Several of these areas have been degraded by recreational activity (e.g., Jenny Creek and Camp Creek) or livestock grazing. Shrub- and tree-dominated wetlands along the shorelines of these reservoirs are relatively young and highly disturbed in many areas by a variety of land uses, including livestock grazing and recreational fishing. In some areas, the wave action on the reservoir appears to be slowly eroding some of the steep shorelines. The slumping or eroding soil accumulates at these sites to form low-gradient benches where a narrow band of coyote willow is becoming established, especially at Iron Gate reservoir.

The riparian deciduous forests in the Copco No. 2 bypass have some of the best structural diversity in the study area. These riparian forests are probably the result of encroachment after the river was diverted. The flowline in the bypass reach has numerous leaks, has created a substantial number of small "wetlands," and creates side channels in the riparian floodplain. These small wetlands are invaded primarily by native hydrophilic species and definitely increase the proportion of wetland to upland vegetation in the Copco No. 2 bypass segment. Most of these small wetlands are too small to be mapped on the Project vegetation map.

There are few sites above the Project high water-line and riparian/wetland zones that are currently affected directly by the Project. Project facilities include power plants, transmission-lines, flowlines, recreation sites, and Project roads. Maintenance of these facilities often involves removing vegetation to maintain a low-growing, early-successional vegetation type and sometimes creates or maintains a certain level of ground disturbance. Residential, commercial, and agricultural developments; road building; and livestock grazing are the primary sources of ground-disturbing activities that have led to the historical introduction and spread of exotic/invasive plant species into the study area landscape. The widespread occurrence and abundance of exotic/invasive plant species in some of the most abundant cover types in the study area are a testament to this fact. Medusahead, yellow starthistle, Canada thistle, bull thistle, and the introduced annual bromes are among the most frequent and abundant plant taxa in the study area. Many of the land uses also have resulted in the loss and fragmentation of habitats used by TES wildlife and plants (Section 8.0 provides a discussion of noxious weeds throughout the study area).

2.8.2 Characterization of Future Conditions

Disturbed areas around Project facilities and access roads are likely to continue to be disturbed by periodic maintenance and general use. Future Project operations and maintenance potentially can facilitate the spread of noxious weeds and non-native invasive plants into previously unoccupied upland and wetland habitats in the Project area. This is particularly true in areas immediately surrounding Project buildings, recreation sites, and along roads that are traveled by Project personnel during daily operation/maintenance. A discussion of future conditions and noxious weeds and non-native plants is provided in Section 8.7.

Project operations and water management patterns also can influence the condition, species composition and abundance of wetlands habitats around reservoir shorelines. Specifically, the wetland vegetation along the shorelines of Iron Gate and Copco reservoirs appears to be relatively young and only recently established since the Project was built and the reservoirs filled. Along portions of shorelines with steep slopes and finer-textured soils there appears to be a process of erosion through wave action and gravity that causes steep slopes around the reservoir to slump and create small bench-like habitats that are potential habitat for wetland vegetation. This process is likely to continue into the future and thus create additional potential wetland habitat along these reservoirs. The future effects of Project operations and maintenance on riparian vegetation along Project river reaches and reservoirs is discussed in detail in Section 3.0.

3.0 WETLAND AND RIPARIAN PLANT COMMUNITY CHARACTERIZATION

3.1 DESCRIPTION AND PURPOSE

The purpose of this study was to characterize and quantify wetland and riparian communities in the Klamath Hydroelectric Project study area. The assessment section evaluates the effects of ongoing pool level fluctuations, seasonal flow patterns, and daily flow fluctuations on the presence of riparian/wetland plant species, habitat structure, and overall condition of these habitats. Information from this assessment also was used in assessing riparian habitat for wildlife, grazing impacts, and fisheries habitat (see Section 2.2.2).

Hydroperiod was widely considered to be a major influencing factor in many riparian and wetland ecosystem processes (Gregory et al. 1991; Poff et al. 1997). These processes include sediment deposition/scouring for seedling establishment, recharge of alluvial aquifers, and growth of riparian plants (Hill et al. 1991). The USBR operation of Upper Klamath Lake and the irrigation project, as well as climatic conditions in the area, control the annual high flows in the river reaches. The hydroelectric Project does not have storage that can be used to effectively increase or decrease the flows on a seasonal basis (see Water Resources FTR, Section 5.0 - Analysis of Project Effects on Hydrology). Therefore, riparian and wetland vegetation was assumed to be affected by the Project through the following:

- Impacts on sediment flow and deposition through the system
- Daily flow fluctuations (stage changes) downstream of the J.C. Boyle powerhouse
- Diversion of water from Fall Creek, Link River, J.C. Boyle bypass reach, and Copco No. 2 bypass reach
- Water level fluctuations in reservoirs

To assess continuing impacts on riparian and wetland communities, it was necessary to investigate the relationship between historical flow or reservoir level data and current vegetation patterns along the various Project reaches and reservoirs. The primary goal of this study was to predict how future operations could affect riparian and wetland vegetation. This information also will aid in assessing any flow-related operational alternatives and help identify potential PM&E measures in the license application. This study will result in data and analyses that are in addition to the data collected for the vegetation cover type mapping study (see Section 2.0).

3.2 OBJECTIVES

In regard to answering key questions, the objectives of this study are the following:

- Classify and characterize riparian and wetland vegetation using quantitative floristic and structural data and develop vegetation type descriptions that include habitat characteristics important to TES species or “focal” wildlife.
- Quantify the potential relationship between riparian and wetland vegetation patterns and historical and existing flow regimes.

- Investigate how riparian vegetation patterns relate to fluvial geomorphic processes including sediment flow and deposition in the Klamath River reaches.

- Assess the overall condition of riparian/wetlands vegetation by using the vegetation types description, the potential relationships between riparian/wetland vegetation and Project flows, and by evaluating observations of Project impacts, erosion, noxious weeds, grazing, and recreational use in riparian/wetland sites.

- Use information from this study to support other studies and to develop PM&E measures for riparian/wetland vegetation along the Klamath River.

3.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

The wetland and riparian characterization study provides information on the species composition, general structural characteristics, and relative condition of existing wetland and riparian plant communities and will assist in evaluating potential Project effects on these communities. With this study, PacifiCorp will address specific agency, tribal, and stakeholder management objectives and resource issues related to botanical and terrestrial resources.

3.4 METHODS AND GEOGRAPHIC SCOPE

The methods described in the following sections incorporate TRWG comments provided in comment letters and at meetings held on the following dates: January 17, March 28, April 24, June 6, and July 11, 2002. The Plenary Group approved the March 2003 version of the study plan.

A site visit was conducted with the geomorphology specialists and the TRWG on June 28, 2002, to discuss sampling sites. The July 11, 2002, TRWG meeting was held in the field in the J.C. Boyle reach to review specific data collection methods. The integration of the findings of the riparian and geomorphology studies was discussed at a meeting on June 6, 2003, in Ashland, Oregon, with the riparian cross-cutting issues subgroup. The riparian cross-cutting issues subgroup met on October 10, 2003, to discuss the strategy for deciding which period of record and the time increment of measured flow data to use in each river reach.

The study area for the wetland and riparian characterization task was the same as the study area for the plant community-mapping task. Wetlands and riparian vegetation have been mapped from Link River dam to the mouth of the Shasta River (see Section 2.0). Riparian and wetland study areas include the following seven river reaches and four reservoirs:

River reaches:

- Link River reach (0.6 mile [1 km])
- Keno reach (8 miles [13 km])
- J.C . Boyle bypass reach (3 miles [5 km])
- J.C. Boyle peaking reach to Copco reservoir (includes four subreaches) (18 miles [29 km])
- Copco No. 2 bypass reach (2 miles [3 km])
- Fall Creek bypass reach (3 miles [5 km])
- Iron Gate reach to the Shasta River (12 miles [19 km])

Reservoir reaches:

- Keno reservoir
- J.C. Boyle reservoir
- Copco reservoir
- Iron Gate reservoir

The selection of sample sites in the various reaches and reservoirs was made in coordination with the "Analysis of Project Effects on Hydrology," "Analysis of Project Effects on Sediment Transport and River Geomorphology," and "Instream Flow Scoping" studies. Generally, these three studies provided the following data to this study:

- Analysis of hydrologic data from Project and USGS river gauges

- Geomorphic reach identification that was used to stratify riparian sample sites and geomorphic characterization and mapping in representative study reaches. This study used the one-dimensional modeling of river flows from representative river reaches (strata) as well as data on vegetation scouring and sediment transport flows that may influence riparian and wetland distribution patterns.

- River cross-section transects and stage discharge relationships for riparian and wetland vegetation characterization sampling sites

3.4.1 Characterization of Existing Wetland and Riparian Resources

Characterization of existing wetland and riparian communities involves ten tasks described below in the following sections.

3.4.1.1 Determine the Distribution of Wetland and Riparian Vegetation

As part of vegetation cover type/wildlife habitat inventory and mapping effort (see Section 2.0), a preliminary vegetation map was produced in early 2002 that included riparian and wetland vegetation throughout the study area. During field work in 2002, the preliminary vegetation map and GIS coverage were updated and field verified.

3.4.1.2 Determine the Distribution of Channel Geomorphic Types

As part of the sediment transport and river geomorphology study, geomorphic reaches were defined and, within representative riverine sample reaches, channel geomorphic types were described and mapped. The study describes channel formation, armoring, and ongoing geomorphic processes in each reach. In addition, the flows required in each reach to mobilize bed material and form surfaces that can be colonized by riparian vegetation were described. Within representative reaches, the study identified channel types and features that may respond to or be affected by altered flows and sediment supplies. Riparian specialists used this information along with detailed vegetation community and inundation duration/frequency data to assess possible relationships.

3.4.1.3 Hydrologic Data from PacifiCorp and USGS River Gauges

The hydrologic data records for the Project are available for different combinations of water years measured at increments of 1 hour and 1 day. The flow data for each of the reservoirs and river reaches were reviewed. These flow data were used in conjunction with stage-discharge curves developed for each river and reservoir sample site to determine inundation frequency and inundation duration for individual plots within the sample sites.

3.4.1.4 Determine the Distribution of Sampling Sites

The riparian sample sites were chosen by stratification into geomorphic reaches and the availability of geomorphic transects and PHABSIM transects within the geomorphic reaches. Riverine sample sites that coincided with both of the geomorphic representative reach sample sites and PHABSIM (or USGS gauge) hydraulic profiles were selected whenever possible. For reservoir segments, ten representative sample sites were chosen subjectively so that palustrine emergent wetlands, palustrine shrub-scrub wetlands, and palustrine forested wetlands were represented. In addition, the position of wetlands in protected, inlet or unprotected, open and exposed portions of the reservoir shoreline was taken into consideration when choosing sites. The distribution of sampling sites is presented in Figure 3.7-1.

3.4.1.5 Choose Sample Sites and Establish Transects

Riparian/wetlands transects were established and sampled during five periods: September 9 to 12, October 7 to 10, October 21 to 25, and November 6 to 10, 2002, and September 14, 2003. The geomorphology and PHABSIM transects that offered the best riparian vegetation sample were chosen for sampling. Typically, these riparian sites and the reservoir sample sites were both the widest and the most structurally/floristically diverse whenever possible to maximize the amount of information collected per sample site and to get the best possible “side-by-side” comparison of cover types and their potential relationship to explanatory variables (i.e., inundation duration, inundation frequency, return interval).

Transects were positioned perpendicular to the flow of the river or reservoir shoreline and start at a depth in the channel sufficient to capture the low elevation edge of submerged and emergent vegetation or unvegetated shoreline habitat and to span the full width of the riparian/wetland vegetation and drawdown zone to the upland-riparian ecotone. At riverine sites, the first riparian/wetland transect at sampling sites associated with channel cross sections was an extension of the channel cross-section transect used for stream flow modeling (see Figure 3.4-1). The vegetation transect extended to both sides of the river if riparian/wetland vegetation existed on both sides of the river, both sides were accessible, and it was safe to cross the river.

At reservoir sample sites that were narrow, additional vegetation transects were established in parallel to ensure capture of the variation in species composition. Multiple, parallel transects were established only in river or riparian sample sites that had more than one flow model transect. Riparian and wetland sampling data were collected in 1,135 plots distributed among 113 sampling sites in the 11 Project sections.

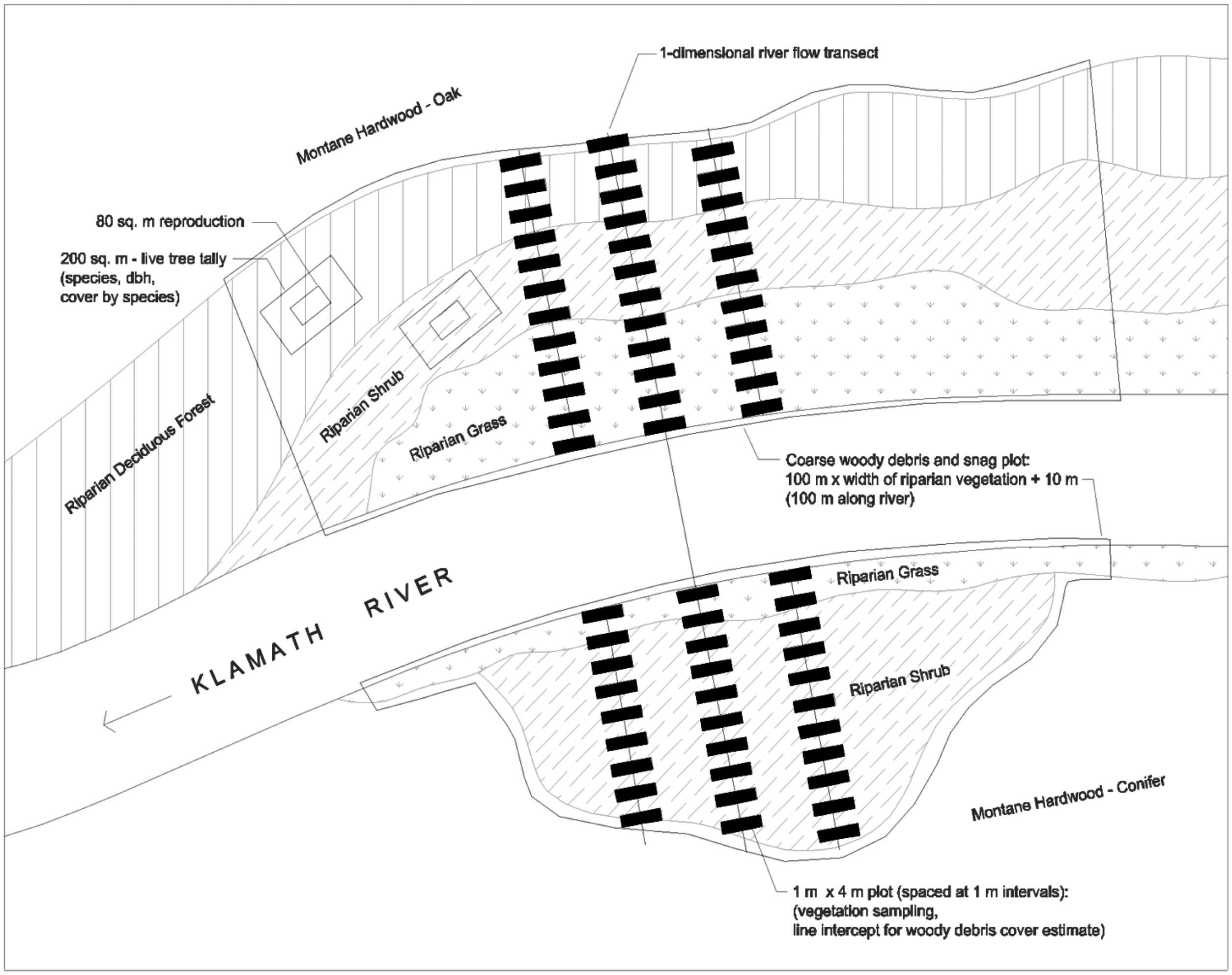

Figure 3.4-1. Conceptual riparian/wetland vegetation sampling design.

3.4.1.6 Survey Elevations and Horizontal Distances of Plots at a Sample Site

To calculate the inundation frequency and inundation duration of vegetation communities, PacifiCorp used a surveying level and stadia rod to determine the elevation of individual plots relative to a benchmark or datum associated with the cross-section transect. The plot elevations were used in conjunction with stage-discharge curves and hydrologic flow data. In addition, the horizontal distances of individual plots and obvious ecotones measured perpendicularly from the waterline were measured. These data were collected to summarize features such as the width and condition of riparian zones and ramping zones.

3.4.1.7 Data Collection at Riparian/Wetland Sampling Sites

Three plot sizes were used to collect quantitative or semi-quantitative data in the riparian and wetland sites. Qualitative data were collected at the scale of the sampling site.

- Vegetation plots, 3.28 feet by 13 feet (1 m by 4 m), were centered lengthwise perpendicular to the vegetation sampling transect. Plots were placed every other meter along transects.

- In addition, at each sampling site, a 2,153-square-foot (200 m^2) rectangular plot (the dimensions varied to fit the size and shape of the polygon) were sampled to collect information on live tree species, tree dbh, and tree and shrub cover.

- A variable-sized plot was established to capture information on coarse woody debris and snags. The plots were up to 328 feet (100 m) along the river and centered over the cross-section transect; the plot was shorter if the riparian habitat did not extend a full 328 feet (100 m). The width was equal the width of the riparian vegetation at the sampling site plus an additional 33 feet (10 m).

During the summer of 2002, PacifiCorp's plant ecologists sampled riparian/wetland vegetation plots. In riparian areas less than 131 feet (40 m) wide, 3.28-foot by 13-foot (1-m by 4-m) plots were placed every other meter along the transect. For riparian and wetland sampling sites that were greater than this width, the distance between plots was increased along the transect in the wider, homogenous bands of vegetation along the transect.

In some sampling sites where the riparian/wetland zone was narrow, additional transects were established parallel to the main transect. In riparian sampling sites, there were typically enough PHABSIM transects available to allow the placement of additional riparian vegetation transects. The riparian vegetation associated with geomorphology transects generally was wide enough to get a good sample from just one vegetation transect. Along reservoir margins with narrow bands of wetland vegetation, additional transects were established in the sampling site to achieve a larger sample of plots.

All cover, height, and tree and shrub regeneration estimates were made by visual estimation within the plots. Calibration of field crews to actual measurements of cover and height took place before data collection. The substrate particle size distribution was estimated by assessing surface cover by each size category in each 3.28-foot by 13-foot (1-m by 4-m) plot. The data collected in the 3.28-foot by 13-foot (1-m by 4-m) plots included the following:

- Cover estimates by cover class - less than 1 percent, 1 to 25 percent, 26 to 50 percent, 51 to 75 percent, and 76 to 100 percent for:

  - Each plant species as it occurs in each of the herb, shrub, or tree layer(s) in the plot

  - Total herb layer cover

  - Total shrub layer cover for each distinctive shrub layer

  - Total tree layer cover for each distinctive tree layer

  - Substrate particle size cover by particle size class (organic, less than 0.06 mm silt, 0.06- to 2.0-mm sand, 2.0- to 64.0-mm gravel, 64.0- to 256-mm cobble, 256- to 1,024-mm boulder)

- Height of each distinct vegetation layer in the plot

Data collection in snag and down wood plots used the BLM guidelines for log and snag data collection, and BLM snag and log classes (BLM, 1995a). Data recorded from the variable-sized plots (see above) included snag dbh, species, height, and decay class. Only snags more than 6 inches (15 cm) dbh and 10 feet (3 m) tall were assessed for height, dbh, and decay class. Data about coarse woody debris that was more than 20 feet (6 m) long and more than 6 inches (15 cm) in diameter at 20 feet (6 m) from the large end were recorded to describe the size, decay class, and species. Line intercept methodology was used to estimate the cover of woody debris more than 4 inches (10 cm) in diameter along the transects.

The assessment of shrub and tree reproduction included estimating cover of seedlings and saplings by species in the individual 3.28-foot by 13-foot (1-m by 4-m) plots.

In some sites, trees were cored in an attempt to evaluate historical reproduction of riparian forest stands. Additional tree coring was conducted in the spring of 2003.

3.4.1.8 Sampling Site Data Collection

In addition to the quantitative and semi-quantitative plot data described above, sampling occurred at the level of the sampling site: qualitative information including observation of recreation use, livestock use, wildlife use, and erosion/deposition was collected.

At each sampling site, the following general data were collected:

- Erosion processes and shoreline stability (i.e., cut bank, sheet wash, substrate deposition)
- Wildlife observations (i.e., species, sex, description of activity)
- Evidence of recreational activity (i.e., fishing trails, vegetation trampling)
- Evidence of livestock grazing impacts (i.e., horses, pigs, cattle, vegetation trampling)
- Slope of floodplain and qualitative evaluation of suitability for pond turtle nesting habitat

In addition to recording the above data, the sites were photographed and sketches were drawn. The photographs and sketches included transect location, vegetation ecotones, the placement of plots, locations of observations of erosion, recreation, and grazing including the location and condition of livestock fencing. The location, in Universal Transverse Mercator (UTM) coordinates, of each sampling site was recorded using a GPS.

Because field sampling occurred at various times from August to November, some non-persistent plant species may have disappeared or become difficult to identify by the time of sampling in 2002. Therefore, as requested by the TRWG, the Project botanist selectively visited riparian locations in April, June, and September 2003 to search for ephemeral species that may have been overlooked during sampling in 2002. The result was that several species of sedge (*Carex* sp.) with relatively small distributions in the Project area remain unidentified and no new ephemeral species were found.

3.4.1.9 Categorize Plots Based on Vegetation Composition and Other Characteristics

The riparian/wetland vegetation data collected in 2002 and 2003 were subjected to two-way indicator species analysis (TWINSPAN) (Hill, 1979a). TWINSPAN was used to cluster the plots into species assemblages or vegetation types using plant species abundance data. Detrended correspondence analysis (DCA) was used to demonstrate the relationship of the primary environmental gradients derived from DCA and the vegetation types developed from the

TWINSPAN analysis (Auble et al. 1994) by overlaying vegetation types on top of the ordination diagrams to see how well the TWINSPAN vegetation types separate along the elevation/inundation duration gradient represented by DCA ordination Axes 1 and 2. Potential explanatory environmental variables for the distribution of plots along the primary environmental gradient(s) (DCA ordination Axes 1 and 2) were assessed "after-the-fact" using correlation coefficients calculated for individual environmental variables and the DCA ordination axes plot scores.

The correlation coefficients are produced as part of the output of DCA using PCORD software (McCune and Mefford, 1999). The "r" and "tau" values in the PCORD output represent the Pearson's r and Kendall's tau correlation coefficients, respectively, between the variable and the plot scores for Axes 1 and 2. The correlation coefficients convey the linear (Pearson's r) and the rank (non-linear or non-parametric Kendall's tau) relationship between the plot scores and an environmental variable. Outliers in the environmental data may indicate that Kendall's tau (the non-parametric correlation coefficient) was a better indication of variable performance. However, one should be cautious in interpreting the performance of individual variables that have outliers because the outliers could represent a meaningful value or it could be an error in measurement or observation. Outliers also can decrease the Pearson's r coefficient.

This PCORD output for DCA also provides a measure of how much variation in the species cover/abundance plot data was accounted for by DCA ordination Axes 1 and 2. It was typical for the first one or two axes resulting from DCA to identify the bulk of the variation in the species cover/abundance data that was not attributable to noise. Noise in a species abundance data set was the chance or random variation attributable to the ability of individual plant species to grow in less than optimal habitats thereby confounding the ability to identify clear-cut vegetation "communities" and infer processes that best explain vegetation patterns. The degree of noise in the species data is often particularly high for riparian vegetation because of the high degree of disturbance associated with flow regimes in most rivers. For most of the Project river reaches the percentage of variation explained by the first ordination axis was far greater than for the subsequent axes (Axes 2 and 3). Therefore, the first ordination axis was the primary focus of this analysis and was considered to represent the primary environmental gradient that influences the distribution of riparian vegetation types along Project river reaches and reservoirs. Site scores along the DCA axes are unitless measures of variation in the species/abundance data collected in sample plots.

3.4.1.10 Determine the Inundation Duration and Inundation Frequency

By establishing the stage discharge relationship for each transect, the flow required to inundate each 3.28-foot by 13-foot (1-m by 4-m) plot can be estimated. The Project flow gauge data were analyzed by PacifiCorp's hydrologist to produce plot-level estimations of inundation duration, return interval, and inundation frequency. The inundation frequency and inundation duration of individual plots were determined using the following parameters: either the full period of record or just the past 5 years, growing season or full year, and flow data measured at either hourly or daily increments. Growing season was determined on the basis of the general observations of the initiation of early spring plant growth and the senescence of plants in the fall and early winter. There were three different growing seasons used for the Project area: April 30 to October 1 upstream of J.C. Boyle dam; April 15 to October 15 between J.C. Boyle dam and Copco dam, California; and April 1 to November 1 downstream of Copco, California. The different combinations of parameters used in each of the Project sections are provided in Table 3.4-1.

Table 3.4-1. Period of record, time period, and increment of flow record used to calculate inundation duration, inundation frequency, and return interval for Project sections.

	Inundation Duration					**Inundation Frequency**					**Return Interval**	
	Growing Season		**Full Year**		**POR***	**Growing Season**		**Full Year**		**POR***	**Annual Peak Flow**	**POR***
River Reach	**Daily**	**Hourly**	**Daily**	**Hourly**		**Daily**	**Hourly**	**Daily**	**Hourly**			
Link River	X				1961-01						x	1961-03
Keno Canyon		X			1997-01				X	97-01	x	1904-01
J.C. Boyle Bypass	X				1996-01						x	1996-01
J.C. Boyle Peaking		X			1997-01				X	97-01	x	1959-01
Fall Creek	X				1933-59						x	1933-59
Copco No. 2 Bypass	X				na						x	na
Iron Gate Reach	X				1960-03						x	1960-01
Reservoirs												
Keno	X				1997-01							
J.C. Boyle	X				1997-01							
Copco	X				1997-01							
Iron Gate	X				1997-01							

* POR = Period of record.

The inundation frequency was expressed as the number of times a plot was inundated per unit of time and was calculated for the J.C. Boyle peaking and Keno Canyon reaches. Inundation frequency was calculated only for these reaches to accurately describe the peaking pattern in the peaking reach and to capture the relatively frequent flow fluctuations in Keno Canyon resulting from re-regulation of irrigation return flows to Keno reservoir. Return interval was calculated using annual peak flow data for the entire period of record available for Project river reaches. A full description of the methods used by the Project hydrologist to calculate inundation duration, inundation frequency, return interval for individual plots, and stage-discharge relationships at sampled cross-sections profiles is provided in Appendix 3A.

3.4.2 Wetland and Riparian Assessment

The purpose of this assessment was to evaluate the effects of the existing Project and continued operations on the presence and condition of riparian/wetland cover types and habitat structure. Methodology for the wetland and riparian assessment included the following subtasks:

- Characterization and quantification of wetland and riparian vegetation for each Project reservoir and river reach
- Correlation of the condition and occurrence of wetland and riparian habitat vegetation to Project flow patterns, hydrology, and benthic substrate

- Documentation of the occurrence and distribution of historic (pre-Project) vegetation to describe a reference condition that can help to identify factors important for evaluating existing conditions

- Summarization of the condition of all Project wetland and riparian vegetation based on the results of the studies listed above and the development of suitable PM&E measures to mitigate potential Project impacts

The following sections describe in detail the specific methodology used for each wetland and riparian assessment subtask.

3.4.2.1 Characterization of Existing Project Wetland and Riparian Vegetation

The wetland and riparian characterization data were summarized for each river reach. TWINSPAN was used to classify species abundance data into vegetation types. Descriptions of vegetation types were provided for all Project river reaches and reservoirs, and included plot data on species composition and abundance; stand structure as percent cover and height for the tree, shrub and herb layer(s); and woody riparian species reproduction captured in the plot data. PacifiCorp's plant ecologists provided reach-level descriptions that included a combination of quantitative and qualitative site-level data related to mean tree diameters, large woody debris and snags, and observations of the potential influence of adjacent land uses including grazing, recreation, and wildlife. The latter observations were used throughout the following sections to describe their influence on riparian vegetation in addition to the hydrological and geomorphological influences.

3.4.2.2 Wetland and Riparian Vegetation and Project Flows, Hydrology, and Substrate

The purpose of this task was to discuss the results of the riparian vegetation characterization in the context of existing Project flows specific to each reach and reservoir. Information from the literature and, where applicable, results from geomorphology and hydrology studies performed during the relicensing process are included in the results and discussion sections. The results of direct gradient analysis and overlays on the ordination diagrams were used to compare the distribution of vegetation types along the primary environmental gradient and to depict the performance of individual environmental variables to "explain" variation in the species data along the primary environmental gradient. The results provide the platform from which to discuss potential Project effects. The vegetation patterns in each reach were discussed in relation to inundation duration, discharge, return interval and, where applicable, return frequency. Flood frequency, drawdown zones, ramped reaches, seasonal flows, geomorphic data, historical vegetation patterns evaluated from aerial photography, and land use patterns were introduced as needed to accent the interactions among these variables, calculated hydrologic parameters, and present-day vegetation patterns.

Secondly, the ecology of wetland/riparian plant species, such as reed canarygrass (*Phalaris arundinacea*) and coyote willow (*Salix exigua*), was discussed in the context of hydrology, geomorphology, and land use. The tree age data collected at various locations in the Project river reaches were related to geomorphological and hydrological events that potentially influence woody riparian species reproduction. The tree age analysis and the ecology of wetland/riparian plant species were helpful to understand the influence of return interval and the timing and magnitude of flows required to inundate a site and to trigger changes in the river environment that are required for some riparian plant species to reproduce.

The geomorphology study (see Water Resources FTR, Section 6.0) describes channel and point bar formation, armoring, and ongoing geomorphic processes in each representative reach. That study describes flows required in each reach to mobilize bed material and form surfaces that can be colonized by riparian vegetation. It also identifies areas where sediment deposition takes place. Within representative reaches, that study identifies channel types and features that may respond to or be affected by altered flows and sediment supplies. Project riparian specialists and geomorphologists used this information in conjunction with detailed riparian vegetation data and hydrologic to assess possible relationships.

Age data from tree cores also were assessed relative to historical flow data. The distribution of trees is discussed primarily in the context of coyote willow regeneration in Project reaches. The formation and maintenance of alluvial and floodplain habitats for riparian trees are discussed for each Project river and reservoir reach. The distribution of different riparian vegetation types in relation to bed material composition, channel types, and other features (flood deposits, point bars, alluvial channels) is qualitatively addressed throughout Section 3.7. This evaluation involved applying the potential relationship between discharge and riparian vegetation cover types to a set of hypothetical flow regimes in a particular river reach. For reservoirs, the analysis used vegetation maps, shoreline bathymetry contours, and hydrology data to qualitatively assess potential wetland responses resulting from changes in pool level fluctuations.

Exhibit E in the license application combines the wetland and riparian characterization information with the cover type characterization and the summary of the ecology of wetland plants and vegetation to help assess the potential PM&E measures for riparian/wetland vegetation in the study area. Potential sites for riparian vegetation enhancement (e.g., fencing, plantings, monitoring) are identified by evaluating riparian data and GIS cover type maps.

3.4.3 Historic (Pre-Project) Vegetation

Documentation of historic wetland and riparian vegetation as well as upland habitat types was accomplished using information on historical vegetation communities—including pre-Project land surveys, aerial photographs, historical narratives, and historical oblique photographs. The historic river photography analysis was coordinated with the geomorphology study. The results of the historic river photography analyses are presented in the geomorphology study (Water Resources FTR, Section 6.7).

Resources used for the investigation, analysis, and mapping of pre-Project vegetation at Project reservoirs included the following:

- 1952 aerial photo series of J.C. Boyle and Keno reservoirs and surrounding areas
- 1955 aerial photo series of Iron Gate reservoir and surrounding regions
- Pre-Project land survey of what is now Copco reservoir and the surrounding vicinity
- Historical family photos, journals, and memorabilia provided by Mrs. Jenieve Harder

- Historical photos and documentation provided by the BLM
- Various historical utility pamphlets, photos, and narrative documentation describing the biota of the Klamath River provided by the Siskiyou County Museum

As requested by the TRWG, for riparian and upland habitat resources that were present before the Project, but are now inundated by Project reservoirs, PacifiCorp characterized a "reference condition" of riparian and upland habitat for each reservoir. To the extent possible, PacifiCorp delineated riparian grass, riparian shrub, riparian tree, and upland polygons (e.g., as grass/shrub, woodland, and conifer forest types) using digital maps that show the pre-Project channel and adjacent topography as a base. The delineation was made by examining historic aerial photos (available for all but Copco and upper Keno reservoirs and Link River) and PacifiCorp survey maps, and visually estimating where vegetation community boundaries occur, and transferring that information to GIS using heads-up digitizing over bathymetry contour lines. The normal full-pool level was used to define the upper boundary of the inundated habitat. GIS was used to calculate acreage and length of shoreline occupied by each vegetation type. PacifiCorp shared this information with the TRWG and considered such information to accurately reflect pre-Project conditions. This information was developed as a reference condition that could help identify factors important to the understanding of past, present, and future conditions. It was not intended to be an assessment of original Project effects because current conditions are the baseline for this relicensing.

3.4.4 Project Summary: Wetland and Riparian Vegetation Condition

PacifiCorp summarized the condition of each river and reservoir segment using the data collected as part of this study, the cover type mapping and GIS database, and aerial photography interpretation. In particular, factors affecting habitat quality are summarized for each Project section in Sections 3.7.1 and 3.8.

The quantitative plot data on plant species abundance and stand structure were used to determine the presence of quality habitat for "focal bird species" that are highly associated with riparian habitat components to assess the habitat quality present in the study area (e.g., RHJV, 2000; OWPIF, 2001). At the request of the BLM (during the July 11, 2002, site visit), each site was evaluated for pond turtle nesting habitat based on slope and vegetation. The semi-quantitative data collected at each site were used along with data collected in other riparian/wetland polygons as part of the vegetation cover type/wildlife habitat inventory and mapping study (Study Plan 2.1) to evaluate habitat quality for selected focal wildlife species (a maximum of five species was selected in consultation with the agencies). The habitat data collected in the field were compared to the values considered preferable or optimal in existing literature, management plans, or Habitat Suitability Index (HSI) models. For example, yellow warblers require tall shrubs composed mostly of hydrophytic species, so the data were evaluated against the published habitat "requirements" or objectives. An additional landscape-level analysis of riparian habitat was conducted as part of the connectivity study (see Water Resources FTR, Section 6.7).

3.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

Together with the vegetation cover type/wildlife habitat inventory and mapping study (Study Plan 2.1), this study provides information for the BLM to (1) assess compliance with aquatic conservation strategy (ACS) objectives under the Northwest Forest Plan Record of Decision,

(2) protect and manage BLM Sensitive and Survey and Manage (S/M) species, and (3) evaluate potential natural communities in wetland and riparian areas along the Project-affected river reaches. This information will help PacifiCorp develop PM&E measures to meet the intention of the identified regulations and plans, meet tribal cultural interests, and fulfill FERC requirements for addressing ongoing Project effects.

3.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were conducted on January 17, March 28, April 24, June 6, and July 11, 2002, and February 4, August 5, and October 10, 2003, to discuss various elements of this study. Comments were received from stakeholders that included suggested modifications to the scope of the study plan, or that requested additional studies or study tasks. These comments were reviewed and, in most instances, the study plan was revised to address requested modifications and additional study tasks.

3.7 STUDY OBSERVATIONS AND FINDINGS

Section 3.7.1 describes the vegetation types for Project river reaches and reservoirs and explores the relationship between environmental data and vegetation patterns. Section 3.7.2 summarizes the historical vegetation analysis performed on Project reservoirs.

Some riparian/wetland sampling data have been summarized and used in various Terrestrial Resources FTR sections including the noxious weed study (Section 8.0), the grazing analysis study (Section 9.0), and the wildlife habitat synthesis study (Section 7.0).

3.7.1 Characterization of Existing Wetland and Riparian Resources

The following sections describe the vegetation types in each of the 11 river and reservoir Project sections. The locations of riparian/wetland sampling sites in Project river and reservoir reaches are provided in Figure 3.7-1. The scientific and common names of plants used in the following descriptions are located in Terrestrial Resources FTR, Appendix 5D.

3.7.1.1 River Vegetation

The riparian/wetland vegetation sampled at Link River reach, Keno Canyon reach, J.C. Boyle peaking and bypass reaches, Copco No. 2 bypass reach, Fall Creek reach, and the Iron Gate to Shasta River (Iron Gate reach) reach was described separately for each of these reaches using TWINSPAN and included a total of 618 plots along 52 transects and 501 species. The plot data were analyzed separately for each reach to increase the potential for explaining vegetation patterns that may result from Project flow patterns specific to each reach. However, a hierarchical classification was created to provide a means of comparing the vegetation types in different river reaches (Table 3.7-1).

Note: The numbers in parentheses that follow the individual vegetation type description headings are vegetation codes used in Section 3.7.2 (Riparian and Wetland Assessment).

Link River

Riparian vegetation sampling at Link River occurred at 89 plots along four transects. In total, six tree, 11 shrub, and 56 herbaceous plant species were documented in the Link River plots. The average width of the wetland vegetation along sampled transects was 124.6 ± 69.2 feet (38.0 ± 21.1 m); the average slope was 12.0 ± 3.8 percent.

The riparian vegetation at Link River was influenced by river hydrology and by seepage from the West Side canal and the East Side canal and penstock. Seepage, especially from the West Side canal, has created many perched wetland habitats well away from the hydrological influence of normal river flows in the reach. The riparian vegetation at Link River was unique compared to other Project river reaches because of the presence and abundance of introduced woody species. Apple (*Malus* sp.), plum (*Prunus* sp.), and elm (*Ulmus* sp.) were commonly the dominant species in the tree layer. A non-native species of rose (*Rosa* sp.) was uncommon, but locally abundant. Reed canarygrass, a species of questionable origin in the region (Merigliano and Lesica, 1998), was also abundant in close proximity to the active channel and in seepage areas.

The tree tally data for the Link River riparian vegetation revealed that the average tree cover in the Link River reach was 42 percent while shrub cover averaged 46 percent. The average riparian tree diameter was 11.1 ± 4.4 inches (28.2 ± 11.2 cm) dbh. There were no logs documented in the Link River riparian sampling plots.

The TWINSPAN analysis resulted in five vegetation types dominated to varying degrees by hardstem bulrush (*Scirpus acutus*), reed canarygrass, red osier dogwood (*Cornus sericeus*), apple, elm, Himalayan blackberry (*Rubus discolor*), Scouler's willow (*Salix scouleriana*), arroyo willow (*Salix lasiolepis*), and shining willow (*Salix lucida* ssp *lasiandra*). The following sections describe the Link River vegetation types.

Scouler's Willow (3). The Scouler's Willow vegetation type was documented in 12 plots that were sampled approximately 130 to 196 feet (40 to 60 m) from the active river channel along one transect. The Scouler's willow patch that was sampled was anomalous in the sense that Scouler's willow generally grows in much smaller patches and as scattered individuals at the Link River. However, the small number of unique species growing in the 12 sampled plots contributes to the diversity of vegetation/habitat vegetation types at the Link River and thus warrants description.

Scouler's willow and plum were the only tree layer species documented. Tree layer heights ranged from 18 to 40 feet (5.5 to 12 m) and the mean percent cover of the tree layer was 78.6 ± 24.9. Himalayan blackberry, non-native rose, Scouler's willow, and plum occur in four, five, seven, and three plots, respectively. Shrub layer heights ranged up to 15 feet (4.5 m) and the shrub layer cover averaged 40.7 ± 30.4 percent.

The herb layer species included blue wildrye (*Elymus glaucus*), catchweed bedstraw (*Galium aparine*), plum, and stinging nettle (*Urtica dioica*) that occurred in three, four, seven, and three plots, respectively. Herb layer heights ranged up to 2.3 feet (0.7 m) and the herb layer cover averaged 10.2 ± 10.7 percent.

Figure 3.7-1. Riparian sampling locations.

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Figure 3.7-1

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Table 3.7-1. Wetland and riparian vegetation types classified using TWINSPAN for Project river and reservoir reaches. Wetland riparian vegetation types are lumped together because of the difficulties associated with distinguishing the influence of groundwater seepage and river hydrology.

River Reaches		
Riparian Grass and Palustrine Emergent Wetlands	**Riparian Shrub and Palustrine Scrub Shrub Wetlands**	**Riparian Mixed Conifer-Hardwood, Riparian Deciduous Forest, Palustrine Forested Wetland**
Bearded Wildrye/Colonial Bentgrass	Brown Dogwood/Snowberry	Box Elder/Stinging Nettle
Kentucky Bluegrass/Yarrow/Field Cress	Red Osier Dogwood/Himalayan Blackberry	Oregon Ash/Colonial Bentgrass/Kentucky Bluegrass
Medusahead/Cheatgrass	Red Osier Dogwood/Reed Canarygrass	White Alder/Oregon Ash
Perennial Ryegrass	Red Osier Dogwood/Reed Canarygrass/Colonial Bentgrass	White Alder/Rice Cutgrass/Hairy Willowherb
Reed Canarygrass	Scouler's Willow	Oregon Ash/Colonial Bentgrass/Woolly Sedge
Reed Canarygrass/Woolly Sedge	Shining Willow/Reed Canarygrass	Oregon Ash/Douglas' Spiraea
Reed Canarygrass/Western Goldenrod	Coyote Willow/Himalayan Blackberry	Oregon Ash/Himalayan Blackberry
Rice Cutgrass/Hardstem Bulrush	Coyote Willow/Knotgrass	Oregon Ash/Himalayan Blackberry/Blue Wildrye
Chicory/Tall Fescue	Coyote Willow/Poison Hemlock	Oregon Ash/Western Birch
Curly Pondweed	Coyote Willow/Reed Canarygrass/Colonial Bentgrass	Oregon Oak/BlueWildrye
Devils' Beggarstick/Knotweed	Coyote Willow/Rice Cutgrass	Oregon Oak/Western Serviceberry/Snowberry
Hardstem Bulrush	Mock Orange	Ponderosa Pine/Douglas-fir/Western Serviceberry
Hardstem Bulrush/Devil's Beggarstick	Mock Orange/Reed Canarygrass	White Alder
Hardstem Bulrush/Duckweed	Mock Orange/Sierra Plum/California Rose	
Hardstem Bulrush/Reed Canarygrass		
Kentucky Bluegrass/Timothy/Colonial Bentgrass		

Table 3.7-1. Wetland and riparian vegetation types classified using TWINSPAN for Project river and reservoir reaches. Wetland riparian vegetation types are lumped together because of the difficulties associated with distinguishing the influence of groundwater seepage and river hydrology.

Reservoirs		
Riparian Grass and Palustrine Emergent Wetlands	**Riparian Shrub, Riparian Deciduous Forest, Palustrine Scrub Shrub Wetlands, Palustrine Forested Wetland**	
Beardless Ryegrass	Coyote Willow	
Golden Dock/Bur-reed		
Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed		
Hardstem Bulrush/Stinging Nettle/Cattail		
Kentucky Bluegrass/Teasel/Beardless Ryegrass/Canada Thistle		
Marsh Spikerush/Bentgrass/American Speedwell		
Needle Spikerush/Canadian Smartweed		
Saltgrass		
Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass		
Starthistle/Medusahead/Hairy Brome		

<u>Red Osier Dogwood/Himalayan Blackberry (11).</u> The dogwood/blackberry vegetation type was documented in 29 plots that were sampled approximately 50 to 150 feet (16 to 45 m) from the active channel. The most obvious difference between the dogwood/blackberry vegetation type and the two previous “dogwood” vegetation types at Link River was the absence of reed canarygrass and colonial bentgrass. The dogwood/blackberry vegetation type was a “melting pot” in the sense that consecutive plots along different transects demonstrated strong clustering of different combinations of woody species including apple, elm, arroyo willow, shining willow, and Pacific ninebark (*Physocarpus capitatus*).

Tree layer species included elm, apple, and shining willow, which occurred in seven, five, and ten plots, respectively. The tree layer heights ranged from 23 to 30 feet (6.9 to 9 m) and the tree canopy averaged 32.4 ± 39.2 percent.

Himalayan blackberry and red osier dogwood occurred in 29 and 24 plots, respectively. Arroyo willow, Pacific ninebark, and gooseberry (*Ribes* sp.) were present in eight to 11 sampled plots. Shrub layer heights ranged from 4.6 to 18.0 feet (1.4 to 5.5 m) and the shrub layer cover averaged 71.7 ± 28.4 percent.

The herb layer species had low constancy among plots, but were best represented by cattail (*Typha latifolia*), water smartweed (*Polygonum amphibium*), arroyo willow, Eaton's aster (*Aster* cf. *eatonii*), non-native rose, elm, curly dock (*Rumex crispus*), and plum. The mean percent cover of the herb layer was 3.3 ± 6.7. The heights of the herb layer ranged from 0.7 to 4.9 feet (0.2 to 1.5 m), except in two plots with cattail where the herb layer height reached 8.2 feet (2.5 m).

<u>Red Osier Dogwood/Reed Canarygrass/Colonial Bentgrass (20).</u> The dogwood/canarygrass/bentgrass vegetation type was documented in 20 plots primarily in low-lying areas that collect seepage from Project canals often well away from the active channel, but also at the edge of the active channel in low-lying areas connected hydrologically to the river. Colonial bentgrass (*Agrostis capillaris*), hairy willowherb (*Epilobium ciliatum*), yellow monkeyflower (*Mimulus guttatus*), water pepperweed (*Polygonum hydropiperoides*), American speedwell (*Veronica americana*), fowl bluegrass (*Poa palustris*), devil's beggarstick (*Bidens frondosa*), field mint (*Mentha arvense*), creeping buttercup (*Ranunculus repens*), and rigid hedge nettle (*Stachys ajugoides*) were the most commonly occurring species in this vegetation type. Seedlings of elm and arroyo willow were observed in the dogwood/canarygrass/bentgrass vegetation type. The height of the herb layer ranged from 2.3 to 8.2 feet (0.7 to 2.5 m) and the herb layer averaged 84.5 ± 23.9 percent.

Shining willow and elm frequently occurred in this vegetation type and were often abundant in the shrub and tree layer. Large elm and shining willow formed a tree layer either within or overhanging this vegetation type in 11 of the 20 sampled plots. Tree layer height ranged from 20 to 50 feet (6 to 15 m) and the mean percent cover of the tree layer was 26.7 ± 38.0. Red osier dogwood was present in all 20 sampled plots, but was not quite as widespread as this sampling effort would imply. Himalayan blackberry was present in ten of the sampled plots. The height of the shrub layer ranged from 5 to 11.5 feet (1.5 to 3.5 m) and the shrub layer cover averaged 25.1 ± 19.7 percent.

<u>Red Osier Dogwood/Reed Canarygrass (21).</u> The dogwood/canarygrass vegetation type was documented in ten plots over the same range of horizontal distances from the active channel as the dogwood/canarygrass/bentgrass vegetation type. The absence of the low-lying areas with surface water and the absence of species characteristic of the dogwood/canarygrass/bentgrass vegetation type distinguished the two vegetation types. The species most conspicuously absent from the dogwood/canarygrass vegetation type were creeping buttercup, yellow monkeyflower, hairy willowherb, field mint, rigid hedge nettle, and water pepperweed.

Large elm trees were common in this vegetation type and occurred in six of the ten sampled plots. The tree layer heights ranged from 28 to 46 feet (8.5 to 14 m) and mean percent tree cover was 36.2 ± 40.75. Himalayan blackberry, tall shining willow shrubs, and red osier dogwood occurred in six, six, and ten, respectively, of the ten sampled plots. Shrub layer heights ranged from 3.3 to 16.4 feet (1 to 5 m) and the cover of the shrub layer averaged 40.7 ± 23.6 percent.

The herb layer was primarily reed canarygrass, but also included small amounts of climbing nightshade (*Solanum dulcamera*), American bittercress (*Barbarea orthocerus*), plum, American speedwell, colonial bentgrass, and devil's beggarstick. The height of the herb layer ranged from 1.6 to 7 feet (0.5 to 2.2 m) and the herb layer averaged 57.6 ± 37.8 percent.

<u>Hardstem Bulrush (4).</u> The hardstem bulrush vegetation type was documented in 18 plots distributed primarily at or near the edge of the active channel. Hardstem bulrush also was found

growing in exposed, sunny locations away from the active channel in isolated wetlands created by canal seepage. Reed canarygrass was often a co-dominant species in the tall herb layer with hardstem bulrush and even displaced hardstem bulrush completely in some places along the Link River. Rice cutgrass (*Leersia oryzoides*) was common, but seldom abundant, in this vegetation type. The herb layer was absent from two plots that fell within the active channel (open water), but overlapped no bulrush. Bulrush cover approached 100 percent in the densest stands. Hardstem bulrush and reed canarygrass grew to 8.2 feet (2.5 m) in height in some sampled stands, although the herb layer height ranged from 1.0 to 8.2 feet (0.3 to 2.5 m). Herb layer cover averaged 10.2 ± 10.7 percent.

Large elm and shining willow frequently were found growing at the edge of the active channel in close proximity to bulrush, but rooted at higher elevation. These species formed either a tall tree layer (13 to 40 feet [8.5 to 13 m]) or a somewhat horizontal layer that hung over the bulrush and was composed of broken stems and branches and beaver–felled trees. Tree canopy cover can be as high 85 percent because the overhanging tree and the tree layer typically was quite tall, although there was often no shrub layer.

<u>Keno Canyon</u>

Riparian vegetation sampling at Keno Canyon occurred at 51 plots along four transects. Three tree, six shrub, and 47 herbaceous plant species were documented in the Keno Canyon plots sampled in 2002. The average width of the wetland vegetation along the sampled transects was 80.7 ± 43.6 feet (26.4 ± 13.3 m); the average slope was 8.3 ± 3.3 percent.

The generally steep stream gradient and v-shaped valley characteristic of Keno Canyon create conditions whereby the active channel comprises a relatively large proportion of the valley bottom. Streamside terraces were relatively few and narrow. Substrates composed of finer particles were rare relative to the coarse, boulder substrates that comprise the most abundant habitat available to riparian plants along the streambanks. Total tree and shrub cover estimates were both low in Keno Canyon, averaging less than 4 percent. There were 3.5 logs/acre (8.8 logs/ha), totaling 87 feet/acre (66.3 m/ha) in this reach. Total log cover was less than 0.1 percent. There was an average of 0.5 ± 0.9 snags/acre (1.3 snags/ha).

The TWINSPAN analysis resulted in nine vegetation types in the Keno Canyon. Reed canarygrass, hardstem bulrush, and river bulrush (*Scirpus fluvitialis*) were the most frequently occurring riparian plant species growing in Keno Canyon and appeared to be well suited to coarse substrates that frequently were inundated by fast-moving water. Other riparian plant species were scarce by comparison and were restricted primarily to narrow benches or terraces. Shining willow, Douglas' spiraea (*Spiraea douglasii*), brown dogwood (*Cornus glabrata*), and arroyo willow were among the few woody species captured in the plot data and occupy various positions along the sampled profiles. The following sections describe each of the Keno Canyon vegetation types.

<u>Mock Orange/Sierra Plum/California Rose (6).</u> The mock orange/plum/rose vegetation type was documented in three plots in Keno Canyon. Mock orange (*Philadelphus lewissii*) and Sierra plum (*Prunus subcordata*) were among the most common and abundant shrub species in Keno Canyon. Mock orange, Sierra plum, and California rose (*Rosa californica*) typically grow at the upper margin of the riparian zone, and mock orange and Sierra plum were common components of more upland vegetation on the lower slopes of the canyon. This vegetation type was sampled

near the river edge on banks characterized by a short, steep gradient and at the outer edge of a low-gradient terrace. It was common for coniferous trees, such as western juniper (*Juniperus occidentalis*), ponderosa pine (*Pinus ponderosa*), and Douglas-fir (*Pseudotsuga menziesii*), to be rooted within or at least overhanging this vegetation type. Snowberry (*Symphoricarpos alba*), Kentucky bluegrass (*Poa pratensis*), five-finger cinquefoil (*Potentilla gracilis*), and reed canarygrass were sampled in the mock orange/plum/rose vegetation type.

The shrub layer heights ranged from 3.9 to 9.8 feet (1.2 to 3.0 m) and the shrub layer cover averaged 66.7 ± 18.9 percent. The herb layer heights ranged from 1.6 to 3.9 feet (0.5 to 1.2 m) and the mean cover of the herb layer was 18.3 ± 12.6 percent.

<u>Brown Dogwood/Snowberry (7).</u> The dogwood/snowberry vegetation type was documented in two plots at the end of one transect in Keno Canyon. This vegetation type was less common than the Mock Orange/Sierra Plum/California Rose vegetation type, but occupies similar topographic positions that have less gravel, cobble, and boulders and more fine-particle substrates. Bur chervil (*Athriscus cacaulis*), poison hemlock (*Conium maculatum*), and blue wildrye occurred in both sampled plots. Reed canarygrass, Kentucky bluegrass, and rigid hedge nettle each occurred in one plot.

The shrub layer heights ranged from 11.5 to 11.8 feet (3.5 to 3.6 m) and the shrub layer cover averaged 65.0 ± 28.3 percent. The herb layer heights ranged from 1.6 to 3.3 feet (0.5 to 1.0 m) and the herb layer cover averaged 27.5 ± 27.7 percent.

<u>Bearded Wildrye/Colonial Bentgrass (25).</u> The wildrye/bentgrass vegetation type was documented in seven plots along one sampled transect in Keno Canyon. This vegetation type occurred along the outer end of a low-gradient terrace adjacent to the Reed Canarygrass/Woolly Sedge vegetative type. Colonial bentgrass and creeping wildrye (*Leymus triticoides*) were the most constant species with each occurring in six of seven sampled plots. Yarrow (*Achillea millefolium*) occurred in five plots. Canadian bluegrass (*Poa compressa*), five-fingered cinquefoil, western aster (*Aster spathulatum*), and reed canarygrass each occurred in four plots. Timothy (*Phleum pratense*), Kentucky bluegrass, Baltic rush (*Juncus balticus*), fowl bluegrass, and California oatgrass (*Danthonia californica*) also were present in the herb layer. The herb layer heights ranged from 1.8 to 3.6 feet (0.7 to 1.1 m) and the cover of the herb layer averaged 79.0 ± 27.4 percent.

Douglas' spiraea occurred in five plots in the shrub layer. Sierra plum, California rose, and snowberry each occurred in one or two plots. The shrub layer heights ranged from 1.6 to 3.6 feet (0.5 to 1.1 m) and the shrub layer cover averaged 15.0 ± 29.2 percent.

<u>Shining Willow/Reed Canarygrass (11).</u> The shining willow/canarygrass vegetation type was documented in four plots in Keno Canyon on a narrow, low-gradient terrace. This vegetation type was not observed frequently in Keno Canyon. In sampled plots, there were large, decadent shining willow trees growing among dense stands of reed canarygrass at elevations similar to the Reed Canarygrass/Western Goldenrod vegetation type. All of the shining willow trees had large horizontal branches either broken because of rot or chewed by beavers. No willow reproduction was observed. The tree layer heights ranged from 14.8 to 19.7 feet (4.5 to 6.0 m) and the tree layer cover averaged 61.25 ± 28.4 percent.

Brown dogwood was the only shrub layer species sampled in the shining willow/canarygrass plots in slightly higher topographic positions. The shrub layer heights ranged up to 11.5 feet (3.5 m); and the shrub layer averaged 15.3 ± 29.8 percent. Reed canarygrass formed a dense, tall herb layer ranging in height from 3.6 to 4.9 feet (1.1 to 1.5 m) with a cover of 80.3 ± 33.5 percent.

Reed Canarygrass/Woolly Sedge (24). The canarygrass/woolly sedge vegetation type was documented in four plots in Keno Canyon. This vegetation type occurred at the upper limit of a steep, short elevation gradient for riparian vegetation along one transect and near the lower end of a low-gradient terrace on a second transect. Reed canarygrass, woolly sedge (*Carex lanuginosa*), and colonial bentgrass occurred in all four sampled plots. Baltic rush, fowl bluegrass, and creeping wildrye each occurred in one plot. The herb layer heights ranged from 3.3 to 4.9 feet (1.0 to 1.5 m) and the herb layer cover averaged 86.3 ± 27.5 percent.

Douglas' spiraea occurred in two plots, and Sierra plum, California rose, mock orange, and snowberry each occurred in one plot. The shrub layer heights ranged up to 3.3 feet (1 m) and the cover of the shrub layer averaged 10.5 ± 13.7 percent.

Reed Canarygrass/Western Goldenrod (10). The canarygrass/goldenrod vegetation type was documented in four plots, but was well represented in Keno Canyon at slightly higher elevations than other vegetation types dominated by reed canarygrass and hardstem bulrush, which often reside in or just above the active channel. Reed canarygrass was often dense and occurred with small patches of the rhizomatous western goldenrod (*Euthamnia occidentalis*). The herb layer heights ranged from 3.9 to 10.5 feet (1.2 to 3.2 m) and the herb layer cover averaged 85.3 ± 8.7 percent. Hardstem bulrush and California rose occurred in one of the sampled plots. Other species observed in this vegetation type, but not sampled, included cattail, hairy willowherb, and climbing nightshade.

Reed Canarygrass (19). The Reed Canarygrass vegetation type was the most abundant riparian vegetation type in Keno Canyon. The canarygrass vegetation type was documented in 12 plots that were sampled on mid-channel islands and was abundant at the water's edge among large boulders. This vegetation type typically occurred in less open water than the Hardstem Bulrush/Devil's Beggarstick and the Hardstem Bulrush vegetation types. Reed canarygrass was present in all 12 sampled plots and often formed dense stands that appeared to preclude most other species. The herb layer heights ranged from 3.9 to 10.5 feet (1.2 to 3.2 m) and the herb layer cover averaged 77.7 ± 22.0 percent.

Hardstem bulrush and river bulrush occurred, respectively, in four and nine of the sampled plots, but most often at lesser abundance. Arroyo willow, western goldenrod, and duckweed (*Lemma minor*) were the only other species documented in this vegetation type.

Hardstem Bulrush/Devil's Beggarstick (18). The bulrush/beggarstick vegetation type was documented in eight plots that were sampled at the water's edge or on mid-channel islands. This vegetation type most often occurred in slow-moving or still, shallow water in the active channel. This habitat frequently supports reed canarygrass, river bulrush, and hardstem bulrush, which were present in seven, seven, and eight of the eight sampled plots, respectively. American speedwell and devil's beggarstick grow in open water among the bulrush and canarygrass. The herb layer heights ranged from 3.9 to 10.5 feet (1.2 to 3.2 m) and the herb layer cover averaged 70.4 ± 26.2 percent.

Hardstem Bulrush (16). The Hardstem Bulrush vegetation type was documented in seven plots that were sampled at the water's edge or on mid-channel islands. Hardstem bulrush was present in five of the seven sampled plots; one plot with only cattail and duckweed and one plot with only duckweed were included in this vegetation type. Hardstem bulrush typically was rooted in the water, a habitat that also supports reed canarygrass and river bulrush. The herb layer heights ranged from 4.3 to 10 feet (1.3 to 3.3 m) and the herb layer cover averaged 35.8 ± 28.7 percent.

J.C. Boyle Peaking and Bypass Reaches

Riparian vegetation sampling in the J.C. Boyle peaking and bypass reaches occurred at 204 plots along 23 transects. Five tree, 12 shrub, and 78 herb layer plant species were documented in the J.C. Boyle peaking and bypass reach plots sampled in 2002. The average width of the wetland vegetation along the sampled transects in the peaking reach was 54.1 ± 31.2 feet (16.5 ± 9.5 m); the average slope was 13.8 ± 7.0 percent. In J.C. Boyle bypass reach, the average width of the wetland vegetation along sampled transects was 37.1 ± 12.8 feet (11.3 ± 3.9 m); the average slope was 18.9 ± 10.8 percent.

In the riparian zone of the peaking reach, tree cover averaged approximately 33 percent, while shrub cover was 10 percent. Tree cover in the bypass reach averaged less than 1 percent, but shrub cover averaged 63 percent. The tree tally data for the J.C. Boyle peaking and bypass riparian vegetation revealed that the riparian tree diameters averaged 6.0 ± 4.9 inches (15.2 ± 12.4 cm) dbh. There was an average of 3.3 ± 3.8 logs/acre (8.2 ± 9.4 logs/ha) in riparian habitat along the peaking reach, which equated to approximately 119.4 ± 145.1 feet/acre (89.9 ± 109.3 m/ha). The bypass reach had a similar log abundance of 3.3 ± 0.5 logs/acre, but slightly lower total length—98.6 ± 33.3 feet/acre (74.3 ± 25.1 m/ha). In the peaking reach, there were 1.0 ± 1.5 snags/acre (2.5 ± 3.7 snags/ha), but the bypass reach had no snags in the sampling plots. The snags in the peaking reach averaged nearly 15 inches (38 cm) dbh.

Reed canarygrass, colonial bentgrass, Oregon ash (*Fraxinus latifolia*), Kentucky bluegrass, Himalayan blackberry, woolly sedge, coyote willow, western goldenrod, perennial ryegrass (*Lolium perenne*), and devil’s beggarstick were the most frequently occurring riparian plant species growing in J.C. Boyle peaking and bypass reaches, and in various combinations form the dominant vegetation types. The following sections describe the 11 vegetation types identified by TWINSPAN in the J.C. Boyle peaking and bypass reaches.

Perennial Ryegrass (8). The perennial ryegrass vegetation type was documented in ten plots in J.C. Boyle peaking and bypass reaches. This vegetation type was representative of many of the mesic to dry portions of irrigated pastures located on fossilized terraces in the peaking reach. These pastures often were cropped closely by cattle and in some cases the herb layer cover was sparse because of overgrazing or cattle trampling the area beneath shade trees near the river. Kentucky bluegrass, colonial bentgrass, bird's foot trefoil (*Lotus corniculatus*), panicled willowherb (*Epilobium brachycarpum*), Mediterranean barley (*Hordeum marinum*), Canadian bluegrass, and water smartweed were observed frequently in the herb layer.

Oregon ash and Oregon white oak (*Quercus garryana*) often occur as individual trees in this vegetation type. The tree layer heights ranged up to 39.4 feet (12 m) and the mean percent cover of the tree layer was 14.5 ± 30.1. Himalayan blackberry and cutleaf blackberry (*Rubus laciniatus*) formed small to large patches in this vegetation type. The shrub layer heights ranged up to 5.6 feet (1.7 m) and the shrub layer cover averaged 0.8 ± 1.8 percent.

Mock Orange (10). The Mock Orange vegetation type was documented in ten plots in the J.C. Boyle bypass reach. This vegetation type was sampled along six different transects with short, steep, boulder-covered banks at the outer, upper edge of the riparian zone. Mock orange occurred in nine of ten plots, and various shrub and tree species with affinities to more upland habitats were present in, at most, two of the ten plots. The shrub layer species included snowberry, brown dogwood, and western serviceberry (*Amelanchier alnifolia*). The shrub layer heights ranged from 8.9 to 13.1 feet (2.7 to 4.0 m) and the shrub layer cover averaged 70.2 ± 18.0 percent.

The tree layer species included ponderosa pine, white fir (*Abies concolor*), chokecherry (*Prunus virginiana*), and Oregon oak (*Quercus garryana*). The coniferous tree layer species height ranged up to 115 feet (35 m) and deciduous tree layer species ranged from 19.7 to 32.8 feet (6 to 10 m). The mean tree canopy cover was 29.1 ± 36.2 percent. The herb layer was sparse with only a few plants growing between large boulders; only blue wildrye and Oregon grape (*Berberis aquifolium*) were present in two of the ten sampled plots.

Oregon Oak/Western Serviceberry/Snowberry (23). The oak/serviceberry/snowberry vegetation type was documented in nine plots along five transects in the peaking reach. The oak/serviceberry/snowberry vegetation type was one of the most abundant vegetation types abutting the river. Most of these stands occurred at the upper end of the elevation gradient that supports riparian vegetation and was considered "riparian" by virtue of its close proximity to the river rather than the wetland indicator status of its associated plant species. The elevation gradient can be short and steep, which places this vegetation type in close proximity to the active channel. The elevation gradient also can be longer and more gradual, which places this vegetation type on the outer edges of terraces, sometimes well away from the active channel.

Oregon oak, western serviceberry, and snowberry occur in seven, seven, and six sampled plots, respectively. Two or more of these species typically were present in this vegetation type, and in all plots Oregon ash was absent. Oregon oak was the dominant tree layer species in seven plots and black oak (*Quercus kelloggii*) was the dominant tree layer species in one plot and was a minor component of the tree layer in another plot. Observations of similar stands along the river indicated that other tree layer species can occur in this vegetation type including incense cedar (*Calocedrus decurrens*), Douglas-fir, and ponderosa pine. The tree layer heights ranged from 36.1 to 45.9 feet (11 to 14 m) and the mean tree layer cover was 65.0 ± 26.5 percent.

Western serviceberry and snowberry occurred more frequently in sampled plots, but other, less frequently occurring species, such as Douglas' spiraea and brown dogwood, were more abundant in some plots. The shrub layer heights ranged from 1.64 to 9.8 feet (0.5 to 3.0 m) and the mean shrub layer cover averaged 43.8 ± 29.5 percent.

Blue wildrye, smooth scouring rush (*Equisetum hyemale*), and Oregon grape occurred in five, three, and three of the nine sampled plots, respectively. The presence of smooth scouring rush along one transect was supported by irrigation seepage. Kentucky bluegrass and yarrow were the only other herb layer species to occur in more than one plot. The herb layer heights ranged from 0.7 to 5.2 feet (0.2 to 1.6 m) and the herb layer cover averaged 30.4 ± 32.7 percent.

Kentucky Bluegrass/Yarrow/Field Cress (18). The bluegrass/yarrow/field cress vegetation type was documented in 12 plots in the peaking reach. This vegetation type was sampled on one terrace across from Frain Ranch. The presence of Kentucky bluegrass, yarrow, and field cress (*Lepidium campestre*) in 11, six, and six sampled plots, respectively, loosely bind together a diverse group of species that seemingly tolerate a range of moisture conditions from seasonally wet to dry substrates.

Lesser-panicled sedge (*Carex diandra*), willowherb, poverty rush (*Juncus tenuis*), and willow dock (*Rumex salicifolius*) were species with more mesic affinities. A large portion of this terrace was dry and supported species commonly observed in dry habitats elsewhere in the Project area including Lemmon's needlegrass (*Achnatherum lemmonnii*), medusahead (*Taeniatherum caput-medusae*), and soft brome (*Bromus hordeaceous*). This particular plant species assemblage was observed only on the sampled terrace that was used by recreation enthusiasts as a parking, camping, and turnaround spot; the full extent of this vegetation type in the peaking reach was not known. The herb layer heights ranged from 1 to 2 feet (0.3 to 0.6 m) and the herb layer cover averaged 60.0 ± 17.1 percent.

<u>Kentucky Bluegrass/Timothy/Colonial Bentgrass (19).</u> The bluegrass/timothy/bentgrass vegetation type was documented in 15 plots in the peaking reach. This vegetation type was sampled on two terraces along six different transects. Kentucky bluegrass, timothy, and colonial bentgrass occurred in 15, ten, and 12 sampled plots, respectively. Baltic rush, fox sedge (*Carex vulpinoidea*), western aster (*Aster spathulatum*), plantain (*Plantago lanceolata*), and western goldenrod were recorded in five or more plots. This vegetation type occurred with the Kentucky Bluegrass/Yarrow/Field Cress vegetation type along three transects. Other herb layer species that were present in this vegetation type included woolly sedge, wheat sedge (*Carex atheroides*), common rush (*Juncus effusus*), and poverty rush. The herb layer heights ranged from 1.0 to 2.6 feet (0.3 to 0.8 m) and the herb layer cover averaged 79.0 ± 17.8.

The shrub and tree layers generally have sparse cover consisting of scattered individual plants. Oregon oak, Douglas' spiraea, snowberry, and western serviceberry all occur infrequently in this vegetation type, often as overhanging limbs and branches.

<u>Oregon Ash/Colonial Bentgrass/Woolly Sedge (44).</u> The ash/bentgrass/sedge vegetation type was documented in 17 plots along seven transects in the peaking reach. Oregon ash was the dominant tree layer species in 16 plots and white alder (*Alnus rhombifolia*) dominated the tree layer in one stand. Black oak was the only other tree layer species. The tree layer heights ranged from 13.1 to 49.2 feet (4 to 15 m) and the tree layer cover averaged 60.4 ± 36.7 percent.

Oregon ash was the only important shrub layer species in the ash/bentgrass/sedge vegetation type, occurring in six plots. Arroyo willow, black hawthorn (*Crataegus douglasii*), brown dogwood, Himalayan blackberry, California rose, and lacinate-leaf blackberry (*Rubus laciniatus*) also were present in the shrub layer. The shrub layer heights ranged up to 9.2 feet (2.8 m) and the shrub layer cover averaged 18.7 ± 23.7 percent.

Colonial bentgrass and woolly sedge each occurred in 12 or more of the sampled plots. Reed canarygrass, water smartweed, perennial ryegrass, and common horsetail (*Equisetum arvense*) occurred in ten, nine, and seven plots, respectively. Eight of the 17 plots were influenced by groundwater seepage as indicated by the presence of common horsetail, peppermint (*Mentha* x *piperata*), and spikerush (*Eleocharis macrostachya*). The groundwater seepage also increased the upper elevation limits for hardstem bulrush and reed canarygrass in this vegetation type. The slope of the streambank varied from site to site, but the source of the seepage appeared to be return water from irrigation. The herb layer heights ranged from 0.7 to 5.8 feet (0.2 to 1.8 m) and the mean percent cover of the herb layer was 63.4 ± 26.9.

Oregon Ash/Himalayan Blackberry (45). The ash/blackberry vegetation type was documented in 29 plots along four transects in the peaking reach. Most of these stands occurred on the right bank downstream of Beswick Ranch. The presence of Oregon ash and Himalayan blackberry define this vegetation type. The relatively wide ecological amplitude of these species permits a variety of species with narrower ecological limitations to grow in the ash/blackberry stands.

Oregon ash was the dominant tree layer species in 26 of 29 plots. White alder was a co-dominant tree layer species with Oregon ash in relatively low areas along the river and in areas influenced by irrigation seepage. Coyote willow was present in the tree layer in one plot and occurred infrequently in lower lying areas in the ash/blackberry stands as a shorter, second tree layer. Oregon oak was the dominant tree layer species in two plots and was co-dominant in two other plots along with Oregon ash at relatively higher topographic positions. The tree layer heights ranged from 24.6 to 64.0 feet (7.5 to 19.5 m) and the tree canopy cover averaged 76.3 ± 32.4 percent.

Himalayan blackberry was present in 26 of 29 sampled stands and often dominated the shrub layer. Brown dogwood, Douglas' spiraea, and black hawthorne were present in 12, eight, and four plots, respectively. Coyote willow shrubs also were present in five of the 29 plots. The shrub layer in most stands was two-layered with Himalayan blackberry up to 5 feet (1.5 m) and the other shrub layer species growing up to 14.8 feet (4.5 m). The mean percent cover of the short and tall shrub layer was 52.5 ± 38.8 and 17.6 ± 34.5, respectively.

The herb layer species indicated a strong influence in some stands from adjacent irrigated pastures. This influence was not so much from the effects of irrigation returns, but more from the close proximity of a seed source of pasture grasses and herbs: Kentucky bluegrass, perennial ryegrass, orchard grass (*Dactylis glomerata*), white clover (*Trifolium repens*), and fowl bluegrass. Other widespread native and non-native species also present in these plots included sticky cinquefoil (*Potentilla glandulosa*), knotted hedge parsley (*Torilis nodosa*), blue wildrye, field cress, and prickly lettuce (*Lactuca serriola*). In other plots in the ash/blackberry vegetation type, the herb layer often was not present under a dense blackberry shrub layer. A taller herb layer in plots in low-lying areas within these stands or in plots near the river consisted of species capable of competing with Himalayan blackberry; these species included reed canarygrass, climbing nightshade, and devil's beggerstick. The variety of hydrologic conditions, the close proximity on non-native seed sources, and interspecific competition resulted in a wide range of herb layer heights and aerial cover within the 29 sampled plots. The herb layer heights ranged from zero in plots with no herb layer up to 7.2 feet (2.2 m). The mean cover of the herb layer was 17.3 ± 28.8 percent.

Coyote Willow/Reed Canarygrass/Colonial Bentgrass (12). The willow/canarygrass/bentgrass vegetation type was documented in 22 plots along nine different transects in the peaking and bypass reaches. This vegetation type occurred at a slightly higher elevation, adjacent to the Reed Canarygrass vegetation type and shares several species in common in that type. The willow/canarygrass/bentgrass vegetation type was most abundant on low-gradient terraces although small clumps of coyote willow were observed in a similar topographic position on banks with a much shorter, steeper gradient.

There were many positions along the river that potentially could support coyote willow, but supported only reed canarygrass. Plots sampled in these positions were classified in some cases as being a part of the Reed Canarygrass vegetation type (described below) and in other cases as being a part of the Coyote Willow/Reed Canarygrass/Colonial Bentgrass vegetation type. This indicates that factors other than inundation duration and inundation frequency were important in explaining the relative position of the Reed Canarygrass and Coyote Willow/Reed Canarygrass/Colonial Bentgrass vegetation types along the elevation gradient.

Coyote willow in the tree and shrub layers was present in 18 of the 22 sampled plots. Oregon ash and white alder each occurred in one plot. Himalayan blackberry and lacinate-leaf blackberry were present in the shrub layer of four sampled plots. The coyote willow tree layers ranged in height from 19.7 to 24.5 feet (6 to 7.5 m). The mean cover of the tree layer was 29.3 ± 31.1 percent. The coyote willow shrub layer heights ranged from 3.3 to 18 feet (1.0 to 5.5 m) and the mean canopy cover averaged 26.6 ± 24.6 percent.

The herb layer species composition in 19 plots was predominately reed canarygrass. In six plots, including three plots without reed canarygrass, there was a strong “meadow” composition of species including common rush, swordleaf rush (*Juncus ensifolius*), velvet grass (*Holcus lanatus*), timothy, and fox sedge (*Carex vulpinoidea* [some sedges might be *Carex diandra*]). Species occurring frequently across all plots included western goldenrod, sweet clover (*Melilotus alba*), Baltic rush, rigid hedge nettle, and young sprouts of coyote willow. Other herb layer species that occurred at low frequency included woolly sedge, hairy willowherb, stinging nettle, hardstem bulrush, fowl bluegrass, and common horsetail. The herb layer height ranged from 1.6 to 7.2 feet (0.5 to 2.2 m). The mean cover of the herb layer was 71.3 ± 27.2 percent.

<u>Mock Orange/Reed Canarygrass (52).</u> The mock orange/canarygrass vegetation type was documented in eight plots in the J.C. Boyle bypass reach. This vegetation type was sampled on along six different transects with short, steep, boulder-covered banks at the outer, upper edge of the riparian zone. Mock orange and reed canarygrass were present in all eight sampled plots. This vegetation type was closely allied to the Mock Orange vegetation type, but occurred at slightly lower streambank elevations in close proximity to the active channel or at least the water table. Mock orange was able to establish in elevated patches among large boulders, while reed canarygrass was rooted among the boulders in patches of substrates connected to the water table.

The only shrub layer species recorded with mock orange in one plot was arroyo willow. The shrub layer heights ranged from 8.2 to 11.5 feet (2.5 to 3.5 m) and the mean canopy cover was 39.3 ± 23.7 percent.

The areal cover of reed canarygrass varied from 5 to 90 percent. The herb layer cover averaged 28.8 ± 27.2 percent. The areal cover of other herb layer species was low and included barnyard grass (*Echinochloa crus-gallae*), river sedge (*Carex* cf. *nudata*), stinging nettle, western goldenrod, meadow rye (*Hordeum brachyantherum*), and Baltic rush. Blue wildrye, a component of the Mock Orange vegetation type, also was present in two of the eight sampled plots.

<u>Reed Canarygrass (53).</u> The canarygrass vegetation type was documented in 52 plots along 14 transects in the J.C. Boyle peaking and bypass reaches. This vegetation type occurred primarily at the edge of the active channel rooted in silty to gravelly substrates deposited among large boulders. In the peaking reach, reed canarygrass appeared to thrive in the varial zone where the “hydroponic washing” with nutrient-rich water occurs on a daily basis. Reed canarygrass occurred in dense stands to individual clumps secured to boulders in the active channel. Reed canarygrass was equally as common and abundant in the bypass reach where flow fluctuations

occurred infrequently. Generally, hardstem bulrush was absent from the Reed Canarygrass vegetation type in the peaking and bypass reaches in contrast to the Keno Canyon stands, which rarely had stands of reed canarygrass that were not strongly associated with hardstem bulrush or river bulrush.

Coyote willow, white alder, Douglas' spiraea, Oregon ash, shining willow, and arroyo willow were among the few woody species that either were observed or recorded in the plot data as occurring (rooted) in the Reed Canarygrass vegetation type. The shrub layer heights ranged up to 11.5 feet (3.5 m) and the tree layer heights ranged up to 42.6 feet (13 m). The mean canopy cover of the shrub and tree layers was 3.2 ± 11.0 and 4.2 ± 18.3 percent, respectively.

Several associated herb layer species occurred at relatively low abundances, but were consistently observed in this vegetation type. Devil's beggarstick, hairy willowherb, stinging nettle, watercress (*Rorippa nasturtium-aquatica*), climbing nightshade, and knotweed (*Polygonum hydropiperoides*, *P. lapathifolium*, *P. persicara*, *P. arenastrum*) were present in eight or more of the 52 sampled plots. Other species that were commonly observed, but less frequently recorded in the plot data included colonial bentgrass, water hemlock (*Cicuta douglasii*), woolly sedge, rice cutgrass, and duckweed. In the bypass reach, young sedge (*Carex* cf. *nudata*) clumps were observed at many locations in the active channel and frequently were associated with the reed canarygrass. Many of the associated herb layer species occurred in more open stands of reed canarygrass, in small pools or openings within the reed canarygrass stands, and at the fringes of the Reed Canarygrass vegetation type. The herb layer heights ranged from 1.5 to 8.2 feet (0.4 to 2.5 m) and the mean cover was 55.4 ± 35.0 percent.

<u>Hardstem Bulrush/Reed Canarygrass (27).</u> The bulrush/canarygrass vegetation type was documented in 18 plots along eight transects in the J.C. Boyle peaking reach. This vegetation type occurred in the active channel rooted in silt and sand substrates deposited among cobble and boulders. This vegetation type was restricted to low-gradient shelves or benches at the edges of the active channel often in secure locations next to boulders or in protected side-channel pools or backwater areas. Hardstem bulrush and reed canarygrass occurred in 18 and 14 of the 18 sampled stands, respectively. Reed canarygrass was almost always more abundant than hardstem bulrush in plots where they occurred together. In plots without reed canarygrass, hardstem bulrush occurred at less than 25 percent cover. The Hardstem Bulrush/Reed Canarygrass vegetation type and the Reed Canarygrass vegetation type shared a number of herb layer species in common including devil's beggarstick, colonial bentgrass, rice cutgrass, knotweed, woolly sedge, and climbing nightshade.

The presence of bulrush, water speedwell (*Veronica anagallis-aquatica*), and barnyard grass in 18, seven, and four plots, respectively, in the herb layer of the bulrush/canarygrass vegetation type helps separate the two vegetation types. Also, with the exception of the Coyote Willow/Reed Canarygrass/Colonial Bentgrass vegetation type, the bulrush/canarygrass vegetation type was the only vegetation type with young coyote willow shoots (vegetative) in the herb layer. The herb layer heights ranged from 3.3 to 9.5 feet (1.0 to 2.9 m) and the mean cover of the herb layer was 40.6 ± 31.8 percent.

Coyote willow was present in the shrub layer of four plots. Himalayan blackberry rooted outside the plot was the only other species that was recorded in the shrub layer. Oregon ash and white alder were recorded in the tree layer, but only white alder was actually rooted in one of the sampled plots. The shrub layer heights ranged up to 13.1 feet (4 m) and the tree layer heights ranged up to 54.1 feet (16.5 m). The mean cover of the shrub and tree layers was 8.6 ± 19.6 percent and 11.4 ± 25.0, respectively.

<u>Copco No. 2 Bypass</u>

Riparian vegetation sampling at Copco No. 2 bypass occurred at 51 plots along three transects. Five tree, nine shrub, and 62 herb layer species were documented in the Copco No. 2 bypass plots sampled in 2003. The average width of the wetland vegetation along the sampled transects was 26.2 ± 18.0 feet (8.0 ± 5.5 m).

The riparian vegetation at Copco No. 2 bypass was influenced by river flows that were low compared to pre-Project flows. The lower water level has made available more potential substrate for riparian and wetland plants on previously inundated portions of the channel bed. This has resulted in an increase in abundance of riparian vegetation (encroachment) particularly in closer proximity to and at lower elevations in the active channel in Copco No. 2 bypass. There was no observational evidence that the higher elevation limit of the riparian vegetation that was established during pre-Project flows has changed. The steep canyon slopes that abut the river channel likely restricted the pre-Project riparian vegetation to a narrow band along most parts of the Copco No. 2 bypass reach. The present-day riparian vegetation also was influenced significantly by seepage from the Copco No. 2 bypass penstock. Seepage from the penstock has created wetland habitats between the penstock and the left bank of the Copco No. 2 bypass reach. The riparian vegetation at Copco No. 2 bypass was unique compared to other Project river reaches for the many large white alder that formed the dominant tree canopy present in the reach. The dense white alder canopy may be a contributing factor to the scarcity of the shade-intolerant coyote willow and reed canarygrass relative to other Project reaches.

The TWINSPAN analysis resulted in five vegetation types in which the most frequently occurring species were white alder, Himalayan blackberry, devil's beggarstick, Oregon ash, knotweed, stipitate sedge, California grape (*Vitis californica*), poison hemlock, prickly lettuce, hairy willowherb, and rice cutgrass.

<u>Oregon Ash/Himalayan Blackberry/Blue Wildrye (5).</u> The ash/blackberry/wildrye vegetation type was documented in 13 plots along three transects in the Copco No. 2 bypass reach. This vegetation type represents a loosely associated assemblage of species some of which have affinities to the "wetter" White Alder/Oregon Ash vegetation type and others that have affinities to drier habitats. The latter group of species demonstrates considerable variation in composition from plot to plot within this vegetation type, but nevertheless helps to distinguish the ash/ blackberry/wildrye vegetation type from other riparian vegetation types in Copco No. 2 bypass. The presence of Himalayan blackberry and blue wildrye often help to distinguish this vegetation type in the absence of Oregon ash in the tree layer.

Oregon ash and white alder were present in the tree layer in six and four of the 13 sampled plots, respectively. Black oak was the dominant or co-dominant tree layer species in three plots and white oak was a co-dominant tree layer species in one plot. The tree layer height ranged from 32.8 to 72.0 feet (10 to 22 m) in plots with a tree layer. There was no tree layer in two of the sampled plots. The mean canopy cover of the tree layer was 63.8 ± 35.5 percent.

Himalayan blackberry was the most frequent shrub layer species occurring in nine plots. Oregon ash and poison oak (*Toxicodendron diversilobum*) were present in five and four plots, respectively. California grape was present in five sampled plots primarily as low, creeping stems in the herb layer. Coyote willow was the dominant shrub layer species in one plot that had no tree layer. Chokecherry was present in one plot and was unique to this vegetation type. The shrub layer height ranged from 3.9 to 16.4 feet (1.2 to 5.0 m) and the mean canopy cover was 31.2 ± 20.2 percent. No shrub layer was present in one sampled plot.

Blue wildrye was the most frequent herb layer species, occurring in five sampled plots. Knotted hedge parsley, California brome, Oregon oak, Oregon ash, ripgut brome, cheatgrass, and poison oak occur in the herb layer in two or three plots. Large-flowered colomia (*Colomia grandiflora*), California lomatium (*Lomatium californica*), and sweet cicely (*Ozmorhiza chilensis*) each occurred in one sampled plot and were unique to the ash/blackberry/wildrye vegetation type. The herb layer height ranged from 0.7 to 3.6 feet (0.2 to 1.1 m) and the mean cover was 6.8 ± 11.6 percent. No herb layer was present in five sampled plots.

<u>White Alder/Oregon Ash (3).</u> The alder/ash vegetation type was documented in 19 plots along three transects in the Copco No. 2 bypass reach. White alder occurred in the tree layer in 18 of 19 sampled plots and was the dominant or co-dominant species in the tree layer in all 18 plots. Oregon ash occurred in the shrub layer and tree layer in ten and four of the sampled plots, respectively. Bigleaf maple (*Acer macrophyllum*) was present in the tree layer of one plot. The tree layer height ranged from 32.8 to 59.0 feet (10 to 18 m) and the mean canopy cover was 86.5 ± 25.4 percent.

In addition to Oregon ash, Himalayan blackberry was the only other frequently occurring shrub layer species (six plots). Mock orange and white stemmed gooseberry each occurred in one plot. California grape, a species that was abundant below Iron Gate dam, was present in six Copco No. 2 bypass plots. California grape can have high areal cover and also can range vertically from the herb layer up into the tree layer because of its vining growth form. Excluding California grape, the shrub layer height ranged up to 16.4 feet (5 m) and the mean canopy cover was 7.4 ± 11.4 percent. No shrub layer was present in seven sampled plots.

The most frequent herb layer species were present in four to seven of the sampled plots and included poison hemlock (seven), stinging nettle (six), climbing nightshade (five), ripgut brome (four), prickly lettuce (four), stipitate sedge (four), and white alder seedlings (four). The herb layer of the alder/ash vegetation type has many species in common with the White Alder/Rice Cutgrass/Hairy Willowherb vegetation type, but seldom do they occur in more than two sampled plots; these species include water hemlock, rice cutgrass, hairy willowherb, teasel, black medic, Mexican muhly, sweet white clover, common rush, and water smartweed. Several infrequently occurring species were unique to the alder/ash vegetation type: bur chervil, chickweed (*Cerastium* sp), alkali grass (*Puccinellia* sp), lesser burdock (*Arctium minus*), white clover, vetch (*Vicia* sp.), and reed canarygrass. The herb layer height ranged up to 3.9 feet (1.2 m) and the mean cover the herb layer was 8.3 ± 9.6 percent. No herb layer was present in two sampled plots.

<u>White Alder/Rice Cutgrass/Hairy Willowherb (2).</u> The alder/cutgrass/willowherb vegetation type was documented in 11 plots along three transects in the Copco No. 2 bypass reach. White alder occurred in the tree layer in nine of 11 sampled plots. The associated species that bind the two plots without alder in the tree layer to the alder/cutgrass/willowherb vegetation type are

discussed below. The ubiquitous Oregon ash also was present in the tree layer of two plots. The average tree layer cover (27.3 ± 33.5) was low compared to the other alder-dominated vegetation types in Copco No. 2 bypass reach. The height of the tree layer, when present, ranged from 32.8 to 59.0 feet (10 to 18 m).

The high frequency of white alder saplings in eight of the 11 sampled plots and the occurrence of arroyo willow in five sampled plots were unique to this vegetation type. Mock orange, Himalayan blackberry, white stemmed gooseberry, and Oregon ash occurred infrequently in the shrub layer. The shrub layer height ranged up to 5.2 feet (1.6 m) and the mean canopy cover was 2.8 ± 2.7 percent.

Like the Devils' Beggarstick/Knotweed vegetation type, devils' beggarstick and knotweed were important components in the herb layer of the alder/cutgrass/willowherb vegetation type and occurred in nine and ten of the 11 sampled plots, respectively. Hairy willowherb, rice cutgrass, and stipitate sedge each occurred in seven sampled sites and their presence in the herb layer helped to distinguish the alder/cutgrass/willowherb vegetation type from other alder-dominated vegetation types in Copco No. 2 bypass. Common rush, river sedge, curly dock, climbing nightshade, sweet white clover (*Melilotus alba*), poison hemlock (*Conium maculatum*), water hemlock, Mexican muhly (*Muhlenbergia mexicana*), and stinging nettle also were present in the herb layer. The herb layer heights ranged from 1.3 to 3.9 feet (0.4 to 1.2 m) and the mean cover was 28.8 ± 19 percent.

<u>Devils' Beggarstick/Knotweed (1).</u> The beggarstick/knotweed vegetation type was documented in seven plots along three transects in the Copco No. 2 bypass reach. This vegetation type most often was observed on the lowest, wettest ground nearest to the active channel and frequently was associated with the herb layer component of the White Alder/Rice Cutgrass/Hairy Willowherb vegetation type. Devils' beggarstick, knotweed, and seedlings of white alder occurred in five or more of the seven sampled plots. Young sedges, tentatively identified as river sedge, and white alder shrubs each was present in three of the sampled plots. Common rush and yellow monkeyflower each was present in two plots. The herb layer heights ranged from 1.3 to 1.6 feet (0.4 to 0.5 m) and the mean cover was 3.0 ± 1.0 percent.

White alder saplings were the only shrub layer species present and were usually perched on boulders and rooted in cracks in boulders. The shrub layer height ranged up to 3.9 feet (1.2 m) and the mean canopy cover was 0.6 ± 1.5 percent.

The absence of white alder trees rooted within the plot or in close proximity to the beggarstick/knotweed plots separates the beggarstick/knotweed vegetation type from the white alder tree-dominated vegetation types in the reach. However, the areal cover of the tree layer when white alder overhangs the beggarstick/knotweed vegetation type was estimated. The height of the overhanging tree layer, when present, ranged from 32.8 to 55.8 feet (10 to 17 m) and the mean canopy cover was 37.1 ± 42.0 percent.

<u>Fall Creek</u>

Riparian vegetation sampling at Fall Creek occurred at 30 plots along three transects. Five tree, 13 shrub, and 25 herbaceous plant species were documented in the Fall Creek plots sampled in 2002. The average width of the wetland vegetation along the sampled transects was 26.2 ± 18.0 feet (8.0 ± 5.5 m); the average slope was 22.8 ± 12.6 percent.

The riparian vegetation at Fall Creek was influenced by river hydrology and by seepage from the Fall Creek canal. Seepage from the canal has created wetland habitats between the canal and the left bank of Fall Creek. The riparian vegetation at Fall Creek was unique compared to other Project river reaches for the presence and abundance of conifers in the riparian zone. Ponderosa pine, white fir, and Douglas-fir were rooted in close proximity to the banks of Fall Creek, which likely indicates a lack of significant hydrological influence laterally from Fall Creek. Western birch (*Betula occidentalis*) was also abundant in the Fall Creek riparian zone and was infrequent or does not occur along other Project river reaches. White alder grows in distinct stands, although these stands differ considerably from the white alder stands in the Copco No. 2 bypass. In addition, shrub species diversity was the highest among all Project reaches with 13 shrub layer species. Coyote willow was conspicuously absent from the Fall Creek data set.

Along Fall Creek, the tree cover in riparian plots averaged 38 percent, while shrub cover was 63 percent. The riparian tree diameters average 4.3 ± 2.9 inches (10.9 ± 7.4 cm) dbh. There were many logs along Fall Creek; sampling found 18 logs/acre (5.5 logs/ha) or 561 feet/acre (427 m/ha). Similarly, the density of snags was quite high—13 snags/acre (33 snags/ha), which average 13.3 inches (33.8 cm) dbh.

The TWINSPAN analysis resulted in five vegetation types dominated to varying degrees by Oregon ash in the shrub and tree layers, and Douglas' spiraea, white alder, western serviceberry, Pacific ninebark, Oregon grape, blue wildrye, white-stemmed gooseberry (*Ribes inerme*), snowberry, and American speedwell.

<u>Oregon Ash/Western Birch (8).</u> The ash/birch vegetation type was documented in five plots along the right bank of one transect in the Fall Creek reach. Oregon ash and western birch were the dominant tree layer species in all five plots. Western birch formed a distinctly shorter, second tree layer of scattered clumps of small diameter stems. The ground was often muddy and saturated with some pooled water that accumulated from lateral wicking into low areas adjacent to Fall Creek. The tree layer heights ranged from 16.4 to 23.0 feet (5 to 7 m) and the mean canopy cover was 72.0 ± 21.1 percent.

Douglas' spiraea and Oregon ash were the most frequently occurring shrub layer species in five and four plots, respectively. Poison oak, snowberry, white-stemmed gooseberry, and tall Oregon grape occurred in at most two of the five sampled plots. The shrub layer height ranged from 3.3 to 9.8 feet (1.0 to 3.0 m) and the mean canopy cover was 30.0 ± 14.6 percent.

American speedwell occurred in four plots. Cow parsnip (*Heracleum lanatum*), yellow monkeyflower, Bolander's sedge (*Carex deweyana*), and rigid hedge nettle each occurred in two or three sampled plots. Snowberry and Oregon grape were the only herb layer species in one plot. The herb layer heights ranged from 1.3 to 3.3 feet (0.4 to 1.0 m) and the mean cover was 23.0 ± 29.1 percent.

<u>Oregon Ash/Douglas' Spiraea (9).</u> The ash/spiraea vegetation type was documented in seven plots along the left bank of two transects in the Fall Creek reach. Oregon ash formed a dense, tall canopy in all seven sampled plots. White alder was present in the tree layer of two plots. The ground was often muddy and saturated from lateral wicking into low areas adjacent to Fall Creek as well as seepage from the canal. The tree layer heights ranged from 26.2 to 46.0 feet (8 to 14 m) and the mean canopy cover was 90.0 ± 6.5 percent.

Douglas' spiraea was present in all seven sampled plots. White-stemmed gooseberry and Oregon ash each was present in four plots and Pacific ninebark in three plots. *Rosa* sp., Himalayan blackberry, mock orange, and Douglas-fir also were present in one or two sampled plots. The shrub layer height ranged from 4.9 to 7.2 feet (1.5 to 2.2 m) and the mean canopy cover was 48.6 ± 27.06 percent.

Stipitate sedge (*Carex stipitata*), hairy willowherb, rigid hedge nettle, Eaton's aster, and Nebraska sedge (*Carex nebrascensis*) were the most frequently occurring herb layer species, but each occurred in at most two plots. The herb layer heights ranged from 0.3 to 9.8 feet (0.1 to 3.0 m) and the mean cover was 15.6 ± 19.3 percent.

<u>White Alder (5).</u> The White Alder vegetation type was documented in seven plots along the left bank and right bank of three transects in the Fall Creek reach. White alder formed a sparse to dense, relatively short canopy in all seven sampled plots. Oregon ash was present in the tree layer of three plots. The ground was often muddy and saturated from lateral wicking into low areas adjacent to Fall Creek as well as seepage from the canal. The tree layer heights ranged from 14.8 to 26.2 feet (4.5 to 8.0 m) and the mean percent cover of the tree layer was 60.8 ± 37.8.

Douglas' spiraea and Pacific ninebark were present in four and three sampled plots, respectively. White-stemmed gooseberry, poison oak, snowberry, and Oregon grape each occurred in one plot. The shrub layer height ranged from 3.3 to 8.2 feet (1.0 to 2.5 m) and the mean canopy cover was 47.1 ± 30.4 percent.

Common horsetail and lady fern (*Athyrium felix-femina*) were unique to this vegetation type and occurred in three and two sampled plots, respectively. The remaining herb layer species included a mixture of species that also occur in the Oregon Ash/Douglas' Spiraea vegetation type and the Oregon Ash/Western Birch vegetation type.

Hairy willowherb, rigid hedge nettle, American speedwell, yellow monkey flower, water hemlock, Nebraska sedge, small bedstraw (*Galium trifidum*), and Columbia lily (*Lilium columbianum*) were species shared by one or more of the three vegetation types. The constancy of herb layer species within and between these three vegetation types was low. The herb layer heights ranged from 1.3 to 3.3 feet (0.4 to 1.0 m) and the mean cover was 24.3 ± 21.5 percent.

<u>Ponderosa Pine/Douglas-fir/Western Serviceberry (6).</u> The pine/fir/serviceberry vegetation type was documented in 11 plots along the left bank and right bank of three transects in the Fall Creek reach. This vegetation type was representative of the drier or more upland aspect of the riparian mixed conifer—hardwood vegetation described and mapped in the Upland Vegetation Characterization and Mapping report (see Section 2.0). The small scale of the riparian plots (3.3 feet by 13.1 feet [1 m by 4 m]) has resulted in many "holes" in the plot data for the Ponderosa Pine/Douglas-fir/Western Serviceberry vegetation type. This means that the constancy of individual species within the vegetation type was quite low because the small plot size consistently missed the frequently occurring species.

In this vegetation type at Fall Creek, the scale of the vegetation was coarse compared to riparian vegetation present elsewhere in the Project area. In part, the coarseness of the riparian mixed conifer-hardwood vegetation was the result of the flow patterns from different locations along the Fall Creek canal creating an inconsistent occurrence of plants with wetland affinities. Also, in the simplest terms, the upland vegetation component has a coarser scale because of the limitations of more xeric habitats to support plants in closer proximity to one another. Therefore, some liberties were taken here to describe the Ponderosa Pine/Douglas-fir/Western Serviceberry vegetation type using the riparian plot data.

Ponderosa pine and Douglas-fir formed a tall, sparse canopy cover in five and two sampled plots, respectively. Black oak was present in six plots. Oregon ash and white alder were present in the tree layer of five and four plots, respectively. The tree layer height for hardwood species ranged from 14.8 to 23.0 feet (4.5 to 7.0 m) and the mean percent cover of the tree layer was 27.5 ± 26.8. The taller conifer tree layer ranged from 42.6 to 65.6 feet (13 to 20 m) and the mean canopy cover was 17.6 ± 23.1 percent.

Western serviceberry, tall Oregon grape (*Berberis aquifolium*), and snowberry were the most frequently occurring shrub layer species in eight, six, and five plots, respectively. Poison oak, Himalayan blackberry, Pacific ninebark, California rose, and Douglas' spiraea were present in, at most, three sampled plots. Douglas-fir, black oak, and Oregon ash were tree species present in the shrub layer. The shrub layer height ranged from 2.6 to 9.8 feet (0.8 to 3.0 m) and the mean canopy cover was 45.9 ± 21.7 percent.

Blue wildrye, Oregon grape, and bulbous bluegrass were present in five, five, and four sampled plots, respectively. Kentucky bluegrass, multistemmed sedge (*Carex multicaulis*), California brome (*Bromus carinatus*), and black oak seedlings each occurred in three plots. The herb layer heights ranged from 1 to 3 feet (0.3 to 0.9 m) and the mean cover was 30.7 ± 20.1 percent.

Iron Gate Dam to Shasta River

Riparian vegetation sampling in the Iron Gate dam to Shasta River reach (Iron Gate reach) occurred at 193 plots along 11 transects. Six tree, six shrub, and 85 herb layer plant species were documented in the Iron Gate reach. The average width of the wetland vegetation along the sampled transect was 45.9 ± 25.6 feet (14.0 ± 7.8 m); the average slope was 19.7 ± 11.5 percent.

Tree cover in the Iron Gate reach averaged 37.3 percent and shrub cover averaged 18.3 percent. The tree tally data for the Iron Gate reach riparian vegetation revealed that the average riparian tree diameter was 5.7 ± 5.7 inches (14.5 ± 14.5 cm) dbh. There were 0.4 ± 1.0 logs/acre (1.0 log/ha) in this river reach, with the total log length averaging 19.9 ± 52.8 feet/acre (15.2 ± 40.2 m/ha). There were no snags in riparian sampling plots.

The TWINSPAN analysis resulted in 12 vegetation types. Coyote willow, colonial bentgrass, Oregon ash, rice cutgrass, Himalayan blackberry, western goldenrod, curly pondweed (*Potamageton crispus*), teasel (*Dipsacus fullonum*), duckweed, and knotgrass were the most frequently occurring riparian plant species growing in the Iron Gate reach and in various combinations form the dominant vegetation types. These vegetation types are described below.

Medusahead/Cheatgrass (36). The Medusahead/Cheatgrass vegetation type was documented in seven plots along six different transects in the Iron Gate reach. This vegetation type was representative of many disturbed habitats that abut the river. This vegetation type contained species that occur at relatively low constancy and also have affinities to a wide range of substrate moisture. Medusahead and cheatgrass (*Bromus tectorum*) occurred in five and four of the seven sampled plots, respectively. These species were widespread and abundant in upland habitats throughout much of the study area. The close proximity of this vegetation type to the river (water table) allowed species such as coyote willow, teasel, white sweet clover, mugwort (*Artemisia douglasii*), field cress (*Lepidium campestris*), Kentucky bluegrass, and chicory (*Cichorium intybus*) with more mesic habitat affinities to occur with more shallowly rooted, upland species. Species present in this vegetation type with affinities to drier, upland habitats include ripgut brome (*Bromus diandrus*), yellow starthistle (*Centaurea solstitialis*), and hairy brome (*Bromus japonicus*). California rose and Himalayan blackberry were the only shrub layer species other than coyote willow to occur in the shrub layer.

The shrub layer heights ranged up to 6.5 feet (2 m) and the mean cover of the shrub layer was 11.7 ± 19.7 percent. The herb layer heights ranged from 0.2 to 2.3 feet (0.2 to 0.7 m) and the mean cover of the herb layer was 30.7 ± 32.7 percent.

<u>Chicory/Tall Fescue (39).</u> The chicory/fescue (*Festuca arundinacea*) vegetation type was documented in five plots along two transects in the Iron Gate reach. This vegetation type, like the Medusahead/Cheatgrass vegetation type, was representative of many disturbed habitats that abut the river. The presence of ripgut brome in both of these vegetation types closely ties these two vegetation types. However, the absence of medusahead and the presence of tall fescue and chicory distinguished these two vegetation types in the TWINSPAN analysis. Chicory, tall fescue, yellow starthistle, and ripgut brome occurred in five, three, four, and four sampled plots, respectively. Plantain and field pepperweed each occurred in three plots.

This vegetation type had some species that occurred at relatively low constancy and also have affinities to a wide range of substrate moisture. The close proximity of this vegetation type to the river (water table) allowed species such as coyote willow, teasel, white sweet clover, mugwort, and Kentucky bluegrass with more mesic habitat affinities to occur with more shallowly rooted, upland species. Species present in this vegetation type with affinities to drier, upland habitats included ripgut brome and yellow starthistle. Coyote willow, Oregon ash, and Himalayan blackberry were the only shrub layer species.

The shrub layer heights ranged up to 6.9 feet (2.1 m) and the mean cover of the shrub layer was 15.0 ± 18.7 percent. The herb layer heights ranged from 0.3 to 3.9 feet (0.1 to 1.2 m) and the mean cover of the herb layer was 56.0 ± 11.9 percent.

<u>Oregon Oak/BlueWildrye (37).</u> The oak/wildrye vegetation type was documented in 15 plots along six different transects in the Iron Gate reach. This vegetation type was sampled at the upper end of short elevation (moisture) gradient created by steep slopes at the river's edge. The tree component of the oak/wildrye vegetation type formed an interrupted or patchy tree layer along many portions of the Iron Gate reach. Oregon oak occurred in six of the 15 sampled plots. Two other tree layer species co-occurred or replaced Oregon oak in some stands including western juniper and Oregon ash. The tree layer heights ranged from 19.7 to 59.0 feet (6 to 18.0 m) and the mean canopy cover was 64.7 ± 35.0 percent.

Himalayan blackberry and Oregon ash were the most frequent shrub layer species, occurring in six and five plots, respectively. Snowberry was present in four plots. Three-leaf sumac, coyote willow, and shining willow each occurred in one plot. The shrub layer heights ranged from 1.6 to 13.1 feet (0.5 to 4 m) and the mean canopy cover was 26.3 ± 22.1 percent.

The oak/wildrye vegetation type has no herb layer species except for ripgut brome (nine) and Kentucky bluegrass (six), which occurred in more than four plots. Brome (*Bromus* cf. *carinatus*), teasel, mugwort, California rose, Oregon ash, field pepperweed, knotted hedge parsley, colonial bentgrass, western goldenrod, and bur chervil each occurred in three or four plots. The herb layer heights ranged from 1.3 to 4.3 feet (0.4 to 1.3 m) and the mean cover of the herb layer was 36.1 ± 26.4 percent.

Oregon Ash/Colonial Bentgrass/Kentucky Bluegrass (38). The ash/bentgrass/bluegrass vegetation type was documented in 21 plots along seven transects in the Iron Gate reach. This vegetation type was one of the most abundant tree-dominated riparian vegetation types in the Iron Gate reach. Nearby pastures have had a strong influence on the ash/bentgrass/bluegrass vegetation type that include several grass species commonly planted for forage as associated species in the herb layer; these species include perennial ryegrass, tall fescue, and Kentucky bluegrass. Oregon ash was the dominant tree layer species in 16 plots. Black oak and western juniper were present in the tree layer in one and two plots, respectively. In four plots, there was no tree layer. The tree layer height ranged up to 54 feet (16.5 m) and the mean canopy cover was 49.3 ± 38.3 percent.

Oregon ash and shining willow occurred in one of the 21 sampled plots. Coyote willow was present in five sampled plots, sometimes at high abundance. The shrub layer height ranged up to 13.1 feet (4 m) and the mean canopy cover was 9.14 ± 20.1 percent.

The herb layer of the ash/bentgrass/bluegrass vegetation type was in many ways similar to the Chicory/Tall Fescue vegetation type. Chicory, tall fescue, Kentucky bluegrass, field pepperweed, and yellow starthistle were all components of both vegetation types. Colonial bentgrass, tall fescue, Kentucky bluegrass, and perennial ryegrass were the most frequent herb layer species, occurring in 13, ten, 13, and ten sampled plots, respectively. Teasal, white clover, chicory, and bird's-foot trefoil each occurred in at least four plots. The herb layer height ranged from 0.3 to 4.9 feet (0.1 to 1.5 m) and the mean cover of the herb layer was 50.9 ± 36.3 percent.

Coyote Willow/Poison Hemlock (40). The willow/hemlock vegetation type was documented in 11 plots along three transects in the Iron Gate reach. This vegetation type was less common in the Iron Gate reach than willow stands with and without Himalayan blackberry. The sampled plots were in slightly more hydric habitats (shallow water table) as indicated by the presence of hardstem bulrush in six plots. The sampled sites had many more young coyote willow sprouts (vegetative reproduction) in the herb layer relative to other willow-dominated stands in the Iron Gate reach.

The tree and shrub layers were dominated by coyote willow, although the vertical distinction between the two layers was sometimes indistinct. The tree and shrub layer in the willow/hemlock vegetation type in the Iron Gate reach was similar to the Coyote Willow/Reed Canarygrass/Colonial Bentgrass vegetation type in the J.C Boyle peaking reach. The coyote willow tree layer heights ranged from 19.7 to 42.6 feet (6 to 13 m) and the mean percent cover of the tree layer was 67.8 ± 34.6. The coyote willow shrub layer heights ranged from 3.3 to 10.5 feet (1.0 to 3.2 m) and the mean canopy cover was 13.8 ± 13.0 percent.

The most frequently occurring herb layer species included poison hemlock, coyote willow, hardstem bulrush, and western goldenrod in ten, eight, six, and five sampled plots, respectively. Stinging nettle, teasel, and field mint (*Mentha arvense*) were present in at least two plots. The herb layer height ranged from 0.7 to 9.8 feet (0.2 to 3.0 m) and the mean cover of the herb layer was 50.9 ± 36.3 percent.

Coyote Willow/Himalayan Blackberry (41). The willow/blackberry vegetation type was documented in 46 plots along eight different transects in the Iron Gate reach. This vegetation type was the most abundant vegetation type sampled in the Iron Gate reach. The willow shrub layer was the most distinctive aspect of these stands, although in some stands there was a taller willow layer or tree layer that occurred with or supplanted the shrub layer, similar to the Coyote Willow/Poison Hemlock vegetation type stands in the Iron Gate reach and the Coyote Willow/Reed Canarygrass/Colonial Bentgrass vegetation type stands in the J.C. Boyle peaking reach. In addition to coyote willow, the tree layer included individual trees of Oregon ash, Oregon oak, western juniper, and black oak, which occurred in nine, two, two, and two stands, respectively. These species were typically taller than the coyote willow, but did not form a distinct or abundant canopy in any of the willow stands. The tree layer heights ranged from zero to 45.9 feet (zero to 14 m) and the mean canopy cover was 34.5 ± 35.1 percent.

The coyote willow shrub layer heights ranged from zero to 19.7 feet (zero to 6.0 m) and the mean percent cover of the shrub layer was 58.9 ± 29.8 percent. Himalayan blackberry was present in 31 of the 46 sampled stands and formed a second, shorter shrub layer beneath the coyote willow. California rose and Oregon ash were the only other shrub layer species and each occurred in four plots. The shorter shrub layer height ranged up to 6.6 feet (2 m) and the mean cover of the shorter shrub layer was 2.6 ± 12.8 percent.

The most frequently occurring herb layer species were colonial bentgrass and teasel, which were present in 15 and 11 sampled plots, respectively. The herb layer cover tended to be sparse or non-existent under the dense willow shrub and tree layers. Stinging nettle, field pepperweed, bird's foot trefoil, western goldenrod, woolly sedge, coyote willow sprouts (vegetative reproduction), and tall fescue each occurred in at least four plots. The herb layer height ranged from zero to 4.9 feet (zero to 1.5 m) and the mean cover of the herb layer was 14.8 ± 24.2 percent.

Oregon Ash/Colonial Bentgrass/Woolly Sedge (88). The ash/bentgrass/sedge vegetation type was documented in nine plots along three transects in the Iron Gate reach. The Oregon Ash/Colonial Bentgrass/Woolly Sedge vegetation type in the J.C. Boyle peaking reach were different from the Oregon Ash/Colonial Bentgrass/Woolly Sedge in the Iron Gate reach, especially with respect to the species composition of the shrub and herb layers. The Iron Gate reach stands occurred on relatively flat gravel/cobble bars influenced by a shallow water table connected directly to the river. Oregon ash was the dominant tree layer species in seven plots and there was no tree layer in two of the sampled plots. In most stands, the ash trees were well spaced with large overhanging canopies. The tree layer heights ranged from zero to 55.8 feet (zero to 17.0 m) and the mean canopy cover of the tree layer was 54.6 ± 35.3 percent.

Coyote willow was the only important shrub layer species in the ash/bentgrass/sedge vegetation type, occurring seven sampled plots. Arroyo willow and shining willow were the only other shrub layer species. The predominance of willow in the shrub layer separates this vegetation type from the Oregon Ash/Colonial Bentgrass/Woolly Sedge vegetation type described for the J.C. Boyle peaking reach. The shrub layer in the ash/bentgrass/sedge vegetation type resembles the Coyote Willow/Himalayan Blackberry vegetation type, except that the shorter and relatively open willow shrub layer allows more light to hit the ground, resulting in denser growth and greater species diversity in the herb layer. The shrub layer height ranged up to 16.4 feet (5 m) and the mean canopy cover was 40.6 ± 30.9 percent.

Colonial bentgrass and woolly sedge were present in eight and six plots, respectively. Western goldenrod, coyote willow, and rice cutgrass were each was present in five sampled plots. The herb layer in the Oregon Ash/Colonial Bentgrass/Woolly Sedge vegetation type in the J.C. Boyle peaking reach shares few species in common with the Iron Gate reach stands, except for colonial bentgrass and woolly sedge. The herb layer heights ranged from 1.6 to 4.3 feet (0.5 to 1.3 m) and the mean cover was 69.2 ± 31.3 percent.

<u>Coyote Willow/Rice Cutgrass (89).</u> The willow/cutgrass vegetation type was documented in 14 plots along seven different transects in the Iron Gate reach. This vegetation type was observed most frequently between the vegetation types with low-growing knotgrass (*Paspalum distichum*) and the denser willow growth indicative of the Coyote Willow/Himalayan Blackberry vegetation type. Typically, there was no tree layer associated with the willow/cutgrass vegetation type.

Coyote willow forms the often-dense shrub layer and was present in all sampled plots. No other shrub layer species were observed in this vegetation type. The coyote willow shrub layer heights ranged from 6.6 to 21.3 feet (2.0 to 6.5 m) and the mean canopy cover was 59.4 ± 26.1 percent.

Rice cutgrass, western goldenrod, and colonial bentgrass were present in 12, seven, and six sampled plots, respectively. Herb layer species typically associated with habitats in closer proximity to the active channel or in generally wetter substrates include hardstem bulrush, marsh spikerush, knotweed, and knotgrass. The herb layer height ranged from 0.3 to 8.2 feet (0.1 to 2.5 m) and the mean cover was 44.0 ± 34.5 percent.

<u>Coyote Willow/Knotgrass (45).</u> The willow/knotgrass vegetation type was documented in six plots along five transects in the Iron Gate reach. Knotgrass was observed most frequently in gravel and cobble at the edge of the active channel. Frequently, this species was submerged during spring high flow and when it was not submerged, the ground typically was saturated as a result of wicking. Where the wicking extends into the coyote willow fringe along the river, knotgrass often formed a dense mat under the willows. Typically, there was no tree layer associated with the willow/knotgrass vegetation type, with the exception of overhanging branches of tall trees.

Coyote willow formed a dense shrub layer in this vegetation type in all but one sampled plot. No other shrub layer species were observed in this vegetation type. The coyote willow shrub layer heights ranged from 2.6 to 11.5 feet (0.8 to 3.5 m) and the mean canopy cover was 26.7 ± 28.9 percent.

Knotgrass was present in all six sampled plots. Coyote willow and curly dock (*Rumex crispus*) occurred in five and four sampled plots, respectively. Other herb layer species that were present in two or more plots included colonial bentgrass, Oregon ash seedlings, broadleaf plantain (*Plantago major*), water speedwell, water smartweed, and field pepperweed. The herb layer height ranged from 0.3 to 1.6 feet (0.1 to 0.5 m) and the mean cover was 64.2 ± 15.3 percent.

<u>Rice Cutgrass/Hardstem Bulrush (46).</u> The cutgrass/bulrush vegetation type was documented in 17 plots along five transects in the Iron Gate reach. The cutgrass/bulrush vegetation type was

observed most frequently in gravel and cobble at the edge of the active channel. Frequently, this vegetation type was submerged during spring high flow and during much of the year. Typically, there was no tree layer associated with the cutgrass/bulrush vegetation type, with the exception of overhanging branches of tall trees.

Coyote willow and Oregon ash were the only shrub layer species in four and one sampled plot, respectively. The shrub layer height ranged up to 9.8 feet (3 m) and the mean canopy cover was 5.4 ± 16.0 percent.

Rice cutgrass, hardstem bulrush, and knotweed were present in 16, 14, and ten sampled plots, respectively. Knotgrass, colonial bentgrass, river sedge, barnyard grass, and peppermint were present in eight to six sampled plots. There were two minor patterns in the herb layer species composition in the Rice Cutgrass/Hardstem Bulrush vegetation type. Barnyard grass was present in six plots with high cover of hardstem bulrush. In six other plots with a relatively low cover or no cover of hardstem bulrush, there was a small suite of species that was not found in other plots including marsh spikerush, devil's beggarstick, and water speedwell. The herb layer height ranged from 0.7 to 9.8 feet (0.2 to 3.0 m) and the mean cover was 88.9 ± 18.9 percent.

Hardstem Bulrush/Duckweed (7). The bulrush/duckweed vegetation type was documented in 13 plots along five transects in the Iron Gate reach. The bulrush/duckweed vegetation type was always observed at the edge of the active channel on low river bars and protected, shallow backwater. Coyote willow was present in some of the 13 sampled plots in the tree, shrub, and herb layers.

Hardstem bulrush and duckweed each occurred in 12 sampled plots. Narrowleaf cattail (*Typha latifolia*) and curly pondweed each were present in four plots. Knotgrass, knotweed, field mint, and spearmint (*Mentha spicata*) also occurred in this vegetation type. The herb layer height ranged from 0.7 to 10.8 feet (0.2 to 3.3 m) and the mean cover was 69.6 ± 20.0 percent.

Curly Pondweed (6). The curly pondweed vegetation type was documented in 29 plots along 11 transects in the Iron Gate reach. The curly pondweed vegetation type was always observed in water within the active channel. There was no tree layer or shrub layer associated with the curly pondweed vegetation type, with the exception of overhanging branches of tall and shrub.

Curly pondweed was present in all 29 plots. Canadian waterweed (*Elodea Canadensis*), waterthread pondweed (*Potamageton diversifolius*), and duckweed were present in 13 plots and hornwort (*Ceratophyllum demersum*) was present in 11 plots. Pacific mosquito fern (*Azolla filiculoides*) and horned pondweed (*Zannichellia palustris*) round out the compliment of aquatic species present in the curly pondweed vegetation type. Several species closely associated with the Rice Cutgrass/Hardstem Bulrush vegetation type also were present in a few of the curly pondweed vegetation type plots including hardstem bulrush, rice cutgrass, knotgrass, and river sedge. The herb layer height ranged from 0.3 to 9.2 feet (0.1 to 2.8 m) and the mean cover was 45.4 ± 32.6 percent.

3.7.1.2 Reservoir Vegetation

The riparian/wetland vegetation sampled at Keno, J.C. Boyle, Copco, and Iron Gate reservoirs is described below. TWINSPAN was performed on data from 473 plots along 41 transects and included 233 species. Twelve vegetation types are described as a result of the TWINSPAN analysis. In contrast to the plot data collected in the seven Project river reaches, the reservoir plot data were combined for all of the reservoirs and one TWINSPAN was performed. This was done primarily because the reservoir vegetation was more homogenous and the potential relationships between vegetation patterns and reservoir pool levels were likely to be more straightforward compared to the complex relationship between flow regimes and vegetation patterns in river reaches.

Keno Reservoir

Ten wetland vegetation types were classified at Keno reservoir based on sampling at 136 plots and ten transects. In total, three tree, seven shrub, and 87 herb layer species were documented in the Keno plots sampled in 2002. The average width of the wetland vegetation along sampled transects was 86.4 ± 68.7 feet (26.3 ± 20.9 m); the average slope was 12.7 ± 15.4 percent. The most frequently occurring species in the plot data included stinging nettle, hardstem bulrush, cattail, broad fruited bur-reed, bearded wildrye, hairy willowherb, climbing nightshade, American speedwell, bull thistle, cat mint, and Canada thistle.

The wetland vegetation at Keno reservoir was more diverse than at any other reservoir. The greater diversity of vegetation types was attributable, in part, to the wide variety of land uses that have modified habitats around Keno reservoir and now support a variety of vegetation types suited to grow on grazed, plowed, bermed, flooded, fill substrate, and graded habitats. The most abundant wetland vegetation types were dominated by hardstem bulrush and broad fruited bur-reed, especially on the Tule Smoke Gun Club property. Cattle grazing adjacent to some parts of the reservoir was responsible for low areal cover of wetland vegetation with a high proportion of weedy species including Canada thistle, bull thistle, Scotch thistle, and Mediterranean sage. Diked or bermed sections of shoreline frequently also had a large component of weedy plant species including yellow iris (*Iris pseudocarus*). Beardless ryegrass grew in nearly pure stands in less disturbed areas and particularly on the island downstream of the Highway 140 bridge. Saltgrass grew in pure stands and as a low-growing herb layer species among gray rabbitbrush. Wet meadow vegetation was observed in low-lying shoreline locations that had some remnant of the historical topography. The "upland" vegetation near the upper end of sampled transects was a slightly different version of the starthistle/medusahead/hairy brome vegetation type described for Copco and Iron Gate reservoirs.

Tree and shrub cover at Keno reservoir riparian plots was low—6.3 and 6.5 percent, respectively. Trees averaged 8.4 inches (21.3 cm) dbh. There were no logs or snags along Keno reservoir.

Box Elder/Stinging Nettle (1). The Box Elder/Stinging Nettle vegetation type was documented in eight plots along three transects at Keno reservoir. This vegetation type was documented on the island downstream of the Highway 140 bridge and was not common at Keno reservoir. Tree dominated vegetation types were uncommon and typically grew in small stands or as individual trees scattered along the shoreline. Box elder (*Acer negundo*) was the only tree layer species in this vegetation type, although individual shining willow and introduced species of willow (*Salix* sp.) and elm (*Ulmus* sp.) occurred sporadically along the shoreline. The tree layer ranged in height up to 29.5 feet (9 m) and the mean percent cover was 49.0 ± 34.6. Wood rose (*Rosa woodsii*) was abundant in both the tree and the herb layer, but occurred in only four plots. Stinging nettle, bur chervil, and cat mint (*Nepeta catepa*) were present in ten, eight, and five plots, respectively. The herb layer ranged in height from 0.7 to 6.2 feet (0.2 to 1.9 m) and the mean cover was 25.7 ± 23.3 percent.

Beardless Ryegrass (2). The Beardless Ryegrass vegetation type was documented in eight plots along three transects at Keno reservoir. This vegetation type was documented on the island downstream of the Highway 140 bridge and was common in relatively undisturbed, low-lying habitats. Beardless ryegrass grew in nearly pure stands with dense cover that excluded most other species. Hairy brome, cat mint, tansy mustard (*Descurania* sp.), bur-chervil, poison hemlock (*Conium maculatum*), stinging nettle, spearleaf orache (*Atriplex patula*), and Canada thistle occurred infrequently in sampled plots, but were present in openings within the ryegrass mat. Saltgrass was observed growing in slightly lower positions adjacent the bearded ryegrass. The herb layer ranged in height from 2.7 to 8.2 feet (0.7 to 2.5 m) and the mean cover was 90.0 ± 8.7 percent.

Starthistle/Medusahead/Hairy Brome (3). The starthistle/medusahead/brome vegetation type was documented in two plots along two transects at Keno reservoir. This vegetation type was representative of "weedy" vegetation found at the "upland" end of the riparian/wetland transects. The plant species in this vegetation type had affinities to both upland and wetland habitats. The structure of the vegetation was not as low growing as was observed at Iron Gate and Copco reservoirs. The areal cover of the herb layer was also much less at Keno reservoir. The lower areal cover was attributable to ground disturbance by cattle and relatively drier substrates compared to Iron Gate and Copco reservoirs. Cheatgrass replaced hairy brome as the primary indicator of this vegetation type. Starthistle and medusahead occurred less frequently at Keno reservoir and were not documented in the starthistle/medusahead/brome vegetation type at Keno reservoir. Needlegrass (*Achnatherum* sp.), squirreltail (*Elymus elymoides*), and yellow salsify also were documented in one of the sampled plots along with big sagebrush and gray rabbitbrush, which were both present at low abundance. Several, generally taller, herbaceous species formed a taller, open herb layer in the other sampled plot; these species included Canada thistle, poison hemlock, western goldenrod, cat mint, and mullein (*Verbascum thapsus*). The herb layer ranged in height from 1.3 to 3.3 feet (0.4 to 1.0 m) and the mean cover was 47.6 ± 46.0 percent.

Coyote Willow (4). The Coyote Willow vegetation type was documented in nine plots along two transects at Keno reservoir. The structure of the vegetation was dominated by coyote willow in the shrub layer, but the sampled coyote willow stands were not the dense, often impenetrable stands observed at Iron Gate and Copco reservoirs. One dense willow stand was observed in a heavily grazed pasture, but it was not sampled. One of the two transect locations had some plots with low willow cover as a result of recent ground disturbance.

Coyote willow was present in all sampled plots at both transect locations. At the recently disturbed transect location, the herb layer was sparse, but comprised of sweet white clover, needlegrass, bull thistle, mullein, and a small amount of reed canarygrass. The other transect location represents one of the few intact sites dominated by woody wetland vegetation at Keno reservoir. Arroyo willow and several ponderosa pine saplings also occurred in the shrub layer. Kentucky bluegrass, bearded ryegrass, Canada thistle, Baltic rush, and coyote willow (vegetative reproduction) were present in the herb layer. The shrub layer height ranged from 3.0 to 23.0 feet (0.9 to 7.0 m) and the mean cover was 33.7 ± 43.9 percent. The herb layer ranged in height from 0.7 to 3.6 feet (0.2 to 1.1 m) and the mean cover was 29.9 ± 26.2 percent.

Kentucky Bluegrass/Teasel/Beardless Ryegrass/Canada Thistle (5). The bluegrass/teasel/ryegrass/thistle vegetation type was documented in ten plots along four transects at Keno reservoir. In contrast to J.C. Boyle reservoir, Kentucky bluegrass and teasel were the less important indicators of the vegetation type at Keno reservoir. Canada thistle and beardless wildrye, in particular, were better indicators of this vegetation type at Keno reservoir.

Beardless wildrye, Canada thistle, Kentucky bluegrass, and teasel were present in nine, four, three, and three of the ten sampled plots, respectively. This vegetation type was similar to the Beardless Wildrye vegetation type except that the wildrye growth was not as dense, which allowed other plant species to grow alongside the wildrye. Mullein, bull thistle, tall wheatgrass (*Elytrigia pontica*), yarrow, cat mint, and stinging nettle were among the more frequently occurring herb layer species. The herb layer ranged in height from 1.6 to 6.9 feet (0.5 to 2.1 m) and the mean cover was 82.0 ± 20.4 percent.

The only shrub layer species in one plot was coyote willow at a high abundance. It was not clear why this plot was not classified in the Coyote Willow vegetation type.

Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass (6). The sedge/rush/bentgrass/bluegrass vegetation type was documented in 15 plots along three transects at Keno reservoir. This vegetation type was observed in low-lying shoreline locations that had some remnant of the historical topography that was conducive to wicking substantial moisture into the root zone without the flooding, which so often was observed in the hardstem bulrush dominated vegetation types.

The sedge (*Carex* sp.) component in these plots consisted of several species of sedge that were generally present in different combinations and abundances in nine of the 15 sampled plots. The most frequently occurring sedges included Nebraska sedge, sedge (*Carex* sp.), clustered field sedge (C*arex praegracilis*), and woolly sedge.

Canada thistle, Kentucky bluegrass, colonial bentgrass, and Baltic rush were the most frequently observed herb layer species occurring in 11 to eight sampled plots.

The presence of any two of the namesake taxa for this vegetation type was indicative of the sedge/rush/bentgrass/bluegrass vegetation type. Yarrow, western aster (*Aster* cf. *spathulatum*), western goldenrod, meadow foxtail, bull thistle, sweet white clover, reed canarygrass, curly dock, and short-podded thelypodium (*Thelypodium brachycarpum*) were among the more frequently occurring herb layer species. The herb layer ranged in height from 2.0 to 4.9 feet (0.6 to 1.5 m) and the mean cover was 97.2 ± 4.9 percent.

Coyote willow and arroyo willow were the only shrub layer species recorded in this vegetation type in three and two sampled plots, respectively.

Saltgrass (7). The Saltgrass vegetation type was documented in two plots at Keno reservoir. The dominance of the herb layer composed of saltgrass (*Distichlis spicata*) and the absence of a dominant, taller vegetation layer were what distinguished this vegetation type from other vegetation types with saltgrass as a component of the herb layer. Fivehorn smotherweed (*Bassia hyssopifolia*) and beardless wildrye were the only other species documented in this vegetation type.

Hardstem Bulrush/Stinging Nettle/Cattail (8). The bulrush/nettle/cattail vegetation type was documented in 47 plots along nine transects at Keno reservoir. This vegetation type was the most abundant wetland vegetation type at Keno reservoir and occupied a slightly higher elevation habitat than the Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed vegetation type. However, the two vegetation types share many species in common. Stinging nettle, cattail, and hardstem bulrush were present in 39, 32, and 26 sampled plots, respectively. Broad fruited bur-reed, hairy willowherb, climbing nightshade, and American speedwell were among the most frequently observed species in this vegetation type and occurred in 16 to 21 sampled plots. The herb layer ranged in height from 1.6 to 8.2 feet (0.5 to 2.5 m) and the mean cover was 89.72 ± 19.2 percent. Wood rose was the only woody species documented in this vegetation type.

Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed (9). The bulrush/bur-reed/duckweed/knotweed vegetation type was documented in 30 plots along seven transects at Keno reservoir. This vegetation type was one of the most abundant vegetation types at the edge of the reservoir pool. The Keno plots representing this vegetation type more closely resembled this vegetation type at J.C. Boyle reservoir than at Copco and Iron Gate reservoirs. In contrast to the Hardstem Bulrush/Stinging Nettle/Cattail vegetation type, this vegetation type was dominated by open water, hardstem bulrush, or bur-reed. Stinging nettle and cattail often were present in this vegetation type, but were not dominant species. Three plots classified as the bulrush/bur-reed/duckweed/knotweed vegetation type had low cover of hardstem bulrush, but the consistent presence of short-podded thelypodium, Baltic rush, and silver cinquefoil; these three plots, oddly, were not classified as part of the Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass vegetation type.

Hardstem bulrush, duckweed, bur-reed, and stinging nettle were present in 20, 15, 14 and ten plots, respectively. Water pepperweed was present in three sampled plots.

Cattail, hairy willowherb, short-podded thelypodium, Canadian waterweed, curly pondweed, and climbing nightshade were present in four or more sampled plots. The herb layer ranged in height from 0.7 to 8.2 feet (0.2 to 2.5 m) and the mean cover was 66.1 ± 29.2 percent. Coyote willow was the only woody species documented for this vegetation type and occurred in two sampled plots.

Golden Dock/Bur-reed (12). The dock/bur-reed vegetation type was documented in four plots at Keno reservoir. This vegetation type, like the Box Elder/Stinging Nettle vegetation type, was not common at Keno reservoir. The sampled plots all were in one large low-lying ephemeral pool on the island downstream of the Highway 140 bridge. Golden dock (*Rumex maritimus*) was the dominant species in the dry pool in September 2002. Broad fruited bur-reed and cudweed (*Gnaphalium* cf *palutre*) each was present in three sampled plots. Nodding bur-marigold (*Bidens cernua*), hairy willowherb, and stinging nettle were the only other species present in the pool habitat.

J.C. Boyle Reservoir

Six wetland vegetation types were classified at J.C. Boyle reservoir based on sampling at 138 plots and nine transects. In total, three tree, six shrub, and 98 herb layer species were documented in the J.C. Boyle plots sampled in 2002. The average width of the wetland vegetation along sampled transects was 136.1 ± 68.1 feet (41.5 ± 20.8 m); the average slope was 3.0 ± 2.8 percent. The most frequently occurring species in the plot data included Kentucky bluegrass, Baltic rush, Nebraska sedge, clustered field sedge, teasel, colonial bentgrass, needle spikerush, hardstem bulrush, marsh spikerush, and broad fruited bur-reed.

The wetland vegetation at J.C. Boyle reservoir was more diverse, and relatively more abundant than at Copco and Iron Gate reservoirs. The prevalence of low-gradient slopes near J.C. Boyle reservoir was conducive to the formation of wetland habitat when J.C. Boyle reservoir was filled. Marsh, wet meadow, and dry meadow habitats were especially abundant upstream of the Highway 66 bridge. Undisturbed marsh and wet meadows were particularly abundant at the Sportsman's Park. Most of the wetlands from Spencer Creek westward along the reservoir were low-growing during most of the year as a result of cattle grazing. Kentucky bluegrass, Baltic rush, colonial bentgrass, Nebraska sedge, reed canarygrass, hardstem bulrush, broad fruited bur-reed, and marsh spikerush were among the most frequently encountered species at J.C. Boyle reservoir.

All of the classified vegetation types at J.C. Boyle reservoir were dominated by herbaceous plant species. Wetlands dominated by woody species were conspicuously absent. It was not clear what factors might be limiting to the establishment of woody vegetation. J.C. Boyle reservoir is frequently ramped as part of Project operations and it was not obvious if this affects the establishment of willow and other woody wetland plants species. Dense herbaceous vegetation and the relative absence of disturbance to the shoreline vegetation likely limits willow establishment. The wetland vegetation at J.C. Boyle reservoir does not appear to be limited by hydrology, given that the growth of herbaceous wetland vegetation was lush by comparison to other Project reservoirs.

There were no riparian tree and shrub dominated vegetation type sampled at J.C. Boyle reservoir. Ponderosa pine, big sagebrush (*Artemisia tridentata*), and gray rabbitbrush (*Chrysothamnus nauseosus*) frequently occurred in upland positions adjacent to the herb-dominated wetlands sampled at J.C. Boyle reservoir. No tree and shrub cover estimates were made in these upland vegetation types. There were 0.4 ± 0.8 logs/acre (1.0 ± 2.0 logs/ha) along J.C. Boyle reservoir wetland sites, the total length averaging 11.6 ± 21.8 feet/acre (8.8 ± 16.6 m/ha). There were no snags in wetland/riparian plots along J.C. Boyle reservoir.

<u>Kentucky Bluegrass/Teasel/Beardless Ryegrass/Canada Thistle (5).</u> The bluegrass/teasel/ryegrass/thistle vegetation type was documented in 23 plots along seven transects at J.C. Boyle reservoir. This vegetation type was more or less the "weedy" equivalent to the Starthistle/Medusahead/Hairy Brome vegetation type at Copco and Iron Gate reservoirs; it occurred at the "upland" end of the riparian/wetland transects and had plant species with affinities to both upland and wetland habitats. Kentucky bluegrass (*Poa pratense*) and teasel were the primary indicators of the vegetation type at J.C. Boyle reservoir. Beardless wildrye (*Leymus triticoides*) and Canada thistle (*Cirsium canadensis*) were strong indicators of this vegetation type at Keno reservoir only.

Kentucky bluegrass and teasel were present in 20 and ten of the 23 sampled plots, respectively. Sanguisorba (*Sanguisorba occidentalis*) was especially abundant along one transect and was present in ten plots. Field cress and yarrow were among the more frequently observed species, occurring in nine and six plots, respectively. Cheatgrass, storksbill (*Erodium cicutarium*), Lemmon's needlegrass, yellow salsify (*Tragopogon dubius*), panicled willowherb, sweet white clover, American wintercress (*Barbarea orthocerus*), timothy, meadow foxtail (*Alopecurus* *pratensis*), and five-fingered cinquefoil were present in three or more of the sampled plots. This list of species certainly indicates that there was considerable variation in substrate moisture conditions within this vegetation type. The herb layer ranged in height from 0.3 to 6.6 feet (0.1 to 2.0 m) and the mean cover was 71.7 ± 32.0 percent.

The shrub layer species present in the bluegrass/teasel/ryegrass/thistle vegetation type included big sagebrush, gray rabbitbrush, western serviceberry, chokecherry, and white stemmed gooseberry. A shrub layer was present in five plots and ranged in height from 1.6 to 3.2 feet (0.5 to 1.0 m). The mean canopy cover of the shrub layer was 4.2 ± 11.0 percent.

<u>Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass (6).</u> The sedge/rush/bentgrass/bluegrass vegetation type was documented in 59 plots along eight transects at J.C. Boyle reservoir. This vegetation type was the most abundant vegetation type at J.C. Boyle reservoir. It often occurred on wide, low-gradient shorelines at elevations just above the hardstem bulrush and bur-reed dominated vegetation types and just below the weedy "upland" vegetation types at J.C. Boyle reservoir. The sedge (*Carex* sp.) component in these plots consisted of several species of sedge that were generally present in different combinations and abundances in different locations. The most frequently occurring sedges, (listed in descending order) were clustered field sedge (C*arex praegracilis*), Nebraska sedge, woolly sedge, lesser panicled sedge, big leaf sedge (*Carex amplifolia*), slender beaked sedge (*Carex athrostachya*), and possibly several other sedge species that were impossible to distinguish during sampling.

Baltic rush, clustered field sedge, Nebraska sedge, Kentucky bluegrass, and colonial bentgrass were the most frequently observed herb layer species, occurring in 26 to 34 sampled plots. The presence of any two of these species typically was indicative of the sedge/rush/bentgrass/ bluegrass vegetation type. Nebraska sedge was the sole dominant herb layer species in five sampled plots. Teasel, yarrow, timothy, woolly sedge, and meadow foxtail were among the next most frequently occurring species. However, these species were present in only eight to eleven (13 to 19 percent) sampled plots. The diversity of plant species in this vegetation type was higher than any other vegetation type at J.C. Boyle. The high diversity of species together with the relatively low constancy of individual species translates into tremendous variation in species composition among the different sampling locations. The herb layer ranged in height from 0.3 to 3.9 feet (0.1 to 1.2 m) and the mean cover was 98.7 ± 4.8 percent.

<u>Hardstem Bulrush/Stinging Nettle/Cattail (8).</u> The bulrush/nettle/cattail vegetation type was documented in nine plots along four transects at J.C. Boyle reservoir. The plots representing this vegetation type at J.C. Boyle reservoir were, at best, a poor fit compared to plots representing this vegetation type, which was abundant, at Keno reservoir. Field mint and reed canarygrass were present in seven and six plots, respectively. The J.C. Boyle plots more closely resembled the Copco reservoir plots, which also had abundant reed canarygrass. Water pepperweed, hardstem bulrush, woolly sedge, Nebraska sedge, devils beggarstick, and hairy willowherb each was present in four sampled plots. There was no cattail sampled at J.C. Boyle reservoir and stinging nettle was present in only one sampled plot representing this vegetation type. The herb layer ranged in height from 3.3 to 7.2 feet (1.0 to 2.2 m) and the mean cover was 95.3 ± 9.1 percent.

<u>Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed (9).</u> The bulrush/bur-reed/duckweed/knotweed vegetation type was documented in 22 plots along three transects at

J.C. Boyle reservoir. This vegetation type was observed more frequently at elevations above the Needle Spikerush/Bentgrass/Canadian Waterweed vegetation type and below the Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass vegetation type. The J.C. Boyle plots representing this vegetation type more closely resemble this vegetation type at Keno reservoir than at Copco and Iron Gate reservoirs. Hardstem bulrush, bur-reed, duckweed, and needle spikerush (*Eleocharis acicularis*) were present in 20, 13, 13 and nine plots, respectively. The latter two species were either floating or pasted/rooted in wet mud beneath the taller bulrush and bur-reed. Knotweed was present in two sampled plots. Devil's beggarstick, small bedstraw (*Galium trifidum*), reed canarygrass, and climbing nightshade each occurred in five or fewer plots. The herb layer ranged in height from 2.3 to 8.2 feet (0.7 to 2.5 m) and the mean cover was 92.4 ± 14.5 percent.

<u>Marsh Spikerush/Bentgrass/American Speedwell (10).</u> The spikerush/bentgrass/speedwell vegetation type was documented in 17 plots along four transects at J.C. Boyle reservoir. This vegetation type was observed most frequently at the upper elevation limits of bur-reed and hardstem bulrush dominated vegetation, but did not seem to thrive in the shade of these two species. This vegetation type was closely cropped by cattle in some locations. The spikerush/bentgrass/speedwell vegetation type was almost exclusive to J.C. Boyle reservoir with the exception of two Iron Gate reservoir plots that were classified as this vegetation type. Marsh spikerush, colonial bentgrass, and American speedwell were present in 16, 15, and 14 sampled plots, respectively. Devils beggarstick, needle spikerush, Baltic rush, rice cutgrass, and broad fruited bur-reed were present in nine to five plots. The herb layer ranged in height from 0.03 to 3.9 feet (0.01 to 1.2 m) and the mean cover was 86.5 ± 25.9 percent.

<u>Needle Spikerush/Canadian Smartweed (11).</u> The spikerush/speedwell vegetation type was documented in eight plots along four transects at J.C. Boyle reservoir. This vegetation type grows on silty mud flats exposed when the reservoir level is ramped down. Needle spikerush and Canadian waterweed were present in seven and six plots, respectively. Owyhe mudwort (*Limosella acualis*), marsh spikerush, and duckweed were the only other species documented in this vegetation type. The herb layer ranged in height from 0.03 to 0.7 foot (0.01 to 0.2 m) and the mean cover was 29.9 ± 18.1 percent.

<u>Copco Reservoir</u>

Four wetland vegetation types were classified at Copco reservoir based on sampling at 83 plots and 24 transects. Four tree, eight shrub, and 58 herb layer species were documented in the Copco plots sampled in 2002. The average width of the wetland vegetation along sampled transects was 39.9 ± 12.0 feet (12.2 ± 3.7 m); the average slope was 18.5± 9.7 percent. The most frequently occurring species in the plot data include hardstem bulrush, coyote willow, knotgrass, knotted hedge parsley, yellow starthistle, water pepperweed, medusahead, hairy brome, reed canarygrass, Oregon ash, and duckweed.

The wetland vegetation at Copco reservoir was far more restricted in area than at Iron Gate reservoir. This was primarily because of the prevalence of steeper slopes around most of the reservoir and, conversely, relatively fewer low-gradient shoreline habitats. The low-gradient shoreline habitats present at Copco reservoir were occupied by wetland vegetation similar to that found at Iron Gate reservoir. Copco reservoir has been in existence far longer than Iron Gate reservoir so the "lag time" discussion of colonization by woody species (see above) for Iron Gate reservoir should have less relevancy at Copco reservoir. Like at Iron Gate, coyote willow was present in the predominantly weedy, low herbaceous wetland vegetation in low-gradient locations along the shoreline and formed dense, generally small stands. Other willow species were even less common than at Iron Gate reservoir. Large individual trees of oak, ash, and willow were not as prevalent (except at the larger estuaries) in sheltered habitats along steep rocky sections of shoreline as seen at Iron Gate. Large Oregon ash trees were ubiquitous in their patchy, inconsistent distribution at both reservoirs. Arroyo willow and shining willows were infrequent if not rare at both reservoirs. At Iron Gate reservoir, the relatively large willows in the reservoir arm fed by Scotch and Camp creeks could be attributable to the high proportion of willows in those creeks and thus a larger supply of seed. At Jenny Creek, the predominant tree species was white alder, a species that grows along rocky rivers beds with year-round discharge. The Copco reservoir shoreline may not be suitable habitat to support white alder so it never may become established there. The J.C. Boyle peaking reach is a potential source for willow seed for Copco reservoir, although arroyo willow and shining willow were not particularly abundant in the canyon. Willow seed viability was notoriously short-lived so upstream seed sources that are too distant from Iron Gate and Copco reservoirs may seldom or never provide viable seed.

Coyote willow was plentiful in some areas at Copco reservoir and it was not clear why it was not more widespread given the apparent availability of potential habitat. Shining willow and arroyo willow were not common, although their presence indicates that there was suitable habitat for these species. The availability of viable seed could be limiting willow distribution. If viable seed was not limiting and willows do germinate, then why were they not more widespread? Herbivory could be a possible factor.

It is possible the reservoir drawdown during the critical first-year growth of willow seedlings also could be a factor limiting survival. However, there were many low-gradient shorelines that never dry out as a result of wicking even during the lowest drawdown levels observed during 2002 and 2003. The young willows observed in the herb layer of some sampled plots were nearly always coyote willow and it was determined that they were vegetative reproduction from this rhizomatous species. Exclusion fencing, monitoring during willow seed dispersal and establishment periods, and supplemental plantings of willow would be ways to determine its viability in habitats presumed to be suitable.

Tree and shrub cover at Copco reservoir averaged 26.8 and 29.2 percent, respectively. Trees were small, averaging 3.2 ± 1.8 inches (8.1 ± 4.6 cm) dbh. There were 0.2 ± 0.5 logs/acre (0.5 ± 1.3 logs/ha) along Copco reservoir, the total length averaging 8.0 ± 25.2 feet/acre (6.1±19.2 m/ha). Snags were relatively common at 2.4 ± 7.5 snags/acre (6.0 ± 18.8 snags/ha).

<u>Starthistle/Medusahead/Hairy Brome (3).</u> The starthistle/medusahead/brome vegetation type was documented in 18 plots along eight transects at Copco reservoir. This vegetation type at Copco reservoir was similar to the same vegetation type at Iron Gate with respect to “weedy” vegetation found at the “upland” end of the riparian/wetland transects and the plant species in this vegetation type with affinities to both upland and wetland habitats. The structure of the vegetation was dominated by a low-growing, often grazed, herb layer with scattered tall, less palatable herbaceous and woody species. The gradient of the shoreline was most often shorter and steeper, and generally formed a narrower band along the Copco reservoir than at Iron Gate reservoir.

Hairy brome, knotted hedge parsley, yellow starthistle, medusahead, teasel, panicled willowherb, and hedgehog dogtail (*Cynosurus echinatus*) were the most frequently encountered herb layer species occurring in 78 to 28 percent of the sampled plots. Taller herbaceous species formed a sparse second herb layer in most of the sampled plots. The taller herb layer species were present in 17 to 33 percent of the sampled plots and included teasel, western goldenrod, and bachelors buttons. Species growing in this vegetation type at Iron Gate reservoir that were conspicuously absent or less important at Copco reservoir include knotgrass, bird's foot trefoil, and cocklebur. The herb layer ranged in height from 1.0 to 4.9 feet (0.3 to 1.5 m) and the mean cover was 55.8 ± 27.3 percent.

The shrub layer consisted primarily of scatter individuals of coyote willow and arroyo willow, poison oak, Oregon ash, and snowberry. A shrub layer was present in 28 percent of the sampled plots and the shrub layer height ranged from 3.3 to 14.8 feet (1.0 to 4.5 m). The mean canopy cover of the shrub layer was 9.0 ± 20.8 percent.

The tree layer species include individuals of Oregon ash and coyote willow. A tree layer was present in 22 percent of the sampled plots and the tree layer height ranged from 13.1 to 26.2 feet (4 to 8 m). The mean canopy cover of the tree layer was 13.1 ± 23.0 percent.

<u>Coyote Willow (4).</u> The Coyote Willow vegetation type was documented in 36 plots along eight transects at Copco reservoir. The structure and composition of the coyote willow stands at Iron Gate and Copco reservoir were similar. Coyote willow in the tree and shrub layer was present in 28 of the 31 sampled plots. Compared to the Iron Gate willow stands, the Copco stands have a higher proportion of stands with willow trees to willow shrub. In six sampled plots without coyote willow, arroyo willow and Himalayan blackberry each was dominant in the shrub layer in three stands.

Poison oak, Oregon ash, snowberry Oregon oak, and Oregon grape were the only other shrub layer species in sampled stands. A shrub layer was present in 75 percent of the sampled plots and the shrub layer heights ranged from 2.6 to 19.7 feet (0.8 to 6.0 m). The mean canopy cover of the shrub layer was 26.1 ± 30.0 percent. Oregon ash, Oregon oak, and western juniper were the only other tree layer species in addition to coyote willow that were sampled. A tree layer was present in 67 percent of the sampled plots and the tree layer heights ranged from 13.1 to 42.6 feet (4 to 13 m). The mean canopy cover of the tree layer was 55.3 ± 42.7 percent.

The most frequently occurring herb layer species included coyote willow (vegetative reproduction), knotted hedge parsley, woolly sedge, Kentucky bluegrass, and hardstem bulrush. These species were present at relatively low frequencies ranging from 11 to 36 percent of sampled plots. Reed canarygrass was present in three plots. In two plots, the only species present were coyote willow and Canadian waterweed. An herb layer was present in 78 percent of sampled plots and ranged in height from 0.3 to 8.2 feet (0.1 to 2.5 m). The mean cover of the herb layer was 20.9 ± 29.9 percent.

<u>Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed (9).</u> The bulrush/bur-reed/duckweed/knotweed vegetation type was documented in 25 plots along seven transects at Copco reservoir. Hardstem bulrush, and duckweed, and knotweed were the primary indicators of the vegetation type at Copco reservoir. Broad fruited bur-reed (*Sparaganium eurycarpum*) was common and often abundant in this vegetation type at J.C. Boyle and Keno reservoirs, but was

not observed at Copco reservoir. The bulrush/bur-reed/duckweed/knotweed vegetation type occupies the same topographic position at both Copco and Iron Gate reservoirs.

Hardstem bulrush, knotweed, and duckweed were present in 24, 14, and eight of the 25 sampled plots, respectively. Devil's beggarstick, Canadian waterweed, fall panicgrass, reed canarygrass, and barnyard grass were present in six to two plots. One plot without hardstem bulrush was dominated by reed canarygrass. The herb layer ranged in height from 3.3 to 8.2 feet (1.0 to 2.5 m) and the mean cover was 70.8 ± 20.3 percent.

Coyote willow was present in the tree, shrub, and herb layers in, at most, two plots. Oregon ash was present in the tree layer of one plot.

Hardstem Bulrush/Stinging Nettle/Cattail (8). The bulrush/nettle/cattail vegetation type was documented in four plots along one transect at Copco reservoir. Hardstem bulrush and reed canarygrass were present in three and four plots, respectively. Water pepperweed was the only other species present in this vegetation type at Copco reservoir. The herb layer ranged in height from 6.6 to 7.8 feet (2.0 to 2.4 m) and the mean cover of the herb layer was 97.8 ± 2.5 percent. This vegetation type was far more common and abundant at J.C. Boyle and Keno reservoirs.

Iron Gate Reservoir

Five wetland vegetation types were classified at Iron Gate reservoir based on sampling at 116 plots and 30 transects. Five tree, nine shrub, and 89 herb layer species were documented in the Iron Gate plots sampled in 2002. The average width of the wetland vegetation along sampled transects was 45.5 ± 22.1 feet (13.9 ± 6.7 m); the average slope was 23.1± 14.6 percent. The most frequently occurring species in the plot data included coyote willow, knotgrass, hardstem bulrush, knotted hedge parsley, hairy brome, cheatgrass, Oregon ash, yellow starthistle, cocklebur, duckweed, marsh spikerush, medusahead, Oregon oak, and bird's foot trefoil.

The wetland vegetation at Iron Gate reservoir was best developed along portions of the shoreline where the gradient was shallow enough to allow the reservoir pool to wick into the potential root zone of plants growing along the reservoir. Wetland vegetation also was established in some sites where the slopes were fairly steep, but through wave action or slope instability the soil had slumped or eroded into the reservoir and created patches of substrate suitable for colonization by wetland species. Most habitats capable of supporting wetland vegetation were dominated by a generally low-growing mix of weedy, non-native herbaceous species. These habitats often are grazed heavily by cattle, which contributed to the low habit of the most palatable plant species.

Coyote-willow-dominated stands were present in many locations. These stands tended to be homogenous with respect to the predominance of willow and the low number of species that were capable of growing in the dense shade provided by the willow. Many of the sites supporting the predominant low-growing herbaceous vegetation also supported some willow. The willow growing in these sites often was grazed and trampled by deer and cattle, and, in some cases, also eaten by beaver. Grazing may be a factor limiting the dispersal of willow at Iron Gate reservoir. Recreation also influenced riparian vegetation, but typically in a more concentrated fashion at specific reservoir access points and in high use areas.

Other factors that affect willow distribution were likely to be associated with the lag time between the construction of Iron Gate dam and colonization of previously upland habitats that were inundated at the reservoir margin. The wetland vegetation still may be evolving and expanding at Iron Gate reservoir. The randomness of the climate, the evolution or development of habitat conditions suitable for wetland species, and the vagaries of plant reproduction, seed dispersal, and establishment events were factors that contributed to the lag time for colonization, particularly for woody species.

In some of the steepest, rockiest portions of the reservoir shoreline, especially in the Scotch Creek and Camp Creek arm of the reservoir (excluding the estuaries), there were sometimes large individual trees of Oregon ash, shining willow, arroyo willow, and coyote willow. These large individual trees likely were established soon after the reservoir filled, assuming they were not already in place. Why these large specimens generally were not as well established in what appeared to be higher quality, low-gradient shoreline locations elsewhere around the reservoirs was not obvious. It seems likely that the low-gradient shoreline locations were less protected from the assortment of herbivores that likely would eat any new seedlings. The low-gradient shorelines have a compliment of relatively weedy, fast-growing herbaceous species that can more rapidly colonize the shoreline and are resilient to herbivores.

In the estuaries of larger tributaries, there were many large trees. Historic aerial photography shows that riparian vegetation was well established along the larger tributaries before inundation and that the riparian vegetation has increased in distribution near the reservoir since the reservoirs were filled. The larger trees currently growing in some of the estuaries probably were established before inundation.

Tree and shrub cover at Iron Gate averaged 17.3 and 23.3 percent, respectively. Trees were small, averaging 3.5 ± 2.6 inches (8.9 ± 6.6 cm) dbh. There were 1.8 ± 6.1 logs/acre (4.5 ± 15.3 logs/ha) along Iron Gate reservoir; the total length averaging 57.6 ± 190.9 feet/acre (43.9 ± 145.5 m/ha). Snags were relatively common—0.9 ± 3.1 snags/acre (2.3 ± 7.8 snags/ha)—but quite small at an average 6.3 inches (16 cm) dbh.

Starthistle/Medusahead/Hairy Brome (3). The starthistle/medusahead/brome vegetation type was documented in 48 plots along 11 transects at Iron Gate reservoir. This vegetation type was representative of "weedy" vegetation found at the "upland" end of the riparian/wetland transects at Iron Gate reservoir and the plant species in this vegetation type have affinities to both upland and wetland habitats. The structure of the vegetation was dominated by a low-growing, often grazed, herb layer with scattered tall, less palatable herbaceous and woody species. The gradient of the shoreline was most often shallow and formed a narrow band along the reservoir. The starthistle/medusahead/brome vegetation type formed a distinct, narrower band at the interface between the wetland habitat created by the reservoir pool and the adjacent upland vegetation.

Hairy brome, knotted hedge parsley, knotgrass, cheatgrass, yellow starthistle, medusahead, and bird's foot trefoil were the most frequently encountered herb layer species, occurring in 19 to 40 percent of the sampled plots. A small number of taller herbaceous species formed a sparse second herb layer in most of the sampled plots. The taller herb layer species occurred in 9 to 19 percent of the sampled plots and included cocklebur (*Xanthium strumarium*), western goldenrod, teasel, curly dock, bachelors buttons (*Cichorium intybus*), sweet white clover, and annual sunflower (*Helianthus annua*). The biennial species in this group also can be an abundant component of the shorter herb layer when first-year rosettes contribute to the low-growing herbaceous cover. The herb layer ranged in height from 0.3 to 7.2 feet (0.1 to 2.2 m) and the mean cover was 46.6 ± 36.0 percent.

The shrub layer consisted primarily of scattered individuals of mugwort, coyote willow, and shining willow. A shrub layer was present in 48 percent of the sampled plots and the shrub layer height ranged from 2.6 to 11.5 feet (0.8 to 3.5 m). The mean canopy cover of the shrub layer was 13.3 ± 26.1 percent.

The tree layer species included Oregon ash, white alder, and western juniper. A tree layer was present in 42 percent of the sampled plots and the tree layer height ranged from 19.7 to 45.9 feet (6 to 14 m). The mean canopy cover of the tree layer was 26.8 ± 39.5 percent.

Coyote Willow (4). The Coyote Willow vegetation type was documented in 41 plots along nine transects at Iron Gate reservoir. The structure of the vegetation was dominated by coyote willow in the tree and shrub layers. The herb layer was most often sparse. The largest coyote willow stands were located at the mouths of larger tributaries and along low-gradient, protected areas along the shoreline.

Coyote willow in the tree and shrub layer was present in 38 of the 41 sampled plots. In many stands, coyote willow formed a continuous vertical structure that blurred the distinction between shrub and tree growth forms. Trees had fallen over and sent up numerous lateral branches. In other stands, coyote willow grew in dense stands of pole-like trees.

Poison oak, Oregon ash, and arroyo willow were the only other shrub layer species in sampled stands. A shrub layer was present in 68 percent of the sampled plots and the shrub layer height ranged from 2.6 to 21.3 feet (0.8 to 6.5 m). The mean percent cover of the shrub layer was 35.6 ± 37.8. Oregon ash and Oregon oak were the only other tree layer species in sampled stands. A tree layer was present in 61 percent of the sampled plots and the tree layer height ranged from 14.8 to 32.6 feet (4.5 to 10.0 m). The mean canopy cover of the tree layer was 53.9 ± 45.4 percent.

The most frequently occurring herb layer species included coyote willow (vegetative reproduction), knotgrass, knotted hedge parsley, woolly sedge, blue wildrye, marsh spikerush, and bird's foot trefoil. These species were present at relatively low frequencies ranging from 12 to 37 percent of sampled plots. The herb layer ranged in height from 0.3 to 4.9 feet (0.1 to 1.5 m) and the mean cover was 26.1 ± 29.7 percent.

Hardstem Bulrush/Broad Fruited Bur-reed/Duckweed/Knotweed (9). The bulrush/bur-reed/duckweed/knotweed vegetation type was documented in 24 plots along seven transects at Iron Gate reservoir. Hardstem bulrush and duckweed were the primary indicators of the vegetation type at Iron Gate reservoir. Knotweed was common and, in some locations, abundant at Iron Gate reservoir, but was present in only four of the sampled plots. Broad fruited bur-reed was common and often abundant in this vegetation type at J.C. Boyle and Keno reservoirs, but was not observed at Iron Gate reservoir. The bulrush/bur-reed/duckweed/knotweed vegetation type typically grows with its "feet in the water" on low-gradient portions of the shoreline at lower elevations than the Starthistle/Medusahead/Hairy Brome vegetation type and the Coyote Willow vegetation type. The distribution of this vegetation type was patchy and many habitats that appeared to be suitable to support this vegetation type were mostly unvegetated. This may be the result of the presumably ongoing evolution and colonization of shoreline habitats (previously upland habitats) following the construction of Iron Gate dam in the early 1960s.

Hardstem bulrush and duckweed were present in 19 and 13 of the 24 sampled plots, respectively. In five plots, duckweed and panicled bulrush (*Scirpus microcarpus*) were present together in the absence of hardstem bulrush. Marsh spikerush (*Eleocharis macrostachya*) and water pepperweed were present more or less together in five and four plots, respectively, with relatively low abundance of hardstem bulrush. The latter habitats have saturated, muddy substrates generally above the water surface or have shallow water compared to sites with a higher abundance of hardstem bulrush. The herb layer ranged in height from 0.7 to 7.5 feet (0.2 to 2.3 m) and the mean cover was 79.6 ± 16.7 percent.

Coyote willow was the only woody species present in this vegetation type and was present in the shrub layer in three sampled plots. Other notable species present in this vegetation type at Iron Gate reservoir include cattail, fall panicgrass (*Panicum dichotomiflorum*), knotgrass, rice cutgrass, and barnyard grass.

<u>Other Vegetation Types at Iron Gate Reservoir (6 and 10).</u> Two additional vegetation types were classified for Iron Gate reservoir, but were relatively uncommon there. The Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass vegetation type was documented in one Iron Gate reservoir plot, but was common and abundant at Keno and J.C. Boyle reservoirs where dense, wet meadow vegetation with a variety of sedges, rushes, and introduced grass species were more common. The Iron Gate reservoir plot representative of this vegetation type contained Nebraska sedge and Baltic rush.

The Marsh Spikerush/Bentgrass/American Speedwell vegetation type was documented in two plots at Iron Gate reservoir. The presence and high abundance of marsh spikerush in these two plots were the primary link between these plots and plots at J.C. Boyle reservoir, where this vegetation type was most abundant.

3.7.2 <u>Wetland and Riparian Assessment</u>

DCA was conducted separately on plot data from reservoir transects and from river transects.

3.7.2.1 Reservoirs

DCA was performed on 445 plots and 135 species following the removal of species that occurred less than four times in the plot data. The vegetation codes (1 through 12) that were used in the legends of figures for reservoir analyses are explained in Table 3.7-2. Figure 3.7-2 illustrates the distribution of vegetation types along Axis 1 and Axis 2 of the ordination for reservoir plots. DCA Axes 1 and 2 represent approximately 24 percent of the variation in the species/abundance data for reservoir plots.

Table 3.7-2. Reservoir vegetation types, vegetation codes, and number of plots classified into each vegetation type.

Vegetation Type	**Vegetation Code**	**Number of Plots**
Box Elder/Stinging Nettle	1	10
Beardless Ryegrass	2	8
Starthistle/Medusahead/Hairy Brome	3	67
Coyote Willow	4	86
Kentucky Bluegrass/Teasel/Beardless Ryegrass/Canada Thistle	5	30
Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass	6	60
Salt Grass	7	2
Hardstem Bulrush/Stinging Nettle/Cattail	8	59
Hardstem Bulrush/Bur-reed/Duckweed/Knotweed	9	93
Marsh Spikerush/Bentgrass/American Speedwell	10	19
Needle Spikerush/Bentgrass/Canadian Waterweed	11	8
Golden Dock/Bur-reed	12	4
Total Plots		**445**

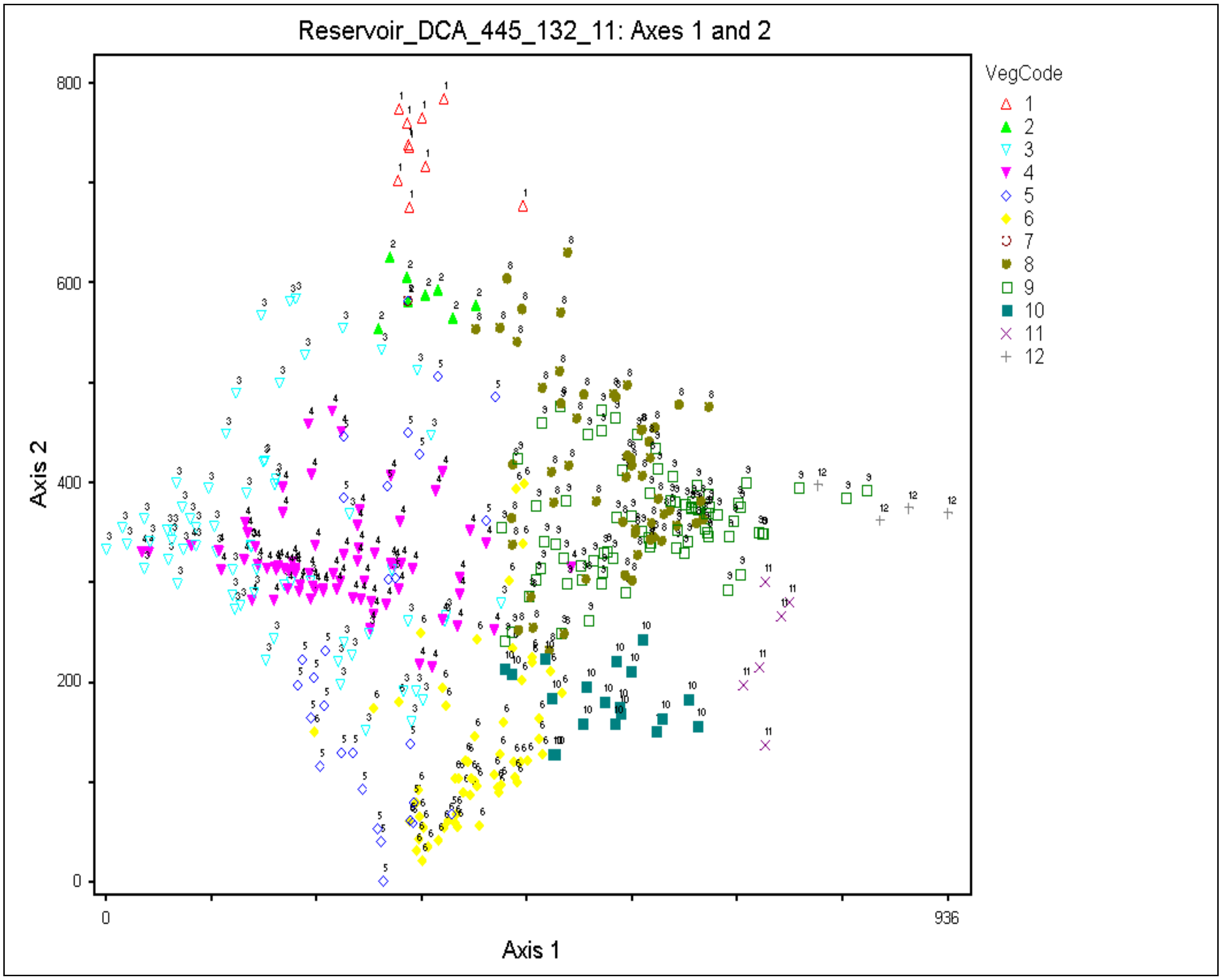


Figure 3.7-2. Detrended correspondence analysis (DCA) ordination Axes 1 and 2 with an overlay of reservoir vegetation types.

The scatterplots and regression lines for variables with Pearson's r coefficients greater than 0.3 for the first DCA ordination axis were overlaid the first two DCA ordination axes. Figures 3.7-3, 3.7-4, 3.7-5, and 3.7-6 show the scatter plots and regression lines for actual values of inundation duration, standardized plot elevation, organic cover, and plot slope (y axis) for reservoir plots against ordination Axis 1 plot scores (x axis). The scatterplots with a more diagonal structure indicate a stronger correlation with the axis plot scores. The "r" and "tau" values in Figures 3.7-3, 3.7-4, 3.7-5, and 3.7-6 represent the Pearson and Kendall correlation coefficients, respectively, between the variable and the plot scores for Axes 1 and 2.

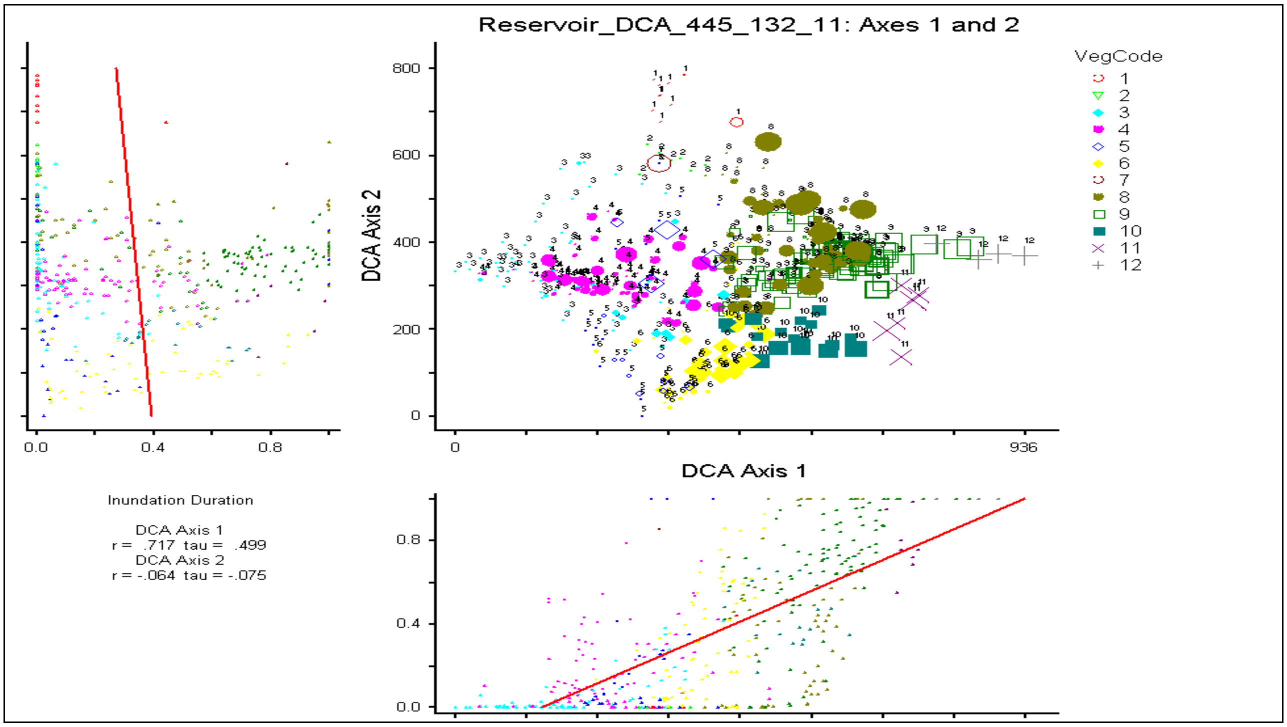


Figure 3.7-3. Scatter plots and regression lines illustrating the relationship of inundation duration and DCA Axes 1 and 2. Symbol size in the ordination diagram indicates the relative value of inundation duration in a plot. The reservoir cover types are overlaid the DCA ordination of reservoir plots.

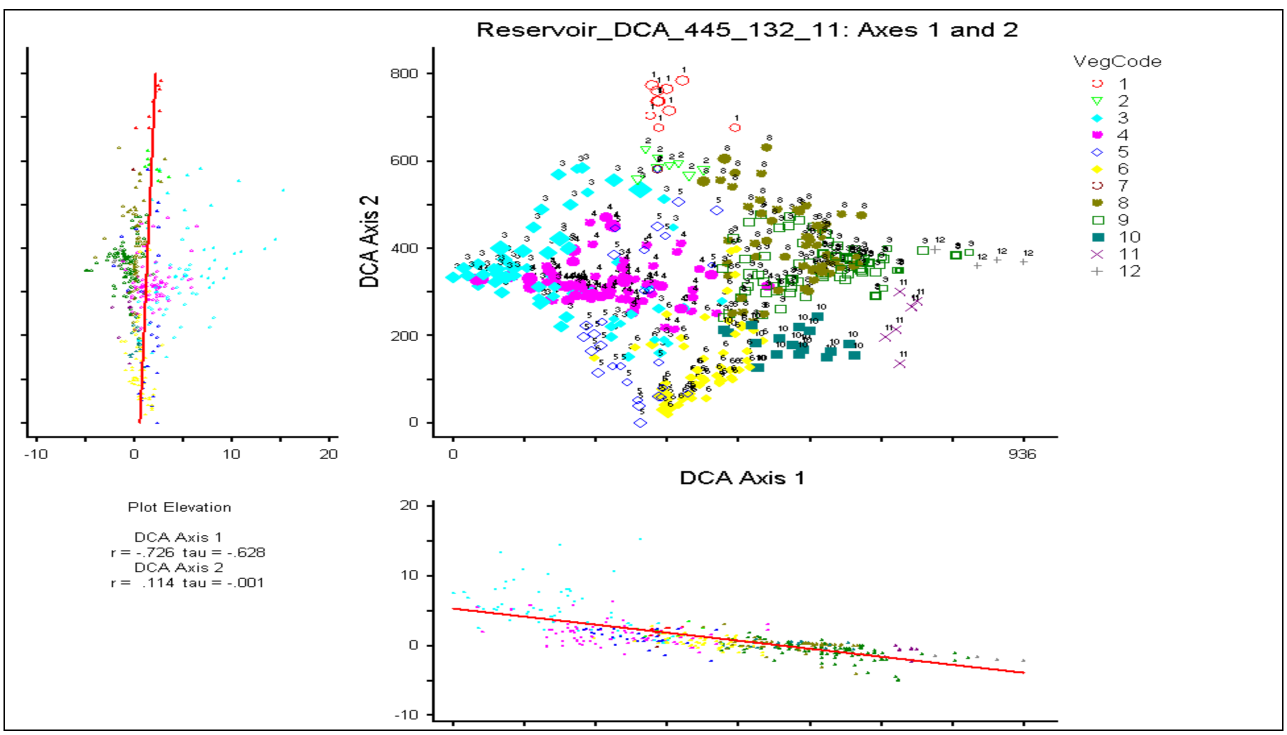


Figure 3.7-4. Scatter plots and regression lines illustrating the relationship of plot elevation and DCA Axes 1 and 2. Symbol size in the ordination diagram indicates the relative value of elevation in a plot. The reservoir cover types are overlaid the DCA ordination of reservoir plots.

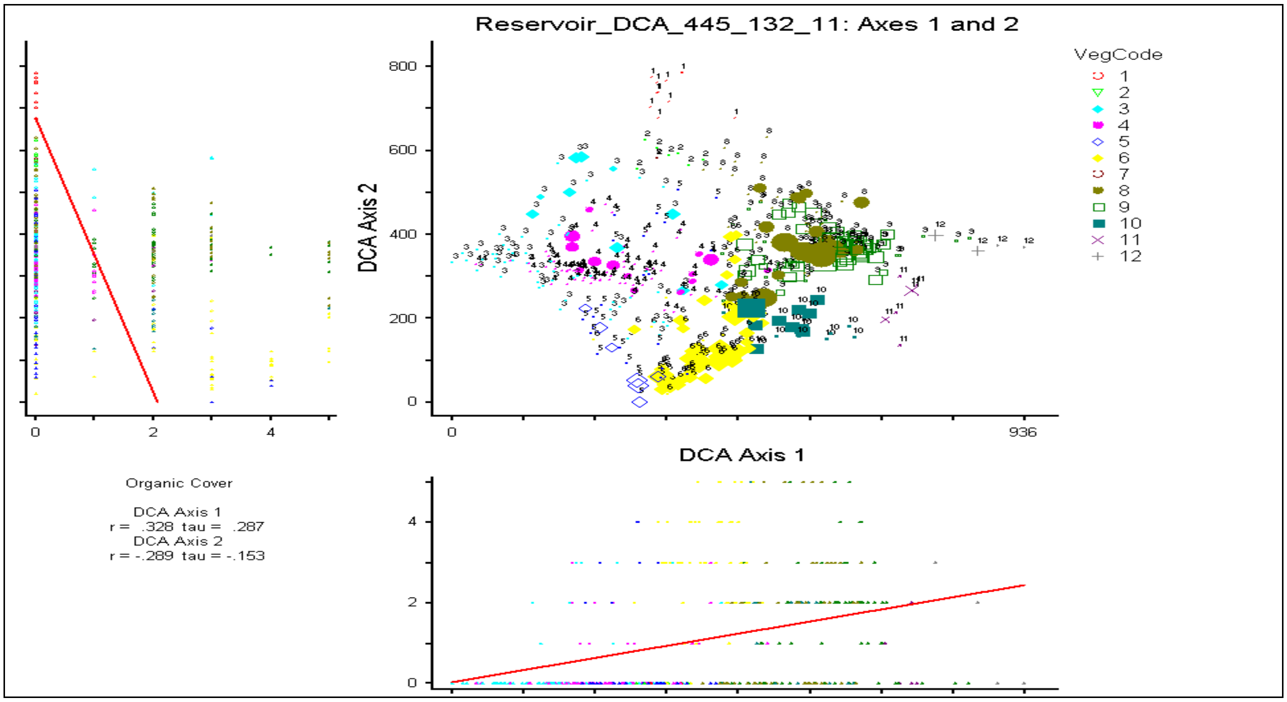


Figure 3.7-5. Scatter plots and regression lines illustrating the relationship of organic cover and DCA Axes 1 and 2. Symbol size in the ordination diagram indicates the relative value of organic cover in a plot. The reservoir cover types are overlaid the DCA ordination of reservoir plots.

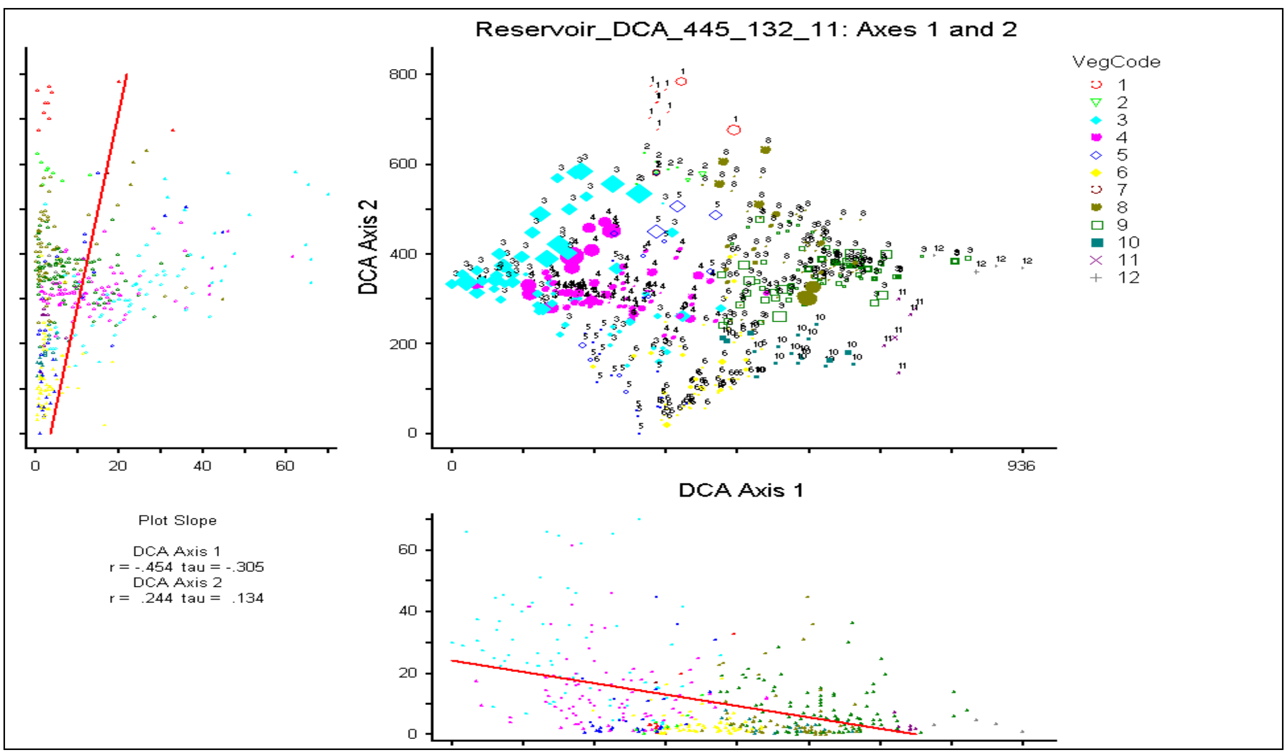


Figure 3.7-6. Scatter plots and regression lines illustrating the relationship of plot slope and DCA Axes 1 and 2. Symbol size in the ordination diagram indicates the relative value of plot slope. The reservoir cover types are overlaid the DCA ordination of reservoir plots.

Inundation duration and elevation had the highest correlation to DCA Axis 1 at .717 and .726, respectively. However, the variation in the species/abundance plot data that was associated with the DCA Axis 2 was nearly as great as for DCA Axis 1. It was clear that this variation was not well correlated to inundation duration, plot slope, plot elevation, and substrate particle size based on the low correlation with site scores for the second DCA ordination axis. Of these variables, organic substrate has the best correlation (Pearson's $r = 0.29$) with the second ordination axis primarily; the organic debris was primarily from thatch that had decomposed and built up in the sedge-dominated vegetation types at J.C. Boyle reservoir and Keno reservoir. It was also clear that different vegetation types associated with Keno and J.C. Boyle reservoirs dominate either end of the second axis. There is no obvious single variable that explains this variation, but the different general environmental conditions between Keno and J.C. Boyle reservoirs probably account for much of the variation.

One approach to comparing reservoirs was to look at vegetation differences relative to changes in inundation duration. The percentage of plots in each vegetation type that were associated with different values of inundation duration are provided in Figure 3.7-7. Figure 3.7-8 provides a reference for the following discussion and includes average elevation relative to mean pool level and average inundation duration percentages for vegetation types at each Project reservoir.

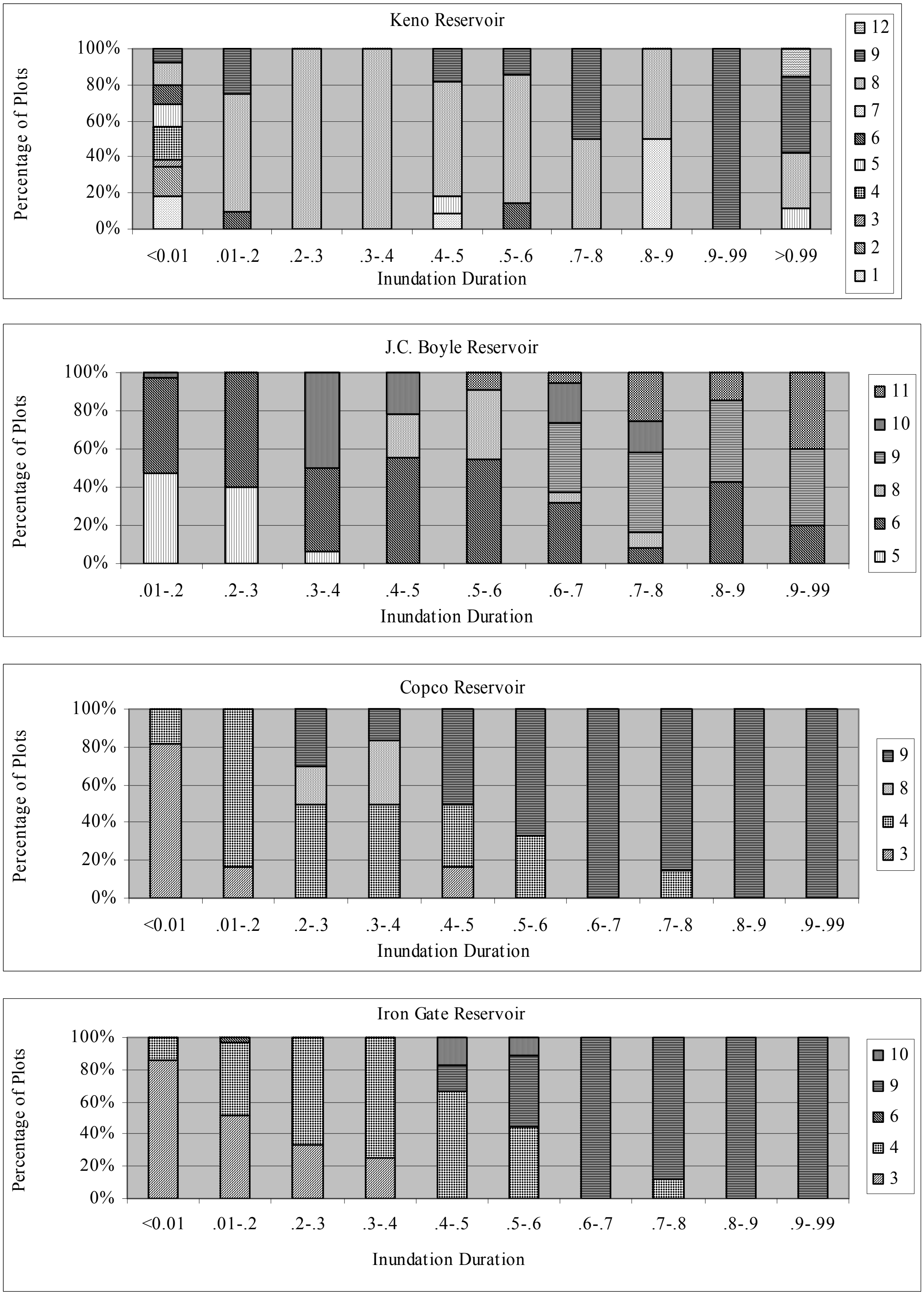


Figure 3.7-7. Percentage of plots in each vegetation type along inundation gradient by reservoir. See Table 3.7-2 for vegetation types and codes corresponding to legend.

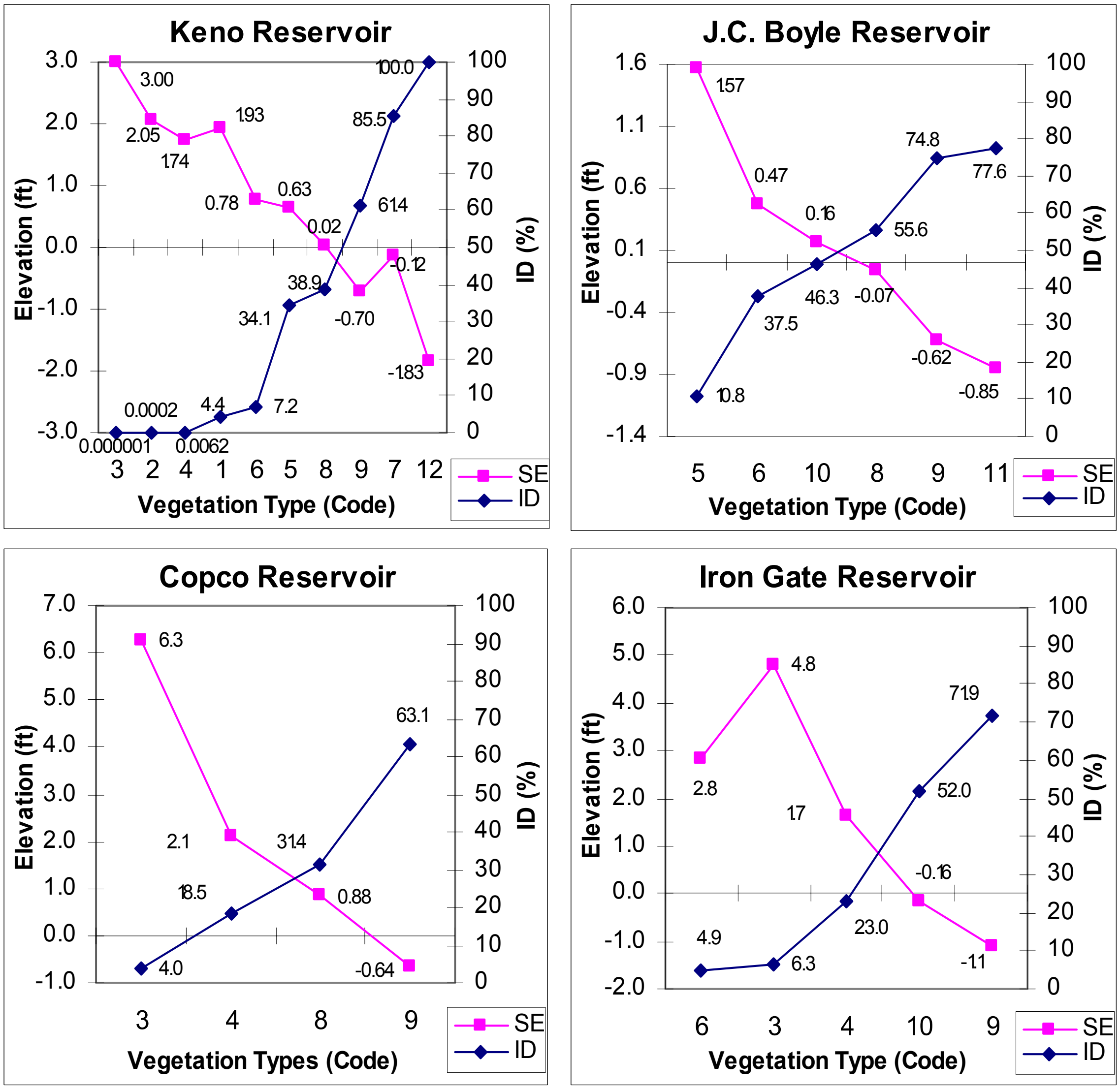


Figure 3.7-8. Standardized plot elevation (SE) relative to mean pool level and average inundation duration (ID) for vegetation types at each Project reservoir. See Table 3.7-2 for vegetation types and codes corresponding to the x axis.

Keno Reservoir

The ten wetland vegetation types documented at Keno reservoir make it the most diverse of the four Project reservoirs sampled. The average elevation of vegetation types sampled at Keno reservoir ranged from -1.83 feet (-0.56m) to +3.0 feet (+0.91 m) relative to the mean growing season reservoir water level. The mean and 95 percent confidence intervals for inundation duration and plot elevations were provided for the riparian/wetland vegetation types at Keno reservoir in Figure 3.7-9.

One of the most obvious patterns for Keno reservoir was at the “drier” end of the inundation gradient where eight vegetation types, some of which occur in wet habitats around Keno reservoir, were documented at elevations that were inundated by the reservoir less than 1 percent of the time (Figure 3.7-8). These eight vegetation types were observed at Keno reservoir in a range of habitats from dry to seasonally wet or medic to wet. At the drier end of the inundation gradient were the Starthistle/Medusahead/Hairy Brome, Beardless Wildrye, and Box Elder/Stinging Nettle vegetation types and at the wetter end were vegetation types with hardstem bulrush. The most obvious reason for more hydrophilic vegetation growing at relatively high elevations at Keno reservoir was the high incidence of irrigation returns and altered topography that collected surface runoff. These factors essentially confound the inundation gradient associated with the reservoir and are discussed further below.

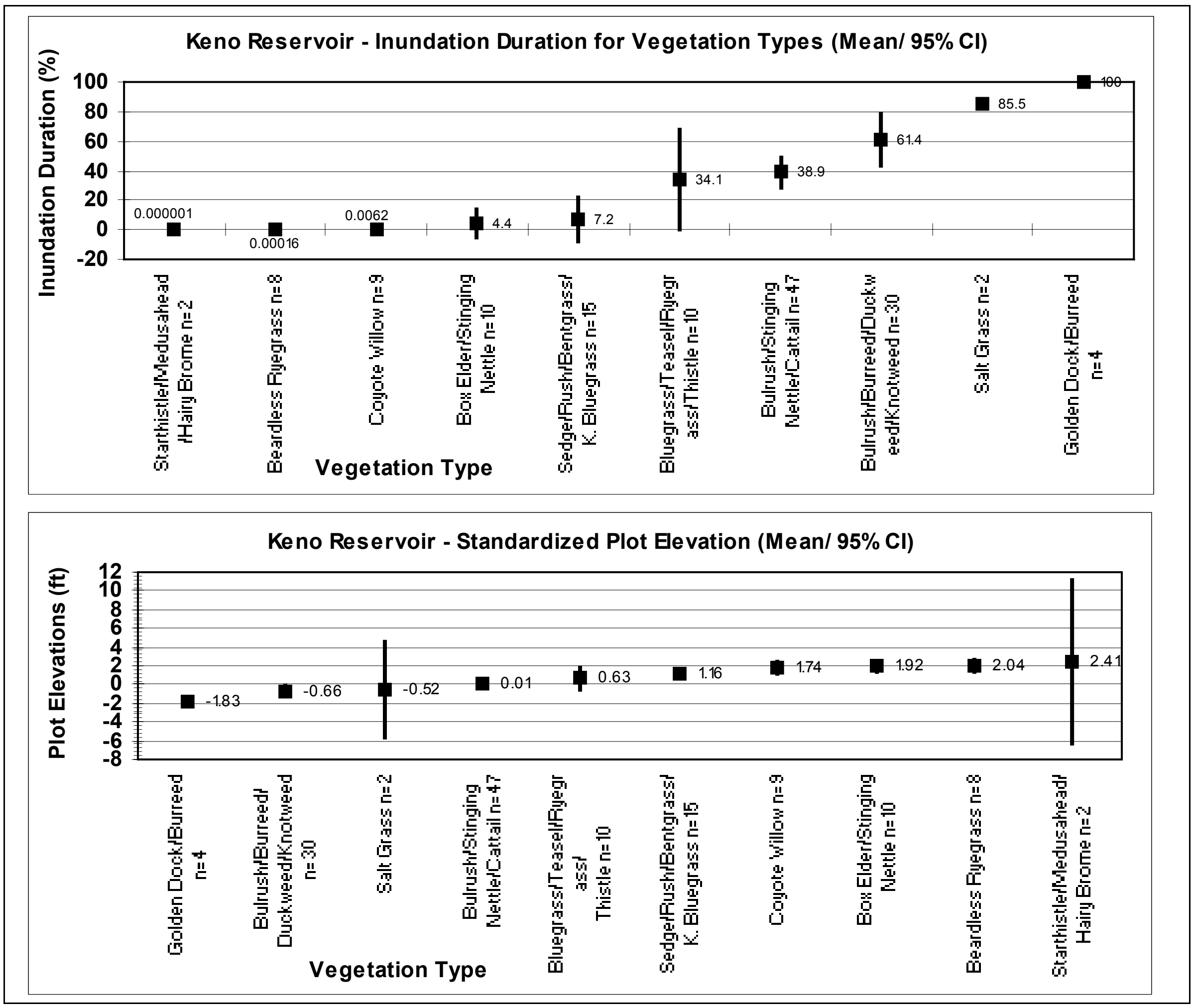


Figure 3.7-9. Mean and 95 percent confidence interval (CI) for inundation duration and plot elevation for riparian/wetland vegetation types at Keno reservoir. Plot elevations based on mean pool level of 4,085.4 feet; normal full pool = 4,085 feet.

The Box Elder/Stinging Nettle vegetation type was not commonly observed at Keno reservoir, but was sampled on the edge of an island with flat topography elevated approximately 1.9 feet (0.58 m) above the mean pool level. This vegetation type graded into the Beardless Ryegrass and Saltgrass vegetation types on the island and grew at average elevations of 2.05 feet (0.63 m) and -0.12 foot (-0.04 m), respectively. The Golden Dock/Bur-reed type grew on the same island, but was sampled in a low swale (mean elevation = -1.83 feet [-0.56 m]) that was highly saline and dries out in the summer. Similar swales on the island and elsewhere around Keno reservoir supported different assemblages of species not sampled during field work for this study. The sampled island vegetation was probably one of the best remaining examples of native wetland vegetation at Keno reservoir, although even here many noxious weed and non-native species were abundant. Nevertheless, this island was one of the least disturbed sites at Keno reservoir.

The confoundedness of the inundation gradient associated with Keno reservoir was exemplified by the wide range of inundation duration percentages associated with some of the most widespread vegetation types at Keno reservoir (Figure 3.7-7). The two most abundant vegetation types, Hardstem Bulrush/Bur-reed/Duckweed/Knotweed and Hardstem Bulrush/Stinging Nettle/Cattail, grew at a range of inundation percentages from 1 to 100 percent, but averaged 61.4 and 38.9 percent, respectively. The Kentucky Bluegrass/Teasel/Beardless Ryegrass/Thistle vegetation was a weak assemblage of native and non-native species associated with habitats inundated from zero to 100 percent. The influence of water sources not connected directly to the reservoir has a major influence on some transects. However, Figure 3.7-9 shows that the mean and 95 percent confidence intervals for inundation duration calculated for all the wetland/riparian vegetation types using all transects, even the confounded one, have good separation along the inundation gradient at Keno reservoir.

The Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass vegetation type had an inundation duration percentage of 7.1, but would be nearer to 1 percent if not for one sedge meadow plot that slumped down next to the reservoir edge. The Coyote Willow type was not common at Keno reservoir, but grew in dense, small stands in low-lying pastures protected by levies. These willow stands were similar to those observed at Iron Gate and Copco reservoirs. The two sampled coyote willow stands at Keno reservoir were located at the downstream end of Keno reservoir where the pool level varied little from the pre-Keno dam pool level. One site was disturbed recently and had a high proportion of bare, gravel substrates. The young coyote willow at this site appeared to be increasing in abundance. The other sampled stand had much older coyote willow and arroyo willow and occurred at the upper end of a long, low-gradient slope that did not appear to have been disturbed for many years. The average inundation duration for coyote willow at these sites was less that 0.01 percent compared to 23 and 17.5 percent for coyote willow vegetation types at Iron Gate and Copco reservoirs, respectively. It may be that the relatively constant pool level permitted willow at the two sampled sites to tap into the relatively stable water table level or some disturbance to the substrate occurred at the sampled sites that provided germination sites for coyote willow.

Keno reservoir is managed to minimize pool level fluctuations. The shoreline margin ranged from natural topographic surfaces to man-made constructs including flood control barriers and water conveyance channels. The natural topographic features were almost always flat or low-gradient surfaces. Dirt berms or rock-armored levies along the reservoir shoreline are often steep and lined with rock. Below the full pool level, the reservoir was often shallow, based on bathymetry data. This was similar to the low-gradient mud flats observed at J.C Boyle reservoir during reservoir drawdown.

Altering (fluctuating) the Keno pool level management, presumably to stabilize flows regimes downstream, would result in a net decrease in mean pool level at Keno reservoir. This may have an effect similar to that observed at J.C. Boyle reservoir where reservoir drawdown exposes a low-gradient mud flat. Provided the drawdown does not have a daily fluctuation cycle like J.C. Boyle reservoir, then it is likely that some encroachment of wetland vegetation into the low-gradient mudflat likely would occur. There would likely be opportunities for restoration or revegetation of the newly exposed shoreline. The current steady pool level management leaves few locations along the elevation gradient that are not too wet for willows, although other factors that promote or inhibit riparian plant species reproduction probably also come into play. For instance, coyote willow is among the most tolerant willow species of wet soil conditions, but must have part of its root crown out of the water, does not tolerate shade, requires fresh bare substrates for germination, and does not grow well in alkaline soils (see Reed Canarygrass and Coyote Willow in Section 3.7.2.2 for more discussion of coyote willow).

Concurrent with the downward shift of vegetation at the lower, wetter end of the inundation gradient, the upper end of the current inundation gradient could shift downward favoring a "drier" assemblage of plant species. The flora at Keno reservoir has a strong representation of noxious and non-native weedy plant species introduced primarily by agriculture, industry, and recreation enthusiasts. The drier habitats created by drawdown likely would have a strong compliment of weedy plant species without careful vegetation management activities designed to restore native vegetation.

<u>J.C. Boyle Reservoir</u>

The six wetland/riparian vegetation types at J.C. Boyle reservoir were all dominated by herbaceous vegetation. The vegetation types were sampled at an average elevation ranging from -0.85 to +1.57 feet (-0.26 to 0.48 m [= 2.42 feet (0.74 m) vertical range]) relative to the mean pool level. The slope of the shoreline averaged about 3 percent and the average width of the sampled shoreline transects was the longest among the Project reservoirs at approximately 136 feet (41.5 m). The pool level at J.C. Boyle reservoir fluctuates in accordance with the peaking schedule for the J.C. Boyle powerhouse. During field data collection for this study, wide stretches of mud flat were sampled during drawdown. The Needle Spikerush/Canadian Waterweed vegetation type grew on these mudflats and had an average inundation duration of 77.6 percent and an average elevation of -0.85 foot (-0.26 m) (Figure 3.7-8). The reservoir drawdown periods contribute to the relatively low average inundation duration percentage for plot and vegetation type occurring at negative average elevations. In general, water level fluctuations tend to attenuate the low end of the inundation duration gradient and plants can persist at lower elevations (relative to average pool) than they could if the reservoir water level were more constant.

Figure 3.7-10 shows the separation of vegetation types at J.C. Boyle reservoir based on their mean and 95 percent confidence intervals for inundation duration and plot elevations. The Marsh Spikerush/Bentgrass/American Speedwell vegetation type occurred over a wide range of inundations from 16 to 73 percent, but averaged 46.3 percent (Figure 3.7-8). The plot elevations ranged from -0.5 to 1.0 feet (-0.15 to 0.3 m). The Hardstem Bulrush/Bur-reed/Duckweed/ Knotweed vegetation type averaged 74.8 percent and the elevation ranged from -1.55 to -0.21 feet (-0.47 to -0.06 m). The Hardstem Bulrush/Stinging Nettle/Cattail vegetation type grew at elevations between the Hardstem Bulrush/Bur-reed/Duckweed Knotweed and the Marsh Spikerush/Bentgrass/American Speedwell vegetation types. The Hardstem Bulrush/Stinging Nettle/Cattail vegetation type grew at elevations ranging from -0.5 to 0.21 foot (-0.15 to 0.06 m) and had an average inundation duration of 55.6 percent (Figure 3.7-8). However, the Marsh Spikerush/Bentgrass/American Speedwell vegetation type seldom grew adjacent to these two other vegetation types and was sampled primarily in the heavily grazed wetlands on the west side of the reservoir across from the Sportsman's Park.

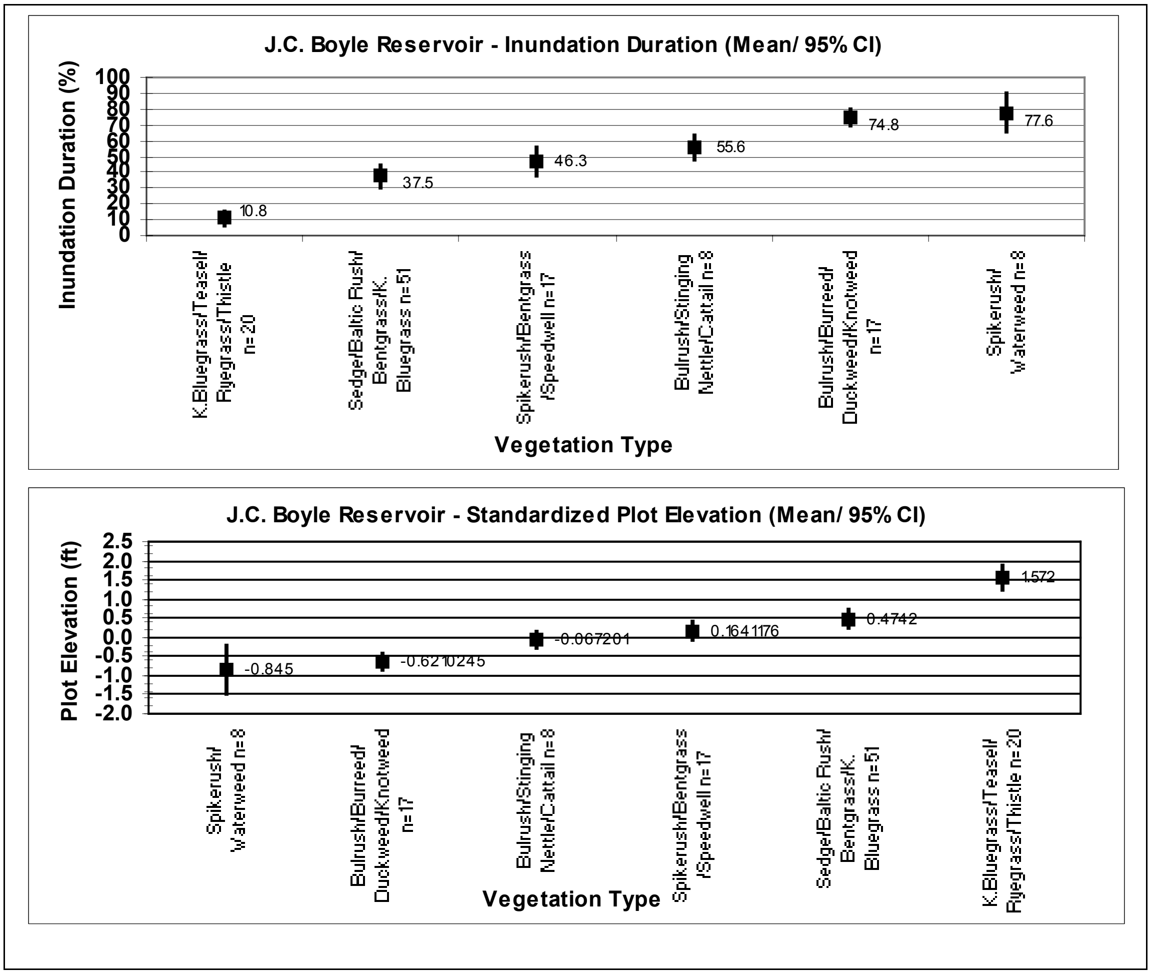


Figure 3.7-10. Mean and 95 percent confidence interval (CI) for inundation duration and plot elevation for riparian/wetland vegetation types at J.C. Boyle reservoir. Plot elevations based on mean pool level of 3,791.4 feet; normal full pool = 3,793.5 feet.

J.C. Boyle reservoir pool level management changes likely would affect riparian/wetland vegetation. The operation of flows through J.C. Boyle powerhouse primarily dictate the level of J.C. Boyle reservoir although operational changes upstream also affect inflows to the reservoir. Maintaining a more consistent pool level at the current mean pool level possibly could widen the band of bulrush-dominated vegetation because its upper margin would receive more consistent inundation and its lower end may be able to tolerate the increased inundation. The sedge-dominated band of vegetation probably would become narrower and wetter as it was squeezed against the existing topographical constraint.

Lowering the mean water level to a point on the current "mud flat" likely would shift the bulrush vegetation downward and widen the sedge meadows so that a longer moisture/inundation gradient was created from wet meadow to dry meadow. The upper end of the new inundation gradient probably would favor a larger component of upland plant species. The pre-Project aerial photography does not exhibit a wetland signature for J.C. Boyle reservoir. Not only was the pre-Project vegetation signature not "wet", but there was no obvious riparian shrub signature along the old river channel. What effect lowering the mean pool elevation might have on the potential establishment of willow vegetation is not clear. In the case of coyote willow, there appears to be some evidence in this study that the coyote willow vegetation types might be associated with more gravelly substrates analogous to the fresh, disturbed gravelly substrates where this vegetation type was observed in some of the river reaches. The predominantly silt and organic substrates and the dense vegetation currently present at J.C. Boyle reservoir may not be suitable habitat for this species. However, the potential for other willow species to grow at J.C. Boyle reservoir could be explored given that suitable potential habitat would appear to be abundant whether the current pool level is altered up or down.

At J.C. Boyle reservoir sites with a steeper shoreline slope, the current wetland vegetation was often perched on a low bench or low gradient slope above the current pool level. Lowering the mean pool level likely would shift these sedge/grass meadows toward a drier assemblage of species. Maintaining the current mean pool level with less ramping likely would favor a wetter assemblage of species, such as bulrush, bur-reed, and spikerush.

PM&E measures directed toward improving the quality of wetlands currently growing at J.C. Boyle reservoir is an excellent objective. Exclusion fencing at wetland locations currently grazed would be one way to improve the vertical structural diversity and possibly even the plant species diversity of those wetland habitats. The introduction of supplemental or experimental planting of willows also has excellent potential. The Keno reservoir willow stands sampled at two different sites at the downstream end of that reservoir can provide some general guidelines for where arroyo willow and coyote willow might be planted at J.C. Boyle reservoir given that the two reservoirs have similar shoreline gradients and are in relatively close proximity to one another.

<u>Copco and Iron Gate Reservoirs</u>

Copco and Iron Gate reservoirs are presented together because of striking similarities in the vegetation and its relationship to the inundation duration gradient (Figure 3.7-7) and standardized elevations (Figure 3.7-8). The vegetation types at Copco and Iron Gate reservoirs were comprised of both herbaceous and woody vegetation. At Copco reservoir, the vegetation types were sampled at an average elevation ranging from -0.6 to 6.3 feet (-0.18 to 1.92 m) relative to the mean pool level (a vertical range of 6.9 feet [2.10 m]). The slope of the shoreline averaged 19 percent and the average width of the sampled shoreline transects was approximately 40 feet (12.2 m). At Iron Gate reservoir, the vegetation types were sampled at an average elevation ranging from -1.1 to 4.8 feet (-0.34 to 1.46 m) relative to the mean pool level (a vertical range of 5.9 feet [1.80 m]). The slope of the sampled shoreline averaged 23 percent and the average width of the sampled shoreline transects was approximately 46 feet (14 m). Copco and Iron Gate reservoirs have relatively steep banks and narrow bands of wetland/riparian vegetation compared to Keno and J.C. Boyle reservoirs. Copco and Iron Gate reservoirs also have less confounded inundation gradients because of the scarcity of seeps, springs, and irrigation returns that influences the inundation gradient-vegetation relationship along some transects sampled at Keno and J.C. Boyle reservoirs.

The upper end of the inundation gradient was dominated by the Starthistle/Medusahead/Hairy Brome vegetation type. The steep, short upper portion of the inundation gradient associated with this vegetation type makes for a blurry boundary between upland and wetland vegetation types as indicated by the presence of so many plant species with affinities to drier habitats. The average inundation percent for this vegetation type at Copco and Iron Gate reservoirs was 4.0 and 6.3 percent, respectively (Figure 3.7-8). While the distinction between upland and wetland was blurred within the elevation range of this vegetation type, it was clear that some species strongly associated with wetland habitats were present. Coyote willow occurred in the herb, shrub, and tree layers of this vegetation type, albeit at low frequency. Shining willow seedlings were observed in two of the sampled Starthistle/Medusahead/Hairy Brome plots at Iron Gate reservoir. Shining willow trees were not abundant, but were present in several locations along Iron Gate reservoir. These mature trees were surprisingly distant from the reservoir, pre-date the reservoir, and typically were growing in or near seemingly dry ravines that presumably overlay a water source. These observations provoke the question, why was willow seemingly so restricted in distribution at both Iron Gate and Copco reservoirs?

Cattle and deer are known to eat and subsequently kill first-year coyote willow seedling by ripping them out of the ground (Kovalchik and Elmore, 1992). Light to moderate spring cattle grazing (20 to 55 percent utilization) was shown to be associated with greater seedling densities for coyote willow and heavy season-long grazing (56 to 75 percent utilization) was associated with lowest densities of coyote willow seedlings (Shaw, 1992). Shaw (1992) attributed the greater seedling densities to the cattle creating microsites by consuming spring plant growth that was competing with the young seedlings. Clary et al. (1996) found that coyote willow under light spring grazing (21 percent herbaceous utilization and 6-inch [15-cm] stubble height) coyote willow achieved greatest densities while the heavy season-long grazing (70 percent herbaceous utilization and 2-inch [5-cm] stubble height) resulted in the lowest densities. Kovalchik and Elmore (1992) found that cattle prefer herbaceous vegetation until stubble height reaches 4 to 6 inches (10 to 15 cm) (65 percent utilization), then they start to eat the current-year's growth. At stubble heights of about 2 to 4 inches (5 to 10 cm) (85 percent utilization), the cattle will begin to eat the older willow growth.

The Starthistle/Medusahead/Hairy Brome vegetation type was heavily grazed by deer and cattle at both Copco and Iron Gate reservoirs, although direct observations of herbivory on willow were not made during field data collection for this study. The Starthistle/Medusahead/Hairy Brome vegetation type was capable of supporting willow; coyote willow was present in 21 and 22 percent of plots sampled in this vegetation type at Iron Gate and Copco reservoirs, respectively. There was strong circumstantial evidence that herbivory (and trampling) could be responsible for some mortality of willow seedlings. Herbivory of willow saplings, presumably by beaver, was observed in some locations. Oregon ash shrubs also were present in the Starthistle/Medusahead/Hairy Brome vegetation type and they often were deformed as a result of breakage by cattle gathering near the reservoir.

Another possible barrier to willow establishment is the availability of suitable substrates for germination for willow seed, particularly for coyote willow. Coyote willow establishment is known to occur on bare substrates that receive good light. Many of the field observations of coyote willow in the herb layer were the result of vegetative shoots emerging through dense vegetation cropped low to the ground by herbivores. Any coyote willow reproduction, whether from seed or from vegetative growth, likely would be eaten or trampled and the dense, low-growing vegetation is not the ideal habitat for coyote willow establishment from seed. The dense, low vegetation is unlikely to be a good seed bed for willow unless it was disturbed so that bare substrate is exposed and it was in close enough proximity to the reservoir to provide sufficient moisture for the young seedlings to survive.

An analysis of reservoir pool level data from 1997 to 2001 reveals that another potential barrier to coyote willow establishment may be the lack of coincidence of appropriate pool levels at the time of year when willow seeds are dispersing. In May and June, when coyote willow seed is dispersing, Copco and Iron Gate reservoir levels are often at their most constant because of spring runoff, but can vary considerably between wet and dry years, between spring and summer, and within the summer months. The average daily fluctuation of both Copco and Iron Gate reservoirs was 0.5 foot (0.15 m) and the average annual fluctuation was 4 feet and 6.5 feet (1.2 to 2.9 m), respectively. However, the pool level in 2000 (normal water year) and 1999 (wet year) drops considerably around June 1 at Iron Gate reservoir. A drop in pool level at this time of year may coincide with the dispersal of coyote willow and the dewatering of bare, moist substrates. However, this drop in pool level was rather abrupt, from approximately 2,328 to 2,326 feet msl (216 to 709.1 m), then throughout the summer months, the pool level fluctuations ranged between 2,323 feet msl (708.2 m) and 2,327 feet msl (709.5 m). From the perspective of willow seed germination and survival an abrupt permanent drop of only 2 feet (0.61 m) could be lethal to a new seedling. Conversely, an abrupt raising of the pool level that covers new seedlings could drown them if sustained too long. In the dry year of 2001, there was no spring peak runoff flow and the Iron Gate pool level fluctuated between approximately 2,324.5 and 2,328.5 feet msl (708.7 to 709.9 m) between April 1 and August 1. This would appear to be a better year for seedling establishment because if the seed found a suitable patch of ground at roughly 2,326.5 feet msl (709.3 m), germinated, and then was not subjected to a sudden drop in water level it may have had time to set roots. However, the seedlings then would be subjected to relatively frequent inundation events throughout the summer because of the re-regulating function of the reservoir. There was no clear evidence from this study that reservoir fluctuation either favors or hinders seedling survival in the first year.

At Copco reservoir, the 2000 and 1999 pool levels fluctuated roughly between 2,601 feet msl (793.0 m) and 2,607 feet msl (794.8 m) between April 1 and August 1. In 2001, the pool level fluctuated between 2,600 feet msl (792.7 m) and 2,607.5 feet msl (795.0 m) during the same period. Although no abrupt drop in pool level was observed around the first of June, there was considerable pool level fluctuation, as much as 6 to 7 feet (1.8 to 2.1 m), through the spring and summer. One could speculate that a new willow seedling could survive that type of inundation if the magnitude of the pool rise was not too great as to drown the seedling and the period between inundations was not too great so the seedling would not desiccate. Unfortunately, much of this is speculative given that no confirmed willow seedlings were documented on sampled transects at Iron Gate and Copco reservoirs. The lack of seedling observations does not, however, mean that coyote willow cannot establish at Iron Gate and Copco reservoirs. It is likely that in some years the pool level fluctuation is not suitable for willow seed germination and survival.

The coyote willow vegetation types have an average inundation duration of 18.5 percent and 23.5 percent at Copco and Iron Gate reservoirs, respectively. The elevation for coyote willow vegetation types at Copco reservoir ranged from -1.16 to 6.4 feet (-0.35 to 1.95 m). At Iron Gate reservoir, the elevation ranged from -0.93 to 5.83 feet (-0.28 to 1.78 m). These elevation ranges overlap the Starthistle/Medusahead/Hairy Brome vegetation type, which has a minimum elevation of 0.38 foot (0.12 m) and 0.45 foot (0.14 m) at Iron Gate and Copco reservoirs, respectively, even though the means and 95 percent confidence intervals show good separation between these two vegetation types along the inundation gradient (Figures 3.7-11 and 3.7-12). Given that the Starthistle/Medusahead/Hairy Brome vegetation type was abundant at both reservoirs, it can be assumed that there is potential for willow to grow in some locations along the inundation gradient currently occupied by the Starthistle/Medusahead/Hairy Brome vegetation type.

At Iron Gate reservoir, some of the youngest willow stands were located along the peninsula that was roughly due south of Camp Creek campground. The presence of these stands indicated that willow was able to establish under relatively recent pool level management. The substrate along this section of shoreline was relatively fresh, bare silty substrates recently deposited from adjacent slopes that have eroded as a result of wave action. This type of erosion along otherwise steep slopes around the reservoirs often was observed to be the source for new substrates that were potential habitat for riparian vegetation. Some of these of these sites were protected by steep slopes, and in some areas, steep, eroded cut-banks adjacent the young willow stands may serve to limit access by less agile herbivores. Given the presence of willow stands of various ages at both reservoirs, it is unclear if and how reservoir level fluctuation might be affecting willow establishment. It is likely that willow establishment is as dynamic as the events that create conditions suited to willow establishment and survival. Under recent reservoir level management, the right combination of conditions that are suited to willow establishment occur, but relatively infrequently. In the case of Copco reservoir, the right combination of conditions may be rare. The scarcity of fresh substrate necessary to eliminate competing herbaceous vegetation and to provide suitable sites for willow seed germination may be limiting willow distribution. Likewise, protection from herbivory and trampling may need to coincide with formation of fresh substrate to allow survival of willow seedlings.

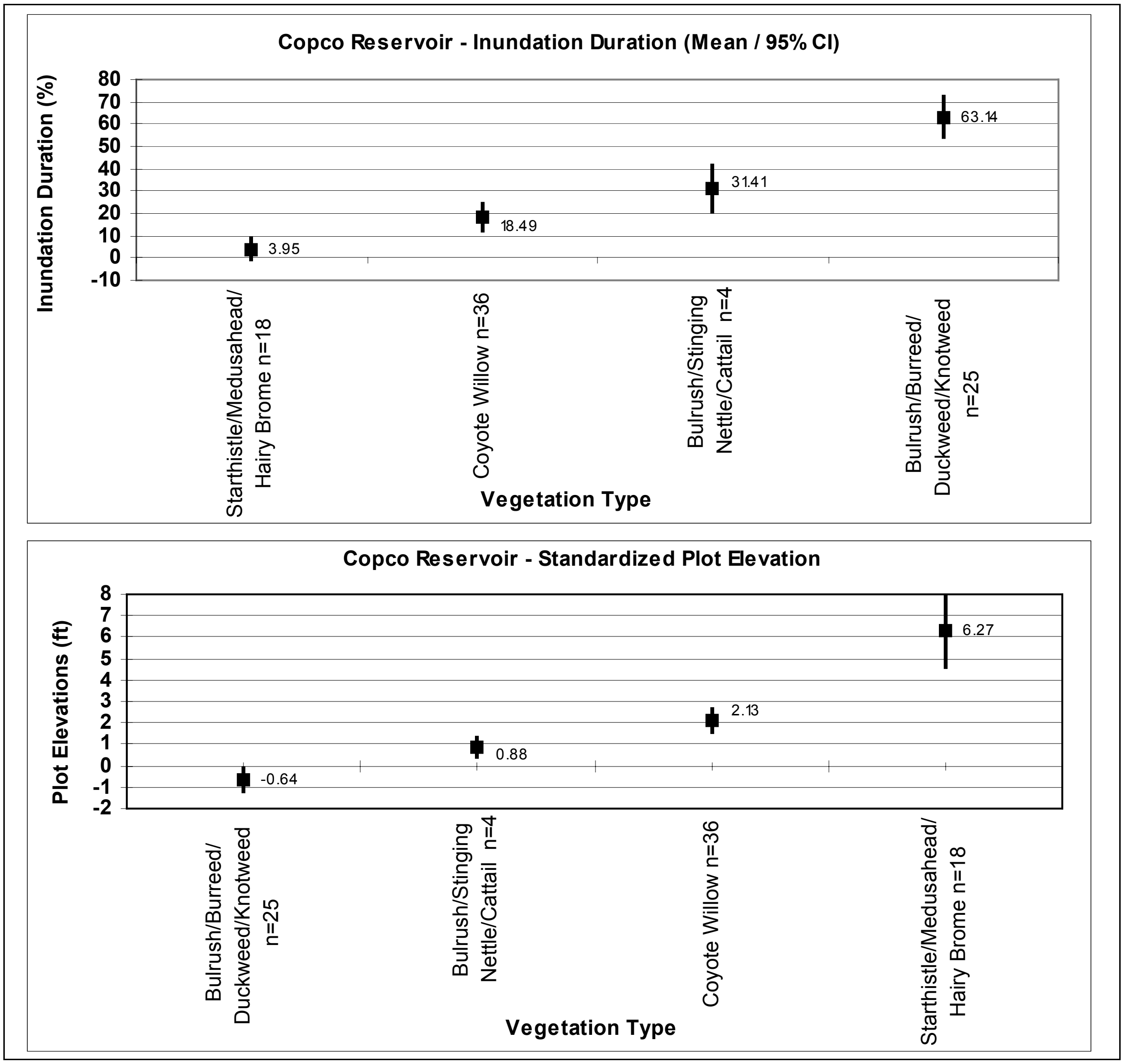


Figure 3.7-11. Mean and 95 percent confidence interval (CI) for plot elevation and inundation duration for riparian/wetland vegetation types at Copco reservoir. Plot elevations based on mean pool level of 2,604.3 feet; normal full pool = 2,607.5 feet.

The other vegetation type shared by both Iron Gate and Copco reservoirs was the Hardstem Bulrush/Bur-reed/Duckweed/Knotweed vegetation type. The average inundation duration for this type was 71.9 percent and 63.1 percent at Iron Gate and Copco reservoirs, respectively, which corresponds to average plot elevations of -1.1 and -0.64 feet (-0.34 to -0.12 m). The Hardstem Bulrush/Bur-reed/Duckweed/Knotweed vegetation type occurred in the drawdown zone (mean pool level +/- mean daily drawdown [0.5 foot (0.12 m)]) at both reservoirs. Unlike at Keno and J.C. Boyle reservoirs, this vegetation type does not form continuous bands of vegetation at Iron Gate and Copco reservoirs, but grows in distinct, usually small patches along the shoreline. The plot slope for this vegetation type averaged 10.6 percent at both reservoirs and when the reservoirs were drawn down it was apparent that there were many potential sites that were unoccupied.

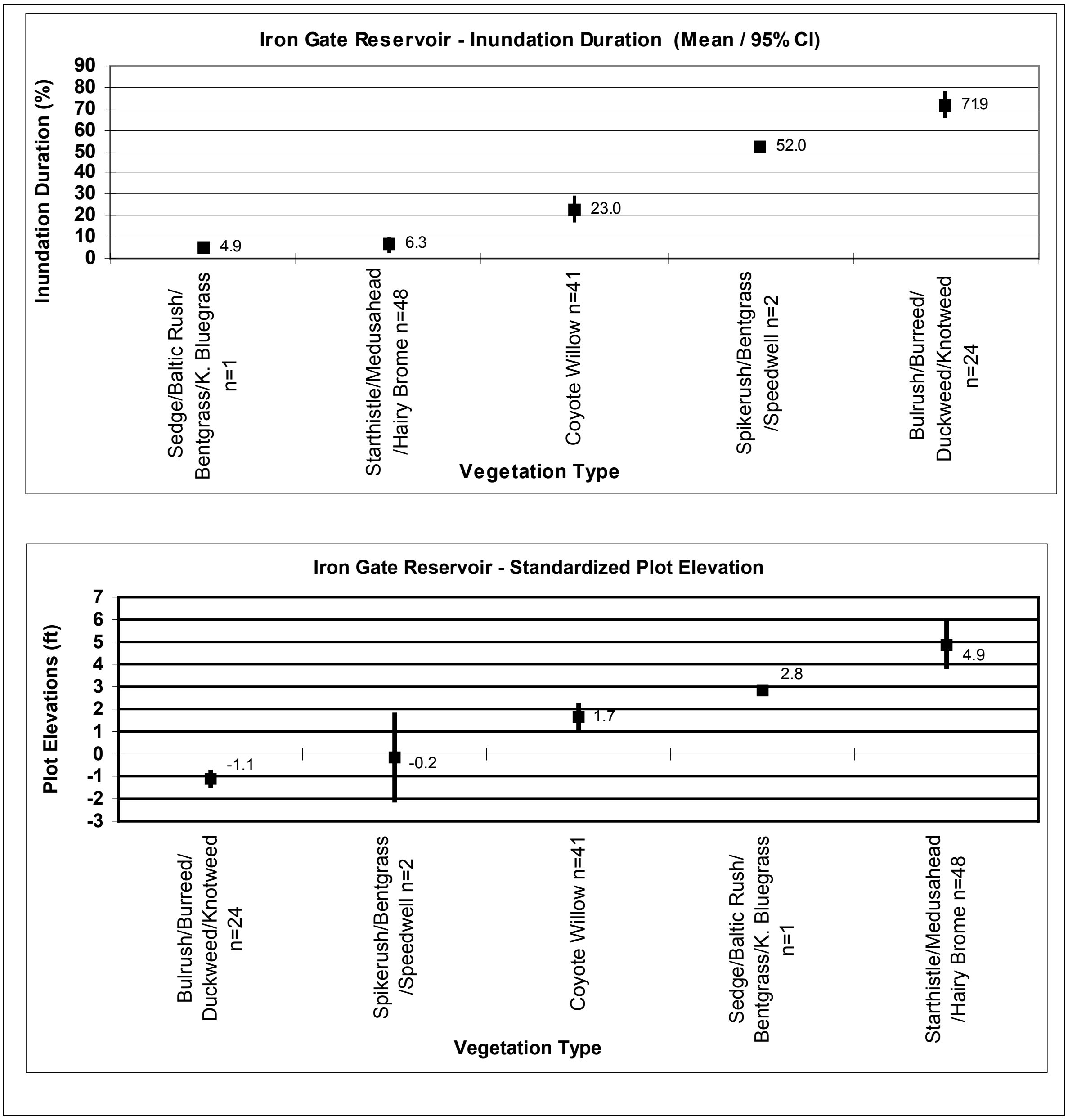


Figure 3.7-12. Mean and 95 percent confidence interval (CI) for plot elevation and inundation duration for riparian/wetland vegetation types at Iron Gate reservoir. Plot elevations based on mean pool level of 2326.4 feet; normal full pool = 2,328.0 feet.

At Copco reservoir, the Hardstem Bulrush/Stinging Nettle/Cattail vegetation type grows at elevations ranging from 0.5 to 1.2 feet (0.15 to 0.37 m). This vegetation type was sampled in only one site near the estuary of one small ephemeral tributary. This site had an average slope of 4.8 percent and was the only site observed to support dense growth of reed canarygrass at either Iron Gate or Copco reservoirs.

At Iron Gate reservoir, the Marsh Spikerush/Bentgrass/American Speedwell vegetation type has a mean inundation duration of 53 percent and grew at elevations averaging 0.16 foot (0.05 m) below the mean pool level. Marsh spikerush was a common species at Iron Gate reservoir, but generally was distributed sparsely near the waterline. The Sedge/Baltic Rush/Bentgrass/

Kentucky Bluegrass vegetation type grows at elevations roughly 2.8 feet (0.85 m) above the mean pool level and had an average inundation duration of 2.6 percent. This vegetation type was uncommon at Iron Gate reservoir, although the primary associated species (Nebraska sedge and Kentucky bluegrass) commonly grow at the lower end of the inundation gradient that supports the Starthistle/Medusahead/Hairy Brome vegetation type. The ramping of the reservoirs and the relatively steep bank slopes likely keep this portion of the inundation duration/elevation gradient “dry enough” to support a large compliment of weedy upland species like medusahead, starthistle, and hairy brome. If the water level were more consistent at Iron Gate reservoir, conditions likely would favor species associated with both the Marsh Spikerush/Bentgrass/ American Speedwell and the Sedge/Baltic Rush/Bentgrass/Kentucky Bluegrass vegetation types and also drown some of the weedy, upland species associated with the Starthistle/Medusahead/ Hairy Brome vegetation type that have encroached into the riparian/wetland zone.

3.7.2.2 River Reaches

The seven Project river reaches are described below based on the results of DCA for each river reach. The DCA results first will be summarized for all reaches; subsequent sections will discuss each reach with respect to the DCA results, flow regimes particular to each reach, and unique relationships of vegetation patterns to a variety of conditions (i.e., grazing, geomorphology, plant ecology, vegetation dynamics) more or less unique to each reach. Comparisons among reaches are made when appropriate to help demonstrate differences and similarities among reaches, which may help to identify factors useful with respect to PM&E measures.

<u>River Reach DCA Results</u>

Separate analyses were performed on the seven Project river reaches using DCA. The first ordination axis for each reach analysis typically identified the variation in the species data that demonstrated the strongest relationship between vegetation patterns and environmental variables used in the analysis. The environmental variables used in the DCA were inundation duration, return interval for annual peak flows, substrate particle size cover, plot slope, and discharge associated with each plot.

The results of the DCA for all of the river reaches are summarized in Table 3.7-3 and include a measure of how much variation in the species cover/abundance plot data was accounted for by Axes 1 and 2 of the DCA ordination. It is typical for the first one or two axes resulting from DCA to identify the bulk of the variation in the species cover/abundance data that is not attributable to noise in the data (see Section 3.4.1.9 for a detailed explanation of interpreting DCA results). For most of the Project river reaches, the percentage of variation explained by the first ordination axis is far greater than for the subsequent axes (Axes 2 and 3). Therefore, the first ordination axis is the primary focus of this analysis and is considered to represent the primary environmental gradient that influences the distribution of riparian vegetation types along Project river reaches.

Table 3.7-3. Results of detrended correspondence analysis (DCA) for Project river reaches.

	DCA Axis 1			DCA Axis 2		
	Variance Explained %	Pearson's r	Kendall's tau	Variance Explained %	Pearson's r	Kendall's tau
Iron Gate Reach	29.5			8.9		
Inundation Duration		0.84	0.70		na	Na
Discharge		-0.42	-0.62		na	Na
Return Interval		-0.16	-0.62		na	Na
Copco No. 2 Bypass	40.1			12.6		
Organic Cover		.50	.34			
Fall Creek	37.0			9.5		
Discharge		0.64	0.53		na	Na
Plot Slope		0.45	0.34		na	Na
Organic Cover		-0.37	-0.28		na	Na
J.C. Boyle Peaking	26.6			14.7		
Inundation Duration		-0.68	-0.65		na	Na
Discharge		0.66	0.66		na	Na
Return Interval		0.40	0.67		na	Na
Silt Cover		0.54	0.48		na	Na
J.C. Boyle Bypass	59.7			6.9		
Inundation Duration		0.76	0.69		na	Na
Discharge		-0.57	-0.70		na	Na
Keno Canyon	55.9			8.5		
Inundation Duration		-0.67	-0.54		na	Na
Discharge		0.80	0.55		-0.48	-0.30
Return Interval		0.73	0.58		0.47	0.28
Silt Cover		0.74	0.56		0.46	0.44
Sand Cover		0.55	0.30		na	Na
Boulder Cover		-0.78	-0.55		na	Na
Link River	44.4			8.0		
Return Interval		0.67	0.50		na	Na
Discharge		0.47	0.47		na	Na
Plot Slope		0.42	0.30		na	Na
Inundation Duration		-0.30	-0.46		na	Na

The vegetation types derived for each river reach through TWINSPAN analysis also were overlaid on the ordination diagrams and provide a visual estimation of how the vegetation types relate to the ordination analysis. The mean site scores for each of the vegetation types were provided in the following sections and were used to determine which of the vegetation types respond most directly to the primary environmental gradient represented here by the first ordination axis. The vegetation codes used in the various DCA ordination diagrams for the Project river reach analyses are explained in Table 3.7-4.

For all river reaches, except the Link River and Keno Canyon reaches, inundation duration had the highest correlation to DCA Axis 1. Discharge was typically among the best performing variables, but tended to have some high values when plots were sampled, perhaps too high along the elevation gradient. Particularly high values that resulted in high Kendall's tau correlation coefficient potentially can misrepresent the importance of a variable as an explanatory variable. The performance of the return interval varied in performance similar to discharge also because of high values in the data set. Inundation duration, discharge, and return interval are all highly correlated, which means they should perform similarly as explanatory variables. In the following section, some patterns of how these variables are correlated will be discussed. Generally, in some reaches discharge and return interval tend to be more highly correlated at the higher end of the elevation gradient while discharge and inundation duration tend to be more highly correlated at the lower end of the elevation gradient.

Table 3.7-4. Klamath Project river reaches, vegetation types, and vegetation type codes.

Project River Reaches/Vegetation Types	Vegetation Code	Number of Plots
Link River		
Scouler's Willow	3	1
Hardstem Bulrush	4	1
Red Osier Dogwood/Himalayan Blackberry	11	29
Red Osier Dogwood/Reed Canarygrass/Colonial Bentgrass	20	20
Red Osier Dogwood/Reed Canarygrass	21	6
Keno Canyon Reach		
Mock Orange/Sierra Plum/California Rose	6	3
Brown Dogwood/Snowberry	7	2
Reed Canaryrass/Western Goldenrod	10	4
Shining Willow/Reed Canarygrass Vegetation	11	4
Hardstem Bulrush	16	7
Hardstem Bulrush/Devil's Beggarstick	18	8
Reed Canarygrass	19	12
Reed Canarygrass/Woolly Sedge	24	4
Bearded Wildrye/Colonial Bentgrass	25	7
J.C. Boyle Peaking Reach		
Perennial Ryegrass	8	10
Coyote Willow/Reed Canarygrass/Colonial Bentgrass	12	21
Kentucky Bluegrass/Yarrow/Field Cress	18	12
Kentucky Bluegrass/Timothy/Colonial Bentgrass	19	15
Oregon Oak/Western Serviceberry/Snowberry	23	8
Hardstem Bulrush/Reed Canarygrass	27	18
Oregon Ash/Colonial Bentgrass/Woolly Sedge	44	17
Oregon Ash/Himalayan Blackberry	45	30
Reed Canarygrass	53	32

Table 3.7-4. Klamath Project river reaches, vegetation types, and vegetation type codes.

Project River Reaches/Vegetation Types	Vegetation Code	Number of Plots
J.C. Boyle Bypass Reach		
Mock Orange Vegetation	10	10
Coyote Willow/Reed Canarygrass/Colonial Bentgrass	12	1
Mock Orange/Reed Canarygrass	52	8
Reed Canarygrass	53	20
Iron Gate Dam to Shasta River		
Curly Pondweed	6	25
Hardstem Bulrush/Duckweed	7	12
Medusahead/Cheatgrass	36	5
Oregon Oak/BlueWildrye	37	11
Oregon Ash/Colonial Bentgrass/Kentucky Bluegrass	38	14
Chicory/Tall Fescue	39	5
Coyote Willow/Poison Hemlock	40	11
Coyote Willow/Himalayan Blackberry	41	34
Coyote Willow/Knotgrass	45	4
Rice Cutgrass/Hardstem Bulrush	46	11
Oregon Ash/Colonial Bentgrass/Woolly Sedge	88	6
Coyote Willow/Rice Cutgrass	89	14
Fall Creek		
Oregon Ash/Western Birch	8	5
Oregon Ash/Douglas' Spiraea	9	7
White Alder	5	7
Ponderosa Pine/Douglas-fir/Western Serviceberry	6	11
Copco No. 2 Bypass		
Devils' Beggarstick/Knotweed	1	7
White Alder/Rice Cutgrass/Hairy Willowherb	2	11
White Alder/Oregon Ash	3	18
Oregon Ash/Himalayan Blackberry/Blue Wildrye	5	13

Link River

The riparian vegetation types for the Link River reach identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-13). The vegetation types are sorted by elevation to a large degree along DCA Axis 1. The distribution of vegetation types as represented by their average DCA Axis 1 plot scores along the first ordination axis indicate an imperfect relationship with the means for inundation duration and discharge associated with the five Link River vegetation types (Figure 3.7-14). Return interval and discharge performed best as explanatory variables for DCA Axis 1 plot score (Table 3.7-3).

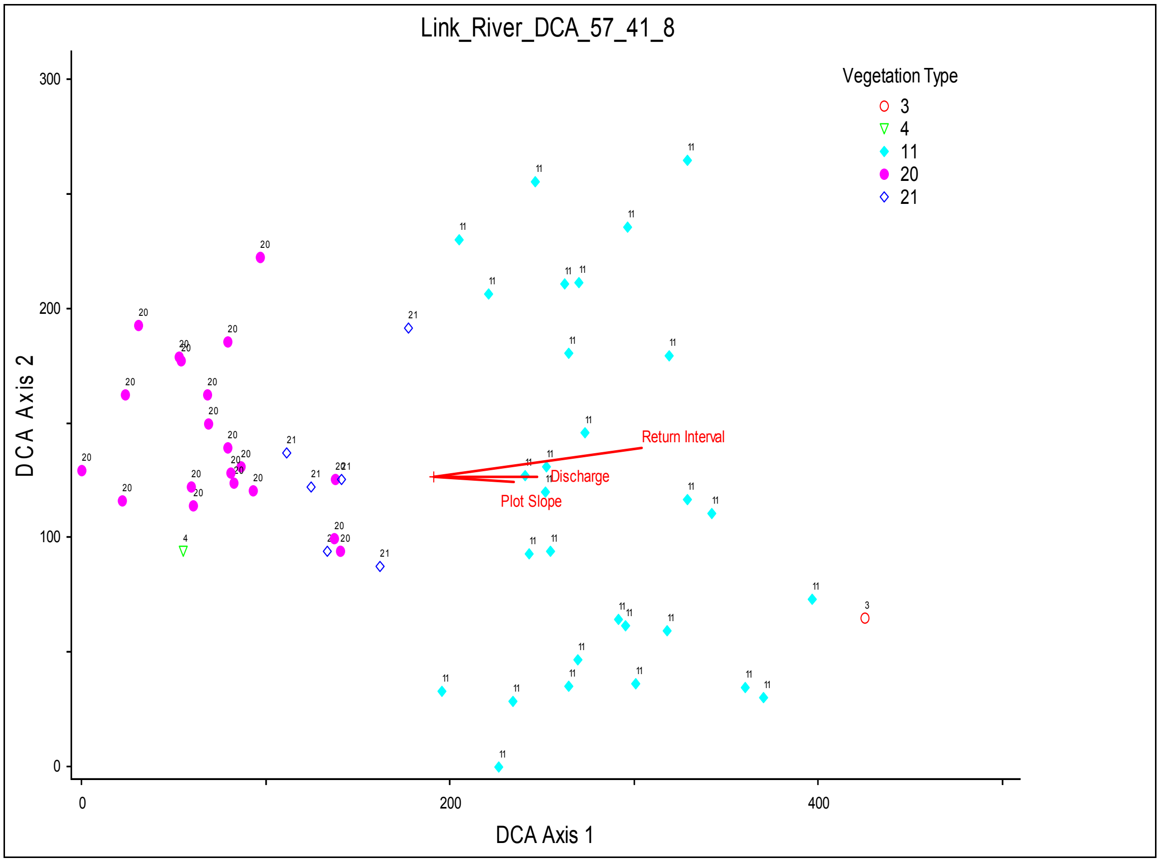


Figure 3.7-13. Detrended correspondence analysis (DCA) ordination for Link River reach plots. The length of the vector line for return interval, discharge, and plot slope indicates relative importance of variable in explaining variation in the species/abundance data.

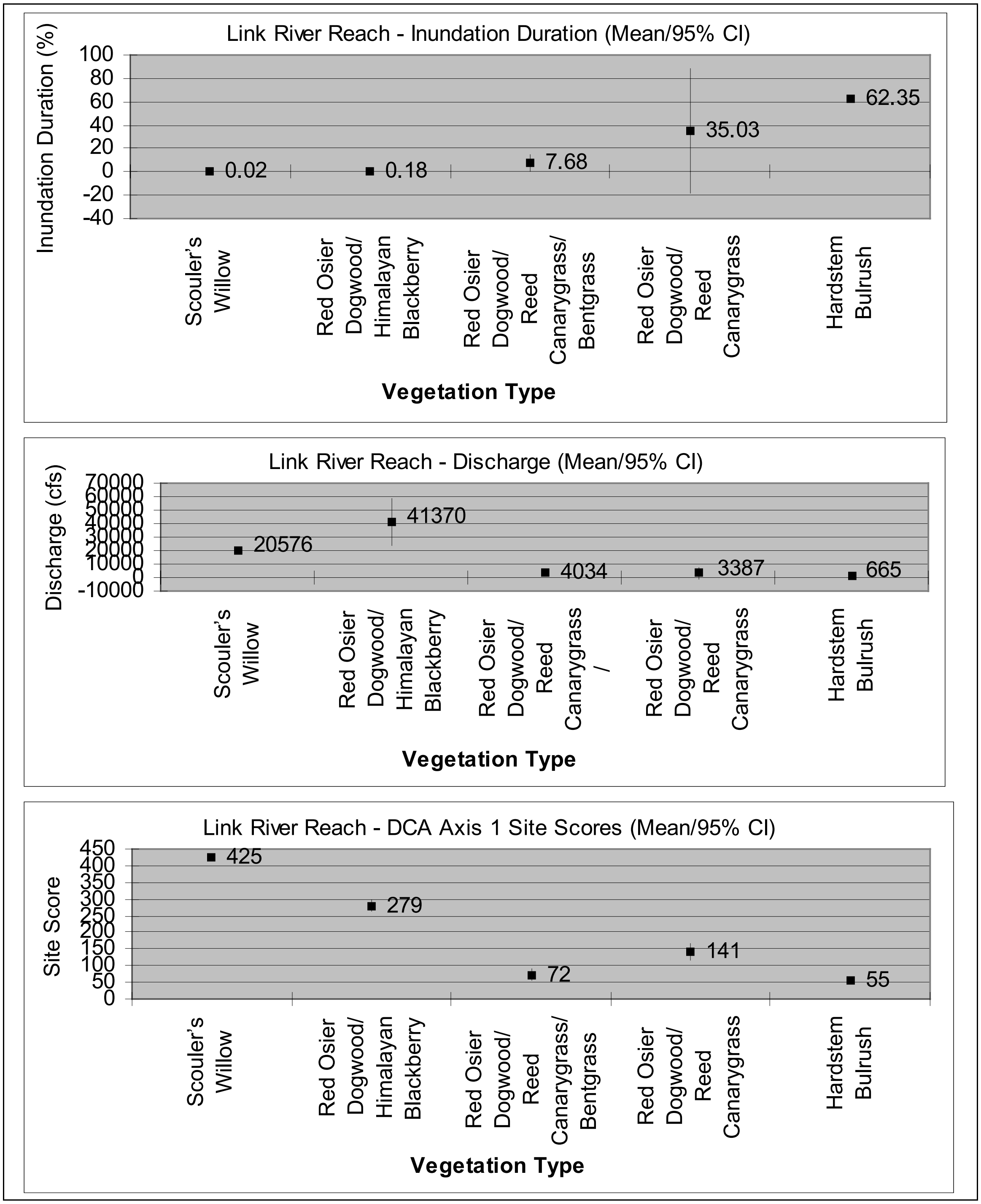


Figure 3.7-14. Mean and 95 percent confidence (CI) intervals for detrended correspondence analysis (DCA) Axis 1 site scores, discharge, and inundation duration for riparian vegetation types in the Link River reach.

The inundation/elevation gradient associated with the river hydrology is confounded by seepage from the West Side canal. As a result of seepage, obligate wetland plant species grow up to 300 feet (30.5 m) or more from the river channel that would be affected only by extremely large discharges. In the analysis, these plots are essentially outliers and create an unrealistically high correlation with site scores along DCA Axis 1. In reality, seepage is promoting the wetland/riparian vegetation types at these elevations This is not to say that large discharges do not or will not at some point play a role in affecting riparian vegetation in the Link River. Historical aerial photography reveals a slight increase in riparian vegetation cover from 1979 to 2000 (see Water Resource FTR, Section 6.7.6). It is impossible to determine what effect large flood flows may have had before 1979. Near the time of initial East Side Project construction, there was little riparian habitat, a condition likely resulting from a combination of periodic high flows scouring vegetation along the bedrock-lined channel and the extensive human development that had already taken place.

As seen in other river reaches, inundation should have at least moderately high correlation with DCA Axis 1 plot scores (Table 3.7-3). In those reaches, the vegetation types at the lower end of the elevation/inundation gradient are primarily responsible for any correlation that resulted for inundation duration and the DCA Axis 1 site scores. In other reaches, discharge typically mirrored the results of inundation to a high degree except for sites where riparian vegetation types grew at unusually high elevations. The reasons for riparian vegetation types occurring at unusually high elevations are potentially the result of many factors including the growth patterns of certain colonial riparian plant species and seepage areas affecting the distribution of wetland/riparian plant species. At Link River, the inundation duration variable performed particularly poorly (Pearson's r correlation coefficient of -0.30) in explaining site scores along DCA Axis 1 (Table 3.7-3). In part, the performance of inundation duration probably is masked by the unrealistic performance of discharge and return interval. Above a certain discharge, inundation duration values become so small that they become uninfluential in the correlation analyses. Conversely, above a certain elevation, the calculated return interval becomes so large that it becomes an unrealistically important factor in the correlation analysis.

One other reason for the poor performance of inundation duration at Link River is that one transect that was included in the TWINSPAN analysis used to classify Link River riparian vegetation types was not included in the DCA analysis because it could not be safely measured during the instream flow study. The absence of these data resulted in some small sample sizes for some riparian vegetation types that grow at the lowest end of the elevation gradient. Sixteen of 17 plots classified as the Hardstem Bulrush vegetation type occurred along the missing transect. This vegetation type was dominated by hardstem bulrush and reed canarygrass and is the dominant vegetation type growing on in-channel bars and at island margins.

The Red Osier Dogwood/Himalayan Blackberry vegetation type occurred over the widest range of discharge of any of the Link River vegetation types (Figure 3.7-14). This vegetation type is little affected by inundation duration as indicated by its mean inundation duration of 0.18 percent. In contrast, the Red Osier Dogwood/Reed Canarygrass vegetation type demonstrated little variation in discharge, but occurred over a range of elevations that reflect the largest range of inundation duration for any of the Link River vegetation types based on modeled river hydrology. This range of the inundation duration (minimum = 0.01 percent, maximum = 100 percent) and discharge (minimum = 48.5 cfs [1.4 cms], maximum = 6,031 cfs [171 cms]) likely represents, in part, the range of elevations over which riparian vegetation change likely would take place in the absence of the influence of seepage from the West Side canal.

The return interval for the Red Osier Dogwood/Reed Canarygrass vegetation type ranged from less than 1 year up to approximately 8 years (based on 52 years of flow data). The 8-year return interval for the upper end of the elevation range for the Red Osier Dogwood/Reed Canarygrass vegetation type is a reasonable approximation of the riparian vegetation maintenance flood flow (see Reed Canarygrass and Coyote Willow sections for explanation of riparian vegetation maintenance flow). The 8-year return interval falls within the range of return intervals (1.5 to 10 years) for flows hypothesized to maintain riparian vegetation, particularly in alluvial reaches in the arid western United States (Hill et al. 1991).

The lower elevation end of the Red Osier Dogwood/Reed Canarygrass vegetation type overlaps the Red Osier Dogwood/Reed Canarygrass/Colonial Bentgrass vegetation type (Figure 3.7-14). However, the wide variation in discharge and inundation duration for the Red Osier Dogwood/Reed Canarygrass vegetation type actually resulted in lower mean discharge and higher mean inundation duration (Figure 3.7-14). This is likely the result of consistent substrate moisture along the elevation gradient as a result of seepage and the aggressive growth of the highly adapted reed canarygrass into higher elevations (see Reed Canarygrass and Coyote Willow sections for more discussion of reed canarygrass). The most distinctive difference between these two vegetation types is that when reed canarygrass does not fill in all the gaps between the dogwood shrubs, then colonial bentgrass is not shaded out and can maintain its position. This pattern of growth for reed canarygrass and colonial bentgrass (and other species) is similar to that seen in the J.C. Boyle peaking reach. In many areas at the Link River, taller woody species tend to shade out reed canarygrass.

The Red Osier Dogwood/Himalayan Blackberry and Scouler's Willow vegetation types were the classified vegetations types that occur above elevations inundated by 6,031 cfs (171 cms). However, the vegetation is really a mosaic of many different species assemblages sorted by the degree of inundation resulting from seepage. It is difficult to predict exactly how the Link River wetland and riparian plant species would re-sort to form new assemblages in response to the absence of seepage from the West Side canal, either above or below elevations inundated by 6,031 cfs (171 cms).

Keno Canyon

The riparian vegetation types in the Keno Canyon reach (Keno reach) identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-15). The vegetation types are sorted by elevation to a large degree along DCA Axis 1. The distribution of vegetation types as represented by their average DCA Axis 1 plot scores along the first ordination axis indicate a strong but imperfect relationship with the means for inundation duration and discharge associated with the nine Keno Canyon reach riparian vegetation types (Figure 3.7-16). However, discharge, not inundation duration, performed best as an explanatory variable for the distribution of DCA Axis 1 plot scores (Table 3.7-3). In contrast to other Project river reaches, there were several variables that performed well with Pearson's r correlation coefficients greater than 0.70, including boulder cover, silt cover, and return interval. Return interval is highly correlated with discharge, which also does not capture the small-scale changes in vegetation types at lower elevations along the inundation gradient. This is because return interval estimations for elevations inundated at intervals less than 1 year are unreliable and were lumped into a return interval category of 0.5 year in the environmental data set.

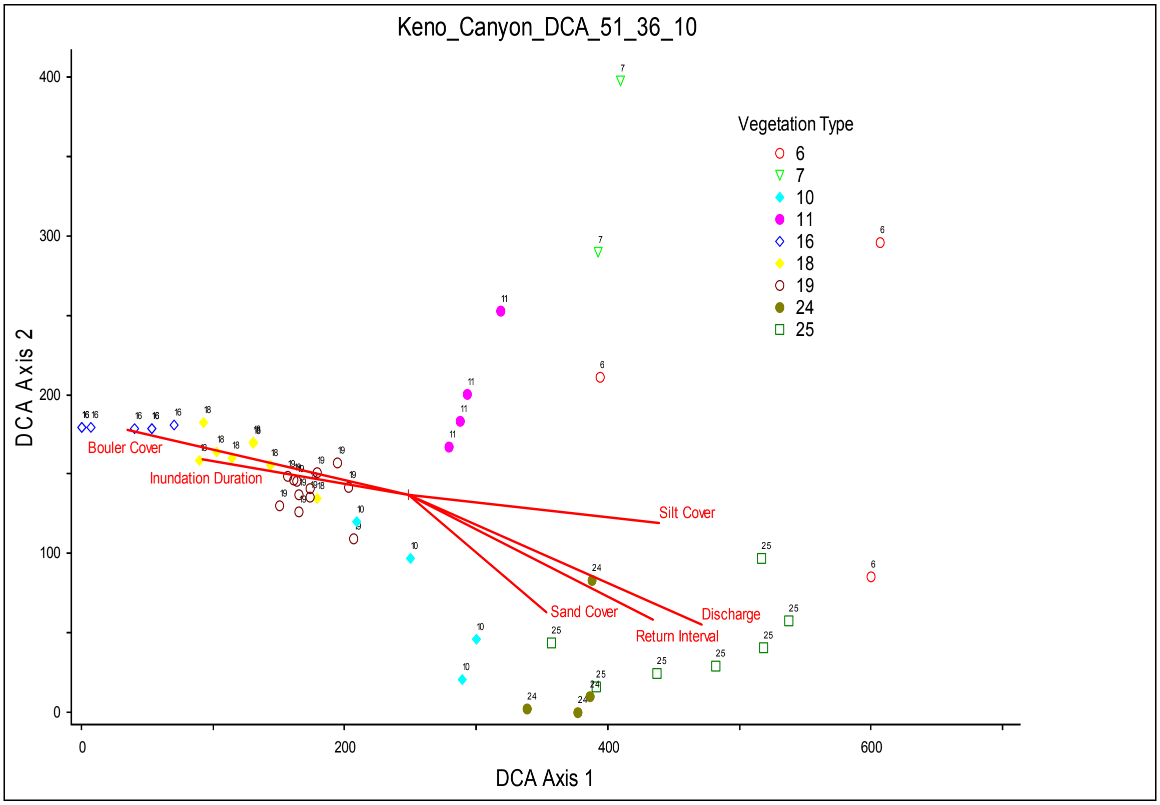


Figure 3.7-15. Detrended correspondence analysis (DCA) ordination for Keno Canyon reach plots. The length of the vector line for inundation duration, discharge, return interval, inundation duration, boulder cover, sand cover, and silt cover indicate relative importance of a variable in explaining variation in the species/abundance data.

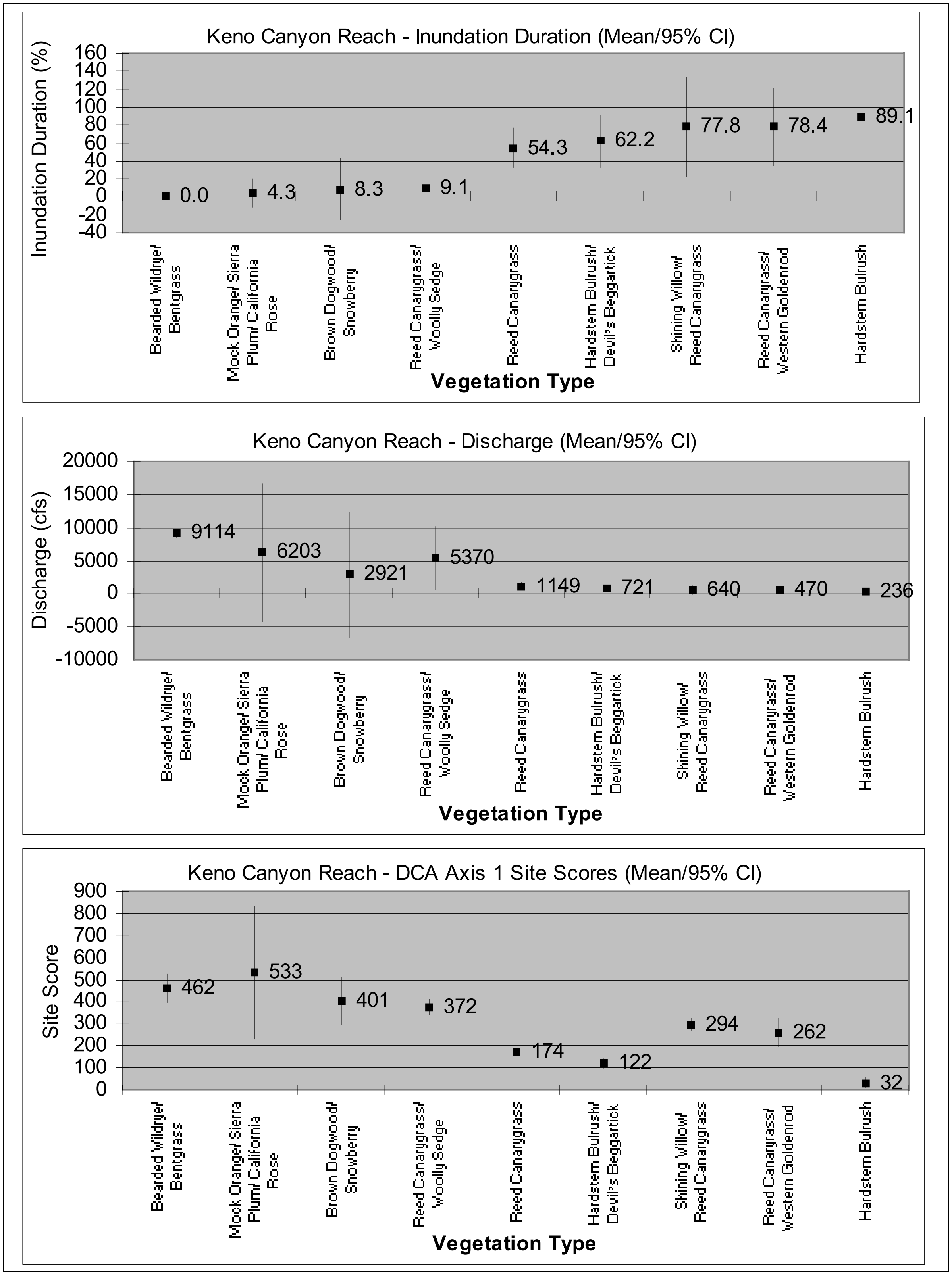


Figure 3.7-16. Mean and 95 percent confidence intervals (CI) for inundation duration, discharge, and detrended correspondence analysis (DCA) Axis 1 site scores for riparian vegetation types in the Keno Canyon reach.

The inundation frequency for the Keno reach plots were calculated using flow data collected at 1-hour time increments during the entire water year from 1997 to 2001. The inundation frequency calculations for sampled transects performed similarly to return interval in that large values associated with plots at higher elevations along the sampled transects correlate well with the presence of vegetation types such the Mock Orange/Sierra Plum/California Rose and Bearded Wildrye/Colonial Bentgrass. The small inundation frequency values for vegetation types at lower elevations along sampled transects exhibit little influence on DCA Axis 1 plot scores relative to the inundation frequency values of much greater magnitude for the Mock Orange/Sierra Plum/California Rose and Bearded Wildrye/Colonial Bentgrass vegetation types (Figure 3.7-17).

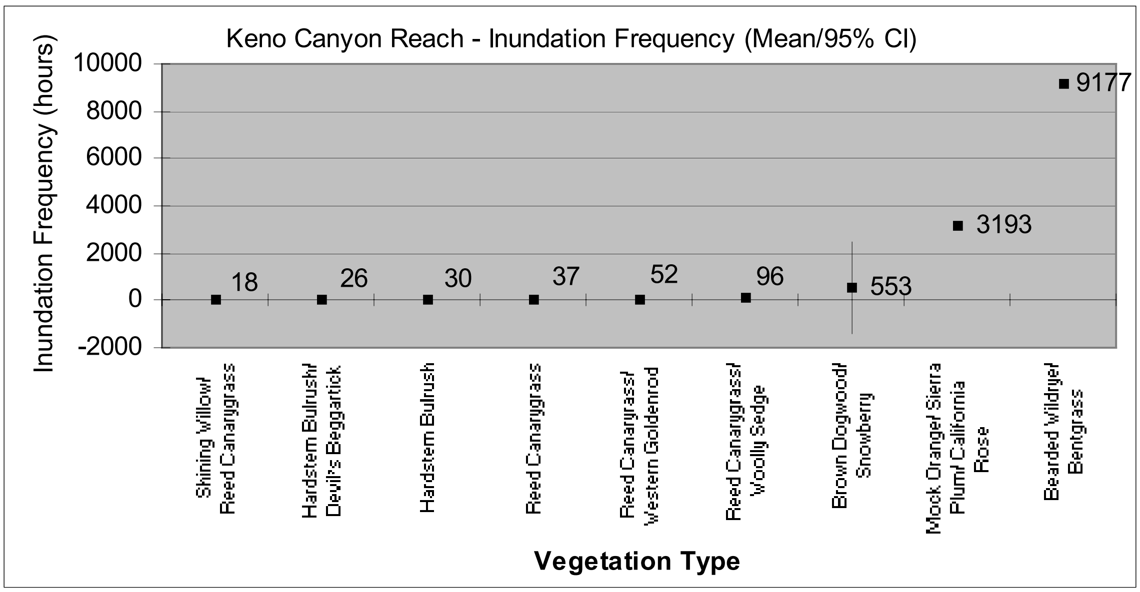


Figure 3.7-17. Mean and 95 percent confidence intervals (CI) for inundation frequency for riparian vegetation types in the Keno Canyon reach.

In Keno reach, there is generally a sharp demarcation between coarse substrates within the active channel and finer substrates on narrow terraces at the base of the canyon slopes. Keno reach vegetation types sort along the substrate bands, resulting in relatively high Pearson's r correlation coefficients for boulder cover, silt cover, and DCA Axis 1 site scores (Table 3.7-3).

The Keno reach has emergent vegetation and large boulders and bars within the channel that are almost always exposed during the growing season. It appears that the USBR Link River diversion dam, built in 1921 on Upper Klamath Lake, has influenced the flow regime in the Keno reach and possibly reduced base flows in the reach during the growing season (Figure 3.7-18).

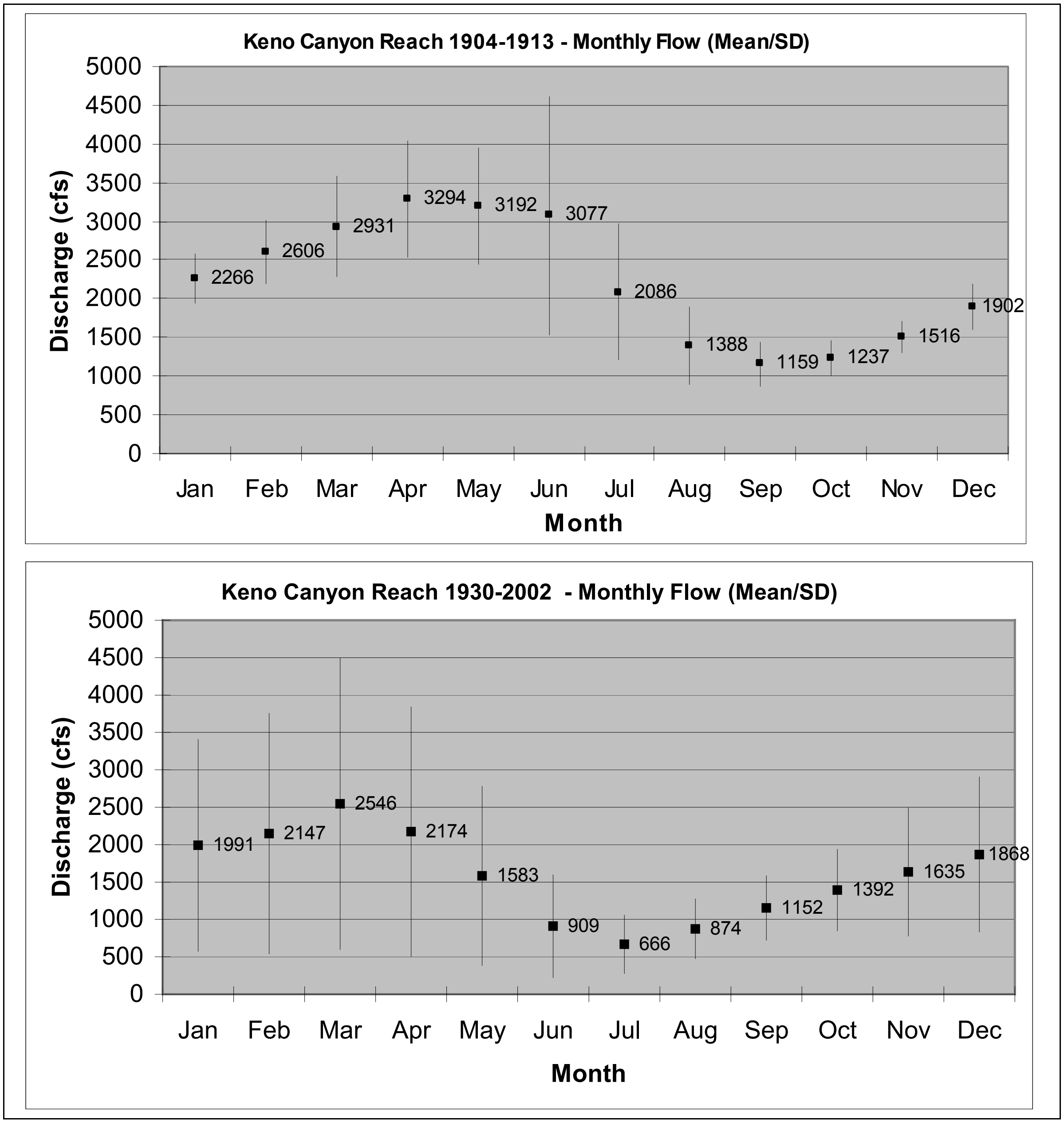


Figure 3.7-18. Mean monthly flows in the Keno Canyon reach before and after the construction of Link River dam in 1921.

Between 1904 and 1914, the mean monthly flows were generally higher throughout the year compared to the period after Link River dam was built (1930-2002). Before 1921, the mean monthly flows during spring runoff were highest in April and mean monthly summer low flow was lowest in September. This is substantially different from the period between 1930 and 2002 when mean monthly flow during the spring was highest in March and mean monthly summer low flow was lowest in July (Figure 3.7-18). Mean monthly flows before 1921 decreased more gradually between the spring (April) and the fall months (September), which may be a more favorable flow regime for woody riparian species establishment depending on, among other factors, the shape of the hydrograph in any given year. (See Tree Age section in Section 3.7.2.2 for discussion of tree ages in Keno Canyon). The mean yearly peak flows increased from 3,821 cfs (108 cms) to 5,066 cfs (143 cms) before and after 1921, respectively. However, the small sample size of the period of flow records (10 years) before 1921 may not include a representative number of dry to wet water years. Perhaps the most important change in flow regime between these two periods is the decrease in magnitude of mean monthly low summer flows from 1,159 cfs (33 cms) in September before 1921 to 666 cfs (19 cms) for flows in July after 1921. The general decrease in summer low flows increased the potential riparian habitat substrate during the growing season thereby promoting encroachment of primarily herbaceous riparian vegetation to lower positions within the channel.

Compared to the pre-1968 (1930 to 1967) flow regime, the Keno reach post-1968 (1968 to 2001) had larger mean monthly flows in the spring and smaller mean monthly flows in the late summer and fall (Figure 3.7-19). The lower mean monthly flows in the summer after 1968 decreased again compared to the pre-1921 flow regime. This would have resulted in even more available growing space for plants in the channel bottom and likely would facilitate further encroachment of riparian vegetation. However, aerial photography from 1960 and 1994 revealed no large-scale changes to riparian vegetation in the Keno reach (see Water Resource FTR, Section 6.7.6.2) The small-scale changes in vegetation lower in the channel would be difficult to detect given the resolution limitations of the aerial photographs.

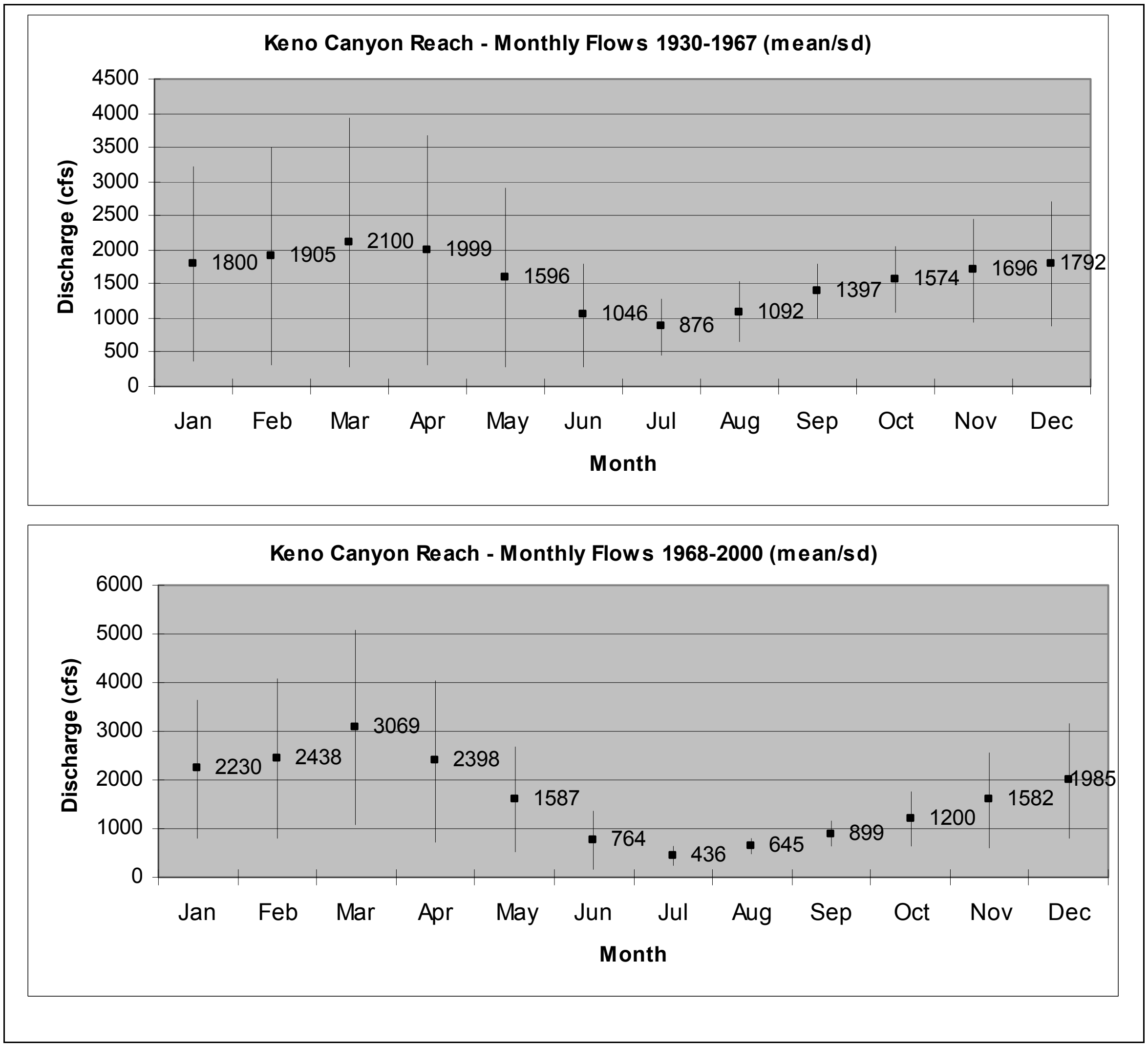


Figure 3.7-19. Mean monthly flows in the Keno Canyon reach before and after the construction of Keno dam in 1967.

The timing of the highest and lowest mean monthly flows in March and July, respectively, are the same for both periods, which means that on average the rate of drop in the river during the spring and early summer increased in the Keno reach following the construction of Keno dam. This may have created an unfavorable flow regime for the establishment of some woody riparian species. However, changes in mean monthly flows are, at best, an approximation of an appropriately shaped hydrograph for establishment of woody riparian vegetation and there are other factors that need to be considered (see Tree Age section in Section 3.7.2.2 for further discussion of tree ages). The construction of Keno dam and the management of the pool level to reregulate irrigation inflows appear to have permitted greater flow fluctuations in the Keno river reach that may have resulted in unfavorable conditions for the establishment of woody riparian species in this reach.

J.C. Boyle Bypass Reach

The riparian vegetation types in the J.C. Boyle bypass reach identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-20). The vegetation types are sorted by elevation to a large degree along DCA Axis 1. The distribution of vegetation types as represented by their average DCA Axis 1 plot scores along the first ordination axis indicate a direct, strong relationship with the means for inundation duration and discharge associated with the four J.C. Boyle reach riparian vegetation types (Figure 3.7-21). Discharge and inundation duration performed best as an explanatory variables for the distribution of DCA Axis 1 plot scores (Table 3.7-3). High inundation duration values for the Reed Canarygrass vegetation type that grows in the active channel and also extends upslope among the large boulders that line many parts of the reach. The Mock Orange vegetation type was most associated with steep slopes at elevations that require relatively large discharges for inundation.

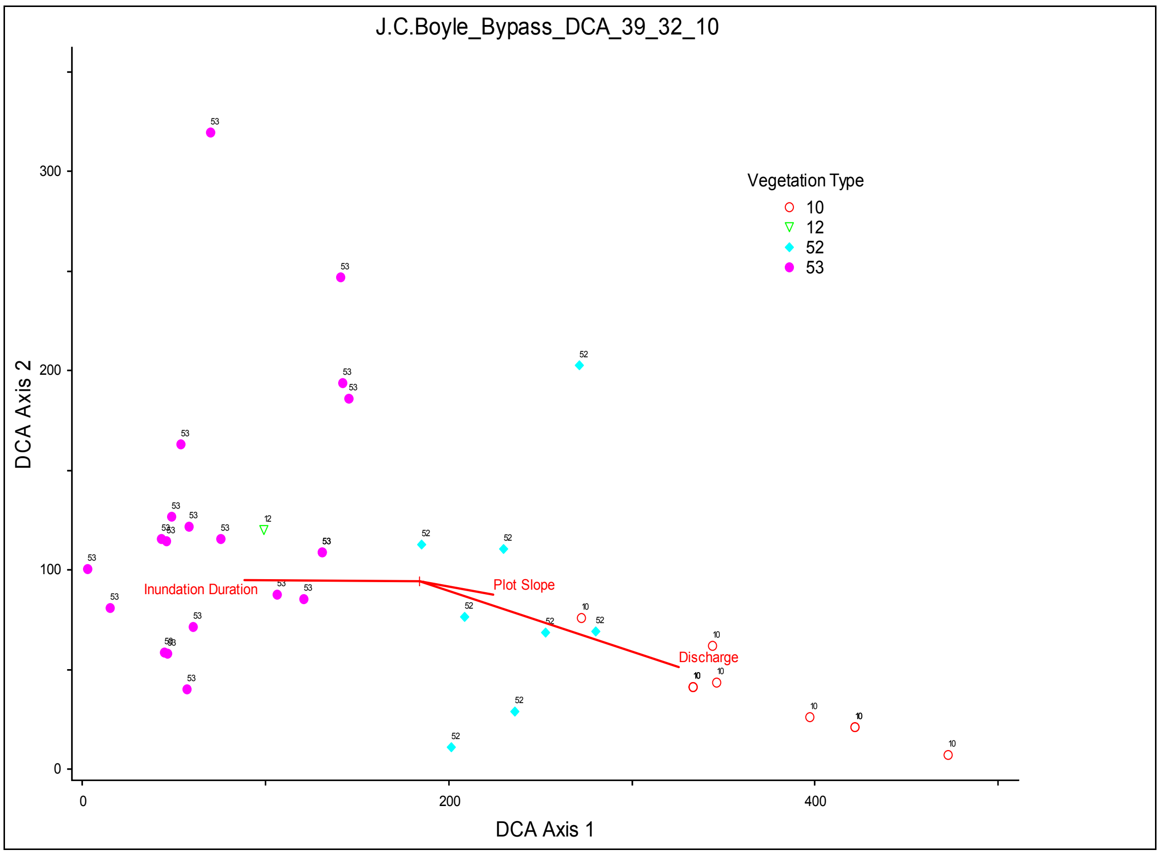


Figure 3.7-20. Detrended correspondence analysis (DCA) ordination for J.C. Boyle bypass reach plots. The length of the vector line for inundation duration, discharge, and plot slope indicate relative importance of variable in explaining variation in the species/abundance data.

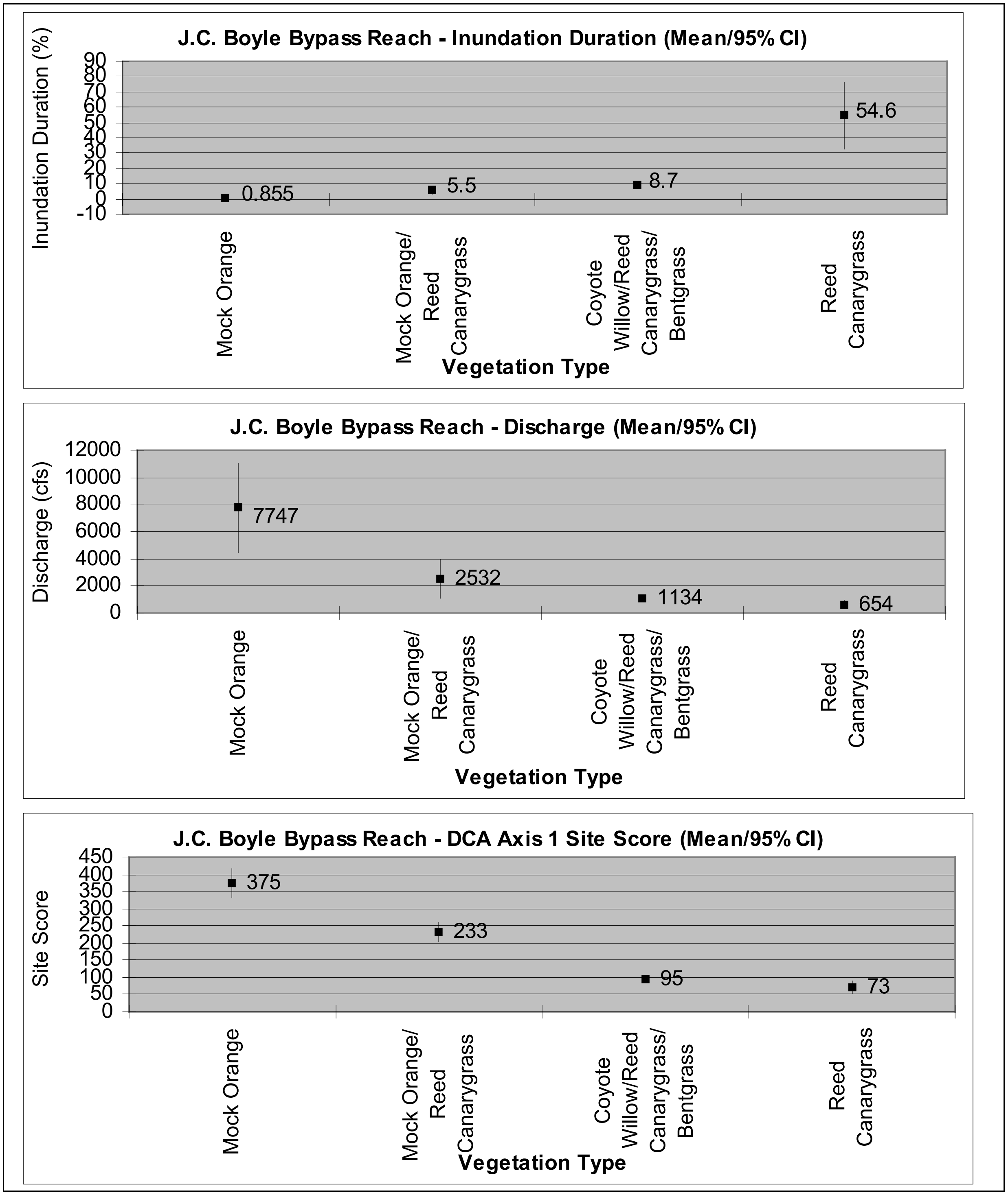


Figure 3.7-21. Mean and 95 percent confidence intervals (CI) for detrended correspondence analysis (DCA) Axis 1 site scores, discharge, and inundation duration for riparian vegetation types in the J.C. Boyle bypass reach.

The reduced flows in the J.C. Boyle bypass reach are clearly evident in the encroachment of primarily herbaceous vegetation types, particularly the Reed Canarygrass vegetation type. Reed canarygrass is distributed throughout the reach within the active channel, at higher elevation with mock orange and, in one plot, with coyote willow. Young willow was observed in several locations within the reach on the higher elevation portions of mid-channel islands. Also, because of the somewhat consistent water level, young clumps of sedge (*Carex* sp.) (possibly *Carex* cf. *nudata*, although no inflorescences and fruits could be found) appear to be reproducing in some backwater areas and on the edges of side channels with slower-moving water. Douglas' spiraea was observed growing on one of the larger terraces. This is at least some evidence that species other than reed canarygrass may be reproducing in the J.C. Boyle bypass reach. One hypothesis as to why some species reproduce here, but apparently not elsewhere in the study area, is that the periodic, relatively large (relative to current normal flow regime) releases from J.C. Boyle dam provide disturbance (scouring) to alluvial surfaces, which promotes vegetation turnover. The large releases are associated with spill flows during spring runoff and flows released into the reach when certain types of maintenance are being performed on the J.C. Boyle canal and powerhouse. However, many areas within the reach appear stable and support dense swards of reed canarygrass. A sustained increase in mean discharge into the bypass reach probably eventually would drown or scour some of the reed canarygrass swards in the reach.

J.C. Boyle Peaking Reach

The riparian vegetation types for the peaking reach identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-22). The distribution of vegetation types is presented by their average DCA Axis 1 plot scores along the first ordination axis (Figure 3.7-23). The mean and 95 percent confidence intervals for the inundation duration and discharge associated with the nine peaking reach riparian vegetation types also are provided in Figure 3.7-23 for comparison to the average DCA Axis 1 plot scores. The mean plot scores generally mimic the discharge/inundation duration gradient with the notable exception of two vegetation types: Oregon Oak/Himalayan Blackberry and Oregon Ash/Bentgrass/Woolly Sedge. These two vegetation types fall near the center of ordination Axis 1, where they appear to fit well adjacent to other vegetation types with some shared species (Figure 3.7-23). The Oregon Ash/Himalayan Blackberry vegetation type was sampled in the largest tree-dominated riparian stand in the peaking reach. This vegetation was growing on a large and relatively old river deposit that has a silt/sand substrate with accumulation areas high in organic material. The age of the large Oregon ash trees at this site may indicate a relationship between past flow events and tree establishment (see Tree Age section later in Section 3.7.2.2 for discussion of tree ages). At the lower elevation edge of these stands, the Oregon Ash/Bentgrass/Woolly Sedge vegetation type intergraded with willow-dominated stands along the river. One possible explanation as to why the site scores for these two vegetation types do not correspond well to discharge and inundation duration is that the stage-discharge may not model well at this particular cross-section profile.

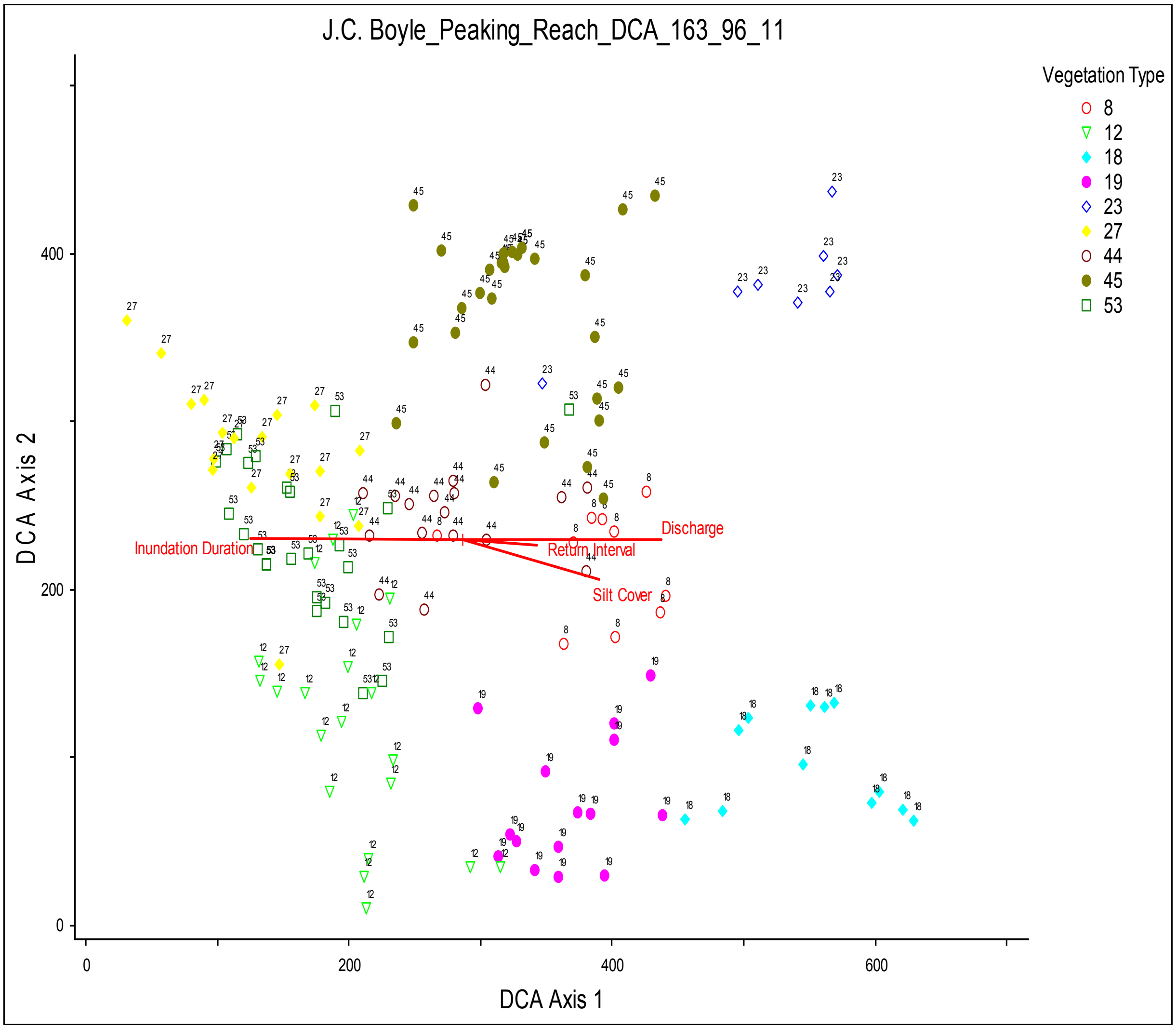


Figure 3.7-22. Detrended correspondence analysis (DCA) ordination for J.C. Boyle peaking reach plots. The length of the vector line for inundation duration, discharge, return interval, and silt cover indicate the relative importance of the variable in explaining variation in the species/abundance data. The ordination diagram was rotated 25 degrees to maximize the correlation of inundation duration with DCA Axis 1.

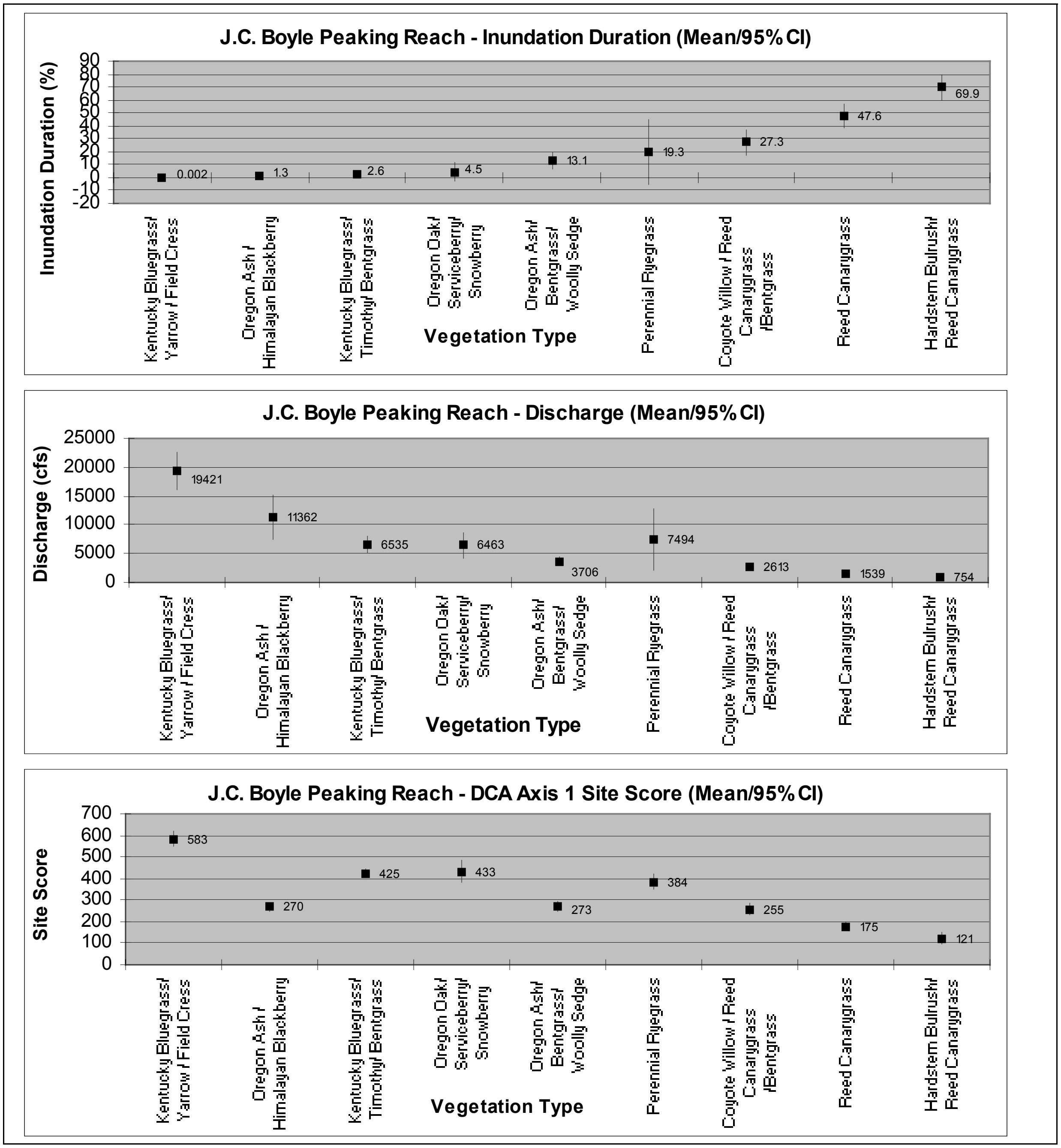


Figure 3.7-23. Mean and 95 percent confidence intervals (CI) for detrended correspondence analysis (DCA) Axis 1 site scores, discharge, and inundation duration for riparian vegetation types in the J.C. Boyle peaking reach.

The Kentucky Bluegrass/Yarrow/Field Cress vegetation type was sampled on a relatively “high and dry” terrace along the peaking reach. The sampled terrace has an average return interval of approximately 160 years (average 19,421 cfs [550 cms]). This vegetation type may be representative of the type of vegetation that would invade portions of the much larger terraces currently used for growing hay and raising cattle. It was not clear why there was no evidence of the sampled terrace being invaded by Oregon oak, ponderosa pine, juniper, or some of the other species with upland affinities that grow at similar elevations near the river in other parts of the peaking reach.

The 1965 aerial photography revealed some scouring at the lowest edge of one of these larger terraces (RM 206) near Shovel Creek that likely resulted from the 1964 high water. The 1964 flood was the largest ever recorded at the USGS gauge at Bogus Creek downstream of Iron Gate dam, and runoff from streams on the west side of the Cascade Range were greater than on the east side of the Cascade Range. In the peaking reach, the 1964 flood (8,830 cfs [250 cms]) was not exceptional, which may indicate that diversions in the upper part of the basin attenuate large flood events. Peak flood flows in the peaking reach have been higher than the 1964 flood flow in 12 years since 1959, ranging from 8,500 to 11,600 cfs (241 to 328 cms). The calculated 100- and 500-year return interval in the peaking reach was 20,100 and 26,350 cfs (570 to 746 cms), respectively. Some of the sampled plots had calculated return intervals of more than 500 years and the elevations of these plots would not have completely covered most of the larger terraces along the peaking reach, although flows this large likely would cause substantial disturbance in the active channel and possibly even to some portion of the larger alluvial terraces. A 100- or 500-year flood may be required to significantly alter some of larger alluvial terraces in the peaking reach. Project hydrologists have hypothesized that the large terraces in the peaking reach might be considered relicts from a different flow regime of much greater magnitude in the past, perhaps during the Pleistocene.

The Oregon Oak/ Serviceberry/Snowberry and Kentucky Bluegrass/Timothy/ Bentgrass vegetation types also occupy terrace habitats like the Kentucky Bluegrass/Yarrow/Field Cress vegetation type, but were sampled at lower elevations closer to the river. The Oregon Oak/Serviceberry/Snowberry vegetation type was not restricted to terraces and was observed in mesic forested sites in clearly upland habitats. Hence, it was a little surprising that this vegetation type was sampled at elevations with an average return interval of 3.6 years and an average inundation duration of 4.5 percent (6,463 cfs [183 cms]) (Figure 3.7-23). It seems likely that vegetation this close to the river would have the potential to be scoured by large flows. The magnitude of peak flows since 1959 was insufficient to overcome many of the larger geological constraints of the peaking reach, although historical aerial photography indicates that smaller scale in-channel and side channel modifications to the river bars and islands have occurred in the peaking reach since 1959 (see Water Resources FTR, Section 6.7.6). Project geomorphologists noted local changes in riparian vegetation primarily associated with alluvial features. These types of disturbances occur at lower elevations relative to the occurrence of the Oregon Oak/Serviceberry/Snowberry vegetation type and the other vegetation types growing on terraces. Without periodic disturbance from river flows, the vegetation on terraces is likely to move toward a more upland, longer-lived species assemblage in close proximity to the river.

The Kentucky Bluegrass/Timothy/Bentgrass vegetation type had average values of 6,535 cfs [185 cms] discharge, 4.2-year return interval, and 2.6 percent inundation duration, which are similar to the Oregon Oak/Serviceberry/Snowberry vegetation type (Figure 3.7-23). The substrate particle cover for this vegetation type was much finer (silty) than the coarser, small boulder substrates recorded at some of the sampled Oregon Oak/Serviceberry/Snowberry plots. The finer textured substrates and herbaceous species component for the Kentucky Bluegrass/ Timothy/Bentgrass vegetation type may represent a younger surface more recently deposited or disturbed than sites supporting the Oregon Oak/Serviceberry/Snowberry vegetation type. The average peak flood flow since 1959 was 6,211 cfs (176 cms), which is close to the inundation discharge for this vegetation type, but no sign of recent disturbance from high flows was evident on the sampled terraces. Barring additional disturbance, it may be only a matter of time before upland species, such as Oregon oak, western serviceberry, and snowberry, invade the Bluegrass/Timothy/Bentgrass vegetation type. Unfortunately, there is no way to link terrace-forming events or the disturbance history of these terraces to specific flow events based on historic aerial photography and flow records.

The Perennial Ryegrass vegetation type is the most variable with respect to ranges of discharge and inundation duration (Figure 3.7-23). The Perennial Ryegrass vegetation type is representative of many of the irrigated pastures that abut the river and supports a mixture of commonly planted pasture grass species. These introduced grass species extended to the water's edge (within the varial zone: 350 to 3,000 cfs [9.9 to 85 cms]) where they grew next to plant species with stronger hydrophilic affinities, particularly in areas where the riparian vegetation had been trampled by cattle. Data collection along transects that bisected pastures typically did not include the entire width of the terrace or pasture. Hence, the upper portions of the elevation gradient that crossed the pastures/terraces were not captured in the data. However, the pastures tended to be rather homogenous in their species composition as a result of irrigation and cultivation. The discharge required to inundate the portion of sampled pastures ranged from about 2,500 to 12,000 cfs (71 to 340 cms). This range of discharges overlaps the range of flows that provide habitats for all other peaking reach vegetation types excluding the Reed Canarygrass and Hardstem Bulrush/Reed Canarygrass vegetation types. The Perennial Ryegrass vegetation type likely displaces other vegetation types in the J.C. Boyle peaking reach.

Respectively, 65, 90, and 100 percent of plots representing the Coyote Willow/Reed Canarygrass/Bentgrass, Reed Canarygrass, and Hardstem Bulrush/Reed Canarygrass vegetation types occurred within or below the "varial zone" or elevation range associated with peaking flow fluctuations from 350 to 3,000 cfs (9.9 to 85 cms) (Figure 3.7-23). For the remaining peaking reach vegetation types, 65 to 100 percent of the plots representing these vegetation types occurred above the varial zone. The plots representing the Coyote Willow/Reed Canarygrass/ Bentgrass, Perennial Ryegrass, and Oregon Ash/Colonial Bentgrass/Woolly Sedge vegetation types were the most equitably distributed vegetation types across the upper boundary of the varial zone. The average inundation frequency values for vegetation types within the varial zone are compared to the average return interval for vegetation types that lie above the varial zone (Figure 3.7-24). The average inundation frequency of plots in the varial zone ranged from 12 to 17 hours. The frequent inundation of plots in the varial zone recharges the soil moisture each day thereby increasing the inundation duration for those plots compared to a more natural flow regime. The frequent inundation also may result in more anoxic conditions than is indicated by calculations of average inundation duration for vegetation types within the varial zone, which ranged from 27 to 70 percent. This is because the frequent inundation keeps the soils saturated even when the plots are not actually inundated. The frequent inundation also increases scour for those plots in the lower part of the varial zone plants and restricts plants to more protected locations among large rocks. At flows above the varial zone, the inundation frequency was not considered to be the best variable to describe the potential relationship between periodic inundation and vegetation patterns. Instead, return intervals based on annual peak flood series data were used to describe this relationship (see Terrestrial Resources FTR, Appendix 3A, for discussion of inundation return interval). Return interval has been reported to be important with respect to the riparian vegetation maintenance flows (Hill et al. 1991; Chapin et al. 2002). (See Reed Canarygrass and Coyote Willow sections later in Section 3.7.2.2 for additional discussion of riparian vegetation maintenance flows and relationships between river hydrology and vegetation patterns in the peaking reach.)

The Hardstem Bulrush/Reed Canarygrass vegetation type was the only peaking reach vegetation that grew at elevations lower than the 350 cfs (9.9 cms) flow. The vegetation types that have coyote willow and reed canarygrass are discussed in more detail below.

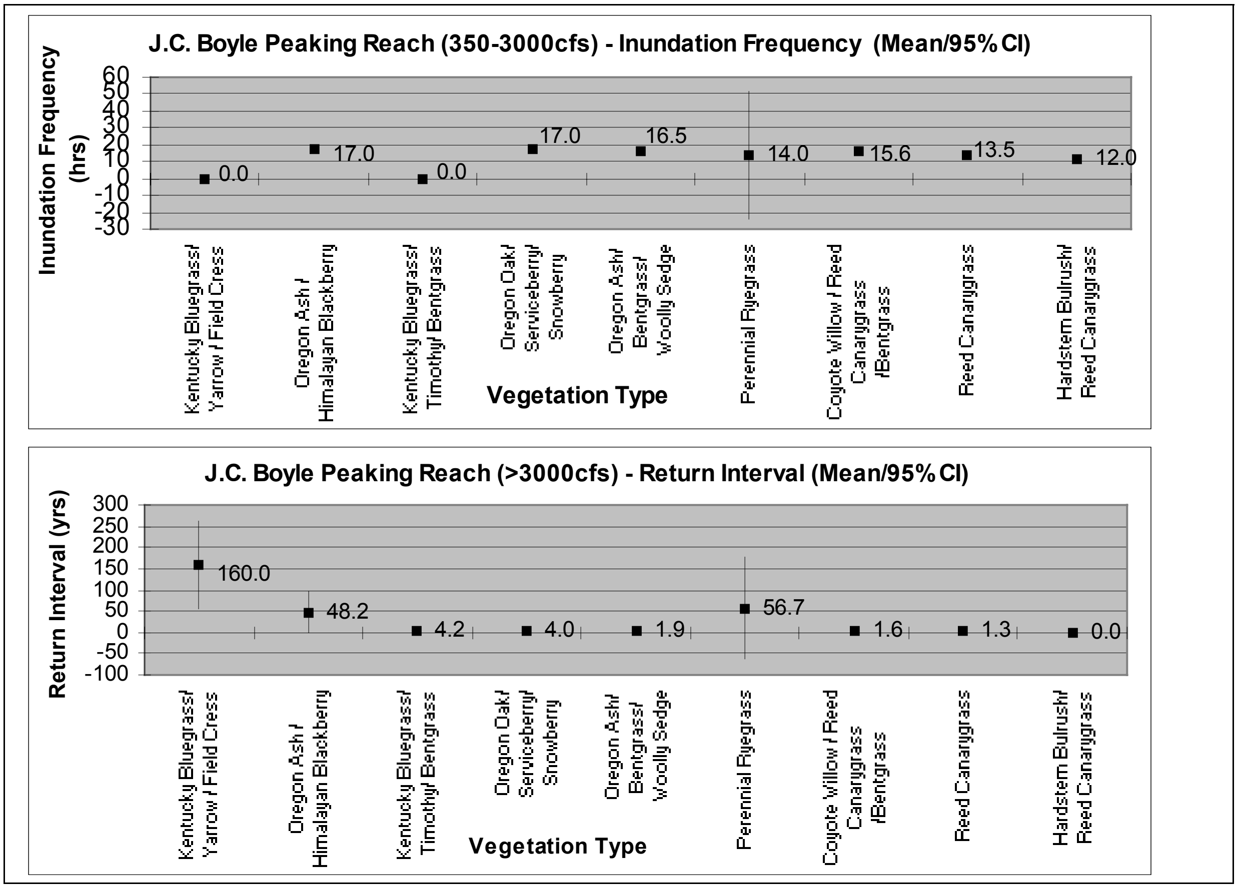


Figure 3.7-24. The average inundation frequency values for riparian vegetation types within the varial zone (350 to 3,000 cfs) are compared to the average return interval for vegetation types that fall outside the varial zone (more than 3,000 cfs).

Fall Creek

The riparian vegetation types in the Fall Creek reach identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-25).

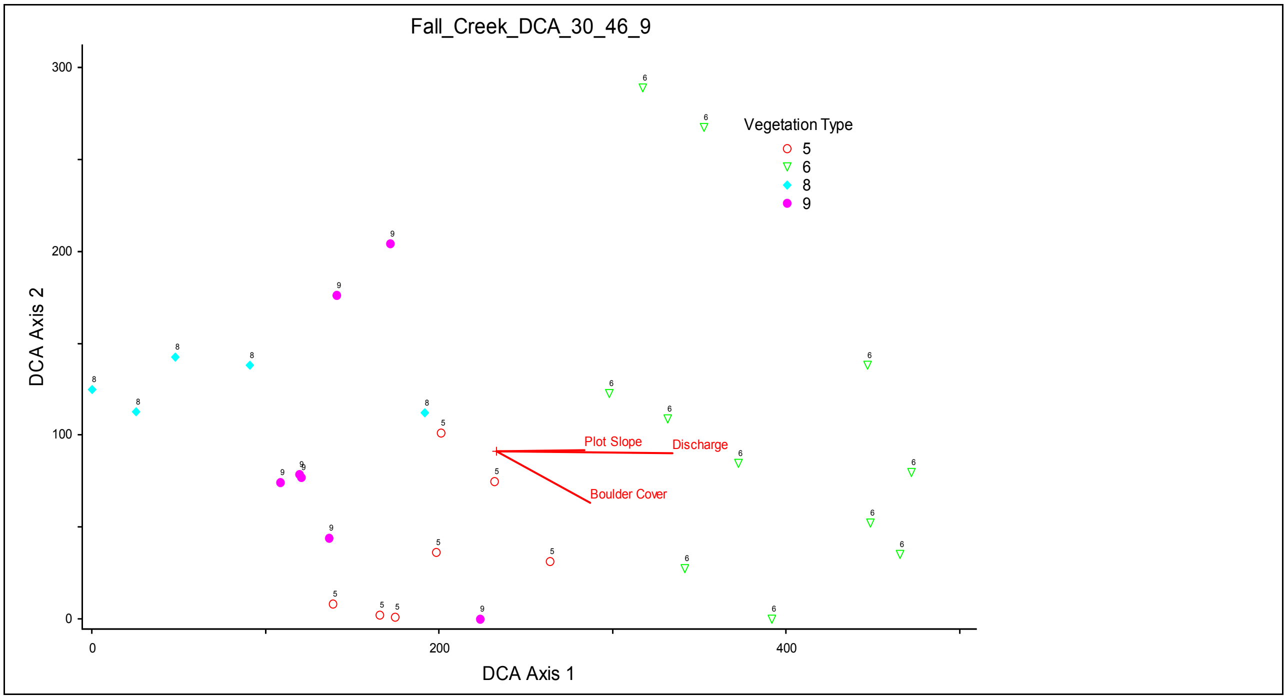


Figure 3.7-25. Detrended correspondence analysis (DCA) ordination for Fall Creek reach plots. The length of the vector line for discharge, plot slope, and boulder cover indicate the relative importance of a variable in explaining variation in the species/abundance data.

The distribution of vegetation types, as represented by their average DCA Axis 1 plot scores along the first ordination axis, indicate a poor relationship with the mean for discharge associated with the four Fall Creek riparian vegetation types (Figure 3.7-26). Discharge performed best as an explanatory variable for the distribution of DCA Axis 1 plot scores (Table 3.7-3), but the high discharge associated with the Ponderosa Pine/Douglas-fir/Western Serviceberry vegetation type dominates the correlation analysis. The seepage from the Fall Creek canal helps support the growth of species with affinities to both wetland and upland habitats growing in close proximity to one another. In some locations, the large conifer trees growing in close proximity to Fall Creek probably established soon after Fall Creek was dammed and diverted in 1903. Similarly, woody riparian deciduous species, such as western birch and Douglas' spiraea, probably also increased their distribution after 1903 in response to seepage from Fall Creek canal.

Seepage from the Fall Creek canal intersects to varying degrees all of the sampled transects along the left bank of Fall Creek. Therefore, the importance of discharge is exaggerated because the vegetation at higher elevations was, at many locations, supported by canal seepage. However, unlike Link River, the riparian vegetation types at the higher elevations have a distinct upland plant species component. For instance, the Ponderosa Pine/Douglas-fir/Western Serviceberry vegetation type clearly has upland affinities and is found in mesic habitats well away from Fall Creek in many locations in the Project area. In most locations along the bypassed portion of Fall Creek, the large conifer trees growing in close proximity to the creek probably established soon after the Fall Creek diversion was constructed in 1903. Similarly, woody riparian deciduous species, such as western birch and Douglas' spiraea, probably also increased their distribution after 1903 in response to seepage from Fall Creek canal.

The White Alder, Oregon Ash/Western Birch, and Oregon Oak/Spiraea vegetation types do not show any correlation with discharge, as is illustrated in Figure 3.7-26. This likely was the result of seepage affecting the growth of wetland/riparian plant species at the sampled Fall Creek transects. Along the portion of Fall Creek that parallels the Fall Creek canal, there are some areas that supported woody and herbaceous riparian vegetation that received no discernable seepage from the Fall Creek canal. In these areas, the flow regime in Fall Creek probably plays a stronger role in controlling riparian vegetation pattern. These areas exhibited a flatter cross-section profile that was similar to the sampled left bank transects that received canal seepage. Along most of Fall Creek that parallels the canal, dense cover of woody species limits the growth of herbaceous vegetation. Small patches of dense growing sedges, rushes, and grasses along the creek bank primarily were restricted to areas that receive more light. Open, seep-fed areas away from the creek support lush sedge-dominated vegetation in many areas on and below the canal bank.

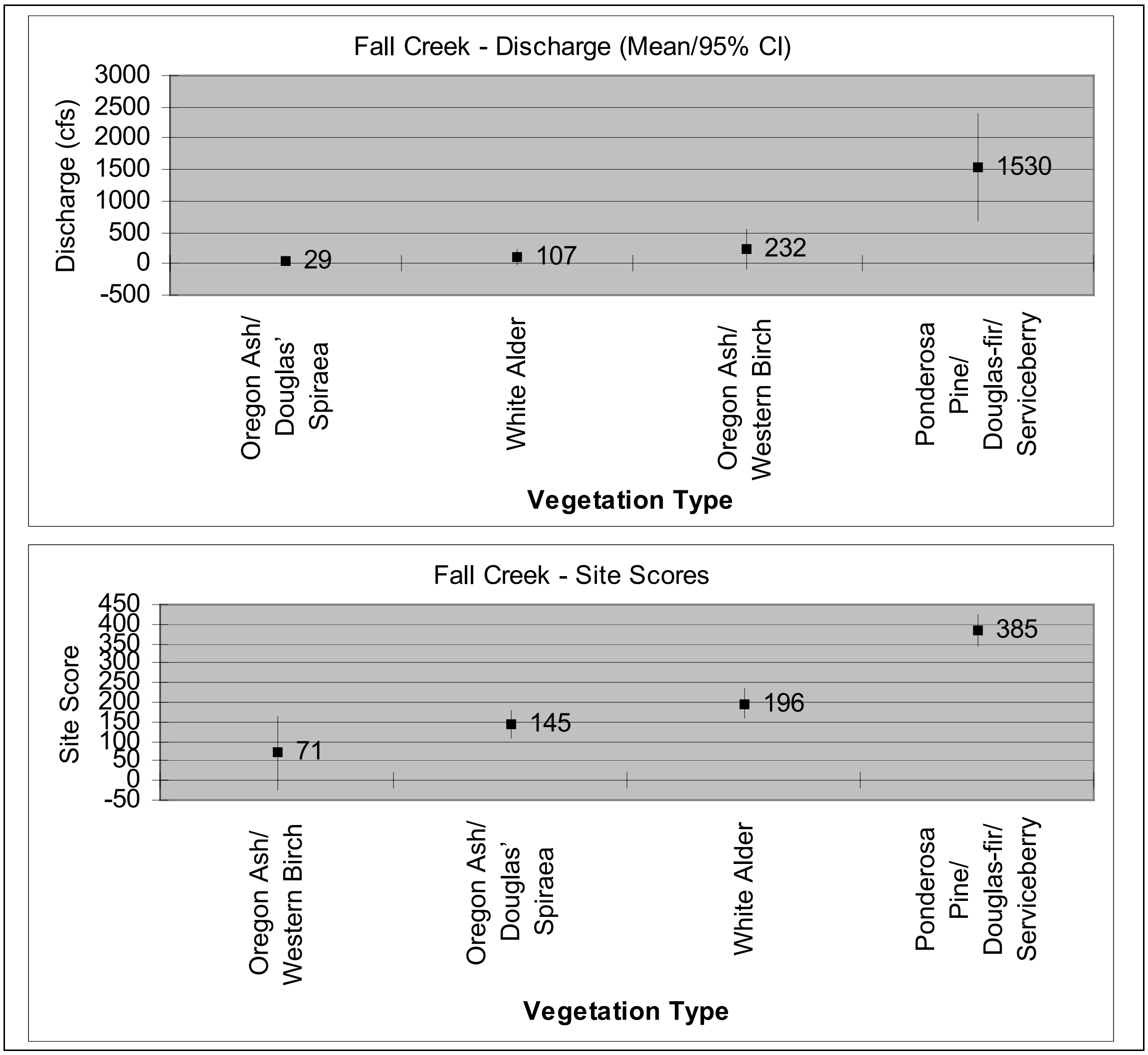


Figure 3.7-26. Mean and 95 percent confidence intervals (CI) for detrended correspondence analysis (DCA) Axis 1 site scores and discharge for riparian vegetation types in the Fall Creek reach.

Inundation duration and return interval were not calculated for the Fall Creek plots because the period of record (Table 3.4-1; 1933-1959) was not representative of flows in the bypassed portion of Fall Creek; the USGS gauge was located downstream of the powerhouse. The history of upstream diversions at Spring Creek, which is a tributary of Jenny Creek, as well as other agricultural water diversions on Fall Creek make estimating the flows in the bypassed portion of Fall Creek impossible with the available data.

In many locations where Fall Creek parallels the canal, it is difficult to determine by looking at the riparian/wetland vegetation along Fall Creek exactly where the influence of river hydrology and seepage hydrology begins and ends. However, in downstream portions of Fall Creek where the creek is not influenced by canal seepage, the gradient of the creek steepens and the riparian vegetation becomes narrow, but was generally continuous and well-developed along the streambanks. The creek is also more exposed, which is conducive to the growth of herbaceous riparian/wetland plants species growing in small patches of in-channel alluvium. Most in-channel alluvium likely would have been under water during 1933-1959. The current growth of herbaceous plants on in-channel alluvium is probably indicative of encroachment. However, the small size of Fall Creek probably would have permitted in-channel growth of some herbaceous vegetation at least in protected locations even under a larger flow regime (1933-1959). The relatively long history of upstream diversion (Spring Creek and Fall Creek canal) and the short period of flow record make it difficult to assess how the Fall Creek riparian vegetation has been affected by the Project.

Copco No. 2 Bypass

The riparian vegetation types in the Copco No. 2 bypass reach identified using TWINSPAN are presented as an overlay on the first two DCA ordination axes (Figure 3.7-27). The Copco No. 2 bypass vegetation types are ported by elevation despite the fact that seepage from the adjacent flowline intercepts the left bank in many places and creates many wetland habitats in the former river channel. The encroachment of vegetation into the channel is obvious, with numerous mature alder occupying what was formerly in-channel islands and bars. The 10 cfs (0.28 cms) base flow in Copco No. 2 bypass is held constant except during large spills typically associated with spring runoff or, on rare occasions, Project maintenance activities. White alder is a colonizing species that requires continuously moist substrates. Analysis of tree ages indicates that there is apparently an age gap in the white alder population at Copco No. 2 bypass. There are mature trees that range in age from 32 to 62 years based on tree age measurements and there are young saplings up to approximately 5 feet (1.5 m) in height, but there are few trees in between. The 32-year-old tree was the youngest tree that was sampled and was among the smallest trees encountered. There were no particularly large peak flows in the early 1970s compared to other years in the period of record that might have eroded the small tree age class. Periodic spill flows may have been enough to have killed intermediate-sized trees, but that seems unlikely. The white alder forest that established within the channel after Copco No. 2 dam was built may have become too dense by the 1970s to support white alder reproduction. There was evidence that some older white alder trees had died, which may have opened the canopy enough to permit the establishment and growth of the white alder saplings that can be seen today. Currently, there is no obvious explanation for why young white alder trees are not present in the portion of Copco No. 2 bypass that was sampled.

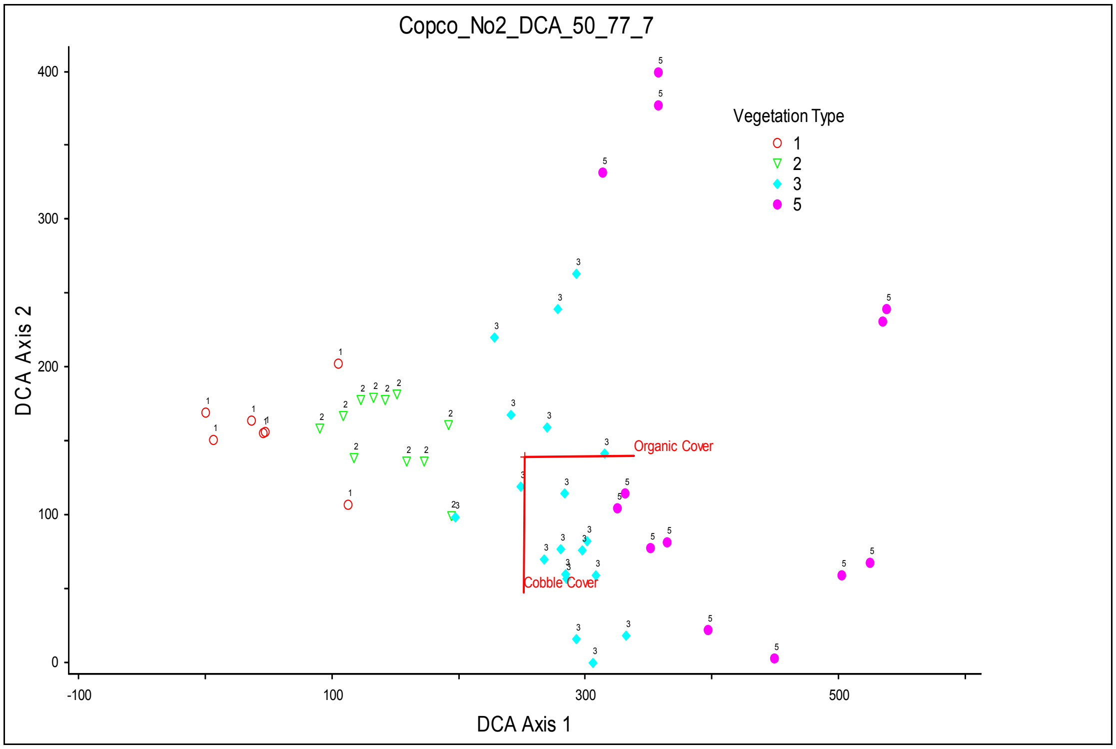


Figure 3.7-27. Detrended correspondence analysis (DCA) ordination for Copco No. 2 bypass plots. The length of the vector line for organic cover and cobble cover indicate the relative importance of a variable in explaining variation in the species/abundance data.

An increase in base flow in this reach probably would not kill the larger white alder in the reach. However, increased scour likely would kill some of the young saplings, depending on the magnitude of the increase in base flow.

The DCA analysis did not include values for inundation duration, return interval, or discharge because of the inability to gather stage-discharge data in time for this FTR.

Iron Gate Dam to Shasta River

The riparian vegetation types for the Iron Gate reach identified using TWINSPAN are presented as an overlay on top of the first two DCA ordination axes (Figure 3.7-28). The distribution of vegetation types is presented by the average plot scores along DCA Axis 1 (Figure 3.7-29). The mean and 95 percent confidence intervals for the inundation duration and discharge associated with the 12 Iron Gate reach riparian vegetation types also are provided in Figure 3.7-18 for comparison to the average DCA Axis 1 site scores.

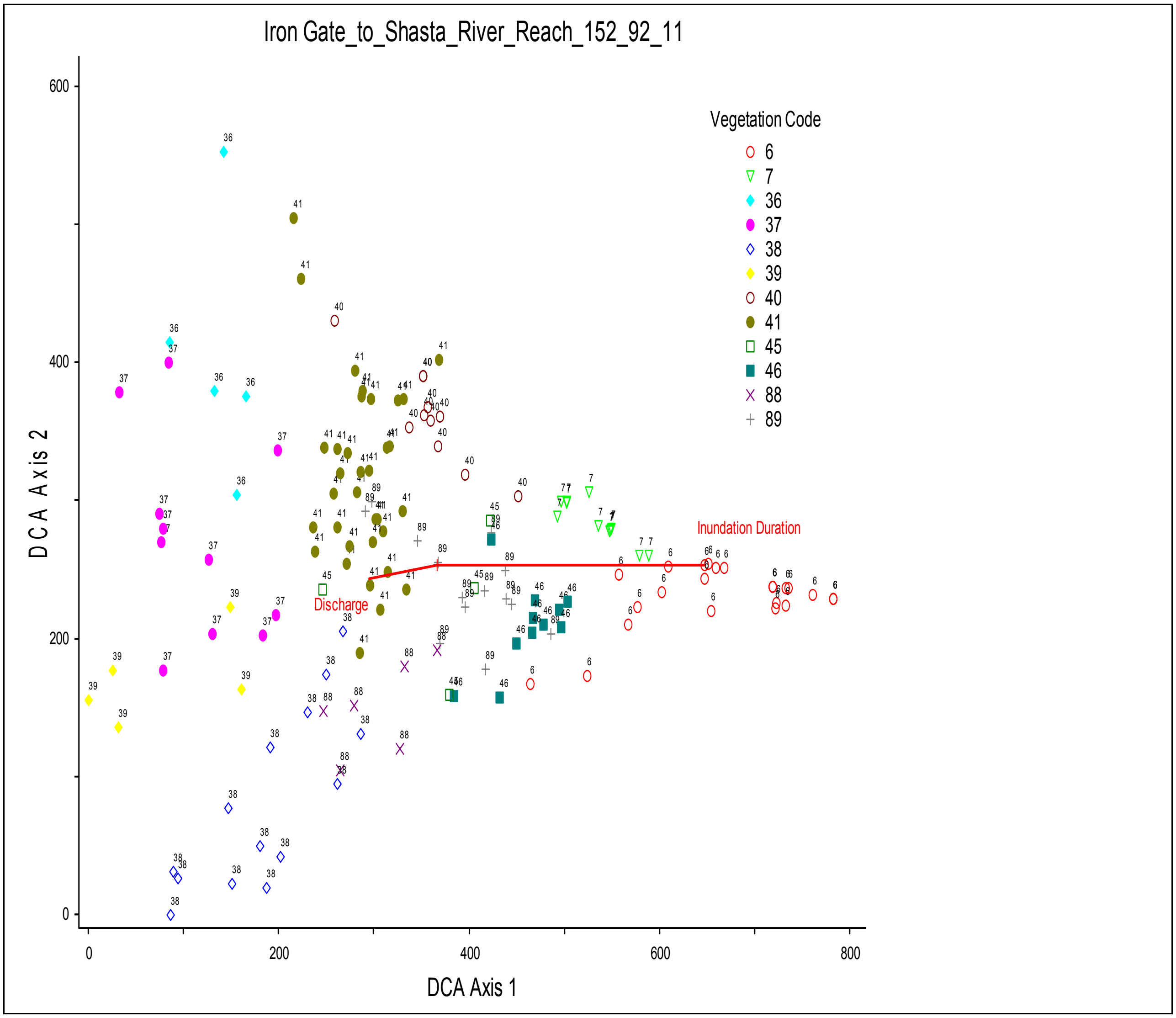


Figure 3.7-28. Detrended correspondence analysis (DCA) ordination for Iron Gate reach plots. The length of the vector line for inundation duration and discharge indicate the relative importance of the variable in explaining variation in the species/abundance data.

The mean site scores for DCA Axis 1 and inundation duration had a high Pearson's r of 0.8 (Table 3.7-3), which indicates the Iron Gate reach vegetation types, by virtue of their strong separation along DCA Axis 1, had a strong correlation with inundation duration. The site scores for vegetation types at the lower elevation end of the inundation duration gradient offer a particularly good reflection of inundation duration (Figure 3.7-29). The inundation duration values for plots positioned lower in the elevation gradient are much more sensitive to small changes in discharge. The inundation duration for plots at higher positions along the elevation gradient were less sensitive to changes in discharge because above a certain elevation, the inundation duration becomes so close to zero that there were only small changes in inundation duration values even with large changes in elevation and discharge.

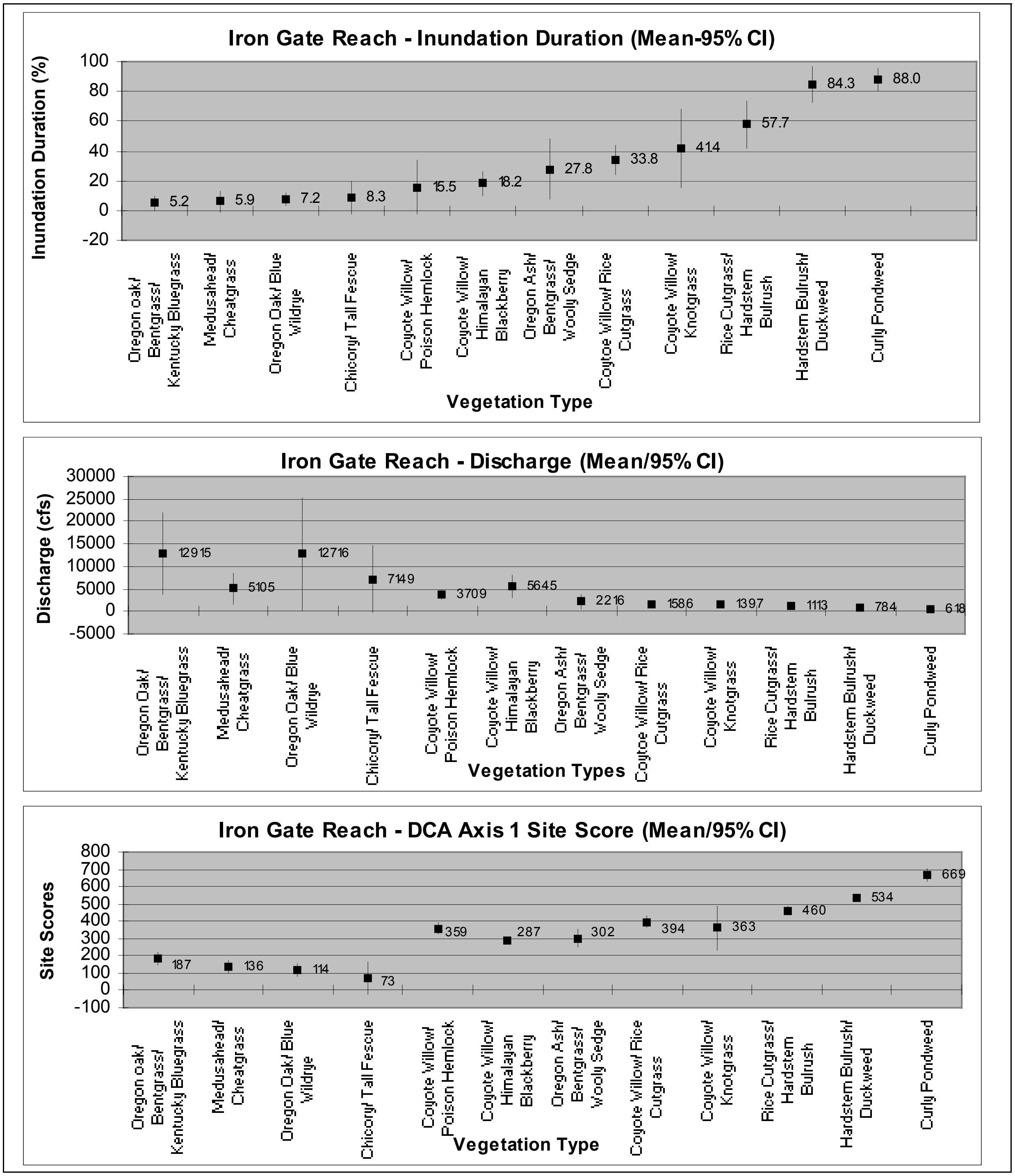


Figure 3.7-29. Mean and 95 percent confidence intervals (CI) for detrended correspondence analysis (DCA) Axis 1 site scores, discharge, and inundation duration for riparian vegetation types in the Iron Gate dam to Shasta River reach.

At the higher end of the elevation gradient, the Oregon Oak/Bentgrass/Kentucky Bluegrass, Medusahead/Cheatgrass, Oregon Oak/Blue Wildrye, and Chicory/Tall Fescue vegetation types were somewhat incongruent with respect to their average sites scores and average inundation duration values. These four vegetation types exhibited a substantial amount of variation in their respective inundation discharge values. The 95 percent confidence intervals for their inundation discharges also overlapped one another to a high degree (Figure 3.7-29). There are various reasons why the upper end of the sampled elevation gradient was so variable with respect to the calculated inundation discharge. Some of the reasons have to do with sampling methods and others relate to limitations of modeling stage-discharge relationships at higher elevations along sampled cross-section profiles. However, the crux of the issue pertaining to factors that influence riparian vegetation at higher elevations along the profile is related to return interval or the periodicity of flows that disgorge or scour substrates, replenish water tables, and supply flushes of nutrients at these elevations.

The magnitude of yearly peak flood flows is also potentially a critical influence on riparian vegetation outside the influence of anoxic conditions closer to the river. For example, during a 100-year period, ten annual peak flood events might inundate a site, but only one of them might be of sufficient magnitude to have any net effect on the site and the riparian vegetation that grows there. One important ramification of this is that any direct relationships between return interval and vegetation pattern should be carefully interpreted.

In the Iron Gate reach, DCA of the Kendall's tau correlation coefficient was 0.62 for both discharge and return interval relative to the DCA Axis 1 site scores. Kendall's tau coefficient is more sensitive than Pearson's r coefficients to outlier or relatively high values for a variable such as discharge and return interval. This moderately high correlation coefficient only suggests that it requires a large discharge to inundate the higher elevation sites along the inundation gradient, but does not indicate the magnitude of flow required to affect a site and the riparian vegetation. The return interval is only a crude estimate of how often sites at higher elevation received flows that actually disturb or prepare the sites for invasion of a new assemblage of species that may have affinities to riparian vegetation types found at lower positions along the elevation gradient. There is some indication in Figure 3.7-29 (based on overlapping confidence intervals for discharge and inundation duration) that some of the Coyote Willow/Himalayan Blackberry, Coyote Willow/Poison Hemlock, and Oregon Ash/Bentgrass/Woolly Sedge vegetation types might invade disturbed sites at the lower end of the portion of the gradient that currently supports the Oregon Oak/Bentgrass/Kentucky Bluegrass, Medusahead/Cheatgrass, Oregon Oak/Blue Wildrye, and Chicory/Tall Fescue vegetation types.

The average return intervals for the Oregon Oak/Bentgrass/Kentucky Bluegrass, Medusahead/ Cheatgrass, Oregon Oak/Blue Wildrye, and Chicory/Tall Fescue vegetation types are 4.4, 1.9, 3.4, and 3.7 years, respectively. The 95 percent confidence limits for return interval and discharge overlap considerably for these four vegetation types, which may indicate that these vegetation types are interchangeable above some elevation. This elevation is inundated by a flow of 5,300 cfs (150 cms), which is the lower 95 percent confidence limit for discharges averaged across the four vegetation types. Above this elevation, the presence of any of the four vegetation types is likely to be influenced as much or more by adjacent land use than by flows that potentially inundated this portion of the elevation gradient. It is likely that a flow far greater than the average return interval flows is required to modify the stream channel and create conditions suitable for invasion by a different or similar assemblage of species above 5,300 cfs (150 cms).

At elevations that are inundated by less than 5,300 cfs (150 cms)**,** the Oregon Oak/Bentgrass/ Kentucky Bluegrass, Medusahead/Cheatgrass, Oregon Oak/Blue Wildrye, and Chicory/Tall Fescue vegetation types may become more interchangeable or replaced with some of the other eight Iron Gate reach vegetation types, provided the right conditions are created within the scope of the current flow regime or even some prescribed management guidelines. It is difficult to determine what type of flow would be required to create amenable conditions for some preferred vegetation type.

There is evidence from historical aerial photographs that channel modifying flows occurred in the Iron Gate reach during the 1964 flood, which peaked at 29,400 cfs (833 cms) and has a calculated return interval of 30 years. The 1965 aerial photos show many locations along the Iron Gate reach with fresh surfaces resulting from the 1964 flood. Upstream of the I-5 rest area, one of the riparian sites sampled in 2002 appeared to have started forming or widening in 1965 aerial photography. By 1979, the sampled willow bar had grown to near its current size. Also by 1979, the width of another sampled willow bar downstream several hundred feet also had increased in width to near its current width. The formation of these bars may be jointly associated with the I-5 improvements and the 1964 flood, which appears to have at least initiated bar formation. The construction of the I-5 bridge also forced the river into a new left bank channel, forming an island immediately downstream of the bridge.

Project geomorphologists identified several other areas in the Iron Gate reach with minor changes to alluvial bedform and where riparian vegetation has increased in abundance just downstream of Iron Gate dam and near the railroad bridge and the Klamathon bridge between 1955 and 2001 (see Water Resources FTR, Section 6.0, Figures 6.7-33, 6.7-34, 6.7-35, and, 6.7-36). The 1964 flood (29,400 cfs [834 cms]) does not appear to have modified higher positions along the streambank based on 1965 aerial photography.

During the period of time that has aerial photography available, there have been relatively minor changes in the distribution of riparian vegetation in most portions of the Iron Gate reach. In part, the vegetation patterns are similar over time because the same land uses have been occurring since before the earliest aerial photography. The most evident vegetation changes are related to adjacent land use activities including construction of Iron Gate dam, construction of the Bogus Creek fish hatchery, modifications to the I-5 corridor, and construction of recreation facilities along the river. These activities for the most part were fairly site-specific. More widespread land use activities affecting the continuity and quality of the riparian vegetation in the Iron Gate reach include cattle grazing, agriculture, and recreation trails used primarily by fisherman.

Management activities designed to increase the distribution and improve the health and continuity of riparian vegetation may be needed to improve the fisheries and wildlife habitat in the Iron Gate reach. If changes to riparian vegetation are desired in a short time period, rather than relying on the flow events like the 1964 flood to initiate channel modification and promote riparian vegetation changes amenable to wildlife and fisheries, it may be more feasible to actively prescribe management activities to achieve these objectives within the breadth of ESA-mandated flows.

Reed Canarygrass and Coyote Willow in Project Reaches

The varial zone in the J.C. Boyle peaking reach is the elevation range within the active channel that is affected by daily fluctuation cycles in river flows resulting from the operation of the J.C. Boyle power plant. The daily flow fluctuations are thought to influence the distribution and abundance of riparian vegetation growing in the reach. The peaking reach vegetation types growing in the varial zone (350 cfs to 3,000 cfs [10 cms to 85 cms]) and above the varial zone (more than 3,000 cfs [85 cms]) are summarized in Figure 3.7-24. Of the nine peaking reach vegetation types, only two did not have a least one plot within the varial zone. The Kentucky Bluegrass/Yarrow/Fieldcress and Kentucky Bluegrass/Timothy/Bentgrass vegetation types were sampled on terraces and did not occur at elevations inundated by flows less than 3,000 cfs (85 cms). Of major concern to TRWG members are the effects of Project operation on native willows and the potentially non-native, invasive reed canarygrass. The following sections describe the presence of coyote willow and reed canarygrass in the Project area in relation to hydrologic and geomorphic characteristic and the life-history characteristics of these species.

<u>Reed Canarygrass</u>. Reed canarygrass was present in 78 (48 percent) of the riparian plots sampled in the J.C. Boyle peaking reach. Fifty eight (74 percent) of these plots occurred within in the varial zone and seven plots with reed canarygrass occurred at elevations inundated by flows less than 350 cfs (10 cms). Reed canarygrass is also the most abundant species in the varial zone and is hypothesized to be particularly abundant because of the frequently fluctuating river flows. Reed canarygrass abundance within the varial zone had a positive relationship with discharge and a negative relationship with inundation frequency and inundation duration (Figure 3.7-30). Above the varial zone (more than 3,000 cfs [85.0 cms]), reed canarygrass abundance has a negative correlation with elevation (Figure 3.7-31). These growth patterns for reed canarygrass demonstrate that reed canarygrass has a unimodal distribution with the peak abundance in the upper portion of the varial zone. Within the varial zone, reed canarygrass abundance peaks (cover class 5 mid-point = 88 percent cover) at elevations equivalent to average values of 1,967 cfs (55.7 cms) discharge, 15.5-hour inundation frequency, and 35.5 percent inundation duration. The lower elevation end of the unimodal distribution of reed canarygrass represented by cover classes 1, 2 and 3 (means for combined cover classes 1, 2, and 3 = 1,222 cfs [34 cms) discharge and 54.5 percent inundation duration) may begin to approach the limits of reed canarygrass to withstand intense scouring and possibly too much inundation (Figure 3.7-30). The 1,400 cfs (39.6 cms) flow approximates the one turbine discharge from J.C. Boyle powerhouse. The upper elevation end of the unimodal distribution, represented by combined reed canarygrass cover classes 1, 2 and 3, has mean values for discharge and inundation duration of 4,590 cfs (130.0 cms) and 5.3 percent, respectively (Figure 3.7-31). Peaking flows extend the horizontal distribution or width of reed canarygrass in the peaking reach by creating an artificially narrow range of inundation duration over a greater range of horizontal distances.

Return interval was calculated for plots that require more than 3,000 cfs (85 cms) for inundation because the calculations of inundation frequency at these elevations are based on such a small sample size available from the relatively short period of flow record that estimates become unreliable. The mean values for discharge, inundation duration, and return interval for dense reed canarygrass (cover class 5) growing at elevations that require more than 3,000 cfs (85.0 cms) to be inundated are 3,368 cfs (95.4 cms), 9.1 percent, and 1.4 years, respectively. The mean values for reed canarygrass cover class 5, regardless of position within or outside the varial zone, are 2,188 cfs (62.0 cms) discharge (95 percent CI = 1,804 cfs, 2,572 cfs [51.1 cms, 72.8 cms]) and 31.3 percent inundation duration (95 percent CI = 22.3 percent, 40.3 percent).

Only three plots sampled above the elevation that is flooded by 3,000 cfs (85.0 cms) had reed canarygrass with a cover value of 5; no sampled plots had a cover value of 4 (mid-point cover = 63 percent). Plots with reed canarygrass at lower abundances (cover classes: 1 = 0.5 percent, 2 = 13 percent, and 3 = 38 percent) above elevations inundated by the 3,000 cfs (85.0 cms) tended to support species assemblages in which reed canarygrass either occurred infrequently and was unimportant or occurred as one of several species frequently occurring in a vegetation type, such as the Coyote Willow/Reed Canarygrass/Bentgrass vegetation type.

Predicting the effects of different flow regimes on reed canarygrass is difficult. However, the following is a preliminary discussion of possible changes. An increase in flow at the lower end of the varial zone probably would kill some of the reed canarygrass lower in the varial zone because of increased scouring and, to some degree, increased inundation. It also likely would push the Hardstem Bulrush/Reed Canarygrass vegetation type to higher elevations in the current varial zone. However, the Hardstem Bulrush/Reed Canarygrass vegetation type tends to be a loose and low cover association of these two species. The frequent inundation and, most importantly, scour associated with flows in the varial zone restricts the occurrence of these two species to protected locations among boulders and backwater areas.

A reduction of flow at the upper end of the varial zone (lowering maximum peaking discharge) likely would shift the optimal discharge conditions (2,188 cfs [62.0 cms] discharge and 31.3 percent inundation duration) for elevations with reed canarygrass occurring at highest densities (cover class 5) to a lower elevation. The lowering of optimal conditions for reed canarygrass also likely would result in a downward shift of species associated with reed canarygrass that currently are growing at or above elevations that are inundated by approximately 3,000 cfs (85.0 cms). However, the associated species would be in direct competition with reed canarygrass to colonize the newly available substrate. In the discussion below, the contrast in life history strategies of coyote willow and reed canarygrass indicate that reed canarygrass is an intense competitor.

Figure 3.7-30. Inundation duration, discharge, and inundation frequency for reed canarygrass abundance (cover classes) and vegetation types with reed canarygrass in the J.C. Boyle peaking reach varial zone (350 to 3,000 cfs). (PHAARU = *Phalaris arundinacea*, reed canarygrass).

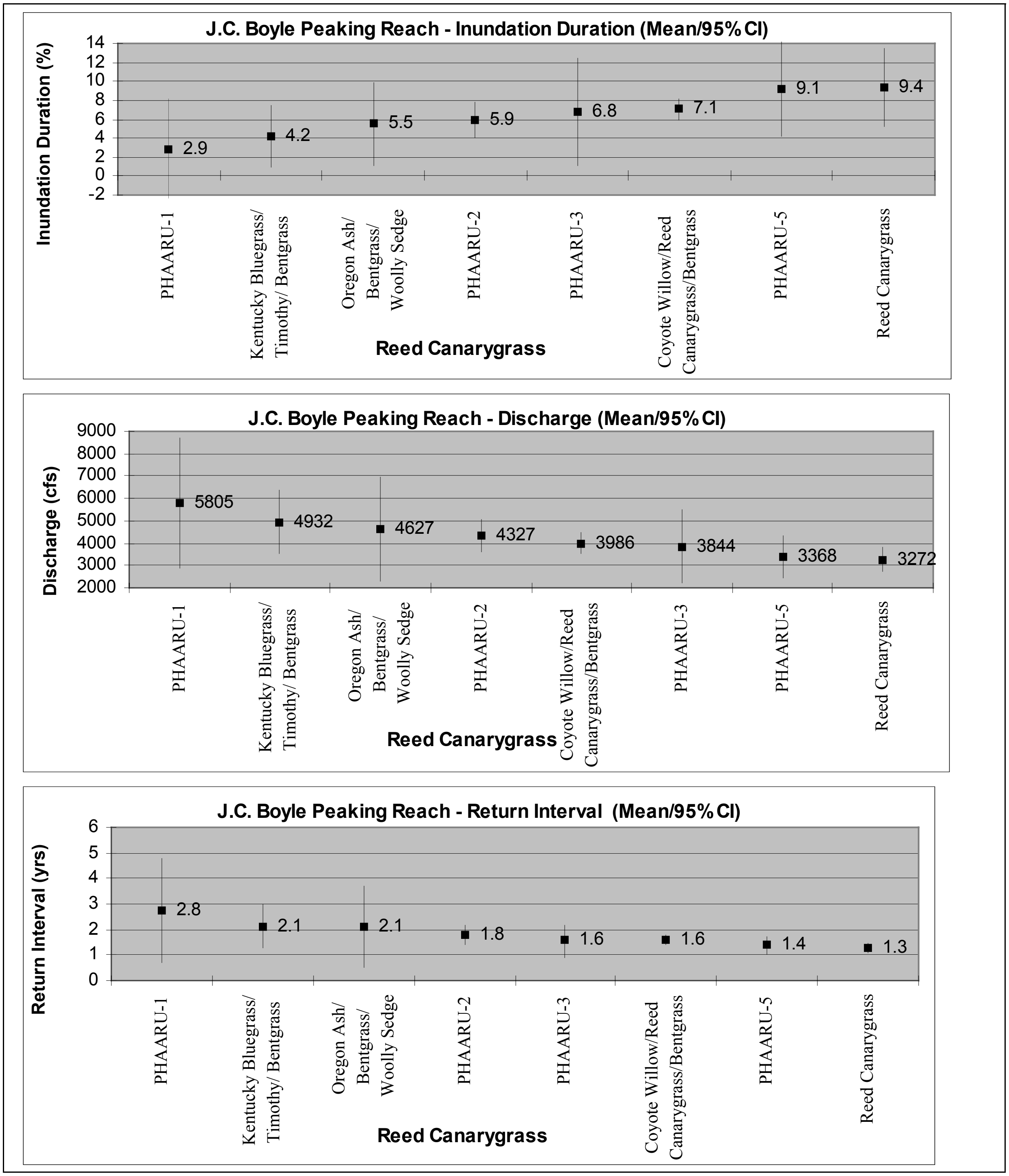


Figure 3.7-31. Inundation duration, discharge, and inundation frequency for reed canarygrass abundance (cover classes) and vegetation types with reed canarygrass in the J.C. Boyle peaking reach above the varial zone (more than 3,000 cfs). (PHAARU = *Phalaris arundinacea*, reed canarygrass).

A reduction of maximum peaking flows may also increase the total width of riparian vegetation in the peaking reach depending on the response of riparian vegetation at the upper end of the elevation gradient. The question arises as to whether the lowering of maximum peaking flows has any effect on the flows required to maintain riparian vegetation (Chapin et al. 2002) at the upper end of the current riparian vegetation boundary.

Periodic flooding of riparian vegetation is important for maintaining growth of riparian plant species (Hill et al. 1991; Chapin, 2002). At lower elevations along the riparian elevation gradient, inundation duration is believed to be important by promoting riparian plants species capable of enduring a range of anoxic soil conditions (Franz and Bazzaz, 1988). At higher elevations along the riparian elevation gradient, flood frequency is believed to be more important than inundation duration for maintaining wetland characteristics of riparian vegetation, particularly in the arid western United States (Hill et al. 1991). The riparian vegetation maintenance flow is the flow that inundates all riparian vegetation. The riparian vegetation maintenance flow was calculated for all transects in the peaking reach to assess whether reducing the frequency of maximum peaking flows would affect the upper boundary of riparian vegetation in the J.C. Boyle peaking reach.

The plots in the vegetation type(s) at the higher end of the elevation gradient that had at least 50 percent of their plant species with a wetland indicator status of facultative or wetter (Reed, 1998) and were not affected by groundwater seepage and irrigation returns were included in the calculations riparian vegetation maintenance flows. The vegetation growing on the larger terraces in the peaking reach typically had a strong representation of upland species and was not included in this analysis. The average return interval plus one standard deviation for each of the highest vegetation types along each transect were averaged across all transects to derive the riparian vegetation flood frequency of 4.6 ± 0.95 years. However, among all peaking reach transects, there are two groups of vegetation types that emerge. The first group includes the Coyote Willow/Reed Canarygrass/Bentgrass, Reed Canarygrass, and Oregon Ash, Reed Canarygrass/Woolly Sedge vegetation types. These are the highest elevation vegetation types in more constrained portions of the peaking reach and have a strong compliment of obligate wetland species. The mean values for this group are 1.8 ± .31 year return interval, 4,373 ± 722 cfs (123.8 ± 20.4 cms) discharge, and 27.1 ± 20.5 percent inundation duration. The second group includes the Kentucky Bluegrass/Timothy/Bentgrass, Kentucky Bluegrass/Yarrow/Fieldcress, and Oregon Ash/Himalayan Blackberry vegetation types, which grow in generally wider, more alluvial portions of the peaking reach. The mean values for this group are 7.1 ± 3.6-year return interval, 9,454 ± 2,557 cfs (267.7 ± 72.4 cms) discharge, and 3.7 ± 3.1 percent inundation duration. The discharges required to inundate both groups far surpass the 3,000 cfs (85.0 cms) peaking flow, and changes to the maximum peaking flow are unlikely to change the upper boundary of riparian vegetation in the peaking reach.

<u>Coyote Willow</u>. Coyote willow is a species widely considered to have a high value as fish and wildlife habitat and as a streambank stabilizer. In the peaking reach, the Coyote Willow/Reed Canarygrass/Bentgrass vegetation type is one of three vegetation types (see above) that "straddle" the upper boundary of the varial zone. A total of 67 percent of the plots representing this vegetation type occurred below the elevation inundated by 3,000 cfs (85.0 cms) while 33 percent were above the 3,000 cfs (85.0 cms) level. There is no strong association between abundance and position along the inundation/ elevation gradient (Figures 3.7-32 and 3.7-33). Coyote willow abundance certainly does not demonstrate the same pattern of abundance as reed canarygrass (Figures 3.7-30 and 3.7-31).

Coyote willow in the Iron Gate Reach demonstrates a similar pattern of coyote willow abundance in relation to hydrological variable as in the J.C. Boyle peaking reach (Figure 3.7-34). This pattern in both reaches probably relates to coyote willow's life history strategy, the disturbance history, growing conditions and inter-species interactions that affect coyote willow growth in more or less unique ways in any given site. For example, in the Iron Gate reach, the Coyote Willow/Himalayan Blackberry vegetation type and coyote willow with a cover value of 5 have highly variable values for discharge and for return interval. This variation is, in part, the result coyote willow's ability to spread by lateral roots or suckers to a much higher position in the cross-section profile that is associated with higher discharge values. It also may be that coyote willow stands trap sediment and thereby increase in elevation over time. In addition, some of the willow at these higher elevations also may be subsidized by irrigation returns from adjacent pastures. Another factor that may play a role in generally greater abundance of coyote willow in the Iron Gate reach is the ability of large flood events to affect alluvial features and either create new potential habitat for coyote willow or maintain existing willow habitat. Based on 1965 aerial photography, the 1964 flood scoured many river bars and existing islands in the Iron Gate reach creating many fresh alluvial substrates that could support coyote willow germination and growth. The exposure of fresh substrates resulting from the 1964 flood occurred on a much smaller scale in the J.C. Boyle peaking reach.

The differences in abundance of reed canarygrass and coyote willow likely are related to their life history strategies and their ability to take advantage of the environment in the peaking reach. The following paragraphs compare and contrast life history strategies of coyote willow and reed canarygrass. Coyote willow seeds disperse in June and July (Brinkman, 1974). Based on few observations, coyote willow seed dispersal in the Project area may occur slightly earlier in May and June, at least in 2002; coyote willow capsules were still green in April. However, no systematic observations of coyote willow seed dispersal were made during the course of this study. The dispersal dates generally coincide with the portion of the decreasing limb of the annual hydrograph (average daily flows) that follows the average annual spring peak flow at around mid-March (see Water Resources FTR, Section 5.0, Figure 5.7-1). This species requires bare, alluvial substrates in close proximity to the water table for germination (Hansen et al. 1988a) and the seeds, which are capable of photosynthesis, require light to successfully germinate (Brinkman, 1974). The dense vegetation cover and the coarse, boulder-covered banks along the peaking reach shade the soil surface too much to permit coyote willow seeds to germinate. Substantial deposits of sediment likely would be required to cover existing vegetation and fill gaps between large boulders to expose fresh alluvium for germination of coyote willow seed. Coyote willow seeds are short-lived and rarely germinate after a week (Ware and Penfound, 1949; Densmore and Zasada, 1983; Krasny et al. 1988b). This means that newly dispersed seed must quickly find a suitable site for germination.

Once established, the roots of this willow species can increase its range by suckering to produce either male or female clones (Argus, 1973) to a wide range of elevations from dry to frequently inundated habitats (Krasny et al. 1988b). The spread of clones is greatest when the water table is stable at a depth of 8 inches (20 cm) below the soil surface. There is no active spreading and stem mortality occurs when the water table drops more than 32 inches (80 cm) below the soil surface (Ottenbriet and Staniforth, 1992). Sucker production is reported to peak between 5 and 6 years and taper off by 9 to 11 years of age (Krasny et al. 1988). Coyote willow colonies in the J.C. Boyle peaking reach often had large, decadent stems surrounded by suckers of various ages growing up through reed canarygrass.

Coyote willow is intolerant of shade in all stages of growth. Dense growing species like reed canarygrass can grow as tall as 8 feet (2.5 m) and can shade out young vegetative shoots and seedlings of coyote willow. Similarly, large tree species, such as Oregon oak, Oregon ash, and white alder, can shade out the willow shrubs. After coyote willow is established in a disturbed site, it may require repeated flooding (Hansen et al. 1988b) or additional disturbance to maintain a competitive advantage and persist. In some riparian sites, it may be the only shrub to survive flooding (Brunsfield and Johnson, 1985). In the J.C. Boyle peaking reach, daily inundation at the upper portion of the varial zone may help maintain willow in lieu of other common woody riparian species. Krasney et al. (1988b) noted that suckering occurs frequently in sites, particularly in frequently flooded and in dry, sandy sites, where reproduction from seed occurs only infrequently.

It is difficult to say exactly how peaking flows directly affect coyote willow presence and abundance: 71 percent of plots with coyote willow occurred within the varial zone, often alongside reed canarygrass. Several of these plots occurred in the varial zone because of slumping on one of the sampled terraces, which lowered a portion of the cross-section profile permitting vegetative expansion of existing willow colonies. Coyote willow in the J.C. Boyle peaking reach and the Iron Gate reach have patchy distributions primarily because of the vagaries of the timing and the magnitude of flows that create alluvial habitats for this species. Disturbance within the stream channel that could facilitate coyote willow establishment seems to occur only infrequently and typically is limited to minor in-channel shifting of islands and bars based on historic aerial photography (see Water Resources FTR, Section 6.7.6). The general lack of disturbance observed in the J.C. Boyle peaking reach is corroborated by historic aerial photography. A variety of factors probably contributes to the relative lack of disturbance in the J.C. Boyle peaking reach including coarse substrates that resist scouring during large flow events, the lack of finer particle sizes in the river required for sedimentation, streambanks stabilized by dense vegetation that also resist scouring, and possibly an attenuation of potentially scouring flood flows during major flood events as a result of upper basin diversions. The life history strategy of coyote willow leaves no doubt about its requirement for fresh alluvial substrate for reproduction from seed.

Reed canarygrass seed germinates best immediately following maturation, and some seed remains viable throughout the winter and following summer (Vose, 1962). Reed canarygrass seed also matures asynchronously (Baltensperger and Kalton, 1958), suggesting that freshly matured and viable seed is dispersed into the environment for a relatively long period in June and July, and possibly August in the J.C. Boyle peaking reach. The hotter months of June, July, and August increase the possibility of two-turbine peaking, especially in wetter years when there is enough inflow to permit this type of operation. This would provide the perfect dispersal mechanism for reed canarygrass seed into that part of the varial zone where it has been documented that the optimal conditions for reed canarygrass growth is indicated by the densest reed canarygrass patches along sampled transects. Conversely, the alternation between one-turbine (1,400 cfs [39.6 cms]) and two-turbine flows (3,000 cfs [85.0 cms]) probably also contributes to preventing reed canarygrass from becoming established at elevations between the two flows because of removal of any seed that is deposited there and also as a result of scouring of any seedlings that are not rooted in protected locations around boulders and other protected areas. Vose (1962) also showed that reed canarygrass germination was increased when seeds were soaked in 50ºF water, mechanically damaged, exposed to more light, and oxygenated. Daily inundation in the upper part of the varial zone could provide the mechanical damage to the seed and thereby increase germination. Ramping down flows could leave the seed stranded at the upper elevations in protected portions of the varial zone and also reduce inundation, which would increase oxygenation.

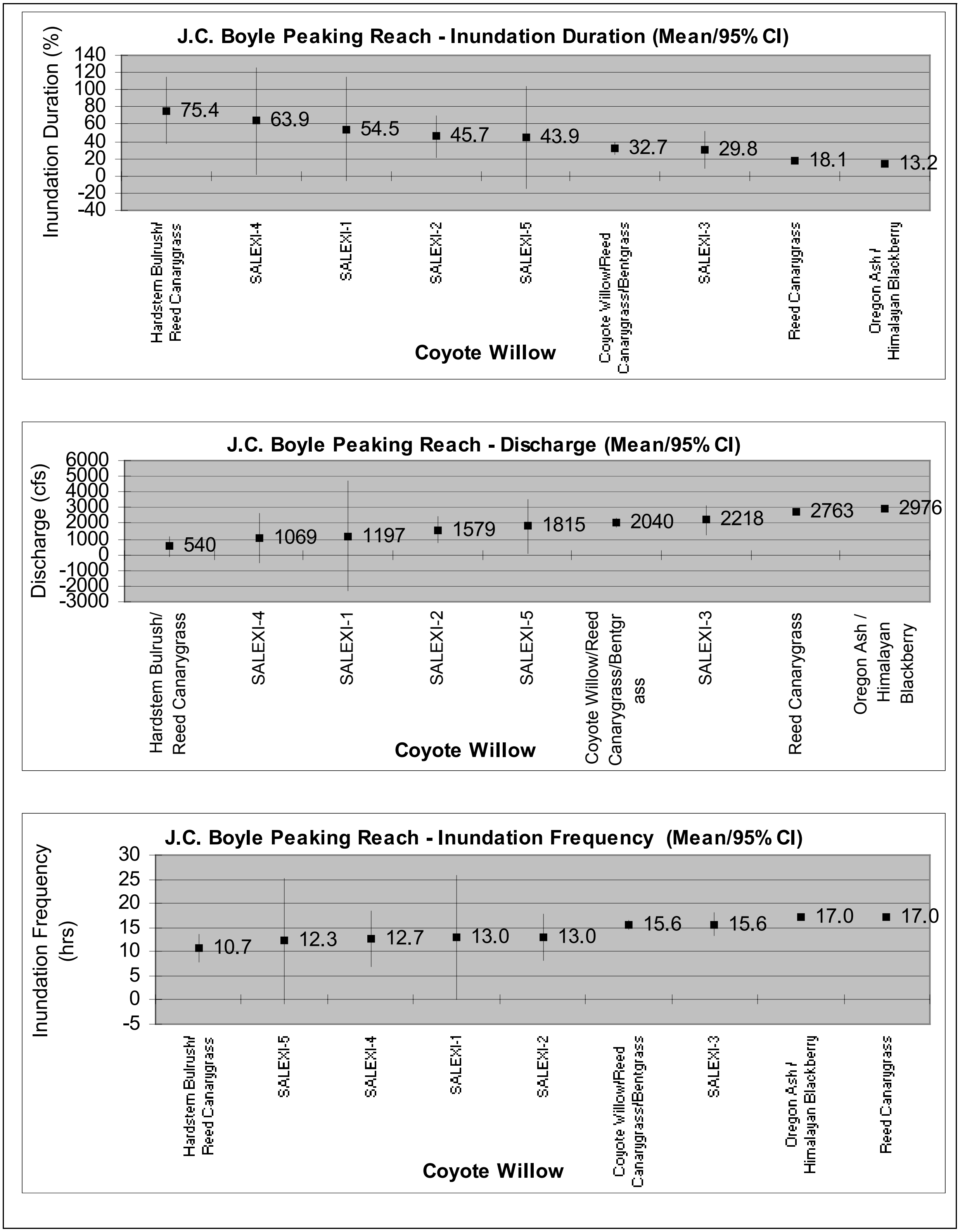
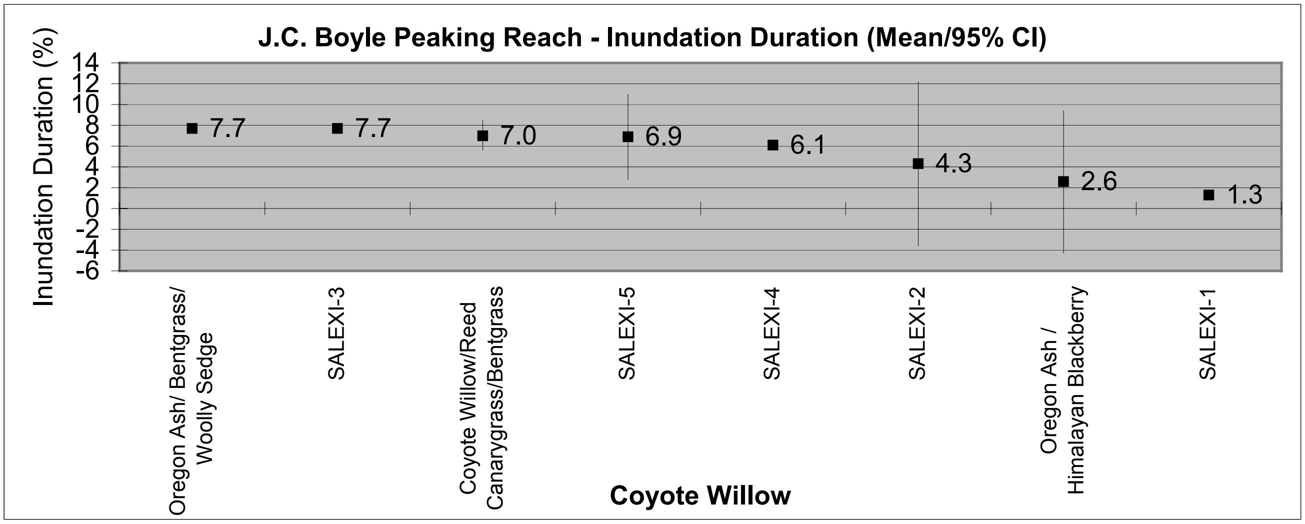
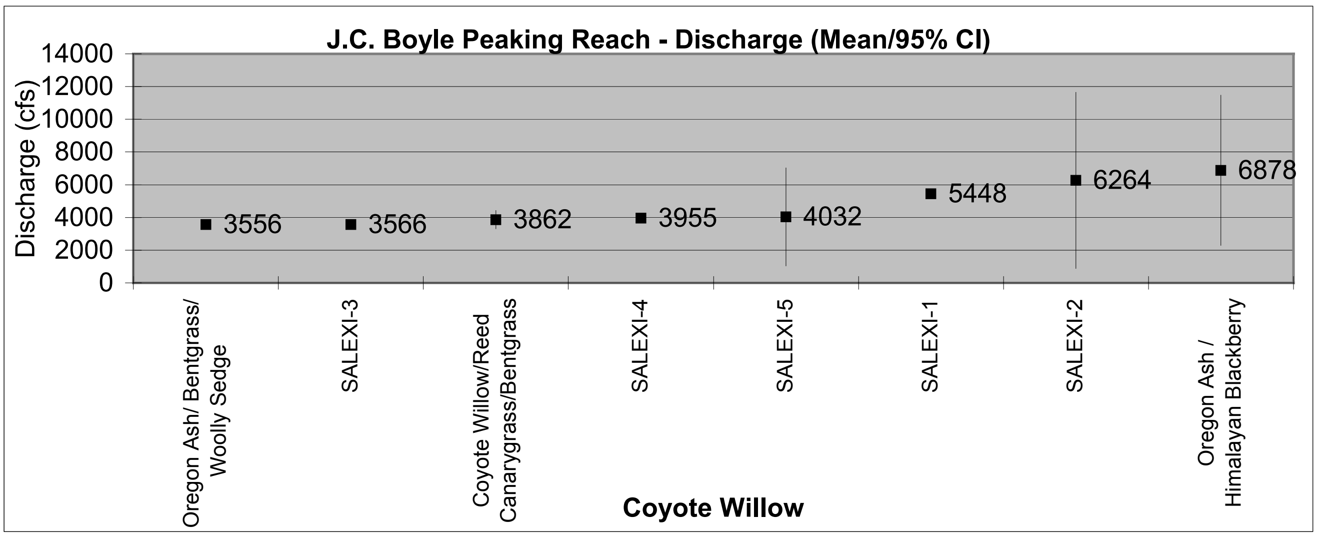


Figure 3.7-32. Coyote willow abundance (by cover class) and vegetation types with coyote willow in the J.C. Boyle peaking reach growing at elevations inundated by flows between 350 and 3,000 cfs (varial zone).


J.C. Boyle Peaking Reach - Inundation Duration (Mean/95% CI)
Inundation Duration (%)
14
12
10
8
6
4
2
0
-2
-4
-6
7.7
7.7
7.0
6.9
6.1
4.3
2.6
1.3
Oregon Ash/ Bentgrass/ Woolly Sedge
SALEXI-3
Coyote Willow/Reed Canarygrass/Bentgrass
SALEXI-5
SALEXI-4
SALEXI-2
Oregon Ash / Himalayan Blackberry
SALEXI-1
Coyote Willow


J.C. Boyle Peaking Reach - Discharge (Mean/95% CI)
Discharge (cfs)
14000
12000
10000
8000
6000
4000
2000
0
3556
3566
3862
3955
4032
5448
6264
6878
Oregon Ash/ Bentgrass/ Woolly Sedge
SALEXI-3
Coyote Willow/Reed Canarygrass/Bentgrass
SALEXI-4
SALEXI-5
SALEXI-1
SALEXI-2
Oregon Ash / Himalayan Blackberry
Coyote Willow

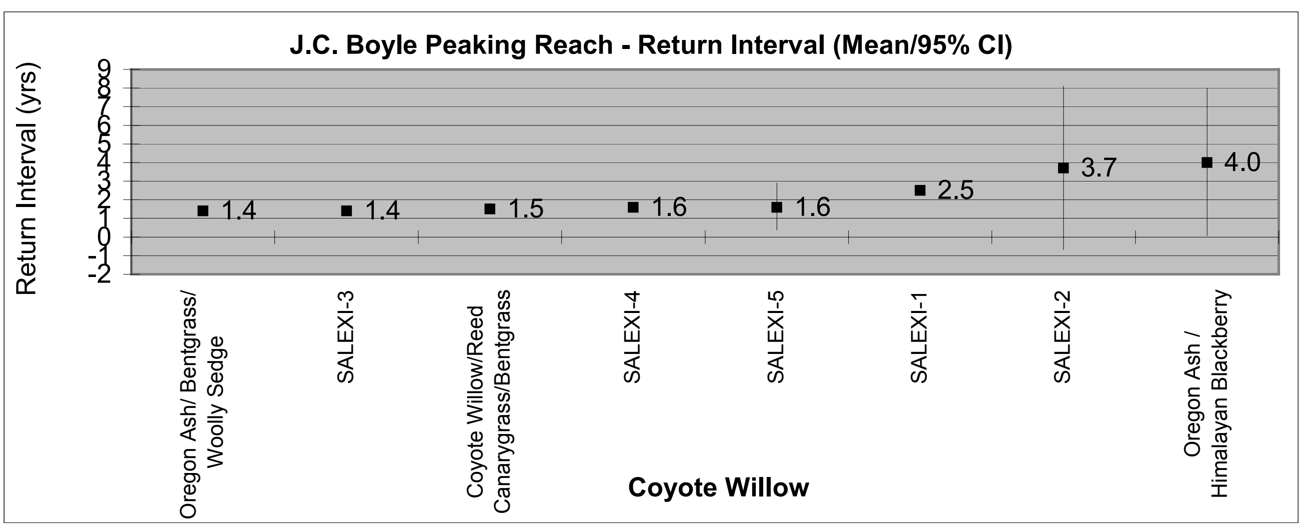

J.C. Boyle Peaking Reach - Return Interval (Mean/95% CI)
Return Interval (yrs)
9
8
7
6
5
4
3
2
1
0
-1
-2
1.4
1.4
1.5
1.6
1.6
2.5
3.7
4.0
Oregon Ash/ Bentgrass/ Woolly Sedge
SALEXI-3
Coyote Willow/Reed Canarygrass/Bentgrass
SALEXI-4
SALEXI-5
SALEXI-1
SALEXI-2
Oregon Ash / Himalayan Blackberry
Coyote Willow

Figure 3.7-33. Coyote willow abundance (by cover class) and vegetation types with coyote willow in the J.C. Boyle peaking reach growing at elevations inundated by flows above 3,000 cfs (above the varial zone).

Given the dense swards of reed canarygrass in the J.C. Boyle peaking and bypass reaches and the Keno Canyon reach, one could safely assume that reed canarygrass spreads aggressively. Reed canarygrass has been shown to out-produce both cattail and river bulrush (*Scirpus fluvitialis*) (Klopatek and Stearns, 1978) as measured by hay production in a rich marsh. In a greenhouse study, reed canarygrass rhizomes formed in 26 days following germination and by week 16 had an average of 48 rhizomes per plant (Comes et al. 1981). Laboratory studies indicate that 74 percent of shoots arise from tillers while the remaining 24 percent arise from auxiliary buds on basal nodes of the parent clone (Casler and Hoven, 1980). Barnes (1999) documented the ability of reed canarygrass to become the dominant species on a small river island in Wisconsin in just 15 years. At elevations less than 3.2 feet (1 m) above normal flows, some herbs and grasses were displaced and now occur infrequently. Barnes (1999) attributed the increase in reed canarygrass, in part, to an aggressive non-native strain of reed canarygrass and to low summer flows that made a greater area available for vegetative expansion for a longer period of time during the growing season.

Maurer and Zedler (2002) showed that aboveground biomass of reed canarygrass was reduced 73 percent and 97 percent under flooding and heavy shading, respectively; survival of rhizome fragments of reed canarygrass was reduced by 30 percent and 25 percent, respectively. The reduction in aboveground biomass is consistent with observations of relatively sparse reed canarygrass canopies beneath some of the denser stands of coyote willow in the J.C. Boyle peaking reach. Maurer and Zedler (2002) also showed that clonal subsidy facilitated vegetative expansion of reed canarygrass into dense shade. Reed canarygrass clones subsidized or supplemented with a high nutrient treatment increased aboveground growth and tiller spread by almost 50 percent thereby increasing leaf surface area and light capturing ability. Without the nutrient supplement, the root biomass of reed canarygrass clones increased by 30 percent by increasing tiller density closer to the parent clone thereby increasing the forage capacity of the plant. Thus, it would appear that reed canarygrass is highly adaptable to conditions with and without high nutrient levels. However, these results are potentially significant in the J.C. Boyle peaking, Keno Canyon, and J.C. Boyle bypass reaches because the relatively high nutrient content in these reaches from the natural system and from agricultural runoff may be facilitating the spread of reed canarygrass into other vegetation types and, in many places, to the complete exclusion of other species by promoting dense growth of reed canarygrass.

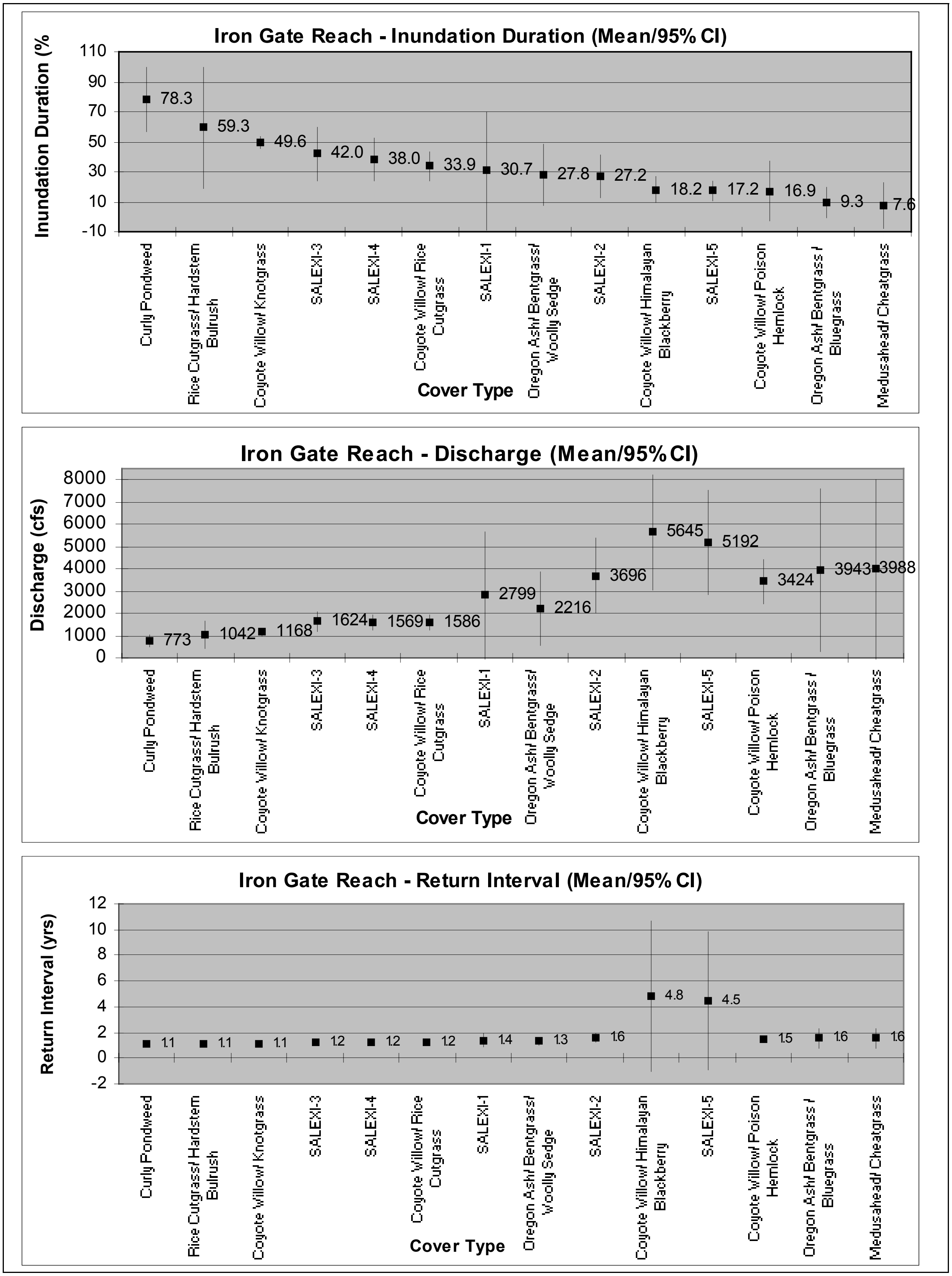


Figure 3.7-34. Coyote willow abundance (by cover class) and vegetation types with coyote willow in the Iron Gate reach.

Reed canarygrass has been shown to be highly adaptable under a wide range of growing conditions and appears to respond to various inundation patterns and to nutrient supply. Conchou and Pielou (1988) showed that reed canarygrass was well adapted to seasonal variation in substrate moisture and responded with two periods of growth during the year. Rice and Pinkerton (1993) showed that reed canarygrass grew nearly equally well under no inundation and complete inundation in 13 inches (33 cm) of water on both a cycle of 1 full day of inundation and 2 full days of inundation with 1 day out of the water between each inundation period. These inundation patterns are not directly comparable to what occurs in the J.C. Boyle peaking reach varial zone, but they demonstrate the adaptability of reed canarygrass to different inundation patterns.

Kercher and Zedler (2004) studied the invasiveness of reed canarygrass into a resident wet prairie species assemblage. They demonstrated that nutrient addition increased both resident and reed canarygrass biomass and frequency. Constant flooding and early season flooding resulted in greater reed canarygrass biomass compared to intermittent flooding; the opposite results were observed in the resident vegetation. The addition of low and high amounts of nutrients to the different flood regimes showed reed canarygrass biomass to increase the most with increasing flood intensity and increasing nutrient supply. The resident vegetation in their study had the lowest biomass under constant flooding and highest nutrient treatment.

The intermittent flood regime in the Kercher and Zedler (2004) study flooded reed canarygrass during the first 2 days of every 14-day cycle for seven cycles. It is difficult to determine if the 15.5-hour inundation frequency and 35.5 percent inundation duration observed for the highest abundance of reed canarygrass in the varial zone more closely approximates their intermittent flood regime or their early season and constant flood regimes. The 35 percent inundation duration for peak abundance of reed canarygrass is certainly greater than the approximately 14.3 percent inundation duration (2 days/14 days x 100) associated with their intermittent flood regime. The 35 percent inundation duration is far less than their constant flood regime. However, as previously mentioned, the calculated 35 percent inundation duration may underestimate the intensity of inundation in the varial zone because inundation occurs so frequently that soil conditions may remain anoxic between inundation events. It appears that increased nutrient supply from agricultural runoff and increased disturbance by increasing inundation in some parts of the varial zone may have additive effects in promoting the invasive and aggressive growth of reed canarygrass in the J.C. Boyle peaking reach. The scouring effect of flows lower in the varial zone in the J.C. Boyle peaking reach would appear to counter the effects of increased inundation on the abundance of reed canarygrass.

In comparison, the J.C. Boyle bypass and Keno Canyon reaches have an even higher percentage of plots with reed canarygrass. The most obvious environmental factor in common between these reaches is the relatively high nutrient content in the river from agricultural run-off. J.C. Boyle bypass and Keno Canyon reaches have even greater mean inundation duration values for vegetation types with greatest abundance of reed canarygrass at 54 percent (Figure 3.7-21) and 54 to 78 percent (Figure 3.7-16), respectively. The lower base flows in these reaches increases the available area for riparian plants, but only for those species that can endure greater inundation.

The distribution of reed canarygrass downstream of the J.C. Boyle peaking reach appears to be restricted to a few locations at the upper end of Copco reservoir and was observed near the mouth of Jenny Creek at Iron Gate reservoir. There are few plausible reasons to explain why reed canarygrass is not already abundant downstream of the J.C. Boyle peaking reach. Dams can act as barriers to short-floater seeds that die after less than 2 days of inundation (Jansson et al. 2000). However, Comes et al. (1978) found that most reed canarygrass seed decomposed or germinated after 3 months, but could remain viable for up to 48 months. It is unlikely that reed canarygrass seed drowns in Project waters, but it might sink or Project dams may act as a barrier, which would help explain why reed canarygrass has not been found in the reach below Iron Gate dam. There may be environmental differences, such as higher maximum temperature during the growing season downriver of J.C. Boyle peaking reach, which may be limiting to reed canarygrass growth. However, consistent moisture in shoreline habitats at both Copco reservoir and Iron Gate reservoir would seem to be able to counteract the generally hotter air temperatures.

The prevalence of reed canarygrass both upstream and downstream of J.C. Boyle reservoir would seem to contradict the hypothesis that reed canarygrass seed sinks or that J.C. Boyle dam acts as a barrier. However, J.C. Boyle reservoir is small by comparison to Iron Gate reservoir. Reed canarygrass seed would pass through J.C. Boyle reservoir relatively quickly, especially because the reservoir is regularly drained and filled (i.e., low retention time) as part of the operation of J.C. Boyle powerhouse. Reed canarygrass is restricted to scattered, small patches in recently disturbed areas, such as near the Highway 66 bridge footings. The dense and relatively undisturbed wetland vegetation around most of J.C. Boyle reservoir may serve as a barrier to invasion by reed canarygrass via seed arriving from the Keno Canyon reach. The presence of reed canarygrass on both sides of J.C. Boyle reservoir does not necessarily mean that there was dispersal across the dam. The fact that seeds of aggressive species like reed canarygrass can disperse by other means than water transport should be kept in mind if preventing reed canarygrass from spreading downstream of the J.C. Boyle peaking reach is a management goal. For existing reed canarygrass swards, Maurer and Zedler (2002) recommend reducing or eliminating nutrient supplies to reduce reed canarygrass. Other researchers recommend planting species that can potentially shade reed canarygrass and help to reduce the cover of dense reed canarygrass swards.

Tree Age Data

Iron Gate-Shasta Reach. The discussion of tree ages in the Iron Gate-Shasta reach (Iron Gate reach) focuses primarily on coyote willow growing at five transects where stage-discharge was modeled. There are three groups of tree ages associated with these transects. The first group consists of a sample of 36-year-old trees growing on an island just downstream of the I-5 bridge that crosses the Klamath River at RM 179 and is associated with transect I5-3. The second group of tree ages ranges from 25 to 28 years old and was sampled at three transects located at RM 179.3 (transect I5-1), RM 179.4 (transect I5-2), and RM 189.4 (transect IG-4). The third group consists of trees that are 11 years old distributed in two transects at RM 179 (transect I5-3) and RM 189.6 (transect IG-1). The water years over which flow the regime was evaluated with respect to tree age samples extends from 1964 to 2001. The focus of the analysis is spring peak flows and the descending limb of the annual hydrographs, which are the time periods most important for willow establishment. The timing and rate of drop of the descending limb with respect to the elevation of the coyote willow tree-age samples were assessed to evaluate the potential association between flows and willow occurrence. One important assumption of this analysis is that coyote willow seed disperses in May and June. Only incidental observations of coyote willow seed dispersal were made in late May or early June 2002.

The timing of the descending limb (peak spring flow to the start of lower summer flows) is summarized for all years between 1964 and 2001 (Figure 3.7-35). In most years, the descending limbs of the hydrographs peak in March and end in June. Summary statistics for the 28 descending limbs are provided in Table 3.7-5. The length in days of the descending limb ranges from 28 days in 2001 to 185 days in 1997. The mean daily rate of drop in discharge was lowest in years with small spring peak flows, such as in 1991 and 1992 (Table 3.7-5). The largest spring peak flows associated with 1972, 1982, and 1997 were not necessarily associated with the highest mean daily rate of drop in discharge. This, in part, is because of the variability in the timing and the magnitude of run-off during spring snowmelt. In 23 years with peak spring flows more than 5,000 cfs (141.6 cms), there were 12 years in which one to three large spikes occur after the peak spring flow. The magnitude of spikes that encompass 5,000 cfs (141.6 cms) is potentially important with respect to how the spikes inundate vegetation types with coyote willow; vegetation types with coyote willow occur at elevations that are inundated by mean discharges ranging from 1,397 to 5,645 cfs (39.6 to 159.9 cms) (Figure 3.7-34). The discharges associated with spikes that dip below and then exceed 5,000 cfs (141.6 cms) discharge range from 1,600 to 7,000 cfs (45.3 to 198.2 cms). The coincidence of these spikes and the descending limb with the dispersal of coyote willow seed is likely critical to coyote willow reproduction in the Iron Gate reach.

The 36-year-old coyote willow trees at transect I5-3 were the largest and likely among the oldest trees on the island sample site. Based on the tree ring count, the sampled 36-year-old tree established in 1967. In 1967, the establishment site was a left bank gravel island/bar (with a narrow left bank channel) that was freshly cleared of most vegetation by the 1964 flood, based on 1965 aerial photography. The elevation of the sampled willow currently corresponds to an inundation discharge of 4,830 cfs (136.8 cms). Whether the island was at the same elevation in 1967 as it is now is difficult to assess. The only portion of the descending limb for the 1967 hydrograph that equals or exceeds the 4,830 cfs (136.8 cms) discharge falls between the dates of May 12, and May 18, 1967 (Figure 3.7-36). Likewise, it is impossible to determine whether these dates correspond to the coyote willow seed dispersal in 1967. The rate of drop in both discharge and in stage between the de-watering date of the plot and the start of the summer low flow in 1967 is -145 cfs (-4.1 cms)/day and -1.70 inches (-4.3 cm) /day (Table 3.7-6).

Figure 3.7-35. Iron Gate - Shasta reach: Time period for descending limb of annual hydrograph from 1964 to 2001.

11 x 17

Front

Figure 3.7-35. Iron Gate - Shasta reach: Time period for descending limb of annual hydrograph from 1964 to 2001.

11 x 17

back

Table 3.7-5. Iron Gate-Shasta reach descending limb of annual hydrographs from 1964 to 2001: length of descending limb, mean daily discharge, summer low flow, maximum spring flow, mean daily rate of drop in the river. Rows with bold text represent years associated with tree-age samples.

Year	Length of Descending Limb (days)	Daily Discharge (mean/s.d.) (cfs)	Summer Low (cfs)	Spring Peak (cfs)	Mean Daily Rate of Drop (mean/s.d.) (cfs)
1964	64	1,852 ± 982	745	3,690	-46 ± 240
1965	131	4,463 ± 3,196	771	11,600	-83 ± 225
1966	48	1,172 ± 490	656	3,340	-55 ± 141
1967	**36**	**3,143 ± 1,570**	**687**	**6,730**	**-169 ± 351**
1968	76	1,283 ± 432	656	2,970	-30 ± 109
1969	81	3,309 ± 2,124	708	8,590	-98 ± 518
1970	136	3,281 ± 2,540	694	12,700	-88 ± 378
1971	84	5,420 ± 2,290	820	10,600	-117 ± 610
1972	93	5,348 ± 3,992	782	16,200	-165 ± 369
1973	79	1,367 ± 419	725	2,920	-28 ± 80
1974	86	3,759 ± 2,961	725	12,500	-138 ± 400
1975	**99**	**3,647 ± 1,637**	**765**	**6,810**	**-61 ± 303**
1976	112	1,735 ± 757	711	3,440	-24 ± 88
1977	**55**	**1,409 ± 376**	**719**	**2,850**	**-39 ± 113**
1978	**142**	**3,186 ± 1,188**	**725**	**6,590**	**-41 ± 251**
1979	85	1,747 ± 774	721	3,280	-29 ± 189
1980	108	2,315 ± 1,254	732	5,790	-47 ± 190
1981	64	1,225 ± 371	723	2,840	-33 ± 108
1982	112	5,125 ± 3,363	714	16,100	-139 ± 524
1983	106	4,701 ± 2,247	757	10,500	-92 ± 476
1984	120	3,564 ± 2,015	722	8,120	-62 ± 300
1985	37	3,124 ± 1,812	1,020	7,830	-189 ± 353
1986	90	3,421 ± 2,640	714	10,800	-114 ± 310
1987	82	1,620 ± 835	720	3,310	-28 ± 89
1988	88	1,399 ± 524	741	2720	-22 ± 88
1989	89	4,193 ± 2,155	733	9,780	-102 ± 407
1990	101	1,442 ± 503	721	2,660	-19 ± 105
1991	96	824 ± 172	603	1,470	-9 ± 71
1992	**138**	**571 ± 133**	**456**	**889**	**-3 ± 46**
1993	98	3,892 ± 2,610	736	10,800	-103 ± 598
1994	157	696 ± 182	541	1,380	-5 ± 108
1995	84	3,509 ± 1,918	755	8,740	-96 ± 489
1996	139	3,514 ± 2,265	1,030	12,000	-79 ± 422
1997	185	3,890 ± 3,168	804	18,500	-96 ± 405

Table 3.7-5. Iron Gate-Shasta reach descending limb of annual hydrographs from 1964 to 2001: length of descending limb, mean daily discharge, summer low flow, maximum spring flow, mean daily rate of drop in the river. Rows with bold text represent years associated with tree-age samples.

Year	Length of Descending Limb (days)	Daily Discharge (mean/s.d.) (cfs)	Summer Low (cfs)	Spring Peak (cfs)	Mean Daily Rate of Drop (mean/s.d.) (cfs)
1998	103	4,558 ± 2,153	1,120	8,680	-74 ± 414
1999	122	4,069 ± 2,206	1,310	9,070	-64 ± 359
2000	105	2,504 ± 885	1,040	5,060	-38 ± 183
2001	28	1,814 ± 286	977	2,120	-42 ± 105

The 1967 peak spring flow was not particularly large at 6,730 cfs (190.6 cms) (Figure 3.7-36), but the magnitude of the peak is highly coincident with the elevation of the sampled 36-year-old tree and the general timing of seed dispersal for coyote willow in May and June. It is also possible that the presence of this tree is the result of clonal growth by suckers. The 1964 flood may have buried or scoured, but not killed, the parent of the sampled tree, which then re-sprouted. The deposition of sediment during flooding is known to promote the growth of adventitious roots in coyote willow (Krasny et al. 1988a) The 1955 aerial photography shows this island to have a high cover of large shrubs or small trees that are traceable, in part, to 1965 photography. However, in-channel changes to the left channel and the island between 1965 and 1979 make it difficult to trace individual trees to present-day.

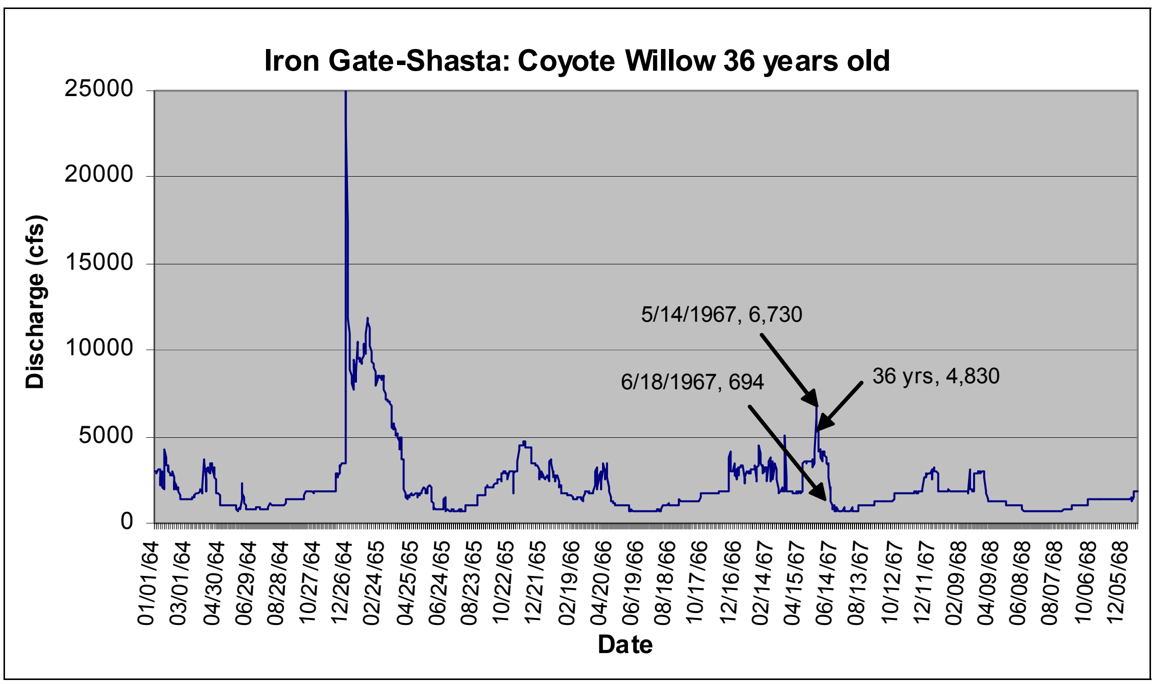


Figure 3.7-36. Thirty-six-year-old coyote willow at transect I5-3 inundated at 4,830 cfs. The labeled annotation refers to the date and flow (cfs) of the peak and general low flows and the age and approximate flow (cfs) that is required to inundate the sampled tree.

The 25-, 26-, and to 28-year-old trees were sampled from three different transects – IG-1, I5-2, and I5-1, respectively. The quality of the tree cores used to determine the age of these trees was not as good as the core from the 36-year-old tree because of rotten wood at the center of the trees. This creates some uncertainty about the exact age of these trees. In addition, the discharges predicted from the stage-discharge curve for transect I5-2 seemed to be a little high compared to transects with similar vegetation types, which may indicate a potential problem with the stage-discharge model or the transect site has accrued sediment since 1977. Nevertheless, the predicted inundation discharges are plotted against the yearly hydrographs from 1973 to 1979 in an attempt to evaluate the establishment dates or episodes of clonal growth for trees 25 years old, 26 years old, and 28 years old (Figure 3.7-37).

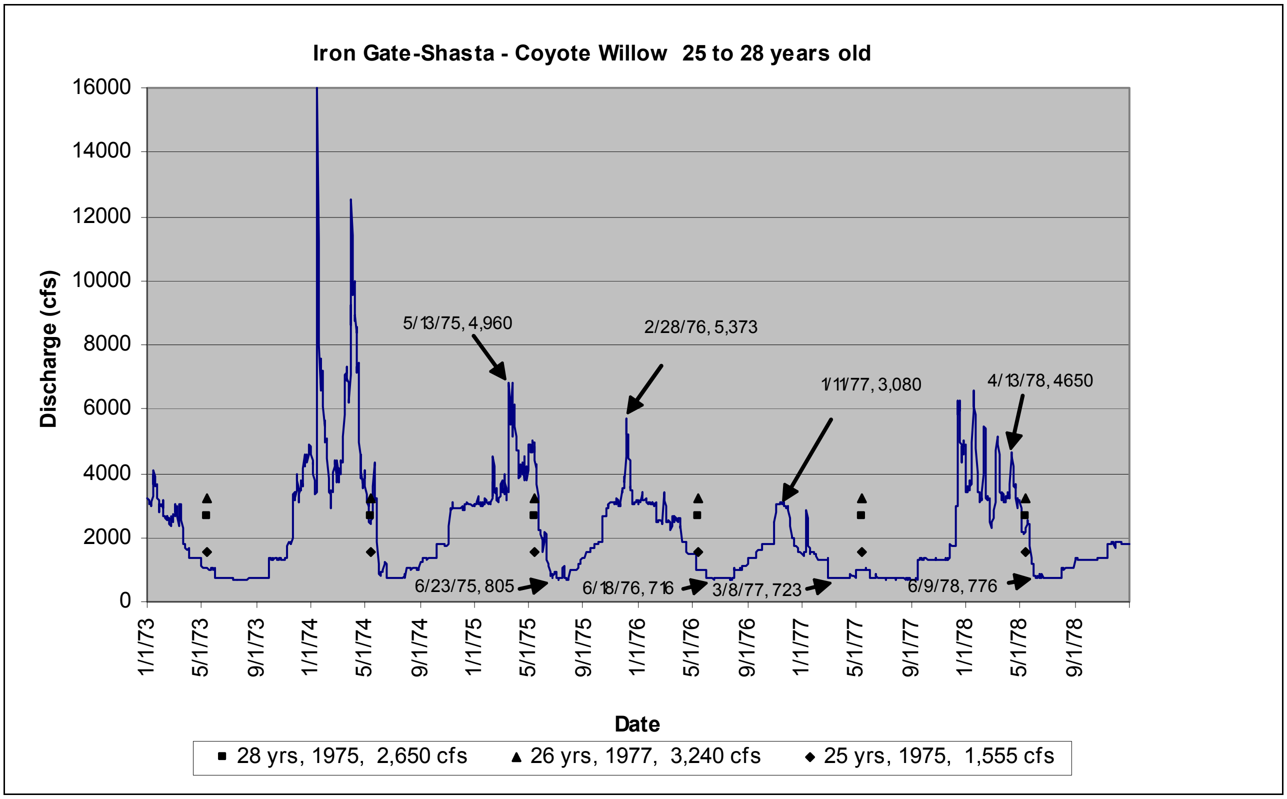


Figure 3.7-37. Twenty-five- to 28-year-old coyote willows at transects I5-1, I5-2, and IG-1 inundated at 2,650 cfs, 3,240 cfs, and 1,555 cfs, respectively. The labeled annotation refers to the date and flow (cfs) of the peak, and general low flows and the age and approximate flow (cfs) that is required to inundate the sampled tree.

The elevation of the 26-year-old tree at transect I5-2 was inundated at 3,240 cfs (91.8 cms). In 1977, the peak spring flow was only 3,080 cfs (87.2 cms), which is lower than the potential establishment site and occurred in January, well before seed dispersal (Figure 3.7-37). Also, the descending limb more or less reached its minimum flow by March 8, well before coyote willow seed is generally known to mature and disperse.

The inundation discharges associated with the elevations supporting the 25- and the 28-year-old trees correspond to time periods along the descending limbs of the hydrograph in 1978 and 1975, respectively, that coincide with the general dispersal dates for coyote willow seed in May and June (Figure 3.7-37). In 1975, the elevation of the sampled 28-year-old willow was exposed on or about May 23. The rate of drop in the river between May 23 and June 23, 1975, was -74 cfs (-2.1 cms)/day and -1.0 inch (-2.5 cm)/day (Table 3.7-7). In 1978, the elevation of the sampled 25-year-old willow was exposed on May 25. The rate of drop in the river between May 23, and June 23, 1978, was -65 cfs (-1.8 cms)/day and -0.94 inch (-2.4 cm)/day (Table 3.7-7). These rates are similar to those calculated for the sampled 36-year-old coyote willow.

The age group of 11-year-old willow trees would have established either from seed or from clonal sprouting in 1992. The hydrograph for 1992 reveals that elevations associated with the sampled trees never were inundated by peak flows in the 1992 water year or by the descending limb in May and June (Figure 3.7-38). There were only 7 years between 1964 and 2001 in which these elevations were not inundated in the Iron Gate reach. The two trees sampled at transect IG-4 are growing at elevations inundated by flows of 1,065 cfs (30.2 cms) and 1,545 cfs (43.8 cms).

The spring and summer flows in 1992 were among the lowest of any year between 1964 and 2001 and ranged from 400 (11.3 cms) to 850 cfs (24.1 cms). The trees growing at the elevation inundated by 1,065 cfs (30 cms) are approximately 2.21 feet (0.7 m) and 0.61 foot (0.19 m) above the 400 cfs (11.3 cms) and 850 cfs (24.1 cms) flows, respectively. The trees growing at elevations inundated by 1,545 cfs (44 cms) are approximately 3.4 feet (1.0 m) and 1.8 feet (0.6 m) above the 400 cfs (11.3 cms) and 850 cfs (24.1 cms) flows, respectively. The tree growing at the elevation inundated by 1,065 cfs (30 cms) at transect I5-1 is approximately 1.5 feet (0.5 m) and 0.4 foot (0.1 m) above the 400 cfs (11.3 cms) and 850 cfs (24.1 cms) flows, respectively. The elevations associated with these trees were inundated briefly three times between January 20, 1991, and March 16, 1993. Only one of the three brief periods of inundation (May 21, 1991) coincided with coyote willow seed dispersal period in May and June, which could lead to the conclusion that the 1992 recruitment was vegetative reproduction. Coyote willow is known to prefer a more constant water level (Busch and Smith, 1995) and may have responded to increased aeration in the soil in 1992 by increasing its foraging capability through vegetative suckering into areas that may be too wet in most years.

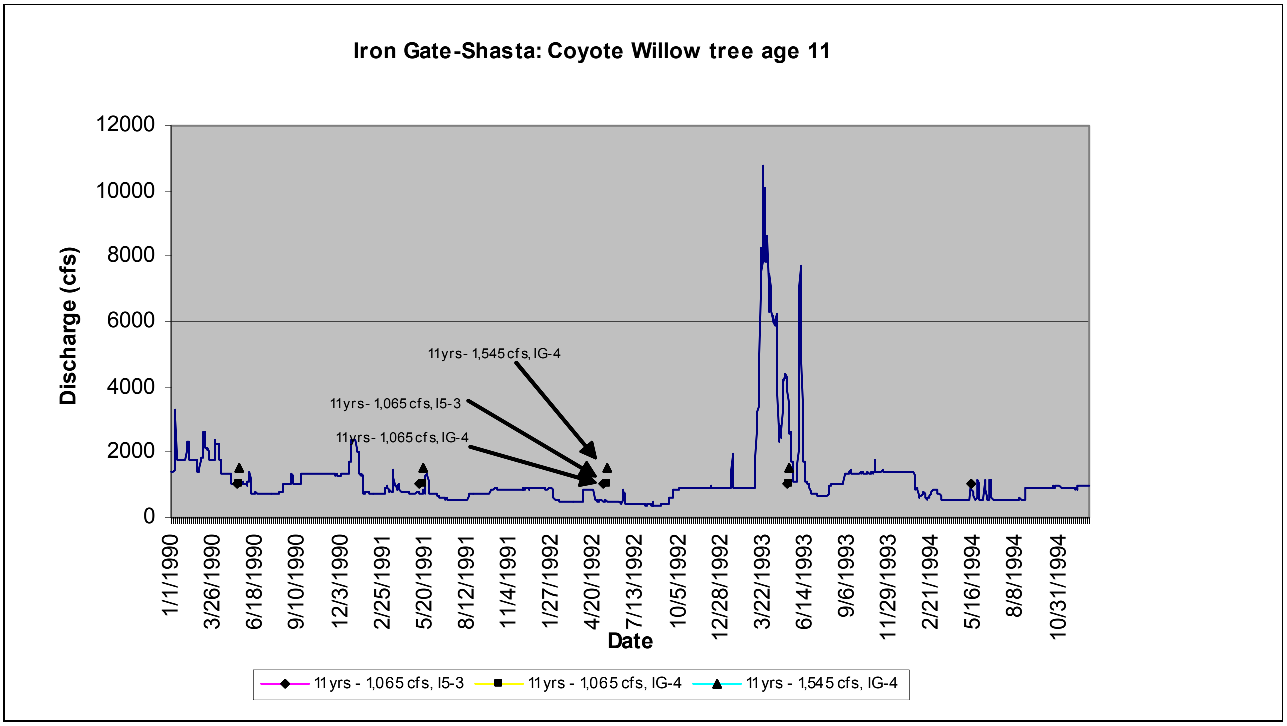


Figure 3.7-38. Eleven-year-old coyote willow inundated at 1,065 cfs and 1,545 cfs at transect IG-4 and at 1,065 cfs at transect I5-1. The labeled annotation refers to the date and flow (cfs) of the peak and general low flows and the age and approximate flow (cfs) that is required to inundate the sampled tree.

The clonal habit of coyote willow makes it difficult to know if the tree-age samples are the result of vegetative expansion by suckers or of sexual reproduction from seed. If it is assumed that tree-age samples resulted from sexual reproduction then the “establishment year” with the spring hydrographs for other years can be compared to get some idea of how often conditions that are suitable for reproduction may occur in the Iron Gate reach. The trees that are believed to have established in 1967 and in 1975 were chosen for comparison to the period of record from 1964 to 2001.

The working hypothesis is that coyote willow disperses seed during May and June, and the seed lands in moist, alluvial substrates just as they are becoming dewatered. There were 8 years between 1964 and 2001 in which the elevation associated with the sampled 36-year-old tree emerged in May (Table 3.7-6). There were no years in which the sampled 36-year-old tree elevation emerged in June.

Table 3.7-6. Summary statistics for years between 1964 and 2001 in which the elevation of the sampled 36-year-old tree at transect I5-3 emerged (4,830 cfs) in May and June.

Year	Emergence Limb Length (days)	Emergence Date	Tree Age* (years)	Maximum Emergence Discharge (cfs)	Approximate Summer Discharge (cfs)	Mean Daily Rate of Drop	
						(cfs/day)	(inches/day)
1967	32	18-May	36	5,080	694	-145 ± 311	-1.7 ± 3.8
1969	52	3-May	34	5,860	708	-75 ± 563	-0.93 ± 6.1
1971	32	19-May	32	5,750	820	-166 ± 581	-1.7 ± 4.9
1975	53	4-May	28	5,050	765	-77 ± 191	-0.92 ± 2.2
1983	54	6-May	20	4,960	757	-85 ± 324	-0.97 ± 3.3
1989	38	1-May	14	5,290	733	-123 ± 391	-1.4 ± 4.0
1995	33	7-May	8	5,760	755	-131 ± 383	-1.5 ± 3.3
1996	53	19-May	7	6,390	1,030	-63 ± 428	-0.74 ± 3.4

* Hypothetical tree ages at I5-3 transect with exception of measured 36-year-old tree.

The rate of drop in the river after dewatering in the eight potential "establishment" years ranges from -0.9 to -1.9 inches (-2.4 to 4.7 cm) in stage per day or -80.8 to -154.1 cfs (-4.7 to -4.36 cms) per day. There are not large difference between the "May/June" mean daily rate of drop (Table 3.7-6) and the rates calculated for the entire descending limb (Table 3.7-5); the rate of decent is steeper in four of the eight "May/June" years. The mean daily rates for the entire limb generally have a much higher standard deviation because of innumerable spikes in the hydrographs after the spring peak. The spikes occurring before May likely have little effect on willow with the exception of spikes large enough to cause in-channel changes to alluvial surfaces thereby creating the fresh alluvium required by coyote willow for germination, or, if the descending portion of the spike happens to correspond with willow seed dispersal. Larger spikes or floods occurring after seed dispersal may drown or scour new seedlings. However, smaller spikes may provide needed moisture to new seedlings. For example, Fremont cottonwood and black willow can have higher seedling densities in positions closer to the water table (i.e., closer to the river) at base flows, but greater survival on higher alluvial surfaces protected from scouring and inundation during floods (Stromberg et al. 1991). In 5 of the 8 years, there were spikes that inundated the 36-year-old tree elevation after the initial dewatering in early May. In 1969, 1975, 1983, 1995, and 1996 the spikes inundated the 36-year-old tree elevation for 1 to 4 days and by 0.3 to 0.6 foot (0.1 to 0.2 m) of water. In all of these years, the spikes in flow still occurred within the estimated dispersal period and potentially could coincide with willow seed dispersal.

Because these spikes in flows are relatively small, they may have had little if any effect on any potential new seedlings in those 5 years. One tentative conclusion of this analysis is that, at this elevation, there was a potentially suitable May/June hydrograph every 4 years during the period of record from 1964 to 2001. If it is assumed that the descending limb associated with 1967 in May and June promoted willow establishment, then the rate of drop in the descending limb can be evaluated and an attempt can be made to determine if willow root growth could have kept pace with the declining water table. The rate of drop in 1967 was -145 ± 311 cfs (-4.1 ± 8.8 cms) per day (Table 3.7-6) (see below for comparison to literature values for rate of drop).

Table 3.7-7. Summary statistics for years between 1964 and 2001 in which the elevation of the sampled 28-year-old tree at transect I5-1 emerged (2,650 cfs) in May and June.

Year	Emergence Limb Length (days)	Emergence Date	Tree Age[1] (years)	Maximum Emergence Discharge (cfs)	Approximate Summer Discharge (cfs)	Rate of Decent	
						(cfs/day)	(inches/day)
1967	13	6-Jun	36	3,400	694	-202 ± 356	-2.9 ± 5.0
1970	26	17-May	33	2,930	694	-76 ± 302	-1.2± 4.6
1971	10	10-Jun	32	2,700	820	-223 ± 262	-3.2 ± 3.6
1972	36	30-Apr	31	3,480	782	-67 ± 373	-0.96 ± 4.7
1974	47	10-May	29	4,340	725	-50 ± 296	-0.73 ± 3.6
1975	34	23-May	28	3,160	765	-74 ± 194	-1.0 ± 2.6
1978	36	3-May	25	2,900	772	-65 ± 131	-0.94 ± 1.9
1979	21	14-May	24	3,010	721	-121 ± 208	-1.7 ± 2.9
1982	30	13-May	21	2,880	714	-73 ± 175	-1.1 ± 2.6
1983	9	20-Jun	20	2,820	757	-241 ± 330	-3.6 ± 4.5
1984	48	30-May	19	3,090	725	-56 ± 251	-0.79 ± 3.1
1985	17	1-May	18	2,880	1,020	-134 ± 170	-1.8 ± 2.2
1989	23	16-May	14	2,720	733	-106 ± 250	-1.5 ± 3.6
1993	47	14-May	10	2,930[2]	736	-53 ± 649	-0.77 ± 6.0
1995	22	18-May	8	2,990	755	-143 ± 230	-1.9 ± 2.6
1996	67	5-May	7	2,670[2]	1,030	-25 ± 450	-0.35 ± 4.3
1997	59	6-May	6	3,240	823	-59 ± 209	-0.75 ± 2.3
1998	18	18-Jun	5	2,800	1,120	-123 ± 280	-1.6 ± 3.6
1999	50	20-May	4	2,710	1,370	-39 ± 135	-0.49 ± 1.6
2000	39	13-May	3	2,670	1,040	-50 ± 101	-0.69 ± 1.3

[1] Hypothetical tree ages at I5-1 transect with exception of measured 28-year-old tree.

[2] Second peak in 1993 and 1996 was 7,710 cfs (5/25) and 6,390 cfs (6/5), respectively.

There were 20 years between 1964 and 2001 in which the elevation associated with the sampled 28-year-old tree emerged in May and June (Table 3.7-7). Hypothetically, the elevation occupied by the 28-year-old tree receives appropriate flows for establishment approximately 54 percent of the time. The rate of drop in May/June flows for 1975 was -74+/-194 cfs (2.1 +/- 5.5 cms) per day during a 34-day period starting on May 23, 1975. The elevation of the 28-year-old tree is less than the elevation for the sampled 36-year-old tree and more spike flows in the descending limb that inundate the site following the initial May/June dewatering would be expected. However, there were 2 years, 1993 and 1996, in which flows re-inundated the 28-year-old tree elevation. In 1996, the threshold elevation initially dewatered on May 6 (2,540 cfs [71.9 cms]), then the river dropped to 1,420 cfs (40.2 cms) on May 11, increased to 5,190 cfs (147.0 cms) on May 19, and then dropped again to 2,380 cfs (67.4 cms). At the peak flow, the threshold elevation was inundated by 2.7 feet (0.8 m) of water, which could have killed new seedlings by drowning, scour, erosion, or even burial by sediment.

If, however, willow already was established at this elevation, then a spike in flow like the 1996 spike or even a larger spike actually might have a positive effect on the growth of coyote willow. Sedimentation is known to initiate adventitious rooting in coyote willow (Krasney et al. 1988). Vegetation established on river bars increases surface roughness thereby encouraging sedimentation (Hupp, 1992). Increased sedimentation buries existing low-growing vegetation, which decreases competition for coyote willow and helps maintain the habitat suitable for coyote willow dominance. Sedimentation also potentially raises the elevation of the river bar thereby creating a habitat for colonizing species that prefer river bars at slightly higher elevations, such as black cottonwood or shining willow. The only site near the mainstem of the Klamath River in the Iron Gate reach where black cottonwood was observed was at the mouth of Cottonwood Creek. The largest willows in the reach were typically old shining willow trees and minimal willow reproduction observed. One shining willow tree was determined to be approximately 100 years old. It may be that there are no river bars at appropriate elevations to support cottonwood and species of willow other than coyote willow.

The Project river reaches are highly constrained by geomorphology and little meandering or aggradation was evident in the Project reaches. Even large flows have invoked only relatively minor in-channel changes to alluvial surfaces (see Water Resources FTR, Section 6.7). The established riparian vegetation along narrow river banks and minor floodplains appear relatively unaffected by large flows. The peak flows that have occurred during the period of record seem to do little more than maintain the river channel and have little to do with floodplain development. It may be that the general scarcity of finer sediment moving through the river is limiting the ability of large flows to deposit fresh sediment into the floodplain at least upstream of Cottonwood Creek. Scouring within the channel following the 1964 flood was observed in 1965 aerial photography, but in many years, the threshold of mobility is probably too high because the bed material is coarse (see Water Resources FTR, Section 6.7). Aggradation and degradation appear to be somewhat limited by geomorphological constraints, reduced fines in the bedload and generally coarse substrates.

In many studies in the literature, researchers have indicated that fluvial processes can play a major role in generating landforms (i.e., floodplains of different heights) suitable for the establishment of woody riparian species (Stromberg et al. 1991; Johnson, 1994; Scott et al. 1983; Rood and Mahoney, 2000). This is probably because these studies typically are being performed in braided and meandering river systems that have distinctly different geomorphic characteristics than the Project river reaches. The zone of interaction of fluvial and geomorphic process in the Project river reaches seems to be primarily limited to in-channel alluvial deposits. This may help explain why riparian tree species associated with river bars at higher elevations than coyote willow do not appear to be regenerating on the mainstem of the Klamath River.

The potential limitations to the survival of coyote willow seedlings related to scour, sedimentation, and submergence were discussed previously. The literature on the establishment of cottonwood and species of willow implicate the abrupt drop in the descending limb of the hydrograph as a primary cause for failure of cottonwood and willow to regenerate because root growth cannot keep pace with the drop in river stage. Rood and Mahoney (1991) cite various studies that consistently determined that a drop of approximately 2 inches (5 cm)/day or less was required for seedling survival. If the May/June hydrographs are compared to that value, it is obvious that the mean rate of drop in the Iron Gate reach is less than 2 inches (5 cm) per day in all 8 years associated with the elevation of the 36-year-old willow (Table 3.7-6) and in 17 of

20 years associated with the elevation of the 28-year-old willow (Table 3.7-7). The standard deviations for the mean rates of drop, however, are quite high.

The elevations of the 28-year-old and the 36-year-old willow are 2.3 feet (0.7 m) and 3.8 feet (1.2 m), respectively, above the mean summer low flow or base flow (797 cfs [22.3 cms]) in July. The growth of seedling roots needs to be in contact with the water table at the end of the growing season to ensure survival. There are limits to how far seedling roots can grow during the first year of growth. The root growth of seedlings of Fremont cottonwood and Goodding's willow could not always keep pace with the drop in water table level to the end of summer when growing on surfaces more than approximately 2 feet (0.6 m) above the summer base flow (Stromberg et al. 1991). These two species became scarce on surfaces more than 2 feet (0.6 m) above the summer base flow. The 36-year-old willow would have had to grow almost twice this distance, which seem unlikely. As stated above, it may be that the current elevation of the 36-year-old tree is not representative of its elevation in 1967. The elevation of this surface may have aggraded since 1967.

<u>J.C. Boyle Peaking Reach.</u> The tree-age data collected in the J.C. Boyle peaking reach were not subjected to the same analysis as tree age elevations in the Iron Gate reach. This assessment is more qualitative primarily because of an insufficient coverage of hourly data in the period of record. The trees were collected at transects 2015B (RM 204.6) and 177B (RM 206.5). The ages determined for some of the older coyote willow trees were somewhat unreliable because of rot; the estimated ages of the older willows ranged from 42 to 66 years old. The inundation discharge for trees sampled at transects 2015B and 177B was 2,948 cfs (84 cms) and 1,885 cfs (54 cms), respectively; the estimate of return interval is 1.1 years and less than 1 year, respectively. The approximate inundation frequency for both sites is 16 to 17 hours. Many of the willow colonies in the J.C. Boyle peaking reach consisted of one or more older trees surrounded by stems of varying size and densities. There were often a few old dead stems of willow either standing or prostrate within many of the colonies. It is likely that the many of these colonies pre-date the construction of J.C. Boyle dam.

One of the locations where younger trees were sampled was at transect "peak-70A" at RM 216.6. The distribution of young stems well away from the larger established colony may represent new recruitment either from seed or from a piece of root; it seems unlikely, but not impossible, that the young stems are the result of "long distance" suckering. The young trees were determined to be 4 and 5 years old and were positioned on top of a section terrace or floodplain that had slumped 2 to 3 feet. The slumped portion of the terrace was fully vegetated and willows ranged in age from 4 years to 24 years. The stems were positioned in a chronological sequence from youngest to oldest upriver to a larger colony. The hydrograph for 1979, which approximates the year of establishment for the 24-year-old willow, was not exceptional. The elevations of these willows falls within the varial zone and are inundated by discharges ranging from 1,014 cfs (29 cms) to 2,950 cfs (84 cms). The estimated inundation frequency ranged from 11 to 16 hours, based on hourly flow data from 1997 to 2001. The annual peak flows in 1978 and 1979, which may have caused the terrace to slump, are unexceptional. During that 5-year period, these elevations were inundated approximately 700 to 800 times. This type of inundation pattern likely was not conducive to reproduction of coyote willow from seed for several of the reasons discussed above. The riparian vegetation at transect "peak-70A" is dominated by reed canarygrass along the river. It seems clear that coyote willow can increase its distribution by suckering in the peaking reach when the conditions are right. The ability of coyote willow to reproduce by suckering probably contributes to the ability of this species to persist on in-channel bars and islands between establishment events.

A large Oregon ash stand located at RM 204.6 is the largest riparian deciduous stand in any of the Project sections. The ash trees range in age from 63 to 79 years, which correspond to 1940 and 1924, respectively. This is one of the few higher elevation floodplains in the peaking reach that is inundated by peak flood flows up to 12,000 cfs (340 cms) and has a return interval of about 13 years. The dense cover of Himalayan blackberry and Oregon ash currently provides too much shade to support colonizing species, such as cottonwood or willow. However, a few spindly coyote willow remain in the middle of the stand from what was probably once a large coyote willow colony.

Keno Canyon

The post-1921 flow regime, which has lower spring flows and a more rapid decrease in flows between spring high flows and summer low flows, may be a deterrent to establishment of some woody riparian species (Figure 3.7-18). The flow data from 1904 to 1913 (USGS gauge at Keno, Oregon) indicates that before the construction of Link River dam in 1921 the mean monthly flows were higher in every month but October and November compared to the post-1921 flow regime (Figure 3.7-18). The differences in mean monthly flow with respect to stage are greatest in June and July with differences of 3.1 feet (0.93 m) (=2,167 cfs [61.4 cms]) and 2.5 feet (0.75 m) (=1,420 cfs [40.2 cms]), respectively. (The stage differences are based on the stage-discharge relationship modeled at transect KC-geo-2 at RM 232.3.). Based on mean monthly flows, the timing of the spring peak and yearly low flows from pre-1921 to post-1921 were also very different. The low mean monthly flow for pre-1921 and post-1921 was 1,159 cfs (32.8 cms) in September and 666 cfs (18.9 cms) in July, respectively; the resulting difference in stage is 1.0 foot (0.3 m). The shift in timing of the average descending limb and yearly low flow potentially affects the reproduction of shining willow. Shining willow trees were the only riparian tree species represented by large trees, more than 100 years old in Keno Canyon. Shining willow seed disperses from June to August (Brinkman, 1974). The elevation of the 100-plus-year-old tree at transect KC-geo-3 (RM 232.4) is inundated by a flow of approximately 2,200 cfs (62.3 cms) that corresponds roughly to decreasing mean monthly flows in June for the period of record from 1904 to 1913 (Figure 3.7-18).

3.7.3 Historic (Pre-Project) Vegetation Analysis

Figures 3.7-39, 3.7-40, 3.7-41, and 3.7-42 show the historic, pre-Project vegetation types for areas currently inundated by Keno (between current dam and the historical Needle dam site), J.C. Boyle, Copco, and Iron Gate reservoirs, respectively. It should be noted that this information was developed as a reference condition to help identify factors important to understanding existing conditions. It was not intended to be an assessment of original Project impacts because current conditions are the baseline for this relicensing process. Because numerous studies have

Figure 3.7-39. Keno reservoir historic vegetation cover.

11x17 front

Figure 3.7-39

Back

Figure 3.7-40. J.C. Boyle reservoir historic vegetation cover.

11x17 front

Figure 3.7-40

Back

Figure 3.7-41. Copco reservoir historic vegetation cover.

11x17 front

Figure 3.7-41

Back

Figure 3.7-42. Iron Gate reservoir historic vegetation cover.

11x17 front

Figure 3.7-42

Back

documented the importance of riparian and wetland habitat to wildlife (e.g., Swanson et al. 1982; Gregory et al. 1991; Kauffman et al. 2001), an emphasis of the analysis was on the distribution of these habitats under pre- and post-Project conditions. Assessment of the aerial and oblique photography taken before each dam being constructed indicated that in general, the distribution of wetland and riparian habitat in these areas consisted of long, thin bands running along the historic Klamath River channel. In comparison, somewhat wider, but more widely scattered patches of these vegetation types exist along the present-day Project reservoir shorelines. Table 3.7-8 provides a summary of riparian and wetland habitat extent for pre- and post-Project conditions for all Project reservoirs combined.

Table 3.7-8. Existing and pre-Project riparian and wetland vegetation shoreline lengths for Project reservoirs.

Reservoir	Existing Conditions Reservoir Shoreline Length		Pre-Project Conditions Shoreline Length	
	(feet)	(percent)	(feet)	(percent)
Keno	6,903	29	6,562	35
J.C. Boyle[1]	13,216	30	12,829	28
Copco[2]	12,544	19	37,334	49
Iron Gate[3]	22,809	22	63,149	68

1 Existing conditions acreage and shoreline do not include the aquatic bed.

2 Existing conditions acreage includes 36.1 acres of PFO wetland that is adjacent to, but not hydrologically dependent on, the reservoir.

3 Existing conditions acreage includes several stringers of riparian vegetation along tributaries.

As indicated in Table 3.7-8, the percentage of shoreline wetland and riparian habitat is less than pre-Project levels that existed except at J.C. Boyle reservoir. The greatest difference in terms of percentage was for Iron Gate reservoir. The greater shoreline length of wetland and riparian habitat in the J.C. Boyle reservoir vicinity (30 versus 28 percent) (Table 3.7-8) likely reflects the large contiguous wetland areas that developed from upland habitat along the southeast shore of the reservoir and at the mouth of Spencer Creek.

Although, in general, there is a lower proportion of shoreline with wetland and riparian areas today compared to pre-Project conditions, comparison of pre-Project vegetation mapping with existing riparian habitat revealed a concomitant increase in the average width of shoreline wetland and riparian patches (Table 3.7-9). The average width of shoreline wetland and riparian patches is more than double for each reservoir area for existing versus pre-Project conditions. However, the difference in quality between current and historic aerial photography sets used may make this comparison less accurate. Average shoreline wetland and riparian patch width increases pre- to post-Project installation ranged from 218 percent (100.9 to 220.3 feet [30.8 to 67.2 m]) for Copco reservoir to 426 percent (22.5 to 95.8 feet [6.9 to 29.2]) for Iron Gate reservoir.

Table 3.7-9. Percent shoreline length and average wetland and riparian corridor widths for existing and pre-Project conditions.

Reservoir	Existing Conditions		Pre-Project Conditions	
	Percent Shoreline Length	Average Corridor Width (feet)	Percent Shoreline Length	Average Corridor Width (feet)
Keno	29	108.1	35	27.3
J.C. Boyle	30	207.3	28	58.3
Copco	19	220.3	49	100.9
Iron Gate	22	95.8	68	22.5

In the relatively arid environment surrounding the Klamath River in the Project vicinity, riparian corridors typically exist as narrow, fragmented bands with habitat extending from water channels only as far as can be supported by a river's hydrology and elevated water table. However, Project reservoirs have shoreline elevations that include expanses of flat, formerly upland areas, which now support wider fragmented patches of wetland and riparian habitat.

Analysis of changes to wetland and riparian habitat would be incomplete without a thorough assessment of specific changes to habitat areas located adjacent to each Project reservoir. The availability of wetland and riparian habitat areas for use by wildlife may be limited depending on the distribution and spatial arrangement of all surrounding habitat types. The extent of fragmentation is dependent on the size and juxtaposition of the wetland and riparian habitat patches. The sections below describe and quantify differences in vegetation and habitat types between pre-Project riverine shoreline and existing reservoir margins.

Keno Reservoir

Relative to the large-scale pre-Project to current Project differences in habitat types at other Project reservoirs, the portion of Keno reservoir between the dam site and the old Needle dam that formerly occurred near the highway bridge has remained largely unchanged from conditions documented in 1952 aerial photographs. Although Keno reservoir under current conditions encompasses 2,475 acres (1,002 ha), only 124 acres (50 ha) were created as part of Project operations. Before the development of Keno reservoir to its current extent, Needle dam, located approximately 5,000 feet (1,524 m) upstream of the current location of Keno dam, held upstream water levels at the same elevation and extent as today. Thus, only 5 percent of the total area currently inundated by Keno reservoir has changed post-Project implementation. Given that the river channel was historically wide in this location and riverine aquatic habitat accounted for nearly 80 acres (32 ha) of the 124 acres (50 ha) added to the reservoir in 1955, the Project expansion of Keno reservoir in 1955 resulted in the conversion of only 44 acres (18 ha) of upland habitat to open water.

Table 3.7-10 provides a summary of habitat types that existed in 1952 under what is now Keno reservoir from the historic location of Needle dam downstream to the current location of Keno dam. Table 3.7-11 provides a summary of habitat types in the same portion of the river that is now part of Keno reservoir. It must be emphasized that these tables do not reflect habitat types in the same land footprint. However, a comparison of percent shoreline length provides a general overview of habitat change around Keno reservoir from the early 1950s to today.

Table 3.7-10. Historic vegetation cover types in area now occupied by Keno reservoir.*

Cover Type	Cover Type Code	Area		Mainstem Shoreline Length		Tributary Shoreline Length	
		Acres	Percent	Feet	Percent	Feet	Percent
UPLAND TYPES							
Annual/Perennial Grassland	AGL	3.51	2.8	1,870	9.9	0	0.0
Mixed Chaparral	MXC	2.08	1.7	1,768	9.3	0	0.0
Rabbitbrush	RB	0.64	0.5	378	2.0	0	0.0
Sagebrush	SB	7.56	6.1	944	5.0	0	0.0
Pasture	PA	23.29	18.8	3,107	16.4	0	0.0
Developed/Disturbed	DST	2.82	2.3	548	2.9	0	0.0
Subtotal—Uplands		39.90	32.2	8,614	45.4	0	0.0
WETLAND AND RIPARIAN TYPES							
Palustrine Emergent	PEM	1.16	0.9	2,133	11.2	0	0.0
Riparian Grassland	RG	0.41	0.3	0	0.0	0	0.0
Riparian Shrub	RS	2.54	2.1	4,429	23.4	0	0.0
Subtotal—Wetlands and Riparian		4.11	3	6562	34.6	0	0.0
AQUATIC TYPES							
Riverine Unconsolidated Bottom	RUB	79.84	64.5	3,788	20.0	0	0.0
Total		**123.85**	**100**	**18,965**	**100**	**0**	**0**

* Source: EDAW, Inc. Interpretation of July 15, 1952, black-and-white aerial photographs.

Table 3.7-11. Vegetation cover types adjacent to Keno reservoir.[1]

Cover Type	Cover Type Code	Area[2]		Reservoir Shoreline Length	
		Acres	Percent	Feet	Percent
UPLAND TYPES					
Ponderosa Pine	PP	80.26	19.7	623	2.6
Mixed Chaparral	MXC	13.82	3.4	1,006	4.1
Rabbitbrush	RB	50.78	12.5	10,200	42.1
Sagebrush	SB	18.01	4.4	2,174	9.0
Residential	RES	224.53	55.1	2,413	10.0
Industrial	IND	0.48	0.1	314	1.3
Disturbed	DST	2.16	0.5	610	2.5
Subtotal—Uplands		390.04	95.8	17,339	71.5
WETLAND AND RIPARIAN TYPES					
Palustrine Emergent	PEM	14.04	3.4	6,277	25.9
Palustrine Scrub-Shrub	PSS	3.08	0.8	626	2.6
Subtotal—Wetlands and Riparian		17.12	4.2	6,903	28.5
Total		**407.17**	**100**	**24,242**	**100**

1 Source: EDAW, Inc. Land Cover (limited to area between the present day dam and the dam site present in 1955).

2 Includes all polygons that share boundary with reservoir.

A comparison of percent shoreline differences in habitat type between pre-Project and existing conditions along Keno reservoir reveals that there is a slightly lower percent of wetland and riparian habitat today. Pre-Project (Table 3.7-10), 34.6 percent of the Klamath River shoreline consisted of wetland and riparian habitat, while currently, along this same portion of the reservoir, 28.5 percent of the shoreline consists of wetland and riparian habitat. However, under current conditions only a smaller portion of the wetland and riparian habitat consists of shrub habitat than what was along the river. Thus, while the percent of shoreline areas consisting of wetland and riparian habitat along Keno reservoir has remained largely unchanged, the nature of such habitat has changed largely from a riparian shrub community to palustrine emergent vegetation. Some of this conversion is likely the result of increased agricultural uses along the shorelines.

J.C. Boyle Reservoir

A comparison of historic habitat distribution (Figure 3.7-40) with current conditions around J.C. Boyle reservoir reveals that currently there is more wetland and riparian habitat surrounding the reservoir in this area. The low-lying uplands located southeast of the Klamath River that used to be composed of sagebrush and grassland now are dominated by a large contiguous patch of palustrine emergent wetland near the Sportsmen's Park that has formed from the raised water level.

Only 20.5 percent of the mainstem Klamath River shoreline historically located under J.C. Boyle reservoir consisted of wetland and riparian habitat (Table 3.7-12). However, 98.8 percent of in-flowing tributary shorelines in this area were bordered by wetland and riparian habitat. These areas have developed into the large contiguous patches of wetland habitat extending inland from the confluence of J.C. Boyle tributaries with the reservoir. This was most evident adjacent to the Sportmen's Park and the wetland at the mouth of Spencer Creek. Thus, excluding the aquatic bed habitat, wetland or riparian communities currently border approximately 22.9 percent of the reservoir shoreline (Table 3.7-13).

Table 3.7-12. Historic vegetation cover types in area now occupied by J.C. Boyle reservoir.*

Cover Type	Cover Type Code	Area		Mainstem Shoreline Length		Tributary Shoreline Length	
		Acres	Percent	Feet	Percent	Feet	Percent
UPLAND TYPES							
Annual/Perennial Grassland	AGL	101.78	30.0	6,268	15.5	53	1.2
Sagebrush	SB	41.69	12.3	3,954	9.8	0	0.0
Juniper	J	1.12	0.3	339	0.8	0	0.0
Ponderosa Pine	PP	33.19	9.8	8,748	21.6	0	0.0
Klamath Mixed Conifer	KMC	5.25	1.5	3,151	7.8	0	0.0
Mixed Chaparral	MXC	3.98	1.2	1,786	4.4	0	0.0
Developed/Disturbed	DST	9.24	2.7	2,728	6.7	0	0.0
Subtotal—Uplands		196.26	57.9	26,974	66.5	53	1.2
WETLAND AND RIPARIAN TYPES							
Palustrine Emergent	PEM	12.14	3.6	6,071	15.0	1,488	32.6
Riparian Grassland	RG	3.46	1.0	1,184	2.9	3,029	66.3
Riparian Shrub	RS	1.56	0.5	1,057	2.6	0	0.0
Subtotal—Wetlands and Riparian		17.16	5.1	8,312	20.5	4,517	98.8
AQUATIC TYPES							
Riverine Unconsolidated Bottom	RUB	125.83	37.1	5,260	13.0	0	0.0
Total		**339.25**	**100**	**40,546**	**100**	**4,570**	**100**

* Source: EDAW, Inc. Interpretation of August 9, 1952, black-and-white aerial photographs.

Table 3.7-13. Vegetation cover types adjacent to J.C. Boyle reservoir.[1]

Cover Type	Cover Type Code	Area[2]		Reservoir Shoreline Length	
		Acres	Percent	Feet	Percent
UPLAND TYPES					
Perennial Grassland	PGL	68.38	7.8	683	1.2
Klamath Mixed Conifer	KMC	10.75	1.2	1,516	2.6
Ponderosa Pine	PP	611.51	69.9	16,954	29.4
Sagebrush	SB	39.56	4.5	3,092	5.4
Mixed Chaparral	MXC	18.44	2.1	3,700	6.4
Exposed Rock	ER	11.86	1.4	1,666	2.9
Residential	RES	3.07	0.4	432	0.7
Recreation	REC	10.41	1.2	2,476	4.3
Subtotal—Uplands		773.99	88.5	30,518	52.9
WETLAND AND RIPARIAN TYPES					
Palustrine Emergent	PEM	62.45	7.1	12,870	22.3
Palustrine Aquatic Bed	PAB	37.62	4.3	13,935	24.2
Riparian Grassland	RG	0.44	0.1	346	0.6
Subtotal—Wetlands and Riparian		100.51	11.5	27,151	47.1
Total		**874.50**	**100**	**57,670**	**100**

[1] Source: EDAW, Inc. Land Cover.
[2] Includes all polygons that share boundary with reservoir.

Historically, the riparian corridor surrounding both the mainstem and tributaries was dominated by a narrow fringe of palustrine emergent wetland with a small amount of riparian grassland and riparian shrub (Table 3.7-12). Under current conditions, wetland habitats surrounding the reservoir are wider, but are still dominated by palustrine emergent wetlands (Table 3.7-13). Riparian scrub shrub habitat does not occur on the immediate reservoir shoreline, but exists nearby in Spencer Creek.

Copco Reservoir

A comparison of historic vegetation distribution around Copco reservoir (Figure 3.7-1) with existing conditions reveals that there are large differences in habitat distribution and surrounding land-use. As mentioned above, Copco reservoir was the only Project reservoir that had a lower amount of available wetland and riparian habitat compared to historic conditions. Before reservoir development, lands now inundated by Copco reservoir supported a total of 86.5 acres (34.6 ha) of wetland and riparian habitat (Table 3.7-14). Currently, lands surrounding Copco reservoir include 63.43 acres (25.67 ha) of wetland and riparian habitat (Table 3.7-15). Much of the existing acreage is on slopes above the reservoir and not truly influenced by the Project hydrology.

Percent of shoreline occupied by wetland and riparian habitat types is currently lower than it was for the historic river shoreline (18.5 versus 47.2 percent, respectively). Historically, habitat peripheral to Klamath River tributary shorelines under the current footprint of Copco reservoir consisted completely (100 percent) of wetland and riparian areas (Table 3.7-14). Under pre-Project conditions, there were several large river bends that supported well developed riparian forests.

As opposed to the unique topographical areas around Keno and J.C. Boyle reservoirs where new wetland and riparian habitat became established after reservoir inundation, the topography of the Klamath River valley in the current vicinity of Copco reservoir limited the establishment of wetland and riparian areas following reservoir inundation. Historically, the lands under Copco reservoir consisted of a wide floodplain confined by steep slopes. Several river bends supported wide, dense riparian forest. With the water shoreline now extending up these steep slopes, few areas are available for wetland and riparian habitat establishment. The shoreline slope at Copco reservoir was 19 percent, which is substantially greater than that at either Keno or J.C. Boyle reservoirs. Under current conditions, the Copco reservoir shoreline runs adjacent to upland along 81.5 percent of its length (Table 3.7-15). This is substantially higher than historic conditions along the Klamath River in this area where about 43.8 percent of the shoreline was surrounded by uplands (Table 3.7-14). Notably, upland areas existing adjacent to Copco reservoir consist primarily of steep areas of grasslands with sparse oak and oak conifer forest; habitat types historically present, but located outside of and above the Klamath River floodplain.

Table 3.7-14. Historic vegetation cover types in area now occupied by Copco reservoir.*

Cover Type	Cover Type Code	Area		Mainstem Shoreline Length		Tributary Shoreline Length	
		Acres	Percent	Feet	Percent	Feet	Percent
UPLAND TYPES							
Annual/Perennial Grassland	AGL	5.33	0.5	8	0.0	0	0.0
Juniper	J	25.10	2.5	1,248	1.7	0	0.0
Montane Hardwood Oak	MHO	192.00	19.2	11,909	16.1	0	0.0
Montane Hardwood Oak—Conifer	MHOC	144.56	14.5	9,123	12.3	0	0.0
Mixed Chaparral	MXC	13.40	1.3	3,122	4.2	0	0.0
Exposed Rock	ER	1.40	0.1	670	0.9	0	0.0
Pasture	PA	92.81	9.3	1,460	2.0	0	0.0
Orchard	OR	37.58	3.8	2,459	3.3	0	0.0
Agriculture	AG	73.33	7.3	2,439	3.3	0	0.0
Residential	RES	7.14	0.7	0	0.0	0	0.0
Developed/Disturbed	DST	2.93	0.3	0	0.0	0	0.0
Subtotal—Uplands		595.59	59.6	32,438	43.8	0	0.0
WETLAND AND RIPARIAN TYPES							
Palustrine Emergent	PEM	10.15	1.0	714	1.0	0	0.0
Palustrine Forested	PFO	10.15	1.0	2,445	3.3	0	0.0
Riparian Deciduous	RD	18.40	1.8	8,332	11.3	0	0.0
Riparian Grassland	RG	12.64	1.3	394	0.5	0	0.0
Riparian Mixed	RM	5.43	0.5	161	0.2	2,366	100.0
Riparian Shrub	RS	29.68	3.0	22,922	31.0	0	0.0
Subtotal—Wetlands and Riparian		86.45	8.7	34,968	47.2	2,366	100.0
AQUATIC TYPES							
Riverine Unconsolidated Bottom	RUB	119.56	12.0	173	0.2	0	0.0
OTHER							
Unknown	UNK	197.65	19.8	6,452	8.7	0	0.0
Total		**999.25**	**100**	**74,032**	**100**	**2,366**	**100**

* Source: EDAW, Inc. Interpretation of historic land cover maps (C. 1900) and photos.

Table 3.7-15. Vegetation cover types adjacent to Copco reservoir.[1]

Cover Type	Cover Type Code	Area[2]		Reservoir Shoreline Length	
		Acres	Percent	Feet	Percent
UPLAND TYPES					
Annual/Perennial Grassland	AGL	296.38	26.0	10,983	16.2
Juniper	J	38.18	3.4	1,181	1.7
Montane Hardwood Oak	MHO	265.48	23.3	18,211	26.9
Montane Hardwood Oak—Juniper	MHOJ	12.34	1.1	353	0.5
Montane Hardwood Oak—Conifer	MHOC	335.27	29.5	10,288	15.2
Klamath Mixed Conifer	KMC	8.77	0.8	187	0.3
Mixed Chaparral	MXC	48.78	4.3	3831.2	5.7
Residential	RES	36.17	3.2	7,848	11.6
Recreation	REC	0.57	0.1	458	0.7
Industrial	IND	20.37	1.8	320	0.5
Pasture	PA	9.11	0.8	1,151	1.7
Disturbed	DST	2.97	0.3	374	0.6
Subtotal—Uplands		1,074.38	94.4	55,185	81.5
WETLAND AND RIPARIAN TYPES					
Palustrine Emergent	PEM	6.57	0.6	4,831	7.1
Palustrine Forested	PFO	36.05	3.2	4,542	6.7
Palustrine Scrub-Shrub	PSS	1.58	0.1	1,884	2.8
Riparian Deciduous	RD	19.22	1.7	1,288	1.9
Subtotal—Wetlands and Riparian		63.43	5.6	12,544	18.5
Total		**1,137.81**	**100**	**67,729**	**100**

[1] Source: EDAW, Inc. Land Cover.

[2] Includes all polygons that share boundary with reservoir.

Another distinct difference between Copco reservoir (and to a lesser extent Iron Gate reservoir) and the upper Project reservoirs described above, was the sinuous nature of the historic Klamath River channel in these lower Project sections. Development of Keno and J.C. Boyle reservoirs simply served to elevate and extend the river shorelines. Thus, the total shoreline length increased through the development of the upper Project reservoirs (allowing an apparent increase in total wetland and riparian shoreline length concomitant to a decrease in the percent shoreline length of these habitat types in the case of Keno reservoir). However, in the area now occupied by the lower Project reservoirs—most notably Copco reservoir—the Klamath River channel consisted of complex sinews winding through a larger floodplain. Inundation of the various river channel reticulations resulted in a decrease in the total shoreline length.

Iron Gate Reservoir

In general, pre-Project upland habitat conditions peripheral to the Klamath River in areas now inundated by Iron Gate reservoir were similar to pre-Project habitat conditions in the Copco reservoir vicinity. However, much of the river shoreline was adjacent to steep upland areas in the river canyon (Table 3.7-16). Before reservoir development, the large wetland and riparian habitat areas that currently exist near the mouths of Jenny, Scotch, and Camp creeks were at elevations above the mainstem Klamath River (i.e., they were located on flat, elevated steps above the river) and were composed mostly of upland vegetation. Reservoir development raised the reservoir water level and created a flat bench for wetland and riparian vegetation.

Table 3.7-16. Historic vegetation cover types in area now occupied by Iron Gate reservoir.*

Cover Type	Cover Type Code	Area		Mainstem Shoreline Length		Tributary Shoreline Length	
		Acres	Percent	Feet	Percent	Feet	Percent
UPLAND TYPES							
Annual/Perennial Grassland	AGL	376.4	39.9	14,980	20.2	53	0.3
Montane Hardwood Oak	MHO	159.0	16.9	6,346	8.5	0	0.0
Montane Hardwood Oak—Juniper	MHOJ	86.0	9.1	5,181	7.0	0	0.0
Mixed Chaparral	MXC	45.9	4.9	578	0.8	0	0.0
Pasture	PA	133.9	14.2	1,319	1.8	0	0.0
Rock Talus	RT	0.5	0.0	0	0.0	0	0.0
Subtotal—Uplands		801.7	85.0	28,404	38.3	53	0.3
WETLAND AND RIPARIAN TYPES							
Palustrine Emergent	PEM	2.0	0.2	704	0.9	0	0.0
Palustrine Scrub-Shrub	PSS	0.5	0.1	136	0.2	0	0.0
Riparian Deciduous	RD	29.1	3.1	42,884	57.8	18,039	98.8
Riparian Shrub	RS	1.0	0.1	1,216	1.6	170	0.9
Subtotal—Wetlands and Riparian		32.6	3.5	44,941	60.5	18,208	99.7
AQUATIC TYPES							
Riverine Unconsolidated Bottom	RUB	108.5	11.5	883	1.2	0	0.0
Total		**943**	**100**	**74,227**	**100**	**18,262**	**100**

* Source: EDAW, Inc. Interpretation of August 9, 1955, black-and-white aerial photographs.

A comparison of the shoreline length with wetland and riparian habitat indicates that there are lower amounts on the current reservoir than on the historic river. Before development of Iron Gate reservoir, 44,941 feet (13,697 m) or 60.5 percent of the river shoreline consisted of wetland and riparian habitat (Table 3.7-17). Currently, 21.6 percent of the reservoir shoreline, a total of 22,809 feet (6,952 m), runs adjacent to wetland and riparian habitat. Habitat surrounding tributaries now inundated by reservoir waters consisted almost entirely (99.7 percent) of wetland and riparian corridors. A general characterization of habitat differences between current reservoir and historic river channel at Iron Gate reservoir is that historically, long, narrow strips of wetland and riparian habitat existed along the historic river and tributaries, and, currently, a reservoir with widely scattered patches of riparian/wetland habitat along the reservoir edge exists.

Table 3.7-17. Current vegetation cover types adjacent to Iron Gate reservoir.[1]

Cover Type	Cover Type Code	Area[2]		Reservoir Shoreline Length	
		Acres	Percent	Feet	Percent
UPLAND TYPES					
Annual/Perennial Grassland	AGL	916.8	29.4	21,015	19.9
Juniper	J	404.3	12.9	10,383	9.8
Montane Hardwood Oak	MHO	747.9	23.9	18,568	17.5
Montane Hardwood Oak—Juniper	MHOJ	775.7	24.8	14,758	13.9
Mixed Chaparral	MXC	170.5	5.5	7,248	6.9
Exposed Rock	ER	0.8	0.0	559	0.5
Rock Talus	RT	1.5	0.0	231	0.2
Residential	RES	8.3	0.3	0	0.0
Recreation	REC	24.6	0.8	5,080	4.8
Industrial	IND	15.5	0.5	2,478	2.3
Developed	DEV	1.8	0.1	615	0.6
Disturbed	DST	5.0	0.2	2,068	2.0
Subtotal—Uplands		3,072.5	98.4	83,003	78.4
WETLAND AND RIPARIAN TYPES					
Palustrine Emergent	PEM	7.3	0.2	6,687	6.3
Palustrine Forested	PFO	27.7	0.9	3,369	3.2
Palustrine Scrub-Shrub	PSS	11.5	0.4	11,048	10.4
Riparian Deciduous	RD	3.4	0.1	1,093	1.0
Riparian Shrub	RS	0.3	0.0	613	0.6
Subtotal—Wetlands and Riparian		50.2	1.6	22,809	21.6
Total		**3,122.7**	**100**	**105,813**	**100**

1 Source: EDAW, Inc. Land Cover.

2 Includes all polygons that share boundary with reservoir.

3.8 DISCUSSION

The following sections discuss the existing and future conditions of riparian/wetland resources in the Project study area. This information will be used in coordination with other investigations to assess potential Project impacts on plants and wildlife.

3.8.1 Characterization of Existing Conditions

The following sections describe the overall existing conditions of wetland and riparian communities along reservoirs and river reaches. Additional information on the condition of riparian and wetland communities is presented in the vegetation characterization (Section 2.7), noxious weed (Section 8.7), and grazing (Section 9.7) sections of this FTR.

Reservoirs

The TWINSPAN analysis of reservoirs sites included 445 plots and 135 species; the analysis identified 12 different vegetation types for all reservoirs combined. The analysis of growing season hydrology data indicated that within each reservoir there was good separation of the vegetation types based on the inundation duration/elevation gradient represented by DCA Axis 1. Inundation duration and plot elevation were the best explanatory variables for the separation of plot scores along DCA Axis 1. DCA Axis 2 explained nearly as much variation in the species/abundance data as the first DCA Axis, but correlated poorly with the environmental variables. The plot scores along the second DCA Axis appeared to reflect differences in general environmental conditions between plots at Keno reservoir and at J.C. Boyle reservoir.

Keno Reservoir

Keno reservoir has the most wetland/riparian habitat, the highest diversity of riparian/wetland vegetation types, and the highest abundance of habitats disturbed by industry and agriculture. The steady pool level in Keno reservoir creates a continuous margin of wetland/riparian vegetation except where the adjacent land use creates disturbance (i.e., cattle grazing, industrial development, water control structures, active or abandoned cultivated fields). Irrigation returns in many areas along the reservoir confound the effects of inundation from the reservoir. The generally low-lying topography adjacent to the reservoir is unique among the Project reservoirs. These low-lying areas represent the old floodplain and support the few remnants of native vegetation that contribute to the high diversity of vegetation types at Keno reservoir. The generally low gradient of adjacent upland areas extends into the reservoir in most areas excluding Lake Ewauna. These areas currently under the reservoir could present significant restoration opportunities should the mean pool level be lowered under a different management scenario. If Keno reservoir were managed as a frequently fluctuating reservoir like J.C. Boyle reservoir, then the result might be similar in that the exposed mudflat would be relatively free of vegetation cover.

Willow-dominated vegetation is rare at Keno reservoir and was sampled only at two sites. The average inundation duration for coyote willow at these sampled sites was less that 0.01 percent compared to 23 and 17.5 percent for coyote willow vegetation types at Iron Gate and Copco reservoirs, respectively. The relatively constant pool level and low-gradient shoreline permit willow at the two sampled sites to tap into the relatively stable water table level and grow higher up on the bank. Recent disturbance to the substrate at one sampled site may have provided germination sites for coyote willow or at least stimulated vegetative expansion by vegetative suckering.

Most wetlands at Keno reservoir are located at the Tule Smoke Gun Club (Rat Club) and at the ODFW Klamath Wildlife Refuge. In some areas around Keno reservoir, the combination of a high water table, dikes that hold back the reservoir pool that might directly inundate surrounding land, and abandoned agricultural developments perpetuate marsh-like habitats with a thick spongy layer of organic matter and tall, emergent hardstem bulrush and stinging nettle. The tops of the berm and levies often are dominated by weedy species, such as poison hemlock and Canada thistle. The pool level at Keno reservoir fluctuates less than at the other Project reservoirs. This fact, together with the generally low-lying character of land around Keno reservoir, allows this reservoir to support much more wetland vegetation than the other Project reservoirs

J. C. Boyle Reservoir

J.C. Boyle reservoir is a relatively small reservoir that fluctuates in accordance with operation of the J.C. Boyle powerhouse and/or inflows influenced by the upstream irrigation project. In some portions of the reservoir there are wide margins of bare mudflat exposed on a daily basis whereas other areas are more constrained and flow like a river during low pool levels. J.C. Boyle reservoir is the only Project reservoir that has no woody riparian/wetland vegetation immediately along the shoreline. Observations from the two sampled coyote willow stands at Keno reservoir may provide some general guidelines for site characteristics to look for if introducing willow to J.C. Boyle reservoir is determined to be a management objective. The low-gradient topography at J.C. Boyle reservoir appears to be conducive to wicking from the reservoir and supports dense emergent marsh and wet to dry meadow vegetation. The historic aerial photography indicates that these areas did not have a wetland signature before construction of J.C. Boyle dam. Currently, the portions of the reservoir that have steeper gradient shorelines have little in the way of riparian/wetland vegetation and transition quickly to upland shrub and tree-dominated vegetation. Cattle grazing along the northwest shoreline has resulted a fairly durable close-cropped, wet to mesic meadow vegetation. J.C. Boyle reservoir has the fewest occurrences of exotic, non-native invasive species of any of the Project reservoirs. The wetland vegetation does not appear to be limited by reservoir operation/hydrology given that the growth of herbaceous wetland vegetation was lush by comparison to other Project reservoirs.

J.C. Boyle reservoir generally has undisturbed wetland/riparian vegetation. However, some low-gradient areas along the northwest shoreline are grazed by cattle grazing along the reservoir margin. Recreation access points and where roads and transmission lines cross or come close to the reservoir tend to be more disturbed and have a ruderal or weedy mixture of plant species including reed canarygrass at the reservoir margins. Woody and herbaceous riparian and wetland vegetation a few hundred feet from the reservoir along Spencer Creek is particularly lush and intact, primarily because of the fence that protects this area. The Spencer Creek wetlands appear to be relatively uninfluenced by the reservoir pool level. The last few hundred feet of Spencer Creek are influenced by reservoir fluctuation and have herbaceous riparian vegetation only along the normal high pool elevation and low, grazed, mesic meadow vegetation in adjacent higher elevations.

Copco and Iron Gate Reservoirs

Copco and Iron Gate reservoirs are similar with respect to topography, vegetation, and hydrological parameters. The mostly low herbaceous riparian/wetland vegetation at the shoreline is heavily grazed and the vegetation has an abundant ‘weedy” component of starthistle and medusahead in many locations. Coyote willow stands are common and abundant in some portions of the shoreline where the gradient is shallow. Coyote willow appears to be able to reproduce at least infrequently in some portions of Iron Gate reservoir and Copco reservoir. The working hypothesis is that the availability of fresh substrates in which coyote willow seed can germinate is limiting the distribution of coyote willow. Sites at Iron Gate reservoir provide examples of willow reproduction in colluvial deposits eroded from steep slopes under current reservoir management practices despite fairly wide fluctuations in reservoir level during some parts of the growing season. Dense, low vegetation cover is also a potential barrier to willow reproduction because it is durable and not easily eroded. In other studies, researchers have documented that a low level of cattle grazing can increase seedling densities by creating disturbance and openings in dense herbaceous cover that may otherwise compete with willow seedlings (see Section 3.7.2.2, Copco and Iron Gate Reservoirs). Conversely, heavy grazing is typically detrimental to willow seedling survival and growth. Herbivory from cattle and deer also may be a factor limiting the distribution of willow at Iron Gate and Copco reservoirs. Another limiting factor for willow along the reservoirs may be the relatively long periods between recruitment events, especially at Copco reservoir, because it takes time for shoreline slopes to erode and supply the bare substrates essential for willow recruitment in new areas from seed.

Most tree-dominated wetlands and riparian habitats along Iron Gate and Copco reservoirs are associated with the larger tributaries of Jenny, Scotch, Dutch, and Beaver creeks. Several of these areas have been degraded by recreational activity (e.g., Jenny Creek and Camp Creek) or livestock grazing. Shrub- and tree-dominated wetlands along the shorelines of these reservoirs are relatively young. In some areas, the wave action on the reservoir appears to be slowly eroding some of the steep shoreline slope. The slumping or eroding soil accumulates at these sites to form narrow, low-gradient benches that were observed to support young coyote willow stands, especially at Iron Gate reservoir. Most shorelines areas have only a thin, interrupted growth of individual wetland plants growing along the narrow margin of potential wetland habitat where the reservoir pool level intersects steep slopes. Lower gradient shorelines generally support continuous bands of herbaceous wetland vegetation that is kept in a low-growing state by grazing cattle and deer during the growing season.

3.8.1.1 River Reaches

The TWINSPAN analysis of river sites examined 618 plots along 52 transects and 501 species. The result was the following numbers of vegetation types in each river reach: Link River—five types, Keno Canyon—nine types, J.C. Boyle bypass and peaking reaches—11 types, Fall Creek—five types, Copco No. 2 bypass—five types, and Iron Gate-Shasta—12 types.

The DCA results for Link River and Fall Creek indicate that the relationship to the elevation/inundation duration gradient is invalid because seepage from the West Side canal and from Fall Creek canal, respectively, confound the inundation/elevation gradient. The same is true for Copco No. 2 bypass with respect to seepage from the Copco No. 2 flowline even though hydraulic variables were not calculated for this reach. In Keno Canyon, discharge, return interval, boulder cover, and silt cover all had slightly higher correlations with DCA Axis 1 than inundation duration. Inundation duration may have performed poorly in Keno Canyon because of difficulties associated with modeling stage-discharge for one of the sampled transects. Inundation duration performed best as an explanatory variable in the Iron Gate-Shasta reach and in the J.C. Boyle peaking and bypass reaches. Discharge and return interval were typically among the best performing variables in these reaches, but tended to be poorly correlated with plots lower in the cross-section profile.

Link River

In addition to the confounding effects of seepage from the West Side canal, there is another reason for the poor performance of inundation duration in explaining site score for plots at Link River. One transect that was included in the TWINSPAN analysis used to classify Link River riparian vegetation types was not included in the DCA because it could not be safely measured during the instream flow study conducted by PacifiCorp. The absence of these data resulted in small sample sizes for some riparian vegetation types that grow at the lowest end of the elevation gradient. This vegetation type was dominated by hardstem bulrush and reed canarygrass, which is the dominant vegetation type growing on in-channel bars and at island margins.

The Red Osier Dogwood/Reed Canarygrass vegetation type is hypothesized to represent, in part, the range of elevations over which riparian vegetation most likely would be affected by river hydrology without the influence seepage from the West Side canal. The 8-year return interval (6,031 cfs [171 cms]) that was calculated for plots at the upper end of the elevation range for the Red Osier Dogwood/Reed Canarygrass vegetation type approximates the riparian vegetation maintenance flow of 1.5 to 10 years hypothesized by Hill et al. (1991) to maintain riparian vegetation in alluvial reaches in the arid western United States. One important observation in the Link River reach that potentially has implications for other reaches is that red osier dogwood (and other native and non-native woody species) provides shade that appears to limit the upslope spread of reed canarygrass. Other herbaceous species that are more tolerant of shade appear to be able to persist alongside reed canarygrass in some of the wet areas that are heavily shaded by the shrub and tree canopies.

The Link River reach riparian and wetland vegetation is affected to a large degree by the urban surroundings, hydroelectric development, and past agricultural developments in the reach. People frequently use the urban trail that runs along the West Side canal and the well-established dirt paths that run throughout the riparian vegetation. Many impromptu campsites occur in the thick cover of riparian trees and shrubs. The vegetation has a large compliment of introduced and naturalized populations of elm, plum, and apple particularly along the right (west) bank. The riparian vegetation along the right bank forms relatively continuous cover that is structurally diverse. The East Side canal/flowline is associated with a higher level of ground disturbance and discontinuous vegetation that is primarily restricted to the edge of the left bank. Recent maintenance activities have resulted in clearing most of the vegetation along the east side of the Link River reach.

Keno Canyon

Flow regimes in the reach below Keno dam appear to have changed following construction of the upper basin irrigation project and Link River dam, affecting vegetation composition below Keno dam particularly for woody riparian trees. The flow data from 1904 to 1913 (USGS gauge at Keno, Oregon) are the only indicator of the flow regime before the construction of Link River dam in 1921. These data indicate that mean monthly flows were generally larger before the construction of Link River dam. The differences in mean monthly flow with respect to stage are greatest in June and July with differences of 3.1 feet (0.93 m) (=2,167 cfs [61.4 cms]) and 2.5 feet (0.75 m) (=1,420 cfs [40.2 cms]), respectively. The flow data also indicate that the timing and magnitude of the mean monthly spring high flows and the summer/fall low flows were different than the post-1921 flow regime. The spring high flow switched from occurring in

March to occurring in April. The yearly low flow based on mean monthly flow data for pre-1921 and post-1921 was 1,159 cfs (32.8 cms) in September and 666 cfs (18.9 cms) in July, respectively; the resulting difference in stage is 1.0 foot (0.3 m).

The generally lower flows in post-1921 Keno Canyon, particularly during the growing season, promote encroachment of riparian vegetation.

The change in flow regime after the construction of Keno dam (1966)was a continuation of the flow regime that presumably began with the irrigation diversions from the upper basin. After 1968, however, the magnitude of mean monthly flows was generally higher in March and even lower in July compared to the 1930 to 1968 flow regimes. The lower mean monthly flows in July during the growing season likely would have facilitated additional encroachment of riparian vegetation into the valley bottom. The flow regime in Keno Canyon probably is affected further by maintenance of Keno reservoir at a constant pool level to regulate irrigation inflows and withdrawals; the result is that flows in Keno Canyon hover at one stage, then dart to another, then another. This pattern may not affect riparian vegetation in the Keno reach as much as the general decrease in flows, especially during the growing season that may have resulted from upper basin and Keno reservoir irrigation diversions. Flow regime changes that increase base flows in Keno Canyon may scour some of the existing reed canarygrass clumps and it may drown others if they are inundated for long enough periods during the growing season.

The change in the timing of the descending limb and yearly low flow that came about after 1921 potentially had ramifications for the reproduction of shining willow, which was the only riparian tree species represented in Keno Canyon by large trees more than 100 years old. If the period of record from 1904 to 1913 is truly representative of flows before the construction of Link River dam, it is difficult to reconcile the differences in the timing and magnitude of spring flows and base flows unless the use of Klamath River water for irrigation or general climatic differences (different precipitation pattern between the period of record before 1913 and the period after 1930) may explain these differences. The 1904 to 1913 hydrograph is hypothesized to be favorable to establishment of trees such as shining willow and cottonwood that disperse seed later in the summer in June and July, the months that correspond more closely to the timing of the declining water levels for that period. No recently established shining willows have been observed, possibly indicating that current conditions are less than suitable for establishment. The shift of the descending limb of the hydrograph could have ramifications for the Upper Klamath River reaches below Link River dam with respect to riparian tree reproduction.

The Keno Canyon reach primarily supports intact, undisturbed riparian grass vegetation dominated by reed canarygrass. The slopes of the canyon are steep, yet the riparian vegetation is fairly consistent along the narrow shoreline in most areas along the reach. The transition from riparian to upland vegetation is structurally diverse with many connections to primarily shrub-dominated vegetation (or forested types with shrub understories) on the canyon slopes. The exception to this is at river access points that have been heavily used by fishermen.

J.C. Boyle Bypass Reach

J.C. Boyle bypass reach is a case study of reduced flows creating a lower, wider area available for riparian plants in the canyon bottom. Reed canarygrass is a dominant component of vegetation types in the J.C. Boyle bypass reach, especially in the wetted valley bottom. However, the more consistent flow regime distinguishes this reach from both Keno and J.C. Boyle peaking reaches. Herbaceous species other than reed canarygrass were observed growing in some part of the reach. Young sedges (*Carex* cf. *nudata*) and willow are reproducing in the some parts of the bypass reach. The identification of this sedge species was not confirmed, but river sedge is a species known to prefer more stable water level, which is provided in the J.C. Boyle bypass reach. It may be that relatively large, periodic spill and maintenance flows (compared to the 320 cfs [9.0 cms] base flow) are enough to scour and keep some surfaces available for colonization by species other than just reed canarygrass. A sustained increase in base flows may actually kill some reed canarygrass by scouring or by drowning, depending on the depth and duration of the new flow regime.

The vegetated banks of J. C. Boyle bypass reach (which includes some stream channel) are typically wider than other reaches and have predominantly reed canarygrass vegetation growing among the large, coarse boulder substrate. One of the more obvious landmarks in the bypass reach is the canal and the long, steep slopes of the canal banks. The fill bank below the canal in some areas is not suitable riparian substrate although some trees are growing among the boulders in some places. Another obvious feature of the bypass reach is the spillway at the end of the canal. The scour zone below the spillway is devoid of almost any vegetation because of periodic scouring flows.

J.C. Boyle Peaking Reach

The Oregon Ash/Himalayan Blackberry vegetation type had the largest trees of all riparian stands in the peaking reach. This vegetation type was growing on a large and relatively old river deposit that has a silt/sand substrate with much accumulated organic material. Old coyote willow trees, perhaps as old as 62 years, occur at the fringe of this stand and a few young, wispy willow occur under the dense 62- to 79-year-old Oregon ash trees. This stand is growing on an alluvial surface that likely aggraded during a period when coyote willow dominated the site and trapped sediment. This site is one of the few higher elevation floodplains in the peaking reach and is inundated by peak flood flows of approximately 12,000 cfs (340 cms) and has a return interval of about 13 years.

Four vegetation types—Kentucky Bluegrass/Yarrow/Field Cress, Oregon Oak/ Serviceberry/Snowberry, Kentucky Bluegrass/Timothy/ Bentgrass, and Perennial Ryegrass—grow on relatively "high and dry" terraces in the peaking reach. Analysis of the 1965 aerial photography revealed some scouring at the lowest edge of one of these larger terraces near Shovel Creek (RM 206) that likely resulted from the 1964 high water. In the peaking reach, the 1964 flood (8,830 cfs [250 cms]) was not exceptional in that higher yearly peak flows ranging from 8,500 to 11,600 cfs (241 to 328 cms) have occurred in 12 years since 1959. The larger terraces or floodplains in the reach appear to be little affected by recent peak flows, which may indicate that the large terraces in the peaking reach are relicts from a different flow regime of much greater magnitude in the past, perhaps during the Pleistocene. A 100- or 500-year flood (20,100 and 26,350 cfs [570 to 746 cms]), may be required to significantly alter some of larger alluvial terraces in the peaking reach. Based on aerial photography, Project geomorphologists noted only local changes in alluvial features and in riparian vegetation in this reach.

Respectively, 65, 90, and 100 percent of plots representing the Coyote Willow/Reed Canarygrass/Bentgrass, Reed Canarygrass, and Hardstem Bulrush/Reed Canarygrass vegetation types occurred within or below the "varial zone" that is associated with Project peaking flow fluctuations of 350 to 3,000 cfs (9.9 to 85 cms). These vegetation types would be most affected by changes to flow patterns in the varial zone. For the remaining peaking reach vegetation types, 65 to 100 percent of the plots representing these vegetation types occurred above the varial zone. The riparian vegetation maintenance flows for vegetation types above the varial zone are unaffected by flows in the varial zone and the upper boundary of the riparian vegetation is unlikely to change as a result of any prescribed changes to flows in the varial zone (see Section 3.7.2.2, Reed Canarygrass and Coyote Willow for further discussion). The plots representing the Coyote Willow/Reed Canarygrass/Bentgrass, Perennial Ryegrass, and Oregon Ash/Colonial Bentgrass/Woolly Sedge vegetation types were the most equitably distributed vegetation types across the upper boundary of the varial zone.

Many of the wetlands and irrigated pastures abutting the river in the J.C. Boyle peaking reach occur on relatively wide terraces primarily above the bank full zone. The larger pastures are located between the Oregon-California border and Copco reservoir. The wetland and riparian habitats in these pastures are fed by irrigation canals either intentionally or through leakage. This land use has two primary effects on the riparian wetland vegetation in the peaking reach (1) creating vertical and horizontal discontinuity in riparian vegetation along the river and (2), creating disturbance and reducing cover of native herbaceous and woody riparian vegetation thereby promoting conditions that are known to support exotic and non-native invasive species, such as Himalayan blackberry, whitetop, and non-native pasture grasses. Recreation land uses have similar effects on riparian vegetation, but are typically more restricted in area and have more intense disturbance associated with that smaller area. For example, at the BLM campground and at the Frain Ranch, motor vehicles use some of the few, generally small, floodplain terraces in the reach for parking. In contrast to many of the larger terraces used for agriculture downriver of the Oregon-California border, the terraces used for parking in the upper parts of the peaking reach are among the few higher floodplain surfaces in the reach that would have been inundated by larger peak flood flows between 1959 and 2001 (approximately 8,000 to 12,000 cfs [227 to 340 cms]). The fact that they are inundated by the current flow regime makes them critical sites for colonization by riparian plants following high flows that potentially disturb these sites and for restoration opportunities.

The width of riparian vegetation in many part of the J.C. Boyle peaking reach is dictated by geomorphological constraints, especially in the steeper portions of the reach. These reaches tend to have narrow, often discontinuous bands of riparian vegetation of primarily of reed canarygrass and relatively small patches of coyote willow. Many of the steeper portions of the reach are in the Hell's Corner reach and are relatively inaccessible except by boat. Evidence of occasional light cattle grazing and one river rafting campsite were observed in the gorge section of the reach.

<u>Copco No. 2 Bypass</u>

The Copco No. 2 vegetation types were observed to sort by elevation within the valley bottom, but this does not necessarily indicate that inundation duration is critical to their differentiation. This is because seepage from the adjacent wood stave flowline intercepts the left bank in many places and creates wetland habitats in the former river channel. The right bank is not affected by seepage and the vegetation types actually may be responding to inundation duration associated with river hydrology.

The encroachment of vegetation into the channel is obvious, with numerous mature white alder occupying what was formerly in-channel islands and bars formed during the pre-Copco dam (1925) flow regime. The white alder trees ages that were measured ranged from 32 (1971) to 62 (1941) years old; there are larger trees nearby that may pre-date the construction of the Copco No. 2 bypass facilities in 1925. There apparently is a gap in tree ages represented by the absence of trees ranging in size from small saplings to trees approximating the size of the sampled 32-year-old tree. There were no particularly large peak flows in the early 1970s compared to other years in the period of record that might have eroded the small tree age class.

Periodic spill flows may be enough to have killed intermediate-sized trees, but that seems unlikely. The white alder forest that established within the channel after Copco No. 2 dam was built in 1925 may have become too dense by the 1970s to support white alder reproduction. There was evidence that older white alder trees have died, which may have opened up the canopy enough to permit the establishment and growth of the small white alder saplings that can be observed today. Currently, there is no strong argument for explaining why there are few young white alder trees present in Copco No. 2 bypass. The 10 cfs (0.28 cms) base flow in Copco No. 2 bypass is held constant except during large spills typically associated with spring runoff or, on rare occasions, Project maintenance activities. A small increase in base flow in this reach probably would not kill the larger white alder in the reach. However, the increased scour associated with an increase in base flow likely would kill some of the young alder saplings and existing herbaceous vegetation, depending on the magnitude of the increase in base flow.

The white alder stands in the Copco No. 2 bypass provide some of the densest riparian tree cover in the Project area. These riparian forests are the result of encroachment after the river was diverted. The flowline in the bypass reach has numerous leaks and has created a substantial number of small “wetlands” on the left bank slopes above the river and on the river bars and islands exposed after the diversion was created. The seepage areas and the exposed in-channel bars and islands have been invaded primarily by native and non-native hydrophilic herbaceous species that form a relatively sparse herb layer under the dense white alder canopy.

Fall Creek

Similar to the Link River reach, seepage from the Fall Creek canal confound the inundation duration/elevation gradient for the riparian/wetland vegetation types along the creek. The seepage patterns help support the growth of species with affinities to both wetland and upland habitats growing in close proximity to one another. In some locations, the large conifer trees growing in close proximity to Fall Creek probably established soon after Fall Creek was diverted in 1903. Similarly, woody riparian deciduous species, such as western birch and Douglas’ spiraea probably also increased their distribution after 1903 in response to seepage from Fall Creek canal. The period of record available for Fall Creek extends from 1933 to 1959. These data were not particularly useful in assessing the vegetation patterns because the USGS gauge was located downstream of the diversion and Fall Creek powerhouse and does not reflect the flow history of the bypassed reach that was sampled.

In many locations where Fall Creek parallels the canal, it is difficult to determine exactly where the influence of river hydrology and seepage hydrology begins and ends. Cattle and horses were observed grazing in the wet meadow vegetation created by canal seepage. However, in downstream portions of Fall Creek where the creek is not influenced by canal seepage, the gradient of the creek steepens and the riparian vegetation becomes narrow, but was generally continuous and well-developed along the streambanks. The creek is also more exposed because of less cover of both riparian and adjacent upland trees. Greater exposure is conducive to the growth of herbaceous riparian/wetland plants species in small patches of in-channel alluvium.

Iron Gate-Shasta Reach

The Iron Gate reach vegetation types fall into three groups that occupy three generally different elevation zones. Group 1 consists of vegetation types that typically grow in or just above the water: Coyote Willow/Knotweed, Rice Cutgrass/Hardstem Bulrush, Hardstem Bulrush/Duckweed, and Curly Pondweed. Group 2 consists of vegetation types that occupy in-channel bars and islands and the lower floodplain elevations: Coyote Willow/Himalayan Blackberry, Coyote Willow/Poison Hemlock, and Oregon Ash/Bentgrass/Woolly Sedge. Group 3 consists of vegetation types that occupy steep banks and higher floodplain elevations: Oregon Oak/Bentgrass/Kentucky Bluegrass, Medusahead/Cheatgrass, Oregon Oak/Blue Wildrye, and Chicory/Tall Fescue.

The elevation inundated by a discharge of 5,300 cfs (150 cms) may approximate the upper elevation limit of vegetation types that have coyote willow as a dominant species. Above this elevation, the presence of any of the Group 3 vegetation types is likely to be influenced as much or more by adjacent land use (primarily recreation, agricultural, and road construction development) than by flows. Based on comparison of the 1965 aerial photography, it is likely that a flow greater than the 1964 flood (29,400 cfs [834 cms]) would be required to modify substrates at or above the elevation equivalent to 5,300 cfs (150 cms).

Large flood events or in-river construction are needed to create the fresh substrates that are conducive to willow colonization. The 1965 aerial photos show many locations along the Iron Gate reach with fresh in-channel surfaces resulting from the 1964 flood. Upstream of the I-5 rest area, one of the riparian sites sampled in 2002 appeared to have started forming or widening in 1965 aerial photography. By 1979, the sampled willow bar had grown to near its current size. Also by 1979, the width of another sampled willow bar downstream several hundred feet also had increased in width to near its current width. The formation of these bars may be jointly associated with the I-5 road improvements and the 1964 flood, which appears to have at least initiated bar formation. The construction of the I-5 bridge also forced the river into a new dominant left bank channel, which created an island immediately downstream of the bridge.

Woody riparian vegetation is more abundant in the Iron Gate reach than in any other Project reach. However, the tree-dominated stands are typically much smaller in area than some of the Oregon-ash-dominated stands in the J.C. Boyle peaking reach, white alder stands in the Copco No. 2 bypass, and the non-native-tree-dominated stands in the Link River reach. The lack of large riparian tree-dominated stands in the Iron Gate reach is the result of recreation development on the larger floodplain surfaces between Iron Gate dam and Cottonwood Creek. In most of the reach, the floodplain is mostly restricted to narrow terraces between the in-channel alluvium and steeper slopes or higher elevation surfaces. The narrow terraces typically support coyote willow, shining willow, Oregon ash, and Oregon oak. Cattle grazing in many areas has degraded these stands as well as some of the coyote willow stands growing on in-channel bars. Local landowners also have cleared willow stands in some portions of the reach. Signs of herbivory by beaver were observed in many of the willow stands. With the exception of recreation developments, the land uses described above generally create relatively minor breaks in riparian vegetation along the river although the structural diversity of the riparian vegetation is compromised by some of these land uses. Agricultural development, residential development, road construction, and various other types of developments have created major discontinuity between riparian vegetation and native upland vegetation types along most of the reach.

Coyote Willow and Reed Canarygrass

Coyote willow is most abundant in the Iron Gate-Shasta reach especially downstream of Cottonwood Creek and immediately downstream of Iron Gate dam. The descending limbs of the annual hydrographs for the period from the 1964 to 2001 were evaluated to determine the frequency of appropriate water level declines in May and June—months when coyote willow seed dispersal and germination likely occur. There were 8 years between 1964 and 2001 in which the elevation associated with the sampled 36-year-old willow tree were dewatered in May and June; the elevation of this tree was inundated by 4,830 cfs (137 cms). There were 20 years between 1964 and 2001 in which the elevation associated with sampled 28-year-old tree was dewatered in May and June; the elevation associated with this tree was inundated by 2,650 cfs (75 cms).

The rate of drop in water level was calculated from the date of peak flow preceding the estimated dewatering in May and June to the date when flows reached their approximate summer low flow. The rate of drop was compared to a hypothesized maximum rate of drop of 2.0 inches (5.0 cm) per day or less that allows root growth in cottonwood and willow seedlings to keep pace with declining water levels in their first year of growth. In all 8 years that the elevation of the sampled 36-year-old tree was dewatered in May and June, the rate of drop was less than 2.0 inches (5.0 cm) per day. In 17 of 20 years that the elevation of the sampled 28-year-old tree was dewatered in May and June, the rate of drop was less than 2.0 inches (5.0 cm) per day.

Because there are limits to how much seedling roots can grow during the first year of growth, it is important that the summer low flows do not result in plant seedling desiccation. For example, Fremont cottonwood and Goodding's willow seedling survival is low on surfaces more than 2.0 feet (0.6 m) above the summer base flow. The elevations of the sampled 28-year-old and the 36-year-old coyote willows in their establishment years were 2.3 feet (0.7 m) and 3.8 feet (1.2 m), respectively, above the mean summer low flow or base flow in July. The sampled 36-year-old willow would have had to grow almost twice the hypothesized distance, which seems unlikely. It may be that the bars on which the willows are growing have aggraded since their establishment year, or that the seedlings received sufficient moisture from the water table in their establishment year despite the large elevation difference.

In the Iron Gate reach, the timing of the descending river flows was appropriate for coyote willow reproduction from seed at the two elevations (sampled 36-year-old tree and sampled 28-year-old tree) evaluated in this study in 22 percent and 54 percent of the 37 years evaluated (1964 and 2001); again, this assumes coyote willow seed dispersal actually occurs in May and June. If coyote seed dispersal were to occur in June or later, then the percentage of years in which the timing of dewatering is deemed appropriate would be much lower. The rate of drop in the river was also appropriate for willow establishment from seed in most of the hypothesized "establishment" years (8 years and 20 years) evaluated. The water table at these sites, however, may be too low at most summer base flows to support willow seedling root growth in the first year. Another consideration is the possibility that the sampled trees were not established from seed, but from clonal growth. Of the two trees evaluated, the sampled 36-year-old tree was most likely the original tree because it was associated with the formation of the island at the I-5 bridge, based on aerial photography. However, even with aerial photography, it is not possible to perfectly track the origin of individual trees from seed.

Willow tree ages in the J.C. Boyle peaking reach were interpreted more qualitatively with respect to hydrological parameters. Trees estimated to be 42 to 66 years (1961 to 1937) are old specimens of this short-lived species. The literature reports maximum tree ages of 31 years, but this age was reported from only one study site. The ages of these trees are “ball park” estimates based on the average of two cores from each tree; all of the older sampled trees had rotten centers and the number of annual rings in the rotten sections was estimated based on the rate of growth in the oldest 1 inch of discernable annual rings. The “ballpark” estimates indicate these trees established either before or near the time of the construction of J.C. Boyle dam in 1959.

Many of the coyote willow colonies in the J.C. Boyle peaking reach had older, decadent trees surrounded by younger stems of various ages. Not all of the older stems were of the same size as the older sampled trees. The older sampled trees were all part of colonies that grew in the upper part of the varial zone. Based on hourly flow data, the sample of the older and younger trees from two different transects have been inundated approximately 350 and 750 times, respectively, in the 5 years between 1997 and 2001. This pattern of inundation for the sample of 4- to 6-year-old trees does not seem to be amenable to reproduction of coyote willow from seed. It seems more likely that all of the sampled younger trees are the result of clonal growth either from root fragments or from suckering following the slumping of the terrace.

The current hypothesis is that that willow does not establish from seed in the varial zone. This may be true for several reasons: (1) the elevations of alluvial surfaces where coyote willow might establish are inundated many times during the growing season, which either drown or scour young seedlings or wash willow seed into inappropriate sites, (2) dense reed canarygrass swards in most parts of the peaking reach may provide too much shade and competition for young willow seedlings, (3) fresh bare alluvium was not observed in the peaking reach in 2002 and 2003, which may indicate a general lack of finer bedload material in the system, which is consistent with the findings of the geomorphology study, and (4), the alluvial substrates observed in the peaking reach are often coarse and willow seeds that land in those locations likely would be deposited in dark crevices among the large cobble and boulders (coyote willow seed requires light to germinate).

Reed canarygrass is the most abundant riparian plant species in Keno Canyon and in the J.C. Boyle bypass and peaking reaches. In the J.C. Boyle peaking reach, reed canarygrass abundance has been shown to have a unimodal distribution with peak abundance centered on the upper part of the varial zone. The mean flow required to inundate the densest reed canarygrass swards, regardless of position within or outside the varial zone, is 2,188 cfs (62.0 cms) (95 percent CI = 1,804 cfs [51.1 cms]—2,572 cfs [72.8 cms]), which has a 31.3 percent inundation duration (95 percent CI = 22.3—40.3 percent). The scouring effect of flows lower in the varial zone in the J.C. Boyle peaking reach would appear to counter any beneficial effects of increased inundation on the abundance of reed canarygrass. At elevations above the varial zone, decreasing inundation duration is associated with lower abundance of reed canarygrass.

Reed canarygrass has been shown to be highly adaptable under a wide range of growing conditions and appears to respond positively to nutrient additions and/or inundation patterns (Conchou and Pielou, 1988; Rice and Pinkerton, 1993; Kercher and Zedler, 2004). Maurer and Zedler (2002) demonstrated that high nutrient and light levels increased the ability of reed canarygrass to invade native vegetation. Kercher and Zedler (2004), in a study of reed canarygrass into resident vegetation, demonstrated that nutrient addition increased both resident vegetation and reed canarygrass biomass and frequency. Constant flooding and early season flooding resulted in greater reed canarygrass biomass compared to intermittent flooding; the opposite results were observed in the resident vegetation. The addition of low and high amounts of nutrients to the different flood regimes showed reed canarygrass biomass to increase the most with the additive treatment of increasing flood intensity and increasing nutrient supply. The highest flood intensity in combination with the highest nutrient treatment resulted in the lowest growth for the resident vegetation.

The intermittent flood regime in the Kercher and Zedler (2004) study flooded reed canarygrass during the first 2 days of every 14-day cycle for seven cycles. It is difficult to determine if the 15.5-hour inundation frequency and 35.5 percent inundation duration observed for the highest abundance of reed canarygrass in the varial zone more closely approximate their intermittent flood regime or their early season and constant flood regimes. The 35 percent inundation duration for peak abundance of reed canarygrass is certainly greater than the approximately 14.3 percent inundation duration (2 days/14 days x 100) associated with their intermittent flood regime. The 35 percent inundation duration is far less than their constant flood regime (Kercher and Zedler, 2004). However, the calculated 35 percent inundation duration may underestimate the intensity of inundation in the varial zone because inundation occurs so frequently that soil conditions may remain anoxic between inundation events. It appears that increased nutrient supply from agricultural runoff and increased inundation in some parts of the varial zone may have additive effects in promoting the invasive and aggressive growth of reed canarygrass in the peaking reach.

In comparison, sampled plots in the J.C. Boyle bypass and Keno Canyon reaches have an even higher percentage of plots with reed canarygrass. The lower base flows in these reaches increase the available area for riparian plants, but only for those plants that can endure greater inundation. J.C. Boyle bypass and Keno Canyon reaches have even greater mean inundation duration values compared to J.C. Boyle peaking reach for vegetation types with greatest abundance of reed canarygrass at 54 percent (Figure 3.7-21) and 54 to 78 percent (Figure 3.7-16), respectively. The higher inundation values may help explain the relatively greater frequency and abundance of reed canarygrass in those reaches.

The distribution of reed canarygrass downstream of the J.C. Boyle peaking reach appears to be restricted to a few locations at the upper end of Copco reservoir and was observed near the mouth of Jenny Creek at Iron Gate reservoir. There is no good explanation of why reed canarygrass is not already abundant downstream of the J.C. Boyle peaking reach. Dams can act as barriers to "short-floater" seeds that die after less than 2 days of inundation, but may be less of a barrier to seeds capable of enduring longer period of inundation (Jansson et al. 2000). Comes et al. (1978) found that most reed canarygrass seed decomposed or germinated after 3 months, but could remain viable for up to 48 months. It is unlikely that reed canarygrass seed drowns in Project waters, but it might sink or Project dams may act as a barrier despite the relatively long life of reed canarygrass seed. There may be environmental differences, such as higher maximum air and water temperatures or algae growth in the reservoirs, that somehow may affect reed canarygrass seed viability and dispersal in the reservoirs. None of these explanations is convincing, however, and it may be only a matter of time before reed canarygrass increases its distribution downstream of the J.C. Boyle peaking reach.

3.8.2 Characterization of Future Conditions

Without protection, recreation and grazing along the lower river and Iron Gate and Copco reservoirs will continue to adversely affect the health of existing riparian communities. Some additional wetland/riparian habitat is likely to develop along reservoir margins in response to the slow process of sedimentation/erosion creating benches in the shallowly flooded zones. Historically, riparian habitat was never abundant or wide in the Project area. It conformed to topography and was influenced by adjacent land uses. PM&E measures proposed in Exhibit E of the license application will help protect and enhance this important resource.

J.C. Boyle reservoir is integral to the operation of J.C. Boyle powerhouse and any changes to the flow regime in the J.C. Boyle peaking reach will have a direct effect on the pool level management of J.C. Boyle reservoir. The effects of various hypothetical flow regimes on vegetation are discussed in more detail in Section 3.7.2. The structural diversity of wetland and riparian vegetation at J.C. Boyle reservoir could be enhanced in several locations by installing livestock exclusion fencing and planting willow at suitable sites.

Coyote willow establishment at Copco and Iron Gate reservoirs appears to occur infrequently because of a variety of factors including a short supply of available bare substrate, herbivory of willow seedlings and, in some years, large water level fluctuations. Willow plantings and exclusion fencing along the reservoirs would substantially increase the rate of spread of willow at these reservoirs.

Reed canarygrass currently grows at few locations at Copco and Iron Gate reservoirs. It is likely that this species will spread at these reservoirs given that no good reason is available to explain why it should not continue to spread. A weed management plan could help to control the spread of this species at Copco and Iron Gate reservoirs.

Relatively modest changes in the flow regime in the J.C. Boyle peaking reach are unlikely to influence vegetation in the reach to any great extent. For example, while a 100-cfs (2.8 cms) increase in the base flow (from 320 to 420 cfs [9.0 to 11.89 cms]) would reduce the width of the varial zone (by 1 to 19 feet [0.3 to 5.8 m] depending on the channel shape), it would not affect the lowest vegetation types—Hardstem Bulrush/ Reed Canarygrass and Reed Canarygrass—which have mean elevations inundated by discharge values of 754 cfs (21.3 cms) and 1,539 cfs (43.6 cms), respectively. Riparian plants would continue to be influenced (scoured) at elevations inundated by flows during both one-turbine (1,400 cfs [39.6 cms]) and two-turbine (3,000 cfs [85.0 cms]) peaking. An increased inundation duration associated with operations favoring more sustained flows could increase reed canarygrass biomass at elevations inundated by those flows. Reed canarygrass is known to respond well to increasing inundation intensity, but in the lower parts of the varial zone, the potential effects of increased inundation duration are countered by increased scour. At higher elevations in the varial zone, the effects of scouring are reduced and reed canarygrass starts to become more abundant where flows approach 1,807 cfs (51.2 cms). Reed canarygrass abundance peaks at elevations inundated by approximately 1,967 cfs (55.7 cms). It is possible that at times when inflows are limited (during the summer), an operational regime that favors one-unit peaking over two-unit peaking would increase the inundation duration below 1,400 cfs (39.6 cm) because of longer duration peaks compared to what would be possible under a two-unit peaking regime with the same amount of inflow. One implication of this would be that reed canarygrass would become more abundant at elevations inundated by 1,400 cfs (39.6 cms). It is also possible that at the same time this also may have an effect on the upper riparian vegetation zone by possibly decreasing the inundation duration at elevations toward the upper end of the riparian vegetation elevation gradient thereby potentially creating conditions appropriate for riparian species other than reed canarygrass.

For coyote willow reproduction and distribution in the J.C. Boyle peaking reach, the effects of modest changes in the flow regime are unlikely to change its status. There are many factors that need to come together for successful coyote willow reproduction, including peak (flood) flows that disturb and create fresh bare surface, timing of declining spring/summer flows that coincide with seed dispersal, declining flows during that growing season that keep pace with the growth of coyote willow roots, and alluvial surfaces that are not too high above the summer base flows so that coyote seedling roots can maintain contact with the water table. This is true for all Project river reaches where coyote willow currently is growing. The Klamath Irrigation Project and the Klamath Hydroelectric Project will continue to affect these factors to varying degrees in different reaches. In many years, it would be difficult to get the right combination of factors even in natural river systems that do not have regulated flows. The most effective way to increase the rate of expansion and abundance of willow in most reaches and reservoirs may be to actively prescribe willow restoration, including planting willow and excluding herbivores. After it is established, coyote willow is likely to maintain its presence in the reach by clonal growth in many instances and potentially will serve as important habitat for fish and wildlife species.

4.0 AMPHIBIAN AND REPTILE INVENTORY

4.1 DESCRIPTION AND PURPOSE

The purpose of this study was to document the presence of amphibian and reptile species in the study area and to determine whether species are affected by ongoing operations of the Klamath Hydroelectric Project. This study combines existing information with new surveys to document species occurrence and identify important habitats and sites for amphibians and reptiles.

4.2 OBJECTIVES

The following are objectives of the Amphibian Reptile Inventory:

- Document amphibian and reptile species occurrence and relative abundance near the Project.
- Describe the distribution of important habitats for amphibians and reptiles.
- Determine which specific sites are used for amphibian breeding.
- Evaluate the effects of Project reservoir water level fluctuations and river instream flow management on habitat quality and breeding amphibians.
- Assess the effects of other Project-related operational activities (e.g., water conveyance system operation, maintenance activities, and recreation developments).
- Collect information that is useful for developing PM&E measures.

4.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

The FERC requires descriptions of existing wildlife resources in the study area. Amphibians and some reptiles are reliant on aquatic, wetland, and riparian habitat and are some of the wildlife species most likely to be affected by continued operation of the Project. Several resource agencies in the area have been conducting amphibian and reptile investigations in the general vicinity of the study area to address population dynamics and habitat use. This study augments the existing information to describe which species occur in the study area and which sites provide important habitat. This information also will be used to assess the need for PM&E measures to protect or enhance these resources.

4.4 METHODS AND GEOGRAPHIC SCOPE

The general study area for the Amphibian and Reptile Inventory was the same as the study area for the plant community mapping (see Section 2.0), but this study focused on the following primary study area with emphasis on sites most likely affected by Project operations:

- Project reservoirs and facilities
- 0.25-mile (0.40-km) buffer around river reaches from Link River to Iron Gate dam
- The Klamath River and riparian/wetland communities along the Klamath River from Link River to the mouth of the Shasta River
- PacifiCorp-owned lands near the Project

Because most impacts are expected to be associated with water level fluctuations in ramped reaches and along reservoirs, fieldwork and analyses focused on riverine, wetland, and riparian habitats. Other near-shore upland habitats, isolated wetlands, springs, and talus areas also were assessed if these areas were determined to have the potential to be affected by Project vegetation maintenance, Project roads, transmission line management, or Project-related recreation. A limited amount of survey effort focused on areas located outside the study area.

To the extent possible, survey sites complemented those sampled by the BLM amphibian and reptile surveys conducted in the canyon (Roninger, 2000, 2001) and pond turtle surveys conducted by Bury (1995) downstream of J.C. Boyle reservoir.

Tasks approved by the TRWG that were completed during 2002 included the following:

- A review of existing amphibian/reptile data
- Surveys of ponds and wetlands for breeding amphibians
- Surveys of selected tributary streams for stream-dwelling amphibians
- Upland amphibian surveys
- Upland reptile surveys at 137 plots (1.96 acres [0.79 ha]) and surrounding Project facilities
- Pond turtle basking surveys and suitable nesting habitat mapping
- Incidental observations
- Fisheries electroshocking surveys

Based on review of preliminary results from the 2002 field season, the TRWG requested additional studies that focus on amphibians and reptiles be conducted in 2003. Field studies targeting amphibian and reptile species conducted in 2003 included the following:

- Oregon spotted frog surveys at four select wetland locations located near the J.C. Boyle and Keno reservoirs
- Foothill yellow-legged frog surveys at ten Klamath mainstem and tributary sites meeting basic criteria for habitat suitability
- Supplemental isolated wetland/spring surveys for breeding amphibians
- Additional western pond turtle surveys in the J.C . Boyle bypass and California portion of the J.C. Boyle peaking reach.
- Snake hibernacula surveys throughout the study area, but focused on areas located between roads/recreation sites and the river and potential areas thought to contain high densities of reptiles

Specific methodologies for each survey type and Project amphibian and reptile studies are described in detail in the following sections.

4.4.1 Review Existing Data and Mapping

Preliminary review of existing literature indicated that 16 amphibian and 22 reptile species potentially occur in the study area (Table 4.4-1). The first phase of the Amphibian and Reptile Inventory involved reviewing existing herpetological survey data and the vegetation cover type mapping (Section 2.1) to assess likely species presence and to prioritize data gaps. The data review included the following resources:

- BLM herpetological inventory study conducted in the Oregon portion of the J.C. Boyle peaking reach (Roninger, 2000, 2001)
- CWHRS database
- Atlas of Oregon Wildlife (Csuti et al. 1997)
- General western pond turtle information (Holland, 1994)
- Pond turtle survey data for the Oregon portion of the J.C. Boyle peaking reach (Bury, 1995)
- Amphibian surveys along Spencer Creek (Hayes, 1996, 1997)
- Oregon spotted frog surveys conducted by Hayes (1994)
- Regional herpetological surveys conducted by St. John (1987)
- Klamath Basin Wildlife Refuge information
- Aerial photos
- Consultation with local biologists

The outcome of this phase was used as a foundation for planning field surveys. The preliminary vegetation cover type mapping was used to identify riparian, wetland, and selected upland habitats that were emphasized during amphibian surveys. Upland habitats assessed for terrestrial amphibians included moist talus and dense conifer forest habitat, which occurred mostly in the Keno Canyon.

Table 4.4-1. Amphibian and reptile species potentially occurring in the Klamath River study area.

Common Name ***Scientific Name***	**Habitat Requirements and Previous Documentation in Study Area**
Amphibians	
Pacific Giant Salamander *Dicamptodon tenebrosus*	Adults live in cool, moist forests adjacent to streams and lakes (Leonard et al. 1993); also found in moist talus (Corkran and Thoms, 1996). Neonates prefer Order III-V streams; larva typically found in Order II-V streams, but will use Order I (Corkran and Thoms, 1996). Spencer Creek populations found by Hayes (1996) were located upstream of J.C. Boyle reservoir. These individuals are paedomorphic, thought to be a result of dry upland habitat in the Klamath River basin (Hayes, 2001). This species is expected in low to moderate gradient tributaries with pool morphology and rocky bottoms (Hayes, 2001).
Black Salamander *Aneides flavipunctatus*	Near streams, in talus slopes, or under rocks and logs in open woodlands, and mixed coniferous and mixed coniferous-deciduous forests (Csuti et al. 1997).

Table 4.4-1. Amphibian and reptile species potentially occurring in the Klamath River study area.

Common Name ***Scientific Name***	**Habitat Requirements and Previous Documentation in Study Area**
Clouded Salamander *Aneides ferreus*	Inhabits forests, including burned, clearcut, second-growth, and rocky areas (Corkran and Thoms, 1997). Closely associated with decaying logs and stumps, particularly Douglas-fir (Leonard et al. 1993). Often just beneath the bark in logs, snags, and stumps; has been found 121 feet (37 m) up in snags (Leonard et al. 1993). Inhabits burns and clearcuts until the decay process proceeds to the point where the wood becomes too dry (Leonard et al. 1993). This species' known range is restricted to areas to the west of I-5.
Ensatina *Ensatina eschscholtzii*	Lives in a variety of coniferous and mixed forests. They lay their eggs in burrows or in decaying logs. Juveniles and adults live in logs, debris piles, moist talus that has woody debris, or piles of firewood (Corkran and Thoms, 1997).
Siskiyou Mountains Salamander *Plethodon stormi*	Among loose rock talus on north-facing slopes or in dense wooded areas (Csuti et al. 1997). It may be found under bark near talus. This species is not likely to occur in the study area because its range is west of I-5.
Del Norte Salamander *Plethodon elongatus*	Moist, rocky areas within forests. It can tolerate drier conditions and usually occurs in decaying logs and under litter on forest floor, especially in older conifer forests. This species is not likely to occur in the study area because its known range is west of I-5.
Long-Toed Salamander *Ambystoma macrodactylum*	Wide variety of habitats including forests, grasslands, and disturbed areas (Corkran and Thoms, 1997). Adults stay underground, but can be found under logs and rocks during the rainy season. Eggs are laid in seasonal pools, shallow lake edges, and slow streams through wet meadows in water less than 1.6 feet (0.49 m) deep. Hatchlings and larvae live in sediments in shallow water.
Rough-Skinned Newt *Taricha granulosa*	Forested and developed areas. They breed in ponds, lakes, or stream backwaters that are between 1.64 and 6.56 feet (0.5 and 2 m) deep (Corkran and Thoms, 1997). Juveniles and adults live in or under soft logs and forage on the forest floor during damp conditions.
Tailed Frog *Ascaphus truei*	Fast, small, permanent forest streams with clear, cold water (<53.6°F [<12ºC]); cobble or boulder substrate; and little silt lakes (Leonard et al. 1993). Abundant in Order II and III streams, but absent from Order IV and V streams in the Little River basin in Oregon (Bury and Major, 1996). Generally, tadpoles are found attached to the undersides of moss-free rocks in rapidly moving water; adults also can occur under rocks during the day (Leonard et al. 1993; Corkran and Thoms, 1996; Nussbaum et al. 1983). At night and during rainy weather, adults occur along stream edges and in adjacent forest stands (Leonard et al. 1993; Corkran and Thoms, 1996; Nussbaum et al. 1983). Adults breed in Order II-IV streams; tadpoles can be found in Order II-V streams; juveniles and adults prefer Order I and II streams, but may use Order III and IV streams (Corkran and Thoms, 1996).
Western Toad *Bufo boreas*	Adults are highly terrestrial outside the February-early May breeding season; common near marshes and small lakes; can be found in dry forests, shrubby areas, and meadows (Leonard et al. 1993; Corkran and Thoms, 1997). Breeds in ponds, shallow lake edges, slow-moving streams. Water depths <1.6 feet (0.5 m) (Corkran and Thoms, 1997). Minimum water temperature = 42.8 to 45.5°F (6.0 to 7.5ºC) (Nussbaum et al. 1983). Hatchlings and tadpoles live in the warmest water available, up to 86°F (30ºC) (Corkran and Thoms, 1997; Nussbaum et al. 1983). Roninger (2000, 2001) documented this species in the Klamath River Canyon in hardwood and mixed-conifer woodlands, as well as non-forested habitats.

Table 4.4-1. Amphibian and reptile species potentially occurring in the Klamath River study area.

Common Name *Scientific Name*	**Habitat Requirements and Previous Documentation in Study Area**
Pacific Treefrog *Hyla regilla*	Marshes, mountain meadows, woodlands, brush, and disturbed areas (Corkran and Thoms, 1997). They breed in water less than 1.6 feet (0.5 m) deep in permanent or seasonal pools. Tadpoles live in shallow water while froglets occur in vegetation along the perimeter of ponds. Roninger (2000, 2001) documented this species along the Klamath River in pine and mixed-conifer woodlands, as well as non-forested habitats. St. John (1987) found this species at many sites along the Klamath River.
Northern Red-Legged Frog *Rana aurora aurora*	Marshes, streams, lakes, reservoirs, and ponds usually below 3,000 feet (914 m) in elevation. Adults: highly terrestrial outside the breeding season; occur in moist coniferous or deciduous forests up to 984 feet (300 m) away from water (Leonard et al. 1993; Csuti et al. 1997); also inhabit forested wetlands (Corkran and Thoms, 1997). Breeds in cool, well-shaded ponds; along the edges of lakes; in beaver ponds; or in slow streams. Water depths = 1.6 to 6.6 feet (0.5 to 2 m) (Corkran and Thoms, 1997). Time of egg deposition is closely dependent on water temperature. Minimum water temperature = 42.8 to 45.5°F (6 to 7.5ºC) (Nussbaum et al. 1983). Range appears to not overlap the study area.
Cascades Frog *Rana cascadae*	Adults occur in wet meadows, bogs, moist forests, pond and stream edges (Corkran and Thoms, 1997). Breeds in bogs or ponds with cold springs or snowmelt. Lays eggs in water depths < 7.9 inches (< 20 cm) (Corkran and Thoms, 1997). Eggs are tolerant of temperatures between 42.8 and 80.6°F (8 and 21ºC); 46.4 to 69.8°F (6 to 27ºC) is probably optimal (Nussbaum et al. 1983). Range appears to not overlap the study area. It is known from Spencer Creek above 5,000 feet (1,524 m) elevation.
Spotted Frog *Rana pretiosa*	Most aquatic native frog species. Adults occur in or near perennial water, including marshes, springs, ponds, lake edges, or sluggish streams (Leonard et al. 1993). Also found in riparian forests and areas with dense shrub cover (McAllister and Leonard, 1997). Breeds in shallow, marshy pools; quiet backwaters associated with intermittent run-off channels; flooded meadows beside ponds or streams; floodplain wetlands; and temporary ponds (McAllister and Leonard, 1997; Corkran and Thoms, 1997). There are old historical records of this species in the study area (near Link River).
Foothill Yellow-Legged Frog *Rana boylii*	Permanent slow-moving streams with rocky bottoms in a variety of habitats. The species breeds after high water recedes (April through June) (Csuti et al. 1997). Habitat also includes large cobble bars or in-channel islands, coupled with slower backwater areas for larval rearing (Hayes, 2001). There is an historical record near J.C. Boyle dam and several miles from the Klamath River in the Cottonwood, Jenny, and Little Bogus Creek watersheds.
Bullfrog *Rana catesbeiana*	Very warm and sunny permanent ponds, marshes, and slow river backwaters (Corkran and Thoms, 1997). Eggs are laid in ponds during the summer. Tadpoles occur in shallow water with dense aquatic vegetation. Froglets and adults require permanent water with dense submerged, emergent, and shoreline vegetation. This species is known to occur throughout much of the study area (Hayes, 1994; St. John, 1987).

Table 4.4-1. Amphibian and reptile species potentially occurring in the Klamath River study area.

Common Name ***Scientific Name***	**Habitat Requirements and Previous Documentation in Study Area**
Reptiles	
Western Pond Turtle *Clemmys marmorata*	Quiet water in small lakes, marshes, and sluggish streams and rivers. Requires basking sites, such as logs, rocks, mud banks, or cattail mats (Csuti et al. 1997). Upland reproductive habitat includes well-drained, high clay fraction soil, often in oak woodlands with a litter layer (Hayes, 2001). Roninger (2000, 2001) and St. John (1987) documented this species in the Klamath River Canyon and in the Frain Ranch area, respectively. This species also has been observed along the Klamath River near Keno and near Klamath Falls, as well as in Upper Klamath Lake (St. John, 1987). Pond turtles have home ranges of 0.6 to 2.4 acres (0.24 to 0.97 ha).
Red-Eared Slider *Pseudemys scripta*	Ponds and slow-moving streams. This species is not known to occur in the study area.
Northern Alligator Lizard *Elgaria coerulea*	Edges of meadows in coniferous forests and in riparian zones (Csuti et al. 1997).
Southern Alligator Lizard *Elgaria multicarinata*	Grassland, chaparral, oak woodlands, and edges of conifer forests. Also occurs in riparian areas and moist canyon bottoms. It requires thickets, logs, or rock piles (Csuti et al. 1997). Roninger (2000, 2001) documented this species in the Klamath River in hardwood woodlands and non-forested habitats.
Western Skink *Eumeces skiltonianus*	Moist sites under rocks and logs in grassland, chaparral, juniper woodlands, conifer forests, and riparian areas (Csuti et al. 1997). Roninger (2000, 2001) documented this species in the Klamath River in conifer, hardwood, and Douglas-fir woodlands. St. John (1987) found this species at many sites along the Klamath River.
Short-Horned Lizard *Phrynosoma douglassi*	Sagebrush, juniper woodlands, and open conifer forests with sandy or rocky soil (Csuti et al. 1997). This species is not known to occur in the study area.
Sagebrush Lizard *Sceloporus graciosus*	Sagebrush, chaparral, juniper woodlands, and dry conifer forests. Roninger (2000, 2001) documented this species along the Klamath River in pine habitat. St. John (1987) found this species in open sagebrush and woodland habitats.
Western Fence Lizard *Sceloporus occidentalis*	Wide range of habitats, but requires vertical structure. Roninger (2000, 2001) documented this species along the Klamath River in pine, hardwood, Douglas-fir, and mixed conifer woodlands as well as non-forested habitats. St. John (1987) found this species at many sites along the Klamath River.
Rubber Boa *Charina bottae*	Commonly found in forest openings with stumps and logs, but also in forested areas and grasslands. Roninger (2000) documented this species along the Klamath River in mixed-conifer woodlands. St. John (1987) found this species near BLM's Topsy Campground.
Yellow-Bellied Racer *Coluber constrictor*	Sagebrush flats, juniper woodlands, chaparral, and meadows. It avoids dense forests (Csuti et al. 1997). Roninger (2000, 2001) documented this species along the Klamath River in pine, Douglas-fir, non-forested, hardwood, and mixed conifer woodlands. St. John (1987) found this species at many sites along the Klamath River.
Sharptail Snake *Contia tenuis*	Moist sites in conifer forests, deciduous forest, chaparral, especially forest edges, especially known in oaks and other deciduous tree woodlands (Hayes, 2001). Surface activity is limited, with most activity occurring from March to mid-May (Hayes, 2001). Roninger (2001) documented this species along the Klamath River in Douglas-fir habitat.

Table 4.4-1. Amphibian and reptile species potentially occurring in the Klamath River study area.

Common Name *Scientific Name*	**Habitat Requirements and Previous Documentation in Study Area**
Western Rattlesnake *Crotalis viridus*	Areas with low or sparse vegetation and rocky areas. Roninger (2000, 2001) documented this species along the Klamath River in hardwood woodlands and non-forested habitats. St. John (1987) found this species at several sites along the Klamath River Canyon.
Ring-Necked Snake *Diadophis punctatus*	Moist conditions under wood, rocks, talus, or woody debris. The species is known in riparian habitats with a deciduous overstory (Hayes, 2001). Surface activity is limited, with most activity occurring from March to mid-May (Hayes, 2001). Roninger (2001) documented this species along the Klamath River Canyon area in hardwood woodlands. St. John (1987) found this species along Topsy Road in the Klamath River Canyon.
Night Snake *Hypsiglena torquata*	Arid desert scrub habitat near rocky outcrops or rimrock. This species has been recorded from south of Klamath Lake and near Hornbrook (St. John, 1987)
Common Kingsnake *Lampropeltis getula*	Thick vegetation along watercourses, farmland, chaparral, deciduous, and mixed-coniferous forests. Roninger (2000) documented this species along the Klamath River in mixed-conifer woodland.
California Mountain Kingsnake *Lampropeltis zonata*	Pine forests, oak woodlands, chaparral in, under, or near rotting logs. Usually near streams. This species is associated with well-illuminated rocky riparian habitat with mixed deciduous and coniferous trees, especially canyon live oak (*Quercus chrysolepis*) and black oak (*Q. kelloggii*) (Hayes, 2001). Roninger (2000, 2001) documented this species along the Klamath River in mixed-conifer woodlands.
Striped Whipsnake *Masticophis taeniatus*	Grasslands, sagebrush, rocky stream courses, and canyon bottoms, as well as juniper and pine-oak woodlands. Roninger (2000) documented this species along the Klamath River in pine and non-forest habitats.
Gopher Snake *Pituophis melanoleucus*	Wide variety of habitats. Roninger (2000, 2001) documented this species along the Klamath River in pine, hardwood, and mixed-conifer woodlands. St. John (1987) found this species at many sites along the Klamath River.
Western Terrestrial Garter Snake *Thamnophis elegans*	Wide variety of habitats. Roninger (2000, 2001) documented this species along the Klamath River in pine, hardwood, and mixed-conifer woodlands, as well as non-forested habitats. St. John (1987) found this species at several sites along the Klamath River.
Northwestern Garter Snake *Thamnophis ordinoides*	Meadows and forest edges, also near developed areas. Not known from study area; occurs in Jackson County (St. John, 1987).
Common Garter Snake *Thamnophis sirtalis*	Wide variety of habitats. Roninger (2000, 2001) documented this species along the Klamath River in pine and mixed-conifer woodland, and non-forested habitat. St. John (1987) found this species at several sites along the Klamath River.
Western Aquatic Garter Snake *Thamnophis couchii*	Highly aquatic species found in wet meadows, riparian areas, marshes, and moist forests. Documented along Lower Klamath River in Siskiyou County (St. John, 1987).

4.4.2 2002 Field Survey Methods

The 2002 amphibian and reptile surveys included the following:

- Pond-breeding amphibian surveys
- Instream surveys

- Upland amphibian surveys
- Terrestrial reptile surveys at 137 plots and surrounding Project facilities
- Pond turtle basking site surveys and suitable nesting habitat mapping
- Incidental observations and electroshocking data evaluation

Data collected for each detection included: location, species, life stage, number, and habitat; sex, total length, and snout-vent length were recorded when animals were captured. Survey locations (UTM coordinates) were recorded using GPS or on maps and photographed. All data were recorded on standardized datasheets (see Appendix 4A). Data pertaining to any potential impacts from Project operations, which include water level fluctuations, recreation, and vegetation management, also were recorded.

Animals caught were examined, identified, and released immediately; when necessary, individuals or egg samples were held in plastic containers until the plot was surveyed and identification was completed. Amphibian identification was based on Storm and Leonard (1995), Leonard et al. (1993), Corkran and Thoms (1996), and Nussbaum et al. (1983). Reptile identification relied on Storm et al. (1995). Photographs were taken of unique species observations.

The numbers of each type of amphibian and reptile surveys conducted in 2002 are summarized in Table 4.4-2 and described in the following sections.

4.4.2.1 Pond-Breeding Amphibian Surveys

During the spring of 2002, teams of two PacifiCorp biologists reviewed all riparian and wetland polygons in the field, as well as selected stock ponds and springs, to determine pond habitat presence. Biologists searched potentially suitable pond-breeding habitat. The surveys covered small ponds in their entirety; in larger ponds/wetlands, time- and/or area-constrained surveys were used. In total, biologists conducted pond-breeding amphibian surveys at 68 individual pond/wetland sites during 2002 (Table 4.4-2; Figure 4.4-1) during the egg and larval development period when there is the greatest chance of detecting all species that occur (Thoms et al. 1997). The egg and larval development period for the pond-breeding species of interest ranges from late March through June for the study area, depending on elevation and yearly weather conditions. The first surveys in 2002 were conducted in late-March to early April in lower elevations of the study area. Upper elevations were surveyed in mid- to late April.

Most of the sites were visited once in 2002, but nine sites that had the highest quality habitat were surveyed twice. At least two sites were surveyed in every Project segment except for the Copco No. 2 bypass and J.C. Boyle bypass, which lacked pond habitat.

At each of the pond-breeding survey sites, biologists searched shallow water zones and looked for adults, larvae, and egg masses under cover objects within and adjacent to the pond using time- and area-constrained methods described in Olson and Leonard (1997) and Thoms et al. (1997). Because larvae often are concealed in the mud or debris on the bottom, dip nets were used to sweep and sift through sediments to find amphibians.

4.4.2.2 Instream Surveys

Instream amphibian surveys targeting amphibians associated with riverine habitat were conducted in March and August 2002 at 14 individual sites (Figure 4.4-1; Table 4.4-2) and focused on sites not sampled by fisheries biologists during electroshocking surveys. Surveys covered 14 sites that included the Klamath River (edges of the channel) and Fall Creek (upstream and downstream of the diversion), as well as the lowermost 500 feet (approximately 150 m) of selected small tributary streams (Figure 4.4-1). The surveys occurred during low-flow conditions when stream-dwelling amphibians can be detected most easily (Bury and Corn, 1991). At each survey site, a team of two biologists first surveyed the riparian habitat and shorelines. During the shoreline survey time, biologists searched for amphibians under rocks, bark, leaf litter, and logs within the plot (Corn and Bury, 1990). In the aquatic habitat, biologists surveyed the plot by working from the downstream to the upstream end. Surveys involved: (1) searching the shallow-water zones for amphibians; (2) turning rocks, litter, and debris to find adult and larval amphibians; and (3) using nets to catch individuals dislodged from under cover objects and raked gravel and cobble (Corkran and Thoms, 1996; Bury and Corn, 1991; Welsh, 1987; Heyer et al. 1994). Biologists inspected the undersides of the cover objects in the water column to search for tailed frog and foothill yellow-legged frog larvae.

4.4.2.3 Upland Amphibian Surveys

Limited surveys for terrestrial amphibians were conducted in two conifer forest cover type polygons that had suitable habitat when examined in March and April 2002. The most suitable habitat occurred in the conifer forest cover types in the Keno Canyon. Each survey consisted of two biologists searching plots for 30 minutes under moist conditions, defined by moist ground litter and woody debris. Time-constrained surveys are similar to the visual encounter survey (VES) described by Crump and Scott (1994), who indicated that a “randomized walk” design is appropriate when large areas are sampled. The size of each survey plot and length of survey time were determined on the basis of site-specific conditions.

4.4.2.4 Terrestrial Reptile Surveys

Terrestrial reptile surveys were conducted during June 2002 at 139 of the 1.96-acre (0.79 ha) wildlife survey plots distributed in all cover types (Figure 4.4-1; Table 4.4-2). This was augmented by surveying suitable habitat adjacent to Project facilities. Upland reptile surveys occurred during dry, warm conditions. During these surveys, a biologist turned cover objects to search for reptiles. Any reptiles observed were identified on the basis of Storm and Leonard (1995).

Table 4.4-2. Amphibian and reptile survey effort in 2002 by type of survey and Project section.

Type of Survey	Iron Gate-Shasta	Iron Gate Reservoir	Fall Creek	Copco Bypass	Copco Reservoir	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Reservoir	Keno Canyon	Keno Reservoir	Link River	Total
Pond Breeding Amphibian Survey Sites	7	16	4	0	4	23	0	5	2	5	2	**68**
Pond Breeding Amphibian Surveys	9	21	4	0	4	23	0	4	2	6	2	**75**
Instream Survey Sites	2	2	4	0	2	3	0	1	0	0	0	**14**
Instream Surveys	2	2	5	0	3	3	0	1	0	0	0	**16**
Upland Amphibian Surveys	0	0	0	0	0	0	0	0	2	0	0	**2**
Wildlife Survey Plots:	8	23	7	3	17	37	12	8	9	12	3	**139**
Riparian Wildlife Survey Plots	8	2	3	1	5	12	5	2	6	3	2	**49**
Wetland Wildlife Survey Plots	0	17	2	0	6	4	0	1	1	6	0	**37**
Upland Wildlife Survey Plots	0	4	2	2	6	21	7	5	2	3	1	**53**
Facility Surveys	0	2	3	3	1	1	3	1	0	1	3	**18**

Figure 4.4-1. Amphibian and reptile survey effort..

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4.4.2.5 Pond Turtle Surveys

The 2002 pond turtle surveys were coordinated with the TES Study (see Section 4.4.3.4) and incorporated basking surveys and nesting habitat mapping. Surveys for basking turtles were conducted between April and early October 2002 by biologists traveling by boat or vehicle along reservoirs and accessible river reaches. Biologists recorded the location of basking sites and the number of adults and juvenile turtles present at each site. Surveys were not conducted in the Oregon portion of the J.C. Boyle peaking reach because existing data already have been collected by the BLM and Bury (Bury and Pearl, 1999; Roninger, 2000). Sites with basking turtles were recorded using GIS. In addition to documenting basking turtles, each river and reservoir shoreline was mapped into segments based on the presence of suitable nesting habitat in or near the floodplain (low or moderate slope, open understory vegetation, loose soil) (Holland, 1994).

4.4.2.6 Incidental Observations and Electroshocking Data Evaluation

As biologists walked between survey stations or conducted other field surveys, they opportunistically searched for amphibians and reptiles in suitable areas encountered in all habitats. A database was developed for summarizing all of the observations by Project development and habitat. Between October 2001 and October 2002, fisheries investigators conducted backpack electroshocking surveys three to four times in large portions of Fall Creek, Link River, J.C. Boyle bypass, J.C. Boyle peaking reach, Copco No. 2 bypass, and Spencer Creek (Figure 4.4-1). During these surveys, all amphibian detections were recorded.

4.4.3 2003 Survey Methods

The following sections describe specific methodologies for amphibian and reptile field studies completed in 2003. Survey locations are shown in Figure 4.4-1.

4.4.3.1 Oregon Spotted Frog Surveys

Oregon spotted frog surveys were conducted at four select wetland locations identified through consultation with state and federal resource agencies and local species experts as the most-suitable study area locations for species occurrence. Spotted frog survey locations included the Tule Smoke Gun Club wetland, the Klamath Sportman's Park wetland, the Klamath Wildlife Area wetland, and an embayment and associated wetland near the J.C. Boyle reservoir located near the Topsy Campground. Each site was visited three times from April through June 2003. Survey dates were coordinated to correspond with the species' breeding ecology to locate egg masses, juveniles, and adults when they are most evident and likely to occur.

Specific field survey methodology for the Oregon spotted frog surveys closely corresponded to VES survey methodology used during 2002 pond breeding amphibian surveys. Suitable habitat areas were thoroughly and systematically searched and cover objects were turned to detect egg masses, juveniles, and/or adults depending upon survey timing. Microhabitat areas meeting water depth, substrate, and vegetative criteria suitable for spotted frogs were emphasized. Areas included in spotted frog surveys are delineated in Figure 4.4-1.

4.4.3.2 Foothill Yellow-Legged Frog Surveys

The TRWG requested that PacifiCorp conduct surveys for foothill yellow-legged frogs using methods consistent with those that other utilities have used in the Sierra Nevada Mountains (Seltenrich and Pool, 2002). The process of identifying potential foothill yellow-legged frog survey sites and confirming suitable Project-specific survey methodology was initiated in the fall of 2002. The following sections describe the site selection process, specific survey methodology, and a habitat assessment procedure conducted as part of relicensing field studies targeting foothill yellow-legged frogs.

Site Selection

PacifiCorp reviewed aerial photos, maps, and on-the-ground observations made during 2002 amphibian surveys to evaluate potential survey locations using habitat requirement, life history information, historical records in the area, and information provided by California State Water Resources Control Board (Kanz, pers. comm., 2002). Mainstem river sites with a relatively wide channel, cobble and small boulder bars, and backwater habitats provide the shallow, low-velocity habitat necessary for foothill yellow-legged frog oviposition (Kupferberg, 1996). Mainstem sites within 323 feet (100 m) of a tributary also are used most often (Kupferberg, 1996). Tributary streams with perennial flow also were considered to be potential foothill yellow-legged frog habitat, especially for individuals after the breeding season.

Review of the Klamath River and tributaries indicated that 28 sites in the study area may provide some potential foothill yellow-legged frog habitat (Table 4.4-3). Of these, ten sites associated with tributaries and wide or complex main channel habitats were given a higher priority for survey. Included among the ten high priority potential sites are three tributaries (Cottonwood, Jenny, and Little Bogus creeks) and one mainstem site (J.C. Boyle bypass near the J.C. Boyle dam) with historical foothill yellow-legged frog records (Borisenko, 2000; A. Lind, unpubl. data). Upon examination in the field, the lower portion of Little Bogus Creek was found to be completely dry during the spring, while the lower portion of Willow Creek, located just downstream of Little Bogus Creek, had what appeared to be good quality aquatic habitat for amphibians. Therefore, Little Bogus Creek was deleted from the sampling sites and replaced with Willow Creek. (Note: In several TRWG meetings survey results were attributed incorrectly to Little Bogus Creek when results should have referred to Willow Creek.) The remaining 17 sites were deemed to have a lower potential for supporting foothill yellow-legged frogs.

Table 4.4-3. Sites reviewed for 2003 foothill yellow-legged frog surveys.

Site	Section	Position	Description	Notes	Survey in 2003?
RM 179.0 Bar	Iron Gate-Shasta	Mainstem	Left bank side channel just upstream of access road to I-5 rest area and island under I-5 bridge.	Channel is confined where it borders I-5 from RM 181 to the Shasta River. Tributary enters left bank at the site.	No
RM 181.5 Bar	Iron Gate-Shasta	Mainstem	Left bank connected channel 200 feet (61 m) long about 1,969 feet. (600 m) downstream of Cottonwood Creek	Not surveyed in 2002. Nearest tributaries are more than 886 feet (270 m) away.	No

Table 4.4-3. Sites reviewed for 2003 foothill yellow-legged frog surveys.

Site	Section	Position	Description	Notes	Survey in 2003?
Cottonwood Creek	Iron Gate-Shasta	Mainstem and tributary	RM 182.1. Right bank near Hornbrook. Low-gradient stream. There are two short sections of shallow water just downstream of mouth and directly across from the mouth.	Section of Cottonwood Creek surveyed in September 2002. Historical foothill yellow-legged frog sites in upper drainage near Hilt (Borisenko, 2000).	Yes—650 feet (200 m) of mainstem and lower 0.5 mile (0.8 km) of tributary
RM 183.3 Bar	Iron Gate-Shasta	Mainstem	Right bank mid-channel bar approximately 3,192 feet (970 m) downstream of Klamathon Bridge.	Surveyed in May 2002—bar is grazed by cattle. No perennial tributaries nearby.	No
Cape Horn Creek	Iron Gate-Shasta	Tributary	RM 184.1 Right bank.	Not surveyed in 2002. Not perennial.	No
Willow Creek	Iron Gate-Shasta	Tributary	RM 184.0 Left bank along railroad track.	Not surveyed in 2002. Has suitable habitat and is in general vicinity of the historical record on upper Little Bogus Creek.	Yes—lower 0.5 mile (0.8 km) of tributary
Little Bogus Creek	Iron Gate-Shasta	Mainstem and tributary	RM 187.0 Left bank across from “R Ranch.”	Not surveyed in 2002. Historical foothill yellow-legged frog record several miles upstream [in Little Bogus Creek]. River has shallow habitat just upstream of island	No
Dry Creek	Iron Gate-Shasta	Tributary	RM 188.1 Right bank.	Not surveyed in 2002. Stream is not perennial	No
RM 189.4 Bar	Iron Gate-Shasta	Mainstem	Right bank bar and backwater across from Iron Gate gauging station.	Site has complex habitat including shallow, low-velocity habitats. Surveyed in April, May, and June 2002. Nearest tributary is Bogus Creek more than 323 feet (100 m) away.	No
Bogus Creek	Iron Gate-Shasta	Mainstem/ tributary	RM 189.4. Left bank perennial stream with cobble.	Lower 492 feet (150 m) surveyed in August 2002.	Yes—650 feet (200 m) of mainstem and lower 0.5 mile (0.8 km) of creek
Brush Creek	Iron Gate-Shasta	Tributary	RM 189.8 Right bank tributary immediately downstream of Iron Gate dam tailrace.	Surveyed in May and August 2002. No flowing water in August. No good habitat in river.	No
Copco No. 2 Bypass	Copco No. 2 bypass	Mainstem	Boulder-dominated reach fed by springs.	Heavily shaded in narrow canyon without tributaries. Surveyed by electroshocking in 2002.	Yes—0.5 mile (0.8 km)

Table 4.4-3. Sites reviewed for 2003 foothill yellow-legged frog surveys.

Site	Section	Position	Description	Notes	Survey in 2003?
Jenny Creek	Iron Gate reservoir	Tributary	Good flow.	Surveyed in August 2002. Historical foothill yellow-legged frog site at Shoate Spring in upper watershed (Borisenko, 2000).	Yes—lower 0.5 mile (0.8 km) of creek
Fall Creek	Iron Gate reservoir	Tributary	Heavily shaded so probably not ideal habitat.	Surveyed in August 2002.	No
Camp Creek	Iron Gate reservoir	Tributary	Heavily shaded so probably not ideal habitat.	Surveyed in August 2002.	No
Scotch Creek	Iron Gate reservoir	Tributary	Heavily shaded so probably not ideal habitat.	Surveyed in August 2002.	No
Beaver Creek	Copco reservoir	Tributary	Heavily shaded so probably not ideal habitat.	Surveyed in August 2002. Very little flow.	No
Mallard Cove/Deer Creek	Copco reservoir	Tributary	Developed; shaded so probably not ideal habitat.	Not surveyed in 2002. Mostly private property and dense riparian vegetation along lower portion.	No
Snackenburg Creek	Copco reservoir	Tributary	South shore RM 202.5.	Not surveyed in 2002. Not perennial. Very steep.	No (not perennial)
Long Prairie Creek	Copco reservoir	Tributary	RM 203.1. North shore of reservoir.	Not surveyed in 2002. Very steep.	No
RM 202.8	J.C. Boyle peaking reach	Mainstem	Mid-channel bar and left bank shoreline habitat.	Unnamed tributary enters at recreation site at downstream end of site. Tributary could be seasonal.	Yes—650 feet (200 m) of mainstem
RM 204.0 Bar	J.C. Boyle peaking reach	Mainstem	Point bar and side channel near lower pasture on left bank downstream of Miller House.	Electroshocked. Partially surveyed in May-June 2002. No nearby tributaries.	Yes—650 feet (200 m) of mainstem
Shovel Creek	J.C. Boyle peaking reach	Mainstem/ tributary	Tributary associated mainstem.	Shovel Creek surveyed in August 2002. Complex habitat in mainstem within 323 feet (100 m).	Yes—650 feet (200 m) of mainstem and lower 0.5 mile (0.8 km) of tributary
Hayden Creek	J.C. Boyle peaking reach	Mainstem/ tributary	Tributary associated mainstem. Pushup dam in mainstem just upstream of mouth.	Lower portion of Hayden Creek was surveyed in 2002 and by BLM in 2000-2001. It is a very steep drainage.	No
Frain Creek	J.C. Boyle peaking reach	Mainstem/ tributary	RM 214.8. Left bank at Frain Ranch.	Mouth has diverse wetland. Mainstem is very wide.	Yes—650 feet (200 m) of mainstem and lower 0.5 mile (0.8 km) of tributary

Table 4.4-3. Sites reviewed for 2003 foothill yellow-legged frog surveys.

Site	Section	Position	Description	Notes	Survey in 2003?
RM 217.5 Bar	J.C. Boyle peaking reach	Mainstem	Right bank wetland and shoreline just downstream of BLM's Klamath River Campground entrance.	Electroshocked in 2002. Nearest tributary is 820 feet (250 m).	No
J.C. Boyle Bypass	J.C. Boyle bypass	Mainstem	Deep canyon.	Electroshocked. Historical foothill yellow-legged frog site near dam (Borisenko, 2000)	Yes—650 feet (200 m) of mainstem and lower 0.5 mile (0.8 km) of tributary
Spencer Creek	J.C. Boyle reservoir	Tributary	North shore of reservoir.	Electroshocked and surveyed lower 492 feet (150 m) in August 2002. Hayes (1996) studied upper Spencer Creek and reports no foothill yellow-legged frog.	No

Note: Bolded sites were surveyed in 2003.

At the February 4, 2003, TRWG meeting, it was confirmed that sample 2003 foothill yellow-legged frog survey sites would include: three sites in the Iron Gate-Shasta section; lower Jenny Creek; the Copco No. 2 bypass; four sites in the J.C. Boyle peaking reach; and, one site in the lower J.C. Boyle bypass (Table 4.4-3). The location and extent of the ten foothill yellow-legged frog sample sites surveyed in 2003 are provided in Figure 4.4-1.

Field Surveys

PacifiCorp biologists made four visits to the ten foothill yellow-legged frog survey sites during the spring and summer of 2003. According to survey protocol, foothill yellow-legged frog surveys could not be conducted until habitat water temperatures rose above 53.6ºF (12ºC). Water temperatures at prospective survey sites were measured through the early spring of 2003. Temperatures were not found to rise above 53.6ºF (12ºC) until the beginning of May. The first foothill yellow-legged frog surveys were conducted during the first week of May 2003 and continued through September 2003.

A team of two or three biologists used VES methodology during foothill yellow-legged frog surveys. Surveys continued for a minimum of 2 hours at each site and included a minimum of 0.5 mile (0.8 km) of lotic habitat, except at the Frain Ranch and J.C. Boyle bypass sites, which only had 650 feet (200 m) of potential habitat available to survey. Upon completion of the initial VES survey, the upstream and downstream ends of the sites were marked with flagging and survey boundaries were recorded on aerial photographs and in a GPS database.

VES foothill yellow-legged frog methodology changes depending on the presumed life stage of the species. During the early stages, cover objects were systematically turned and dip nets were used to strain the substrate and lower water column to detect egg masses or dislodged egg remnants. June 2003 surveys emphasized the potential presence of tadpoles and VES methodology focused on the lower water column of stream habitat where tadpoles may cling to lotic substrate. September 2003 surveys emphasized the potential occurrence of juvenile and adult frogs. As described by Seltenrich and Pool (2002), at the beginning of the initial site visit, biologists conducted an overall evaluation of the site to assist in determining the habitat(s) that were included in the VES. Amphibian habitats along rivers were divided into distinct habitat units (e.g., cobble/boulder bars, side channels, boulder/sedge habitats, etc.). In such cases, separate VESs and site habitat assessments were conducted at each subsite. Specific datasheets used for the foothill yellow-legged frog VES surveys and associated habitat assessments are located in Appendix 4B.

Habitat Assessment

Following the VES at each site, biologists completed a site habitat assessment. Habitat parameters were measured or estimated and recorded on a habitat assessment datasheet (Appendix 4B).

4.4.3.3 Isolated Wetland/Spring Surveys

To gather additional information on amphibian and reptile use of springs and wetlands potentially affected by hydrologic manipulation, Project maintenance, and recreation, the TRWG requested that PacifiCorp conduct supplemental surveys at selected isolated wetlands and springs in 2003. Because PacifiCorp already had surveyed many sites and the BLM had surveyed many others (Roninger, 2001), PacifiCorp focused this effort on sites with significant habitat and those that were not surveyed in 2002. However, some wetlands/springs that were sampled by PacifiCorp in 2002 or the BLM in 2000/2001 were resurveyed in 2003.

Twenty isolated wetland/spring survey sites were selected through consultation with state and federal resource agencies and local amphibian experts to be surveyed in 2003. Nineteen of these 20 sites were surveyed in April 2003. Several sites where amphibian detections were recorded or that had significant amphibian habitat were resurveyed in June 2003. During each survey, a team of two biologists used VES methodology to search under cover objects and used dipnets to sample the water column. Data were recorded on the dataforms used in 2002 for amphibian and reptile surveys (Appendix 4B).

4.4.3.4 Pond Turtle Surveys

Because the surveys conducted in 2002 by PacifiCorp, the BLM in 2000-2001, and Bury (1995) did not include the J.C. Boyle bypass and California portions of the J.C. Boyle peaking reach, PacifiCorp conducted additional pond turtle surveys in these locations in 2003. Two surveys were conducted at each location in 2003. Surveys were conducted in May and June 2003. In the bypass reach, biologists walked the northern shoreline and/or visually inspected the reach from suitable vantages. In the California section of the J.C. Boyle peaking reach, float surveys were conducted from a raft beginning approximately 0.5 mile (0.8 km) downstream of the Oregon-California border, while the upper portions of the California reach were inspected by a biologist walking along the shoreline. During the surveys, biologists recorded locations of basking turtles, age class information, and qualitative habitat information (e.g., presence of basking logs, shoreline condition).

4.4.3.5 Snake Hibernacula Surveys

The TRWG requested that supplemental reptile surveys be conducted in 2003 to sample potential snake hibernacula sites and those areas thought to historically support high densities of reptiles. Six specific areas were identified through consultation with state and federal resource agencies, local experts, and those familiar with the historical distribution of reptiles in the Project vicinity. VES methods included biologists traversing the identified sites during the spring and early summer, and searching for snakes under rocks and in rock crevices. In addition, VES surveys for reptiles were conducted along transects located adjacent to the J.C. Boyle canal during 6 days of small mammal trapping. All 2003 snake hibernacula and supplemental reptile surveys were conducted at sites shown in Figure 4.4-1.

4.4.4 Analysis

Analysis of the collected data occurred on many levels and involved the following:

- Summarizing species observations geographically to describe distribution and presence within the study area.

- Assessing species diversity and relative abundance to describe sites and habitats that support large numbers of species and/or individuals. Abundance is presented by survey type (i.e., number of observations per unit effort [both time and area]) using standard measures presented by Hayek (1994).

- Assessing breeding habitat quality in relation to current Project water level management practices to determine whether there are adverse impacts from Project operations on egg deposition or larvae development. Specifically, hydrological patterns at known amphibian breeding sites were examined to determine whether Project operations result in fluctuating water levels causing potentially adverse impacts to amphibians during the breeding season and through larvae development.

- Assessing the impact of the Project on amphibian or reptile movement and habitat connectivity, both under this study and under the Wildlife Connectivity Study (see Section 6.0).

- Documenting sites where recreation or Project maintenance activities have the potential to affect amphibian and reptile resources.

4.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

The CDFG, ODFW, and BLM all have management objectives for protecting the overall diversity of wildlife species. In addition, BLM must meet Aquatic Conservation Strategy objectives under the Northwest Forest Plan. This study provides information to help address these federal and state objectives. PacifiCorp will use the results of this study to develop PM&E measures that will protect or enhance amphibian and reptile habitats in the Project area.

4.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were held on the following dates: January 17, March 28, April 18, June 6, and December 10, 2002, and February 4, August 5, and October 10, 2003. At each of these meetings, comments received were incorporated into the Final Study Plan, which was approved by the plenary group in February 2003.

4.7 STUDY OBSERVATIONS AND FINDINGS

The following sections provide a survey effort summary and results for all reptile and amphibian studies conducted in 2002 and 2003 and incorporates data and summaries of previously conducted studies. Figure 4.4-1 shows the locations of all amphibian and reptile surveys conducted as part of terrestrial relicensing studies in 2002 and 2003 by type of survey, and also shows BLM survey locations (Roninger, 2001). Specific survey effort and results are described in the following sections.

4.7.1 2002 Field Survey Results

The following sections provide results from amphibian and reptile studies conducted in 2002.

4.7.1.1 2002 Pond-Breeding Amphibian Surveys

During March 20-25, April 1-5, and April 22-26, 2002, 68 individual pond/wetland sites were surveyed for pond-breeding amphibians (Table 4.7-1; Figure 4.4-1). The size of individual survey sites ranged from 215 feet^2 (20 m^2) at small roadside ditches to nearly 7.4 acres (3 ha) at some of the larger wetland complexes (Table 4.7-1).

The pond-breeding amphibian surveys documented three species of frogs and toads breeding in the study area—Pacific treefrog, western toad, and bullfrog. One species of pond-breeding salamander—long-toed salamander— was found just outside of the study area incidental to other surveys in 2002. Of the 68 wetlands and ponds that were surveyed for amphibians, 49 were located adjacent to Project reservoirs and river reaches; 19 sites were isolated from the river and received their water from seeps or tributary streams. Of the 49 hydrologically connected sites, nine had either dikes or evidence of them receiving water from other sources as well as potentially from the river itself. Adult pond-breeding amphibians were detected in 13 (27 percent) of the sites that were hydrologically connected to the river, while 12 (63 percent) of the isolated wetlands had detections of pond-breeding amphibians. Evidence of breeding (eggs or tadpoles) was noted at seven (37 percent) of the isolated sites, but only four sites (8 percent) of the wetlands adjacent to the river. One of the adjacent sites had only bullfrog tadpoles and no native species. No bullfrogs were noted at isolated wetlands, while two sites adjacent to the Iron Gate-Shasta had detections of bullfrogs. Little effort was made to confirm all locations of bullfrog breeding in Project reservoirs because most of the shallow water zones may provide bullfrog breeding habitat.

Table 4.7-1. Summary of pond-breeding amphibian survey observations by Project section, 2002.

Section	Habitat[1]	Polygon[2]	Date	Area Searched (m^2)	Start Time	Stop Time	Observations: Species	Life Stage	Number of Individuals
Iron Gate-Shasta	DST	434	3/20/2002	2500	13:27	14:15	Western fence lizard	Adult	2
			4/1/2002	15,739	12:07	12:33	Bullfrog	Adult	1
							Bullfrog	Tadpole	1
	PEM	98; 99	4/25/2002	300	16:50	17:00	Bullfrog	Adult	2
			4/1/2002	300	10:46	11:10	Unknown frog	Adult	1
	RD	88	4/1/2002	1,000	10:32	10:42	None		0
		465	3/20/2002	750	14:31	14:53	None		0
	RS	281	3/20/2002	2,500	10:54	11:38	None		0
	RUS	330	3/20/2002	150	12:20	12:27	Unknown snake		1
		331	3/21/2002	151	12:20	12:27	None		0
Iron Gate Reservoir	PEM	865	3/21/2002	260	12:20	12:29	None		0
		962	3/21/2002	29,498	15:15	15:42	None		0
			4/2/2002	29,498	8:15	8:30	None		0
		1045	4/1/2002	500	16:50	17:07	Western fence lizard	Adult	5
	PEM/PAB	994	3/21/2002	4482	13:53	14:14	Treefrog	Eggs	5 masses
							Treefrog	Adult	2
			3/21/2002	1,000	14:15	14:35	None		0
	PEM/RS	1036	4/1/2002	550	14:26	14:36	None		0
	PFO	1106	3/20/2002	1,250	17:00	17:31	None		0
		1115	4/2/2002	7,260	9:50	10:15	None		0
			3/21/2002	6,534	11:35	11:39	None		0
		1137	4/2/2002	3,750	10:15	10:21	None		0
	PFO/PSS	1137, 1303	3/21/2002	300	10:59	11:18	None		0
		623, 621	3/20/2002	1,100	16:00	16:11	None		0
	PFO/RUS	1075; 1021; 1085	4/1/2002	14,305	14:50	15:15	Garter snake	Adult	1
							Western toad	Adult	12
							Western toad	Eggs	Many strings
			4/25/2002	3,958	12:08	12:27	Western toad	Adult	2

Table 4.7-1. Summary of pond-breeding amphibian survey observations by Project section, 2002.

Section	Habitat[1]	Polygon[2]	Date	Area Searched (m^2)	Start Time	Stop Time	Observations		
							Species	Life Stage	Number of Individuals
							Western toad	Eggs	5 strings
			5/10/2002	3,958			None		0
	PSS	541	3/20/2002	125	15:34	15:45	None		0
	PSS/RUS	778, 677, 656	4/1/2002	1,000	16:06	16:20	Western fence lizard	Adult	1
	PUB	654	4/1/2002	335	14:17	14:23	Unknown frog	Adult	1
	PUB/PFO	654, 656	3/20/2002	1,150	16:17	16:40	None		0
	RD	515	3/20/2002	500	15:17	15:29	None		0
Fall Creek	PEM	978, 991	4/2/2002	29,667	9:15	9:31	None		0
	PEM/PSS	1027, 994	3/21/2002	1,250	14:50	15:06	Treefrog	Adult	2
	PEM/PSS/PFO	1001, 991	3/21/2002	13,456	13:20	13:40	None		0
		1025, 1027, 994, 1001	4/2/2002	17,597	8:42	9:15	Treefrog	Eggs	30 masses
							Western pond turtle	Adult	5
Copco Reservoir	DST	1383	3/22/2002	20	9:41	9:49	Treefrog	Eggs	50 masses
				20			Treefrog	Tadpoles	70
	DST/PFO	1484	3/22/2002	120	9:55	10:03	Treefrog	Tadpoles	>200
				120			Treefrog	Eggs	15 masses
							Treefrog	Adult	2
	PFO	1484	3/22/2002	60	8:43	8:57	None		0
	PSS/PFO	1366, 1376	3/22/2002	300	8:15	8:30	None		0
J.C. Boyle Peaking Reach	PEM	827	4/2/2002	3,835	14:06	14:08	None		0
		1013	4/2/2002	15,944	14:30	15:05	Treefrog	Adult	1
		1551	4/3/2002	2,250	10:03	10:15	Western fence lizard	Adult	9
		1600	4/3/2002	2,800	9:30	9:50	Garter snake	Adult	1
		1710	4/3/2002	100	10:50	11:01	Treefrog	Eggs	3 masses
							Common garter snake	Adult	1
		1788	4/4/2002	6,269	11:40	11:59	Treefrog	Adult	1
		1804	4/4/2002	2,981	10:59	11:12	Western fence	Adult	4

Table 4.7-1. Summary of pond-breeding amphibian survey observations by Project section, 2002.

Section	Habitat[1]	Polygon[2]	Date	Area Searched (m^2)	Start Time	Stop Time	Observations		
							Species	Life Stage	Number of Individuals
							lizard		
		1822	4/22/2002	75	11:19	11:40	None		0
		1933	4/4/2002	7,239	12:24	12:56	Treefrog	Eggs	25 masses
							Treefrog	Adult	2
		1953	4/5/2002	2,105	10:44	10:53	None		0
		1991	4/4/2002	1,270	14:00	14:17	Western fence lizard	Adult	2
		2018	4/5/2002	4,442	11:32	11:45	None		0
		2082	4/5/2002	1,397	11:10	11:26	Treefrog	Adult	1
	PEM/AGL	8004	4/4/2002	2,450	17:00	17:15	Treefrog	Eggs	251 masses
							Western fence lizard	Adult	2
	PGL	1784	4/3/2002	10,000	11:30	11:57	Treefrog	Adult	1
	PUB	794	3/23/2002	700	12:18	12:35	None		0
	PUB/MHO	1686	3/22/2002	750	9:07	9:16	Treefrog	Adult	1
	RD	1064	3/22/2002	300	11:29	11:39	Treefrog	Adult	2
		718; 731; 818	4/2/2002	3,000	12:52	13:03	None		0
	SEEP	1874	4/3/2002	4,100	13:10	13:30	Treefrog	Eggs	42 masses
		1887	4/2/2002	2,000	15:42	16:02	None		0
	AGL/PUB	1794	3/29/02	1,200	13:30	14:20	Western toad	Adult	5
J.C. Boyle Reservoir	LUB	2600	4/5/2002	1,630	13:05	13:22	None		0
	PEM	2652	4/5/2002	39,152	13:50	14:06	Treefrog	Adults	5
		2667	4/5/2002	9,820	14:21	14:32	None		0
	PEM/LUB	2502	4/4/2002	3,439	15:40	16:10	Treefrog	Adult	10
		2680, 2699, 2732	4/5/2002	24,936	14:38	14:46	Garter snake		14
							Southern alligator lizard	Adult	1
							Western fence lizard		2
		2491; 2492; 2494	4/4/2002	7,023	16:31	16:41	Treefrog	Adult	1
Keno Canyon	PEM	2693					None		

Table 4.7-1. Summary of pond-breeding amphibian survey observations by Project section, 2002.

Section	Habitat[1]	Polygon[2]	Date	Area Searched (m^2)	Start Time	Stop Time	Observations		
							Species	Life Stage	Number of Individuals
		2534; 2532;					None		
Keno Reservoir	PEM	2527	4/24/2002	1,000	13:02	13:15	None		0
		2612	4/22/2002	36,139	16:12	16:30	Western pond turtle	Adult	19
		2701	4/23/2002	1,500	9:04	9:15	None		0
		2806	4/24/2002	18,611	16:02	16:10	None		0
	PUB	2458	4/24/2002	1,000	13:02	13:15	None		0
Link River	PEM	2891	4/23/2002	852	17:20	17:25	Treefrog		2
	PFO	2864	4/5/2002	10,617	8:38	8:44	None		0

[1] PEM=palustrine emergent wetland, PFO=palustrine forested wetland, PUB=palustrine unconsolidated bottom, RD=riparian deciduous, RS=riparian shrub, DST=disturbed, PGL=perennial grassland, LUB=lacustrine unconsolidated bottom, MHO=montane hardwood oak, AGL=annual grassland, SEEP=small seep, PSS=palustrine scrub-shrub.

[2] See Figure 4.4-1 for location of polygons.

The following summarizes the results for each of the pond-breeding amphibian species documented in the study area during 2002 surveys.

- Western Toad—Two western toad breeding sites were confirmed in 2002: one along the north shore of Iron Gate reservoir (April 1) (polygon numbers 1075, 1021, and 1085 located a short distance southwest of the mouth of Scotch Creek), and one on March 29 in a seasonally flooded portion of an annual grassland along Way Creek near Topsy Road (polygon 1794) (Table 4.7-1). The Way Creek site is likely the same breeding site that was documented by Roninger (2001). Adult toads were seen along lower Scotch Creek, not far from the Iron Gate reservoir breeding site. During 2002, adult toads also were reported from near the Copco No. 1 village. The Iron Gate reservoir breeding site had been found previously by Southern Oregon University surveys (Parker, pers. comm., 2002). Parker also indicated that western toads use pools in upper Scotch Creek as oviposition sites. Biologists inspected several other beaches along shorelines of Iron Gate and Copco reservoirs that had gradual slope, but found no other toad use.

  In addition to the documented records along the Oregon portion of the J.C. Boyle peaking reach, Roninger (2001) and St. John (1987) found western toads in the Frain Creek spring near the river. Given the number of reported locations for this species, there are likely other breeding sites either along the reservoir shorelines or in small, isolated ponds throughout the study area.

- Pacific Treefrog—There were 18 sites at which Pacific treefrogs were noted during 2002 surveys, including eight that were confirmed breeding sites (Table 4.7-1). This species was found breeding in six isolated wetlands, ponds, or roadside ditches (along Copco reservoir), but was found breeding in only two wetlands connected to the river itself—one site along Iron Gate reservoir and one site along the J.C. Boyle peaking reach. One wetland in the J.C. Boyle peaking reach had 251 egg masses, but most other breeding sites were much smaller in terms of density of egg masses (Table 4.7-1). The only Project segments in which treefrogs were not detected during all field activities in 2002 were the Copco No. 2 bypass (no pond-breeding sites present to survey) and Keno reservoir. Given the ubiquitous nature of this species, it is likely that all Project segments support this species. Pacific treefrogs were found breeding at a number of widely scattered locations in the Oregon portion of the J.C. Boyle peaking reach in 2000 and 2001 (Roninger, 2001). St. John (1987) reported this species to be widespread in the Klamath River vicinity.

- Bullfrog—During pond-breeding surveys, bullfrogs were found at only two locations, both downstream of Iron Gate dam. Bullfrogs also were noted in the summer and fall along Keno reservoir and at two locations along Iron Gate reservoir (Appendix 4C). Because pond-breeding surveys in 2002 were timed to increase detections of native species, the surveys were not conducted when bullfrog egg masses would be most evident. However, because bullfrog tadpoles require 2 to 3 years to metamorphose, surveys in 2002 would have detected tadpoles from previous years. Pond-breeding surveys documented two sites with bullfrogs in the Iron Gate-Shasta River segment. Incidental bullfrog observations were recorded for all four of the Project reservoirs, as well as the J.C. Boyle bypass and uppermost portion of the J.C. Boyle peaking reach. Because it was already known that the reservoirs support bullfrog populations, little survey effort was applied to reservoir habitat. During one turtle survey of Keno reservoir, 39 adult or subadult bullfrogs were counted. Hayes (1994) reported bullfrogs at Lake Ewauna, Link River, and along at the Klamath Wildlife Area. Bullfrogs were not detected in the Oregon portion of the J.C. Boyle peaking reach by the BLM in 2000 or 2001 (Roninger, 2001). It is unlikely that any large populations of bullfrogs occur in the Oregon portion of the J.C. Boyle peaking reach because of the high gradient of most of the reach. However, the section of river between the Oregon-California border and Copco reservoir has lower gradient sections that may provide habitat for bullfrogs.

4.7.1.2 Instream Surveys

Fourteen sections of tributary creeks were surveyed for amphibians during the weeks of March 20, 2002, August 5, 2002, and August 26, 2002 (Table 4.7-2; Figure 4.4-1). Three locations were surveyed twice. Instream amphibian surveys were conducted in the first 328 to 492 feet (100 to 150 m) of a creek adjacent to a Project facility or reservoir. The survey covered the entire width of the creek and adjacent riparian habitat and involved walking up the creek, turning rocks, and regularly using drift nets to catch material dislodged by biologists. In addition, the observations made during the electroshocking surveys of the Klamath River upstream of Iron Gate dam and along Fall Creek are presented here.

Instream amphibian and reptile surveys detected no amphibians or reptiles in 11 of the tributary reaches sampled; only Fall Creek, Cottonwood Creek, and Crayfish Creek had species detected. Pacific giant salamander larvae were found above and below the Fall Creek diversion dam (Table 4.7-2). Fisheries electroshocking surveys also documented 26 detections of larval Pacific giant salamanders at Fall Creek. The electroshocking surveys also documented three Pacific giant salamander larvae in the J.C. Boyle bypass.

A survey of the lowermost portion of Cottonwood Creek, a tributary of the Iron Gate-Shasta, found 11 Pacific treefrog adults in the creek and along the shoreline. The only other species detected during the instream surveys was the western fence lizard. Three western fence lizards were documented at Crayfish Creek in the J.C. Boyle peaking reach.

There are very little other data on the presence of river-dependent amphibian species near the Klamath study area. Hayes (1996) conducted a comprehensive survey of Spencer Creek, a major tributary to the J.C. Boyle reservoir and found Pacific giant salamanders. However, all of the detections were at least 1,969 feet (600 m) upstream of the reservoir. It is possible that the abundant trout population limits the population of aquatic salamanders there.

The foothill yellow-legged frog is a species that potentially could occur in the Klamath River and its tributaries, but was not detected during instream surveys in 2002. There are two historical records of this species near the site of the J.C. Boyle dam and in the upper portion of Cottonwood Creek from before Project construction near the town of Hilt, California (Borisenko, 2000). The upper portion of Little Bogus Creek has a historical record as well (A. Linde, unpubl. data). Surveys completed in 2003 provide additional information on the potential occurrence of foothill yellow-legged frog and other riverine-dependent amphibians (Section 4.7.3).

Table 4.7-2. Summary of instream amphibian survey observations, 2002.

Segment	Polygon*	Creek Name*	Date	Area Searched (m^2)	Observations		
					Species	Life Stage	Number of Individuals
Iron Gate-Shasta	444	Bogus Creek	8/5/2002	1,000	None		0
	Upstream of poly 234	Cottonwood Creek	8/29/2002	8,000	Treefrog	Adult	11
Iron Gate Reservoir	1303	Jenny Creek	8/5/2002	1,875	None		0
	1106; 1095	Camp Creek	8/5/2002	75	None		0
Fall Creek	1427	Lower Fall Creek	8/5/2002	250	None		0
	1640	Fall Creek above diversion	3/21/2002	800	None		0
	1581; 1611	Fall Creek below diversion	3/21/2002	360	None		0
		Fall Creek below diversion	8/6/2002	300	Pacific giant salamander	Larva	2
	1611; 1631	Fall Creek below diversion	3/21/2002	400	None		0
		Fall Creek below diversion	8/6/2002	1,200	Pacific giant salamander	Larva	2
Copco Reservoir	1484	Copco Lake Springs	8/6/2002	80	None		0
	1587	Beaver Creek	8/6/2002	360	None		0
J.C. Boyle Peaking Reach	1738; 1772; 1874	Hayden Creek	4/2/2002	2,400	None		0
	1064	Shovel Creek	8/6/2002	980	None		0
	1958	Crayfish Creek	8/28/2002	300	Western fence lizard		3
J.C. Boyle Reservoir	2732; 2734	Spencer Creek	8/7/2002	875	None		0

* See Figure 4.4-1 for location of polygons and creeks.

4.7.1.3 Terrestrial Amphibian Surveys

During the week of April 22, 2002, two plots in mixed-conifer forest in the Keno Canyon were surveyed for the presence of terrestrial salamanders. These two plots were located on north-facing slopes where soil moisture was relatively high. No salamanders were found. In addition to these terrestrial surveys, all of the pond-breeding and instream surveys included the riparian or upland habitat immediately adjacent to the targeted body of water. No amphibian species were found during any of the surveys. The BLM, in their surveys of the J.C. Boyle Canyon, found no terrestrial amphibians at any of the 50 terrestrial sample sites (Roninger, 2001). A survey by St. John (1987) in oak habitat of Klamath County reported no terrestrial amphibian species either. Therefore, it seems unlikely that fully terrestrial amphibians occur with any regularity in the study area.

Although not detected during PacifiCorp surveys or the BLM surveys, it is possible that small populations of terrestrial salamanders—the most likely species being ensatina—occur in the study area. In addition to the limited amount of mixed-conifer forest in the J.C. Boyle Canyon and Keno Canyon, the riparian forests in those sections of the study area could provide some habitat for this species. It is unlikely that any of the other terrestrial amphibians listed in Table 4.4-1 as potentially occurring actually do occur in the study area. The much rarer Siskiyou Mountain, Del Norte, black, and clouded salamanders do not occur in the Klamath River study area because their ranges are restricted to areas west of I-5 or farther north or south.

4.7.1.4 General Wildlife Plot Amphibian and Terrestrial Reptile Surveys

During the week of June 17, 2002, reptile surveys were conducted in 139 of the 1.93-acre (0.78-ha) wildlife survey plots and at six Project facilities (Figure 4.4-1). A total of 159 individual reptiles were documented within the 139 survey plots (1.1 reptiles per plot) (Table 4.7-3). In comparison, an average of 1.5 reptiles/plot were observed in the subset of plots that were classified as riparian or wetland cover types. On a per-plot basis, the greatest number detected was at the Keno reservoir segment, where an average of 2.25 reptiles/plot was detected (Table 4.7-4). This was followed closely by the J.C. Boyle peaking reach with 1.95 reptiles/plot (Table 4.7-4). The lowest number of detections occurred in the Fall Creek segment, where only 1 western fence lizard was found in seven plots (0.14 per plot).

The data from the 36 plots located in wetland or riparian habitats along the 11 Project segments indicate that the species diversity of reptiles was greatest in the J.C. Boyle peaking reach, where eight species (21 individual reptiles) were detected (Table 4.7-4). This equates to 3.5 individuals/plot. The Keno Canyon also had a high density (three individual reptiles per plot); these detections were of only two species, however (Table 4.7-4). All other Project segments had between 0.75 and 1.7 reptiles/plot, except for the J.C. Boyle reservoir, where no reptiles were detected in the riparian/wetland wildlife plots.

Overall, the western fence lizard was by far the most abundant reptile species encountered in the wildlife survey plots, representing 94 of 159 detections (59 percent). An average of 0.67 fence lizard was detected in each plot (Table 4.7-5). Fence lizards were detected in all Project segments except the Link River. Western fence lizards were found in a wide variety of habitats including riparian and wetland habitats, mixed chaparral, juniper, montane hardwood oak woodlands, ponderosa pine forest, Klamath mixed-conifer forest, and lodgepole pine stands

(Table 4.7-3). Fence lizards occur throughout the J.C. Boyle Canyon (Roninger, 2001) and oak habitats of Klamath County (St. John, 1987).

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (^oC)	Observations		
					Species	Life Stage	Number of Individuals
Iron Gate-Shasta	MHOJ	439	6/20/2002	31	None		0
	RD	33	6/21/2002	14	None		0
		367	6/20/2002	29	None		0
	RG	44	6/21/2002	16	None		0
		123	6/21/2002	18	Western fence lizard	Adult	1
		295	6/21/2002	22	None		0
	RS	98	6/21/2002	17	Gopher snake	Adult	1
					Western fence lizard	Adult	1
		298	6/21/2002	22	None		0
		398	6/20/2002	31	None		0
Iron Gate Reservoir	GL	1036	6/21/2002	22	None		0
		1109	6/20/2002	29.5	None		0
	J	1308	6/20/2002	31	None		0
	MHOC	1073	6/21/2002	20.5	Western fence lizard	Adult	2
					Western toad	Adult	1
	MHOJ	485	6/20/2002	30	Western fence lizard	Adult	1
	PEM	865	6/20/2002	31.5	None		0
		902	6/20/2002	29	Western fence lizard		1
		962	6/20/2002	27	Western fence lizard		1
	PFO	552	6/20/2002	31	Sagebrush Lizard	Adult	2
		665	6/20/2002	29	None		0
		1016	6/21/2002	21	Bullfrog	Adult	1
		1303	6/20/2002	30.5	None		0
	PSS	569	6/20/2002	30	None		0
		721	6/20/2002	29	None		0
		1115	6/20/2002	33	None		0
	RD	444	6/20/2002	31	None		0
		960	6/20/2002	33	None		0
		1074	6/20/2002	29	None		0
	RS	434	6/20/2002	31	Bullfrog	Adult	1
		677	6/20/2002	27	Western rattlesnake	Adult	1
		895	6/20/2002	28	None		0
		971	6/21/2002	14	None		0

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (^{o}C)	Observations		
					Species	Life Stage	Number of Individuals
Fall Creek	MHOC	1665	6/20/2002	27	None		0
	MHOJ & MXC	1543	6/20/2002	18	None		0
	PEM	1463	6/20/2002	16	None		0
	PSS	1025	6/20/2002	26.5	Western fence lizard		1
	RM	1427	6/20/2002	31	Western fence lizard	Adult	1
		1581	6/20/2002		Pacific giant salamander	larva	1
		1666	6/20/2002	23	None		0
	RM/PEM	1611	6/20/2002	21.5	None		0
Copco Reservoir	GL	1547	6/20/2002	21	None		0
	J	1237	6/20/2002	16	Western fence lizard	Adult	1
	MHOJ	1168	6/19/2002	26.5	None		0
		1478	6/20/2002	34	None		0
	MXC	1164	6/19/2002	27	None		0
		1288	6/20/2002	33	Western fence lizard		1
		1511	6/20/2002	16	Western fence lizard	Adult	1
	PEM	1413	6/20/2002	16	None		0
		1501	6/20/2002	21	None		0
		9000	6/20/2002	27	None		0
	PFO	1441	6/20/2002	34	Western fence lizard		2
		1484	6/20/2002	28	None		0
	PSS	1376	6/20/2002	16	Southern alligator lizard	Adult	1
	RD	1342	6/20/2002	30	Western fence lizard		1
		1396	6/20/2002	16	None		0
		1529	6/20/2002	20	None		0
	RG	784	6/19/2002	25	None		0
J.C. Boyle Peaking Reach	GL	678	6/19/2002		None		0
		1492	6/19/2002		None		0
		1920	6/19/2002	17	None		0
		1935	6/19/2002	16	Western fence lizard		1
	J	2279	6/18/2002	19	Western fence lizard		1
	KMC	1876	6/19/2002	18	Western fence lizard	Adult	7
	MHO	745	6/19/2002	19.5	Western fence lizard		1
		1634	6/19/2002	22	None		0
		1966	6/19/2002	19	None		0

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (^{o}C)	Observations		
					Species	Life Stage	Number of Individuals
	MHOC	1246	6/19/2002	19	None		0
		1992	6/18/2002	16	Southern alligator lizard		2
					Unknown lizard		1
					Western fence lizard		1
		2138	6/18/2002	23	Western fence lizard		1
		2267	6/18/2002	23	Western fence lizard	Adult	1
	MHOC	1982	6/19/2002	16	Southern alligator lizard		1
					Western fence lizard		1
	MHOJ	2034	6/19/2002	18	Western fence lizard		1
	MXC	1769	6/19/2002	17	Western fence lizard		1
		1985	6/19/2002	23	Western fence lizard		1
	PA	652	6/19/2002		Yellow-bellied racer		1
		870	6/19/2002	22	None		0
	PEM	1729	6/19/2002	21	None		0
		1933	6/19/2002	16	Common garter snake		1
					Southern alligator lizard	Adult	1
					Western rattlesnake	Adult	1
					Western fence lizard	Adult	1
		1991	6/18/2002	22	Gopher snake	Adult	1
					Western fence lizard	Adult	1
		2018	6/19/2002	12	Unknown snake		1
	PP	2167	6/19/2002	22	Western fence lizard		1
	RD	837	6/19/2002	23	Western rattlesnake		1
					Western fence lizard		1
		1064	6/19/2002	19	Western fence lizard		1
	RG	750	6/19/2002	19.5	None		0
		2003	6/18/2002	18	Gopher snake	Adult	1
					Western fence lizard		1
		2014	6/18/2002	18	Common garter snake		1
					Gopher snake		1
		2107	6/18/2002	21	Common garter snake		1

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (^{o}C)	Observations		
					Species	Life Stage	Number of Individuals
		9002	6/19/2002	16	Common garter snake		1
	RM	1437	6/19/2002		None		0
		1710	6/19/2002	21	None		0
	RS	1958	6/19/2002	19	None		0
		2129	6/18/2002	20	Unidentified garter snake	Adult	1
					Western terrestrial garter snake	Adult	1
					Western fence lizard		1
	RS & MHO	737	6/19/2002	22	Yellow-bellied racer	Adult	1
					Western fence lizard	Adult	1
	RT	2163	6/18/2002	21	Western fence lizard		1
J.C. Boyle Bypass	KMC	2456	6/18/2002	19	Western fence lizard		1
	LP	2475	6/18/2002	19	Western fence lizard		1
	MHOJ	2358	6/18/2002	21	Western fence lizard		1
	PGL	2422	6/18/2002		Unknown lizard		1
					Western fence lizard		1
		2547	6/18/2002	22	None		0
	PP	2474	6/18/2002	18	None		0
		2484	6/18/2002	19	None		0
	RD	2486	6/18/2002		None		0
	RS	2323	6/18/2002	22	Western fence lizard		1
		2467	6/18/2002	21	Common garter snake		1
				21	Western fence lizard		1
		2506	6/18/2002	23	None		0
	RS/RD	2412	6/18/2002	24	Western fence lizard	Adult	2
J.C. Boyle Reservoir	PP	2508	6/18/2002	17	None		0
		2718	6/18/2002	18	None		0
	KMC	2545	6/18/2002	16	None		0
	PP/ER	2582	6/18/2002	18	Western fence lizard		1
	PSS	2734	6/18/2002	16	None		0
	RS	2554	6/18/2002	16	None		0
		2588	6/18/2002	16	None		0

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (°C)	Observations		
					Species	Life Stage	Number of Individuals
	SB	2703	6/18/2002	18	None		0
Keno Canyon	MXC	2651	6/17/2002	18	None		0
	PEM	2693	6/17/2002	19	None		0
	PP	2682	6/17/2002	20	Yellow-bellied racer		1
	RG	2688	6/17/2002	20	None		0
		2727	6/17/2002	21	Common garter snake		1
					Gopher snake		1
		2737	6/17/2002	19	Common garter snake	Adult	1
		2742	6/17/2002	19	Common garter snake		3
					Western fence lizard		2
	RS	2576	6/17/2002	21	Sagebrush lizard		1
					Western fence lizard		1
		2583	6/17/2002	21	Southern alligator lizard		1
					Western fence lizard		1
Keno Reservoir	PA	2774	6/17/2002	17	None		0
	J	2496	6/17/2002	18	None		0
	PEM	2527	6/18/2002	21	None		0
		2806	6/17/2002	20	None		0
		2849	6/27/2002	18	Unidentified garter snake		1
	PP	2623	6/17/2002	18	Western fence lizard	Adult	1
					Western pond turtle	Adult	2
					Western pond turtle	Juvenile	1
	RD	2840	6/17/2002	19	Gopher snake	Adult	1
		2846	6/17/2002	19	None		0
		2855	6/17/2002	19	None		0
	RG	2686	6/17/2002	18	None		0
		2731	6/17/2002	18	None		0
		2787	6/17/2002		Western pond turtle	Juvenile	1
Link River	J	2893	6/17/2002	18	None		0
	RD	2869	6/17/2002	18	None		0
	RS	2885	6/17/2002	18	Common garter snake		2
Copco Bypass	MHO	1117	6/20/2002	24.5	Western fence lizard		1

Table 4.7-3. Reptile and amphibian survey observations in 139 wildlife survey plots, June 17-21, 2002.

Project Section	Habitat	Polygon Number	Date	Air Temp (°C)	Observations		
					Species	Life Stage	Number of Individuals
	MHOC	1226	6/20/2002	21.5	None		0
	RD	1216	6/20/2002	19.5	Western fence lizard		1

1 PEM=palustrine emergent wetland, PFO=palustrine forested wetland, PUB=palustrine unconsolidated bottom, RD=riparian deciduous, RG=riparian grass, RM=riparian mixed, RT=rock/talus, ER=exposed rock, RS=riparian shrub, DST=disturbed, PGL=perennial grassland, LUB=lacustrine unconsolidated bottom, MHO=montane hardwood oak, MHOJ= montane hardwood oak/juniper, J=juniper; MHOC= montane hardwood oak/conifer, PP=ponderosa pine, PA=irrigated hayfield/pasture, AGL=annual grassland, SEEP=small seep, PSS=palustrine scrub-shrub, KMC=Klamath mixed conifer, SB=sagebrush, MXC=mixed chaparral.

2 See Figure 4.4-1 for location of plots.

The next most abundant species found during the terrestrial plot surveys was the common garter snake, documented in nine (6 percent) of the 139 plots surveyed in 2002 (Table 4.7-4). This species was noted in the J.C. Boyle peaking reach, J.C. Boyle bypass, Keno Canyon, and Link River segments during these surveys. This species always was associated with riparian habitats (Table 4.7-5), which is consistent with the findings of Roninger (2001). One winter hibernaculum with numerous common garter snakes was located near Keno reservoir. BLM surveys confirmed numerous common garter snake locations in the J.C. Boyle Canyon along the river and at sites at higher elevations in the study area.

Five southern alligator lizards were found in the wildlife plots (Table 4.7-3). This species was found in riparian and wetland habitat in the Keno Canyon, J.C. Boyle peaking reach, and along Copco reservoir. It also was found in montane hardwood oak-conifer forests in the J.C. Boyle peaking reach of the study area. BLM surveys found southern alligator lizards widely scattered throughout the J.C. Boyle Canyon, particularly downstream of the Frain Ranch on southern aspects (Roninger, 2001). A few of the sites documented by Roninger (2001) are close to the river, but most are farther than 0.2 mile (0.3 km).

During the wildlife plot surveys, northern sagebrush lizards were found at only two sites—one in the rocky riparian shrub habitat of the Keno Canyon and one near the edge of a forested wetland along Iron Gate reservoir (Table 4.7-3; note that these specimens were identified at a distance so positive identification was not confirmed). BLM surveys found this species only near the historic Topsy Site (Roninger, 2001). However, St. John (1987) found sagebrush lizards to be quite numerous in suitable habitat, particularly open woodlands. He reported at least four locations in the immediate vicinity of the Topsy Site, BLM's Topsy Campground, and on the north side of the river upslope of the J.C. Boyle powerhouse.

One western terrestrial garter snake was found in the wildlife plots. This snake was located in riparian habitat in the J.C. Boyle peaking reach. Roninger (2001) found western terrestrial garter snakes in the canyon in ponderosa pine, mixed-conifer woodland, hardwood woodland, and non-forested habitats.

Table 4.7-4. Relative abundance (number/plot) of reptiles detected in 139 wildlife plots by Project segment, June 2002.

Species	Iron Gate-Shasta (8 plots)	Iron Gate Reservoir (23 plots)	Fall Creek (7 plots)	Copco Bypass (3 plots)	Copco Reservoir (17 plots)	J.C. Boyle Peaking Reach (37 plots)	J.C. Boyle Bypass (12 plots)	J.C. Boyle Reservoir (8 plots)	Keno Canyon (9 plots)	Keno Reservoir (12 plots)	Link River (3 plots)	Total Relative Abundance
Common Garter Snake	0	0	0	0	0	0.135	0.083	0	0.667	0	0.667	**0.101**
Gopher Snake	0.125	0	0	0	0	0.081	0	0	0.111	0.083	0	**0.043**
Northern Sagebrush Lizard	0	0.087	0	0	0	0.054	0	0	0	0	0	**0.022**
Southern Alligator Lizard	0	0	0	0	0.059	0.027	0	0	0	0	0	**0.007**
Western Fence Lizard	0.375	0.304	0.143	0.66	0.412	1.378	1.250	0.125	0.556	0.083	0	**0.676**
Western Pond Turtle	0	0	0	0	0	0	0	0	0	0.166	0	**0.173**
Western Rattlesnake	0	0.043	0	0	0	0.027	0	0	0	0.083	0	**0.014**
Western Terrestrial Garter Snake	0	0	0	0	0	0.027	0.083	0	0	0	0	**0.014**
Yellow-Bellied Racer	0	0	0	0	0	0.027	0	0	0	0	0	**0.007**
Unidentified Garter Snake	0	0	0	0	0	0.081	0	0	0	0	0	**0.022**
Unknown Lizard	0	0	0	0	0	0	0	0	0.111	0	0	**0.022**
Unknown Snake	0	0	0	0	0	0.108	0	0	0.111	0	0	**0.043**
Total Reptile Relative Abundance for Project Segment	**0.5**	**0.435**	**0.143**	**0.66**	**0.471**	**1.946**	**1.417**	**0.125**	**1.556**	**2.25**	**0.667**	**1.144**

Table 4.7-5. Number of amphibians and reptiles observed in wildlife plots in riparian/wetland cover type in June 2002.

Species	**Copco Bypass (n=1)**	**Copco Reservoir (n=5)**	**Fall Creek (n=4)**	**Iron Gate Reservoir (n=5)**	**J.C. Boyle Bypass (n=3)**	**J.C. Boyle Peaking Reach (n=6)**	**J.C. Boyle Reservoir (n=2)**	**Keno Canyon (n=2)**	**Keno Reservoir (n=3)**	**Link River (n=2)**	**Lower River (n=3)**	**Total Count**
Pacific Giant Salamander			1									**1**
Bullfrog				2								**2**
Western Fence Lizard	1	3	2	2	4	7					2	**21**
Southern Alligator Lizard		1				1						**2**
Northern Sagebrush Lizard				2								**2**
Rattlesnake				1		2						**3**
Common Garter Snake					1	4		5		2		**12**
Gopher Snake		4				3		1	1		1	**6**
Unidentified Snake						2			1			**3**
Western Terrestrial Garter Snake						1						**1**
Yellow-Bellied Racer						1						**1**
Pond Turtle									1			**1**
Total Reptile Relative Abundance for Project Segment	**1.0**	**1.6**	**0.75**	**1.4**	**1.6**	**3.3**	**0.0**	**3.0**	**1.0**	**1.0**	**1.0**	

Two yellow-bellied racers were found in wildlife plots. Both snakes were in the J.C. Boyle peaking reach (Table 4.7-3). One snake was found in a pasture, and one was in riparian habitat. Roninger (2001) found this species to be well distributed throughout the canyon, both immediately along the river and in habitats farther from the river. St. John (1987) also reports yellow-bellied racers as being common in the Project vicinity.

Gopher snakes were found in six (4 percent) of the 139 wildlife plots. These observations were recorded in the Iron Gate-Shasta, Keno reservoir, Keno Canyon, and J.C. Boyle peaking reach segments of the study area (Table 4.7-3). All of the detections in wildlife survey plots were in riparian habitat. However, gopher snakes were detected in various upland habitats incidentally to other field activities. Roninger (2001) reported numerous gopher snake locations scattered throughout the canyon.

The general wildlife survey plots documented three rattlesnakes—one at Iron Gate reservoir and two in the J.C. Boyle peaking reach. All three plots with rattlesnakes were riparian or wetland. Rattlesnakes are known to occur throughout the study area, with an often patchy distribution. There are reports of concentrations of rattlesnakes in the J.C. Boyle bypass and at various sections of the J.C. Boyle peaking reach. There were incidental records of rattlesnakes in various other portions of the study area. St. John (1987) found rattlesnakes at various locations in the canyon. The snake hibernacula surveys conducted in 2003 provide additional data on sites potentially important for rattlesnakes.

An additional 14 reptile detections—one western terrestrial garter snake, one yellow-bellied racer, seven fence lizards, and five western pond turtles—were documented near Project facilities (Table 4.7-6).

Table 4.7-6. Number of reptile observations near Project facilities, May-June 2002.

	Fall Creek Diversion (1 plot)	**J.C. Boyle Powerhouse (1 plot)**	**J.C. Boyle Canal (3 surveys)**	**Keno Dam (1 plot)**	**East Side/ West Side (2 plots)**	**Total**
Western Terrestrial Garter Snake	1	0	0	0	0	**1**
Yellow-Bellied Racer	0	0	1	0	0	**1**
Western Fence Lizard	0	0	2	5	0	**7**
Western Pond Turtle	0	0	0	5	0	**5**
Total	**1**	**0**	**3**	**10**	**0**	**14**

The following terrestrial reptile species were not recorded in any of the wildlife survey plots, but were recorded as incidental observations or from other investigators:

- Common kingsnakes were observed incidentally in the J.C. Boyle Canyon and dead on the paved road north of the Iron Gate-Shasta segment.
- One dead striped whipsnake was found on the road near the Copco No. 1 village in montane hardwood oak habitat. This is a very uncommon snake that Roninger (2001) reported from a

site near Keno dam and a site 0.5 mile (0.8 km) north of river not far from the Oregon-California border.

- Roninger (2001) reported three sharptail snake locations, none of which was closer than about 0.1 mile (0.2 km) from the river. All of the BLM records are west of the Frain Ranch.

- The ringneck snake apparently is not common in the study area. Roninger (2001) reported only one location—approximately 0.1 mile (0.2 km) west of the river across from the Frain Ranch. St. John (1987) reported one dead ringneck snake on the Topsy Road adjacent to steep, rocky slopes dominated by shrubs, oaks, ponderosa pine, and western juniper.

- Western skinks were found by Roninger (2001) at approximately seven locations within the canyon, including two sites immediately north of the river just upstream of the Oregon-California border and at other widely scattered sites 0.2 to 0.8 mile (0.3 to 1.3 km) from the river.

- One rubber boa was found by the BLM in the Klamath River Canyon (Roninger, 2001). This location was east of the Topsy Road outside of the canyon. St. John (1987) found one rubber boa near the BLM's Topsy Campground.

- California mountain kingsnakes were found in 2000 and 2001 at five locations in the J.C. Boyle Canyon by the BLM, including one site near the BLM's Klamath River Campground (Roninger, 2001). The other four sites are located approximately 0.25 mile (0.4 km) from the river. St. John (1987) found one California mountain kingsnake near the Way Ranch and reports that there are other records in the canyon several miles downstream of the J.C. Boyle powerhouse. St. John (1987) speculated that in Klamath County, this species is restricted to the Klamath River Canyon.

- There are no known records of the night snake, western aquatic garter snake, or northwestern garter snake near the study area.

4.7.1.5 2002 Pond Turtle Surveys

Pond turtle surveys conducted in 2002 at Keno, J.C. Boyle, Copco, and Iron Gate reservoirs, and the Klamath River between Iron Gate dam and the Shasta River supplement data collected by the BLM (Roninger, 2001) and Bury (1995) in the Oregon portion of the J.C. Boyle Canyon. Surveys of the J.C. Boyle bypass and California portion of the J.C. Boyle peaking reach were completed in the spring of 2003 (see Section 4.7.3.4). During the entire 2002 field season, there were 501 turtle detections recorded during turtle surveys (Table 4.7-7; Figure 4.7-1). In addition, there were 47 incidental observations in the study area, including 18 turtles in the beaver dam pond/wetland located between Fall Creek and Iron Gate reservoir, and 24 turtle observations along the Keno reservoir shoreline during other wildlife surveys (Appendix 4C).

Table 4.7-7. Summary of pond turtle survey observations, 2002.

Section	Reservoir or Polygon* Surveyed	Date	Area Searched (m^2)	Method	Species	Life Stage	Number of Individuals
Copco Reservoir	Copco reservoir	7/10/2002	Entire reservoir	Boat	Western pond turtle	Adult	8
			Entire reservoir	Boat	Western pond turtle	Juvenile	4
	Littoral zone near poly 709	04/02/02	Upper 1/2 of reservoir	Ground-based	Western pond turtle	Adult	9
Fall Creek	Beaver pond	04/02/02	2,000	Ground-based	Western pond turtle	Adult	9
		05/08/02	2,000	Ground-based	Western pond turtle	Adult	20
		7/10/2002	2,000	Ground-based	Western pond turtle		0
Iron Gate Reservoir	Iron Gate reservoir	03/29/02	Entire reservoir	Ground-based	Western pond turtle	Adult	1
	--	7/10/2002	Entire reservoir	Boat	Western pond turtle	Adult	15
	--		Entire reservoir	Boat	Western pond turtle	Juvenile	2
J.C. Boyle Peaking Reach	2129	04/04/02	2,000	Ground-based	Western pond turtle	Adult	6
J.C. Boyle Reservoir	2691	5/22/2002	Lower 1/2 reservoir	Ground-based	Western pond turtle	Adult	23
	J.C. Boyle reservoir	05/24/02	7,810	Ground-based	Western pond turtle	Adult	1
		7/9/2002	Entire reservoir	Ground-based	Western pond turtle		0
	8015; 2580	7/9/2002	10,181	Ground-based	Bullfrog	Adult	2
Keno Reservoir	2797	10/8/2002	Keno reservoir between Highway 66 and Link River	Boat	Western pond turtle	Adult	7
	Keno log boom	4/23/2002	Keno reservoir between Highway 66 and dam	Ground-based	Western pond turtle	Adult	70
	Keno reservoir	7/8/2002	Keno reservoir between Highway 66 and Highway 140 bridges	Boat	Western pond turtle	Adult	11
	--		Entire reservoir	Boat	Bullfrog	Adult	39
	--		Keno reservoir between Highway 66 and Keno dam	Boat	Western pond turtle	Adult/ Juvenile	265
	Keno reservoir	7/9/2002	Entire reservoir	Boat	Western pond turtle		0
Iron Gate-Shasta	--	05/08/02	Klamathon Bridge to Shasta River	Ground-based	Western pond turtle	Adult	9
	Iron Gate-Shasta	8/22/2002	Entire length of Iron Gate-Shasta	Ground-based	None		0
Total							**501**

* See Figure 4.7-1 for location of GIS polygons.

Figure 4.7-1. Turtle habitat and observations..

Turtle Map - Total of 6 pages - 11X17 – INSERT HERE

Figure 4.7-1—turtle map 1 of 6 pgs

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During one survey of Keno reservoir, 265 turtles were detected between the Highway 66 bridge and the dam, while only 11 basking turtles were found between the Highway 66 bridge and the Highway 140 bridge. Of the minimum count of 276 turtles documented in Keno reservoir, less than 5 percent appeared to have carapace lengths of less than approximately 5.5 inches (14 cm), a size that could represent subadult/juvenile age classes (Holland, 1994; Bury, 1995). Turtles less than about 3.1 inches (8 cm) often occur in calm water with abundant vegetation (Bury, 1995) and, therefore, may be more difficult to detect during general basking surveys. The number of turtles detected on the other reservoirs in 2002 ranged between a low of 12 on Copco reservoir (primarily the upstream portion) and 23 on J.C. Boyle reservoir (Table 4.7-7). A survey of Iron Gate reservoir documented only 17 turtles. However, the wetland near the mouth of Fall Creek is known to support at least 20 turtles. This wetland is a complex of open water, emergent, scrub-shrub, and forested wetland created by a beaver dam on seepage from Fall Creek. It is relatively protected in the middle, but is affected by cattle grazing and recreational activity at the Fall Creek Park along the fringes. Only one location along the Iron Gate-Shasta segment—a site between Cottonwood Creek and I-5—was found to have basking pond turtles in 2002 (Figure 4.7-1). However, the survey of the Iron Gate-Shasta was ground-based and had several gaps in coverage because private lands were inaccessible. Therefore, it is likely that several other locations in pool habitat have pond turtles.

The BLM recorded 67 turtle detections in the Oregon portion of the J.C. Boyle peaking reach (Roninger, 2001). The BLM found that there are several specific sections of river in this reach where turtles were regularly observed basking in 2000 and 2001, and that these sites are consistently used year after year (Roninger, pers. comm., 2003). These locations were at Frain Ranch (RM 214.8), near the old bridge crossing site (RM 216.8), an area near the BLM's Klamath River Campground (RM 217), and a site approximately 0.5 mile (0.8 km) upriver of the BLM's Klamath River Campground (RM 217.7) (Figure 4.7-1). Bury (1995) also documented several specific areas in the canyon that are used by basking turtles. The sites reported by Bury (1995) are "Turtle Cove" at RM 216.2 and "Turtle Cove 2" at RM 216.6. At both sites studied by Bury (1995), basking habitat was provided by fallen trees that extend out of the water onto shore and by boulders. Bury (1995) characterized the two sites as having high velocity during the daytime (0900 to 1300 hours), but relatively calm flow during low water. During low water periods of the day, fallen trees are sometimes left completely out of the water at the turtle basking sites. Bury (1995) also found small numbers of turtles at RMs 221.0, 218.0, 217.2, 214.0, and 210.0.

Bury (1995) indicated that the pond turtle population in the Klamath River was approximately 5 to 15 turtles per river mile. He further reported that the turtles in this population have a high growth rate, possibly the result of the nutrient-rich water that supports large numbers of invertebrates, the primary prey of pond turtles (Holland, 1994). Turtles eat clams, crayfish, snails, leeches, and insects, which are abundant (Bury, 1995). Carapace length of Klamath River pond turtles measured by Bury (1995) was found to be between 6 and 7.4 inches (153 and 189 mm), with several females being larger than the largest females measured at other large populations in northern California. The large size of and high percentage of females in the Klamath River population is an indicator of potentially high reproductive potential as egg clutch sizes increases with female body size. Germano (1994) conducted a growth and demography study of the Klamath River turtle population and compared it to a population at Jackson Creek. In this study, he found that nearly 47 percent of turtles were older than 16 years of age and that only one of 15 turtles captures was a juvenile. For unexplained reasons, the growth rate of

Klamath River turtles declined between 1984 and 1994. If the Klamath River population is skewed toward a high percentage of older individuals versus juveniles, it could be indicative of an unhealthy population (Reese and Welsh, 1998). Reese and Welsh (1998) found that two forks of the Trinity River—one dammed and one not dammed—had the same relatively low densities, but that the dammed fork had a skewed age structure and speculated that the damming could be responsible for reduced juvenile survival or juvenile capture rates. Germano (1994) reported that the growth rate of Klamath River turtles between 1984 and 1994 was reduced, but that growth curves were similar to Yoncalla Creek and greater than Jackson Creek.

In addition to the effects of flow and availability of basking sites on habitat suitability along the Klamath River, Bury (1995) documented that basking turtles are regularly disturbed by whitewater rafters. Turtles dive into the water as boats approach their basking sites, resulting in increased energy expenditure and reduced solar exposure time. He found that turtles seemed to be less disturbed in the Klamath River than at other sites that he had studied, as evidenced by the quick return to basking locations after the boats leave the area.

The turtle nesting habitat suitability mapping conducted in 2002 indicates that out of the 198 miles (319 km) of river and reservoir shoreline in the study area, approximately 42 miles (68 km) (21 percent) were characterized as having suitable nesting and basking habitat (Table 4.7-8; Figure 4.7-1). An additional 60 miles (97 km) (30 percent) have suitable basking habitat structure (logs, large rocks, or patches of persistent emergent vegetation), but do not have the high quality potential nesting habitat either because of steep slopes, developed shorelines, or shorelines with dense understory vegetation. Approximately 94 miles (151 km) (47 percent) of the entire shoreline was determined to have neither basking nor nesting habitat (Table 4.7-8). Slightly less than 2 percent of the shorelines—one area near Gorr Island in the Keno reservoir and one segment along the Iron Gate-Shasta—could not be examined adequately to determine habitat suitability. Within each Project segment, the percent of shoreline that represents potential nesting habitat ranges from zero percent in the Copco No. 2 bypass, which is bordered by steep canyon walls and dense riparian forests, to 42 percent of the J.C. Boyle reservoir (Table 4.7-8). A minimum of 31 percent of each segment has suitable basking habitat.

Several of the shoreline segments with suitable nesting habitat are near recreational sites (e.g., Frain Ranch, the Oregon-California border, BLM's Klamath River Campground), which could represent a potential conflict. This is especially true in areas where the generally steep hillsides limit nesting habitat to a narrow band along the river. Nesting habitat is especially limited in the Keno Canyon and J.C . Boyle bypass reaches because of the steep terrain.

Because turtles can move several miles in aquatic habitat and can move overland up to 3.1 miles (5 km) (Holland, 1994), the relationship between locations of basking sites and nesting habitat is not easily described. Also, it is not known if Klamath River turtles overwinter in aquatic or upland habitats.

Table 4.7-8. Length and percent of shoreline section of pond turtle nesting and basking habitat along reservoirs and river reaches in the Klamath study area*.

Habitat	Copco No. 2 Bypass	Copco Reservoir	Iron Gate Reservoir	J.C. Boyle Bypass	J.C. Boyle Peaking Reach	J.C. Boyle Reservoir	Keno Reservoir	Keno Canyon	Link River	Iron Gate-Shasta	Grand Total
Nesting/Basking (miles)	0.0	2.6	2.8	0.7	6.7	4.6	19.5	2.1	0.7	2.5	**42.1**
Percentage of Section	0.00%	17.92%	12.22%	7.25%	16.61%	42.07%	36.57%	19.50%	18.00%	8.82%	**21.27%**
Basking (miles)	1.5	4.1	4.8	2.5	9.0	1.4	26.3	1.5	1.0	6.6	**59.7**
Percentage of Section	39.09%	28.56%	24.57%	24.04%	22.42%	12.94%	49.34%	14.02%	28.23%	23.70%	**30.20%**
Poor Habitat (miles)	2.3	7.7	14.4	6.7	24.4	4.9	6.1	7.3	2.0	17.8	**93.6**
Percentage of Section	60.91%	53.52%	63.40%	67.72%	60.97%	44.99%	11.41%	66.48%	53.77%	63.75%	**47.29%**
Undetermined (miles)	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	1.0	**2.5**
Percentage of Section	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.68%	0.00%	0.00%	3.72%	**1.25%**
Grand Total	**3.7**	**14.4**	**22.6**	**9.9**	**40.1**	**10.9**	**53.3**	**11.0**	**3.7**	**27.9**	**197.9**

* See Figure 4.7-1 for map of turtle habitat segments.

4.7.1.6 Incidental Observations

Several reptile species were recorded incidental to other surveys in the study area. Incidental detections include those observations recorded opportunistically, outside of other field studies and any detection that was noted by biologists or other qualified consulting personnel near the primary study area. Table 4.7-9 presents data on incidental reptile and amphibian detections.

Table 4.7-9. Incidental detections of amphibians and reptiles by section.

Section	Habitat	Polygon	Date	Area Searched (m^2)	Species	Life Stage	Number of Individuals
Copco No. 2 Bypass	DST	1387	5/7/2002		Striped whipsnake	Dead	1
			6/1/2001		California mountain kingsnake	Adult	1
Copco Reservoir	PFO	1484	3/22/2002		Treefrog	Adult	2
	PUB	1383	3/22/2002		Treefrog	Eggs	Many
Fall Creek	DST	1481	6/1/2001		Common kingsnake	Adult	2
	ER/GL	1398	6/21/2002		Sagebrush lizard	Adult	2
Iron Gate Reservoir	DST	1059	6/18/2002		Common kingsnake	Adult	1
	LUB	Iron Gate reservoir	6/21/2002	7,810	Bullfrog	Adult	1
	REC	819	6/1/2002		Western rattlesnake	Adult	4
		1136	6/1/2002		Western rattlesnake	Adult	3
J.C. Boyle Peaking Reach	J	2279	6/18/2002		Western fence lizard	Adult	1
	MHOC	1825	3/29/2002		Common garter snake	Adult	1
	PUB	1794	3/29/2002		Western toad	Adult	5
J.C. Boyle Reservoir	REC	8014	10/9/2002	251	Bullfrog	Adult	1
				251	Bullfrog	Juvenile	3
Keno Canyon	PP	2682	6/17/2002		Yellow-bellied racer	Dead	1
	REC	2556	4/23/2002		Common garter snake	Juvenile	7

Table 4.7-9. Incidental detections of amphibians and reptiles by section.

Section	Habitat	Polygon	Date	Area Searched (m^2)	Species	Life Stage	Number of Individuals
					Southern alligator lizard	Adult	1
Keno Reservoir	LUB	2859	4/23/2002		Bullfrog	Adult	3
		Keno reservoir	6/17/2002	7,810	Bullfrog	Adult	1
	LUB/PAB	2623	6/27/2002		Bullfrog	Adult	2
Iron Gate-Shasta	DST	427	6/21/2002		Gopher snake	Adult	1
Link River	PEM	2849	5/24/2002	7,810	Treefrog	Adult	1

4.7.2 BLM 2000—2001 Survey and Incidental Data

The following is a summary of surveys conducted by the BLM with cooperation of PacifiCorp during 2000 and 2001 and described in detail in Roninger (2001). In total, 18 BLM aquatic sites were surveyed in between one and three times in spring and summer of 2001 (Figure 4.4-1). Pitfall traps and coverboards also were used by the BLM in the summers of 2000 and 2001. A total of 24 general survey sites was surveyed in 2000. Three of those sites were surveyed twice. Incidental data were collected by the BLM in April through September 2000 and 2001. All of the BLM surveys and incidental observations occurred in the J.C. Boyle peaking reach. Several reptile and amphibian species were observed during the BLM 2000, 2001 survey effort (Tables 4.7-10 and 4.7-11).

Table 4.7-10. Reptiles detected during BLM surveys
(including incidental detections).

Species	Number Detected
California Mountain Kingsnake	**5**
Common Garter Snake	**64**
Common Kingsnake	**8**
Gopher Snake	**18**
Ringneck Snake	**1**
Rubber Boa	**1**
Sharptail Snake	**3**
Striped Whipsnake	**2**
W. Terrestrial Garter Snake	**60**
Western Rattlesnake	**18**
Yellow-Bellied Racer	**80**

Table 4.7-10. Reptiles detected during BLM surveys (including incidental detections).

Species	Number Detected
Northern Sagebrush lizard	**14**
Southern Alligator Lizard	**27**
Western Fence Lizard	**320**
Western Pond Turtle	**67**
Western Skink	**4**
Total	**692**

Source: Roninger (2001).

Table 4.7-11. Amphibians detected during BLM aquatic site surveys.

Species	Crazy Eight Spring	Boulder Spring	Upper Topsy Creek	Way Creek	Hayden Creek Mouth	Boulder Spring	Lower Hayden Creek	Total
Treefrog Adult	1	0	0	0	4	0	0	**5**
Treefrog Tadpoles	0	>220	>430	>200	0	0	>100	**>950**
Treefrog Egg Masses	0	>200	0	0	0	0	0	**>200**
Western Toad Tadpoles	0	0	0	>200	0	0	0	**>200**
Total	**1**	**>420**	**>430**	**>400**	**4**	**0**	**>100**	**>1,355**

Source: Roninger (2001); Unpublished BLM data.

4.7.3 2003 Field Survey Results

The TRWG requested that PacifiCorp conduct additional amphibian and reptile surveys in 2003 to supplement data and results collected during 2002 field surveys. Surveys requested for 2003 targeted special status species or species groups (e.g., Oregon spotted frog surveys, foothill yellow-legged frog surveys, snake hibernacula surveys) for which few recent data were available, or were intended to provide specific additional information supplementing 2002 data (e.g., isolated wetland/spring surveys, 2003 pond turtle surveys). The following sections provide results of amphibian and reptile surveys conducted in 2003.

4.7.3.1 Oregon Spotted Frog Surveys

Oregon spotted frog surveys in 2003 were conducted three times each at four locations located in the upper study area, according to the survey schedule provided in Table 4.7-12. These survey sites included extensive wetland locations at the Tule Smoke Gun Club, Klamath Sportman's Park located along the J.C. Boyle reservoir, and the Klamath Wildlife Area located off of Keno reservoir (Figure 4.4-1). No spotted frogs or evidence of spotted frog current or historical occurrence were detected during 2003. The bullfrog was the only amphibian species detected during 2003 spotted frog surveys (Table 4.7-12). Bullfrogs were detected at each spotted frog survey location, confirming 2002 speculation on the widespread occurrence of this non-native amphibian species throughout the Klamath study area and a source of predation for native frogs (see Table 4.7-12 and Section 4.8 below).

Table 4.7-12. Results of 2003 spotted frog surveys.

Survey Date	Site	Project Section	Spotted Frog Detections	Additional Results
Survey Period #1: 4 locations April 23-24.				
04/23/03	Tule Smoke Gun Club	Keno reservoir	0	No amphibians detected.
04/24/03	Sportsman's Park Wetland	J.C. Boyle reservoir	0	No amphibians detected.
04/24/03	Klamath Wildlife Area Wetland	Keno reservoir	0	10 second-year bullfrog tadpoles in canal.
04/24/03	Topsy Campground Embayment	J.C. Boyle reservoir	0	2 juvenile bullfrogs.
Survey Period #2: 4 locations June 10-12.				
06/10/03	Klamath Wildlife Area Wetland	Keno reservoir	0	10 adult bullfrogs. Approximately 50 bullfrog tadpoles in canal.
06/11/03	Tule Smoke Gun Club	Keno reservoir	0	3 adult bullfrogs. 1 juvenile bullfrog.
06/12/03	Sportsman's Park Wetland	J.C. Boyle reservoir	0	No amphibians detected.
06/12/03	Topsy Campground Embayment	J.C. Boyle reservoir	0	1 adult bullfrog.
Survey Period #3: 4 locations June 26-27.				
06/26/03	Tule Smoke Gun Club	Keno reservoir	0	2 adult bullfrogs.
06/26/03	Klamath Wildlife Area Wetland	Keno reservoir	0	4 adult bullfrogs. 3 second-year bullfrog tadpoles.
06/26/03	Topsy Campground Embayment	J.C. Boyle reservoir	0	No amphibians detected.
06/27/03	Sportsman's Park Wetland	J.C. Boyle reservoir	0	1 juvenile bullfrog.

4.7.3.2 Foothill Yellow-Legged Frog Surveys

Foothill yellow-legged frog surveys in 2003 were conducted at ten locations surveyed four times each, according to the survey schedule provided in Table 4.7-13**.** Areas surveyed generally included the lower 0.5 mile (0.8 km) of Klamath River tributaries and select areas of mainstem river reaches (Figure 4.4-1). No foothill yellow-legged frogs or evidence of their occurrence were detected during 2003 surveys. Amphibian species detected during 2003 foothill yellow-legged frog surveys were limited to bullfrogs, Pacific treefrogs, and western toads (Table 4.7-13). Reptiles detected during foothill yellow-legged frog surveys included garter snakes (spp.) and a western skink. The skink detection, recorded along the J.C. Boyle bypass (Table 4.7-13) represented the sole occurrence of this species documented during PacifiCorp 2002 and 2003 relicensing studies.

Although 2003 foothill yellow-legged frog surveys resulted in no detections of the target species, data from the surveys did provide additional information on breeding locations for another TES amphibian, the western toad. Foothill yellow-legged frog surveys confirmed western toad breeding at two "new" locations in 2003: Willow Creek and Cottonwood Creek. A single western toad tadpole was detected during the second survey visit on May 27, 2003, in Willow Creek**,** and the subsequent survey resulted in the detection of at least 2,000 western toad tadpoles (Table 4.7-13). Forty western toad tadpoles were detected in Cottonwood Creek on May 27, 2003, and three western toad tadpoles were detected on June 12, 2003 (Table 4.7-13).

Table 4.7-13. Results of the 2003 foothill yellow-legged frog surveys.

Survey Date	Site	Project Section	Results
Survey Period #1: May 5-9.			
05/05/03	Cottonwood Creek	Lower River	12 bullfrog tadpoles. 1 Pacific chorus frog adult.
05/05/03	Willow Creek	Lower River	No herptiles detected.
05/06/03	Jenny Creek	Iron Gate reservoir	2 adult bullfrogs.
05/06/03	Bogus Creek	Lower River	No herptiles detected.
05/06/03	Copco bypass	Copco No. 2 bypass	No herptiles detected.
05/07/03	Beswick Ranch - RM 205	J.C. Boyle peaking reach	No herptiles detected.
05/07/03	Shovel Creek	J.C. Boyle peaking reach	Unidentified turtle sp.
05/08/03	J.C. Boyle bypass	J.C. Boyle bypass	1 adult bullfrog. 1 garter snake sp. 1 western skink.
05/08/03	Frain Creek	J.C. Boyle peaking reach	No herptiles detected.
05/09/03	Barn Bar - RM 204.8	J.C. Boyle peaking reach	No herptiles detected.
Survey Period #2: May 27-30.			
05/27/03	Willow Creek	Lower River	350 Pacific chorus frog tadpoles. 1 adult bullfrog. 1 adult western toad. 1 western toad tadpole.
05/27/03	Cottonwood Creek	Lower River	40 western toad tadpoles.
05/28/03	Bogus Creek	Lower River	No herptiles detected.
05/28/03	Jenny Creek	Iron Gate reservoir	1 adult bullfrog.
05/28/03	Copco bypass	Copco No. 2 bypass	No herptiles detected.
05/29/03	Shovel Creek	J.C. Boyle peaking reach	No herptiles detected.
05/29/03	Barn Bar - RM 204.8	J.C. Boyle peaking reach	No herptiles detected.

Table 4.7-13. Results of the 2003 foothill yellow-legged frog surveys.

Survey Date	Site	Project Section	Results
05/29/03	Beswick Ranch - RM 205	J.C. Boyle peaking reach	No herptiles detected.
05/30/03	J.C. Boyle bypass	J.C. Boyle bypass	1 adult bullfrog. 3 garter snake spp. 1 gopher snake. 1 yellow-bellied racer
05/30/03	Frain Creek	J.C. Boyle peaking reach	No herptiles detected.
Survey Period #3: June 9-12.			
06/09/03	Frain Creek	J.C. Boyle peaking reach	3 common garter snakes.
06/10/03	J.C. Boyle bypass	J.C. Boyle bypass	1 adult bullfrog. 1 garter snake sp. 1 western skink.
06/11/03	Barn Bar - RM 204.8	J.C. Boyle peaking reach	No herptiles detected.
06/11/03	Beswick Ranch - RM 205	J.C. Boyle peaking reach	No herptiles detected.
06/11/03	Shovel Creek	J.C. Boyle peaking reach	No herptiles detected.
06/12/03	Copco bypass	Copco No. 2 bypass	1 adult Pacific chorus frog.
06/12/03	Bogus Creek	Lower River	1 common garter snake. 3 fence lizards.
06/12/03	Cottonwood Creek	Lower River	46 bullfrog tadpoles. 3 western toad tadpoles.
06/12/03	Willow Creek	Lower River	200 Pacific chorus frog tadpoles. 2000 western toad tadpoles.
06/13/03	Jenny Creek	Iron Gate Reservoir	No herptiles detected.
Survey Period #4: September 9-11			
09/09/03	Cottonwood Creek	Lower River	No herptiles detected. Stream still flowing
09/09/03	Willow Creek	Lower River	No water in creek - no survey.
09/09/03	Bogus Creek	Lower River	1 common garter snake.
09/09/03	Jenny Creek	Iron Gate reservoir	1 adult bullfrog.
09/09/03	Copco bypass	Copco No. 2 bypass	No herptiles detected.
09/10/03	Beswick Ranch - RM 205	J.C. Boyle peaking reach	No herptiles detected.
09/10/03	Barn Bar – RM 204.8	J.C. Boyle peaking reach	No herptiles detected.
09/10/03	Shovel Creek	J.C. Boyle peaking reach	No herptiles detected.
09/11/03	Frain Creek	J.C. Boyle peaking reach	No herptiles detected.
09/11/03	J.C. Boyle bypass	J.C. Boyle bypass	No herptiles detected.

4.7.3.3 Isolated Wetland/Spring Surveys

Isolated wetland/spring surveys were conducted at a total of 20 select survey locations in 2003 (Table 4.7-14). Four amphibian species—Pacific treefrog, western bullfrog, western toad, and long-toed salamander—were detected during 2003 isolated wetland/spring surveys. By far, the most abundant species detected during isolated wetland/spring surveys was the Pacific treefrog. However, two additional long-toed salamander and several previously unknown western toad breeding sites also were identified.

Although the long-toed salamander was thought to likely occur in the Project vicinity, no detections were recorded for the species within the boundaries of the study area during 2002. In 2003, larval long-toed salamanders were detected in the Long Prairie stock pond and the stock pond southwest of Topsy. Evidence of western toad breeding also was recorded in the Long Prairie stock pond (Table 4.7-14).

4.7.3.4 Pond Turtle Surveys

Two surveys of the J.C. Boyle bypass and the California portion of the J.C. Boyle peaking reach were conducted during the field season of 2003, according to the survey schedule provided in Table 4.7-15. No pond turtles were detected in the J.C. Boyle bypass. A total of 22 pond turtle detections was recorded in the California J.C. Boyle peaking reach during 2003 turtle surveys (Table 4.7-15). Pond turtle detections included 13 adults recorded in the reach on May 29, 2003, and nine adults recorded on June 25, 2003. The locations of all pond turtles detected during 2003 surveys are shown in Figure 4.7-1.

The number and distribution of detections recorded in the California J.C. Boyle peaking reach likely indicate that an aggregation of turtles (approximately ten) use the lower, slow-moving portion of the reach just upstream of Copco reservoir as habitat, while small numbers occur upstream. During both survey visits groups of pond turtles were detected basking on pilings, docks, and other structures located near the confluence of the river with Copco reservoir. Eight adult turtles were detected in this localized area during the May 29, 2003, survey, and five adults were detected in this location during the June 25, 2003, survey. Turtles recorded in the upper portions of the California J.C. Boyle peaking reach included three near the Beswick Ranch, and four located downstream of the Oregon-California border (Figure 4.7-1).

4.7.3.5 Snake Hibernacula Surveys

Six potential snake hibernacula sites and areas located along the J.C. Boyle bypass small mammal trapping transects were surveyed for reptiles in 2003, according to the survey schedule provided in Table 4.7-16. Figure 4.4-1 shows the location of all potential snake hibernacula sites and areas surveyed for terrestrial reptiles in 2003. Survey results are provided in Table 4.7-16.

Table 4.7-14. Summary of 2003 isolated wetland amphibian and reptile surveys.

Survey Date	Site	Project Section	Amphibian Eggs	Amphibian Larva	Amphibian Adults/Juv	Reptiles	Specific Results
Survey Period #1: 19 locations April 20-23.							
04/20/03	Toad Beach	Iron Gate reservoir	X		X		1 adult western toad. 45 western toad egg clusters.
04/20/03	Copco No. 2 Peripheral Wetlands	Copco No. 2 bypass	X	X			Abundant Pacific treefrog tadpoles. 3 Pacific treefrog eggs.
04/20/03	Copco No. 2 Vernal Pool	Copco No. 2 bypass		X			1 Pacific treefrog tadpole.
04/20/03	Copco No. 2 Spring	Copco No. 2 bypass					No herptile or mollusk detections.
04/20/03	Spring #7	Iron Gate reservoir					No herptile or mollusk detections.
04/20/03	Springs #8a and b	Iron Gate reservoir					No herptile or mollusk detections.
04/20/03	Lone Gulch Seep	Iron Gate reservoir	X	X	X		3 adult Pacific treefrogs. 20 Pacific treefrog tadpoles. 1 Pacific treefrog egg mass.
04/21/03	Lone Gulch Wetlands	Iron Gate reservoir	X		X		1 adult Pacific treefrog. 8 Pacific treefrog egg masses.
04/22/03	Long Prairie Stock Pond	J.C. Boyle peaking reach	X	X			6 long-toed salamander larvae. 5 western toad egg remnants.
04/22/03	Wet Feet Wetland	J.C. Boyle peaking reach					No herptile detections.
04/22/03	Crazy Eight Wetland	J.C. Boyle peaking reach					No herptile detections.
04/22/03	Long Prairie Wetlands	J.C. Boyle peaking reach		X		X	10 Pacific treefrog tadpoles. 1 common garter snake.
04/22/03	Salt Caves Wetlands #15	J.C. Boyle peaking reach					No herptile detections.
04/22/03	Hayden Creek Wetlands	J.C. Boyle peaking reach	X	X			8 Pacific treefrog tadpoles. 15 Pacific treefrog eggs.
04/22/03	Hoover Ranch Wetlands	J.C. Boyle peaking reach		X			2 Pacific treefrog tadpoles.

Table 4.7-14. Summary of 2003 isolated wetland amphibian and reptile surveys.

Survey Date	Site	Project Section	Amphibian Eggs	Amphibian Larva	Amphibian Adults/Juv	Reptiles	Specific Results
04/23/03	Frain Ranch - Lower Wetland	J.C. Boyle peaking reach					No herptile detections.
04/23/03	Frain Ranch - Major Spring	J.C. Boyle peaking reach	X		X		1 Pacific treefrog egg mass with approximately 15 eggs. 2 adult Pacific treefrogs.
04/23/03	Frain Ranch - Big Alder Spring	J.C. Boyle peaking reach					No herptile detections.
04/23/03	Fall Creek Pocket Ponds	Fall Creek	X	X	X		50 Pacific treefrog tadpoles. 2 adult Pacific treefrogs. 12 Pacific treefrog eggs.
Survey Period #2: 7 locations June.							
06/09/03	Frain Ranch - Lower Wetland	J.C. Boyle peaking reach					No herptile detections.
06/09/03	Frain Ranch - Major Spring	J.C. Boyle peaking reach		X		X	1 Pacific treefrog tadpole. 1 rattlesnake at wetland edge.
06/11/03	Wet Feet Wetland	J.C. Boyle peaking reach				X	1 garter snake (unidentified sp.)
06/11/03	Crazy Eight Wetland	J.C. Boyle peaking reach					No herptiles detected.
06/24/03	Long Prairie Wetlands	J.C. Boyle peaking reach		X		X	200 to 400 Pacific treefrog tadpoles. 2 garter snakes. (*Thamnophis* sp.) 1 western fence lizard.
06/24/03	Long Prairie Stock Pond	J.C. Boyle peaking reach		X	X		5,000 to 7,000 Pacific treefrog tadpoles. Numerous fully developed juveniles.
06/24/03	Hoover Ranch Wetlands	J.C. Boyle peaking reach		X			1,000 to 2,000 western toad tadpoles located in ponded areas associated with small irrigation canals.
06/13/03	Stock Pond west of Topsy	J.C. Boyle bypass		X			Several long-toed salamanders and many treefrog tadpoles

Table 4.7-15. Results of 2003 pond turtle surveys.

Survey Date	Survey Area	Survey Methodology	Turtle Detections	Detection Locations
Survey #1: May 29.				
05/29/03	J.C. Boyle peaking reach - California	Shoreline Visual Survey and Float Survey	13	2 adult pond turtles 0.5 mile downstream of Oregon-California border. 1 adult pond turtle 0.5 mile upstream of Beswick Ranch residence at diversion dam. 2 adult pond turtles at Barn Bar - RM 204.8. 8 adult pond turtles on short pilings immediately upstream of Copco reservoir.
05/05/03	J.C. Boyle bypass reach	Shoreline Visual Survey	0	No pond turtle detections.
Survey #2: June 25.				
06/25/03	J.C. Boyle peaking reach - California	Shoreline Visual Survey and Float Survey	9	4 adult pond turtles 1.5 miles downstream of the Oregon-California border. 5 adult pond turtles on pilings upstream of Copco reservoir.
06/25/03	J.C. Boyle bypass reach	Shoreline Visual Survey	0	No pond turtle detections.

Table 4.7-16. Results of the 2003 snake hibernacula/terrestrial reptile surveys.

Survey Date	Site Description	Reptile Survey Site Number*	Project Section	Number Reptile Species Detected	Specific Results
2003 Reptile Surveys: 7 locations May 26-30.					
05/26-29/03	J.C. Boyle canal - Mammal transects	1	J.C. Boyle bypass	7	1 northern alligator lizard. 2 western fence lizards. 3 sagebrush lizards. 1 rattlesnake. 1 yellow-bellied racer. 1 ringneck snake. 1 California kingsnake.
05/27/03	J.C. Boyle powerhouse talus	2	J.C. Boyle bypass	2	4 western fence lizards. 1 sagebrush lizard
05/28/03	Frain Ranch - Upstream talus	3	J.C. Boyle peaking reach	2	7 fence lizards. 3 yellow-bellied racers.
05/28/03	Frain/Topsy Road talus	4	J.C. Boyle peaking reach	1	4 western fence lizards. 2 adult Pacific chorus frogs.
05/29/03	J.C. Boyle T-Line talus	5	J.C. Boyle bypass	0	No reptile detections.
05/30/03	Frain Road talus site #1	6	J.C. Boyle peaking reach	1	1 western fence lizard.
05/30/03	Frain Road talus site #2	7	J.C. Boyle peaking reach	2	3 western fence lizards. 1 rattlesnake.

*See 2003 wildlife survey sites map.

Seven reptile species and one amphibian were detected during 2003 reptile surveys (Table 4.7-16). Reptiles detected during 2003 targeted surveys include (in order of abundance): western fence lizard, sagebrush lizard, yellow-bellied racer, western rattlesnake, California mountain kingsnake, ringneck snake, and northern alligator lizard. In addition, the Pacific treefrog was detected in a moist area of rock talus located above Frain Ranch in the J.C. Boyle peaking reach (Table 4.7-16; Figure 4.4-1).

Although reptiles were detected in small numbers in snake hibernacula survey locations, occurrence was not noted in high densities. At none of these sites were reptiles detected in large communal aggregations or in suitable locations for hibernation. The cooler than normal spring weather made it difficult to time surveys to coincide with snake emergence. All reptiles detected during snake hibernacula and terrestrial reptile surveys conducted in 2003 are included for discussion and analysis (Section 4.8).

4.8 DISCUSSION

The following sections discuss the results described in the preceding sections in terms of the study objectives. Existing conditions for amphibians and reptiles in the Project vicinity are characterized on the basis of historical information and data gathered during relicensing surveys conducted in 2002 and 2003.

4.8.1 Characterization of Existing Conditions

The following sections summarize the existing conditions for amphibians and reptiles relative to the Project and study objectives.

4.8.1.1 Geographic Distribution of Species

Surveys conducted in 2002 and 2003 and existing data from the BLM, Bury (1995), Hayes (1996), and St. John (1987) indicate that the following amphibian species occur in the Klamath River study area: long-toed salamander, bullfrog, Pacific treefrog, western toad, and Pacific giant salamander. The first four of these species are pond-breeding (or slow-moving water) species, while the Pacific giant salamander is a stream-dwelling species.

Pond Breeding Amphibians

All of the amphibians detected in the study area except the Pacific giant salamander are generally restricted to breeding in still-water habitat. Of these, the bullfrog and treefrog have a wide distributions. The non-native bullfrog is known to breed in wetlands associated with the Project reservoirs and backwater habitats in riverine reaches. The treefrog, however, is found at large and small isolated wetlands including small puddles. The western toad and long-toed salamander also occur throughout most of the study area, but with a much more patchy breeding distribution, including only a small number of sites at isolated wetlands or in small tributaries that have available still-water habitat. The distribution of these pond-breeding amphibians is largely dictated by the distribution of springs, beaver ponds, slow-moving streams, and floodplain wetlands that have surface water during the spring.

The only other pond-breeding species that have ranges overlapping the study area, but were not detected during surveys, are the rough-skinned newt, Cascades frog, and Oregon spotted frog. The potential for these other pond-breeding species to occur is discussed below.

Rough-Skinned Newt—No rough-skinned newts were observed during PacifiCorp relicensing surveys or in the J.C. Boyle peaking reach by the BLM (Roninger, 2001). The nearest known records are at Buck Lake in the upper Spencer Creek drainage (Hayes, 1996). Rough-skinned newts usually occur in moist forest habitats and live in or under rotten logs (Corkran and Thoms, 1996). Within the Klamath River study area, most of this type of habitat is located in the mixed-conifer forests of the J.C. Boyle and Keno Canyons. When present in an area, rough-skinned newts usually are easily found either in breeding pools or walking on the surface during wet periods. It is unlikely that this species is present in the study area because of the dry habitat conditions.

Cascades Frog—Cascades frogs have a narrow geographic distribution in southern Oregon and northern California, usually above 2,500 feet (762 m) near the Cascade Mountain crest (Corkran and Thoms, 1996). This species was not detected during pond-breeding surveys conducted in 2002; during supplemental isolated wetland/spring surveys conducted in 2003; or by BLM surveys in 2000 and 2001 in the J.C. Boyle peaking reach. There are Cascades frogs in the upper Spencer Creek drainage at approximately 5,000 feet (1,524 m) elevation—well above the Klamath study area. Given the elevation of the study area and lack of recent or historic records, it is unlikely that this species occurs in the study area.

Oregon Spotted Frog—Oregon spotted frogs were historically reported from a site near the Link River and Upper Klamath Lake in the Oregon Natural Heritage Program (ONHP) database. Hayes (1994) conducted surveys of three sites in the study area: (1) a marshy area along the Link River, (2) a marshy edge of Upper Keno reservoir (Lake Ewauna), and (3) the Klamath Wildlife Area. He found no evidence of spotted frogs, but did find bullfrogs at each of the sites, along with various predatory fish species, which could severely limit suitability. No spotted frogs were detected during surveys targeting spotted frogs or other amphibian surveys conducted in 2003 and this species is unlikely to occur in the study area.

Within the region, the spotted frog is known from five sites in the Klamath Basin—Buck Lake on the Spencer Creek system, Klamath Marsh National Wildlife Refuge, Jack Creek, Fourmile Creek, and Wood River (Hayes, 1997). There are no sites in California with recent records of this species (Hayes, 1997). The nearest known population is the Wood River approximately 5 miles (8 km) north of the Klamath River (BLM, unpublished data; Hayes, 1997). Oregon spotted frogs have disappeared from 79 percent of their range in Oregon (Hayes, 1997). In Oregon, sites at which this species remain extant are above 3,117 feet (950 m) elevation and have the least altered hydrology and fewest exotic aquatic predators (Hayes, 1997).

Possible reasons for the absence of spotted frogs include habitat degradation, predation by introduced species, and water quality problems. Post-metamorphic spotted frogs are particularly susceptible to bullfrog predation. Hayes (1997) indicates that the pH of water in the Klamath River system may exceed 9 and that low dissolved oxygen levels (less than 0.000035 ounces/0.26 gallons [less than 1 mg/L]) likely prevent spotted frogs from using the Upper Klamath basin. Marsh habitat loss in the Klamath basin has resulted in extensive loss of habitat for spotted frogs (Hayes, 1997).

Stream-Dependent Amphibians

Only one stream-dependent amphibian species, the Pacific giant salamander, was detected during 2002. The foothill yellow-legged frog is a species with an historical distribution in the Project region, but there were no foothill yellow-legged frog detections during specifically focused surveys in 2003.

Pacific Giant Salamander—The Pacific giant salamander, a stream-dwelling species, was documented only in two areas: Fall Creek and the J.C. Boyle bypass. It is known to occur in other streams near the study area, but generally at higher elevations (e.g., upper Spencer Creek [Hayes, 1996]). Given this species' habitat association, it may occur in appropriate sites in the mainstem and in the perennial tributary streams with water temperatures that are low enough (e.g., Jenny Creek, Bogus Creek, and possibly other streams).

Foothill Yellow-Legged Frog—Before initiation of the 2003 foothill yellow-legged frog surveys, it was speculated that habitat in the mainstem Klamath River had been altered to the degree that the species no longer occupies historical sites, such as the site reported from near J.C. Boyle dam (Borisenko, 2000). The absence of species detections during 2003 supports the hypothesis on the extirpation of foothill yellow-legged frogs from the Project region. Other than the one historical record near the site of the J.C. Boyle dam, it is not known how common or widespread the foothill yellow-legged frog was before construction of the Project. The decline in the populations of foothill yellow-legged frog is thought to be affected by modification of river habitat, introduction of bullfrogs that are competitors and predators, and the invasion by fish (Kupferberg, 1996; Linde et al. 1996). The main causes of mortality in rivers downstream of dams are often desiccation or scour of egg masses resulting from flow alterations (Kupferberg, 1996). The nearest known populations of foothill yellow-legged frogs are in the Rogue River drainage to the north (Borisenko, 2000).

Reptiles

PacifiCorp relicensing surveys targeting reptiles and those conducted previously by other investigators have documented 16 reptile species in the study area. Of these, several (such as the fence lizard and common garter snake) seem to be ubiquitous, occurring throughout the study area in most habitats. However, most of the other terrestrial reptile species are less common and have patchy distributions. Nine of the reptile species were noted in riparian habitats.

4.8.1.2 Species Diversity and Relative Abundance

Studies and existing data indicate that the species diversity of amphibians is very low in the study area, with only five occurring species. One of the five species—the bullfrog—is a non-native, introduced species. Reptile species diversity is extremely high and varied among the riparian, oak woodland, conifer, and chaparral habitats. Species diversity and relative abundance were found to be particularly great in the Klamath River Canyon, along the J.C. Boyle canal, and near Keno reservoir. The diversity of reptiles is likely greatest in these areas because of the varied topography and upland and riparian habitats.

4.8.1.3 Effect of Hydrology on Habitat Quality

Pond-Breeding Species

In general, Project reservoir shorelines and the emergent wetlands that immediately border Project reservoirs with fluctuating water levels appear to provide only marginal breeding habitat for native pond-breeding amphibians. It is possible that reservoirs may represent potential "sinks" in some years where, if breeding occurs, offspring do not survive. The degree to which reservoir sites might be amphibian "sinks" is related to the timing and magnitude of water level fluctuations and could differ among years. For example, in 2002 the Iron Gate western toad breeding site was apparently unsuccessful, while in 2003, numerous young toads were produced at the same site. In 2002, the site experienced a 2-foot (0.6-m) water level drop during egg development, which entirely dried the egg strands. New egg strands were found in the shallow water near the new lower water line. By May 10, 2002, the reservoir had been refilled and had deeply inundated the eggs that were found on April 25, 2002. This rapidly fluctuating water level likely resulted in either desiccation or detachment of the egg masses, which would increase their exposure to predation by yellow perch and bullfrogs. A very low percentage of the surveyed sites adjacent to the river and reservoir had breeding evidence compared to sites isolated from reservoir fluctuations, suggesting that amphibians select sites where water levels are not affected by Project operation.

There may be other limiting factors (e.g., water quality, predation) to amphibian reproduction as well. Reservoir fluctuations alone do not fully account for the lack of reproduction on Keno reservoir, which does not fluctuate. Smaller ponds are perhaps better breeding habitats than reservoirs. The best breeding habitat found adjacent to the reservoirs is likely the beaver dam embayment located between Iron Gate reservoir and Fall Creek. This site is separated from the reservoir by the beaver dam and water levels are more stable during the breeding season.

Treefrog and western toad breeding sites located in or adjacent to irrigation ditches in the J.C. Boyle peaking reach appear to retain water throughout the spring (based on presence of aquatic vegetation), but could be affected by agricultural practices by PacifiCorp grazing leasees (e.g., ditch maintenance, irrigation, and water diversion). This is a potential impact that is not related to the Project.

No sites were found where current riverine water level fluctuations are affecting native pond-breeding amphibians. The few springs and sites adjacent to the river that were found to support breeding amphibians by PacifiCorp or the BLM. Most springs are located such that river fluctuations do not affect them.

Riverine Amphibians

A lack of foothill yellow-legged frog detections recorded during 2003 surveys is consistent with the hypothesis that foothill yellow-legged frogs no longer occur in waters closely associated with the Project (Borisenko, 2000). However, foothill yellow-legged frog surveys in 2003 confirmed breeding of relatively common (Pacific treefrog) and TES amphibian (western toad) species in slow-moving sections of Klamath River tributaries. Project flow manipulation does not affect the hydrology in these tributary sites. In addition, Pacific giant salamanders potentially may be affected by occasional operational flow changes in the J.C. Boyle bypass. However, it is unlikely that the degree of flow change is enough to reduce habitat significantly.

Terrestrial Reptiles

Large groups of snakes have been documented over the years in or near riparian areas along the J.C. Boyle peaking and bypass reaches (City of Klamath Falls, 1986; Roninger, pers. comm., 2002). Although no hibernacula locations were confirmed through 2003 surveys, there are numerous locations in the study area with suitable habitat features to constitute winter snake hibernacula sites. Currently, there is no evidence that water level fluctuations affect snakes or lizards. Surveys in 2002 and 2003 documented high species richness and without large-scale changes in land use or destruction of habitat, high densities of terrestrial reptiles are likely to continue to exist in the Project vicinity.

Pond Turtles

Significant changes in water level can affect the availability of suitable basking sites along the reservoir and river shorelines. Logs that are partially submerged and available for turtles at one flow or pool level could become entirely exposed at lower flows. This would seem to be most likely to occur in the J.C. Boyle peaking reach where daily peaking results in stage changes of several feet in some locations. This is particularly important since Bury (1995) reported that basking logs are in short supply in this reach. However, most basking probably occurs after flows have increased during the daily ramping cycle (i.e., during the daytime). As water levels decrease, pond turtles use rocks and boulders. Pond turtles were regularly observed basking on emerging boulders near the upstream end of Iron Gate reservoir.

There is some speculation that the dense reed canarygrass may hinder turtle access to shoreline nesting habitat. Currently, there is no information to support this hypothesis. If this is true, however, there are some sections of the J.C. Boyle bypass and peaking reaches where there are dense stands of canarygrass adjacent to potential turtle nesting habitat.

Another potential effect of fluctuating water levels in the reservoirs and the J.C. Boyle peaking reach is that lower water levels can reduce the amount of aquatic habitat and make bordering emergent wetlands less accessible (increased distance from water) for hatchling turtles that are known to heavily use these habitats (Holland, 1994). Under current operations, the varial zone can be up to 60 feet (18 m) wide (total width for both banks) at 350 cfs (9m^3/sec) flow, thus reducing habitat during the low minimum flows.

4.8.1.4 Amphibian and Reptile Movement and Habitat Connectivity

Project reservoirs create substantial breaks in the connectivity of riverine and riparian habitat in the Klamath River drainage (see Section 6.0 for details on habitat connectivity). This clearly represents a barrier to movement by Pacific giant salamanders and potentially for pond turtles that usually emigrate along water courses (although turtles can move several miles overland between aquatic habitats [Holland, 1994] and pond turtles occur on reservoirs, too). Terrestrial reptiles are probably less affected as they occur in many other habitats, but even so, there is a recognized importance of riparian habitat during the hot summer months for snakes and lizards (Gregory et al. 2001).

The presence of Project canals, roads, powerhouses, and other facilities has the potential to block movement of amphibians and reptiles. At the West Side Project, the canal represents a barrier to any reptiles attempting to move between the arid upland habitats upslope of the canal and the dense riparian habitat along the river. Many snakes probably can swim across the relatively low velocity canal, but lizards may be restricted to crossing at the one bridge. This results in two segments of 612 and 4,771 feet (187 and 1,454 m) with blockage. The East Side and Copco No. 2 flowlines are elevated sufficiently to allow reptiles and amphibians to cross without being impeded. The 2.1-mile-long (3.4-km-long) J.C. Boyle canal entirely blocks terrestrial reptiles and possibly species such as the western toad, which could occur in the very dry and rocky upland habitats between the canal and the river. During small mammal trapping along the J.C. Boyle canal, several snakes were found immediately adjacent to the canal, indicating that snakes might benefit from crossing opportunity enhancements.

Turtles move into upland habitats for egg deposition and wintering. In both cases, turtles seek sites with duff or loose soil (dry soils with high clay or silt content) that they can excavate. Pond turtles have home ranges of 0.6 to 2.4 acres (0.25 to 1.0 ha). As discussed previously, the movement of turtles could be affected by lowered water levels that make exiting the river difficult or make wetland habitat less suitable. In some areas, dense emergent vegetation may reduce access to upland habitat, although typically small breaks are present. Movement into nesting and overwintering sites also could be affected by Project facilities or recreation sites. It is unlikely that any of the actual Project facilities create problems for turtles because of facility locations. However, several non-Project recreational sites are located near known turtle concentrations (e.g., the BLM's Klamath River Campground). Project recreation sites along Iron Gate reservoir also preclude the use of a small amount of shoreline habitat.

4.8.1.5 Potential Effects of Recreation, Project Maintenance, and Other Activities

Isolated amphibian breeding sites — including the Way Creek and Hoover Ranch western toad breeding sites —may be affected by vehicular traffic going through ponded areas and or in adjacent upland habitat. Recent vehicle tire tracks were noted going through the Way Creek site used by adult western toads. Apparently, vehicles go through the grassland and pond when the section of the Topsy Road becomes impassable as a result of deep mudholes.

One of the most diverse wetlands in the Project vicinity in the beaver pond along lower Fall Creek. This site, used by treefrogs and pond turtles, is affected by road gravel sliding into the wetland, cattle grazing in the mid- and late summer, and recreational activities at Fall Creek Park. These activities cause vegetation removal, trampling, and erosion (Section 2.0).

Numerous human activities pose a threat to western pond turtles including roads, collection, hazardous material spills, and shooting. Turtles are known to be sensitive to human activity at distances of 328 feet (100 m) (Holland, 1994). However, Bury (1995) reported that along the Klamath River, turtles seem to quickly re-emerge onto basking structures after boats pass. Turtles deposit eggs on land 10 to 1,640 feet (3 to 500 m) from water between April and July (Holland, 1994). Mapping of shoreline conditions documented that there are numerous sections of suitable upland turtle nesting and overwinter habitat, especially on the south and southwest aspects, although dense forests in some areas may limit habitat quality. Development, recreation sites, and roads along sections of the Project reservoirs and river reaches may reduce the probability of use of some potential nesting habitat.

Vegetation management along the perimeter of Project facilities, along roads, and rights-of-way (ROWs) can alter cover for terrestrial and aquatic amphibians and reptiles.

4.8.2 Characterization of Future Conditions

The native amphibian and reptile fauna are likely to decline in the future because of habitat loss resulting from human development along Project reservoirs and river reaches. The continuation of the current water level management likely will limit the potential for amphibian and turtle populations to what currently exists.

5.0 THREATENED, ENDANGERED, AND SENSITIVE (TES) SPECIES INVENTORY

5.1 DESCRIPTION AND PURPOSE

The purpose of this study was to assess the presence of TES plant and animal species near Klamath Hydroelectric Project features and provide information needed to determine whether they are affected, either directly or indirectly, by ongoing Project operations. For the purpose of this study, TES species include those plant and wildlife species with federal status through the U.S. Fish and Wildlife Service (USFWS), BLM, USFS, or with state status in Oregon or California. This study also included species that are culturally sensitive for Native American tribes. Other species of special interest or of economic significance also were addressed in this study. This information was used to develop effective PM&E measures in the final license application.

5.2 OBJECTIVES

The specific objectives of the TES species inventory are as follows:

- Document occurrence of TES plant and animal species in the study area based on historical records and survey results

- Gather data that can be used to evaluate the potential effects to TES species resulting from ongoing Project operations that could include:

  - Instream flows (seasonal and daily release patterns)
  - Reservoir water level management
  - Right-of-way (ROW) vegetation management activities
  - Road management (for Project roads)
  - Recreational developments
  - Power lines (Project-related transmission lines)

- Gather information on the occurrence of culturally sensitive plant species that are important to the Native American tribes that use the Project vicinity

- Gather information on TES species to help meet federal and state regulations

- Gather data for developing PM&E measures to ensure maintenance of the populations or suitable habitat, and when feasible, increase population levels or habitat area.

5.3 RELICENSING AND USE IN DECISIONMAKING

Descriptions of federally endangered and threatened species in the Project vicinity are required by FERC for the license application. In addition to federally listed species, this inventory assesses other significant biological resources, including:

- Federal candidate species

- Federal species of concern

- State-listed, sensitive, and special status species
- BLM and USFS Sensitive Species, Assessment Species, and Tracking Species
- S/M species identified in the Northwest Forest Plan (USFS and BLM,1994, 2000, 2001)

This study also included a qualitative assessment of culturally significant plants (provided to the Cultural Resources Work Group [CRWG]).

5.4 METHODS AND GEOGRAPHIC SCOPE

The study area for the TES species inventory corresponded to that used for vegetation cover type mapping (Section 2.0). Field surveys emphasized sites most likely to be directly affected by Project activities. Therefore, survey effort focused on the study area that extends 0.25 mile (0.40 kilometer [km]) from Project facilities and associated recreation sites (and also incorporated PacifiCorp's non-Project recreation sites in the Klamath Canyon). Specific TES species surveys—including surveys for spotted owls, great gray owls, northern goshawks—were conducted where suitable habitat occurred in the Project vicinity. As a result, these surveys were conducted up to 1.3 miles (2.1 km) from Project facilities in California, and 1.2 miles (1.9 km) from Project facilities in Oregon. To describe the occurrence of wide-ranging TES species, such as bald eagles, data were collected from up to 5 miles (8 km) from the study area.

Tables showing data from the TES species inventory are found in Appendix 5A.

5.4.1 Identification of TES Species Potentially Present—Plants

The First Stage Consultation Document (FSCD) (PacifiCorp, 2000) identifies a large number of TES plant and wildlife species that potentially occur in the Project vicinity. In that document, PacifiCorp was intentionally liberal in identifying potential TES plant species. The target TES plant list was reviewed and refined through agency consultation before designing the 2002 field surveys and includes 65 vascular plants, three bryophytes and ten lichens that potentially could occur in the Project vicinity (Table 5A-1 in Appendix 5A). Culturally sensitive (CS) species were compiled on the basis of review of a species list (a confidential list) provided by the CRWG and on information from the Klamath Falls BLM archeologist.

Additional information including site-specific habitat requirements, a qualitative evaluation of suitable habitat in the study area, and a brief summary of documented occurrences of TES species near the Project was compiled to guide development of field inventory methodology (Table 5A-2 in Appendix 5A). Habitat requirement information for TES plants was obtained from the Flora of the Pacific Northwest (Hitchcock and Cronquist, 1973), Vascular Plants of the Pacific Northwest (Hitchcock et al. 1955-1969), The Jepson Manual (Hickman, 1993), the CalFlora database, the California Native Plant Society Electronic Inventory, Scott Sundberg (Oregon Flora Project Coordinator at Oregon State University), and consultation with agency botanists.

5.4.2 Identification of TES Species Potentially Present—Wildlife

A list of TES wildlife species potentially occurring in the Project vicinity was developed through consultation with ODFW, BLM, ONHP, and CDFG. This list of target TES wildlife species included 107 vertebrates (12 amphibians, five reptiles, 67 birds, and 23 mammals), 18 mollusks, and four insects (Table 5A-3 in Appendix 5A). The list included all wildlife species with potential for occurrence in the study area that have a federal (USFWS) or state (ODFW, CDFG) status as well as bird species designated by the USFWS as being “of conservation concern.” Habitat association information for wildlife is based on information obtained from the literature (e.g., Keister, 1981; CWHRS website; Johnson and O’Neil, 2001; Csuti et al. 1997), survey methodology (e.g., Seltenrich and Pool [2002] for foothill yellow-legged frogs), results of BLM surveys (Roninger, 2000, 2001), information provided by the TRWG, and interviews with local agency biologists.

5.4.3 Field Survey Methodology—Plants

Pre-field survey preparations involved botanists familiarizing themselves with the morphological and habitat characteristics of target species. Botanists reviewed herbarium specimens and consulted with local botanical experts to evaluate appropriate survey timing. For many species, botanists used photographs of TES plant species available on the Internet, including photographs of plants in the field and herbarium specimens, to assist with species confirmation. Botanists also visited known locations of TES plants based on USFWS, BLM, ONHP, and California Natural Diversity Database (CNDDB) occurrence records. Wildlife biologists conducting TES wildlife surveys also were consulted about observations of habitats that potentially could support TES plants.

Botanical field surveys were conducted using an “intuitive controlled” approach (Whiteaker et al. 1998), which is similar to the random meander approach (Nelson, 1985). Under this method, botanists traverse the entire study area thoroughly enough to see a representative cross section of all the major habitats and topographic features, looking for target species while en route among different areas. Sites also were examined while traveling among vegetation sampling plots. A complete survey for the target species was made in areas with a high potential of supporting TES plants. In areas immediately adjacent to Project facilities and roads, botanists also covered a higher percentage of the area. In situations where sites could not be accessed safely, such as cliffs, surveys were facilitated with the aid of binoculars.

Survey dates were scheduled based on when each species could be readily identified and often coincided with specific flowering or fruiting periods. Surveys were conducted on multiple occasions for some species to better match their phenological development during the 2002 growing season. Because no future ground-disturbing activities on federal land can be identified at this time, survey methods for S/M Strategy 2 plants (Whiteaker et al. 1998) were not used for surveys. However, during surveys, botanists searched habitats near Project facilities including transmission lines, roads, power plants, substations, and reservoir shorelines for vascular species on the S/M list.

Surveys were conducted by six botanists working in pairs. Surveys took place from May 6 to 11, June 3 to 9, and July 8 to 13, 2002. Additional survey effort occurred during upland and riparian vegetation sampling (Section 2.0 and 3.0) and some specific sites were revisited in October and November 2002 in an attempt to verify the identification of potential TES plants species found during earlier surveys. Several sites were revisited in September 2003 to confirm the identity of potential TES plant species. During field surveys, botanists identified all plant species they observed to the extent possible and compiled a species list. However, emphasis was placed on identifying all taxa that were similar to taxa on the target TES species list (i.e., same genus). TES species occurrences were documented in field notes and on maps or with GPS.

5.4.4 Field Survey Methodology—Wildlife

A variety of techniques and survey methodologies were used to address the large number and diversity of target TES wildlife species. Areas suitable for TES wildlife surveys were identified on the basis of preliminary results of vegetation cover type mapping. Specific survey methods were formulated through multi-agency and TRWG consultation based on the behavior, ecology, and habitat requirements of target species. Before conducting field surveys, biologists reviewed proposed survey locations with resource agencies to ensure species inventory results could be used to qualitatively assess whether Project operations may affect the distribution and abundance of potentially occurring TES wildlife species. All TES species surveys were conducted by qualified biologists with experience in each of the survey methods and practiced knowledge of bird calls and species identification information.

TES species were detected using a variety of target survey methodologies, including the following:

- During the 2002 field season, TES amphibians were searched for during surveys at ponds and wetlands, in selected tributary streams, and during a limited number of upland surveys in mesic coniferous habitat. In 2003, specific targeted surveys were conducted for the Oregon spotted frog and the foothill yellow-legged frog, and supplemental surveys for TES amphibians were conducted at select isolated wetland/spring locations (see Section 4.4 for additional detail).

- In 2002, TES reptile species were searched for during targeted reptile surveys in wildlife survey plots established in habitats throughout the study area. During the 2003 field season, additional TES reptile surveys were conducted in select rock talus areas and at potential snake hibernacula sites as well as incidentally during small mammal trapping studies along the J.C. Boyle, West Side, and Fall Creek canals, and pond turtle surveys were conducted in the J.C. Boyle bypass and lower J.C. Boyle peaking reach (see Section 4.4 for additional detail).

- In 2002, TES bird species were surveyed for during:(1) avian point count and area search surveys in wildlife survey plots; (2) protocol surveys for northern spotted owl and northern goshawk; (3) reservoir surveys for wildlife using aquatic and shoreline habitat; and, (4) during Klamath Bird Observatory (KBO) Rapid Ornithological Inventories (ROI). In 2003, specific surveys for avian TES species included a second season of northern spotted owl surveys and protocol broadcast call surveys for great gray owls conducted in suitable habitat located throughout the Project vicinity.

- TES mammal species were a focus of track surveys and winter bait station field studies completed in the winter of 2003. During the 2003 field season, small mammal trapping and bat roost surveys were conducted to further investigate the distribution of TES mammal species in the Klamath study area.

In addition to the various surveys outlined above, species detections and notable data on TES wildlife were collected opportunistically throughout the Project study area. As biologists moved between survey stations—and whenever qualified personnel were in the Project vicinity—unique areas and high-quality habitat were searched for target TES wildlife species. Biologists opportunistically searched appropriate microhabitats, and looked under cover objects when moving between designated survey points and when driving Project roads. All data were recorded on standard datasheets (Appendix 5B) and included with data on TES wildlife species detections from all field surveys for analysis.

Figure 5.4-1 shows the location of all avian, mammalian, and general TES wildlife surveys conducted as part of PacifiCorp relicensing. TES amphibian and reptile survey locations—including Oregon spotted frog and foothill yellow-legged frog 2003 protocol survey sites—are shown in Figure 4.4-1 (in Section 4.0). Table 5A-4 (in Appendix 5A) provides data on the 149 wildlife survey plots used during TES wildlife species field studies, including information on the general habitat association and Project section.

The following sections describe specific methodologies for surveys used to detect TES wildlife by target species group.

5.4.4.1 Amphibians

Six different types of surveys—pond-breeding amphibian surveys, instream surveys, upland surveys, Oregon spotted frog surveys, foothill yellow-legged frog surveys, and isolated wetland/spring surveys—were used to detect TES amphibian species. Additional detailed information on methodology for the amphibian field studies described below is provided in Section 4.4.2.

<u>Pond-Breeding Amphibian Surveys - 2002</u>

During the spring of 2002, teams of two biologists examined all riparian and wetland polygons in the field, as well as selected stock ponds and springs, to determine if pond habitat was present. Biologists then searched potentially suitable pond-breeding habitat. The surveys covered small ponds in their entirety; in larger ponds/wetlands, time- and/or area-constrained surveys were used to sample the area. At each of the pond-breeding survey sites, biologists searched shallow water zones and looked for adults, larvae, and egg masses under cover objects within and adjacent to the pond using time- and area-constrained methods described in Olson et al. (1997) and Thoms et al. (1997). Surveys were conducted at 68 individual sites from March through April 2002 to cover the egg and larval stages of most target pond-breeding amphibian species (Section 4.0, Figure 4.4-1).

<u>Instream Surveys - 2002</u>

Instream surveys that could detect TES amphibians associated with riverine habitat were conducted in August 2002. Biologists surveyed the first 492 feet (150 m) of a creek upstream or downstream of a Project facility or reservoir; surveys were conducted in 14 different creeks (Section 4.0, Figure 4.4-1). Areas surveyed included specific Klamath River shoreline regions, Fall Creek, and the lower portion of selected tributaries. Surveys were conducted during low-flow conditions when stream-dwelling amphibians are most-easily detected (Bury and Corn, 1991). Surveys involved: (1) searching the shallow-water zones for amphibians; (2) turning rocks, litter, and debris to find adult and larval amphibians; and (3) using nets to catch individuals dislodged from under cover objects, raked gravel, or cobble (Corkran and Thoms, 1996; Bury and Corn, 1991; Welsh, 1987; Heyer et al. 1994).

Upland Amphibian Surveys - 2002

Surveys for terrestrial amphibians were conducted in March and April 2002 in two polygons that contained potentially suitable mesic conifer forest in Keno Canyon (Section 4.0, Figure 4.4-1). Two biologists used time-constrained survey methods similar to the VES method described by Crump and Scott (1994). The size of each upland area surveyed and length of survey time was determined on the basis of site-specific conditions. In addition to targeted surveys for terrestrial amphibians, all terrestrial TES amphibian species observations were recorded during avian studies conducted in the wildlife survey plots and other field studies (see below).

Oregon Spotted Frog Surveys - 2003

Oregon spotted frog surveys were conducted near J.C. Boyle and Keno reservoirs at suitable wetland sites during the 2003 field season. Although no recent records exist for the species in the study area, it was thought that the species may occur in wetland habitat along the Klamath River where adequate protection from predatory bullfrogs and fish is provided. Four wetland sites were identified as potentially suitable for survey through consultation with state and federal resource agencies and local species experts. Consistent with spotted frog survey methodology, each site was surveyed three times through the spring of 2003 (April through June). Figure 4.4-1 (in Section 4.0) shows the location and extent of areas surveyed. Field methodology generally followed VES standards with specific emphasis on microhabitat areas suitable for spotted frog breeding.

Foothill Yellow-Legged Frog Surveys - 2003

The TRWG requested that PacifiCorp conduct surveys for foothill yellow-legged frogs in the spring and summer of 2003 using methodology described in Seltenrich and Pool (2002). Collaboration with state and federal resource agencies and local species experts in the fall of 2002 resulted in the selection of ten foothill yellow-legged frog survey sites (Section 4.0, Figure 4.4-1). These ten sites, located along the Klamath mainstem and associated tributaries, were surveyed four times each in 2003 (Section 4.0, Figure 4.4-1). Two biologists used VES methodology (Seltenrich and Pool, 2002) to survey these sites in April, May, June, and August 2003.

Figure 5.4-1. TES wildlife survey locations.

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Figure 5.4-1

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Figure 5.4-1

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5.4.4.2 Reptiles

Reptile surveys conducted in 2002 included terrestrial surveys and pond turtle basking surveys. Specific reptile field survey effort in 2003 included surveys of selected rock talus sites, potential snake hibernacula sites identified by the BLM, and basking pond turtle surveys Additional detailed information on methodology for these specific field studies is provided in Section 4.4.2.

Terrestrial Reptile Surveys - 2002

TES reptile species were searched for during terrestrial reptile surveys conducted in June 2002. Surveys were conducted in 139 of the 1.96-acre (0.79-ha) wildlife survey plots distributed among all cover types (Table 5A-4 in Appendix 5A) as well as in select locations around Project facilities. Biologists conducted upland reptile surveys in dry, warm conditions by visually inspecting the entirety of a survey plot while turning cover objects to locate TES reptiles. In addition, TES reptile species observations were recorded during avian studies conducted in each of the 149 wildlife survey plots. All reptiles observed were identified based on Storm and Leonard (1995).

Snake Hibernacula Surveys - 2003

The TRWG requested that snake hibernacula surveys be conducted during the 2003 field season to supplement TES reptile species data collected in 2002. Hibernacula surveys focused on known or presumed hibernation sites and areas supporting high densities of reptiles existing between roads, recreation sites, Project facilities, and the Klamath River. Survey location, methodology, and timing were coordinated with the BLM, local reptile experts, and wildlife resource agencies. Seven specific survey locations, generally focusing on rock talus habitat in the Klamath Canyon, were identified by the BLM through the 2002 consultation process (Section 4.0, Figure 4.4-1). These sites were surveyed during spring of 2003 using VES methodology according to the schedule provided in Table 4.7-16 (in Section 4.0). Additional detailed information on terrestrial reptile and hibernacula survey methodology is provided in Section 4.4.2.

Pond Turtle Surveys - 2002 and 2003

Surveys for basking pond turtles were conducted between April and July 2002 by biologists traveling by boat or vehicle along reservoirs and accessible river reaches. Biologists recorded the location of basking sites and the number of adults and juvenile turtles present at each site. In 2003, additional pond turtle basking surveys were conducted along the California portion of the J.C. Boyle peaking reach and in the J.C. Boyle bypass (Section 4.0, Table 4.7-7) to supplement data on turtle occurrence collected in 2002. Surveys were not conducted in the Oregon portion of the J.C. Boyle peaking reach because existing data on the species had been collected in this localized area by the BLM and Bury (Bury and Pearl, 1999; Roninger, 2000). In addition to the documentation of turtle observations, each river and reservoir shoreline was mapped into segments based on the presence of suitable nesting habitat for the species (results of the pond turtle nesting habitat assessment are provided in Section 4.7).

5.4.4.3 Birds

Surveys for avian TES species included avian plot surveys; facility surveys; reservoir surveys; ROI; broadcast call protocol surveys for northern goshawk, northern spotted owl, and great gray owl; and bald eagle surveys. Additional detailed information on survey methodology for the avian field studies described below is provided in Section 7.0.

Avian Plot Surveys - 2002

Plot surveys included a 5-minute avian point count survey, where all bird detections were recorded inside and outside of a circular wildlife survey plot 164 feet (50 m) in radius. Point-count survey methods generally followed those described in Ralph et al. (1993). The 3-minute mark was recorded during each 5-minute point-count survey for standardization and comparison with other avian survey protocols (e.g., Breeding Bird Survey, KBO point counts, etc.). Immediately after the point count, the surveying biologist conducted an area search for 15 minutes by traversing the entirety of the 1.96-acre (0.79-ha) wildlife survey plot. The combined point count and area search resulted in a total survey effort of 20 minutes per avian plot survey (Geupel et al. 1995). Birds detections located both inside and outside of the plot were recorded during the 20-minute survey. Surveys were conducted from15 minutes before sunrise until 4 hours after sunrise and surveys at each plot were initiated after a 1-minute settling period. A total of 149 plots was surveyed for TES avian species (Figure 5.4-1; Table 5A-4 in Appendix 5A) with 137 plots surveyed in May 2002 and all 149 surveyed in June 2002 (12 plots were not surveyed in May 2002 because of inclement weather, which is known to impede avian species detection).

Facility Surveys - 2002

To obtain information on wildlife use near Project facilities, complete area searches were conducted in 2002. Facility surveys were conducted in conjunction with plot surveys (in May and June 2002), but were neither time- nor area-constrained. Facility surveys included an informal, yet systematic, area search around Project facilities until a surveying biologist determined a representative sample of the surrounding avifauna had been detected. Biologists recorded the location, behavior, and associated habitat for all avian species and TES wildlife species detections. Eighteen facility sites located in the study area were surveyed in 2002 (Figure 5.4-1). Facilities surveyed varied in size, and, thus, a standardized area of reference is not associated with facility survey data. Likewise, facility surveys were not time-constrained, but generally were completed in approximately 15 to 40 minutes, depending on the time required to cover the facility area.

Reservoir Surveys - 2002 and 2003

Typically, reservoir surveys were conducted from a vehicle by one or more biologists. Biologists visually inspected reservoirs from various vantages using spotting telescopes and binoculars to ensure complete coverage. All reservoirs were inspected in their entirety during these surveys except Keno reservoir, where pool regions southeast of Highway 66 upstream to the state wildlife refuge boat ramp could not be accessed. All detected TES species were documented according to specific location (e.g., bay or inlet name, or other landmarks). Surveys were conducted six times between April 2002 and March 2003. Data include the date, survey route, start and stop time, weather conditions, species, number, sex, age, and comments. Significant observations of TES species were recorded by a GPS or on maps for inclusion in species distribution analysis.

Rapid Ornithological Inventories - 2002

PacifiCorp contracted KBO to conduct five ROI surveys to document avian use and occurrence in riparian habitat during the fall migration. ROI station locations were selected in consultation with KBO personnel and local, state and federal resource agencies. ROI stations were established in the following locations (Figure 5.4-1):

- In the Iron Gate–Shasta reach downstream of the fish hatchery
- At the mouth of Scotch Creek off of Iron Gate reservoir
- Along the Copco No. 2 bypass
- Near the mouth of Shovel Creek in the J.C. Boyle peaking reach
- Along the Link River in Klamath Falls

ROI methodology includes mist-netting and banding coupled with area searches and nocturnal call-and-response owl surveys conducted during an intensive 3-day survey period (Ralph and Hollinger, 2001). ROI surveys were conducted in the late summer, August 26 through September 4, 2002, to collect information on fall migration and juvenile post-breeding dispersal.

Spotted Owl, Great Gray Owl, and Northern Goshawk Broadcast Call Surveys - 2002 and 2003

Protocol broadcast call surveys were conducted in 2002 for northern spotted owl and northern goshawk in suitable habitat located within 1.3 miles (2.1 km) of Project facilities in California and 1.2 miles (1.9 km) of Project facilities in Oregon (Figure 5.4-1). Protocol broadcast call surveys for spotted owl and great gray owl within this same Project study area were completed during the 2003 field season. Broadcast call surveys incorporate playback of taped species-specific calls in suitable habitat following applicable protocols (Kennedy and Stahlecker, 1993; Joy et al. 1994; BLM, 1995b; USFS, 1996; Lint et al. 1999). Goshawk survey stations were located 1,000 feet (305 m) apart on line transects also spaced 1,000 feet (305 m) apart in all suitable habitat. This methodology established a grid of 138 goshawk calling stations, spaced evenly throughout suitable habitat in the study area (Figure 5.4-1). Suitable habitat for goshawks was defined as conifer or riparian forest, with a northern aspect (north, northeast, or northwest) and more than or equal to 6-inch (15-cm) dbh trees forming more than or equal to 60 percent canopy closure (Marshall, 1992). Spotted owl survey stations were located intuitively to ensure adequate coverage of all available habitat.

In 2002, biologists surveyed 106 spotted owl calling stations in suitable habitat defined as riparian areas and forests with a coniferous component containing trees more than or equal to 6-inch (15-cm) dbh and a canopy closure of more than or equal to 40 percent (Figure 5.4-1) (Lint et al. 1999). In 2003, the same spotted owl calling stations were used although the total number of stations was reduced to 73 after a further review of habitat suitability. Three surveys were conducted at each spotted owl survey station during each field season: one in June 2002, and two in July in 2002; and one survey conducted in April, May, and June in 2003. Goshawk stations were each surveyed twice in 2002: once in June and once in July. Great gray owl suitable habitat was defined as conifer forests with tree cover more than or equal to 60 percent and more than or equal to 42 inches (10.7 cm) dbh that are within 1,000 feet (305 m) of openings (BLM, 1995). A total of 48 great gray owl calling stations each was surveyed according to survey protocol six times from April through June 2003. In addition, supplemental great gray owl broadcast call surveys were conducted at three additional calling stations a total of three times each to include a non-protocol habitat area where a single great gray owl detection was noted in 2002. Although protocol broadcast call surveys specifically targeted northern goshawks, northern spotted owls, or great gray owls, biologists documented the behavior, location, and associated habitat for all TES wildlife species detections. Maps of calling stations and survey schedules were reviewed thoroughly with agency biologists to avoid conflicts and potential "cross calling."

Bald Eagle Surveys - 2002 and 2003

Bald eagle surveys incorporated perch, forage site inventories, and aerial surveys. Frank Isaacs, of the Oregon Cooperative Fish and Wildlife Unit, conducted aerial helicopter surveys on March 27 and May 29, 2002, and on March 27 and May 28, 2003, to document nests and to determine occupancy and productivity of territories in the Klamath Basin. Additional flight time was allocated to survey the terrestrial resource study areas for known and potential new nests. Perch and forage site surveys for eagles were conducted from April through September 2002 and continued from January through March 2003. Methodology for these surveys included the driving of study area roads and stopping to observe reservoirs and shoreline areas from several vantages. Surveys focused on suitable habitat and were conducted in a non-disruptive manner. Locations of all identified nest sites were mapped and described; activity, time, and age estimations were recorded with all observations (locations of eagle nest sites are not reported in the results section [Section 5.7.2] by agency request). In addition, biologists visited four nest sites in August 2002 to collect prey remains from under recently active nests that fledged young for an analysis of area eagle food habits.

5.4.4.4 Mammals

Surveys targeting mammalian TES species conducted as part of relicensing include: winter bait station and track surveys; canal wildlife surveys and small mammal trapping; and bat roost surveys. Winter bait station and track surveys were completed from January through March 2003 and bat roost surveys and small mammal trapping were conducted during the 2003 field season. Because mammals—especially carnivorous species and solitary mammals with large home ranges—are often hard to systematically detect, existing information and documented records from the Project region were compiled and included in the analysis to assess a species' potential occurrence and local distribution in the study area.

Winter Bait Station and Track Surveys - 2003

From January through March 2003, PacifiCorp coordinated with the BLM and ODFW to conduct snow tracking for forest carnivores in the following areas:

- Link River
- Upper Keno Canyon
- J.C. Boyle canal
- Fall Creek

Tracking sample units—sized at approximately 2 to 4 square miles (5 to 10 square km) each to accommodate the home ranges of species of interest—were established in each of these areas and biologists checked for wildlife tracks two times along a minimum of 6.2 miles (10.0 km) of roads and trails in each sample unit (Halfpenny et al. 1995). Tracks were identified using field guides (Halfpenny and Biesiot, 1986; Halfpenny et al. 1995; Taylor and Raphael,1988) and measurements were recorded and, in some cases, castings made for definitive identification of unusual or problematic tracks (Taylor and Raphael, 1988; Halfpenny et al. 1995). All wildlife species detected during track surveys were documented.

In conjunction with the winter track surveys, PacifiCorp established photographic bait stations to document carnivores along the J.C. Boyle canal; downstream of the J.C. Boyle powerhouse; and along the Copco No. 2 bypass. The three bait stations were maintained for 7 weeks from January through March 2003. Each station was baited with carrion and checked weekly. Track observations near the bait station and all detections of wildlife species were recorded during each weekly maintenance check. For additional detailed information on winter bait station and track surveys for forest carnivores see Section 6.4.2.1.

Canal Wildlife Surveys - 2002 and 2003

Surveys of wildlife, emphasizing TES mammal species, were conducted along the J.C. Boyle canal three times during spring and summer of 2002 and a fourth survey was conducted in the winter of 2003 in conjunction with the track surveys. Canal wildlife surveys were conducted by a biologist who walked the length of the canal while documenting all detected wildlife species. Results from these surveys supplement information from other field studies to provide a description of species that are likely to occur around Project canals.

Small Mammal Trapping - 2003

Because canal wildlife surveys may not effectively detect largely nocturnal small mammal species, the TRWG requested that PacifiCorp conduct small mammal trapping along the J.C. Boyle canal, Fall Creek canal, and West Side canal during the summer of 2003. Small mammals were surveyed with Sherman traps monitored over two 3-night trapping periods. Four transects with approximately 25 traps each were established at each location, with two transects located on either side of Project canals (Section 6.0, Figure 6.4-1). Additional detailed information on small mammal trapping is provided in Section 6.4.2.2.

Bat Roost Surveys - 2002 and 2003

Bat roost surveys were conducted one time inside 24 Project facility structures in June 2003. In addition, the undersides of the following 14 bridges were each examined once either in 2002 or 2003 with the aid of binoculars to look for evidence of bat use: I-5 rest area, Klamathon, Iron Gate fish hatchery, Bogus Creek, Jenny Creek, Copco No. 2 Village, Copco Lake, Beswick Ranch, Shovel Creek, bridge over Klamath River near Shovel Creek, service bridge downstream of J.C. Boyle dam, Highway 66 bridge over J.C. Boyle reservoir, Highway 66 bridge over Keno reservoir, and West Side canal bridge.

Locations of bat roost facility survey sites are shown in Figure 5.4-1. Methodology for bat roost surveys included a visual inspection of all practically accessible areas within each target facility by qualified biologists to identify bats to genus or species, if possible. Biologists estimated the number of bats using each Project structure and documented if a facility is used as a nursery site, day roost, or for night roosting. Information from previous bat surveys conducted at Salt Caves and the Hoover Ranch house (Cross et al. 1998) also was assessed and incorporated into an analysis of bat occurrence and distribution in the Project vicinity.

5.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

Field surveys and analysis conducted as part of this study greatly increase knowledge and documentation of TES species in the study area and the relationship between Project operations and TES species and their habitats. This information is required by the FERC in license applications and in compliance with the following regulations:

- Federal ESA
- California ESA
- BLM S/M Species Protection
- Oregon ESA

5.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were held on the following dates: January 17, March 28, April 18, June 6, November 8, and December 10, 2002, and February 4, August 5, and October 10, 2003. At each of these meetings, PacifiCorp received comments that have been incorporated into the Final Study Plan.

5.7 RESULTS AND DISCUSSION

Sections 5.7.1 and 5.7.2 present results from relicensing field studies on TES plants and wildlife, respectively. Each section provides data collected from targeted TES species field studies as well as information on the status, occurrence, and distribution on each potentially occurring TES species based on historic records, published accounts, public agency data, and other existing information. Tables referenced in this section are located in Appendix 5A.

A combined total of 172 TES plant and vertebrate wildlife species (65 vascular plant species and 107 vertebrate animal species) was originally identified as potentially occurring in the Project study area (Tables 5A-1 and 5A-3 in Appendix 5A). Of these species, 61 (14 plant species and 47 wildlife species) were detected in the Project vicinity during relicensing terrestrial wildlife field studies. Please refer to Tables 5A-1, 5A-2, and 5A-3 (in Appendix 5A) for both the scientific and common names of these species. Specific information on each species detected during field survey, as well as all potentially occurring TES wildlife species, is provided in the sections below. Included are two federal threatened species—northern spotted owl and bald eagle—listed by the USFWS; 15 federal species of concern; two Oregon threatened species and one California threatened, and three California endangered wildlife species. One federally endangered plant species; five federal plant species of concern; and one Oregon endangered plant species were found.

5.7.1 Plants

Seventy-nine occurrences of 14 species of TES plants were documented in the primary and secondary study area in 2002 (Figure 5.7-1; Table 5A-5 in Appendix 5A). Thirty of the

79 occurrences were previously documented by the BLM. CNDDB records of TES plants in the study area account for 11 of the 79 documented TES plant occurrences in the study area. Two CNDDB records coincide with BLM records. ONHP occurrence records of TES plants in the study area were mapped with a high level of uncertainty; the ONHP data was displaced by up to 3,281 feet (1,000 m). PacifiCorp biologists attempted to correct the ONHP data by referring to written descriptions provided with ONHP records. After the corrections were implemented there were only two occurrences of TES plants that overlapped the study area.

There are five additional ONHP occurrences that potentially overlap the study area around Keno reservoir. There are potentially 34 to 39 new occurrences of TES plant occurrences in the study area following the 2002 survey. A summary of all 79 occurrences of TES plant species, including their unique labels, their listing and status at the state and federal level, and comments about the occurrences, is provided in Appendix 5C.

The identification of two of the 14 TES plant species has not been confirmed; these species include red root yampah and Lemmon's silene. They are included in this discussion for the following reasons: (1) these occurrences in the study area are a matter of record with the BLM Klamath Falls office; (2) in the case of red root yampah, only four sites were visited late in the season to assess the mature fruits; all four sites had small, round mature fruit indicating Gairdner's yampah, but until all sites are assessed they are being treated as potential red root yampah; and (3) in the case of Lemmon's silene, the plants found keyed to campanulate silene (*Silene campanulatum*). The status of these and the remainder of the species and occurrence records as well as the potential Project effects on TES plants are addressed below. The locations of the 79 occurrences of TES plants and potential TES plants are mapped in Figure 5.7-1.

The Project plant species list that was compiled by botanists during surveys for TES plants is provided in Appendix 5D. The list of culturally sensitive species observed in various Project sections is confidential and has been provided to the CRWG (Appendix 5E).

5.7.1.1 TES Plant Species Accounts

The following sections provide species accounts for TES plant species documented in the study area during 2002 field studies.

<u>Applegate's Milkvetch</u>

Applegate's milkvetch, the only federal endangered plant found, is endemic to Klamath County in central-southern Oregon. This species is threatened from fragmentation and loss of habitat; potential development and road construction; elimination of the natural seasonal flooding regime along the floodplains supporting the species; suppression of fire; invasive/exotic plants; and insect usage (NatureServe website).

One new occurrence of Applegate's milkvetch was found at Keno reservoir in the study area (Figure 5.7-1). The habitat was dominated by gray rabbitbrush and saltgrass. The ONHP has several other occurrence records for Applegate's milkvetch near Keno reservoir. Fifty to 60 plants that displayed vegetative, flowering, and fruiting phases were observed on July 11, 2002. The phenology of these plants was approximately 2 months behind the occurrences of this species visited in the wildlife refuge earlier in the summer of 2002.

The dense saltgrass herb layer in this habitat was undisturbed and did not appear to have been affected by grazing cattle just a few yards away. The gray rabbitbrush shrub layer did appear to be somewhat broken, presumably by cattle, but still had an areal cover of approximately 25 to 35 percent. It is unclear how the reservoir pool influences the water table level at this site and how this might affect the habitat for Applegate's milkvetch. Applegate's milkvetch is growing within 45 to 100 feet (17 to 30 m) of Keno reservoir and runs along the reservoir for approximately 250 feet (76 m). The height or elevation of the site above the reservoir water surface was estimated at less than 2 feet (0.6 m). Under current operations, the Keno reservoir pool level fluctuates less than 2 feet (0.6 m) per year. Between 1998 and 2001 the actual fluctuations of the pool level was less than 1 foot (0.3 m) except for a 3-foot (0.9-m) drop that lasted 1 day.

Greene's Mariposa Lily

Greene's mariposa lily is endemic to Siskiyou County in California and Josephine and Klamath counties in Oregon. There were 23 documented occurrences of Greene's mariposa lily in the study area and Project vicinity (Figure 5.7-1). Eighteen of these occurrences in the Project vicinity were previously known occurrences based on BLM and CNDDB records. Eight of the known occurrences were revisited and Greene's mariposa lily was located at five of eight of the sites. Ten of the 18 sites were not revisited during 2002 surveys because of their remote location in the study area. Five new occurrences of Greene's mariposa lily were documented in the study area and in the general vicinity of the known occurrences around Iron Gate reservoir. The portion of the Greene's mariposa lily population that overlaps the study area occurs from the southwest end of Iron Gate reservoir upriver nearly to Way Creek on the south side of the J.C. Boyle peaking reach and is wholly within California.

Greene's mariposa lily occurs primarily in annual grassland, wedgeleaf ceanothus chaparral, and oak and oak-juniper woodlands. These habitats have a high incidence of non-native and exotic/invasive plant species. Yellow starthistle, medusahead, and annual bromes form the dominant herb layer cover at nearly all of the sites where Greene's mariposa lily was observed growing. The deep-seated bulb of these plants appeared to be highly resistant to trampling. However, grazing, especially late in the reproductive cycle, appears to be a primary threat to reproduction for this species. Deer and cattle were observed grazing on the new leaves of this species early in the season and all occurrences found had chewed leaves. At five of the eight known sites that were visited twice, there was at least one plant in flower or fruit at four sites and at one site in Long Gulch along Iron Gate reservoir, the leaves seen previously had withered

Figure 5.7-1. TES plants.

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Figure 5.7-1

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Figure 5.7-1

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Figure 5.7-1

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without producing flowers. At the five new locations for Greene's mariposa lily, flowers and fruit were observed on four plants; the leaves on the other plants had either withered or had been grazed and only the inflorescence stem remained. There were no occurrences of Greene's mariposa lily that were located near enough to Project facilities to be affected directly by Project operations and maintenance.

Mountain Lady's Slipper

Mountain lady's slipper is fairly widespread in western North America, but typically not abundant where it is found. The BLM and ONHP records document the only occurrence of mountain lady's slipper orchid in the study area. No additional occurrences were found during 2002 surveys. Mountain lady's slipper was observed growing on a shaded and mesic, forested slope above Frain Creek, a small tributary to the Klamath River at Frain Ranch (Figure 5.7-1). Twenty to 30 plants in flower were observed during July surveys. Currently, this population is in a protected location away from river access at Frain Ranch. There is no potential for Project operations and maintenance to affect this population.

Bolander's Sunflower

Bolander's sunflower was observed at two locations: in the six study areas at Hayden Creek and in the Project vicinity at Long Gulch south of Iron Gate reservoir (Figure 5.7-1). One of the BLM populations known from BLM records along the Topsy Road west of Way Ranch was not found during several attempts while traveling through that area. Bolander's sunflower was at peak flowering several weeks before annual sunflower. The diagnostic character for this species is that the central awn on the chaff scale greatly exceeds the disk corollas. A number of specimens observed in the study area had some flowers where the awn was not obviously longer than the disk corollas. This inconsistency in the diagnostic character may have to do with the age of the flower observed. However, the generally narrower phyllaries and wedge-shaped leaf bases helped to distinguish Bolander's sunflower from the annual sunflower. Later in the summer, the search for Bolander's sunflower became increasingly difficult because so much of the annual sunflower was flowering. This annual species was found growing in highly disturbed and degraded sites filled with annual bromes and starthistle. One of the sites for Bolander's sunflower was located along the road through Iron Gate Estates on the south side of Iron Gate reservoir, in one of the largest continuous populations of yellow starthistle in California. The second verified occurrence was located along the lower reach of Hayden Creek, a tributary to the Klamath River in the J.C. Boyle peaking reach. Neither of the occurrences of Bolander's sunflower occurred near enough to Project facilities to be affected directly by Project operations and maintenance.

Salt Heliotrope

Salt heliotrope was observed at five locations in the study area at the upper end of Keno reservoir; none of the five occurrences was previously documented by the BLM or ONHP (Figure 5.7-1). In California, this species is widespread and locally abundant in many of the same types of habitats that are found at Keno reservoir.

This species was found growing in seasonally flooded, low-lying areas with at least some bare, salt-encrusted ground. Saltgrass, short-podded thelypodium, and Columbia yellow cress were observed growing with or adjacent to salt heliotrope. Like Applegate's milkvetch, it is unclear how the Project operations at Keno reservoir might affect salt heliotrope. This species was found in sites that held shallow pools early in the growing season. The flooding of these sites occurs as the result of surface runoff pooling in non-porous, low-lying areas. What is unclear is how the reservoir pool might influence the water table level and work in combination with the saturated ground and surface runoff early in the growing season to affect the filling and maintenance of the shallow pools.

One of the occurrences of salt heliotrope (HECU-5) (note: code-number refers to occurrence on Figure 5.7-1) was located in a drying pond adjacent to Columbia yellow cress. The pond lies in a large, low-lying portion of a pasture grazed by cattle. At the time of survey, there were relatively few cattle in the pasture and only a few meandering trails of deeply embedded hoof prints through the ponded area. Salt heliotrope grows adjacent to Columbia yellow cress, but in a lower, wetter position that is less protected by accompanying dense, matted, and cropped vegetation. The inner portion of the pool is susceptible to damage by trampling. There were no signs that cattle grazed the salt heliotrope and the few plants embedded into deep hoof prints appeared green and healthy. The other four occurrences of salt heliotrope occurred on the island west of HECU-5. The island habitat did not appear to have any recent disturbance.

<u>Bellinger's Meadow Foam</u>

The ONHP database revealed one known population of Bellinger's meadow foam that barely overlapped the Project vicinity just northeast of Grizzly Butte. This occurrence was not visited during field surveys because its isolated location is a buffer from potential Project impacts. No new sites were found during field surveys. The seasonally wet or moist habitat where meadow foam grows is not common below the canyon rim and is uncommon anywhere near the study area except in a few locations around J.C. Boyle reservoir where Egg Lake monkeyflower grows. Because of its remote location, it is unlikely that this site would be affected by Project operations or maintenance. As a result, the site was not included in the survey.

<u>Egg Lake Monkeyflower</u>

Egg Lake monkeyflower was found in five locations in the study area around the southwest end of J.C. Boyle reservoir, in Oregon (Figure 5.7-1). It was found growing in damp mudflats adjacent to shallow and narrow tributaries to J.C. Boyle reservoir.

The percent of vegetation characterization plots with evidence of recreational impacts was greatest at J.C. Boyle reservoir (Section 2.0, Section 2.6-4). Trampling by recreation enthusiasts, including hikers and OHV users, is the most likely threat to the occurrences observed that are located near the reservoir. The shallow, mud-bottomed tributaries where Egg Lake monkeyflower was observed are not primarily influenced by the pool level fluctuation zone of J.C. Boyle reservoir and are far enough from Project operations and maintenance that there is little potential for Project impacts.

Three occurrences of Egg Lake monkeyflower (MIPY-1, -2, and -3) were documented under the transmission line just southwest of J.C. Boyle dam. The potential impacts to these occurrences of Egg Lake monkeyflower are discussed below with red root yampah (PEER-9, -10, and -11), which also potentially grows at these sites.

Red Root Yampah

Red root yampah is reported to grow in seasonally wet meadows and clay depressions. These types of habitats are common above the Klamath canyon rim north of the Project area, but are relatively uncommon below the rim. The wet meadow habitats that supported the *Perideridia* observed during 2002 survey do not exactly match the target habitat. The 2002 and 2003 surveys and BLM data documented 16 streamside and isolated meadows that support species of *Perideridia* (Figure 5.7-1). Ten of these 16 sites were reported to support unconfirmed occurrences of red root yampah by the BLM. The *Perideridia* species was documented in seven additional wet sites as a result of the 2002 surveys.

Possibly two species of *Perideridia* (red root yampah or Gairdner's yampah) were observed growing in the wettest streamside habitats with Howell's yampah. At the drier margins of these meadows, unidentified *Perideridia* species were growing with Oregon yampah.

Species of the genus *Perideridia* are frequently difficult to distinguish from one another in the field. The three similar species—Oregon yampah, Gairdner's yampah, and red root yampah—can best be distinguished in the field with ripe fruit and the ability to compare whether the umbelet rays are equal or unequal in length (Amsberry, 2001). Oregon yampah was fairly easy to distinguish in the field because it had umbelets with rays of equal length, produced flowers and mature fruit relatively early in the growing season, and occupied generally drier sites than the other *Perideridia* species. In an effort to identify the other one or two species, surveys were repeated in the fall of 2002 and 2003 so that the fruits would be fully mature. Four sites that were revisited (PEER-3, 4, 11, and 17; Figure 5.7-1) had ripe fruit; all four sites had numerous plants with small, orbicular fruit less than 0.12 inch (3 millimeters [mm]) in length. This characteristic is diagnostic for Gairdner's yampah. Red root yampah has mature fruit that are oblong and 0.24 inch (3 to 6 mm) in length (Amsberry, 2001).

Perideridia was not observed at four of the BLM sites (PEER-5, 8, 9, and 10) that were visited during 2002 surveys. Three BLM sites (PEER- 2, 6, and 7) were not visited because they were considered too far from the study area to be affected by the Project.

One of the yampah sites, reported here as PEER-17, was determined to be Gairdner's yampah, based on examination of dozens of plants with mature fruits in 2002 and in 2003. This site is a wet meadow adjacent to the Klamath River that currently does not have any sign of erosion or scouring from flows in the Klamath River. This site has a durable, high density cover of meadow vegetation that appears to withstand intensive cattle grazing late in the growing season (observed in 2002) and heavy use by recreationists from the nearby BLM campground. Another potential red root yampah occurrence (PEER-16) in Keno Canyon lies within 35 to 40 feet (11 to 12 m) of and approximately 2.5 feet (0.8 m) above the Klamath River, so only very high flows would reach this occurrence and the large boulders that armor the river bank near this site would offer some protection against scouring.

Three potential occurrences of red root yampah (PEER-9, -10, and -11; PEER-11 was revisited during 2003 and confirmed to be Gairdner's yampah) and three occurrences of pygmy monkeyflower (MIPY-1, -2, and -3) occur within the maintained transmission line ROW west and southwest of J.C. Boyle dam. Generally, these sites are wet and have low-growing herbaceous vegetation that does not require maintenance for transmission line safety and are located away from towers and access roads. This transmission line is a non-Project power line.

The strategy for reporting the results of this TES plant survey is to treat all of the sites as tentatively harboring some red root yampah so that these sites can be tracked and, ultimately, the identity of the yampah has been positively confirmed at all sites. In addition, for purposes of the relicensing process, PacifiCorp will focus only on the sites that are potentially affected by Project operations and maintenance.

Howell's Yampah

Howell's yampah was found growing in wet meadows and along streambanks. There were nine occurrences documented; four in the study area, three in the Project vicinity, and two that straddle between the first two areas (Figure 5.7-1). Howell's yampah was re-located at three of the four BLM populations; no plants were observed at PEHO-9. The remaining five occurrences were not previously known.

Seven occurrences of Howell's yampah were located in the J.C. Boyle peaking reach, one was in Shovel Creek and the final occurrence was in a small seep at Copco reservoir. The Shovel Creek occurrence consisted of two plants growing in a streamside meadow outside of the riparian fence. When this site was revisited later in the growing season, the vegetation was thoroughly trampled and grazed by cattle and there was no sign of the two plants seen previously. The Copco site is unusual in that the seep that fed this site dried out and the plants had withered before any inflorescences had emerged. The sites in J.C. Boyle peaking reach were all undisturbed when first visited. When revisited later in the summer, Hayden Creek (PEHO-4) and Way Creek (PEHO-5), in particular, had been grazed by cattle. Howell's yampah, while not immune to trampling, does appear to survive in sites that are heavily grazed (perhaps over many years). At Way Creek and Hayden Creek, the plants were trampled, but did not appear to have been grazed. Some plants even produced fruit despite being trampled. The deeply-seated, thick, fibrous roots of this species presumably allow it to survive cattle trampling.

None of the documented occurrences of Howell's yampah appears to be susceptible to Project operations and maintenance except possibly one of the BLM populations at J.C. Boyle reservoir. However, plants at this site were impossible to locate (PEHO-10), so there was no definite assessment of potential impacts near the shoreline of J.C. Boyle reservoir. PEHO-3 and PEHO-2 occurrences are large, healthy populations that grow over long stretches of the Hayden Creek and the creek that drains the meadow at Exclosure Spring, respectively, to within 50 feet (15 m) of the Klamath River. While these sites are close to the river, only large discharges or flood events would reach the Howell's yampah habitat.

Columbia Yellow Cress

Columbia yellow cress is located at the northern end of Keno reservoir (Figure 5.7-1). Columbia yellow cress was growing adjacent to salt heliotrope in a distinct elevation band along the margins of a large drying pool. This population is a new record in the ONHP database; the ONHP data indicate at least four other occurrences of Columbia yellow cress in the general vicinity of Keno reservoir.

This species was found in sites that were shallow ponds early in the growing season. The flooding of these sites occurs as the result of surface runoff pooling in relatively non-porous, low-lying areas. What is unclear is how the reservoir pool might influence the water table level and work in combination with saturated ground and surface runoff early in the growing season to affect the filling and maintenance of the shallow pools.

Columbia yellow cress was found in a drying pond that lies in a large, low-lying portion of a pasture grazed by cattle. At the time of survey, there were relatively few cattle in the pasture and only a few meandering trails of deeply embedded hoof prints through the drying pond. The portion of the pool margin where Columbia yellow cress was growing is somewhat protected by a low dense, turf and had few deep hoof prints. There were no signs that cattle grazed the yellow cress.

Fleshy Sage

Five occurrences of fleshy sage were located in the study area; four at Iron Gate reservoir and one along the Iron Gate-Shasta section (Figure 5.7-1). In the study area, fleshy sage grows on bedrock outcrops with thin, loose, rocky substrate. All sites are well above the high pool level of Iron Gate reservoir or above the road along the Iron Gate-Shasta section. The characteristics of fleshy sage shrubs found at these sites is somewhat ambiguous, with leaves on the same plant having characteristics diagnostic for both varieties of fleshy sage, the rarer *Salvia dorrii* var. *incana* and the more widespread variety, *S. d.* var. *dorrii*.

Fleshy sage habitats in the study area are weathered bedrock outcrops overlain with thin, loose, and rocky substrate. The sparse vegetation cover and steep slopes offer little in the way of forage for cattle although deer browse on the wedgeleaf ceanothus that grows in these sites. All five of the fleshy sage sites are located away from Project facilities making fleshy sage highly unlikely to be affected by Project operations and maintenance activities.

Pendulus Bulrush

Pendulus bulrush was found along streambanks and in wet meadows at three locations: along Fall Creek, in the J.C. Boyle peaking reach, and in the meadows along Way Creek (Figure 5.7-1). There were no pendulus bulrush occurrences previously known from the study area.

One pendulus bulrush (SCPE-3) occurrence potentially is affected by the hydrology of the J.C. Boyle peaking reach (see discussion on red root yampah above). Cattle grazing was observed at the other pendulus bulrush locations, but the bulrush appeared unaffected and stood out among the surrounding cropped vegetation.

Lemmon's Silene

All three occurrences of Lemmon's silene are recorded in the BLM database. Two of the three locations were revisited. However, the silene observed had wide, campanulate involucres and the simple, branched inflorescences, which suggest some plants in these locations might be campanulate catchfly. Despite the presence of quality habitat and repeated attempts to locate this species, no specimens of *Silene* were found at the BLM campground in the J.C. Boyle peaking reach.

The habitat at the three locations where the BLM has mapped Lemmon's silene is relatively undisturbed oak- and conifer-dominated forest, even though various land-disturbing activities, such as cattle grazing and recreation, occur nearby. The locations mapped by the BLM are located away from Project facilities and are unlikely to be affected by Project operations and maintenance.

Short-Podded Thelypodium

Short-podded thelypodium was found growing in low-lying saltgrass grassland with some gray rabbitbrush and along the margins of partially vegetated seasonally wet depressions. The three occurrences of this species are located at Keno reservoir (Figure 5.7-1). One occurrence of short-podded thelypodium was growing with Applegate's milkvetch and another with salt heliotrope.

As discussed above for Applegate's milkvetch, salt heliotrope, and Columbia yellow cress at Keno reservoir, it is unclear how the Keno pool level affects occurrences of short-podded thelypodium. One of the three short-podded thelypodium sites (THBR-3) had cattle grazing nearby and there was some ground disturbance as a result of trampling. However, none of the thelypodium appeared to be grazed, although a few plants had broken stems and crushed leaves.

5.7.2 Wildlife

Of the 107 vertebrate TES species originally identified as potentially occurring in the Project vicinity, 47 were detected during terrestrial wildlife field studies associated with relicensing. TES wildlife species detected include one amphibian, five reptiles, 39 birds, and two mammals. Only two of these, the bald eagle and northern spotted owl, are federally listed as threatened or endangered. An additional 16 TES wildlife species have historic records or previous detections in the study area. Table 5A-6 (in Appendix 5A) shows all vertebrate TES species detected during relicensing field studies by Project section and survey methodology. Figure 5.7-2 and associated Table 5A-7 (in Appendix 5A) show the location of all vertebrate TES species detections documented during relicensing field studies (excluding nest site location information, which per TRWG request, will remain confidential).

The following sections provide summaries of TES species detections.

Figure 5.7-2. 2002 TES wildlife state and federal observations.

(pg 1 of 3)

11x17 front

(pg 1 of 3)

11x17 back

Figure 5.7-2

(pg 2 of 3)

11x17 front

(pg 2 of 3)

11x17 back

Figure 5.7-2

(pg 3 of 3)

11x17 front

(pg 3 of 3)

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5.7.2.1 Amphibians

The western toad was the only potentially occurring amphibian TES species (Table 5A-3 in Appendix 5A) that was detected during relicensing field studies. In addition to the targeted amphibian surveys conducted as part of relicensing described in Section 5.4, no TES amphibian species were detected during the following:

- At a total of 18 aquatic sites surveyed by BLM biologists up to three times each during spring and summer of 2001
- In any of the 149 wildlife survey plots during amphibian searches conducted after avian plot surveys
- During 2002 electroshocking fish surveys conducted in Fall Creek, Spencer Creek, the Copco bypass, the Link River, and in the mainstem Klamath River in Keno Canyon, the J.C. Boyle bypass, and the J.C. Boyle peaking reach.

The following sections discuss TES amphibian species occurrence in the Project vicinity.

California Tiger Salamander

No California tiger salamanders were detected in the study area during relicensing field studies. In California, where the species has protected status, the range of the California tiger salamander generally is restricted to areas south of Butte County (CDFG website). However, in the United States, the range of the tiger salamander extends throughout suitable habitat north to the Canadian border. Little suitable habitat is available for the species in Oregon and only two isolated populations exist in the state—one of which is reportedly located south of Klamath Falls adjacent to the California border in Klamath County (Leonard et al. 1993). The California tiger salamander is a lowland species restricted to grasslands and lowland aquatic sites that constitute suitable breeding habitat for the species (Stebbins, 1985; Zeiner et al. 1988; Shaffer and Stanley, 1992). Presence of this species in the California portion of the study area is highly unlikely because there is little suitable habitat and the study area is outside of the known range of the species in California.

Southern Torrent Salamander

No southern torrent salamanders were detected in the study area during field studies. In general, southern torrent salamanders occur in moist forest environments west of, and including, the Coast Range Mountains from Mendocino County, California, north through central Oregon (Leonard et al. 1993; CDFG website). In the general vicinity of the study area, the species' known range includes only the far western portions of Siskiyou County, and west of Cave Junction, in Curry and Josephine counties, Oregon (CDFG website). Without suitably mesic forest habitat or a nearby population for recruitment, this species is unlikely to occur in the study area.

Del Norte Salamander

No Del Norte salamanders were detected in the study area during relicensing field studies. The range of the Del Norte salamander extends west of I-5 in the Siskiyou and Coast Range Mountains of northwestern California and southwestern Oregon (Leonard et al. 1993; CDFG website). Portions of the study area along the Iron Gate-Shasta section exist west of I-5 along the eastern edge of the Siskiyou Mountains. However, the study area generally lies outside of the range of this species and the mesic, forested habitat capable of supporting Del Norte populations is not contiguous with the Iron Gate-Shasta section.

Siskiyou Mountains Salamander

No Siskiyou mountains salamanders were detected in the study area during relicensing field studies. Siskiyou Mountains salamanders are endemic to a range that includes only 145 square miles (375 square km) in Jackson County, Oregon, and northern Siskiyou County, California (Leonard et al. 1993). The majority of the species population exists in the upper Applegate River drainage of Jackson County, Oregon (Leonard et al. 1993). This localized range is located west of the study area and the species is not likely to occur in the Project vicinity.

Clouded Salamander

No clouded salamanders were detected in the study area during relicensing field studies. Clouded salamanders, which have protected status in Oregon, occur from the Coast Range of Sonoma County, California, through the Siskiyou, Coast Range and western Cascade Mountains of Oregon (Leonard et al. 1993). Generally, the species is found in mesic coniferous forests with old growth characteristics (Leonard et al. 1993). Because no such suitable habitat exists in the study area and the Project lies east of the species' known range, clouded salamanders are unlikely to occur in the Project vicinity.

Tailed Frog

No tailed frogs were detected in the study area during relicensing field studies. In general, tailed frogs occur in higher elevation mesic forests around cool, permanent streams in the Coast Range and Cascade Mountains from northern California to British Columbia (Leonard et al. 1993; CDFG website). This range exists outside the study area and this species is not likely to occur in the Project vicinity. Tailed frogs are known to occur in some tributaries of the Klamath River (e.g., Jenny Creek, Spencer Creek), but only at higher elevations well outside of the study area. The foothill yellow-legged frog surveys conducted on Cottonwood, Bogus, Willow, Jenny, and Frain creeks and the J.C. Boyle bypass reach would have been effective at detecting this species, as would the instream survey conducted on the diverted portion of Fall Creek. It is unlikely that tailed frogs occur in the study area.

Western Toad

During the 2002 field season, two western toad breeding sites were located in the Project vicinity: one along the northern shoreline of Iron Gate reservoir and one in seasonally inundated annual grassland along Way Creek above the J.C. Boyle peaking reach. Both of these sites were located during pond-breeding amphibian surveys.

The Iron Gate site located immediately southwest of the mouth of Scotch Creek had 14 adult western toads present on April 1, 2002, including one breeding pair in amplexus (Figure 5.7-2; Table 5A-7 in Appendix 5A). Numerous egg strings also were observed at this site. A second survey of the site was conducted on April 25, 2002, after the water level in the reservoir had dropped approximately 2 feet (0.6 m). During this second survey, toad egg strings located along the previous high-water mark were found desiccated with no eggs visible. Two adults and a few egg strings were found in the water at the lower pool level. Shortly after the second visit, the reservoir level was raised back to full pool. The site was revisited on May 10, 2002, and no western toad adults, tadpoles, or eggs were observed.

The Iron Gate reservoir breeding site was monitored throughout the 2003 field season. Numerous (more than 100) western toad egg strings were observed at the site in the early spring of 2003. Subsequent visits to the site confirmed successful hatching and dispersal of metamorphosed juvenile toads from the site.

The second location confirmed in 2002 to support breeding western toads was located in a wet depression hydrologically associated with Way Creek adjacent to the Topsy Road just outside of the Klamath Canyon in the J.C. Boyle peaking reach. This site was not revisited so the status of breeding could not be confirmed. However, it appears that off-road vehicular traffic may adversely affect the habitat and water quality.

Additional adult western toad detections recorded by PacifiCorp in 2002 include five adult western toads observed incidental to other field studies in polygon 1794 on March 29, 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A); and, an incidental observation of a western toad adult recorded June 21, 2002, in polygon 1073 during a terrestrial reptile surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A). In addition, BLM biologists documented the species on April 27, 2001, during surveys at Way Creek, which flows into the J.C. Boyle peaking reach (Figure 5.7-2; Table 5A-7 in Appendix 5A).

Four additional locations were identified in 2003 as supporting breeding western toads in the Klamath study area. These sites were identified during 2003 isolated wetland/spring surveys and foothill yellow-legged frog surveys. In addition to the Iron Gate shoreline and Way Creek sites, evidence of western toad breeding was detected during 2003 in Willow Creek, at the Long Prairie stock pond, in Cottonwood Creek upstream from the mainstem Klamath River, and in an irrigation ditch/wetland complex located across the river and approximately 0.5 mile (0.8 km) downstream of the Oregon-California border. At Cottonwood Creek, 40 western toad tadpoles were found in the section of creek that had been partially excavated on May 27, 2003, and three tadpoles were found at the same site on June 12, 2003, during foothill yellow-legged frog surveys. Approximately 1,000 to 2,000 western toad tadpoles were seen in the irrigation ditch/wetland complex off the road to Hoover Ranch on June 24, 2003, during isolated wetland/spring surveys. On May 27,2003, during foothill yellow-legged frog surveys in Willow Creek one adult and one western toad tadpole were found. During a revisit of the site, at least several hundred tadpoles were found in the same general area. On April 22, 2003, during isolated wetland/spring surveys, five western toad egg string remnants were found in the Long Prairie stock pond. Additional information on western toad detections in the Klamath study area can be found in Section 4.7.

Northern and California Red-Legged Frog

No red-legged frogs were detected in the study area during relicensing field studies. Red-legged frogs typically occur west of the Coast Range along the Pacific Coast from California to British Columbia (Leonard et al. 1993; CDFG website). Suitable habitat for the species includes moist coniferous or deciduous forests and forested wetlands associated with aquatic sites with clear, cool water (Corkran and Thoms, 1996). Extreme temperature fluctuations in the study area water bodies likely prevent the potential for occurrence of this species in the Project vicinity. In addition, the study area lies east of the known range of red-legged frogs. No critical habitat for the California red-legged frog occurs in the vicinity (Federal Register, March 13, 2001, Vol. 66, No. 49).

Cascades Frog

No Cascades frogs were detected in the study area during relicensing field studies. The known range of the Cascades frog extends as isolated, non-contiguous patches along the Cascade mountain corridor to the Sierra Nevada Mountains in California (Corkran and Thoms, 1996; CDFG website). No populations are known to exist in the immediate Project vicinity. The absence of suitable habitat, typically small pools and streams in sub-alpine meadows (Leonard et al. 1993), likely limits the potential for this species to occur in the study area.

Oregon Spotted Frog

No Oregon spotted frogs were detected in the study area during specific targeted spotted frog surveys conducted in 2003 or during any field studies conducted as part of Klamath relicensing (Section 4.0, Table 4.7-12). Three separate spotted frog surveys were conducted in April and June 2003 at four locations identified by federal wildlife resource agencies and local species experts as having the most suitable habitat for the species in the Project vicinity. Although the species is assumed to have the potential for occurrence in suitable habitat located in the general Project region, a lack of detections recorded during the surveys confirms that spotted frog occurrence in or around the Klamath study area is highly unlikely. Additional information on spotted frog surveys is provided in Section 4.7.

Spotted frogs are thought to be one of the most widely distributed frog species in the western United States (CDFG website), although the species' presumed sporadic range is based on relatively few documented occurrences. Currently, the species' range includes the northern portion of the study area (Leonard et al. 1993). The species' known range in California is based on only seven records from five separate sites (CDFG website), and spotted frogs are now believed to be extirpated from many portions of their historic range in Oregon and the Pacific Northwest (Leonard et al. 1993). Spotted frogs occur in upper Spencer Creek approximately 9.0 miles (14.5 km) upstream from its mouth at the J.C. Boyle reservoir (Hayes, 1997). In addition, a known population of spotted frogs exists in wetlands associated with the Wood River near Klamath Falls (Pearl, pers. comm., 2003).

Foothill Yellow-Legged Frog

No foothill yellow-legged frogs were detected in the study area during relicensing field studies (Section 4.0, Table 4.7-13). Targeted surveys for the foothill yellow-legged frog were conducted at ten locations determined to be most suitable for species occurrence (Section 4.0, Figure 4.4-1). Foothill yellow-legged frog survey sites each were surveyed four times during the 2003 field season: twice in May and one time each in June and September (Section 4.0, Table 4.7-13).

Historically, the foothill yellow-legged frog was known to occur in most Pacific drainages from the Santiam River system in Oregon (Mehama, Marion County) to the San Gabriel River system (Los Angeles County) in California (CDFG website). Historic detections of foothill yellow-legged frogs in the Project region reveal past occurrence in the following locations: Shoat Springs, which appears to be near Spring Creek, a tributary of Jenny Creek, which drains to Iron Gate reservoir; the mainstem Klamath river in the J.C. Boyle bypass; Cottonwood Creek off the Iron Gate-Shasta section; and Little Bogus Creek (Borisenko and Hayes, 1999; A. Linde, unpublished data). It is presumed that habitat along the mainstem Klamath River has been altered to the degree that the species no longer occupies historical sites (Borisenko and Hayes, 1999). Thorough survey of sites most likely to support foothill yellow-legged frogs in the Project vicinity support the observation of Borisenko and Hayes (1999) that the Klamath River probably does not support this species.

5.7.2.2 Reptiles

Five TES reptile species originally were identified as potentially occurring in the study area (Table 5A-3 in Appendix 5A). Four of these species (northwestern pond turtle, northern sagebrush lizard, common kingsnake, and California mountain kingsnake) were detected during relicensing field studies (Table 5A-6 in Appendix 5A). All five of the potentially occurring TES reptile species (including the sharptail snake) were detected during BLM reptile and amphibian field studies conducted in the Project vicinity during 2000 and 2001 (Roninger, 2001) (Figure 5.7-2; Table 5A-7 in Appendix 5A).

In 2002, terrestrial reptile surveys were conducted in 139 of the 149 wildlife survey plots. TES reptile species were detected in three of these plots. Two TES reptile species (northern sagebrush lizard and northwestern pond turtle) were observed during terrestrial reptile surveys. One TES reptile species (northwestern pond turtle) was recorded during facility surveys. Three TES reptile species were detected incidental to other field studies (California mountain kingsnake, common kingsnake, and northern sagebrush lizard). Table 5A-6 (in Appendix 5A) provides data on Project location and methodology associated with all TES reptile species detections resulting from 2002 targeted terrestrial reptile surveys. The following sections provide specific information on detections, occurrence, and distribution for all TES reptile species.

Northwestern Pond Turtle

A minimum of 600 northwestern pond turtle detections were recorded during relicensing field studies including 523 detections recorded during targeted pond turtle surveys; 24 detections recorded during terrestrial reptile surveys in wildlife survey plots; five detections noted around Keno reservoir during facility surveys; and at least 85 observations incidental to other field studies throughout the study area. In addition, BLM documented 67 pond turtle detections in the

Oregon portion of the J.C. Boyle peaking reach during amphibian and reptile field studies in 2000 and 2001 (BLM unpublished data).

In general, northwestern pond turtles have a potential for occurrence in suitable habitat throughout the study area. The species' range in southern Oregon and northern California encompasses the entirety of Project facilities, water bodies. and associated tributaries, and western pond turtles can occur along the Pacific from Baja, California, north to Washington State (Csuti et al. 1997; Brown et al. 1995). Suitable pond turtle habitat includes permanent and intermittent waters associated with marshes, streams, rivers, ponds, and lakes and they tend to favor sites with emergent logs, boulders, and shoreline edges for basking (Csuti et al. 1997; Brown et al. 1995). Pond turtles have been found in the study area in a variety of aquatic habitats and are common-to-abundant in many Project reservoirs and river reaches (see Section 4.0). Section 4.7.1.5 provides detailed information and analysis on all pond turtle detections recorded as part of relicensing studies as well as historic records and literature pertaining to the occurrence of the species in the Project vicinity. Suitable nesting habitat occurs throughout most of the reservoir and river reaches (Section 4.0, Figure 4.7-1).

The Project reservoirs, especially Keno reservoir, provide abundant pond turtle habitat. The daily fluctuation at J.C. Boyle reservoir and in the J.C. Boyle peaking reach may affect turtle access to riparian and wetland habitat and basking structures when water levels are low.

Northern Sagebrush Lizard

PacifiCorp recorded 25 northern sagebrush lizard detections during relicensing field studies. Three detections were recorded during 2002 terrestrial reptile surveys in the wildlife survey plots (two in Iron Gate reservoir section and one in Keno Canyon section). Incidental detections were recorded at the lower Fall Creek falls, the J.C. Boyle canal during small mammal trapping transects; along the J.C. Boyle peaking reach; and other locations (Figure 5.7-2; Table 5A-7 in Appendix 5A). In addition, BLM biologists recorded 14 northern sagebrush detections during surveys conducted in 2000 and 2001 (Roninger, 2001). The BLM records were detected near an isolated pond and associated grassland area located near the confluence of Topsy and Picard Roads, well above the Klamath River (Roninger, 2001).

Northern sagebrush lizards range throughout southern Oregon and northern California, with potential for occurrence in suitable habitat south through northern Baja, California (Csuti et al. 1997; Brown et al. 1995). The species is associated with sagebrush plains, but can be found in a variety of desert shrubland and arid forest habitat with dense low-lying brush cover (Brown et al. 1995). The study area falls well within the species' range and suitable sagebrush lizard habitat is available in all Project sections. St. John (1987) confirmed several populations in or near the J.C. Boyle canal, and J.C. Boyle peaking reach segments.

Sharptail Snake

No sharptail snakes were detected in the study area during 2002 targeted terrestrial reptile surveys, or during any other PacifiCorp relicensing field studies. However, the species was detected in the upper J.C. Boyle peaking reach during BLM surveys in the spring of 2001 (Roninger, 2001). As with most of the hard-to-detect TES reptile species, little is definitively known about the sharptail snake's occurrence and distribution in the Project vicinity. Based on observations west of the study area, the species was previously thought to have a limited range restricted primarily to the Coast Range corridor (Csuti et al. 1997; Brown et al. 1995; Nussbaum et al. 1983). The single BLM detection indicates that the species ranges east into Klamath County, and sharptail snakes occur in suitably moist habitats that may occur in the study area (Csuti et al. 1997).

Common Kingsnake

Four incidental detections of the common kingsnake were recorded during relicensing field studies conducted in 2002 and 2003. All four detections were noted on Copco Road; one on the eastern part of Iron Gate reservoir section, another on the road in the Iron Gate-Shasta section, and the other two just east of the Fall Creek fish hatchery near the old lava flow. All observations were associated with oak/woodland or chaparral habitat. BLM studies documented eight detections of the species in the Oregon portion of the J.C. Boyle peaking reach section (Roninger, 2001). Also, an unconfirmed sighting was reported by the PacifiCorp grazing tenant near the Klamath River at the Beswick Ranch.

Common kingsnakes are relatively wide-ranging in California, but have been reported to occur in Oregon only within the inland valleys of Douglas, Jackson, and Josephine counties (Csuti et al. 1997; Brown et al. 1995; Nussbaum et al. 1983), which lie generally west of the study area. However, BLM reptile and amphibian survey results indicate this species is likely far more wide-ranging in the Project vicinity and likely occurs wherever suitable habitat conditions exist. The species is a relative habitat generalist in comparison to other potentially occurring TES reptiles, but common kingsnakes are thought to be specifically associated with moist river valleys and dense riparian vegetation (Brown et al. 1995; Nussbaum et al. 1983).

California Mountain Kingsnake

One incidental California mountain kingsnake detection was recorded along Copco Road west of the turn-off to Copco No. 1 village in 2002, and a California mountain kingsnake was observed along a small mammal trapping transect located along the J.C. Boyle canal in 2003. In addition, BLM biologists recorded five detections of the species in the upstream end of the J.C. Boyle peaking reach (Roninger, 2001). St. John (1987) reported one detection near the Way Ranch.

California mountain kingsnakes range in the western United States from Baja California to southern Washington State (Brown et al. 1995). In Oregon and northern California, the species' distribution is highly restricted with a limited range centered in the southwestern portion of Oregon, specifically, western Klamath County, and a narrow corridor along the Sierra Nevada Mountains (Brown et al. 1995). In interior California mountain ranges, the species is associated with moist Ponderosa pine and black oak forests, while in lowland areas mountain kingsnakes are thought to be found below the edge of mixed oak coniferous forest in riparian woodlands, usually in canyon bottoms (CDFG website). The species may be associated with isolated riparian woodlands in chaparral and sagebrush or rocky outcrops, which appear to be an important habitat feature (McGurty, 1988). California mountain kingsnakes are likely to occur in the study area where suitable habitat conditions exist.

5.7.2.3 Birds

The following sections provide data and analysis on avian TES species detections recorded in the Project vicinity. Sixty-seven avian TES species originally were identified as potentially occurring within the study area (Table 5A-3 in Appendix 5A). Thirty-nine of these potentially occurring avian TES species were detected during relicensing field studies with a total of more than 2,000 individual detections (Figure 5.7-2; Table 5A-7 in Appendix 5A). Table 5A-8 (in Appendix 5A) provides information on all avian TES species detected in 2002 including associated Project section and survey methodology.

The large majority of avian TES species detections was recorded during 2002 avian plot surveys. Avian plot surveys accounted for 1,168 avian TES species detections with 29 distinct avian species. Overall, at least one avian TES species was detected in 134 of the 149 avian survey plots; avian TES species were detected in 100 plots in May 2002 and 121 plots in June 2002. Avian TES species detections recorded during avian plot surveys resulted in an average of 4.08 avian TES species detections per plot survey (SD 7.24) with TES avian species recorded within all 11 Project sections.

In addition to avian plot surveys, avian TES species detections were recorded during the following activities: facility surveys; reservoir surveys; ROI surveys and mist-netting; avian species protocol surveys, including spotted owl, goshawk, and great gray owl broadcast call surveys; and incidental to other field studies. A total of 190 avian TES detections was recorded during facility surveys (13 species detected): 950 during reservoir surveys (12 species detected), with avian TES species noted on each of the four Project reservoirs; a combined 42 documented during protocol surveys including 24 and 118 detections recorded during northern goshawk (five species detected) and spotted owl/great gray owl (five species detected) nocturnal broadcast call surveys; and 17 individual avian TES species detected during ROI surveys. Furthermore, incidental detections, excluding common or repeated sightings of the same species or individual in a single localized area, account for at least 50 of all avian TES detections recorded in during relicensing field studies.

The following sections provide data on detections for all potentially occurring avian TES species. Relative abundance data (detections per survey) are provided for those species detected during avian plot and facility surveys (Table 5A-8 in Appendix 5A). Some additional habitat relationships are further explored in Section 3.0.

<u>Common Loon</u>

Two common loon detections were recorded during relicensing field studies (Figure 5.7-2; Table 5A-7 in Appendix 5A). One loon was detected on Iron Gate reservoir during reservoir surveys in April 2002 and another was detected on Iron Gate reservoir during May 2002 plot surveys. This species is not known to breed in the Project vicinity or over-winter in large numbers in the study area. However, individuals occasionally may over-winter on Project reservoirs or occur in aquatic habitat associated with large bodies of water (i.e., Project reservoirs) as they migrate from sub-arctic freshwater breeding grounds to coastal and near-shore pelagic marine habitat along the Pacific coast. Loons are considered rare during spring and fall at the Klamath Wildlife Area (ODFW Wildlife checklist of the Klamath Wildlife Area, Miller Island Unit).

Horned Grebe

No horned grebes were detected in the study area during relicensing field studies. Although historically the species was not known to breed in the Project vicinity, relatively recently (1958) horned grebes were detected breeding in a few isolated marshes and water bodies in southern Oregon east of the Siskiyou Mountains (Csuti et al. 1997). The species is now known to breed on Upper Klamath Lake (Csuti et al. 1997) and is likely to have an uncommon occurrence on water bodies throughout the study area. It is an occasional fall visitor to the Klamath Wildlife Area. (ODFW)

Red-Necked Grebe

No red-necked grebes were detected in the study area during relicensing field studies. Typically, red-necked grebes breed in sub-arctic inland areas on freshwater bodies and migrate to coastal marine habitats to over-winter (National Geographic Society, 1999; Csuti et al. 1997). However, an isolated population, estimated at fewer than 50 individuals in 1989, has been known to breed on Upper Klamath Lake since at least 1945 and the species recently (1993) began breeding in the Malheur National Wildlife Refuge (Csuti et al. 1997). As these populations are notably localized and restricted in their distribution and regional movements, it is unlikely that red-necked grebes currently occur in the study area with any regularity. However, documented nesting habitat seems to be expanding for red-necked grebes in the Project region, and Project reservoirs and associated aquatic habitat represent suitable habitat for the species. This species is not listed as occurring at the Klamath Wildlife Area along Keno reservoir.

American White Pelican

During general wildlife plot, facility and reservoir surveys, 837 American white pelican detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). This included 331 detections recorded during plot surveys, 82 facility survey detections, and 424 detections noted during reservoir surveys (Table 5A-9 in Appendix 5A). In addition, white pelicans were detected during ROI censuses conducted along the Link River and Copco reservoir. Most pelicans were detected on Project reservoirs (Table 5A-9 in Appendix 5A; Table 7A-6 in Appendix 7A); the highest number of detections (331) for this species was associated with Keno reservoir.

The 331 American white pelican detections recorded during plot surveys constituted the most avian TES species detections (Table 5A-9 in Appendix 5A) and the third highest number of individual detections across all avian species documented in the summer during relicensing field studies (Appendix 5F). Pelican relative abundance per survey was found to be highest along Keno reservoir and the Link River (6.09 and 4.06 birds per survey, respectively). These relative abundance values likely reflect the large, dispersed flocks of pelicans using these Project sections. The relative abundance of American white pelicans at J.C. Boyle and Iron Gate reservoirs was found to be 1.40 birds per survey at each site, reflecting the consistently smaller flocks (between ten and 60 individuals) detected at these two reservoirs. Only one pelican was observed during the January, February, and March 2003 reservoir surveys. In addition to using reservoirs, this species also occurs along the J.C. Boyle bypass and Keno Canyon reaches.

American white pelicans occur year-round in the Project vicinity and are likely to be found in aquatic habitat throughout the study area. However, American white pelicans have a restricted range in southern Oregon and along the California border, where they are found to be associated with only a few large bodies of inland water (Csuti et al. 1997; CDFG website). Csuti et al. (1997) report the existence of only two isolated breeding colonies in Oregon: an Upper Klamath Lake population and a breeding population at Malheur Lake. Although suitable breeding habitat for the species occurs throughout the study area, individuals occurring in the Project vicinity are likely either non-breeding birds or are associated with Upper Klamath Lake breeding populations because American white pelicans are known to travel up to 60 miles (96.6 km) to feed (Csuti et al. 1997).

Western Least Bittern

No western least bitterns were detected in the study area during relicensing field studies. This species is rarely seen and has a limited distribution in the Pacific states north of the Sacramento Valley (CDFG website; National Geographic Society, 1999). In southern Oregon, near the study area, the species is extremely rare and only six records of the species have been reported in the state since 1981 (Csuti et al. 1997). However, suitable habitat of freshwater cattail and bulrush marshes exists at several locations in the study area and the species is known to have historically occurred in Upper Klamath Lake and downstream (Csuti et al. 1997). It is a rare summer-fall visitor to the Klamath Wildlife Area.

Black-Crowned Night Heron

During general wildlife plot and facility surveys in 2002, 36 black-crowned night heron detections were recorded (Table 5A-10 in Appendix 5A). In addition, two incidental detections for the species were recorded during the fall (November 2002) in the Iron Gate-Shasta section during riparian sampling. Black-crowned night herons also were detected during ROIs. Of the five Project sections in which ROIs were conducted (Iron Gate reservoir, Iron Gate-Shasta section, Link River, J.C. Boyle peaking bypass, Copco reservoir), night herons were detected around the Iron Gate-Shasta section and Link River. Night herons were detected during ROI-associated censuses only and were not captured for banding.

Keno Canyon had the highest relative abundance of night herons (Table 5A-8 in Appendix 5A). On average, the relative abundance of black-crowned night herons across the three Project sections in which they were detected was 0.50 bird per survey in Keno Canyon, 0.39 bird per survey at Keno reservoir, and 0.39 bird per survey along the Link River. Overall, night heron relative abundance was found to be 0.09 bird per survey Project-wide, which constituted the ninth most common TES bird species detected during avian plot surveys. There is a communal roost used by night herons and other heron species in a group of willow trees near the East Side powerhouse adjacent to the Link River. Black-crowned night herons commonly occur in a variety of freshwater aquatic habitat throughout the Project vicinity (Csuti et al. 1997). The species' habit of roosting throughout the day and feeding typically during the crepuscular hours (dusk and dawn) often makes it difficult to detect. However, suitable night heron breeding and foraging habitat exists in association with all Project reservoirs and the species is may occur in the study area year-round. Large numbers of night herons can been seen foraging at the upper end of the Link River throughout the year.

Snowy Egret

Five snowy egret detections were recorded during general wildlife plot and facility surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A): three birds were detected near Keno dam during a June facility survey; one detection was recorded in Keno Canyon during a June 2002 plot survey; and one detection was recorded during a June 2002 facility survey near the Link River dam. In addition, the species was detected during ROI censuses along the Link River.

Southern Oregon and the region along the Oregon and California border comprise the northern limits of the snowy egret's range (Csuti et al. 1997). Like most wading birds, the snowy egret is a species associated with freshwater marshes and the emergent wetland areas existing along the periphery of large water bodies (Ehrlich et al. 1988). However, in southern Oregon the species' occurrence is sporadic and Oregon State populations have fluctuated in size from zero to several hundred breeding pairs (Csuti et al. 1997). Suitable breeding habitat exists along Project reservoirs and in wetland habitat throughout the study area. It is most likely that the species occurs, at least in small numbers, along the Klamath River and its tributaries downstream of Klamath Lake during the summer breeding season.

Great Egret

Eighty-five great egret detections were recorded during relicensing field surveys including: 52 recorded during avian plot surveys, 15 during facility surveys, and 18 detected during reservoir surveys (Table 5A-11 in Appendix 5A). In addition, the species was detected during an ROI census along the Link River and one great egret detection was recorded in the Keno Canyon incidental to amphibian surveys in April 2002. Nearly half of the total detections (41) were recorded at the Link River (Table 5A-11 in Appendix 5A), where a significant amount of suitable emergent wetland foraging habitat exists. Large numbers of great egret detections also were recorded along Keno reservoir and in Keno Canyon with 21 and 18 detections recorded in each Project section, respectively. Notably, no great egrets were detected in six of the 11 Project sections including Copco and Iron Gate reservoirs, where relatively large amounts of open water and peripheral wetland habitat exists. Most observations were in riverine habitat where great egrets were observed foraging.

As indicated in Table 5A-8 (in Appendix 5A), on average, the highest relative abundance of great egrets (1.72 birds per survey) occurred around the Link River. This is consistent with the trend suggested by the total counts of great egret detections. Although the second largest number of great egret detections (21) was recorded along Keno reservoir, this Project section accounted for only the third highest relative abundance of great egrets per survey recorded during plot surveys (0.17 bird per survey). In terms of relative abundance, great egrets were more abundant in J.C. Boyle reservoir than implied by the raw total counts. The relative abundance of great egrets per survey in the J.C. Boyle reservoir (0.15 bird per survey) is similar to the relative abundance values for the species found in Keno reservoir.

In the Pacific States, great egrets range north to Washington State (National Geographic Society, 1999). The largest breeding colony of great egrets in Oregon occurs at Malheur National Wildlife Refuge, but the species is known to breed throughout the Klamath basin and may remain year-round in breeding areas during mild winters (Csuti et al. 1997). This species is a common spring-fall visitor to the Klamath Wildlife Area. Great egrets are likely to occur in suitable freshwater marshland habitat associated with the river and Project reservoirs throughout the year.

White-Faced Ibis

Twenty white-faced ibis detections were recorded during relicensing field studies. Detections included three birds recorded during June 2002 plot surveys along the J.C. Boyle reservoir, and seven birds detected during an April 2002 reservoir survey along the Link River, as well as an incidental sighting of approximately ten birds flying over the Keno reservoir in 2003. The three birds detected during 2002 plot surveys resulted in a relative abundance of 0.15 ibis per survey in the J.C. Boyle reservoir section, and an overall relative abundance of 0.01 ibis per plot survey across all Project sections (Table 5A-8 in Appendix 5A). These relatively limited results for the species may, in fact, provide an accurate assessment of ibis distribution in the Project vicinity: white-faced ibis likely occur in the study area with a consistent though uncommon and isolated distribution in localized areas. Ibises breed in freshwater marshes and lakes, and estuaries, and nest near the water on mats of vegetation and twigs (Ehrlich et al.1988). The species usually occurs in isolated con-specific flocks (Csuti et al. 1997). Ibis typically do not overwinter in Oregon (Csuti et al. 1997). This species is a fairly common spring-summer visitor in the Klamath Wildlife Area. The species may have a sporadic occurrence in the Project vicinity in suitable freshwater marshland habitat during the summer breeding season.

Harlequin Duck

No harlequin ducks were detected in the study area during relicensing field studies and the species is not likely to occur in the Project vicinity. There is one 1958 record of a harlequin duck at the Link River (Campos, per. comm., 1998). Typically, Harlequin ducks breed along high-elevation mountain streams and winter along rocky marine shorelines (Csuti et al. 1997). Approximately 100 breeding pairs are thought to occur in Oregon with suitable nesting habitat confined to the Cascade Mountains (Csuti et al. 1997). No suitable breeding or winter habitat for the species exists in the Project vicinity although the species occasionally could occur as a vagrant in transition from breeding to wintering areas.

Barrow's Goldeneye

Forty-two Barrow's goldeneye were recorded during the winter and spring 2002 and 2003 relicensing field studies. One Barrow's goldeneye was observed incidental to other surveys in an inundated drainage ditch off of Copco reservoir during summer 2002. A total of 41 Barrow's goldeneye were observed during reservoir surveys in the winter of 2002-2003 (Figure 5.7-2; Table 5A-7 in Appendix 5A; Table 7A-5 in Appendix 7A). Of the 41 individuals detected during reservoir surveys, 40 were observed on Keno reservoir and one on Iron Gate reservoir. The species was not detected during general wildlife plot surveys. Most (35) observations were at Keno reservoir during the February 2003 reservoir survey.

Distribution of the species in Oregon is similar to that of the harlequin duck. Barrow's goldeneye tends to breed along high-elevation mountain lakes and winter in coastal areas (Ehrlich et al. 1988). However, small numbers of goldeneye occasionally winter in the Klamath basin (Csuti et al. 1997). Vagrants, occasional over-wintering birds, and migrating stragglers may occur sporadically in various aquatic habitats throughout the study area. It is considered an uncommon fall-winter visitor to the Klamath Wildlife Area.

Bufflehead

More than 225 bufflehead detections were recorded during relicensing field studies. Detections include: two birds noted during 2002 plot surveys around Keno reservoir; one bird recorded during a plot survey along Copco reservoir; 222 birds detected during reservoir surveys; and numerous incidental sightings throughout 2003. Reservoir survey detections of bufflehead included 43 birds detected along the Link River during an April 2002 reservoir survey; 42 detections recorded at Copco reservoir; 17 detections recorded at Iron Gate reservoir; and 106 detections recorded at Keno reservoir. Of the total 225 detections, 222 were seen during reservoir surveys between January and April of 2002. These results emphasize that bufflehead is a common wintering species throughout the study area, and that there are very few year-round residents.

Bufflehead are cavity nesters and typically breed around isolated mountain lakes (Csuti et al. 1997). However, the species often uses artificial nest boxes and may show plasticity in choice of suitable nesting habitat (Ehrlich et al. 1988). After the breeding season, bufflehead may be found in open water and riverine habitat throughout southern Oregon (Csuti et al. 1997).

Golden Eagle

Golden eagles were sighted repeatedly in localized areas in the study area during 2002 and 2003—especially in the lower Project reaches of the J.C. Boyle peaking reach and along Copco and Iron Gate reservoirs. Two golden eagle detections were recorded during 2002 wildlife plot and facility surveys: one along Iron Gate reservoir in May; and one during a facility survey around the J.C. Boyle powerhouse in June. Incidental golden eagle detections included: one at Copco reservoir in April 2002; one in the Copco bypass in April 2002; three in the J.C. Boyle peaking reach in April 2002; two along the J.C. Boyle peaking reach in November 2002; and, one incidental sighting in the Copco No. 2 bypass in February 2003.

No golden eagle nests were located during field studies. There are historical records of several golden eagle nests located on cliffs from Iron Gate reservoir to the J.C. Boyle bypass. However, none of the reported nests is within 1 mile (0.6 km) of any Project facilities. BLM biologists monitor breeding raptors in the Oregon portion of the J.C. Boyle peaking and J.C. Boyle bypass reaches and report that no known golden eagle nest sites exist in that portion of the study area (Kellum, pers. comm., 2003). Natural densities for this species in southern Oregon and northern California are low (CDFG website).

Golden eagles breed in open mountain and hill habitats, and nests of interwoven sticks are used alternately, becoming very large because eagles use two to three nests during a lifetime (Ehrlich et al. 1988). In the western United States, golden eagles are likely to occupy territories year-round (Ehrlich et al. 1988). There have been several golden eagle mortalities documented on non-Project electrical lines or poles in the study area, but none from Project lines. PacifiCorp monitors bird electrocutions and continues to rectify problem poles and structures (Section 6.0).

Bald Eagle

A minimum of 39 bald eagle detections were recorded during relicensing field surveys including 37 detected during targeted avian surveys in 2002. Twenty-nine of these detections were recorded during 2002 general wildlife plot and facility surveys. The largest number of bald eagle detections (11) was recorded along J.C. Boyle reservoir. Copco reservoir detections (eight) accounted for the second highest amount of bald eagle records. The large majority (20) of the total bald eagle detections noted birds associated with lacustrine habitat or flying (Table 5A-12 in Appendix 5A). Bald eagles also were detected during goshawk protocol surveys, reservoir surveys, ROI censuses, and incidental to other Project-related field studies. Five bald eagle detections were recorded during northern goshawk protocol surveys with four along the J.C. Boyle reservoir and one in the J.C. Boyle bypass. Eight bald eagles were recorded during reservoir surveys with four near Copco reservoir, one near J.C. Boyle reservoir, and three near Keno reservoir. Bald eagles also were detected during censuses associated with an ROI conducted in the J.C. Boyle peaking reach. In addition, numerous bald eagle detections were recorded incidental to other field studies in most Project sections.

During February 2003, adult bald eagles and three subadult were seen perched along the southern shoreline of Copco reservoir a short distance east of Mallard Cove. During that time, eagles were seen diving on waterfowl in the lake. Occasionally, bald eagles were observed perched in oak trees or on power poles near the northwest shore of Copco reservoir. At J.C. Boyle reservoir, bald eagles were documented perching near the shoreline along most of its length.

During previous studies, the Grizzly Butte pair of bald eagles was documented perching and foraging along the Klamath River in the J.C. Boyle peaking reach most often during the winter when waterfowl were most common (City of Klamath Falls, 1990). After reservoirs thawed, most eagle use moved out of the canyon, presumably to forage at other sites.

Bald eagle nest surveys were conducted by the Oregon Cooperative Fish and Wildlife Research Unit in the Klamath River study area on March 27, 2002, and May 29, 2002 (Table 5A-13 in Appendix 5A). Nineteen nests were checked near the study area, ten of which were associated with non-Project water bodies. The nine nests most clearly associated with the study area in 2002 were separated into categories by occurrence and reproductive status of the associated breeding pair. The eight young fledged from the eight occupied territories equates to a production rate of 1.0 fledglings/occupied territory, which is equal to the recovery goal of 1.0 young/occupied territory (Table 5A-13 in Appendix 5A).

In 2003, the Oregon Cooperative Fish and Wildlife Research Unit flew bald eagle aerial surveys on March 27 and May 28. The same 19 nests inspected in 2002 were surveyed in 2003. In addition, the 2003 aerial bald eagle surveys found a "new" nest located approximately 540 feet (165 m) southeast of Copco dam. Of the ten bald eagle nests closest to the Project (including the newly discovered "Copco dam nest"), eight nests were occupied and three were found to fledge young in 2003 (0.63 fledglings/occupied territory) (Table 5A-13 in Appendix 5A).

As indicated in Table 5A-13 (in Appendix 5A), only the new Copco dam, Moore Park East, and Topsy and Jenny Creek nests are within 1 mile (1.6 km) of any Project facility. The Pony

Express nest is approximately 7 miles (11.3 km) from a facility, but is immediately along the J.C. Boyle peaking reach.

The study area occurs in the Klamath basin and California/Oregon Coast Zones of the Pacific States Bald Eagle Recovery Plan (USFWS, 1986). In some years, up to 117 bald eagle pairs nest and 1,100 individuals winter in the Klamath basin. In 2000, the Klamath Basin Recovery Zone had 117 occupied breeding sites, which greatly exceeded its habitat management goal of 80 (USFWS, 1986). Eagle reproduction around Upper Klamath Lake has been typical (1.06 fledglings/occupied territory) for this recovery zone during the late 1990s (Issacs and Anthony, 2002). In the California/Oregon Coast Recovery Zone the habitat management goal is 52 bald eagle territories and 28 breeding pairs (USFWS, 1986). The nesting season for bald eagles in Oregon generally runs from February through mid-August.

Prey remains collection under active nests was conducted on August 6, 8, 22, and 23, 2002, for the Pony Express, Moore Park, Jenny Creek, and Black Mountain nests, respectively. In general, prey remains collected were limited to the bones and carcass remnants of California ground squirrels, waterfowl, and fish. The proportion of each of these prey items was found to differ among active breeding pairs. Remains collected under the Moore Park nest site were dominated by waterfowl remains, while a preponderance of fish (likely yellow perch) remains were collected at the Jenny Creek nest site. Prey remains collected at the Black Mountain and Pony Express nest sites were dominated by remnants of small mammals, primarily ground squirrels.

In 1989, a study of the Grizzly Butte bald eagle territory that occurs in the J.C. Boyle peaking reach (City of Klamath Falls, 1990), prey brought to the nest included 68 percent fish and 32 percent mammals. Prey under the nest included fish, ground squirrels, other mammals, waterfowl, and deer hide.

The largest known wintering population of bald eagles in the contiguous United States occurs in the Klamath basin. A large communal roost is located south of Klamath Falls, Oregon, in the Bear Valley National Wildlife Refuge west of Worden, California. The refuge is approximately 6 miles south of Keno reservoir on the opposite side of a mountain ridge. The City of Klamath Falls (1986) studied bald eagle occurrence along the Klamath River for its assessment of the Salt Caves Project. As part of its studies, City of Klamath Falls conducted aerial surveys to locate wintering bald eagles along the Salt Caves Project reach of the Klamath River. Relatively low numbers of wintering bald eagles were observed all along the Klamath River. Most were seen in the upper end of Keno reservoir, J.C. Boyle reservoir, Copco reservoir, and Iron Gate reservoir. A few wintering eagles also were seen immediately below J.C. Boyle dam and along several miles of the river below J.C. Boyle powerhouse. The highest numbers of bald eagles observed during single aerial surveys conducted between Klamath Falls and Iron Gate dam were detected in February 1982 (23 eagles) and January 1986 (30 eagles).

No winter roost sites were identified in the study area for the Salt Caves Hydroelectric Project (City of Klamath Falls, 1990). Surveys conducted during 1981-1986 found several wintering eagles that used J.C. Boyle, Copco, and Iron Gate reservoirs. During that same time period, only four eagles were observed in the J.C. Boyle peaking reach (City of Klamath Falls, 1986). Based on winter observational data and suspected prey availability, the Salt Caves Hydroelectric Project studies found that waterfowl was likely to be the primary prey item, supplemented by small mammals, carrion, and fish (City of Klamath Falls, 1990). Prey remains collected from the

Black Mountain, Jenny Creek, Pony Express, and Moore Park nests confirm the use of a diverse prey base including waterfowl, small mammals, and fish.

The current condition of Project reservoirs may provide foraging opportunities for bald eagles in the study area, with nearby trees serving as perches. The reservoirs provide waterfowl habitat and have high fish production per river mile (relative to riverine reaches) across the study area. During periods when waterfowl were not abundant, most eagle use in the J.C. Boyle peaking reach occurred when flows were low (less than 1,000 cubic feet per second [cfs]) (City of Klamath Falls, 1990). This may indicate that at certain times of the year Project ramping may influence bald eagle foraging in this portion of the study area. Additional secondary Project-related impacts may include recreational use of reservoirs and development of adjacent habitats. No eagle collisions or electrocutions have been reported on FERC-related Project lines since the introduction of PacifiCorp’s Raptor Electrocution Reduction Program (RERP) in the late 1980s (Section 6.0).

Northern Harrier

Eight northern harriers were detected during relicensing field studies. These detections included four northern harriers recorded during 2002 general wildlife plot surveys, four detections noted incidental to other field studies, and three recorded during reservoir surveys. Seven northern harrier detections were recorded in the low-lying marshland and agricultural fields located east of Keno reservoir between the shore and Highway 97. The one remaining detection was observed incidentally in the Iron Gate-Shasta River section during November 2002 field studies. The four general wildlife plot detections amounted to a relative abundance for northern harriers in the Keno reservoir section of 0.17 bird per survey and an overall relative abundance of 0.01 bird per survey for the entire study area (Table 5A-8 in Appendix 5A).

Northern harriers typically show high fidelity to a breeding territory during the summer months (Csuti et al. 1997). The species may range up to 5.0 miles (8.0 km) from an active nest while hunting during the breeding season (Csuti et al. 1997). Repeated localized sightings recorded during 2002 and 2003 likely reflect isolated breeding pairs along the Iron Gate-Shasta River reach and Keno reservoir (Lake Ewauna). Harriers are permanent residents in the Project vicinity and are common at the Klamath Wildlife Area. The species may occur in the study area in even greater numbers during the winter months when the harriers wander throughout their range in search of a suitable prey source.

Sharp-Shinned Hawk

No sharp-shinned hawks were detected in the study area during general wildlife plot surveys. However, sharp-shinned hawks were detected during ROIs, northern goshawk protocol surveys, and incidental to other field studies.

The species was detected incidentally in August 2002 at a ROI station established in the Iron Gate-Shasta section, but was not recorded during formal ROI censuses or mist-netting. Three sharp-shinned hawk detections were recorded during northern goshawk protocol surveys. A pair and one individual were recorded on separate survey days in July 2002 along the J.C. Boyle bypass. In addition, an incidental detection of a sharp-shinned hawk located in oak habitat along the J.C. Boyle peaking reach was noted in March 2002.

Sharp-shinned hawks have an extensive global range from the Arctic regions of Alaska through the southern mountains of Argentina (National Geographic Society, 1999). In southern Oregon and northern California, the species is uncommon (Csuti et al. 1997). However, the species is associated with ponderosa pine, oak, mixed conifer, and riparian habitats (CWHRS) and is likely to occur in the study area year-round.

Cooper's Hawk

Three Cooper's hawk detections were recorded during goshawk protocol surveys and one detection was noted incidental to other field studies. Cooper's hawks were not detected in the study area during general wildlife plot surveys. The three Cooper's hawks detected during the goshawk protocol surveys were noted in July 2002 with two detections along the J.C. Boyle peaking reach and one detection in the J.C. Boyle bypass. The incidental Cooper's hawk detection was noted along the Iron Gate-Shasta reach during riparian field sampling in November 2002.

Cooper's hawks are accipiter species closely related to the sharp-shinned hawk (see above). Species ecology, breeding densities, and distribution are similar between the two species and Cooper's hawks are likely to occur in coniferous and mixed forest stands throughout the Project vicinity.

Northern Goshawk

Detections of this elusive, uncommon forest species were not recorded during plot, facility surveys, reservoir surveys, ROIs, or northern goshawk protocol surveys at 138 stations that used species-specific call-and-response methodology to elicit goshawk detection (Kennedy and Stahlecker, 1993). However, one goshawk was observed flying over the J.C. Boyle peaking reach by botanists conducting vegetation studies near Hayden Creek in August 2002. In addition, an incidental observation of a northern goshawk was reported from the deciduous forest/wetland along the northern shore of Copco reservoir in the late 1990s. Goshawks are known to occur in the Project vicinity and active nests are documented in the Project region. Three known nest sites exist in the Jenny Creek watershed (BLM, 1995a) including active nests with documented production of fledglings at Dixie and Parker Mountain (located north of Copco reservoir within 6 miles [9.7 km] of the study area) (BLM, 1996). Like raptors inhabiting forested areas, goshawks forage over large home ranges and occurrence of the species in suitable habitats in the study area throughout the year is likely.

There are approximately 2,678 acres (1,084 ha) of potentially suitable northern goshawk habitat in the study area (Figure 5.4-1). This includes all forested communities, except oak woodland, oak-conifer woodland, and oak-juniper woodland, with tree size greater than 6 inches (15.2 cm) dbh and 60 percent canopy cover.

Swainson's Hawk

Although Swainson's hawks were not detected in the study area during formal surveys, one Swainson's hawk was detected flying over agricultural fields near Highway 97 southeast of Keno reservoir in May 2002. This detection was recorded incidental to other field studies outside of the study area.

The Swainson's hawk is a buteo that dwells in open country and typically occurs in a variety of grassland, sagebrush, and juniper shrub habitats (Csuti et al. 1997). The species' range generally lies east of the Project region and includes the plains of the Great Basin in southeast Oregon and eastern northern California (Csuti et al. 1997). It is a rare spring and fall migrant at Klamath Wildlife Area. Regional migrating vagrants and hawks foraging west of their breeding range occasionally may occur in the study area.

Ferruginous Hawk

No ferruginous hawks were detected in the study area during relicensing field studies. This species occurs in open grassland and low-lying shrub habitats, and typically occurs in a range similar to that of the Swainson's hawk (Csuti et al. 1997). It is an occasional fall and winter visitor to the Klamath Wildlife Area. Although the study area does not lie within the known range for the species, ferruginous hawks occasionally may occur above the study area's open habitat upstream of Keno dam during migration or post-breeding dispersal.

Osprey

Sixty osprey detections were recorded during relicensing plot surveys with more than half of these detections located around Copco (16) and Iron Gate (15) reservoirs (Table 5A-14 in Appendix 5A). Typically, ospreys were detected flying either foraging in association with open water habitat or transiting from a reservoir to another habitat type.

In addition to the osprey detections recorded during plot surveys, numerous osprey detections were noted within the study area incidentally and during avian protocol surveys. Ospreys were noted during ROI censuses along the Iron Gate-Shasta section and in the J.C. Boyle peaking reach. Detections also were recorded during northern goshawk protocol surveys in July 2002 with five total detections: four in the J.C. Boyle bypass and one along the J.C. Boyle reservoir. Detections of osprey noted incidental to other field studies were recorded in all the Project sections included in Table 5A-14 (in Appendix 5A)

Relative abundance data per survey for osprey are fairly consistent with the raw data on detections. The highest relative abundance was found at Copco reservoir where, on average, 0.43 bird per survey was noted; the second highest relative abundance was found at Iron Gate reservoir with 0.34 bird detected per survey. Overall, osprey were a relatively commonly encountered avian species during 2002 field studies with a combined average relative abundance of 0.20 bird per survey across all Project sections (the sixth most commonly detected avian TES species during plot surveys). The species is a summer breeder in the Project vicinity and is likely to occur around active and historic nest sites.

A minimum of 16 active osprey nests, both artificial nesting platforms and natural sites, are located along the shores of Project reservoirs and river reaches including: one nest site along the J.C. Boyle reservoir; one in the J.C. Boyle peaking reach; one in the Copco bypass; two along both Copco and Iron Gate reservoirs; and nine along the Iron Gate-Shasta section.

There have been no documented electrocutions or collision deaths of osprey along Project lines.

Merlin

One merlin was detected along the J.C. Boyle peaking reach during riparian field sampling in November 2002. The merlin ranges throughout North America and, like many falcon species, travels great distances during migration, from breeding grounds in northern Canada and Alaska to wintering habitat through the contiguous United States south to Central America (Ehrlich et al. 1988). It is a rare spring, fall, and winter visitor to Klamath Wildlife Area. Although the species is unlikely to occur in the study area during the breeding season, merlin may use a variety of forested and open habitats in the Project vicinity during the winter and during migration.

Prairie Falcon

Six prairie falcon detections were recorded during relicensing field studies with two recorded during plot surveys and four noted incidental to other field studies. In 2002, two incidental detections were recorded in October during riparian vegetation surveys; one bird was sighted above the J.C. Boyle bypass and the other was observed near the Keno reservoir campground and boat ramp. In 2003, two prairie falcons were detected flying over the Klamath Wildlife Refuge during spotted frog protocol surveys. Plot survey detections of prairie falcons in 2002 were limited to one bird seen flying above the J.C. Boyle peaking reach in May, and one distant sighting off of a Copco reservoir plot in June.

Prairie falcons are known to range throughout southern Oregon, east of the Coast Range Mountains (Csuti et al. 1997) and are likely to be found foraging above suitable open grassland habitat throughout the Project vicinity. A combination of CDFG and Salt Caves raptor survey data indicate that there were as many as 11 nest sites from the J.C. Boyle powerhouse to the eastern end of Iron Gate reservoir. Three historic prairie falcon nests are located in the eastern portion of the J.C. Boyle Canyon: one in the J.C. Boyle bypass south of the dam; one near Grizzly Butte, north of the Frain Ranch; and one near Salt Caves in the J.C. Boyle peaking reach (Kellum, pers. comm., 2002).The breeding pairs associated with the Salt Caves and Grizzly Butte nests were presumed to be productive in 2002 based on foraging observations by the BLM. No prairie falcons were noted near the nest in the J.C. Boyle bypass in 2002 although a pair was believed to have fledged young in 2001 (Kellum, pers. comm., 2002). No data are available for the other territories. The nearest nest to Project facilities is located more than 4,000 feet (1,219 m) from the J.C. Boyle powerhouse. Generally, falcons forage across large home ranges and the prairie falcon is likely to occur in all Project sections throughout the year.

American Peregrine Falcon

No American peregrine falcons were detected in the study area during relicensing field studies. Peregrine falcons have a global distribution occurring on all continents except Antarctica (Csuti et al. 1997). During the breeding season, their occurrence is usually restricted by the presence of suitable nest sites on cliffs and rocky outcroppings (Csuti et al. 1997). No active peregrine falcon nests are known in the Project vicinity (Kellum, pers. comm., 2002). A historic nest site is suspected at Secret Springs Bluff south of Frain Ranch (FERC, 1990) and an historic peregrine falcon nesting aerie was known to exist at Grizzly Butte—in the same location as the active prairie falcon nest described above—through the mid 1970s (Pagel, 1999). The last record of successful breeding by a nesting peregrine pair at this location was in 1969, although the fledglings were taken from the nest by falconers (Pagel, 1999). A pair thought to be using the aerie was frequently noted around the nest site in 1975 although breeding was never confirmed (Pagel, 1999). Migrating and over-wintering birds occasionally may be found in a variety of habitats, including open grassland areas, forest stands, and Project reservoirs throughout the vicinity of the study area. The study area is located in a management area designated for peregrine falcon recovery (Pacific Coast American Falcon Recovery Team, 1982).

The 225-foot (67-m) cliff above Salt Caves and the cliffs near the J.C. Boyle powerhouse were both rated as highly suitable for peregrine nesting (Pagel, 1999). Both sites were used by prairie falcons in the 1990s.

Ruffed Grouse

No ruffed grouse were detected in the study area during relicensing field studies. The species' range includes the study area, and ruffed grouse may be found in dense forest located in the Project vicinity. Ruffed grouse are ground-dwelling game species, typically associated with deciduous and mixed deciduous-coniferous forest stands (Csuti et al. 1997). They often occur in the dense undergrowth of deciduous forests with a willow or alder component (Csuti et al. 1997) and are most likely to occur in the study area where these specific habitat requirements are met.

Columbian Sharp-Tailed Grouse

No Columbian sharp-tailed grouse were detected in the study area during relicensing field studies. Wild populations of Columbian sharp-tailed grouse are thought to have been completely extirpated from Oregon and California since the beginning of the 20th century, with no reported observations of Columbian sharp-tailed grouse in California since 1915. Attempts have been made to reintroduce the game species to regions of northeastern Oregon (ODFW website), but until successful reintroduction efforts for this relatively-sedentary species extend to the Project region, there is no potential for the occurrence of Columbian sharp-tailed grouse in the Project vicinity.

Western Greater Sage Grouse

No western greater sage grouse were detected in the study area during relicensing field studies. The known range for this species in southern Oregon and northern California generally lies east of the study area (Csuti et al. 1997). The species is almost exclusively associated with sagebrush habitat with a diet consisting nearly entirely of big sagebrush in the fall and winter (Ehrlich et al. 1988). Given this restrictive habitat parameter, sage grouse are most likely to occur around Keno and J.C. Boyle reservoirs where sagebrush habitat is most dominant. However, the species typically is found only sparingly within its known range and is thought to occur only along the eastern edge of Klamath County (Csuti et al. 1997).

Mountain Quail

Four mountain quail detections were recorded during relicensing avian plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A): one quail was recorded during a plot survey along the J.C. Boyle reservoir in May; one along Fall Creek in June; and two were detected along the Iron Gate-Shasta section during a June plot survey. In addition, one incidental detection was recorded in the J.C . Boyle bypass reach in 2002, and a mountain quail was detected in the J.C. Boyle peaking reach during a spotted owl protocol survey in 2003. The mountain quail is a game species in Oregon. The Project region lies along the eastern edge of the species' range (Csuti et al. 1997). Mountain quail generally inhabit open forests, chaparral, and juniper woodlands with a dense undergrowth component that offers suitable refuge (Csuti et al. 1997). Mountain quail are unique among quail in that they breed in higher elevation areas and migrate, on foot up to 40 miles (64 km), to lower elevation winter grounds (Ehrlich et al. 1988, Csuti et al. 1997). Given these local movement patterns and habitat requirements, the species potentially could be found throughout the Keno reservoir, Keno Canyon, J.C. Boyle bypass, J.C. Boyle reservoir, J.C. Boyle peaking reach, Copco reservoir, Fall Creek, Iron Gate-Shasta, and Copco No. 2 bypass sections year-round.

<u>Yellow Rail</u>

No yellow rails were detected in the study area during relicensing field studies. Historically, yellow rails occurred in coastal and inland wetlands and wet meadows throughout California and Oregon (Csuti et al. 1997). The species is no longer thought to breed in California, and was thought to be extirpated from Oregon until a "rediscovery" of the species in 1982 (Csuti et al. 1997; CDFG website). The total breeding population in Oregon is thought to be less than 100 pairs, which includes a small isolated population that supposedly nests along Upper Klamath Lake (Csuti et al. 1997). The species is secretive, and little is known of its ecology and behavior. Suitable yellow rail breeding habitat exists throughout the study area. Species detection is unlikely without specific rail-targeted call-and-response surveys conducted during the summer breeding season.

<u>Greater Sandhill Crane</u>

During the Klamath terrestrial relicensing studies, a minimum of 18 sandhill crane detections was recorded. In 2002, two greater sandhill cranes were detected during a June reservoir survey along the J.C. Boyle reservoir and approximately 12 incidental detections were recorded east of Keno reservoir along Highway 97 near the Klamath Wildlife Refuge (Figure 5.7-2). In 2003, two cranes were sighted repeatedly foraging along the Klamath Sportsmen's Club wetland off of J.C. Boyle reservoir and an active nest with a single egg was located in the bulrush near Sportsmen's Park. This observation represents the only documented confirmation of the species breeding along a Project reservoir. In addition, sandhill cranes were detected again in small numbers along Highway 97 near the Klamath Wildlife Refuge in 2003. The numerous incidental observations of the species in this location likely represent repeated detections of a group of between two to eight birds that remain near the refuge during the breeding season or use the area for staging during migration.

An estimated 1,000 breeding pairs of greater sandhill cranes are reported to nest in Oregon with an additional 500 non-breeding individuals (Csuti et al. 1997). Sandhill cranes nest in marshes and wet meadows, and occasionally in pastures and irrigated hayfields (Csuti et al. 1997). The presence of surrounding water or undisturbed habitat is a primary requirement for sandhill crane suitable nesting habitat (Ehrlich et al. 1988). Cranes typically pair for life and show fidelity to a single nesting area (Ehrlich et al. 1988). In addition to the limited nesting, this species may occur in the study area in transit to known nesting grounds at Upper Klamath Lake and in the Project region. In addition, as the 2003 confirmation of study area breeding confirms, the species may nest in suitable habitat located throughout the Project vicinity.

Western Snowy Plover

No snowy plovers were detected in the study area during relicensing field studies. The snowy plover is a shorebird that typically nests in sandy substrate along the Pacific Coast (National Geographic Society, 1999). However, a small inland population, consisting of less than 1,000 birds in Oregon, is known to nest along the margin of alkaline lakes (Csuti et al. 1997). No suitable breeding habitat for the species exists in the study area. However, the species does have a potential for occurrence along the shoreline of Project water bodies during migration from inland breeding areas to winter grounds along the coasts of southern California and Mexico (Csuti et al. 1997). This species is a rare fall migrant at the Klamath Wildlife Area.

Long-Billed Curlew

No long-billed curlews were detected in the study area during relicensing field studies. Curlews are large shorebirds that are known to breed in open grasslands and wet meadows throughout eastern Oregon (Ehrlich et al. 1988). In the Project vicinity, long-billed curlews breed along the margins of Upper Klamath Lake (Csuti et al. 1997). Although no curlews were detected during avian field studies, suitable breeding habitat for the species exists throughout the study area. In addition, the species' tendency to fly up to 6.0 miles (9.7 km) from a nest to forage during the breeding season makes it likely curlews at least occasionally use the Project vicinity for foraging. It is an uncommon spring and fall migrant at the Klamath Wildlife Area (ODFW website).

In California, the long-billed curlew is a common breeding species in wet meadow habitat of extreme eastern Siskiyou and adjacent Modoc counties (CWHRS website). The known range in California is well east of the study area.

Upland Sandpiper

No upland sandpipers were detected in the study area during relicensing field studies. The upland sandpiper is a large inland-breeding shorebird known to nest in about eight localized areas in Oregon (Csuti et al. 1997). This Oregon breeding population is estimated at less than 100 birds with the majority breeding in Grant County, well north of the study area (Csuti et al. 1997). In Oregon, the species is known to nest in grasslands and flooded meadows typically located in high-elevation sagebrush habitat (Csuti et al. 1997). Although the species' requirement for breeding habitats is met in localized areas in the Project vicinity, the probability for occurrence of this rare species in the study area remains low.

Caspian Tern

In total, 146 Caspian tern detections were recorded during relicensing field surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A) including: 59 detections recorded during avian plot surveys; six detections recorded during facility surveys; and 81 detections recorded during reservoir surveys (Table 5A-15 in Appendix 5A). In addition, Caspian terns were observed incidental to various field studies throughout the 2002 and 2003 field season. Typically, Caspian terns were observed in association with large water bodies and were detected on each of the four Project reservoirs. Data on relative abundance indicate that the Caspian terns were the fifth most frequently detected avian TES species during avian plot surveys with a Project-wide relative abundance of 0.21 detection per survey. The largest number of Caspian terns (60) was detected in the Copco reservoir section. In addition, the 81 detections recorded during reservoir surveys rank Caspian terns as the nineteenth (out of 56 total species detected) most common species recorded using this survey technique (Table 7A-5 in Appendix 7A).

Caspian terns nest in tightly packed colonies along inland water bodies during the summer breeding season and migrate south to winter from southern California through Central America (National Geographic Society, 1999). They nest on undisturbed islands, levees, and shores (CWHRS website). In southern Oregon and northern California, the species nests only on a few isolated inland freshwater lakes, including Upper Klamath Lake (Csuti et al. 1997). This species was encountered often during 2002 and 2003 field studies, in comparison to other avian TES species, and is likely to occur along Project reservoirs and river reaches, primarily during the summer breeding season. In California, the Caspian tern is known to breed in Modoc and Lassen counties and ranges into extreme eastern Siskiyou County, well east of the study area (CWHRS).

Forster's Tern

During relicensing field surveys, 272 Forster's tern detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). Of these detections, 118 were recorded during plot surveys, 22 during facility surveys, and 132 during reservoir surveys (Table 5A-16 in Appendix 5A). In addition, the species was observed incidental to other field studies throughout the 2002 and 2003 field seasons.

The largest number of Forster's tern detections (100) was recorded along Keno reservoir. Eighty-two detections were recorded along the J.C. Boyle reservoir, constituting the second largest number of Forster's tern records. Relative abundance per survey data (Table 5A-8 in Appendix 5A) indicate that, across all Project sections, Forster's terns were the 19th most frequently encountered bird species during general wildlife plot surveys with an overall relative abundance of 0.41 bird per survey throughout the study area. The highest relative abundance per survey for Forster's terns was found along the Link River where, on average, 2.11 birds were detected per survey. The second highest relative abundance occurred around Keno reservoir where, on average, 1.91 Forster's terns were detected per survey.

The breeding, occurrence, ecology, and distribution of Forster's terns in the Project region closely follow that of the Caspian tern (Csuti et al. 1997). Forster's terns are known to breed on several inland lakes in southern Oregon including Upper Klamath Lake (Csuti et al. 1997). In California, the Forster's tern range includes the extreme eastern portion of Siskiyou County, well east of the study area (CWHRS website). The species occurs in the study area during the breeding season and in the late summer during local post-breeding dispersal. Potential nesting habitat may exist along the Keno reservoir. However, no nesting activity was noted in 2002 during PacifiCorp studies or in previous years during other investigations.

Black Tern

Plot survey detection results for black terns were limited to a total of seven birds detected during a single plot survey conducted near the J.C. Boyle reservoir in June 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). Fourteen black tern detections were made during reservoir surveys with seven detections recorded around the J.C. Boyle reservoir (one in May 2002 and six in June 2002) and seven detections around Keno reservoir (four in May 2002 and three in June 2002). The seven plot survey detections resulted in a relative abundance for black terns within the J.C.

Boyle reservoir Project section, of 0.35 tern per survey, and an overall relative abundance, across all areas, of 0.02 tern per survey (Table 5A-8 in Appendix 5A).

The breeding ecology of the black tern is similar to that of the Forster's and Caspian tern (National Geographic Society, 1999). However, black terns travel great distances during migration from breeding grounds on inland water bodies in North America to wintering areas in South America and Africa (Csuti et al. 1997). Black terns are known to breed at Malheur National Wildlife Refuge and are presumed to occasionally breed on isolated inland lakes throughout southern Oregon (Csuti et al. 1999). As is the case with other tern species that nest along the shoreline periphery of freshwater lakes, reservoir water fluctuation could affect the potential for black terns nesting in the study area. Yet, the species is likely to forage in the Project vicinity during the summer breeding season and on migration. In California, the black tern is a common migrant and breeder in eastern Siskiyou County (CWHRS website).

Western Yellow-Billed Cuckoo

No western yellow-billed cuckoos were detected in the study area during relicensing field studies. Although this species is thought to breed in isolated locations along the west coast north to Oregon (National Geographic Society, 1999), consistent breeding records for the species have not been documented in the Project region (Csuti et al. 1997). Cuckoos nest in dense riparian thickets often dominated by willow (Csuti et al. 1997). Suitable breeding habitat exists for the species in the study area and the species may occur in the Project vicinity.

Short-Eared Owl

No short-eared owls were detected in the study area during relicensing field studies. Generally, short-eared owls are diurnal and nest on the ground in open grassland areas (Ehrlich et al. 1988). They are known to commonly occur in the marshes of eastern Oregon (Csuti et al. 1997). Csuti et al. (1997) indicate that the species breeds throughout Klamath County, and suitable breeding and foraging habitat for the species exists throughout the Project vicinity. Therefore, the species is likely to occur in the study area, especially upstream of Keno dam.

Long-Eared Owl

No long-eared owls were detected in the study area during relicensing field studies. This species is a year-round resident throughout southeastern Oregon and in the Project region (Csuti et al. 1997). The species is found in open coniferous and mixed forests, and juniper and riparian woodlands (Csuti et al. 1997). Although breeding records have not been documented in the study area, long-eared owls are likely to occur in the Project vicinity.

Great Gray Owl

Two great gray owl detections, likely separate responses by the same individual bird, were recorded during 2002 spotted owl protocol surveys (Figure 5.7-2). The two detections consisted of great gray owl vocalization responses, both triangulated to a localized area east of Fall Creek near Jenny Creek. The owl was estimated to be approximately 1 mile (1.6 km) east of Fall Creek. To supplement available information on the great gray owl in the Project vicinity, great gray owl protocol broadcast-call surveys were conducted during the 2003 field season. Forty-eight protocol survey stations were established in areas meeting great gray owl habitat criteria and six surveys were conducted from each station during the field season. In addition, three surveys each were conducted at three supplemental great gray owl calling stations established to monitor the area where the 2002 great gray owl detection was recorded (this area did not meet protocol habitat criteria). No great gray owl detections were recorded during the protocol surveys. However, Oregon BLM confirmed that great gray owls were detected during protocol surveys conducted in 2003 in the PWHMA. Although PacifiCorp great gray owl surveys included portions of the PWHMA, BLM calling stations generally were located farther west, far outside of the Project vicinity.

The range of the great gray owl in southern Oregon is thought to be expanding as increased forest openings are created through development and timber harvest (Csuti et al. 1997). The species is known to breed in tree cavities and in abandoned corvid or squirrel nests, typically located near suitable open grassland foraging habitat (Csuti et al. 1997). Approximately 2,219 acres of potentially suitable great gray owl habitat exist in the study area. This includes mixed conifer, ponderosa pine, and riparian mixed forests with tree size more than 11 inches (28 cm) dbh and 60 percent canopy cover that are within 984 feet (300 m) of a natural or manmade opening more than 10 acres (4.0 ha). Although no great gray owls were detected during PacifiCorp 2003 protocol surveys, the species is known to occur throughout the Project vicinity and may nest in suitable habitat located in the Klamath study area.

Northern Spotted Owl

Northern owl protocol surveys were conducted in habitat meeting protocol criteria located throughout the Project vicinity during the 2002 and 2003 field seasons. In 2002, 102 spotted owl calling stations were established and 73 of these stations were re-surveyed through the 2003 field season (29 stations were not resurveyed in 2003 because it was determined that habitat criteria were not met at these locations and station proximity was overly sufficient to allow complete coverage of suitable habitat). Surveys were conducted from each calling station three times during the course of each field season (April through June). A combined total of ten spotted owl detections was recorded during the 2002 and 2003 survey periods. Specific information on detections recorded during each survey year is provided below.

In 2002, five northern spotted owl detections were recorded during spotted owl protocol surveys. Four of these detections likely represent a repeat observation of the same breeding pair (it is assumed that the five total detections account for the detection of three individuals). Incidental spotted owl detections were not noted during other field study types in 2002. The five detections recorded during spotted owl protocol surveys included: one male detected along the J.C. Boyle peaking reach in June; and one pair detected along the J.C. Boyle peaking reach in the same general area on 2 days in July. None of the detections was within 5 miles (8 km) of any Project facilities.

In 2003 (as in 2002), five spotted owl detections were recorded during protocol surveys. It is speculated that these 2003 records reflect the detection of three or four owls. A mixed gender pair of owls was detected southwest of the Beswick Ranch in the J.C. Boyle peaking reach. The location of this pair is consistent with that of a historic pair of owls monitored by the USFS. A lone female owl was detected earlier in the season approximately 0.5 mile (0.8 km) from the pair described above. This bird may have been the female from the mated pair, although the location of the detection may indicate this is a separate isolated individual female owl. Two female spotted owl detections were recorded in the upper Project region less than 1 mile (1.6 km) southeast of the J.C. Boyle reservoir. The two detections, recorded on consecutive evenings, likely represent a single female spotted owl. Although the National Council for Air and Stream Improvement (NCASI) monitors a breeding pair of owls in the upper J.C. Boyle peaking reach, the significant distance from the known breeding location to the area of detection near the J.C. Boyle reservoir may indicate the 2003 upper Project detections reflect a single isolated un-paired female. NCASI and USFS radio telemetry data indicate that the Lucky Springs and Negro Creek spotted owl pairs have home ranges that do not extend within 0.5 mile (0.8 km) of the Klamath River (Cheyne, pers. comm., 2003).

In southern Oregon, spotted owls are known to successfully breed in late-successional mixed coniferous forest (Csuti et al. 1997). Several breeding pairs are known to occur in the Project vicinity (Laponardo, pers. comm., 2002; Schmalenberger, pers. comm., 2002). There are approximately 11,300 acres (4,573 ha) of potentially suitable spotted owl habitat in the study area. This includes all forested communities, except oak woodland and oak-juniper woodland, with tree size more than 6 inches (15 cm) dbh and 40 percent canopy cover. Suitable habitat outside of the study area includes approximately 35,700 acres (14,447 ha) of spotted owl designated critical habitat in the Jenny Creek watershed (BLM, 1995a).

Flammulated Owl

Four flammulated owl detections were recorded during spotted owl protocol surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A). Two detections were recorded in June 2002 along the J.C. Boyle peaking reach, one detection in the J.C. Boyle bypass in June 2002, and one detection along the J.C. Boyle peaking reach in July 2002.

Flammulated owls nest in abandoned woodpecker nest cavities in open forests with a ponderosa pine component (Ehrlich et al. 1988). The species is known to nest in southern Oregon and throughout the Project region (Csuti et al. 1997) and may occur in the more than 12,000 acres (4,856 ha) of forests that have significant coverage of ponderosa pine in the study area (Section 2.7).

Western Burrowing Owl

No western burrowing owls were detected in the study area during relicensing field studies. Burrowing owl nest sites are notably evident, in general, and typically consist of modified ground squirrel or badger burrows (Ehrlich et al. 1988). No suitable breeding habitat, with relatively flat and sparse shrubland and high densities of existing mammal burrows, was noted in the study area, although burrowing owls are known to breed in eastern Oregon and specifically in Klamath County outside of the Klamath study area (Csuti et al. 1997). This species is not likely to occur in the study area.

Black Swift

No black swifts were detected in the study area during relicensing field studies. In northern California and southern Oregon, black swifts are believed to breed only at Salt Creek Falls in Lane County, Oregon, and in a few isolated locations in the southern Cascade Mountains (CDFG website; Csuti et al. 1997). Breeding records for the species north of San Francisco Bay are scarce. However, this species occasionally may be detected transiting through the study area to and from its wintering grounds in Mexico and Central America.

Vaux's Swift

During general wildlife plot surveys, 66 Vaux's swift detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). The largest number of detections (31) was recorded in the J.C. Boyle peaking reach. Other Project sections where relatively large numbers of Vaux's swifts were detected during plot surveys include Fall Creek (13), Iron Gate reservoir (eight), and Copco reservoir (seven) (Table 5A-17 in Appendix 5A). Aside from detections recorded during facility surveys, where habitat associations were not indicated, most Vaux's swifts were detected flying while foraging over a reservoir or river. Vaux's swifts were detected during ROI-associated avian censuses only in the J.C. Boyle peaking reach along Shovel Creek. In addition, numerous observations of Vaux's swifts were recorded incidental to other field studies throughout the 2002 and 2003 field seasons.

Relative abundance per survey data from plot surveys (Table 5A-8 in Appendix 5A) can be used to compare the occurrence for Vaux's swift between different Project sections. Detections in the J.C. Boyle peaking reach (0.43 bird per survey) account for the largest relative abundance of Vaux's swift in all Project sections, and Copco reservoir supports the second largest relative abundance of Vaux's swifts at 0.19 bird per survey. The Project-wide relative abundance of Vaux's swifts is 0.16 bird per survey. Vaux's swifts are known to breed in tree cavities in a variety of forest habitats in the Project region, and were observed at active nests located in oak tree cavities along the Copco reservoir and in the J.C. Boyle peaking reach.

Acorn Woodpecker

Acorn woodpeckers are commonly observed throughout suitable habitat located in the Klamath study area. During 2002 plot surveys, 109 acorn woodpecker detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). Nearly half of these detections (61) were noted in the Copco reservoir section and, notably, most (68) of the acorn woodpecker detections were associated with oak-dominated habitat (Table 5A-18 in Appendix 5A). In addition, the occurrence of acorn woodpeckers in Iron Gate-Shasta section, Iron Gate, Copco bypass, Copco reservoir, and J.C. Boyle peaking reach sections, and conversely, the absence of detections in the J.C. Boyle bypass, Keno Canyon, Keno reservoir, and the Link River sections, appears to be correlated with the absence of suitable oak-dominated habitat in and around survey plots located in these areas.

Acorn woodpecker detections were recorded in four of the five Project sections in which ROIs were conducted. The species was captured in mist nets around Iron Gate reservoir and the Copco bypass, and acorn woodpeckers were detected during ROI-associated censuses in the Iron Gate reservoir, Iron Gate-Shasta, J.C. Boyle peaking reach, and Copco bypass sections. In addition, two individuals were recorded during reservoir surveys on Copco reservoir in January and February 2003.

Accounting for the disproportionate survey effort across Project sections, relative abundance data shows that acorn woodpeckers were detected most frequently near Copco reservoir (average relative abundance 1.65 birds per survey) (Table 5A-8 in Appendix 5A). Yet, the J.C. Boyle peaking reach contained plots with the largest total area of oak-dominated habitat (Table 5.4-4 in Appendix 5A).

Because acorn woodpeckers were found to be predominantly associated with oak-dominated habitat, an analysis of acorn woodpecker relative abundance per surveyed habitat acre was performed. Acorn woodpeckers were detected most frequently in the montane hardwood oak cover type (Table 5A-17 in Appendix 5A). The relative abundance of acorn woodpeckers per acre of montane oak habitat surveyed in the Copco reservoir, Iron Gate reservoir, and J.C. Boyle peaking reach Project sections was 2.06, 0.09, and 0.00 birds per acre (5.15, 0.23, and 0.00 birds per ha), respectively (Appendix 5G) (this includes in-plot detections only, and no acorn woodpeckers were detected within in-plot oak habitat in the peaking reach although detections in the habitat type were recorded outside of survey plots).

The difference in acorn woodpecker abundance between similar habitat stands in different Project sections may be related to snag densities. Typically, acorn woodpeckers nest in cavities located in snags of deciduous tree species—especially oak snags (Ehrlich et al. 1997). Nietro et al. (1985) showed the parameters for suitable acorn woodpecker nest snags included a minimum dbh of 17 inches (43.2 cm) with an early stage decay-class (1 through 3) snag (Section 2.0, Table 2.7-8). Data collected on the occurrence of snags in each habitat type show that snags with a minimum dbh of 17 inches (43.2 cm) occurred in montane oak conifer habitat at a density of more than 0.4 snag per acre (1.0 snag per ha) (Section 2.7.3). Montane oak conifer habitat exists around Copco reservoir and snag density in this area may account for the abundance of acorn woodpeckers detected in this Project section.

White-Headed Woodpecker

One white-headed woodpecker was detected in the study area during relicensing field studies (Figure 5.7-2; Table 5A-7 in Appendix 5A). This bird was recorded during a plot survey along the J.C. Boyle reservoir in June 2002. Although the plot was characterized as riparian/wetland scrub-shrub, the bird was noted in a ponderosa pine tree and likely was associated with the large stands of ponderosa pine habitat located adjacent to the plot.

White-headed woodpeckers are closely associated with ponderosa pine within their range in southern Oregon and northern California (Ehrlich et al. 1988). The species requires nest cavities, which also typically are located in ponderosa pine, with documented white-headed woodpecker nest snags averaging approximately 18 inches (46 cm) for breeding (Csuti et al. 1997). Analysis in Section 2.7.3 indicates that 1.4 ± 3.7 snags more than or equal to 17 inches (43 cm) dbh per acre occur in ponderosa pine cover type. White-headed woodpeckers are likely to occur in the large stands of ponderosa pine with suitable snag densities located in the J.C. Boyle reservoir section and throughout the Project vicinity.

Lewis' Woodpecker

During general wildlife plot and facility surveys in 2002, 13 Lewis' woodpecker detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). All 13 detections occurred in three sections: Iron Gate reservoir, the J.C. Boyle peaking reach, and the Iron Gate-Shasta section. The largest number of detections (eight) was recorded within the Iron Gate-Shasta section (Table 5A-19 in Appendix 5A). Lewis' woodpeckers also were detected in the Iron Gate, Iron Gate-Shasta, J.C. Boyle peaking reach, and Copco bypass sections during ROI avian censuses and incidental to other field studies. The detections were nearly equally divided among montane hardwood oak and various riparian cover types. Incidental detections of Lewis' woodpeckers continued through the 2003 field season and the species can be found in abundance in select locations located mainly in the mid and lower Project regions.

Data on Lewis' woodpecker relative abundance per survey show that the highest average abundance of Lewis' woodpeckers among the three Project sections in which they were recorded during plot surveys was around the Iron Gate-Shasta section (0.33 birds per survey). An average of 0.08 and 0.03 Lewis' woodpeckers per survey was detected in the Iron Gate reservoir and the J.C. Boyle peaking sections, respectively. Total Project-wide relative abundance per survey for Lewis' woodpeckers was 0.04 bird per survey across the study area (Table 5A-8 in Appendix 5A).

The Lewis' woodpecker has a restricted, patchwork range in southern Oregon and northern California, but an isolated portion of the species' range includes the Oregon and California portions of the Project study area (Csuti et al. 1997). Lewis' woodpeckers are largely associated with oak woodlands and mixed oak conifer habitat, but also can be found in a variety of open forest stands including ponderosa pine and cottonwood-dominated riparian areas (Csuti et al. 1997). Breeding pairs were observed in the study area and Lewis' woodpeckers may occur throughout the Project vicinity year-round. See Section 7.7 for additional discussion of Lewis' woodpeckers.

Williamson's Sapsucker

No Williamson's sapsuckers were detected in the study area during relicensing field studies. However, the species is known to occur in the general Project vicinity (Csuti et al. 1997). The species is strongly associated with higher-elevation coniferous forest types including ponderosa pine, lodgepole pine, and Douglas-fir (Ehrlich et al. 1988) and may be found wherever these suitable habitat types exist in the Klamath study area. It is possible that this species is restricted to habitats at elevations above the study area.

Three-Toed Woodpecker

No three-toed woodpeckers were detected in the study area during relicensing field studies. In the Project region, the species has an isolated range and is typically thought to occur north of the study area, along the eastern crest of the Cascade Mountains (Csuti et al. 1997). In general, three-toed woodpeckers are associated with tree species and coniferous forest habitat found at elevations above 4,500 feet (1,372 m) (Csuti et al. 1997) and are unlikely to occur in the immediate Project vicinity.

Black-Backed Woodpecker

No black-backed woodpeckers were detected in the study area during relicensing field studies. Black-backed woodpeckers are similar to three-toed woodpeckers in habitat requirements and ecology, but occur in lower elevation forests (Csuti et al. 1997). The species nests in cavities located in lodgepole and ponderosa pine trees and black-backed woodpeckers are likely to occur in Project areas where these tree species exist.

Pileated Woodpecker

Thirteen pileated woodpecker detections were recorded during general wildlife plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). More than 75 percent of these detections (ten of 13) were recorded in the river reaches below the J.C. Boyle reservoir (Table 5A-20 in Appendix 5A). The rankings of relative abundance among the four Project sections in which the species was detected during plot surveys was (high to low): J.C. Boyle bypass, 0.27 bird per survey; Fall Creek, 0.13 bird per survey; J.C. Boyle peaking reach, 0.06 bird per survey; and Keno Canyon, 0.06 bird per survey (Table 5A-8 in Appendix 5A). Pileated woodpeckers were observed in six different cover types, but were most common in ponderosa pine forests (Table 5A-20 in Appendix 5A)

Pileated woodpeckers also were detected during northern goshawk protocol surveys with six detections in the J.C. Boyle bypass and one observation recorded around the J.C. Boyle reservoir. The species also was noted incidental to other field studies in many Project sections with large forested stands.

Pileated woodpeckers range along the Cascade Mountains and Coast Range corridors from central California north to Alaska (Csuti et al. 1997). The species' regional distribution extends throughout the Project vicinity and pileated woodpeckers are likely to be found in suitable habitat throughout the study area. Pileated woodpeckers require large snags (25+ inches [63.5 cm] dbh) in which to excavate a suitable nest cavity (Section 2.7.3). The analysis of snag densities in vegetation cover types provided in Section 2.7.3 indicates that suitable densities of large snags typically occurred in native Klamath mixed conifer, montane hardwood oak-conifer, palustrine forested wetland, and riparian mixed forests (one plot located in a lodgepole pine plantation was surveyed, but is not included as native habitat).

Olive-Sided Flycatcher

Twelve olive-sided flycatcher detections were recorded during relicensing field surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A). Eleven detections were noted during plot surveys with the large majority (nine) of detections recorded in ponderosa pine habitat (Table 5A-21 in Appendix 5A). In addition, one individual was recorded during the March 2003 reservoir survey at Iron Gate reservoir. Accounting for the different number of general wildlife plot surveys conducted in each Project section, olive-sided flycatchers were found most abundant in Keno Canyon and along J.C. Boyle and Keno reservoirs with relative abundance values for olive-sided flycatchers within these Project sections of 0.17, 0.15, and 0.13 birds per survey (Table 5A-8 in Appendix 5A), respectively.

It appears occurrence in Project sections for this species is largely attributed to the presence of large stands of contiguous coniferous (ponderosa pine) forest. This is consistent with the known habitat preference of the species: olive side flycatchers typically are found in coniferous forests with tall trees providing suitable perch sites (Csuti et al. 1988). The species is thought to be associated with the presence of large perch snags (Ehrlich et al. 1988) and it also may occur in forest habitat with a deciduous component in the study area where this habitat requirement is met (see Section 2.7.3).

Willow Flycatcher

Three distinct willow flycatcher subspecies (*Empidonax traillii, E. t. adastus,* and *E. t. brewsterii)* hold different official federal and state status depending on regulatory jurisdiction. Field identification of *Empidonax* species is often problematic; therefore, willow flycatchers were not identified to subspecies during field surveys to minimize reporting error.

Thirteen willow flycatcher detections were recorded during general wildlife plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). Notably, all willow flycatchers were detected in riparian or wetland habitat located peripheral to a reservoir or river reach, and 69 percent of all detections (nine) were recorded in riparian/wetland scrub-shrub habitat (Table 5A-22 in Appendix 5A). Willow flycatchers also were detected in four Project sections during fall ROIs including the Copco bypass where the species was not recorded during the breeding season plot surveys. In addition, the species was noted throughout the study area incidental to other field studies during both 2002 and 2003. Relative abundance calculations from plot survey data (Table 5A-8 in Appendix 5A) show willow flycatchers to be most abundant around Iron Gate reservoir and the Iron Gate-Shasta section at 0.13 and 0.11 bird per survey, respectively. The 13 willow flycatcher detections amount to a Project-wide relative abundance value for the species of 0.04 bird per survey.

Consistent with relicensing field study findings, willow flycatchers are known to be associated with dense riparian shrub habitat, specifically, dense willow thickets located near a stream, river, or water body (Csuti et al. 1997). The species breeds from southern California north to Canada and is reported to nest in Scotch broom and blackberry thickets located around disturbed habitat in the northern part of its breeding range (Csuti et al. 1997). The species is likely to nest in potential breeding habitat located throughout the study area and may occur during migration in a variety of habitats and all Project sections.

Black Phoebe

Black phoebes were not detected during general wildlife plot surveys. However, the species was noted incidental to other field studies immediately downstream of the Iron Gate dam in 2002 and 2003, and during ROI surveys in the Iron Gate-Shasta section and the J.C. Boyle peaking reach in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A).

Generally, black phoebes range south from California through southern South America (Ehrlich et al. 1988). The Klamath study area exists along the northern limit of the species' range, although most regional field guides indicate that the black phoebe occurs in Oregon only along the Siskiyou Mountains, west of the Project vicinity (Csuti et al. 1997). Phoebes prefer riparian areas (Project detections were noted along river reaches), but build a nest from mud substrate attached to a cliff or earthen bank (Csuti et al. 1997). The species may breed in the Project vicinity, but is probably most likely to occur in the study area during post breeding local dispersal.

Loggerhead Shrike

No loggerhead shrikes were detected in the study area during relicensing field studies. In general, loggerhead shrikes are thought to occur throughout most of North America (National Geographic Society, 1999), but regionally range typically east of the Project vicinity (Csuti et al. 1997).

Loggerhead shrikes “hawk” insects in open habitat including grassland and agricultural pasture and use thorns (barbed wire spikes) to hold their prey (CWHRS website). Although the Project lies at the regional western limit of the species range, loggerhead shrikes may occur in suitable habitat throughout the study area.

Pinyon Jay

No pinyon jays were detected in the study area during relicensing field studies. Pinyon jays have a restricted range that includes limited portions of the interior western United States including portions of central Oregon and northeastern California (National Geographic Society, 1999). Although no pinyon trees exist regionally, the species is associated in central Oregon with western juniper and ponderosa pine woodlands (Csuti et al. 1997). Regionally, pinyon jays are thought to occur only east of the Project vicinity, but the species occasionally may be found in the study area, particularly during the winter months when pinyon jays are known to wander in large con-specific flocks (Ehrlich et al. 1988).

Purple Martin

Purple martins were not detected in the study area during formal avian surveys or censuses. However, one purple martin was detected incidental to other field studies around Fall Creek above the upper falls in June 2002 (Figure 5.7-2; Table 5A-3 in Appendix 5A). ONHP has a record of a purple martin colony in buildings in the City of Klamath Falls. Purple martins have a patchwork breeding range in the western United States, but the study area lies within a regional area in which the species is thought to nest (National Geographic Society, 1999; Csuti et al. 1997). Purple martins are cavity nesters and require suitable nest sites located adjacent to open areas for foraging (Csuti et al. 1997). This species may breed in suitable habitat in the Project vicinity and is likely to occur in the study area during the summer and during migration.

Bank Swallow

No bank swallows were detected in the study area during relicensing field studies. The regional occurrence and distribution of this species in southern Oregon and northern California often is disputed, but most sources include the Project vicinity along the western limit of the bank swallow’s breeding range (National Geographic Society, 1999; Csuti et al. 1997). Bank swallows are colonial and nest in large numbers in small tunnels excavated in cliffs and earthen banks (Ehrlich et al. 1988). In Oregon, 12 known active nesting colonies have been monitored, but some believe the bank swallows may be more abundant than records indicate (Csuti et al. 1997). No colonies are known to exist in the Project vicinity, but the species may occur in the study area during the breeding season and migration.

Black-Capped Chickadee

Four black-capped chickadee detections were recorded in the study area during general wildlife plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). This included one detection in the Copco reservoir section and two Link River detections in May 2002, and one detection around Iron Gate reservoir in June 2002. In addition, black-capped chickadees were detected on census and captured in mist-nets during ROIs along Iron Gate reservoir and the Link River. The species also was detected incidental to other field studies throughout the 2002 and 2003 field seasons. Black-capped chickadees are known to range throughout the western United States and in the Project vicinity (National Geographic Society, 1999). The species is likely to occur in the Project vicinity year-round. Breeding by the species was confirmed during 2002 field studies, and black-capped chickadees are likely to nest in a variety of woodland habitats wherever suitable, small nest cavities can be found.

Pygmy Nuthatch

Twelve pygmy nuthatch detections were recorded during general wildlife plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). All 12 of the detections were located in ponderosa pine habitat with seven detections recorded around the J.C. Boyle reservoir and five detections recorded around Keno reservoir. These detections result in a relative abundance of 0.35 bird per survey in the J.C. Boyle reservoir section, and 0.22 bird per survey in the Keno reservoir section (Table 5A-8 in Appendix 5A). Repeated incidental species detections were noted through 2002 and 2003 in select locations with suitable ponderosa pine habitat. As indicated by the results of avian field studies, regionally, pygmy nuthatches are believed to be restricted to ponderosa pine woodlands (Csuti et al. 1997). In particular, studies have shown the species typically is found in ponderosa pine forests with less than 70 percent canopy closure (Csuti et al. 1997). The study area falls within the range of the pygmy nuthatch and the species is likely to be found throughout the Project vicinity.

Blue-Gray Gnatcatcher

Two blue-gray gnatcatcher detections were recorded during general wildlife plot surveys in 2002 (Figure 5.7-2 and Table 5A-7 in Appendix 5A). Both detections were noted during a single plot survey near Iron Gate reservoir in June 2002. These two detections result in a relative abundance for the species around Iron Gate reservoir of 0.053 bird per survey, and an overall relative abundance of 0.01 bird per survey Project-wide (Table 5A-8 in Appendix 5A). No additional detections of the species were recorded during other field studies in 2002.

Generally, blue-gray gnatcatchers are thought to breed in portions of North America that are south of Oregon (National Geographic Society, 1999). Gnatcatchers were not known to breed in Oregon until nesting was confirmed in 1962 (Csuti et al. 1997). Since 1962, the species' known breeding range has been expanded to include a portion of south-central Oregon that includes the Project vicinity (Csuti et al. 1997). The species is known to breed in the chaparral of the Klamath basin, and is likely to be found in association with this habitat type throughout the breeding season and during migration.

Western Bluebird

Four western bluebird detections were recorded during general wildlife plot surveys in 2002 (Figure 5.7-2; Table 5A-7 in Appendix 5A). All birds were detected in June 2002 with two detections noted within a single plot around Iron Gate reservoir and one detection recorded both in the Copco bypass and around Fall Creek. Accounting for survey number in each Project section, the highest relative abundance for western bluebirds occurred in the Copco bypass with 0.25 bird per survey. Bluebird relative abundance in the Fall Creek and Iron Gate reservoir sections was found to be much lower at 0.06 and 0.05 bird per survey, respectively. The four detections recorded during plot surveys amounted to an overall Project-wide relative abundance for the species of 0.01 bird per survey. The species was not noted during other field studies in 2002 or 2003.

The range of the western bluebird includes the entire Klamath study area and the species likely breeds in the Project vicinity and may occur year-round (Csuti et al. 1997; National Geographic Society, 1999). Western bluebirds can be found in a variety of open habitats. Species occurrence is thought to be limited by the availability of suitable nesting cavities (Ehrlich et al. 1988). In the study area, bluebirds are likely to nest in open clearings adjacent to woodlands or human-made structures providing suitable nest sites.

Yellow Warbler

During general wildlife plot surveys conducted in 2002, 240 yellow warbler detections were recorded (Figure 5.7-2; Table 5A-7 in Appendix 5A). Detections were noted in 14 of the 21 delineated cover types and in all 11 Project sections (Table 5A-23 in Appendix 5A). The large majority (63 percent) of yellow warbler detections was located in riparian/wetland scrub-shrub (104) and riparian/wetland forest (48). The yellow warbler is the only avian TES species that was found to occur in all Project sections and was located in more distinct habitat types than any other avian TES species. In the fall of 2002, ROI data indicate yellow warblers also were detected during ROI censuses along the Iron Gate-Shasta section, Link River, and Iron Gate reservoir, and J.C. Boyle peaking reach riparian habitat. The species was observed in abundance incidental to other surveys conducted throughout the 2003 field season.

Table 5A-23 (in Appendix 5A) indicates that the largest numbers of yellow warbler detections (ranked in descending order) noted during plot surveys were recorded in the Iron Gate-Shasta (50), Keno Canyon (47), Link River (45), and J.C. Boyle peaking reach (42) Project sections. Relative abundance data in Table 5A-23 (in Appendix 5A) provides a more accurate assessment of comparative abundance controlling for the disparate number of surveys in each Project section. Keno Canyon was found to support the highest relative abundance of yellow warblers at 2.61 birds per survey with the Link River a close second at 2.17 birds per survey. Overall, yellow warblers were found to be the ninth most abundant species detected during plot surveys (Table 7A-4 in Appendix 7A; Appendix 5F) with a Project-wide relative abundance of 0.81 birds per survey.

The frequency of yellow warbler detections was highest in riparian/wetland scrub-shrub habitat. Of the 240 plot-survey yellow warbler detections, 173 were in riparian habitat. Of this amount, 74 yellow warbler detections were recorded in a survey plot. These 74 in-plot yellow warbler detections amounted to a relative abundance of 3.54 (SD 5.441) birds per acre (8.85 birds per ha) of in-plot, surveyed riparian/wetland scrub-shrub habitat (Appendix 5G). In general, in-plot yellow warbler densities in riparian/wetland scrub-shrub habitat resulted in less than two birds per acre (five birds per ha) of surveyed habitat in the Copco reservoir, Fall Creek, Iron Gate reservoir, and J.C. Boyle reservoir sections and between four and five birds per acre (ten to 13 birds/ha) in the Link River and Iron Gate-Shasta sections, respectively (Appendix 5G).

Results from avian field surveys are consistent with the known breeding range and habitat association for the yellow warblers. Yellow warblers breed in riparian habitat throughout North America and winter south from Mexico through South America (Ehrlich et al. 1988). See Section 7.7 for additional discussion of the yellow warbler.

Yellow-Breasted Chat

Twenty-two yellow-breasted chat detections were recorded during general wildlife plot surveys (Figure 5.7-2; Table 5A-7 in Appendix 5A). Plot survey data indicate that chats were found in four Project sections and five distinct habitat types (Table 5A-24 in Appendix 5A). The largest number of chat detections (12) was recorded along the Iron Gate-Shasta section while the J.C. Boyle peaking reach accounted for the second largest number of detections (seven). Combined, these two Project sections accounted for 86 percent (19 of 22) of all plot survey chat detections. Most chats were detected in riparian cover types with only two of the 22 total detections recorded in non-riparian upland habitat.

Of the five Project sections in which ROIs were conducted, yellow-breasted chats were detected only in the J.C. Boyle peaking reach. The species was detected during censuses and captured in mist nets during the ROI conducted along Shovel Creek.

Relative abundance data indicates that yellow breasted chats were most commonly detected during surveys in the Iron Gate-Shasta section with 0.67 bird detected per survey (Table 5A-8 in Appendix 5A). This relative abundance value is more than six times the second highest Project section relative abundance for chats (J.C. Boyle peaking reach: 0.10 bird per survey) and more than tenfold higher than the relative abundance per survey for chats around Fall Creek and Copco reservoir. Overall, the 22 chat detections amounted to a Project-wide relative abundance of 0.08 bird per survey for the species.

Consistent with avian survey results, yellow-breasted chats are known to be highly associated with riparian habitat and breed throughout the study region in brushy vegetation, typically willow thickets, along rivers and streams (Csuti et al. 1997). The species also can be found in the brushy understory of deciduous and mixed woodlands (Csuti et al. 1997). Chats are likely to occur throughout the study area, although 2002 avian field study results indicate that the species is likely to be found in highest densities in riparian habitat of the Iron Gate-Shasta section. See Section 7.7 for additional discussion of the yellow-breasted chat.

Black-Throated Sparrow

No black-throated sparrows were detected in the study area during relicensing field studies. The species' range is thought to lie east of the Project region (National Geographic Society, 1999). In Oregon, the black-throated sparrow has been known to breed in the southeastern portion of the state, with sporadic records of breeding in other isolated areas, including Klamath County (Csuti et al. 1997). Even within its known breeding range in Oregon, it is thought that the species may not nest successfully every year (Csuti et al. 1999). The species is unlikely to occur in the Project vicinity, but occasionally may be found (or even nest) in suitable arid, open brushy areas in the study area, upstream of J.C. Boyle dam.

Tri-Colored Blackbird

No tri-colored blackbirds were detected in the study area during relicensing field studies. Tri-colored blackbirds have a restrictive and isolated range along the western United States. The species is colonial, breeding in aggregations of more than 1,000 birds, but the locations of breeding colonies may change year-to-year (Csuti et al. 1997). Tri-colored blackbird breeding aggregations have been documented near Upper Klamath Lake in Oregon (Csuti et al. 1997).

There is one historical record (1980) of tri-colored blackbirds near lower Keno reservoir outside of the study area. In northern California, the only consistently documented breeding colony is at Tule Lake, approximately 30 miles (48 km) southeast of the study area (California Wildlife Habitat Relationship System website). In the Project region, tri-colored blackbirds migrate to southern portions of the species' range (likely central California) to overwinter. Tri-colored blackbirds occasionally may breed in the study area and are likely to occur in the Project vicinity during the summer and during migration to and from northern breeding areas.

5.7.2.4 Mammals

The following sections provide data and analysis on TES mammal species detections recorded in the Project vicinity. Of the 23 mammal species originally identified as potentially occurring in the study area, only two, the western gray squirrel and the Yuma myotis bat, were detected during terrestrial field studies (Table 5A-6 in Appendix 5A). The following section provides data and analysis on TES mammal species detections recorded in the Project vicinity and information on species occurrence and distribution near the Klamath study area based on historic records, species literature, and existing documentation.

Preble's Shrew

No Preble's shrews were detected in the study area during relicensing field studies. Typically, Preble's shrews range east of the study area in arid to semi-arid shrub/grass habitats, although individuals have been recorded in a wide range of habitats (Knopf, 1996). The species occurs as far west as east Lake County in Oregon and east Modoc County in California (Knopf, 1996). Little is known about this small mammal species, and range delineation is based on sparse records. Although the study area lies west of the species' range, there is a potential for occurrence of the Preble's shrew in the Project vicinity.

TES Bat Species – Western Small-Footed, Yuma, Long-Legged, Long-Eared, and Fringed Myotis; Silver-Haired Bat; Spotted Bat; Pale and Pacific Western Big-Eared Bat; Pacific Pallid Bat

The ten TES bat species (and subspecies) identified as having a potential for occurrence in the Project region are addressed together because many of these species share similar ecology and habitat requirements. Although some of these bats exhibit distinctive habitat preferences, in general these species are found in open forests and a variety of habitats (CDFG website). For most of these bats, the availability of suitable roost sites (rock crevices, cliff ledges, and, notably, some human-made structures) limits species distribution and occurrence (Csuti et al. 1997).

Maps of regional distribution for all potentially occurring TES bat species indicate that all species could occur in the study area except the spotted bat (Csuti et al. 1997). The spotted bat often is considered one of the rarest mammals in North America and its known distribution in Oregon is based on only two documented records (Csuti et al. 1997). In the region, the spotted bat is speculated to be rare, but widely distributed and, thus, potentially could occur in the study area. Regardless of the extent of a bat species' known range, knowledge of TES bat species distribution in the Project region is based on so little specific data, that all TES bat species potentially could occur in the study area.

Both the western big-eared bat and the Yuma myotis have been documented in the study area. Cross et al. (1998) conducted a study of bats using the Salt Caves and structures at the Hoover Ranch house, both located in the J.C. Boyle peaking reach section. Both Yuma myotis and western big-eared bats were found to use these areas as roost sites, and mixed-species groups of more than 800 bats were recorded during individual surveys (Cross et al. 1998). The Hoover Ranch structure appears to be used as a maternity site for a large colony of Yuma myotis (Cross et al. 1998). At the Salt Caves, the larger cave was used by western big-eared bats as a maternity site between 1989 and 1993, and was the only maternity site in Klamath County (Cross et al. 1998). Yuma myotis also were tentatively identified in the Copco No. 1 powerhouse and Copco No. 1 gatehouse during bat roost surveys.

In 2003, bat roost surveys were conducted in and around 24 Project facility sites in accordance with survey methodology described in Section 6.4.2.2. Surveys in the upper Project reaches, including 15 facility sites, were conducted on June 9, 2003, and nine lower facility sites were surveyed on June 13, 2003. Of the 24 facility sites inspected, six were found to contain roosting bats and ten were found to contain evidence of recent bat use (Table 5A-25, in Appendix 5A).

Bat roost surveys resulted in the detection of approximately 480 bats. Results are cited approximately because the nature of the facility roosting sites and the behavior and characteristics of the roosting bat populations rendered exact species counts impossible. Detected bats were found roosting in small ceiling cracks and crevices where access precluded comprehensive inspection, or were in large, dense aggregations where the exact number of individuals could not be discerned specifically.

Large aggregations of roosting bats were detected in the Copco No. 2 dam gatehouse and the crane cover driver of the Copco No. 2 powerhouse with an estimated 300 and 100 bats detected at each location, respectively. The estimated numbers of individuals detected at other survey locations generally were found to be much lower, ranging from a low of four bats detected in the transformer bays of the Copco No. 1 powerhouse to a high of 40 bats observed in the rafters of the Iron Gate south gatehouse. Yuma myotis species identification was confirmed through inspection of a dead specimen at the Copco No. 2 powerhouse (possibly injured by the crane mechanism). However, given bat grouping behavior and morphological similarities between species and the difficulty of determining species identification without in-hand inspection, it is possible that the sites with confirmed evidence of bat use support aggregations of more than one species. None of the bats appeared to be western big-eared bats. Several Project personnel report anecdotally that bats used to be more common both at Copco No. 2 village and near the J.C. Boyle dam.

None of the 14 bridges examined in the study area had evidence of bat roosting at the time of survey. However, because each was examined only once and typically was not monitored by "exit counts," it is uncertain if the bridges are used at some times of the year. In the case of several of the major highway bridges, the smooth concrete does not have crevices necessary for bats. In Texas, bat roost site preferences were influenced significantly by crevice depth and width, by whether crevice tops are covered, by the presence or absence of vegetation typically beneath the bridge, and by bridge construction materials (Bat Conservation International website).

Pygmy Rabbit

No pygmy rabbits were detected in the study area during terrestrial field studies. Pygmy rabbits have a spotty distribution throughout their range, but generally are found in the Great Basin and contiguous area sagebrush and rabbitbrush habitat (CDFG website). The Project region lies west of the known range for the pygmy rabbit although small patches of suitable sagebrush and rabbitbrush habitat exist in the study area (See Section 2.7). This species may occur in the Project vicinity in sagebrush habitat.

Sierra Nevada Snowshoe Hare

No snowshoe hares were detected during 2002 field studies. Generally, Sierra Nevada snowshoe hares range in the foothills and higher elevations of the Sierra Nevada Mountains south of Mount Lassen (CDFG website). This species is unlikely to occur in the study area because the Project vicinity lies north of its range and Sierra Nevada snowshoe hares typically are found only at elevations above 4,800 feet (1,463 m) (CDFG website).

White-Tailed Jackrabbit

No white-tailed jackrabbits were detected in the study area during relicensing field studies. White-tailed jackrabbits are a nocturnal species believed to prefer open grasslands and sagebrush habitat (Csuti et al. 1997). Although this species once was thought to be common in the Project region, its distribution in Oregon now is thought to be discontinuous (Csuti et al. 1997). However, the study area lies within the species' range and white-tailed jackrabbits may occur in a variety of open habitat types throughout the Project vicinity.

Western Gray Squirrel

Four western gray squirrel detections were recorded in 2002 incidental to other field studies along the Copco bypass, Copco reservoir, and along J.C. Boyle reservoir. In early 2003, field studies began that targeted mammals (winter bait station and track surveys) and the species was detected again in those three Project sections as well as the J.C. Boyle peaking reach (Table 7A-1 in Appendix 7A). Western gray squirrels can be found in a variety of forested habitat types, but populations have declined from competition with introduced eastern gray squirrels, which often are found in urban areas of the western United States (Csuti et al. 1997). The study area lies in the known range of the western gray squirrel and the species is likely to occur in a variety of forest types in the Project vicinity. Although no systematic study of gray squirrel occurrence and distribution in the Project vicinity has been conducted to date, gray squirrel detections and documented records for the species exist in the study area and throughout the general Project region (Nelson, 1997).

White-Footed Vole

No white-footed voles were detected in the study area during relicensing field studies. The white-footed vole is a small rodent found in humid riparian forests along the Coast Range and west slope of the Cascade Mountains (CDFG website). Suitable riparian habitat contiguous with moist coniferous forest does not occur in the study area and the Project vicinity lies outside of the species' known range (Csuti et al. 1997). Small mammals were specifically targeted for detection during 2003 trapping studies, but this species was not detected.

Oregon Red Tree Vole

No red tree voles were detected in the study area during 2002. The red tree vole has an ecology, range, and regional distribution similar to the white-footed vole (Csuti et al. 1997). Oregon red tree voles are not likely to occur in the Project vicinity.

Sierra Nevada Red Fox

No red foxes were detected during 2002 field studies. Sierra Nevada red foxes are associated with lodgepole pine and red fir forests in the sub-alpine zone and the alpine fell-fields of the Sierra Nevada Mountains (CDFG website). There are no confirmed records for the species from below 5,000 feet (1,524 m) elevation (CDFG website). No suitable habitat for the species exists in the study area and the species is unlikely to occur in the Project vicinity.

Ringtail

No ringtails were detected during 2002 field studies. Ringtails are secretive, nocturnal carnivores in the same family as the raccoon. Bait stations established for the 7 weeks of forest carnivore surveys in 2003 were located in areas/habitats where ringtails could be present. No ringtails were detected during the 2003 bait station surveys. Detection of this species is believed to be unlikely without using species-specific tree-located trapping methodology (Farrell, pers. comm., 2003). However, fur trappers reported trapping the species along the J.C. Boyle peaking reach in years past. The study area lies within the northwestern limit of the ringtail's known range and this species is likely to occur in the Project vicinity in a variety of forest and open habitat (Csuti et al. 1997). Historically, ringtails have been observed in the J.C. Boyle peaking reach downstream of the J.C. Boyle powerhouse.

American Marten

No martens were detected during terrestrial field studies in 2002 and 2003. The American marten is a relatively small carnivore found in closed-canopy forest (Csuti et al. 1997). Studies from radio-collared martens in the Sierra Nevada Mountains indicate that the species prefers old growth type forest stands with 40 to 60 percent canopy closure and avoids stands with less than 30 percent canopy closure (Spencer et al. 1983). Although the species can occur at any elevation, the marten's range in Oregon and northern California generally follows the undeveloped corridors of the Coast Range, and Cascade and Sierra Nevada Mountains (Kucera et al. 1996; Csuti et al. 1997). Few records exist for this species in south-central Oregon. However, the study area lies within the species' known range and martens may occur in suitable forest stands throughout the Project vicinity.

Pacific Fisher

No Pacific fishers were detected in the study area in 2002 and species occurrence is unlikely, although possible, in the Project vicinity. Fishers are forest carnivores with a spotty and restricted range along the Pacific Coast from Alaska south to California (National Audubon Society, 1996). They are known to occur in British Columbia and northwest California, but may be completely extirpated from points in between, potentially including the entire state of Washington (Aubrey and Houston, 1992). They prefer dense, closed-canopy coniferous forest, but may range through a variety of habitats (CDFG website).

Fishers are highly secretive, wide-ranging species and sightings of the species in southern Oregon are extremely rare. However, in comparison to other regions of the species' range in western North America, fishers may be relatively abundant in southwestern Oregon (USFS, 1999). The USFS trapped 22 fishers in the upper Rogue River valley in southwestern Oregon from 1995 through 2000 and monitored 20 individuals fitted with radio tags in land located northeast of Medford (USFS, 2000). Given the large home range of fishers in southwestern Oregon, which has been determined to extend up to approximately 57 square miles (147 square km) based on USFS telemetry data (USFS, 2002), fishers occasionally may occur throughout the Project vicinity although remain undetected. Near the Prospect Hydroelectric Project, along the Rogue River, Oregon, fishers were documented moving on both sides of a water conveyance system (USFS, 2000).

California Wolverine

No wolverines were detected during relicensing field studies. The wolverine, a close relative of the fisher, is a far-ranging, elusive carnivore of high-elevation open forests and alpine habitat (WDFG website). The current and historic known range for this species is based on few documented detections, but generally, wolverines are believed to occur in the high Cascade Mountains of Oregon and in the Sierra Nevada Mountains south of Mount Shasta in California (Csuti et al. 1997; CDFG website). The species is unlikely to occur in the Project vicinity.

Canada Lynx

No lynx were detected in the study area during relicensing field studies. Lynx are rare, solitary, boreal forest felines with a northern range extending south along the west coast to southern Oregon. Records for the species in Oregon are scarce, with the last confirmed specimen taken in Corvallis in 1974 (Csuti et al. 1997). Given the species' scarcity, lynx are unlikely to be detected in the Project vicinity.

Gray Wolf

No gray wolves were detected during terrestrial field studies and the species is highly unlikely to occur in southern Oregon and the Project region. Gray wolves typically range in northern areas of tundra and untouched wilderness (National Audubon Society, 1996). In general, the species' range includes areas north of the United States border and south to Colorado in the Rocky Mountain corridor (Burt and Grossheider, 1980). Although wolves have been documented recently in the far northeastern corner of Oregon, this species has little potential of ranging near the Project region.

5.8 DISCUSSION

The sections below provide an assessment of existing and future conditions for TES wildlife and plant species in the Project vicinity based on the results of the TES species inventory and the vegetation cover type, riparian, wetland characterization studies, Project operations, and proximity to Project features (Sections 2.0 and 3.0). Particular emphasis is placed on those habitats, specific habitat features, and Project sections found to be important for constellations of TES plant and wildlife species or that may be critical to the continued occurrence of TES species with especially sensitive federal or state protective status (e.g., state or federal listed endangered, threatened, or candidate species).

5.8.1 Assessment of Existing Conditions

Fifty-eight of the 172 TES plant and vertebrate species originally identified as potentially occurring in the Project vicinity were detected during relicensing field studies. In addition, 16 TES wildlife species are reported to occur or historically occur in the study area, but were not detected during field studies for this TES species inventory. Thus, a combined total of 77 TES species may occur in the Project vicinity including 14 vascular plant and 63 vertebrate wildlife species. The largest number of TES plants and wildlife species was found in the J.C. Boyle peaking reach.

The Project area contains habitat for the federally listed bald eagle and northern spotted owl. Known nests are unlikely to be directly affected by Project facilities, and the Project will not alter potential nesting habitat. Most spotted owl use occurs outside of the river canyon, although one of the pairs that nest above the canyon rim appears to use the canyon bottom downstream of the J.C. Boyle powerhouse. As for the bald eagle, Project reservoirs provide foraging habitat for nesting and wintering eagles. The J.C. Boyle peaking reach is used by foraging bald eagles from the Grizzly Butte and Pony Express territories; this reach is probably especially important during very cold periods when reservoirs are frozen, and when flows are less than 1,000 cfs (28 cubic m^3/sec]). There is a small chance of recreational disturbance to the Pony Express nest located near the river in the peaking reach, but it is unlikely because of poor access. A new bald eagle nest was identified in 2003, located approximately 540 feet (165 m) from Copco dam. This new "Copco dam" nest is located in an undeveloped forested area with limited access. However, the nest was not active in 2003, so the degree to which the nest is used is not known. Project transmission lines have not caused any known bald eagle mortalities since recordkeeping began in the 1980s.

TES wildlife species were found to occur in each of the 11 Project sections and in every delineated habitat type except rock talus (rock talus habitat comprised a small proportion of the total habitat surveyed for TES species [Table 5A-4 in Appendix 5A] and may be used by several TES reptile species). TES birds represent the largest group of TES species detected in the study area with 39 species detected during field studies for this TES inventory and an additional 11 species known to occur in the Project vicinity. The relative abundance of detected TES bird species allows them to be used as effective indicators of habitats and portions of the study area important to assemblages of TES species. Tables 5A-26 and 5A-27 (in Appendix 5A) provide data on all avian TES detections recorded during plot and facility surveys by habitat type and Project section, respectively.

As indicated in Table 5A-5 (in Appendix 5A), most avian TES detections were recorded in association with wetland, riparian, or open water habitat. TES bird detections recorded in these habitat types—including palustrine emergent wetland, riparian/wetland forest, riparian/wetland scrub-shrub, riparian grass, riparian mixed, and lacustrine and riverine habitats—constituted more than 55 percent of all TES bird detection recorded during avian plot and facility surveys (Table 5A-5 in Appendix 5A). Although this apparent species/habitat association for TES bird species likely was skewed by the predominate focus on these habitat types during avian TES field surveys, TES species inventory results emphasize the importance of riparian and wetland habitats across all TES species groups. All amphibian TES species detected during this study or historically thought to occur in the Project vicinity (i.e., the western toad, spotted frog, and foothill yellow-legged frog) rely on wetland and riparian habitats at some stage in their life cycle and the single amphibious reptile found in the study area, the western pond turtle, is found exclusively in these habitat types. In addition, many TES mammal species, including most of the potentially occurring TES bat species, use riparian areas and the habitat found along the edges of open water bodies for foraging. Closed-canopy forest habitat types also were found to be important to a variety of TES wildlife species (e.g., TES woodpeckers, raptors, mammals, etc.). However, when looking at Project effects, a greater emphasis should be placed on riparian, wetland, and open-water-associated habitat because these habitat types are most likely to be affected by continued and future Project operations.

Relative abundance data (Table 5A-8 in Appendix 5A) indicates that the Link River accounted for the most avian TES species detections per survey (10.78) with Keno reservoir a close second (10.00). Large aggregations of pelagic and waterfowl TES species—specifically large flocks of American white pelicans—found on Keno reservoir, the Link River, and the lower portions of Upper Klamath Lake mask the abundance of other TES species. However, Keno reservoir was found to support a relatively high abundance of TES wildlife across species groups. In particular, the largest number of western pond turtles recorded in the Project vicinity was found to occur along Keno reservoir. The shear relative size and proportion of available wetland and riparian habitat along the margin of Keno reservoir (Section 6.7.4; Section 6.0, Table 6.7-5) proves this Project section of exceptional importance in consideration of the maintenance of TES wildlife species populations in the study area vicinity.

The federally listed plant species, Applegate's milkvetch, occurs along Keno reservoir. One population was found to be less than 2 feet (0.6 m) above the reservoir water level and likely receives groundwater as a result of the reservoir. Changes in reservoir management could affect the species. Water level fluctuations also could effect three other TES plant species at Keno Reservoir: short-podded thelypodium, Columbia yellow cress, and salt heliotrope. Areas peripheral to Keno reservoir are known to support populations of all three of these TES plant species and include both partially flooded habitat and areas with notably shallow sub-surface hydrology. Short-podded thelypodium and Applegate's milkvetch also grow in slightly more upland habitats that presumably still have shallow sub-surface hydrology.

TES plant species found to grow in wet habitats in other parts of the study area include red root yampah, Howell's yampah, mountain lady's slipper, pendulus bulrush, Bellinger's meadow foam, and pygmy monkeyflower. In all cases, the hydrology supporting the specific wetland and riparian micro-habitats in which these species were found was independent of Project-influenced flows because they were at isolated wetlands or springs above the river's normal water surface elevation during the growing season. However, scouring or flooding resulting from extremely high flows (above 3,000 cfs) may affect an isolated area supporting TES plant species located approximately 10 to 15 feet (3 to 5 m) horizontal distance from the river along the J.C. Boyle peaking reach. At this site, pendulus bulrush (SCPE-3) and potential red root yampah (PEER-17) grow in a wet meadow adjacent to the river. No evidence of erosion or scour from Klamath River flows was found at the site and the site appears to have a durable, high-density cover of meadow vegetation that appears to withstand intensive cattle grazing and use by recreationists. Other TES occurrences that lie near to the Klamath River, but not close enough to be affected by any except the largest of flood events, which are not controlled by the Project, include PEHO-2, -3, and -10, and PEER-16.

In general, both plant and wildlife TES species occurrence and distribution in the study area appear largely tolerant or compatible with existing Project operations and largely dependent on maintenance of hydrology capable of supporting sufficient wetland and riparian habitat along the margins of Project reservoirs and river reaches. Among Project reservoirs, the Keno reservoir section was found to contain both the largest amount of available wetland/riparian habitat and the largest percentage of these habitat types along the length of reservoir shoreline. The relatively high "densities" or occurrences of TES species appears to be related to the size, type, and quality of these habitats. The existence of riparian and wetland habitat in this Project section likely is influenced by the low-lying topography and limited water level fluctuations (artificially maintained reservoir levels that contribute to a more consistent hydrological regime) along Keno reservoir relative to other Project reservoirs and river reaches.

5.8.2 Assessment of Future Conditions

Future conditions related to potential Project effects on TES species can be generally categorized into localized influences from: facility maintenance; facility vegetation management; road use and management; recreational disturbance; and transmission line effects on avian species, or they can be larger-scale potential influences, such as the effects of hydrology on populations or habitat. Future potentially occurring conditions are discussed below.

Facility maintenance and vegetation management practices are geographically limited, occurring only in close proximity to built structures and thus have less potential to affect TES species populations than do large-scale habitat changes. A few individuals potentially can be harmed or disturbed by continued Project operations. Project powerhouse and building facilities provide roosting habitat for bats and the potential for disturbance and occasional harm will continue as long as bats use the buildings. On Project ROWs, vegetation will continue to be maintained in an early successional stage, which has the potential to affect a few TES plant populations that occur in these ROWs. Locations of TES plant populations have been identified, making them easier to avoid and protect. Road maintenance activities will continue on Project roads, but few TES species are likely to be affected. Traffic on major roads likely will increase because of growing residential and recreation demands; snakes and other reptiles may be most prone to the recreational and road impacts. Large water birds are the group of TES species that might be most susceptible to transmission line collisions. Continued monitoring and treatment of any problem lines under PacifiCorp's bird powerline management program will continue to improve safety conditions for large birds and reduce avian powerline interactions. If reservoir pool level management regimes continue to be similar to existing conditions, waterfowl and wading birds on the TES list are unlikely to be affected.

The overall future occurrence, status, and distribution of TES plant and wildlife species in the study area, however, will be largely dependent on the continued maintenance of existing suitable habitat throughout the Project vicinity. If no changes are made to the reservoir and river water level management, the availability and condition of riparian and wetland habitat are likely to remain unchanged from the current conditions. Major alterations to Project operations may affect the availability and distribution of wetland and riparian habitat along Project reservoirs, potentially resulting in significant repercussions to existing and potentially occurring TES species populations that are dependent on those habitats. At Keno reservoir for example, because of the flat topography, TES plants could be affected by changes to flow management and pool level alteration at Keno dam. In a similar manner, throughout all Project sections, wetland- and riparian-associated TES wildlife also could be affected by changes to the availability and distribution of these habitat types that result from changes in flows.

Potential impacts to TES species resulting from changes in Project operations could be beneficial or detrimental to species abundance and continued viability. It is difficult to provide a general assessment of how alterations to Project flow management ultimately would affect the availability and distribution of shoreline habitat types. Depending on localized shoreline topography, both increases and decreases in reservoir pool level and river reach flow could result in an increase in available riparian and wetland habitat. Riparian habitat is assessed in more detail in Section 3.0.

In addition to the potential effect of future changes to the availability and distribution of suitable habitat in the Klamath study area, broad-scale regional changes in land use and development patterns are likely to substantially affect the continued occurrence, status, and distribution of TES species in the Project vicinity. It is expected that increased development in southwest Oregon and northwest California will result in continued habitat loss and degradation. Habitat most likely to be affected by increased development includes large areas of unfragmented, contiguous forest as well as wetland and riparian habitat. Loss and degradation of these habitat types is likely to substantially limit the occurrence of TES species in the study area. In particular, regional habitat loss and degradation in areas surrounding the study area could severely limit the recruitment and movement of TES wildlife species into the study area and restrict connectivity between study area habitat and other suitable habitat in the region.

6.0 WILDLIFE MOVEMENT/HABITAT CONNECTIVITY ASSESSMENT

6.1 DESCRIPTION AND PURPOSE

The purpose of the wildlife movement/habitat connectivity assessment is to describe existing impacts to wildlife caused by Klamath Hydroelectric Project reservoirs, diversion canals, powerhouses, flumes, and transmission lines. This assessment includes a literature review and field surveys to address movement and connectivity issues. Also included is a discussion of the role of Project-related habitats in supporting regional wildlife populations.

6.2 OBJECTIVES

The specific objectives of this study are to:

- Describe the effects of Project reservoirs and structures (canals, flumes, transmission lines, and roads) on wildlife movement and their use of habitats critical for meeting their life requisites.
  - Wildlife being entrapped in the Fall Creek, East Side, West Side, and J.C. Boyle canals
  - Wildlife drowning while entrapped in waterways or while attempting to swim across Project reservoirs
  - Terrestrial wildlife not being able to effectively cross the Project
  - Reduced habitat connectivity (primarily riparian habitats) and isolation of meta-populations
  - Mortality as a result of collision with or electrocution by transmission lines (note that distribution lines are more likely to cause electrocution, but are not part of the FERC Project, however, a brief review of the raptor-safe status and PacifiCorp's remediation policy is included)
- Evaluate whether the physical characteristics of the waterways allow entry or prevent crossing by wildlife and whether existing crossing opportunities (bridges or underpasses) along the Project waterways are adequate.
- Identify Project transmission lines that present collision or electrocution hazards to birds (especially TES species, waterfowl, raptors, and other migratory birds) and summarize information (line configuration, avian mortality data collected by PacifiCorp line patrols, and remediation/raptor-safe construction policy) for PacifiCorp-owned power lines in the study area.
- Provide data on road-induced wildlife mortality.
- Provide information useful in developing PM&E measures in the license application.

6.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

The wildlife movement/connectivity assessment primarily addresses the issue of Project features (dams, powerhouses, flumes, transmission lines, roads, and canals) acting as barriers to movement by mammals, amphibians, and reptiles and potentially causing wildlife mortality. Results of the various analyses conducted in this assessment will be used to describe Project effects and develop PM&E measures in the license application, as necessary, to protect or enhance these resources.

6.4 METHODS AND GEOGRAPHIC SCOPE

Methodology for this assessment included: (1) a review of existing literature and data on the effects of reservoirs and hydroelectric Project operations on big game movement; (2) an assessment of wildlife entrainment in canals and connectivity issues including how roads affect habitat connectivity and wildlife movement; (3) an assessment of transmission line effects on wildlife; and (4) an assessment of the role of Project habitats for regional wildlife. The following sections describe these methods in detail.

6.4.1 Literature Review of the Effects of Reservoirs and Hydroelectric Project Operations on Big Game Movement

PacifiCorp reviewed literature and interviewed agency and other biologists to summarize existing information relating to the effects of reservoirs on big game movement. This information emphasized the importance of particular local plant communities, known migration patterns and access to wintering and fawning areas, and results of other studies that examined the direct effects of reservoirs on big game habitat use and mortality. Literature was obtained from various sources, including journals, scientific meeting proceedings, agency studies, electric utility and industry group studies, FERC studies and reports, and agency files and reports. This information was used to identify locations in the study area that represent areas of concern for big game movement. The license application provides recommendations for PM&E measures that address big game movement in the Project boundary.

6.4.2 Wildlife Entrainment in Canals and Wildlife Connectivity Assessment

PacifiCorp conducted an initial assessment of potential impacts from the Project's aboveground waterway features based on existing information and results of vegetation mapping and wildlife surveys conducted in 2002. At the request of the TRWG, additional studies were conducted through the 2003 field season to document wildlife species occurring along Project canals and potentially susceptible to mortality and movement barriers. Components of the entrainment and connectivity assessment include:

- Summarizing and analyzing existing PacifiCorp data on known wildlife losses in the Project canals

- Reviewing vegetation mapping and results of wildlife surveys to determine the species that either are known to occur or potentially occur around the Project waterways, and the suitability of adjacent habitat

- Inventorying and describing the facilities to examine the range of potential threats to animals for each section of waterway. This includes maps of each waterway showing the physical characteristics, such as size, length, elevated flume ground clearances, locations of accessible sections, information on water velocity, waterway composition (e.g., earthen canal versus concrete flume), waterway escape opportunities, and existing crossing opportunities; the surrounding topography and habitat characteristics; and trails and wildlife sign. For canals and flumes, GIS was used to document the locations of existing crossing opportunities.

- Conducting supplemental field studies in 2003 specifically emphasizing wildlife movements, connectivity, and potential distribution near Project facilities including small mammal trapping; winter bait station and track surveys; snake hibernacula surveys; and a wildlife road mortality study.

The following sections describe the methods for these tasks.

6.4.2.1 Data on Wildlife Losses in the Project Canals

Data on wildlife entrapment in Project canals were obtained from two sources. Project personnel provided data on documented wildlife mortality in each of the canals as documented by animal carcasses removed from trash racks during the regular operational activities. PacifiCorp personnel check canal trash racks regularly and document wildlife mortalities as they are observed. The reporting system was designed mainly to record big game mortalities, but wildlife of medium size also are noted. Datasheets used by Project personnel include: observer name, date found, location, species, sex, age, number of antlers, condition, disposal of carcass, follow-up agency contact information, and remedial measures. Database records have been maintained since 1983. The second source of actual entrainment data was the East Side/West Side sucker entrainment study that sampled the two canals for extended periods of time with fyke nets (Gutermuth et al. 1999 and 2000). Datasheets from that study were reviewed for incidental catch observations. The study was conducted from April 1978 through October 1999 and represents approximately 5,370 net-hours for the East Side canals and 4,547 net-hours for the West Side canals.

During a TRWG meeting, the USFWS suggested that PacifiCorp use an above-water trap system to sample the canal to estimate number of small animals entrained. At the December 2002 TRWG meeting, it was decided that a better option was to use live traps in habitats along the canals to determine which small animals occur immediately adjacent to the J.C. Boyle, Fall Creek, and East Side/West Side canals. This small mammal trapping was conducted from May through September 2003 (see Section 6.4.2.2).

6.4.2.2 Habitats and Species Affected by Canals and Other Project Facilities

The following studies were conducted, implemented, and/or reviewed through 2002 to provide data on species potentially affected by Project canals, structures, and select facilities: (1) 2002 vegetation cover type mapping and field confirmation of specific areas along each Project facility; (2) 2002 and winter 2003 wildlife surveys along the J.C. Boyle canal and in the general vicinity of all Project facilities; (3) review of all previous distribution and habitat association studies and information available from published literature and state and federal resource agencies; (4) small mammal live trapping along Project canals; (5) winter bait station and track surveys for forest carnivores and other mammals; (6) snake hibernacula and supplemental terrestrial reptile surveys near Project facilities; (7) a wildlife road mortality study during 2003; and, (8) bat roost surveys in suitable Project facilities. Specific methodologies for 2002 and 2003 surveys and studies conducted as part of the assessment of habitats and species affected by Project canals and facilities are described in detail in the following sections.

Vegetation Cover Type Mapping - 2002-2003

Specific methodology used for vegetation cover type mapping is described in detail in Section 2.4. Results of the vegetation mapping study were used to describe the type of wildlife habitat present along Project facilities. The juxtaposition of habitats also was examined qualitatively to determine how species might move through the area associated with the facilities to meet life requisites. For example, amphibians may move between wetland breeding sites and other habitats while other species may move into riparian habitats during summer.

Project Canal Surveys – 2002-2003

The 2002 field surveys included biologists walking along the J.C. Boyle canal three times during the spring and summer—May 24, June 18, and August 7—and documenting wildlife and wildlife signs; a fourth visit was conducted during the winter track surveys in February 2003. GIS was used to show locations of wildlife trails. In addition, reptile and amphibian information collected at wildlife survey plots (see Section 4.0) was used to document species that occur in vegetation cover types along each canal. Of the 149 1.96-acre (0.79-ha) wildlife survey plots used during terrestrial relicensing studies (Section 4.0, Figure 4.4-1), 31 plots were determined to be located near Project canals in various cover types (Table 6.4-1).

Table 6.4-1. Number of wildlife survey plots sampled near Project canals, 2002.

Cover Type	Copco No. 2	Fall Creek	J.C. Boyle Canal	East Side/ West Side
Emergent Wetland		1		
Scrub-Shrub Wetland		1		
Riparian Grass			1	2
Riparian Shrub			5	3
Riparian Deciduous	1			2
Riparian Mixed		4		
Perennial Grass			1	
Juniper				2
Oak Woodland	1	1		
Oak-Conifer	1	1		
Ponderosa Pine			2	
Lodgepole Pine			1	
Mixed Conifer			1	
Total	**3**	**8**	**11**	**9**

Literature Review – 2002-2003

Literature on species distribution and habitat associations was used to supplement information on wildlife species that might occur along Project canals and structures. Literature included, but was not limited to, Ingles (1965), Chapman and Feldhamer (1982), and the CWHRS database (CWHRS website). Species habitat associations are discussed in detail in Section 7.0.

Small Mammal Trapping – 2003

At the request of the TRWG, PacifiCorp conducted live small mammal trapping surveys at four locations—along the Fall Creek canal, along the Link River Westside canal, and at two locations along the J.C. Boyle canal. Surveys were conducted twice at each site; once in May-June and again in September 2003. Each survey period included three consecutive nights of trapping. At each canal, approximately 100 baited Sherman live traps were set along four parallel transects along both sides of the canals (two transects on each side) (Figures 6.4-1, 6.4-3, and 6.4-4). Traps were checked daily. Thus, more than 600 trap-nights of effort occurred at each of the four canal sites in 2003. Captured animals were marked with a small amount of water-proof marker on the tail and then released. Coincident to the live trapping effort, visual encounter surveys were conducted in suitable patches of habitat along the trapping transect.

Winter Bait Station and Track Surveys – 2003

Between late-January and early-March 2003, wildlife track surveys for forest carnivores and other mammals were conducted in the following areas: (1) Link River (Figure 6.4-1), (2) Keno dam (Figure 6.4-2), (3) J.C. Boyle canal (Figure 6.4-3), and (4) Fall Creek (Figure 6.4-4). A sample unit for forest carnivore surveys generally is considered to cover 2 to 4 miles^2 to account for the home ranges of the species of interest (e.g., usually the smallest home range of interest is the 2 miles^2 [5.2 km^2] range for the marten) (Zielinski and Kucera, 1995). Each study site was set at approximately 2 miles^2 (5.2 km^2) to remain consistent with ongoing BLM studies east of the study area (Kellum, pers. comm., 2003).

Track count surveys were completed twice in each sample unit during January and February 2003. Even though there was little snow cover present during the surveys, the ground had abundant mud areas where tracks could be detected easily. The third planned tracking survey was not conducted because tracking conditions were not suitable during early March 2003. During the track surveys, biologists checked for tracks on all roads within 0.5 to 1.0 mile (0.8 to 1.6 km) of the facility. The total length of roads and trails surveyed varied between 3.6 and 6.2 miles (5.8 and 10 km). Link River and Fall Creek study sites had a shorter survey distances because of a low density of roads and trails in the study area (Figures 6.4-1 and 6.4-4). GPS and aerial photos were used to create GIS maps of all survey routes and forest carnivore track observations.

Tracks were identified using field guides (Halfpenny and Biesiot, 1986; Halfpenny et al. 1995; Murie, 1974; Sheldon, 1997; and Taylor and Raphael, 1988). Standard “complete” measurements were recorded for unusual or hard to identify tracks (number of toepads, size, gait, depth, etc.) (Taylor and Raphael, 1988; Halfpenny et al. 1995). Measurements of gait and straddle, as well as length and width of the track were taken. In addition, photos were taken and casts were made for unusual tracks.

PacifiCorp used three photographic bait stations to document forest carnivores at the following sites: (1) near the mid-point of the J.C. Boyle canal (Figure 6.4-3); (2) at the USGS gauging station just downstream of the J.C. Boyle powerhouse on the peaking reach (Figure 6.4-3); and (3) south of the Copco No. 2 penstock (Figure 6.4-4). Biologists conducted a site reconnaissance trip in mid-January 2003, and met with a BLM biologist experienced with bait station/track surveys to review locations in the field for bait station set up. Trailmaster 1500 infrared remote detecting camera systems were provided by ODFW for use at all three locations (Zielinski and Kucera, 1995). The three bait stations were maintained for 7 weeks from mid-January and the early March 2003 and were checked every 3 to 7 days. Each station was baited with an 11-pound (5-kg) or larger piece of deer meat. In addition, trapping scent (a mix of skunk scent and urine) was applied to the bait at each station to increase the likelihood of a carnivore detecting it.

Snake Hibernacula Surveys – 2003

To address the concern that the J.C. Boyle canal may block snakes from moving between upland habitats and riparian habitat along the river and that some hibernacula may be adversely affected by roads and human activity near them, the TRWG asked PacifiCorp to conduct surveys for snake dens in the rocky habitats along the canal and between the canal and the river and at other select sites where hibernacula may occur near commonly traveled roads in the J.C. Boyle peaking reach. These surveys are described in Section 4.4.3.5.

Wildlife Road Mortality Study – 2003

The stakeholders expressed concern about the potential for wildlife mortality from vehicles traveling roads in the study area. To provide some data on this issue, PacifiCorp asked Project personnel to record locations of road-killed animals on maps and datasheets between winter and fall 2003.

6.4.2.3 Facility Characterization

To assess the risk of wildlife entrainment, the physical characteristics of the Project canals were documented. This included recording the type of structure, canal wall type, canal wall height, adjacent slope, water velocity, and other parameters. GIS was used to calculate lengths of canal segments and create maps showing the characteristics. Wall heights were grouped on the basis of the relative effects on large, medium, and small mammals, reptiles, and amphibians.

Figure 6.4-1. Small mammal and carnivore connectivity surveys, Link River.

front/11x17/color

Back of Fig 6.4-1

back/11x17/color

Figure 6.4-2. Small mammal and carnivore connectivity surveys, Keno dam.

front/11x17/color

Back of Fig 6.4-2

back/11x17/color

Figure 6.4-3. Small mammal and carnivore connectivity surveys, J.C. Boyle canal.

front/11x17/color

Back of Fig 6.4-3

back/11x17/color

Figure 6.4-4. Small mammal and carnivore connectivity surveys, Fall Creek and Copco No. 2 bypass.

front/11x17/color

Back of Fig 6.4-4

back/11x17/color

6.4.3 Transmission Line Assessment

There are numerous transmission lines near the Project. However, only a small percentage of the lines actually is part of the FERC Project. Eight transmission line segments associated with the Project are dedicated solely to Project facilities. From the East Side facility, Line 56-8 (69 kilovolt [kV]) crosses the Link River and connects the powerhouse to a tap point on Line 11 (non-FERC line). The West Side plant has no associated transmission lines, since all adjacent lines would still exist, apart from the facility. One short transmission line is associated with the J.C. Boyle powerhouse. Line 98 (69 kV), also formerly referred to as Line 18-4 on the FERC drawing, connects the powerhouse to a tap point on Line 18 (non-FERC). This line is currently idle. Two line segments are associated with the Fall Creek powerhouse. Line 3 (69 kV) connects the Fall Creek powerhouse to Copco No. 1 switchyard, approximately 1 mile (1.6 km) to the east. Another short segment of Line 3 connects the powerhouse to a tap point on Line 18; Line 18 is adjacent to the powerhouse. Three lines are associated with Copco No. 1 powerhouse. Line 15 (69 kV) connects Copco No. 1 switchyard to Copco No. 2, approximately 1 mile (1.6 km) to the west. Lines 26-1 (69 kV) and 26-2 (69 kV) connect Copco No. 1 switchyard to Copco No. 1 powerhouse. No transmission lines are associated with Copco No. 2 powerhouse. One line is associated with Iron Gate powerhouse. Line 62 (69 kV) runs along the north side of the reservoir, from the powerhouse to Copco No. 2.

The transmission lines covered under the FERC license were evaluated for electrocution and collision hazard relative to standards and guidelines for power lines described in the Edison Electric Institute's publications, Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996 (APLIC, 1996) and Mitigating Bird Collisions with Power Lines: The State of the Art in 1994 (APLIC, 1994).

There are also distribution lines in the study area, none of which is part of the FERC Project. PacifiCorp's bird power line management program provides management guidelines for these lines (as well as transmission lines). Additionally, in 1998, PacifiCorp conducted an assessment of the avian risks of non-Project distribution lines near Project facilities. All of this information was reviewed and is summarized briefly in Section 6.7.3.

Electrocution risk is largely a function of the distance between energized wires. The literature indicates that key protection measures are to provide a 60-inch (152.4-cm) minimum separation between conductors and/or grounded hardware, or to insulate hardware or conductors against simultaneous contact if such separation is not possible (APLIC, 1996). This is particularly important where raptors perch or nest on pole structures associated with transmission or distribution lines. Generally, transmission lines are not a risk for bird electrocutions because they usually provide more than 60-inch (152.4-cm) separation between wires as a result of engineering design criteria.

PacifiCorp assessed Project transmission line configurations for raptor-safe design. To provide background on bird mortalities and existing mitigation for avian impacts, PacifiCorp reviewed avian mortality records collected by line patrols and other PacifiCorp personnel, records of previous remediation efforts, and current practices from PacifiCorp's bird power line management program.

The assessment included identification of the following:

- Transmission lines in the FERC Project (versus the ones that are not Project-related)
- Sections of FERC transmission line (or specific towers) that do not meet raptor safety standards
- Sections of lines that have caused mortality in the past or that cross or are adjacent to sensitive locations (e.g., wetlands, water bodies) and thus present potential collision hazards

Collision risk was assessed by identifying segments of lines that either cross or are near habitats that receive regular use by species such as waterfowl, waterbirds, and large wading birds. These groups of birds are most at risk of collision because of their relative lack of maneuverability, low flight pattern, and flocking behavior (APLIC, 1994). As an example, Willard (1978 as cited in APLIC, 1994) found that white pelicans foraging in the Klamath basin were at increased risk of collision while flying low over water during foraging. Lines running perpendicular to primary flight patterns are much more of a risk than parallel lines (APLIC, 1994). Lines located near the base of cliffs are also a potential problem because raptors often use these areas for their uplifting air currents.

6.4.4 Assessment of Regional Project Significance to Wildlife

PacifiCorp reviewed existing literature and field data to assess ongoing Project effects on wildlife at a regional level. Of particular interest to the TRWG are (1) riparian-dependent species and (2) big game (February 4, 2003, TWG meeting). For both species groups, GIS was used to describe the overall distribution of habitats and analyze the distribution of cover types relative to Project structures and reservoirs. Percent of the shoreline occupied by riparian vegetation, distances between riparian patches, sizes of riparian habitat patches, and habitat structure were calculated using GIS and field data collected during vegetation characterization sampling. For riparian-dependent species, the assessment integrated data from the wildlife habitat association/synthesis (Section 7.0) and used the extensive long-term data set collected by KBO to add perspective on avian use of the study area. For big game, GIS was used to assess the various telemetry datasets, winter range habitat map (CDFG), wildlife management areas, and Project facilities to describe the overall use of the habitats near the Project and the likely effects of the Project.

As part of the Wetland and Riparian Plant Community Characterization Study (Section 3.0), mapping of pre-Project riparian and upland vegetation communities was conducted to describe a reference condition. To emphasize the current distribution and importance of riparian habitat, the assessment of habitat connectivity on a regional level was compared to the pre-Project reference condition. This information was used to explore possible PM&E measures.

6.4.5 Geographic Scope for Assessments

The study area for the transmission line assessment, entrainment, and small animal connectivity assessments included the following:

- All Project reservoirs and facilities

- A 0.25-mile-wide (0.4-km-wide) buffer around the Project facilities, Project roads, and associated transmission lines and the river reaches from Link River to Iron Gate dam

For the effects of reservoirs on big game movement and regional Project significance assessments, the study area data assessment has a regional context covering wide-ranging deer populations.

6.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

The Wildlife Movement/Connectivity Assessment will aid the BLM in complying with the Federal Land Policy and Management Act (FLPMA) (Public Law 94-579), which stipulates multiple use including wildlife management. Addressing wildlife movement and habitat connectivity is consistent with the Oregon management plans for mule deer, elk, black bear, and cougar, as well as the Oregon Wildlife Diversity Plan. In California, the analysis will include the CDFG study titled An Assessment of Mule and Black-tailed Deer Habitats and Populations in California With Special Emphasis on Public Lands Administered by the Bureau of Land Management and the United States Forest Service (1998). Information in this study will be analyzed taking into consideration the federal ESA and Migratory Bird Treaty Act. This study will help PacifiCorp determine appropriate PM&E measures to include in the FERC license application.

6.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were held on the following dates: January 17, March 28, April 18, June 6, November 8, December 10, 2002, and February 4, 2003. At each of these meetings, PacifiCorp received comments that have been incorporated into the Final Study Plan.

6.7 STUDY OBSERVATIONS AND FINDINGS

The following sections summarize the status of the wildlife movement/connectivity assessment.

6.7.1 Literature Review of the Effects of Reservoirs and Hydroelectric Project Operations on Big Game Movement

Several agency and utility biologists were contacted to identify existing information and current studies that address the effects of reservoirs and hydroelectric structures on wildlife movement and overall habitat connectivity. A few were able to provide data or survey results. Table 6.7-1 lists the biologists contacted.

Table 6.7-1. Persons contacted for information on wildlife movement near the Klamath Hydroelectric Project.

Person Contacted	Agency/Organization
Karen Kovacs	California Department of Fish and Game (CDFG)
Bob Williams	CDFG
Dave Smith	CDFG
Melissa Crew	CDFG
Eric Loft	CDFG

Table 6.7-1. Persons contacted for information on wildlife movement near the Klamath Hydroelectric Project.

Person Contacted	Agency/Organization
Bob Schaefer	CDFG
Pat McLaughlin	CDFG
Richard Callas	CDFG
Allen Mitchnick	Federal Energy Regulatory Commission
Lonn Maier	Sacramento Municipal Utility District
Tony Fuchs	Puget Sound Energy
Frank Eddleman	Idaho Power
George Arnold	U.S. Bureau of Land Management (BLM), Medford
Rick Bullock	Mule Deer Foundation
John Pierce	Washington Department of Fish and Game
Michael Fry	PG&E
Brian Boroski	HG Harvey and Associates
Amy Stuart	Oregon Department of Fish and Wildlife (ODFW)
Duane Jackson	ODFW
Tom Collom	ODFW
Terry Farrell	ODFW
Ron Anglin	ODFW
Kent Reeves	East Bay Municipal Utility District
Gayle Sitter	BLM, Klamath Falls

6.7.1.1 Studies/Data Relating to Use of the Klamath Study Area

There are six studies/reports that specifically address deer and elk habitat and movements in the Klamath study area. A brief description of each is provided in the following sections.

Salt Caves Winter Deer Study

The Salt Caves deer study assessed the winter deer use of the portion of the J.C. Boyle peaking reach from RM 209 to 220 (City of Klamath Falls, 1990). This study found that the number of deer varied between 12.3 to 180.5 deer/miles^2 (32 to 467 deer/km^2). Densities on the west side of the river were generally twice that observed on the east side. Densities were related to weather severity. On south exposures during severe winters, densities were up to 180.5 deer/miles^2 (467 deer/km^2). Most use occurred in the upper and mid positions. The authors speculated that the low use of oak habitat may have been the result of the lower shrub cover in this habitat. The Ward Steppe (Pokegama Wildlife Habitat Management Area [PWHMA]), Copco Steppe (north of upper Copco Lake and west of Long Prairie Creek), Horseshoe Ranch Wildlife Area (HRWA) (northwest of Iron Gate reservoir), and lands with a southern aspect along the lower half of the J.C. Boyle peaking reach are important because of the high wedge-leaf ceanothus cover and relatively mild winter temperatures (Figure 6.7-1).

Figure 6.7-1. Elk and deer movement corridors.

front/11x17/color map

Back of Fig 6.7-1

back/11x17/color map

PacifiCorp lands extend through part of each of these five areas. During the Salt Caves study, deer preferred or neutrally selected the middle and top topographic positions while avoiding the bottom positions regardless of weather conditions. Steppe, mixed oak conifer forest, and mixed pine juniper forest habitats were preferred or neutrally selected by wintering deer. Deer can congregate on winter range as early as November if snow depths exceed 12 inches (30 cm) at higher elevations (City of Klamath Falls, 1990). Winter range availability in the canyon is potentially important for deer as demonstrated by an estimate of ten dead deer per mile (16 dead deer/km) in the canyon during a severe winter (FERC, 1990). One anecdotal report was found of one individual deer mortality resulting from falling through ice at J.C. Boyle reservoir. No mortalities have been documented at any of the other reservoirs (FERC, 1990). Project reservoirs rarely freeze (even partially), which likely contributes to the low incidence of this source of mortality.

Horseshoe Ranch Habitat Management Area

The BLM and CDFG manage the HRWA, which is located northwest of Iron Gate reservoir (Figure 6.7-1), for wintering deer. Landsat mapping completed by CDFG indicates that the HRWA and the lands surrounding Iron Gate reservoir provide winter habitat for several deer herds (BLM, 2001). However, approximately 55 percent of the deer winter range (public and private) in this management area is inadequate to support the current deer population. Improvement of this range is of prime concern to the CDFG and Siskiyou County. Approximately 50 to 60 elk use the HRWA or the area just to the east along the Oregon border (BLM website). However, no special management goals for this elk herd have been set by the CDFG (BLM website).

CDFG cover/forage habitat mapping for the HRWA and surrounding lands indicate that much of habitat immediately adjacent to Iron Gate reservoir is of low quality (CDFG unpublished data). There are, however, numerous patches of moderate and high quality habitat in the drainages north of Iron Gate reservoir.

South Cascades Deer Study

Starting in 1994, the ODFW conducted a 4-year study of black-tailed deer age structure, mortality, and movements in the southern Cascade Mountains. More than 200 deer were radio-collared and their movement patterns were tracked across the southern Oregon and northern California Cascades. The 1996 annual progress report for this study indicates that one of four radio-collared deer that wintered on the HRWA during the 1995-1996 winter moved to a location southeast of Iron Gate reservoir during the summer (Jackson and Kilbane, 1996). Thus, deer apparently occasionally cross the river either by swimming across Iron Gate reservoir or by wading/swimming across the river just downstream of Iron Gate dam (Figure 6.7-1). However, the other three radio-collared deer that wintered on the HRWA during the winter moved north or northeast into the Cascades. Many of the radio-collared deer used mixed oak woodland on the west slopes of the Cascades for wintering habitat (Jackson, pers. comm., 2003).

Topsy/Pokegama Landscape Analysis

Plant communities in the Klamath River Canyon are reported to be in poor condition for deer winter range because of a combination of timber harvest, fire suppression, high road density, and forage competition or indirect effects of livestock and wild horses (BLM, 1996). This may explain the relatively low use within the canyon relative to higher use outside of the canyon (BLM, 1996). Winter (November 20 to mid-April) road closures are used to minimize disturbance to big game.

CDFG Deer Winter Range Habitat Map (unpublished GIS data)

The CDFG has identified virtually all of the lands surrounding Iron Gate and Copco reservoirs as critical deer winter range. In the lower elevations along the river downstream of Iron Gate dam, development and agricultural land uses have reduced the value or eliminated winter range. Regionally, the block of winter range along the Klamath River upstream of Iron Gate dam represents the largest contiguous area of winter range in northern Siskiyou County.

Based on the general criteria of shrub/oak-dominated, southern exposures at low elevations providing the most critical deer winter range, GIS was used to define such areas near the Project (Figure 6.7-1).

Elk Telemetry Studies

The CDFG collared three elk that migrated north from the Shasta Valley, and the ODFW collared 20 elk in the Keno Game Management Unit (Callas, pers. comm., 2003; Collom, pers. comm., 2003). Only one elk crossed the study area (Figure 6.7-1). This elk has been migrating across the study area for several years in a similar pattern. The locations of crossing appear to be in the J.C. Boyle peaking reach near the Oregon-California border in the fall and some where between J.C. Boyle and Keno reservoirs in the spring. None of the individuals collared by ODFW crossed the Klamath River, but instead used areas farther to the north (Collom, pers. comm., 2003). While the movement of one elk does not provide enough information to show that Project reservoirs and canals have no effect on the movement of elk through the study area, it does show it is likely that some elk move through the study area, especially during spring and fall migrations.

6.7.1.2 Studies Related to Hydroelectric Projects

A few of the reviewed studies specifically address the effects of hydroelectric waterways and facilities on wildlife movement and habitat connectivity. The significant findings of similar studies reviewed are summarized as follows:

- **Clackamas River Hydroelectric Project, Oregon:** A connectivity study was conducted by Portland General Electric as directed by a collaborative working group to assess the effects of project fish ladders and flowlines on wildlife movement and habitat connectivity. Methods included: (1) vegetation cover type mapping; (2) description of fish ladder/flowline/penstock heights and wildlife crossing opportunities; and (3) surveys for terrestrial amphibians along both sides of the flowline. The study found that the flowline did not represent a substantial barrier to movement of big game because there several sections where big game could cross over it; while the fish ladder, located in an area used by big game, probably represents a substantial barrier to larger wildlife trying to access the river and riparian habitats because of its high walls and fence (McShane and Tressler, 2001). Terrestrial amphibians were found on both sides of the flowline. The degree to which individuals cross the flowline was not addressed. Opportunities for providing additional crossing locations were identified on the basis of minimizing travel distances for wildlife species present in the study area.

- **North Umpqua Hydroelectric Project, Oregon:** PacifiCorp conducted a terrestrial habitat connectivity study that involved: (1) review of relevant literature, existing data, and relicensing study results to define reference and current conditions and assess project impacts; and (2) field assessment by a team of outside species experts of the likely effects of Project waterways on wildlife movement. The study found that populations of elk and deer, as well as other large mammals, probably are affected less by Project waterways than are smaller mammals or amphibians. The study also concluded that Project waterways do not prevent movement throughout the landscape, but may alter movement patterns or corridors, which, in turn, may make animals more susceptible to predation or hunting mortality (Stillwater Sciences Inc., 1998). The study also suggested several management options for terrestrial habitat connectivity focusing on project waterways and improvements to penstocks. Among these recommendations was the installation of wildlife bridges.

- **Hells Canyon Hydroelectric Project, Snake River Idaho:** A deer study was conducted by Idaho Power for its Hells Canyon Hydroelectric Project. Edelman (2001) documents radio-telemetry studies of mule deer associated with Brownlee and Oxbow reservoirs along the Snake River. There, it appears that deer closely associated with the reservoirs may have increased winter and spring green-up mortality rates when concentrations of deer occur near the water. Overall, however, mortality not associated with the reservoirs was a greater factor on overall deer survival. It is unclear what proportion of deer mortality attributed to interactions with the reservoirs is compensatory with other mortality sources. In the rugged terrain of Hell’s Canyon on the Snake River, Idaho Power found that reservoir shorelines interrupted escape terrain for the deer (Edelman, 2001). The utility also found that on occasion, predators (cougars and coyotes) chased deer into the water or trapped deer against shoreline cliffs and on steep rocky shorelines. Deer appeared to be particularly susceptible when reservoirs were partially frozen.

- **Hamilton Branch Canal, California: Pacific Gas and Electric (PG&E)** assessed canal crossings to determine the effectiveness of deer protection facilities associated with a concrete-lined canal in an area with large migratory deer herds. PG&E’s 1983 internal report on Hamilton Branch (Upper North Fork Feather River Project) showed that 90 percent of canal crossings were successful and that the mortalities were limited largely to one age group. Knowing where to locate escape mechanisms in canals is extremely important because animals cross at established specific locations.

- **Trinity River Basin Deer Studies, California:** Several studies addressed deer populations near the Trinity, Clair Engle, and Lewiston reservoirs on the Trinity River. These studies found that deer regularly swim across reservoirs during fall migration and that drowning losses occur, especially when the reservoirs are covered by thin ice. Deer were found to use different crossing locations during spring and fall migration periods. On the Trinity reservoir, between 76 and 388 deer crossed the reservoir during fall migration. Average swimming time was slightly more than 11 minutes and ranged up to 23 minutes (Boroski, 1998). Spring migration was normally between mid-April and early May; fall migration occurred between late September and mid-November. Approximately 97 percent of the deer observed swimming across the reservoir crossed successfully. However, one fawn was confirmed to have drowned; the rest swam out of view. No radio-collared deer that crossed the reservoir drowned, so it does not appear that the reservoir causes increased mortality (Boroski, 1998).

- **Other Canal and Reservoir Studies:** During the 1970s and 1980s, several studies were conducted to document the losses of big game in canals located in arid habitats of the California Central Valley and Arizona (e.g., Fry et al. 1984). These projects were located in areas where large numbers of deer migrated through the area in directions perpendicular to the large canals. The studies demonstrated that deer bridges and escapes are effective at reducing mortality. A recent study in Arizona demonstrated the importance of habitat corridors to allow deer to successful cross a large fenced canal system (Tull and Krausman, 2001).

  CDFG biologists contacted by PacifiCorp noted that most of their focus on deer management is in an effort to understand habitat and population trends as they relate to recreational hunting; therefore, most information about movement patterns is anecdotal. A reference was made regarding the Trinity reservoir, which was built across a known deer migration route. In that area, deer were documented to continue to follow the established migration route by swimming across the narrow reservoir. When asked if there is information on historical migration in the study area, CDFG indicated that there is no such information available (Schaefer, pers. comm., 2003).

  A biologist from the Sacramento Municipal Utility District stated that relicensing efforts for the Upper American River include a mule deer movement study requested by California Sports Fishing Protection Alliance. The study is just in the planning stages, but will address how hydroelectric infrastructure and operations affect deer movement, and will identify the relevant and known factors affecting deer populations in the study area and the extent of wildlife drowning in project canals.

A list of the literature identified and reviewed as part of the study is present in Appendix 6A. Section 6.8 provides a discussion on the current conditions and likely future conditions, incorporating the relevant literature.

6.7.2 Wildlife Entrainment in Canals and Wildlife Connectivity Assessment

6.7.2.1 Canal-Induced Wildlife Mortality

The following sections summarize the wildlife mortality documented by PacifiCorp at each of the project canals.

J.C. Boyle Canal

Since 1988, Project personnel have documented six wildlife mortalities at the J.C. Boyle canal/forebay. This included four deer and one skunk collected from the J.C. Boyle forebay trash rack, and one deer dying from jumping off of the J.C. Boyle canal spillway (Table 6.7-2). Deer mortalities were documented during the months of March, June, August, and September. Two of the deer that died in the J.C. Boyle canal probably fell from the surrounding cliffs as evident from their broken legs. No deer have been collected from the trash rack since 1990, which would suggest that deer entrainment in the canal is a rare event. Entrainment of small animals in this canal has not been assessed because the trash rack grates are too widely separated (2 inches [5 cm] gaps) to stop small animals.

Table 6.7-2. Records of wildlife mortality at the J.C. Boyle canal since 1988.

Species	Date	Sex/Age	Condition	Comments
Deer	6/7/1988	Male/Adult	Dead	Trash rack. Right leg broken
Deer	8/14/1988	Female/Adult	Alive when first seen	Dove off of the end of the spillway and died, after being tranquilized by Oregon Department of Fish and Wildlife personnel
Deer	3/17/1990	Female/Adult	Dead	Trash rack
Deer	6/21/1990	Male/Fawn	Dead	Trash rack. Both right legs broken
Deer	9/5/1990	Female/Juvenile	Dead	Trash rack
Striped Skunk	12/02/2002	Unknown	Dead	Trash rack

East Side/West Side Canals

There have been no reports of medium to large size wildlife mortality from East Side and West Side canal trash racks since records have been kept (1983 to 2003). No data were recorded for small animals that could pass through the 2-inch (5-cm) grates. There are data on wildlife entrapment in these canals from the sucker entrainment study (Gutermuth et al. 1999 and 2000) when fyke nets were monitored from 1997 through 1999.

During the entire entrainment study period, one double-crested cormorant, one muskrat, one mallard, one doe, and one unknown duck were found dead in the West Side canal fyke nets (Table 6.7-3). It is possible that the duck, cormorant, mallard, and muskrat were in the canal voluntarily and were killed by becoming entangled in the sampling net. The mink, which apparently exited the net location safely, probably was investigating the fish trap; it is likely that mink use the canal regularly for foraging. The deer that was killed during January, however, obviously entered the canal and either swam or floated down into the net. It is unknown whether the deer was dead or alive when it entered the net or if it would have successfully escaped if it had not been caught in the net. Other animals observed alive during sampling of the West Side canal included: raccoon, salamanders, frog, beaver, pelican, bullfrog tadpoles, unidentified frogs, newt, western grebe, unidentified snake, and garter snake. It is likely that the tadpoles eventually would have been washed into the penstocks, but the adult frogs and other species could have escaped along the gradual, vegetated slopes of the canal.

Table 6.7-3. Wildlife entrainment observations at the East Side and West Side canals.*

Canal/Year	Month/Date	Observation	Condition	Comment
East Side				
1997	7/28-8/3	2 salamander/newt	Unknown	In net
	9/22-9/28	1 frog	Unknown	In net
	10/28-11/2	1 frog	Unknown	In net
1998	4/13-4/19	1 frog	Unknown	In net

Table 6.7-3. Wildlife entrainment observations at the East Side and West Side canals.*

Canal/Year	Month/Date	Observation	Condition	Comment
	6/15-6/21	1 beaver	Alive	Swimming in forebay, but was caught when net was lifted; released unharmed.
	8/31-9/6	1 large tadpole (bullfrog size)	Unknown	In net
	9/7-9/13	2 bullfrog tadpoles	Unknown	In net
1999	8/16-8/22	1 unidentified snake	Unknown	In net; 1 meter long
West Side				
1997	6/16-6/22	1 garter snake	Unknown	In net with debris
	6/16-6/22	2 newts	Unknown	In net
	6/23-6/29	1 cormorant	Dead	In net; live box
	7/7-7/13	1 beaver	Alive	Observed downstream of net
1998	11/16-11/22	Raccoon	Alive	Observed in vicinity
	3/22-3/29	4 pelicans	Alive	Observed in vicinity
	3/22-3/29	2 western grebes	Alive	Observed in vicinity
	4/6-4/12	Mink	Alive	Only evidence of the mink; no actual sighting
	4/20-4/26	Goslings	Alive	Observed in vicinity
	5/11-5/17	Pelicans	Alive	Observed in vicinity
	5/11-5/17	White egrets	Alive	Observed in vicinity
	5/11-5/17	Herons	Alive	Observed in vicinity
	6/1-6/7	Mink	Sign	Only evidence of the mink; no actual sighting
	6/1-6/7	Muskrat	Dead	In net
1999	1/4-1/10	Golden eye ducks	Alive	Swimming in canal
	1/4-1/10	Doe	Dead	In net; no sign of wounds
	1/4-1/10	Duck	Dead	In net; no sign of wounds
	5/10-5/16	Mallard duck	Dead	In net

* Source: Raw datasheets from Gutermuth et al. (1999 and 2000).

During the 3-year sucker entrainment study, the East Side nets had a beaver, two newts, three unidentified frogs, one bullfrog tadpole, and an unidentified snake (Table 6.7-3). The beaver had been swimming in the forebay, but was caught when the net was lifted. Because of the very short length of the East Side canal, it is possible that the smaller animals entered directly through the diversion from Upper Klamath Lake (passed through the trash rack grating).

Fall Creek Canal

PacifiCorp has not documented any wildlife mortality at the Fall Creek trash racks. However, because of the spacing of the trash rack grating, it is possible that some small animals—especially amphibians and reptiles—enter the canal either at the diversion or along its length and then are passed through the Fall Creek powerhouse turbines.

6.7.2.2 Habitats and Species Affected by Canals and Other Project Facilities

Through a combination of assessing habitat distribution, wildlife survey results, and literature, a list of potentially affected amphibian, reptile, and mammal species was developed for the East Side/West Side canals/penstocks, J.C. Boyle and Fall Creek canals, and Copco No. 2 penstock areas. In addition, the location of important habitats relative to the Project canals was assessed to identify the potential adverse effects of the canals/penstocks on movement by different species groups. The following is a discussion of each of the canals/penstocks.

J.C. Boyle Canal

There were 21 wildlife species that are potentially affected by the J.C. Boyle canal that were confirmed as occurring in the study area; 55 other species potentially occur (Table 6.7-4). The habitat and topography along large sections of the J.C. Boyle canal likely limits the number of amphibian and mammal species that actually would occur in the immediate area around the canal. The most common species trapped along the J.C. Boyle canal during small mammal trapping in 2003 was the deer mouse, which was common both in the disturbed and undisturbed zones (Table 6.7-5). Bushy-tailed woodrats, least chipmunks, and montane voles also were found along the canal. Individuals of these species have small home ranges and probably do not need to cross the canal to meet life requisites. Medium-size mammals that occur along this section include bobcat, raccoon, and striped skunk. These medium-size mammals have larger home ranges than small mammals and may attempt to use habitats on both sides of the canal. The only carnivore species documented in the area of the J.C. Boyle canal during track and bait station surveys conducted in January through March 2003 was the bobcat (Table 6.7-6). There was one incidental observation of a mountain lion near the forebay.

Table 6.7-4. Wildlife species that potentially occur near Project canals and flowlines.

Species	Special Status?	East Side/ West Side	J.C. Boyle	Fall Creek	Copco No. 2	Note
Amphibians						
Bullfrog		C	U	U	U	Warm water
Pacific Giant Salamander		U	U	C	P	Rivers and streams
Ensatina		U	P	U	U	Mesic forests
Foothill Yellow-Legged Frog	SoC, BLM-A, SV	U	U	P	U	Riverine
Pacific Treefrog		C	C	C	C	Various
Rough-Skinned Newt		C	P	P	P	Mesic forests
Western Toad	BLM-T, SV	P	P	P	P	Various
Mammals						
American Badger		P	P	P	P	Various
American Beaver		C	U	C	C	Riparian/riverine
American Marten	SoC, BLM-T, SV	U	P	P	P	Pine forest
American Mink		C	C	P	P	Riparian

Table 6.7-4. Wildlife species that potentially occur near Project canals and flowlines.

Species	Special Status?	East Side/ West Side	J.C. Boyle	Fall Creek	Copco No. 2	Note
American Pika		U	P	U	P	Rock talus
Belding's Ground Squirrel		P	U	U	U	Meadows in pine forests
Black Bear		C	P	P	P	Observed crossing West Side canal
Black-Tailed Jackrabbit		P	P	P	P	All communities
Bobcat		C	C	C	C	Various
Botta's Pocket Gopher		U	U	P	P	Meadows
Broad-Footed Mole		P	P	P	P	Meadows/valleys
Brush Mouse		P	P	P	P	Chaparral and rocky areas
Brush Rabbit		P	P	P	P	Chaparral
Bushy-Tailed Woodrat		P	C	C	C	Forests
California Ground Squirrel		C	C	C	C	Many habitats
California Vole		U	P	P	P	Meadows
Coyote		P	P	P	P	Various
Deer Mouse		C	C	P	P	Various
Douglas' Squirrel		U	P	P	P	Conifer forests
Dusky Shrew		U	U	P	P	Forested areas near streams
Dusky-Footed Woodrat		P	P	C	P	Various
Elk		P	C	C	C	Various
Ermine		U	P	P	P	High mountains
Fisher	SoC, BLM, SC	U	P	P	P	Pine forests
Golden-Mantled Ground Squirrel		P	P	P	P	Pine and fir forests
Gray Fox		P	P	P	P	Pine forests and sagebrush
Great Basin Pocket Mouse		P	U	U	U	Juniper woodland and sagebrush
Heather Vole		U	P	P	P	Open grassy areas in forests
Heermann Kangaroo Rat		P	P	P	P	Valley grassland and foothill woodland
House Mouse		P	P	U	U	Developed
Least Chipmunk		P	C	P	P	Juniper woodland and sagebrush
Long-Tailed Vole		P	P	P	P	Wet meadows, willows
Long-Tailed Weasel		P	P	P	P	Various
Mazama Pocket Gopher		P	P	P	U	Prairies and meadows
Merriam Shrew		P	P	U	U	Sagebrush/bunchgrass
Montane Vole		C	C	C	P	Springs wet grassy meadows

Table 6.7-4. Wildlife species that potentially occur near Project canals and flowlines.

Species	Special Status?	East Side/ West Side	J.C. Boyle	Fall Creek	Copco No. 2	Note
Mountain Beaver		U	U	P	P	Seepage slopes, alder
Mountain Lion		P	C	C	C	Various
Mule/Black-Tailed Deer		C	C	C	C	Documented
Muskrat		C	P	P	P	Streams marshes
Northern Flying Squirrel		P	P	P	P	Conifer forests
Northern River Otter		P	P	P	P	River/riparian
Nuttall Cottontail		P	P	U	U	Juniper woodland and sagebrush
Oregon Vole		U	U	P	P	Marshes and damp sites in forests
Pinyon Mouse		P	P	P	P	Juniper woodland
Porcupine		P	P	P	P	Various
Raccoon		C	C	P	P	Riparian
Red Fox		P	P	P	P	Forests and meadows
Red Squirrel		P	P	P	P	Conifer forests
Ringtail	BLM-T, SU	U	P	P	P	Forests
Shrew Mole		P	P	P	P	Near streams in conifer forest
Snowshoe Hare		P	P	P	P	Thickets, riparian
Striped Skunk		C	C	P	P	Various
Townsend's Chipmunk		P	P	P	P	Pine and fir forests
Trowbridge's Shrew		U	P	P	P	Pine Douglas-fir forest far from water
Vagrant Shrew		P	P	P	P	Forested regions
Virginia Opossum		P	P	U	U	
Water Shrew		U	U	P	U	Cold swift streams
Western Gray Squirrel	BLM-T, SU	U	P	P	P	Oak woodland
Western Harvest Mouse		C	C	C	P	Many communities
Western Jumping Mouse		P	P	P	P	Meadows in forest zone
Western Redbacked Vole		U	U	P	P	Forests
Western Spotted Skunk						
White-Tailed Jackrabbit	BLM-T, SU	P	P	U	U	Sagebrush and open habitats
Yellow-Bellied Marmot		C	C	P	P	Talus slopes and meadows
Yellow Pine Chipmunk		C	P	P	P	Pine forests
Reptiles						
California Mountain Kingsnake	SoC, BLM-T, SV	U	P	P	P	
Common Garter Snake		C	C	P	P	

Table 6.7-4. Wildlife species that potentially occur near Project canals and flowlines.

Species	Special Status?	East Side/ West Side	J.C. Boyle	Fall Creek	Copco No. 2	Note
Gopher Snake		P	C	P	P	Documented along J.C. Boyle
Northwestern Pond Turtle		C	P	U	U	
Northern Alligator Lizard		P	P	P	P	
Northwestern Garter Snake		P	P	P	P	
Yellow-Bellied Racer		P	C	P	P	Documented along J.C. Boyle
Ringneck Snake		U	P	P	P	
Rubber Boa		U	P	P	P	
Sagebrush Lizard	SoC, BLM-T	U	C	C	P	Documented in general area of J.C. Boyle and Fall Creek
Southern Alligator Lizard		P	P	P	P	
Striped Whipsnake		P	P	C	P	Documented in general vicinity of Fall Creek
Western Aquatic Garter Snake		U	U	U	U	
Western Fence Lizard		C	C	C	C	Documented everywhere
Western Rattlesnake		P	C	P	P	Reported from sites along J.C. Boyle
Western Skink		P	P	P	P	
Western Terrestrial Garter Snake		P	P	P	P	

P = potentially occurring, C = confirmed, U = unlikely.
SoC = Species of concern, BLM-T = BLM Tracking Species, BLM-A = BLM Assessment Species, SU = Oregon Sensitive Undetermined, SV = Oregon Sensitive Vulnerable, SC = Oregon Sensitive Critical.

While habitat upslope of the canal is a mixture of mixed conifer, ponderosa pine, and grassland habitats, most of the steep slope between the canal and the river is disturbed from the original construction of the canal and is dominated by loose rock and small patches of grass/shrub. Along the Klamath River downslope of the canal, narrow patches of riparian grass and riparian shrub (primarily dogwood, willow, and ash) habitat occur intermixed with the large boulders. In addition, most of the opposite side of the river canyon has steep slopes of rock talus and chaparral intermixed with dense ponderosa pine forests. Most of the canyon appears to be too steep and rocky for deer and elk to use on a consistent basis. Deer trails were observed paralleling the right (west or uphill) side of the canal along several sections of the canal (Figure 6.7-2). There were deer tracks present at one of the vehicle ramps/deer escapes indicating that animals at least occasionally access the canal (likely to drink water) at those protected backwater areas (Figure 6.7-2). There were no sites with evidence of animals entering the canal. Only near the upstream and downstream ends of the canal does the terrain allow for easy big game movement to and across the river.

Table 6.7-5. Survey results for 2003 small mammal trapping along Project canals.

Survey Date	Transect Position	Total Captured	Number of Mammal Species	Specific Results
Upper J.C. Boyle Canal: 4 transects May 26-29.				
05/26-29/03	Westside - Outer	12	3	7 *Peromyscus spp*. 1 bushy-tailed woodrat. 4 least chipmunks.
05/26-29/03	Westside - Inner	7	2	6 *Peromyscus spp*. 2 montane voles. (3 *Peromyscus* recaptures. 1 *Peromyscus* double recapture. 1 fence lizard in trap.)
05/26-29/03	Eastside - Inner	17	1	17 *Peromyscus spp*. (5 *Peromyscus* recaptures. 2 *Peromyscus* double recaptures.)
05/26-29/03	Eastside - Outer	17	2	16 *Peromyscus spp.* 1 bushy-tailed woodrat nursing female. (12 *Peromyscus* recaptures. 4 *Peromyscus* double recaptures.)
Lower J.C. Boyle Canal: 4 transects May 26-29.				
05/26-29/03	Westside - Outer	0	0	No mammals captured.
05/26-29/03	Westside - Inner	1	1	1 *Peromyscus sp.*
05/26-29/03	Eastside - Inner	12	1	12 *Peromyscus spp.* (1 *Peromyscus* recapture.)
05/26-29/03	Eastside - Outer	8	1	8 *Peromyscus spp*. (3 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
Link River West Side Canal: 4 transects June 10-13.				
06/10-13/03	Westside - Outer	3	3	1 *Peromyscus spp*. 1 yellow pine chipmunk. 1 montane vole.
06/10-13/03	Westside - Inner	7	1	7 *Peromyscus spp.* (3 *Peromyscus* recaptures)
06/10-13/03	Eastside - Inner	2	1	2 montane voles.
06/10-13/03	Eastside - Outer	23	1	23 *Peromyscus spp*. (6 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
Fall Creek Canal: 4 transects June 23-26.				
06/23-26/03	Westside - Outer	4	2	3 *Peromyscus spp*. 1 montane vole. (3 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
06/23-26/03	Westside - Inner	5	2	4 *Peromyscus spp.* 1 dusky-footed woodrat. (2 *Peromyscus* recaptures.)
06/23-26/03	Eastside - Inner	4	2	2 *Peromyscus spp.* 2 dusky-footed woodrats. (2 *Peromyscus* recaptures.)
06/23-26/03	Eastside - Outer	9	2	8 *Peromyscus spp*. 1 western harvest mouse. (1 *Peromyscus* recapture.)
Fall Creek Canal: 4 transects September 10-13.				
09/10-13/03	Westside - Outer	6	2	5 Peromyscus spp. 1 dusky-footed woodrat. (1 *Peromyscus* recapture. 1 *Peromyscus* double recapture.)
09/10-13/03	Westside - Inner	2	1	2 *Peromyscus spp.* (5 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
09/10-13/03	Eastside - Inner	3	1	3 *Peromyscus spp*. (3 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
09/10-13/03	Eastside - Outer	8	1	8 *Peromyscus spp*. (2 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)

Table 6.7-5. Survey results for 2003 small mammal trapping along Project canals.

Survey Date	Transect Position	Total Captured	Number of Mammal Species	Specific Results
Lower J.C. Boyle Canal: 4 transects September 15-18.				
09/15-18/03	Westside - Outer	6	2	6 *Peromyscus spp*. 4 bushy-tailed woodrats. (1 *Peromyscus* recapture.)
09/15-18/03	Westside - Inner	10	2	10 *Peromyscus spp.* 1 bushy-tailed woodrat. (4 *Peromyscus* recaptures. 2 *Peromyscus* double recaptures.)
09/15-18/03	Eastside - Inner	10	1	10 *Peromyscus spp.* (4 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
09/15-18/03	Eastside - Outer	28	1	28 *Peromyscus spp.* (13 *Peromsycus* recaptures. 1 *Peromsycus* double recapture.)
Upper J.C. Boyle Canal: 4 transects September 15-18.				
09/15-18/03	Westside - Outer	7	2	5 *Peromyscus spp.* 1 bushy-tailed woodrat. (2 *Peromyscus* recaptures.)
09/15-18/03	Westside - Inner	5	2	5 *Peromyscus spp*. 1 least chipmunk. (3 *Peromyscus* recaptures. 1 *Peromyscus* double recapture.)
09/15-18/03	Eastside - Inner	30	1	30 *Peromyscus spp*. (10 *Peromyscus* recaptures. 5 *Peromyscus* double recaptures.)
09/15-18/03	Eastside - Outer	29	1	29 *Peromyscus spp*. (8 *Peromyscus* recaptures. 2 *Peromyscus* double recaptures.)
Link River West Side Canal: 4 transects September 18-21.				
09/18-21/03	Westside - Outer	2	2	1 *Peromyscus spp*. 1 montane vole.
09/18-21/03	Westside - Inner	3	1	3 *Peromyscus spp.*
09/18-21/03	Eastside - Inner	5	1	5 western harvest mice.
09/18-21/03	Eastside - Outer	7	2	5 *Peromyscus spp*. 2 western harvest mice. (1 *Peromyscus* recapture.)

Peromyscus spp. = deer mouse (*P. maniculatus*), the most common species; canyon mouse (*P. crinitus*); or pinyon mouse (*P. truei*).

Small and medium-size mammals and reptiles may use the rocky habitat in the middle portions of the reach. During the small mammal trapping, several species of snakes as well as fence lizards were found immediately adjacent to the northwestern canal wall. It appeared that at least some reptiles use the trench along the wall for shade during hot periods. Under current operations there is no opportunity for reptiles to safely cross this canal to reach the riparian zone along the river, which is thought to represent important summer habitat for reptiles. In addition, even though small mammals and reptiles have small home ranges, juveniles of many species disperse greater distances and may be affected by the canal.

There are no pond-breeding amphibian sites near the canal; the nearest pond-breeding site was one used by treefrogs (adults were found, but no evidence of breeding) immediately downstream of the J.C. Boyle dam/spillway (see Section 4.7). The canal does not affect this amphibian breeding site and is not likely to affect any amphibians.

Table 6.7-6. Carnivore detections at bait stations and during track surveys 2003.

Date	Bait Station or Track Survey Route	Species	Method of Detection*	Track Density
1/16/2003	Link River	Bobcat	Tracking	1 trail
1/15/2003	Keno dam	Mink	Tracking	1 trail
1/15/2003	Keno dam	Raccoon	Tracking	1 trail
1/15/2003	J.C. Boyle canal	Bobcat	Tracking	1 trail
2/22/2003	J.C. Boyle canal	Bobcat	Bait station	None
1/16/2003	U.S. Geological Survey (USGS)	Bobcat	Bait station[1]	None
1/16/2003	USGS	Bobcat	Bait station[1]	None
1/17/2003	USGS	Bobcat	Bait station[1]	None
2/5/2003	USGS	Bobcat	Bait station[1]	None
2/6/2003	USGS	Bobcat	Bait station[1]	None
2/7/2003	USGS	Bobcat	Bait station[1]	None
2/9/2003	USGS	Bobcat	Bait station[1]	None
1/24/2003	Copco	Bobcat	Bait station[2]	None
1/25/2003	Copco	Bobcat	Bait station[2]	None
1/26/2003	Copco	Mountain lion	Bait station	None
2/10/2003	Copco	Bobcat	Bait station[3]	None
2/11/2003	Copco	Bobcat	Bait station[3]	None
2/12/2003	Copco	Bobcat	Bait station[3]	None
2/13/2003	Copco	Bobcat	Bait station[3]	None
2/3/2003	Fall Creek	Bobcat	Tracking	1 trail

* All detections with same superscript number were the same individual detected on different days.

East Side/West Side Canals

Based on a combination of direct observations and information literature and databases, 20 wildlife species that could be affected by canals/penstocks were confirmed along the East Side/West Side Project; 45 other species potentially occur in the area (Table 6.7-4). The only carnivore species in the area of the East Side/West Side canals documented during track and bait station surveys conducted in January through March 2003 was the bobcat (Table 6.7-6). Widely scattered deer tracks were commonly observed parallel to the West Side canal, particularly on the west shore of the canal. One black bear was observed running across the West Side canal (in the water) after being flushed from the riparian forests during the fall of 2002. There were no other obvious points where animals had entered the canal. Deer mice, montane vole, and western harvest mouse were documented during small mammal trapping along the West Side canal (Table 6.7-5).

Both East Side and West Side canals create a barrier to smaller wildlife (especially species that cannot swim well) attempting to move between the upland habitats—primarily sparse juniper woodland and shrubland—and the dense riparian forest and wetland that exist along the Link River floodplain. Of the amphibians, this would most likely affect the treefrog and possibly the western toad, which both could breed near the Link River, but then move into upland habitats at other times of the year (no breeding sites were documented near the West Side and East Side canals, but they could occur). Various species of mammals and reptiles likely use the riparian forests during the summer months for shade and foraging. Historical photos show large concentrations of snakes immediately along the Link River in the early 1900s, demonstrating that before significant human development in the area, the site may have supported large numbers of reptiles.

The short length of the East Side canal/forebay probably makes it an insignificant barrier to wildlife. The presence of the City of Klamath Falls immediately to the east of the East Side Project eliminates the possibility of any long-range movement by wildlife through the area.

Fall Creek

There were 15 wildlife species that are potentially affected by the Fall Creek canal that were confirmed as occurring in the study area; 62 other species potentially occur (Table 6.7-4). The only carnivore species in the area of the Fall Creek canal documented during track and bait station surveys conducted in January through March 2003 was the bobcat (Table 6.7-6). Numerous deer mice and several other small mammals were documented during small mammal trapping along Fall Creek (Table 6.7-5). The Pacific giant salamander was found in Fall Creek during amphibian surveys. It and the Pacific treefrog are the two amphibians most likely to be affected by the canal. It is possible that individual Pacific giant salamander larvae or treefrog adults are entrained into the canal at the diversion dam. Small numbers of deer tracks were observed along the canal, but no actual trails were documented.

The Fall Creek canal is located within 150 feet (46 m) of Fall Creek. The habitat along the canal is mostly montane hardwood oak-conifer and riparian mixed deciduous-conifer forest between Fall Creek and the canal. There are several small seeps along the lower canal embankment that support patches of herbaceous wetland vegetation. There are also patches of mixed chaparral scattered throughout the area. The Fall Creek penstock does not represent a barrier or entrainment hazard because it is completely buried. The small distance between the canal and Fall Creek may increase the likelihood of mammals such as mink and other riparian-associated species interacting with the Fall Creek canal.

Copco No. 2 Flowline

There were nine wildlife species that are potentially affected by the Copco No. 2 flowline that were confirmed as occurring in the study area; 66 other species potentially occur (Table 6.7-4). The only carnivore species in the area of the Copco No. 2 flowline documented during track and bait station surveys conducted in January through March 2003 were the bobcat and mountain lion (Table 6.7-6)

Figure 6.7-2. J.C. Boyle canal wall heights and adjacent terrain slope.

front/11x17/color

Figure 6.7-2.

back/11x17/color

The habitat surrounding the Copco No. 2 flowline is mostly oak-juniper, while well-developed riparian forest occurs immediately along the river channel, which is 200 to 300 feet (61 to 91 m) from the pipe. The high canyon rimrock walls that occur on the north side of the river in this area prevent large mammals from passing through the area. However, the terrain on the south side of the river near the penstock is less severe and probably represents an area where wildlife move down to the river and riparian habitats from the surrounding forests and woodlands. There is no blockage of wildlife that move along the river and riparian corridor.

Project Reservoirs

A large number of amphibians, reptiles, and mammals occur along the four Project reservoirs. The Project reservoirs are relatively narrow water bodies and do not represent a barrier to migration by large mammals that easily can swim across the narrow reservoirs. However, small mammals, amphibians, and reptiles are limited to crossing along existing river reaches up and down river from the reservoirs (Hanson et al. 1990; Zwick, 1992). Most of these species have small home range sizes and do not make large movements.

6.7.2.3 Linear Facility Characterization

The physical characteristics of the canals, flowlines, and penstocks were evaluated in the field to assess the risk of entrainment and the degree of blockage for wildlife species. The following sections summarize the findings.

East Side/West Side Canals and Flowline

The East Side water conveyance system consists of a 3,100-feet (945-m)-long flowline and 700 feet (213 m) of canal/forebay. The flowline is mounted on concrete supports spaced along its length. Along most of its length, there is between 0.5 and 3 feet (0.1 and 0.9 m) of clearance under the pipe that allows many species of wildlife to pass under it (Table 6.7-7). Larger mammals probably do not move through the area because developed areas occur immediately to the east.

Table 6.7-7. Canal, flowline, and flume dimensions.

Project Facility	Type of Structure	Approximate Length (feet)	Ground Clearance (feet)	Flow Velocity (feet per second)	Wall (looking downstream)	% Composition		Exterior Height (feet)
						Earthen	Concrete	
East Side	Flowline	3,100	0.5 to 3	n/a	n/a	n/a	n/a	n/a
East Side	Canal	700	n/a	0.88 to 1.82[1]	Right	100	0	n/a
					Left	0	100	0 to 2
West Side	Canal	5,300	0	0.66 to 1.40[1]	Right	100	0	n/a
					Left	100	0	n/a
West Side	Flowline	60	0.5 to 2	n/a	n/a	n/a	n/a	n/a
West Side	Flume	60	0	n/a	n/a	0	100	n/a
J.C. Boyle	Canal	11,000	0	1.5 to 2[2]	Right	40	60	16
					Left	0	100	0 to 16

Table 6.7-7. Canal, flowline, and flume dimensions.

Project Facility	Type of Structure	Approximate Length (feet)	Ground Clearance (feet)	Flow Velocity (feet per second)	Wall (looking downstream)	% Composition		Exterior Height (feet)
						Earthen	Concrete	
Copco	Flowline	1,400	0.5 to 3	n/a	n/a	n/a	n/a	n/a
Fall Creek	Canal	4,700	0	2 to 2.5[2]	Right	100	0	n/a
					Left	100	0	n/a

[1] Source: Gutermuth et al. (2000). Link River Hydroelectric Project (East Side and West Side powerhouses). Final Entrainment Study Report March 1997 - October 1999.

[2] Estimated on 2/3-5/03. Velocity will change with flow.

The East Side canal has earthen banks on one side and vertical concrete block wall on the other side. The canal is approximately 16 feet (5 m) deep and 700 feet (213 m) long, and there is little to no barrier to animal entrance to the canal on either side. The concrete wall is between 0 and 2 feet (0 and 0.6 m) above the ground. No bridges cross the canal. Water velocities in the East Side canal estimated by Gutermuth (2000) ranged between 0.88 and 1.82 feet per second (0.27 to 0.55 m/sec.) depending on horizontal and vertical position in the canal (Table 6.7-7).

The West Side canal is approximately 5,300 feet (1,615 m) long and is formed entirely by earthen banks that have moderate to steep sloping terrain (see photo below). The West Side canal is built into the hill slope west of the Link River. There are no barriers for animal entrance to the canal on either side. A 60-foot (18-m) section of flume serving as a spillway, and another 60-foot (18-m) section of aboveground flowline are located at the southern end of the West Side canal. Neither poses a significant risk of animal entrainment. One vehicle bridge crosses the canal approximately 600 feet (182.8 m) from the diversion dam (Figure 6.4-1). This bridge is 15 to 20 feet (4.5 to 6.0 m) wide and has a gravel surface. Water velocities in the West Side canal estimated by Gutermuth (2000) ranged between 0.66 and 1.40 feet per second (0.20 to 0.43 m/sec.) depending on horizontal and vertical position in the canal (Table 6.7-7).

West Side canal (water level has been drawn down for maintenance)

J.C. Boyle Canal

The J.C. Boyle canal is nearly 11,000 feet (3,352 m) long and is a combination of vertical concrete walls, bedrock, and gunite-lined earthbanks (Table 6.7-8). The entire left (eastern or downslope) wall is concrete and is 16 feet (4.9 m) tall (see photo below). The right side canal wall (west side or inner wall) varies greatly in height above ground and accessibility. Inside the canal, the height of the freeboard varies depending on the amount of water in the canal, but generally exceeds several feet so that after they are in the water, animals cannot exit except at the two escapes or the forebay. There are no bridges that allow animals to cross the J.C. Boyle canal.

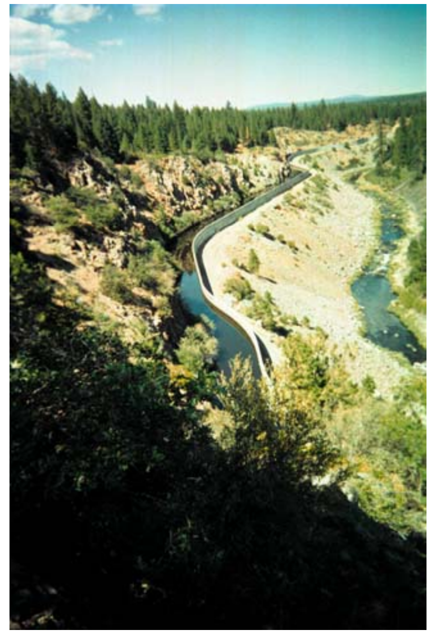
J.C. Boyle canal

Table 6.7-8. Summary of J.C. Boyle canal right (north) wall characteristics.

Wall Height (feet)	Adjacent Slope: Gradual (less than 40%)		Moderate (40 to 60%)		High (more than 60%)		Total	
	Length (feet)	Percent	Length (feet)	Percent	Length (feet)	Percent	Length (feet)	Percent
0 to 2	90	0.8	285	2.6	4,590	41.8	4,966*	45.2
2 to 4	150	1.4	329	3.0	249	2.3	728	6.6
4 to 12	171	1.6	1,354	12.3	2,076	18.9	3,601	32.8
More than 12	783	7.1	910	8.3	0	0.0	1,693	15.4
Total	1,194	10.9	2,878	26.2	6,915	62.9	10,988	100.0

* 4,485 feet of the zero to 2 feet length is rock/gunite-lined as opposed to free-standing concrete wall.

Because of this variability, a detailed inventory was conducted in 2002 to divide the right side canal wall into segments. This analysis revealed that more than 45 percent of the wall is less than 2 feet (0.6 m) tall and thus the most potentially accessible for most wildlife; another 6 percent of the wall was between 2 and 4 feet (0.6 to 1.2 m) tall (Table 6.7-8). A large portion of the canal that has no or little aboveground wall on the right side is located in steep terrain and is not likely to be used for wildlife movement. The 37 percent with gradual or moderate slopes (including segments of all wall heights) seemed accessible for wildlife (i.e., passable if a canal wall was not there). However, less than 4 percent of the wall is both less than 2 feet (0.6 m) tall and adjacent to gradual to moderate slopes. These moderate terrain areas next to low walls would be the most likely areas where animals could enter the canal. These areas do include two constructed vehicle access or deer escape points where a road extends to a break in the uphill side of the canal wall and an area of still water. Additional locations were noted where deer might be able to climb out of the canal (Figure 6.7-2). Deer trails were observed paralleling the canal and there were deer tracks present at one of the vehicle ramps/deer escapes indicating that animals at least occasionally access the canal at those protected backwater areas (Figure 6.7-2). Habitat on the downslope side is mostly talus and riprap from the road to the river. There are a few patches of forested habitat on the west side near the forebay. There were no sites with evidence of animals entering the canal.

Fall Creek Canal

The Fall Creek canal is approximately 4,700 feet (1,433 m) long and is lined entirely with bedrock, gunite, or earth fill (Table 6.7-7). The canal varies between 4 and 10 feet (1.2 to 3.0 m) wide and has an estimated velocity of 2.0 to 2.5 feet/per second (0.61 to 0.77 m/sec). The ground level is between 1 and 4 feet (0.3 and 1.2 m) above the water level and is vegetated except where bedrock is at the surface, which is limited to 100 to 200 feet (30 to 60 m). There is one 8-inch-wide (20-cm-wide) wooden plank lying across the canal approximately 1,000 feet (305 m) from the downstream end. This plank represents the only opportunity for terrestrial animals to cross the canal without either jumping, which large mammals probably can do, or swimming. There were widely scattered deer tracks along the canal, but no obvious high-use areas or obvious entry points.

Copco No. 2 Penstock

The Copco No. 2 penstock is approximately 1,400 feet (427 m) long and has between 0.5- and 3-foot (0.5- and 0.9-m) clearance (Table 6.7-8) (see photo below). This penstock has a road over it at the western end and also can be crossed at its eastern end where it is underground. The Copco No. 2 penstock is constructed from wood stave and has numerous leaks where water sprays under pressure along its length.


Clearance under Copco No. 2 penstock

6.7.3 Transmission Line Assessment

There are numerous transmission lines near the Project, but only eight lines are covered under the FERC relicensing process—Lines 56-8, 98, 3 (two segments), 15, 26-1, 26-2, and 62 (Figure 6.7-3) (see photos, below). There are also numerous distribution lines in the study area, none of which is part of the FERC Project.

Project transmission lines meet the raptor-safe construction standards of 60-inch (152-cm) line separation in most cases. Project transmission lines do not appear to present an electrocution hazard to birds. One of the lines—Line 98—near J.C. Boyle powerhouse is not energized.

Figure 6.7-3. Project transmission lines.

front/11x17/color

Figure 6.7-3

back/11x17/color

The following text describes PacifiCorp's avian mortality data and PacifiCorp policy to address electrocutions. PacifiCorp has a corporate program to document all bird mortalities associated with its lines and to remedy the lines to prevent future mortalities at problem sites. PacifiCorp has a memorandum of understanding (MOU) filed with both California and Oregon state wildlife agencies, as well as the USFWS regional office. The MOUs have been in place since the late 1980s and they provide guidelines for the reporting and disposal of birds found near PacifiCorp lines or facilities. The following is a summary of these PacifiCorp guidelines (Liguori and Burruss, 2002):

- **Mortality Reporting:** Employees are required to report any large dead bird found in or around Project facilities. The PacifiCorp internal website contains a database titled Bird Mortality Tracking System (BMTS), where all observations are documented. Database records have been maintained since 1988.

- **Bird Power Line Management Program Guidelines:** These guidelines were created for the use of PacifiCorp field employees and were distributed to all offices to provide information on mortality reporting forms, agency contacts, and raptor identification. The guidelines also provide information for making existing structures raptor-safe. The latest edition of these guidelines was distributed to field personnel in early 2003.

- **Raptor-Safe Distribution Line Construction Standards:** Raptor-safe construction standards for new and re-built rural distribution lines require a minimum of 60 inches (152 cm) of clearance between conductive or conductive and grounded parts of a transmission line. "Problem poles" are identified (where an eagle or other birds have been killed) and retrofitted with insulator covers, brushing caps, triangles or perches, or jumper wire hose when feasible. Other more extreme options include the replacement of problem poles that cannot be retrofitted adequately.

FERC Line 3 with osprey nest platform

FERC Line 56-8 near West Side canal

A review of PacifiCorp's avian mortality database records (current version is called the BMTS) indicates that there have been no collisions or electrocutions documented by PacifiCorp personnel for any of the FERC Project-related transmission lines since the MOUs took effect in the late 1980s. Recently, a radio-telemetered spotted owl was found dead under a power line (not a Project line) south of the J.C. Boyle peaking reach outside of the canyon (Hardy, pers. comm., 2003). Necropsy results did not find an apparent cause of death; the owl was in good condition and there was no sign of collision or electrocution (Rock, pers. comm., 2003).

The 1998 assessment of power lines conducted by PacifiCorp biologists indicates that non-Project distribution lines downstream of Iron Gate dam do not meet the raptor safety standards, but they do not pose a substantial risk for raptors. Over the years, PacifiCorp has retrofitted a number of poles in the Klamath study area that receive regular raptor use to ensure avian safety and prevent power outages. A number of poles have been fitted with osprey nesting platforms. Most of these poles are used each year by nesting osprey without incident. During 2003, a review of transmission line drawings and field inspections found that several poles south of Copco No. 2 pipeline had distribution line underbuilds (distribution line crossarms attached under the transmission line crossarms) on the same poles and do not meet raptor safety standards. These poles are located on a north-facing canyon hillside and possibly could represent a hazard to raptors.

There are four segments of Project transmission lines located near areas of high waterfowl and wading bird use (Figure 6.7-3). These types of birds are most likely to collide with lines (APLIC, 1994). Segments of FERC lines near areas with the most consistent waterfowl and wading bird use include the line at the Link River, two segments of the line that crosses Iron Gate reservoir, and the segment of line that is near the upstream end of Iron Gate reservoir (Figure 6.7-3). Of these, Line 56-8, a 69-kV line that crosses the Link River, crosses a heavily used flight corridor between Lake Ewauna and Upper Klamath Lake. Many ducks, waterbirds, and colonial nesting wading birds fly between the two water bodies to forage and roost. This line includes a wooden, two-pole structure on either side of the Link River. The wires are parallel in construction and high above the ground, thus reducing the likelihood of a bird collision when compared to vertically arranged wires. No bird mortalities or collision-induced power outages have been reported from this line.

The transmission line segments that cross the Jenny Creek inlet and run parallel to the upper end of Iron Gate reservoir (Line 62) are located in an area used consistently by waterfowl and waterbirds. Some waterfowl use occurs on Iron Gate reservoir near the mouths of Camp and Scotch creeks. However, this area is more than 0.5 mile (0.8 km) from the line (Figure 6.7-3). The short line near the J.C. Boyle powerhouse is not much of a risk because of its short length, its orientation going up the slope as opposed to crossing the river, and the low waterfowl use in that area. The lack of significant croplands and large wetlands near the Project transmission lines reduces the likelihood that waterfowl and other birds occurring along Project reservoirs would fly through the transmission line ROWs and, therefore, reduces the chances of avian collisions (APLIC, 1994). No bird mortalities or collision-induced power outages have been reported from these lines.

6.7.4 Road Mortality

At the request of the TRWG, PacifiCorp collected data on wildlife killed along roads traveled by Project personnel. A total of 30 wildlife carcasses was observed from March 14, through July 29, 2003 (Table 6.7-9). By far, the most commonly observed carcasses were California ground squirrels. Seven snake carcasses also were found along these roads during that time period. Five live snakes were seen basking on roads.

Table 6.7-9. Results of 2003 PacifiCorp personnel wildlife sightings and wildlife road mortality documentation*.

Survey Date	Observer	Wildlife	Road	Location	Comments
April 26, 2003	BE	Ground squirrel	J.C. Boyle Powerhouse Road	Forebay Hill	Carcass
May 13, 2003	MB	Gopher snake	Copco Road	Camp Creek	Carcass
May 14, 2003	DL	Ground squirrel	Copco No. 2 Powerhouse Drive	Powerhouse driveway	Carcass
May 17, 2003	DH	Ground squirrel	Copco Road	Fall Creek	Carcass
May 17, 2003	DH	Jack rabbit	Copco Road	The Narrows	Carcass
May 23, 2003	DL	Ground squirrel	Copco No. 2 Powerhouse Drive	On bridge to bunkhouse	Carcass
May 28, 2003	MB	Ground squirrel	Copco Road	Camp Creek	Carcass
May 30, 2003	DL	Bird	Copco Road	West of Fall Creek fish hatchery	Carcass
June 4, 2003	**DL**	**Gopher snake**	**Copco Road**	**Near Fall Creek**	**Basking**
June 4, 2003	**DL**	**Gopher snake**	**Copco No. 2 Village Road**	**Near Copco No. 2 pumphouse**	**Basking**
June 4, 2003	BS	Rabbit	Copco Road	Mirror Cove	Carcass
June 5, 2003	**DL**	**Gopher snake**	**Copco No. 2 Powerhouse Drive**	**Beginning of Copco No. 2 pavement**	**Active**
June 5, 2003	MB	Gopher snake	Copco Road	Yreka Water Plant	Carcass
June 5, 2003	BS	Squirrel	Copco Road	Tormey Cove	Carcass
June 6, 2003	DL	Jack rabbit	Copco Road	Mirror Cove	Carcass
June 22, 2003	BS	Gopher snake	Copco Road	Sentinel Point	Carcass
June 27, 2003	DH	Jack rabbit	Copco Road	Copco Cove	Carcass
June 27, 2003	DL	Kangaroo rat	Long Gulch	Above Iron Gate hatchery	Carcass
June 30, 2003	DH	Gopher snake	Copco Road	Copco Cove	Carcass
June 30, 2003	BS	Rat	Copco Road	Mirror Cove	Carcass
July 1, 2003	BS	Squirrel	Copco Road	Fall Creek	Carcass
July 5, 2003	DL	Rattlesnake	Copco Road	100 yards west of Beswick Ranch	Carcass
July 6, 2003	BS	Bull frog	Copco Road	Mirror Cove	Carcass
July 7, 2003	BS	Rattlesnake	Copco Road	The Narrows	Carcass
July 8, 2003	BS	Rattlesnake	Copco Road	Jenny Creek	Carcass
July 11, 2003	DL	Ground squirrel	Copco Road	Copco No. 2 turnoff	Carcass

Table 6.7-9. Results of 2003 PacifiCorp personnel wildlife sightings and wildlife road mortality documentation*.

Survey Date	Observer	Wildlife	Road	Location	Comments
July 14, 2003	BS	Rabbit	Copco Road	Fall Creek	Carcass
July 19, 2003	**BE**	**Rattlesnake**	**J.C. Boyle Powerhouse Road**	**Forebay Hill**	**Heading toward canyon.**
July 20, 2003	BS	Rat	Copco Road	Mirror Cove	Carcass
July 20, 2003	BS	Squirrel	Copco Road	Juniper Point	Carcass
July 22, 2003	**BE**	**Rattlesnake**	**Topsy Road**	**Topsy 5**	**Basking on road**
July 23, 2003	BS	Squirrel	Copco Road	Camp Creek	Carcass
July 24, 2003	BS	Squirrel	Copco Road	Camp Creek	Carcass
July 29, 2003	BS	Owl	Copco Road	Overlook	Carcass
July 29, 2003	DH	Pigeon	Copco Road	Fall Creek	Carcass

* Bold text indicates live animal sightings.

Results from this study must be interpreted with caution because the data collection was neither systematic nor comprehensive. Estimates of the amount of roadway inspected each day ranged from an average of 15 to 85 miles (24 to 137 km). The large majority of this informal survey effort was conducted along county roads such as the Siskiyou County road north of Iron Gate and Copco reservoirs (Copco Road), Highway 66, and short roads leading to the forebays, powerhouses, and dams. The informal nature of this study precludes a systematic analysis of results. However, no obvious problem areas in terms of wildlife mortality were noted. Only four of the carcasses were found on roads most heavily used for Project purposes, while the rest were on more heavily traveled public roads (Table 6.7-9). Wildlife mortality appears to be most evident along road sections with relatively high traffic volumes and those areas with visitor access and potential for higher vehicular speeds.

PacifiCorp completed an inventory of roads and found that there are 300 miles (483 km) of roads and 18 miles (29 km) of OHV routes in the terrestrial study area. Approximately 93 miles (150 km), or 31 percent, of the roads are on PacifiCorp land. Most PacifiCorp roads are located near Iron Gate reservoir, Copco No. 1 and No. 2 dams, and J.C. Boyle and Keno dams. Eight miles (13 km) of the OHV routes are on PacifiCorp land in the terrestrial study area.

6.7.5 Assessment of Regional Project Significance to Wildlife

The relative effect of the Project on regional habitat connectivity is described below for riparian habitat and the overall distribution of big game winter range. The overall availability of riparian and wetland habitat is summarized in the description of vegetation resources (Section 3.7). Additional information on riparian wildlife species relationships is described in Section 7.0.

6.7.5.1 Riparian Habitat

The distribution of riparian vegetation and fragmentation is a result of natural physiographic and anthropogenic processes. Impacts of riparian habitat fragmentation on wildlife are complex and often species specific (McGarigal and Marks, 1995; Donovan et al. 1997; Tewksbury et al. 1998). However, riparian vegetation communities typically provide important habitat for a wide range of species, including migratory birds, amphibians and reptiles, and aquatic furbearers (see Section 7.7). It also serves important functions for other terrestrial mammals. Within the Klamath River watershed, the mainstem Klamath River and a small number of major tributaries support the great majority of the region’s riparian habitat. Numerous springs and small tributaries support some riparian and wetland habitat in the drainage. However, those types of sites are small and narrow. Typically, the smaller tributaries do not provide water year-round and do not have well-developed riparian zones. Thus, the riparian and wetland habitat along the Klamath River is some of the most extensive and permanent in the immediate area. Section 3.7 provides a detailed discussion of riparian vegetation communities.

It is clear from analysis of avian data collected by the KBO throughout the watershed during the last 5 years and by PacifiCorp in the study area in 2002 that Klamath River habitats provide breeding habitat for a large percentage of the species that occur in the region (see Section 7.7). In particular, riparian-dependent species occur along the river reaches and some sections of Project reservoirs, at abundances not approached in surrounding uplands. ROI sampling conducted by the KBO further demonstrates the importance of riparian habitats along the Klamath River for dispersing birds after the breeding season (see Section 7.7). These riparian habitats are also critical for a wide variety of amphibians, reptiles, and small mammals that use them.

As a way to assess the landscape level distribution of riparian habitat available for wildlife, the inter-riparian shoreline distance was calculated for each segment. Along the flowing sections of the river, mapped riparian habitat occurs along 37 to 89 percent of the shoreline (Table 6.7-10). The lowest percentage of shoreline with riparian vegetation was in the narrow Keno Canyon, where little room exists on the floodplain for riparian vegetation. The other river reaches have at least 62 percent of their shorelines bordered by mappable riparian vegetation (Table 6.7-10). Along Project reservoirs, riparian and wetland habitat occurs along a low of 19 percent of the Copco reservoir and a high of 53 percent of the Keno reservoir (Table 6.7-10). The J.C. Boyle reservoir also has a relatively high percentage—30 percent—of riparian/wetland habitats. The average break between neighboring riparian habitat patches on Project reservoirs is significantly ($P = 0.02$) larger than—between 1,773 and 3,495 feet (540 and 1,065 m) at individual reservoirs—the average break along flowing river reaches, which is 270 to 2,134 feet (82 to 650 m) (Table 6.7-10). On a regional scale, the riparian habitat is broken several times throughout the study area; the most significant breaks in riparian habitat occur at impoundments at Iron Gate, Copco, J.C. Boyle and Keno reservoirs. Other Project features that have influenced riparian habitat include the bypass reaches and canal segments at Copco No. 2, J.C. Boyle, and the Link River.

To serve as a point of reference, an analysis of the pre-Project vegetation communities was completed for areas now inundated by the Project reservoirs as well as for representative river reaches that currently exist. This analysis indicates that, similar to current conditions, riparian habitat always was limited to narrow bands immediately along the river. The one exception to this pattern was in the area now under the western portion of Copco reservoir. In this area of the river, historical photos indicate that there were large patches of riparian forest habitat along bends of the river. In the area that is now Iron Gate, J.C. Boyle, and Keno reservoirs, human development (logging, livestock grazing, and residences) already had occupied large portions of the lowlands and had significantly limited the extent and quality of riparian habitat in some areas before Project construction (see Section 3.7 for a more detailed discussion of pre-Project vegetation mapping).

Compared to pre-Project riverine habitat, the percent of reservoir shoreline bordered by wetland and riparian habitat is less at Iron Gate and Copco reservoirs. Before Project construction, approximately 68 and 49 percent of the river now under the two reservoirs, respectively, had obvious (but typically thin) wetland or riparian habitat. Even so, a number of ranches had already encroached into the floodplain. The current Iron Gate and Copco reservoir shorelines have 22 and 19 percent wetland/riparian habitat, respectively (see Section 3.7 for additional discussion). At Keno Reservoir, pre-Project mapping was completed only for the section between the existing dam site and the site of Needle Dam, which was in place before the Project was built. The rest of Keno reservoir and Lake Ewauna did not change from the conditions present at the time of Project construction. Although, under existing conditions a large portion of the Keno reservoir shoreline is occupied by wetland habitat (53 percent), the portion that did change as a result of Project construction now has 28 percent wetland/riparian vegetation compared to 35 percent before construction. At J.C. Boyle reservoir, it appears that an increase in wetland and riparian habitat has occurred because of the Project reservoir. Before construction, 28 percent of the river shorelines had wetland/riparian habitat, while the present-day reservoir has 30 percent. GIS calculations indicate that the riparian vegetation width averaged 22, 27, 58, and 101 feet (7, 8, 18, and 31 m) along sections of river now occupied by Iron Gate, Copco, J.C. Boyle, and Keno reservoirs, respectively. In comparison, wetland and riparian patches along reservoirs extend farther from the shoreline, ranging from 96 to 220 feet (29 to 67 m) wide.

Table 6.7-10. Riparian habitat connectivity on Project reservoirs and river reaches in 2002.

Project Segment	Percent of Shoreline with Riparian/ Wetland Habitat	Mean Break in Riparian/ Wetland Habitat (feet)	S.D. (feet)	Minimum Break in Riparian/ Wetland Habitat (feet)	Maximum Break in Riparian/ Wetland Habitat (feet)
Iron Gate-Shasta	89	227	270	11	1,631
Iron Gate Reservoir	22	1,773	2,910	77	14,017
Copco No. 2 Bypass	75	1,257	1,935	36	3,488
Copco Reservoir	19	3,084	4,705	64	18,062
J.C. Boyle Peaking Reach	62	915	1,222	15	6,481
J.C. Boyle Bypass	66	845	698	58	2,224
J.C. Boyle Reservoir	44	2,298	3,147	43	9,197
Keno Canyon	37	2,134	2,464	100	9,340
Keno Reservoir	53	3,495	5,018	53	23,438
Link River	67	1,710	2,409	46	5,700

S.D. = Standard deviation.

6.7.5.2 Big Game Winter Range

The low and mid-elevation habitats in the Klamath River watershed provide important winter range for deer and elk in the region. Most important are the HRWA and the PWHMA, two wildlife management areas located north of the study area (Figure 6.7-1). In particular, the south-facing slopes provide habitat during the most severe winters. The winter range polygons shown in Figure 6.7-1 represent general regions of winter use based on elevation and aspect; actual use depends on the presence of appropriate forage and cover habitats. It appears that there are many acres of potential winter range on both the north and south sides of the river downstream of Copco reservoir. However, ongoing residential development in some areas is fragmenting this habitat. There are some data documenting deer and elk crossing the river corridor, but the degree to which these movements occur is unknown.

The abundance of oak and oak-conifer, and mixed chaparral habitats the study area provide important habitat for big game at various times of the year. Currently, there are approximately 18,452 acres (7,467 ha) of habitat that have wedgeleaf ceanothus and mountain mahogany—major deer browse species—as a shrub layer major component. These two shrub species were estimated to be a major component in 14 different vegetation cover types, especially in the montane hardwood oak-juniper (7,209 acres [2,917 ha]), mixed chaparral (4,418 acres [1,788 ha]), montane hardwood oak-conifer (4,327 acres [1,751 ha]), and montane hardwood oak (1,223 acres [495 ha]). There were 2,235 acres (904 ha) of habitat with these two preferred shrubs surrounding Iron Gate, but close to the reservoir it is relatively widely scattered and the better habitat is near the Horseshoe Ranch. There was substantial acreage of the desirable browse in the Copco No. 2 bypass (1,136 acres [460 ha]), Fall Creek (780 acres [1,316 ha]), and J.C. Boyle peaking reach (10,517 acres [4,356 ha]) Project segments. Non-native and noxious weed infestations and decadent shrub cover adversely affect a large percentage of the big game winter range.

Mapping of pre-Project riparian habitats indicated that before Project construction, river reaches were bordered by generally narrow bands (22 to 101 feet [7 to 31 m] on average) of riparian shrubs and trees, which provided minimal cover and forage for big game. However, a larger percentage of the river shoreline had riparian vegetation that could have been used by wintering big game. Before the Project, the uplands surrounding the Klamath River varied by section, but generally was composed a mix of grassland, oak woodland, oak-pine forest, and agricultural lands (see Section 3.7 for more details). These vegetation communities likely provided similar habitat as under current conditions, although the combination of fire suppression and a long history of livestock grazing has reduced the forage value in many areas of the study area during the last several decades.

6.7.5.3 Oak Habitat

Oak habitat is well distributed throughout the study area from the lower river upstream to the J.C. Boyle bypass. Overall, there are 22,676 acres (9,177 ha) of either pure oak woodland or mixed oak-conifer or oak-juniper woodland (see Section 2.0, Table 2.7-2). These oak habitats are considered to be extremely valuable for a wider variety of wildlife species. It was reported by Gleason (2001) that oak trees in the canyon are more productive than those on the plateaus outside of the canyon. Pre-Project mapping indicated that oak habitats occurred scattered along the river in the Iron Gate and Copco reservoir sections of river and were particularly dominant in the Copco area.

6.7.5.4 Forests with Large Trees

The vegetation database was queried to estimate the amount of forest habitat with large trees. This analysis revealed that only about 13 acres (5 ha) of forested habitat in the study area have an average tree size of more than 24 inches (61 cm) diameter. However, 275 acres (111 ha) or 33 percent of the Klamath mixed-conifer forest has an average diameter of between 11 and 24 inches (28 and 61 cm). Approximately 43 percent of the 5,070 acres (2,052 ha) of montane hardwood oak habitat has an average diameter greater than 11 inches (28 cm). Only about 21 percent of the montane hardwood oak-conifer has large-diameter trees.

6.8 DISCUSSION

The following sections describe existing conditions pertaining to connectivity and wildlife movement as well as future trends.

6.8.1 Characterization of Existing Conditions

The following sections summarize the existing conditions for wildlife connectivity relative to Project. The discussion is divided into separate sections for big game movement, wildlife entrainment, small mammal and avian habitat connectivity, and effects of transmission lines.

6.8.1.1 Assessment of Project Effects on Big Game Movement

There is no evidence that the Project facilities create adverse effects on big game movement. There have been few documented cases of deer dying while attempting to cross canals or reservoirs. A small number of deer has died in the J.C. Boyle canal and there is only one anecdotal report of a deer falling through ice at J.C. Boyle reservoir. It is likely that the big game populations in the region have become accustomed to the presence of the reservoirs and Project facilities, and have adjusted their movement patterns accordingly.

From a regional perspective, the canyon and mid-elevation hillsides and plateaus between the J.C. Boyle powerhouse and Iron Gate dam is considered critical deer winter range by the BLM, ODFW, and CDFG. This area represents one of the largest contiguous areas of winter range in the southern Oregon and northern California region. Near the Project, two wildlife management areas play important roles in providing deer winter range. These are the HRWA, located northwest of Iron Gate reservoir, and the PWHMA, located along the north side of the river from J.C. Boyle dam to north of Copco reservoir. These two areas have as one of their management goals, maintenance of big game winter range. The Pokegama Cooperative Habitat Management Project is an agreement between the ODFW, BLM and several private landowners, including PacifiCorp that provides road closures during the winter and promotes habitat enhancement projects to benefit the Pokegama deer herd. The goals of the Pokegama Project are to improve big game winter range and reduce illegal take and harassment of wildlife on critical winter ranges (BLM, 1996). Within the study area, south facing canyon walls and hillsides are some of the most critical habitat for wintering the migratory Pokegama black-tailed deer herd as well as for resident deer (City of Klamath Falls, 1990) (Figure 6.7-1).

Studies of the Pokegama deer herd conducted for the Salt Caves Project during the winters of 1985 and 1986 resulted in the following conclusions (City of Klamath Falls, 1986):

- The areas with the highest deer use were the farthest west portions of the management area, close to the California border.
- The highest use of the area was in November through January and declined by March.
- Deer use was most intense during the winter in the mid and upper slopes of the canyon as opposed to habitats immediately along the river.

Deer habitat use, population levels, and movement patterns in the area are largely affected by elevation that affects snowfall in the winter and the pattern of forage and cover habitats throughout the area. The long-term changes in management of forests and shrublands that occurred in the early 1900s have caused a decline in the disturbances that perpetuate early-successional habitats, which provide important deer habitat (CDFG, 1998). Since the 1960s, a combination of intensive timber harvest and fire suppression (or in some cases inappropriate prescribed fire timing) has resulted in more forage-limited second-growth forests and more decadent shrublands that have unavailable or low quality browse and little herbaceous vegetation (CDFG, 1998). Generally, as tree canopy increased with the management, the understory shrub and herbaceous vegetation decreased. Forage condition on winter range also is declining because of infestations of exotic weeds (BLM, 2002). A long history of livestock grazing also could have played a role in reducing forage availability and big game habitat use through direct competition for browse, herbaceous vegetation, and mast or indirectly because of reduced shrub flowering and subsequent seed production (CDFG, 1998; Bronson, 1992; Loft and Menke, 1988).

Deer movement has not been studied extensively in the immediate study area. However, the South Cascades deer study documented movement from the wintering range on the Horseshoe Ranch to the Cascade Mountains north of the project (Jackson and Kilbane, 1996; ODFW unpublished data). This study did show at least some movement across the river either across or near Iron Gate reservoir (Figure 6.7-1). Elk telemetry data showed a long-range migration pattern between the Shasta Valley in California and the forests to the west of Upper Klamath Lake in Oregon (Figure 6.7-1). Analysis of 20 radio-collared elk in 1994 demonstrated summer ranges in the upper portions of the Long Prairie Creek and Jenny Creek areas as well as several areas at higher elevations north of the river (BLM, 1996). No data exist on elk wintering near the Project reservoirs, so it is unclear whether low-elevation habitat affects wintering elk survival in the study area. Some elk cross the study area during the migration periods, but do not appear to remain in the study area for long periods of time. Areas such as the Shasta Valley to the south of the Project and the PWHMA to the north may be more important to elk.

Along the Trinity River, deer continue to use historical migration routes by swimming across a narrow reservoir. The narrowness of the J.C. Boyle reservoir, Iron Gate reservoir, and the eastern third of Copco reservoir likely allows deer and elk to cross. Only during the rare events, when the reservoirs freeze, would mortality be an issue.

The presence of the reservoirs may affect how big game use habitats and can change mortality rates under certain circumstances. In the rugged Hells Canyon section of the Snake River, Edelmann (2001) found that mule deer may suffer increased risk of predation with ice cover on the reservoir. In addition, Edelmann (2001) reported that mule deer were killed within a day following swimming across the reservoir, suggesting that individuals that break through ice might suffer increased predation because of fatigue. If only a few animals die each year or every few years, there is little negative effect on the populations. There appears to be relatively little mortality of big game because of reservoir interaction as evidenced by the few documented mortalities. In the case of the Klamath study area, the gentler terrain and lack of conditions leading to water freezing probably decrease the effect of the reservoir on deer movement and mortality. The lack of continuous riparian shrub/tree habitat along Project reservoirs may reduce the suitability of adjacent grassland, shrub, and oak woodland for big game by limiting hiding cover. Existing habitat conditions in the open grasslands and some of the oak, juniper, oak-juniper, and oak-conifer woodlands have been adversely affected by the long history of livestock grazing and the dominance by exotic weeds (see Sections 9.7 and 8.7). This could affect carrying capacity and movement patterns for deer in the study area. Thus, future habitat improvements that increase winter browse and spring forb availability could enhance conditions for both resident and wintering deer that move through the area.

Deer populations in California have been adversely affected by a combination of habitat loss and degradation, timber harvest, livestock grazing, wildfire and fire suppression, reservoirs, predation, regulated hunting, poaching, diseases, weather patterns, highway mortality, and competition with non-native wildlife species (CDFG, 1998). In recent years, the deer population in northeastern California (I-5 to the Nevada border) has declined more than in any other region in the state. The primary reason for the decline is considered to be the loss of high quality, early-successional habitat (CDFG, 1998).

Within the 1,039-mile^2 (2,691-km^2) Keno Management Unit located north of the Klamath River in Oregon, the ODFW has identified a winter mule/black-tailed deer population goal of 3,200 individuals. The population structure would include 15 bucks for every 100 does (after the hunting season), and 35 fawns for every 100 adults (ODFW, 2002). In the mid-1980s, approximately 3,000 black-tailed deer wintered in the Keno Management Unit area; this number was reduced by at least 40 percent during the severe winter of 1992-1993 (BLM, 1996) and the population has been slow to recover. Currently, the winter deer population is at 37 percent of the management objective or approximately 1,200 individuals (Collom, pers. comm., 2003).

Most of the deer that winter in the Keno Management Unit are also resident during the summer. Additionally, approximately 10 percent of the 13,400 deer that winter in the Rogue Unit (the adjacent management unit to the west) also spend their summers in the Keno Unit (Collom, pers. comm., 2003).

Currently, about 400 elk winter in the Keno Management Unit (Collom, pers. comm., 2003). Telemetry studies have shown that elk herds in a given summer range may move to different winter ranges; most elk have an affinity for certain ranges and generally will use the same summer and wintering grounds throughout their life (ODFW, 2002a). Some elk are resident animals as well. The severity of winter often will influence how far and to what elevation elk will move to avoid adverse weather conditions (ODFW, 2002a). Many elk in the Cascade Mountains (Roosevelt subspecies) show migration patterns, but their seasonal movements are generally shorter than that of the Rocky Mountain subspecies (ODFW, 2002a). Studies have shown that elk often winter on the west slope of the Cascades and cross to central Oregon in the summer (ODFW, 2002a).

Elk wintering survival is affected by three main factors; availability of forage, thermal cover, and hiding cover (ODFW, 2002a). Factors affecting elk security are topographic relief, vegetation density, and proximity to human activity (ODFW, 2002a). These factors are especially important in areas where predator density is high (ODFW, 2002a).

In conclusion, it does not appear that the Project affects big game movement on a population level. Small numbers of deer and elk are year-round residents of the study area, while some animals move through the area during migration between winter and summer ranges. Habitats in the study area provide deer winter range, but the most important areas are north of the Project in areas not affected by the Project. Future habitat improvements could benefit both resident and migratory deer and elk.

The steep and rocky nature of the J.C. Boyle bypass canyon makes it unlikely that the area is used consistently by big game. However, based on the configuration of the canal, terrain, and adjacent habitat, the addition of one bridge over the canal would enhance movement opportunities for big game and other wildlife.

6.8.1.2 Assessment of Wildlife Entrainment in Canals

Entrainment data indicate that medium-size and large mammals are not entrained in any Project canals with any regularity. It is likely that wildlife populations have become accustomed to the presence of the canals and have changed their movement patterns to avoid Project canals. The Fall Creek and West Side canals do not appear to represent significant entrapment hazards to big game or most other wildlife because their velocities are low and the canal banks are earthen construction that allows animals to escape. Small portions of the J.C. Boyle canal and some of the East Side canal appear to be potential hazards to wildlife. Concrete walls and steep cliffs prevent animals from accessing most of the J.C. Boyle canal. Less than 400 feet (122 m) of the J.C. Boyle canal wall is less than 2 feet (0.6 m) above the ground and bordered by gentle or moderate slopes, where most terrestrial species would occur. The other 4,590 feet (1,399 m) of canal wall that is less than 2 feet (0.6 m) above the ground, is bordered by steep terrain and likely is not used by many terrestrial species. The East Side canal (actually more of a forebay) has one earthen side that would provide the opportunity for entrained animals to escape (Table 6.7-4).

Based on the wildlife surveys conducted in 2002 and 2003, it appears that there are several small mammal species, particularly the deer mouse, bushytail woodrat, dusky-foot woodrat, montane vole, canyon mouse, and least chipmunk, were relatively common immediately along one or more of the canals. In addition, several species of snakes and lizards also were found using habitats along the J.C. Boyle canal. Lizard species could, in theory, climb the concrete walls of the J.C. Boyle canal while the other species would be able to access the inside of the canal only at certain locations with low or no walls.

6.8.1.3 Small Animal and Avian Connectivity

The ability to assess the effect of habitat connectivity on the specific persistence of terrestrial species is limited by incomplete information for most wildlife species on their dispersal capabilities, genetic interactions, and demographic parameters that influence successful dispersal. The following is brief discussion of the effects of riparian habitat connectivity on small animals and avian species.

Discontinuous and patchy distributions of riparian plant species occur more often in river systems with multiple impoundments than in natural free-flowing rivers. The patchy distribution of riparian habitats and unnatural distribution of riparian plant species may decrease the linear movement of several avian, reptile, amphibian, and mammalian species.

The species that are likely to be affected by the increased inter-riparian shoreline distances and patchy riparian plant distribution include riparian species that are closely tied to riparian habitat during all or part of their life history. Clearly, several amphibian species as well as small mammals, aquatic furbearers, and some reptiles use riparian habitats for breeding, foraging, or cover. Several TES and riparian focal species including the yellow warbler (*Dendroica petechia*), song sparrow (*Melospiza melodia*), willow flycatcher (*Empidonax traillii*), black-crowned night heron (*Nycticorax nytcticorax*), yellow rail (*Coturnicops noveboracensis*), western yellow-billed cuckoo (*Coccyzus americanus*), purple martin (*Progne subis*), yellow-breasted chat (*Icteria virens*), foothill yellow-legged frog (*Rana boylii*), Oregon spotted frog (*Rana pretiosa*), and western toad (*Bufo boreas*), also use the riparian habitats significantly more often than upland habitats. Floodplain woodlands support higher densities of breeding birds than upland woodland or herbaceous habitats (Stauffer and Best, 1980). Although birds are highly mobile, there has been some documentation that riparian connectivity plays an important role especially during dispersal. Juvenile birds are often more dependent on continuous riparian habitat for dispersal than are adults of the same species (Machtans et al. 1996). Large lakes more than 650 feet (200 m) wide may form barriers for many forest birds during dispersal (Machtans et al. 1996). This would indicate that all of the Project reservoirs might affect aspects of local avian movement (e.g., dispersal, but not migration) in at least some areas.

Furbearers, such as the mink, river otter, beaver, and muskrat, might be affected by the distribution of riparian habitat (Waller et al. 1999). For these species, adequate shelter and availability of aquatic foods (Bellrose and Brown, 1941; Melquist and Hornocker, 1983; Mitchell, 1961; Toweill, 1974) dictates distribution.

Observations of aquatic furbearers were relatively rare during the 2002-2003 field surveys. This likely was the result of the lack specific surveys targeting these secretive species. Nonetheless, mink (*Mustela vison*), beaver (*Castor Canadensis*), muskrat (*Ondatra zibethicus*), and river otter (*Lutra canadensis*) were documented in various portions of the study area. It is likely that the reservoirs create breaks in some of the populations because of a lack of adequate shoreline vegetation. However, dispersal probably occurs along each reservoir and adjacent river reaches. The Iron Gate and Copco No. 1 dams may be difficult for dispersing wildlife to go around because of their height and location in narrow canyons. However, the Copco No. 2, J.C. Boyle, and Keno dams are relatively low and probably do not create a physical barrier for most wildlife attempting to make long-range movement upstream or downstream. The J.C. Boyle canal probably blocks movement by individual terrestrial mammals and reptiles. The impact likely is limited to the individual animal, but there could be benefits to local populations by enhancing crossing opportunities along the canal. PacifiCorp's proposal for J.C. Boyle enhancements is presented in the license application.

Project roads throughout the study area potentially can affect small animal connectivity and be a source of mortality. Culverts under roads may have their greatest impact on the upstream movement of aquatic macroinvertebrates and amphibians. This blockage of movement can be especially common where streams cross roads in undersized or "shotgun" culverts (Vaughan, 2002). In some states, culvert underpasses large enough to pass reptile and small mammal species have aided crossings on busy highways (Federal Highway Administration, 2000).

Amphibian and reptile densities near roads are often reduced (Fahrig et al. 1995, Findlay and Houlahan, 1997, Findlay and Bourdages, 2000). In Texas, timber rattlesnakes (*Crotalus horridus*) are less abundant with increasing proximity to individual roads (Rudolph et al. 1998; Rudolph et al. 1999). In New England forests, salamanders, newts, and frogs avoided crossing forest roads (deMaynadier and Hunter 2000, Gibbs 1998). Reptiles often use roads and adjacent habitats and, consequently, incur increased mortality (McClure, 1951; Bernardino and Dalrymple 1992; Krivda, 1993; Rosen and Lowe, 1994; Boarman and Sazaki, 1996; Fowle, 1996). Effects of roads on small mammal densities and community composition are mixed. Some species tend to be more abundant near roads, while other species are less abundant (Garland and Bradley 1984; Adams and Geis, 1981, 1983). Roads have been shown to be a movement barrier for many small mammal species (Garland and Bradley 1984; Richardson et al. 1997). Oxley et al. (1974) demonstrated that the width of the cleared opening is the most important factor as to whether small mammals will cross roads. Typically, vehicle collisions are not a significant impact on small mammal populations (Adams and Geis, 1981; Adams and Geis, 1983; Garland and Bradley, 1984). However, as documented by PacifiCorp's monitoring during 2003, California ground squirrels seem to be subject to increased mortality in the Klamath study area.

Avian communities are affected by fragmentation, which has been shown to increase predation of nests and increase brown-headed cowbird populations. The more agricultural fields, human development, and grasslands in forested areas, the greater the risk of cowbird nest parasitism (Freemark et al. 1995; Saab, 1999).

The distribution of riparian habitat may have a major impact on the distribution of riparian-dependent bird species. The KBO's long-term monitoring has indicated that the riparian areas are important not only for breeding, but also during fall migration. However, in other semi-arid areas, studies concluded that because most riparian habitat is patchy, linearly oriented, and fragmented naturally, effects of habitat fragmentation may be less evident (Saab, 1999).

6.8.1.4 Assessment of Transmission and Distribution Line Effects on Avian Species

Overall, the FERC transmission lines associated with the Project do not appear to present a problem for avian collisions or electrocutions. There has been no evidence that avian collisions occur on Project lines (e.g., dead birds under lines or power outages caused by collisions). There was one record of waterfowl colliding with a small distribution line near the upper end of Iron Gate reservoir, but not with the FERC line. The segments that are closest to waterfowl use areas include the following: (1) Line 56-8 that crosses the Link River, and (2) Lines 15 and 62 that cross the upstream end of Iron Gate reservoir, and (3) Line 62 near Jenny Creek inlet (Figure 6.7-3).

Information in the literature indicates that the rates of collision with transmission lines are infrequent to rare, with one estimate of between 0.01 and 0.05 percent of flights that cross lines resulting in collisions (APLIC, 1994). One study of a 56-mile (90 km)-long transmission line in Washington resulted in no detected collisions during more than 12,000 flights through the plane of the transmission line by various bird species (Framatome ANP DE&S, 2002). As a group, waterfowl and other water-associated birds are more susceptible to collision than other groups. Large water birds (herons, cranes, and pelicans) have limited mobility and are at greater risk of collision (Morkill and Anderson, 1991; Brown and Drewien, 1995). Dabbling ducks may be more susceptible to collision than diving ducks because divers gain elevation more slowly (Faanes, 1987 cited in APLIC, 1994). Stout and Cornwell (1976) found that waterfowl collision mortality made up less than 0.1 percent of non-hunting mortality.). Most waterfowl that use reservoirs near the Project lines are diving ducks (see Section 7.7). Flocking species are more prone to hit wires (APLIC, 1994). Raptors are less prone to collision because most are resident and accustomed to lines and they have keen eyesight. Because the Project lines do not pass between the reservoirs/rivers and major wetlands or cropland that would attract foraging birds, the probability of collision is reduced. Lines with overhead ground wires are most dangerous because the wire, mounted above the main wires, is thinner and less visible. The Project transmission line segments do not have an overhead ground wire.

There are no known electrocution problems associated with the FERC Project transmission lines in the study area, which have wide spacing between wires (power outages likely would occur as a result of electrocutions). PacifiCorp will continue to use its Raptor Electrocution Reduction Program (RERP) to minimize future electrocutions on all PacifiCorp-owned lines in the region, including those that are part of the FERC Project. PacifiCorp continues to monitor bird electrocution and rectify problem poles and structures. Mitigation used to prevent avian electrocutions may include installing perch and nest platforms above narrowly spaced wire sections in combination with anti-perching triangles, installing insulator covers, or separating energized wires to provide 60-inch (152 cm) clearance as recommended by raptor safety standards (APLIC, 1996).

6.8.2 Characterization of Future Conditions

Wildlife connectivity across the study area will continue to be affected by the presence of the Project canals, flowlines, and reservoirs. The impact is likely greatest for small mammal, amphibian, and reptile species, whereas animals with larger home ranges, such as deer and elk, can move around the facilities or swim across narrow sections of the reservoirs. Continuation of the current water level management in reservoirs and bypass reaches likely will maintain shoreline wetland habitat as it exists today and thus the potential for dispersal for riparian-dependent wildlife will be similar to current conditions. Some additional wetland and riparian habitat likely will develop along Project reservoirs as shorelines continue to "slump," but these sites probably will not be as wide and diverse as sites along river reaches. Continued habitat enhancement activities that benefit riparian habitat in the study area will increase the connectivity of this important habitat. Movement enhancements at Project canals will be explored in the license application.

7.0 WILDLIFE HABITAT ASSOCIATION ASSESSMENT AND SYNTHESIS OF EXISTING WILDLIFE INFORMATION

7.1 DESCRIPTION AND PURPOSE

The purpose of this assessment and synthesis is to: (1) provide habitat-based information on wildlife occurring in the Klamath River Hydroelectric Project vicinity that are not specifically addressed by other relicensing studies; (2) consolidate and summarize information on all species; and, (3) provide an analysis of potential threats to wildlife and habitat in the Project vicinity. Information on species habitat associations, developed and compiled from existing sources and the combined results of all relicensing field studies, is presented in this section with a specific emphasis on wetland and riparian species. This section also presents the results of avian field surveys and provides an analysis of avian occurrence, distribution, and abundance as an indicator of the health and condition of Project wetland and riparian areas, specifically, and habitats in general. Wildlife species associated with riparian and wetland habitats and those habitats likely affected by Project operations are emphasized to help assess potential continued and future effects of Project operations.

7.2 OBJECTIVES

The specific objectives of this study are the following:

- Consolidate species-habitat association information for wildlife resources obtained from the literature, PacifiCorp relicensing studies, and incidental observations.

- Prepare a wildlife species habitat association matrix using data from available literature, agency data, historical records, and relicensing field studies.

- Present results of general avian field studies with an emphasis on broad-scale and Project-wide avian occurrence, distribution, and abundance.

- Document occurrence, distribution, and habitat conditions for designated Riparian Focal Species (RFS)—including the western pond turtle (*Clemmys marmorata*), willow flycatcher (*Empidonax trailii*), Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), yellow warbler (*Dendroica petechia*), yellow-breasted chat (*Icteria virens*), song sparrow (*Melospiza melodia*), black-headed grosbeak (*Pheucticus melanocephalus*), and aquatic fur-bearing mammals—in the Project vicinity.

- Produce a synthesis analysis emphasizing wildlife habitat associations in wetland, riparian, and habitats most-likely influenced by Project operations to help characterize resources and evaluate ongoing and potential Project effects in the license application.

- Provide information for developing PM&E measures for area wildlife addressing regulations, management goals, and plans.

7.3 RELICENSING AND USE IN DECISIONMAKING

Information on wildlife habitat associations is needed to describe existing resources in the study area. This section provides a comprehensive synthesis of information from the Vegetation Cover

Type/Wildlife Habitat Inventory and Mapping Study (Section 2.0), Wetland and Riparian Plant Community Characterization Study (Section 3.0), and all wildlife studies (Sections 4.0, 5.0, and 6.0) to assess potential Project impacts in the license application.

7.4 METHODS AND GEOGRAPHIC SCOPE

The study area for the wildlife habitat association assessment included the following:

- All Project reservoirs and facilities
- All lands existing within 0.25 mile (0.40 km) of Project facilities, roads, and transmission lines as well as river reaches from the Link River to Iron Gate dam
- The Klamath River and peripheral riparian and wetland communities from Iron Gate dam to the mouth of the Shasta River.

In general, methodology for the wildlife habitat association assessment primarily involved: (1) thoroughly reviewing literature on species distribution and known habitat associations; (2) combining data on wildlife observations collected during field surveys; and, (3) assessing wildlife data along with information from other relicensing studies. Existing information was used as a base with data collected during the various tasks identified above used to fill gaps and create a more complete description of wildlife and botanical resources and their relationships. Habitat association classifications were coordinated with cover type classifications in the Vegetation Cover Type/Wildlife Habitat Inventory and Mapping Study (Section 2.0).

PacifiCorp’s review of existing literature, agency databases, documented records, and all pertinent information included the following sources in addition to those specifically cited in the text:

- Atlas of Oregon Wildlife (Csuti et al. 1997)
- Wildlife-Habitat Relationships in Oregon and Washington (Johnson and O’Neil, 2001)
- California Wildlife Habitat Relations System (CDFG, 1999)
- Salt Caves wildlife studies and environmental assessments (City of Klamath Falls, 1986; FERC, 1990)
- USFS Redwood Sciences Laboratory and KBO studies completed as part of a basin-wide avian monitoring effort (Alexander and Ralph, 2001)
- Amphibian and reptile surveys conducted by BLM in the Klamath River Canyon during 2000 and 2001 (Roninger, 2000, 2001)
- Literature on the effects of hydroelectric projects on wildlife
- Resource agency data and general wildlife information

The following sections briefly describe methods for each specific study component.

7.4.1 General Wildlife

Field survey results incorporated into the wildlife habitat association assessment study include data from targeted avian, amphibian, reptile, and mammalian field studies conducted in 2002 and 2003. Methodology for targeted surveys associated with amphibian, reptile, and mammalian field studies are described in detail in Sections 4.0 and 6.0. Methodology for field surveys specific to avian species is described in Section 7.4.1.1. Additional information on methodology for surveys specifically focused on TES species is provided in Section 5.0.

7.4.1.1 Avian Field Studies

Surveys to document general avian populations in the Project vicinity included: (1) avian plot surveys, (2) facility surveys, and (3) reservoir surveys. Specific methodologies for avian TES species field surveys including bald eagle surveys and northern spotted owl, northern goshawk, and great gray owl broadcast call protocol surveys are described in detail in Section 5.4.4.3. In addition, data from avian censuses and mist-netting at constant effort stations (CES) conducted by KBO in the Project vicinity are included in this wildlife habitat association assessment.

Avian Plot Surveys

Plot surveys were conducted during 2002 and included a 5-minute avian point count, where all bird detections were recorded from the center of a 164-foot (50-m) radius circular survey plot, immediately followed by a 15-minute area search during which each plot was systematically traversed to detect all birds in the plot vicinity. Point count survey methods generally followed those described in Ralph et al. (1993). The 3-minute mark was recorded during each 5-minute point count survey for standardization and comparison with other avian survey protocols (e.g., Breeding Bird Survey, KBO point counts, etc.). The combined point count and area search resulted in a total survey effort of 20 minutes per avian plot survey (Geupel et al. 1995).

Birds detected both inside and outside of the plot were recorded during the 20-minute plot survey protocol. The habitat association for all avian detections was characterized in two ways: (1) each plot was defined by a general habitat designation based on the most prevalent habitat existing within the plot; and, (2) the specific habitat in which each bird was detected was recorded. Surveys were conducted from 15 minutes before sunrise until 4 hours after sunrise and were initiated after a 1-minute settling period. A total of 149 plots was used with 137 surveyed in May 2002 and all 149 surveyed in June 2002. Twelve plots were not surveyed in May 2002 because of inclement weather that is known to impede avian species detection.

Facility Surveys

Facility surveys were conducted in conjunction with plot surveys in May and June 2002 to document avian use in the immediate vicinity of Project facilities. Facility survey protocol included an area search immediately adjacent to Project facilities that ended after a surveying biologist determined that a representative sample of the surrounding avifauna had been detected. These surveys were supplemental to the plot surveys and were neither time- nor area-constrained. Biologists recorded the location and behavior of all detected birds. Nests of raptors or other species were recorded if encountered. Other wildlife species observed also were documented. Eighteen facility sites located in the study area were surveyed in 2002 (Section 5.0, Figure 5.4-1). Facilities surveyed varied in size, and, thus, a standardized area of reference is not associated with facility survey data. Likewise, facility surveys were not time-constrained, but generally were completed in approximately 15 to 40 minutes.

Reservoir Surveys

Copco, Iron Gate, and Keno reservoirs were surveyed six times each and J.C. Boyle reservoir was surveyed five times from April 2002 through March 2003 for a combined total of 23 reservoir surveys conducted as part of the wildlife habitat association study. Typically, reservoir surveys were conducted from a vehicle by one or more biologists. Biologists visually inspected reservoirs from various vantages using spotting telescopes and binoculars to ensure complete coverage. All reservoirs were inspected in their entirety during these surveys except Keno reservoir, where pool regions southeast of Highway 66 upstream to the state wildlife refuge boat ramp could not be accessed. All avian species detections were documented according to specific location.

KBO Point Count and CES Surveys

As part of its avian monitoring studies, KBO has conducted avian area search censuses and mist-netting at numerous point count stations located throughout the Klamath River watershed and at a CES at the Frain Ranch since 1997. Data from these surveys are included in the wildlife habitat association assessment to add long-term and regional perspective to the avian data collected in the study area in 2002. Methodology for CES surveys follows Ralph et al. (1993), and Ralph and Hollinger (2001). Constant-effort mist netting and capture of birds is a relatively broad-scale and cost-effective method to provide researchers with the demographic information essential for the assessment of the status and health of bird populations. KBO operates a CES at Frain Ranch (TOPS), where ten nets have been established. The site is visited every 10 days during the breeding season (May 20 through August 30) and weekly during migration (September 1 through October 20). During a visit, birds are captured and banded for approximately 5 hours beginning within 15 minutes of sunrise, and the age, sex and physiological condition of each bird is assessed. During this time a minimum of two area search censuses is conducted for the standard 20-minute duration.

Between 1997 and 2002, KBO established more than 1,700 point count census stations throughout the Upper Klamath basin and Klamath River Canyon. Surveys were conducted one to six times at each station during the breeding season. Data collected from a subset of these stations, located within and adjacent to the PacifiCorp study area, were summarized to be compared qualitatively with bird census data collected as part of the relicensing study.

7.4.1.2 Amphibian and Reptile Field Studies

Field surveys targeting general amphibian and reptile species included: pond-breeding amphibian surveys; terrestrial amphibian surveys; instream surveys; and, general wildlife plot and facility reptile surveys. In addition, surveys targeting special status herptiles and unique habitat including the Oregon spotted frog, foothill yellow-legged frog, western pond turtle, and potential snake hibernacula sites were conducted during the 2003 field season. Detailed information on methodology for all field studies targeting amphibian and reptile species is provided in Section 4.4.2. Methodology for surveys targeting TES amphibian and reptile species is provided in Section 5.4.4.1.

7.4.1.3 Mammalian Field Studies

Field studies conducted to inventory mammalian species in the Project vicinity include: photographic bait stations surveys; track surveys; and wildlife surveys conducted along Project canals. In addition, live trapping for small mammals along the West Side, J.C. Boyle, and Fall Creek canals was conducted during the 2003 field season. Detailed information on methodology for mammalian field studies is provided in Section 6.4.2.2.

7.4.2 Riparian Focal Species

Before the initiation of relicensing field studies, the TRWG developed the following list of ten RFS (or species groups):

- Western pond turtle
- Lewis' woodpecker
- Willow flycatcher
- Swainson's thrush
- Warbling vireo
- Yellow warbler
- Yellow-breasted chat
- Song sparrow
- Black-headed grosbeak
- Aquatic fur-bearing mammals including mink (*Mustela vison*), river otter (*Lutra canadensis*), muskrat (*Ondatra zibethica*), and beaver (*Castor canadensis*).

These species were chosen for their known association with aquatic, riparian, and wetland habitat systems (Riparian Habitat Joint Venture [RHJV], 2000) and other important habitats [Lewis' woodpecker]). Consistent with the objectives of the wildlife habitat association assessment, field studies and analysis for this study focused on these species as indicators of the health and functioning of aquatic, wetland, and riparian habitat in the Project vicinity.

7.4.2.1 RFS Targeted Surveys

Wildlife field studies associated with Project relicensing generally focused on wetland and riparian habitat located peripheral to Project reservoirs and river reaches. As such, a preponderance of data was collected on the status, distribution, and occurrence of RFS in the study. In addition, surveys specifically targeting RFS including ROI and western pond turtle surveys were conducted to provide additional data on RFS in the Project vicinity. Methodologies for RFS targeted surveys are described in detail in the following sections.

Rapid Ornithological Inventory

To obtain specific information on RFS and avifauna associated with Project riparian and wetland systems, PacifiCorp contracted KBO to conduct ROI surveys along Project reservoirs and river reaches. As a complement to the CES, the ROI monitoring technique is used to quickly gain a measure of the birds at a single station to compare their abundance, composition, and population structure with other, similar stations in order to assay their relative value. Surveys were conducted at six ROI stations from August 26 through September 4, 2002, to collect specific information on avian RFS and to obtain additional information on migration phenology and post-breeding dispersal of study area birds in general. ROI station locations were selected in consultation with KBO personnel and local, state, and federal resource agencies. ROI methodology included mist-netting and banding coupled with area searches and nocturnal call-and-response owl surveys conducted during an intensive 3-day survey period (Ralph and Hollinger, 2001). ROIs (a 3-day effort to document bird abundance in different areas near CES sites) were conducted at five sites within the PacifiCorp study area. Mist-nets were operated for an entire day (6 hours in morning and 4 hours in evening) and for a following morning (5 hours), and area searches are conducted throughout the netting effort. One or two surveys and netting efforts for small owls also were conducted at each site. ROI stations were established: (1) in the Iron Gate-Shasta reach downstream of the Iron Gate-Shasta fish hatchery; (2) near the mouth of Scotch Creek off of Iron Gate reservoir; (3) along the Copco No. 2 bypass; (4) near the mouth of Shovel Creek in the J.C. Boyle peaking reach; (5) along the Link River; and, (6) in the J.C. Boyle peaking reach at Frain Ranch (Section 5.0, Figure 5.4-1).

Western Pond Turtle Surveys

Surveys targeting basking western pond turtles were conducted between April and July 2002 by biologists traveling by boat or vehicle along reservoirs and accessible river reaches. Additional surveys were conducted in July through September 2003 to document pond turtle use in the California segment of the J.C. Boyle peaking reach and in the J.C. Boyle bypass. During surveys, biologists recorded the location of basking sites and the number of adults and juvenile turtles present at each site. Surveys were not conducted in the Oregon portion of the J.C. Boyle peaking reach because data and detailed information on pond turtle occurrence and habitat use previously had been collected in this localized area (Bury and Pearl, 1999; Roninger, 2000). In addition to the documentation of turtle observations, each river and reservoir shoreline was mapped into segments based on the presence of suitable nesting habitat for the species (Section 4.4.2.5).

7.4.2.2 Wildlife Habitat Association Analysis and Data Summary

Compilation and analysis of wildlife habitat association data included a systematic review of relevant literature coupled with a quantitative and statistical analysis of data on wildlife occurrence, distribution, and abundance from field studies. Documented wildlife habitat associations and species distribution data were used to focus RFS and general wildlife relicensing surveys in appropriate habitats and regions. Existing literature, studies, and data sources pertaining to western pond turtle occurrence and distribution included Bury (1994), Germano (1994), and Holland (1994). Development of field survey methodology and species habitat association analysis for birds was guided by: information in the Riparian Bird Conservation Plan (RHJV, 2000); historical data on regional avian occurrence provided by KBO; Ralph et al. (1993); Geupel et al. (1995); and, specific Habitat Suitability Index (HSI) models for the Lewis' woodpecker (Sousa, 1983), yellow warbler (Schroeder, 1982), and song sparrow (USFWS, 1978). Specific preliminary information on the occurrence of aquatic fur-bearing mammals in the Project region was provided in Csuti et al. (1997) and Nelson (1997).

Results are presented with tables and figures that separate data by habitat and Project section to illustrate notable differences in habitat associations and local occurrence. Statistical analyses of differences between and among habitats and Project sections—as well as findings of statistically significant differences or trends—are described in the text (Section 7.7).

An analysis of habitat suitability in each Project section was conducted on the basis of existing HSI models for three RFS species—song sparrow, yellow warbler, and Lewis' woodpecker (Section 7.7.2.2). HSI models provide an index of habitat suitability for designated species based on a quantitative assessment of defined habitat parameters and documented species occurrence. Such models are used to provide an objective, quantifiable comparison of habitat parameters to determine a relative index value for existing habitat. In all cases, calculated HSI models produce a range from 0.00 to 1.00 with higher values reflecting increased theoretical habitat quality. Parameters affecting habitat suitability for each HSI by species are as follows:

Song Sparrow HSI

- Shrub distribution and grouping
- Percent vegetative cover
- Perch site density
- Average shrub height
- Distance to water

Yellow Warbler HSI

- Percent deciduous crown cover
- Average height of deciduous shrub canopy
- Percent composition of hydrophytic shrub cover

Lewis' Woodpecker HSI

- Percent vegetative cover
- Snag density
- Density of mast-producing trees and shrubs
- Distance to nearest mast storage site

The specific parameters affecting calculated habitat suitability are described whenever HSI models are used to quantify the suitability of available habitat for these three RFS (Section 7.7.2.2).

7.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

The BLM, ODFW, and CDFG all have management goals that mandate the continued maintenance of vertebrate species diversity. These include the BLM's resource management plans for the Klamath Falls and Redding resource areas (BLM, 1993 and 1995). The BLM and USFS also must meet ACS objectives under the Northwest Forest Plan Record of Decision (USFS and BLM, 1994, 2000, and 2001).

In Oregon, it is the policy of the state to manage wildlife to prevent the serious depletion of any indigenous species and to provide optimum recreational and aesthetic benefits for present and future generations of citizens of the state (*Oregon Revised Statute* [ORS] 496.012). The Wildlife Diversity Program helps carry out this policy by:

- Monitoring the abundance and distribution of wildlife species

- Assisting in the recovery of threatened and endangered species
- Helping to prevent species from qualifying for threatened or endangered status
- Working to maintain a diversity of healthy wildlife populations and habitats
- Providing information about wildlife to the public and helping landowners having wildlife problems
- Providing recreational opportunities for citizens and visitors

In California, the mission of the CDFG is to manage California's diverse fish, wildlife, and plant resources and the habitats upon which they depend for their ecological values and for their use and enjoyment by the public (CDFG website). Within the CDFG, the Natural Community Conservation Planning (NCCP) program provides for the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity (NCCP website). Conservation of riparian habitat and associated species—including all designated avian RFS—follows recommendations put forth in the Riparian Bird Conservation Plan (RHJV, 2000).

This study provides information necessary to address the Project's ongoing effects on vertebrate species and their habitats and will allow PacifiCorp to develop targeted, biologically appropriate PM&E measures.

7.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were held on the following dates: January 17, March 28, April 18, June 6, November 8, and December 10, 2002, and February 4, August 5, and October 10, 2003. At each of these meetings, PacifiCorp either received comments that were incorporated into the Final Study Plan or presented and discussed study results.

7.7 RESULTS AND DISCUSSION

Tables showing data from Section 7.0 analyses are found in Appendix 7A. Results from field studies included in the wildlife habitat association assessment are summarized in the habitat species matrix (Table 7A-1 in Appendix 7A). The habitat species matrix provides information on the occurrence of all wildlife species detected or known to occur within habitats and Project sections in the study area during the course of relicensing field studies.

7.7.1 General Wildlife

In total, 225 distinct vertebrate wildlife species were detected or confirmed from other sources as occurring in the Project vicinity. These 225 species include five amphibians, 16 reptiles, 174 birds, and 30 mammal species (Table 7A-1 in Appendix 7A). The sections below provide specific detailed results on each species group.

7.7.1.1 Avian Field Studies

During relicensing field studies, 174 bird species were detected in the study area with a total of more than 20,000 individual detections. More than 11,000 of these detections were recorded on Project reservoirs during reservoir surveys conducted in 2002 and 2003 (see Reservoir Surveys below). Of the remaining avian detections, more 7,800 were recorded during avian plot surveys and approximately 1,300 avian detections were recorded during facility surveys.

Plot Surveys

Results from avian plot surveys provided most data for analysis of species habitat associations. Bird numbers and species diversity detected during plot surveys varied across survey months, Project sections, and specific locations (Figure 7.7-1). This range of avian abundance and species diversity across surveys largely reflects differences in available habitat, as well as landscape-level differences in habitat surrounding survey plots. Between May and June surveys, observed differences in avian abundance and species diversity likely reflect species migration phenology (differences in migration timing across species) and seasonal behavioral changes associated with the avian breeding cycle.

The largest numbers of avian detections across habitats were recorded in lacustrine, riparian/palustrine scrub-shrub wetland, and riparian/palustrine forested wetland habitats with 998, 868, and 807 detections recorded in each habitat type, respectively, during plot surveys (Table 7A-2 in Appendix 7A). A comparison of plot survey detections across Project sections (Table 7A-2 in Appendix 7A), indicates that the largest numbers of avian detections were recorded in the Keno reservoir, J.C. Boyle peaking reach, and Iron Gate reservoir Project sections with 1,357; 1,315; and 1,092 detections recorded, respectively. The abundance of detections along Iron Gate and Keno reservoirs likely was influenced by large aggregations of birds on the reservoirs. The abundance of detections recorded in the J.C. Boyle peaking reach resulted from the large number of surveys conducted in this Project section (n=73) rather than higher avian densities.

Data presented in terms of relative abundance (birds detected per plot survey) account for the disparate number of surveys conducted across Project sections and general plot habitat types. This standardized measure provides a more accurate assessment of relative avian densities for comparative purposes (Figures 7.7-2 and 7.7-3). A Tukey's comparison of means revealed a statistically significant difference ($p \leq 0.05$) between the average number of avian detections per survey recorded along Keno reservoir and all other Project sections except the Link River (average relative abundance for Link River surveys was found to differ significantly from the Copco reservoir, J.C. Boyle peaking reach, and Fall Creek Project sections [$p \leq 0.05$]).

The large relative abundance of birds detected in the Keno reservoir Project section—as well as the large variation between surveys—likely resulted from large aggregations of birds associated with the reservoir that were detected outside the plot. Regardless of general plot habitat, the flat geography and open habitat of lands surrounding Keno reservoir allowed open-water-associated birds to be detected from various plots throughout the Project section.

Across habitats, surveys conducted in rock talus and mixed riparian plots resulted in the lowest avian relative abundances at 13.50 ± 0.71 and 13.50 ± 6.86 detections per survey, respectively;

plots generally defined by sagebrush, wetland, and pasture habitat resulted in the highest relative abundance at 43.00 ± 31.21, 40.78 ± 38.19, and 38.50 ± 7.53 birds per survey, respectively. It should be noted that no plots were generally defined by aquatic habitat (plots could not be located in open water) and plots defined by various general habitat designations often were located near aquatic habitat, skewing the data on avian relative abundance by general plot habitat designation.

Figure 7.7-3 provides data on standardized relative species diversity—average number of species detected per survey—across Project sections and general plot habitat types. Across Project sections, the Keno reservoir (13.13 ± 2.98 species per survey), J.C. Boyle reservoir (13.05 ± 4.24 species per survey), and Iron Gate-Shasta (12.33 ± 3.34 species per survey) Project sections were found to have the highest relative species diversity. The average number of species detected during surveys in these three Project sections was found to differ significantly from the lower relative species diversity noted around Fall Creek ($p \leq 0.05$). Surveys along Keno reservoir also were found to result in a significantly higher relative species diversity than the average species diversity in the J.C. Boyle peaking reach ($p \leq 0.05$). These significant differences in relative species diversity between Project sections likely result from a greater diversity of aquatic, wetland, and riparian habitat in these Project sections, especially along Keno reservoir. No other statistically significant differences in relative species diversity were detected across Project sections.

A comparison of relative species diversity by general plot habitat revealed relatively little variance in survey results across surveys conducted in plots defined by different general habitat types (Figure 7.7-3). The only statistically significant difference ($p \leq 0.05$) in the average number of species recorded per survey among general plot habitat types, shown through a Tukey's comparison of means, was found to exist between surveys conducted in riparian/wetland scrub-shrub plots (12.22 ± 3.42 species per survey) and montane hardwood oak conifer plots (8.42 ± 2.31 species per survey). The relatively small variation across general plot habitat types is likely largely influenced by the heterogeneous composition of actual habitat types existing within and near each survey plot.

Figure 7.7-1. Avian abundance in wildlife survey plots.

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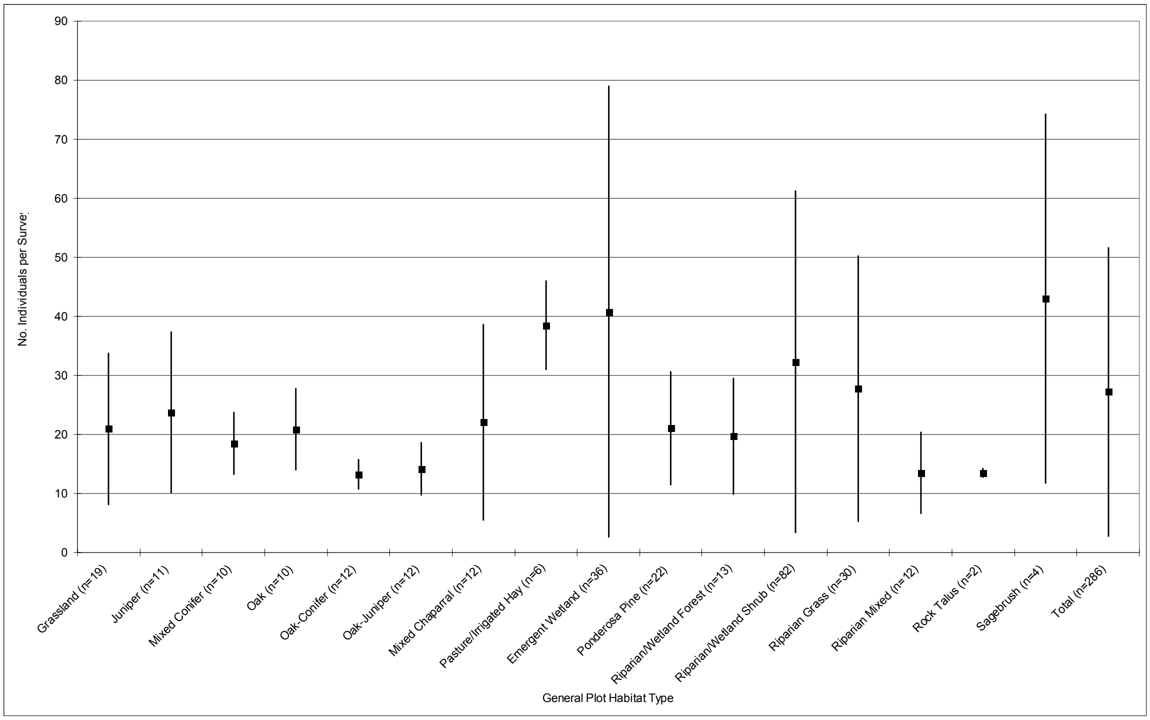


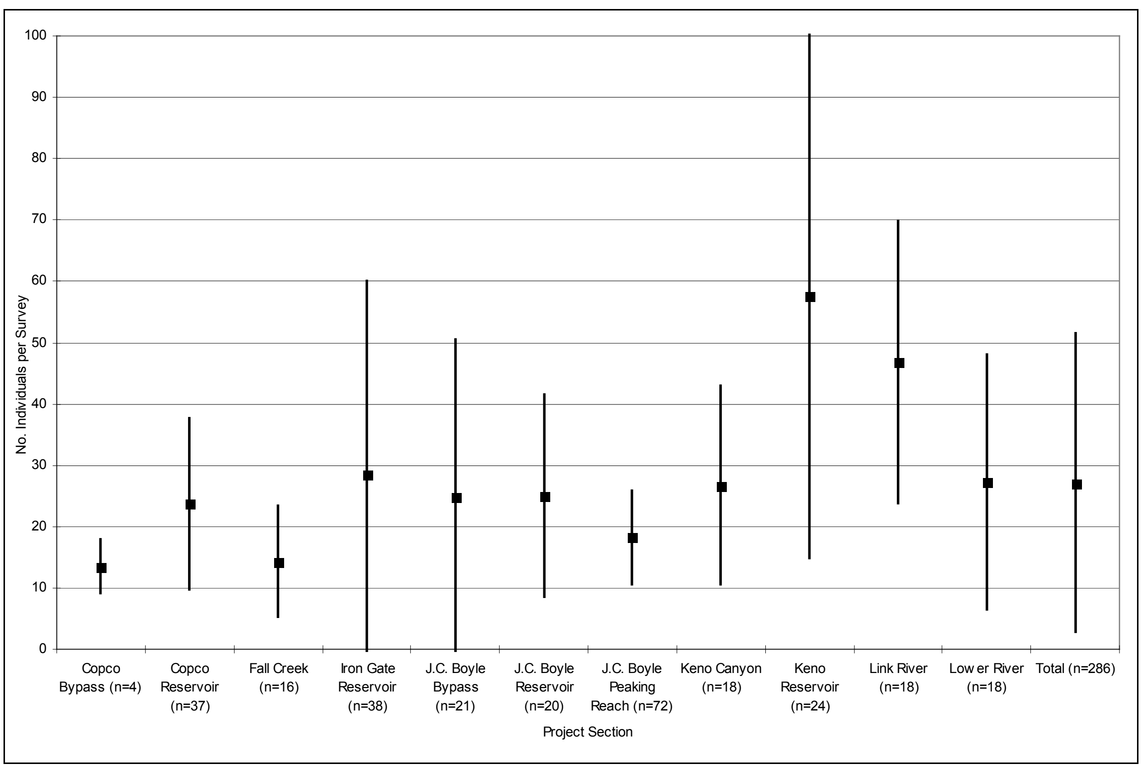
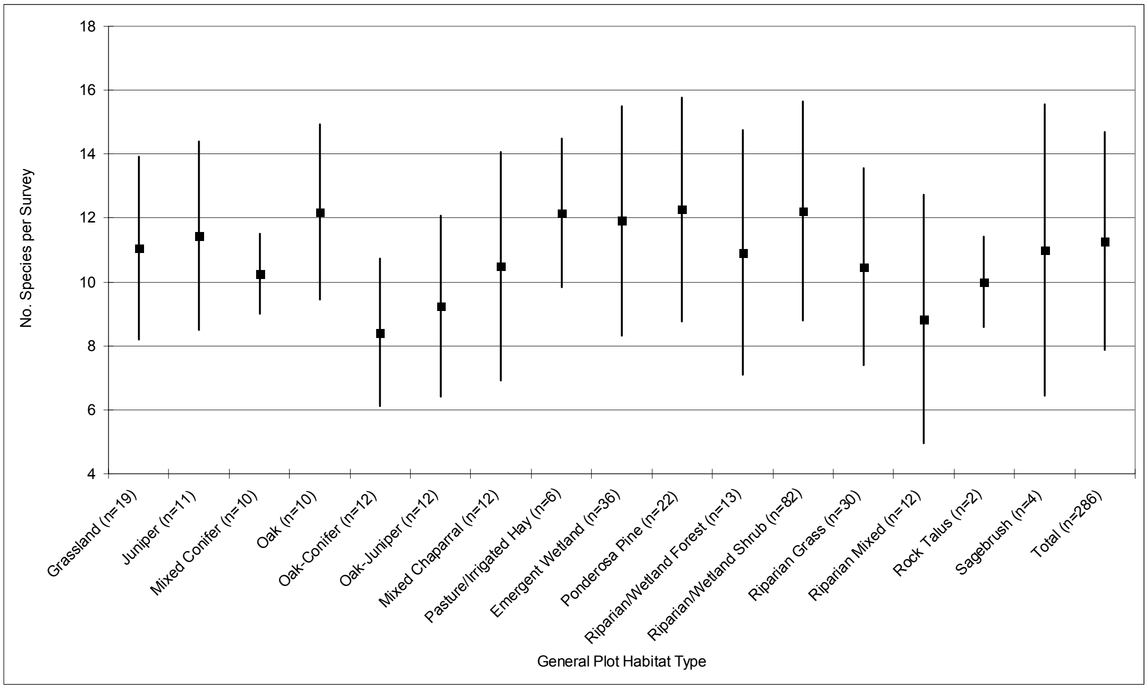


Figure 7.7-2. Relative abundance (bird detections per survey) across Project sections and general plot habitat types. (Bars represent standard deviations.)



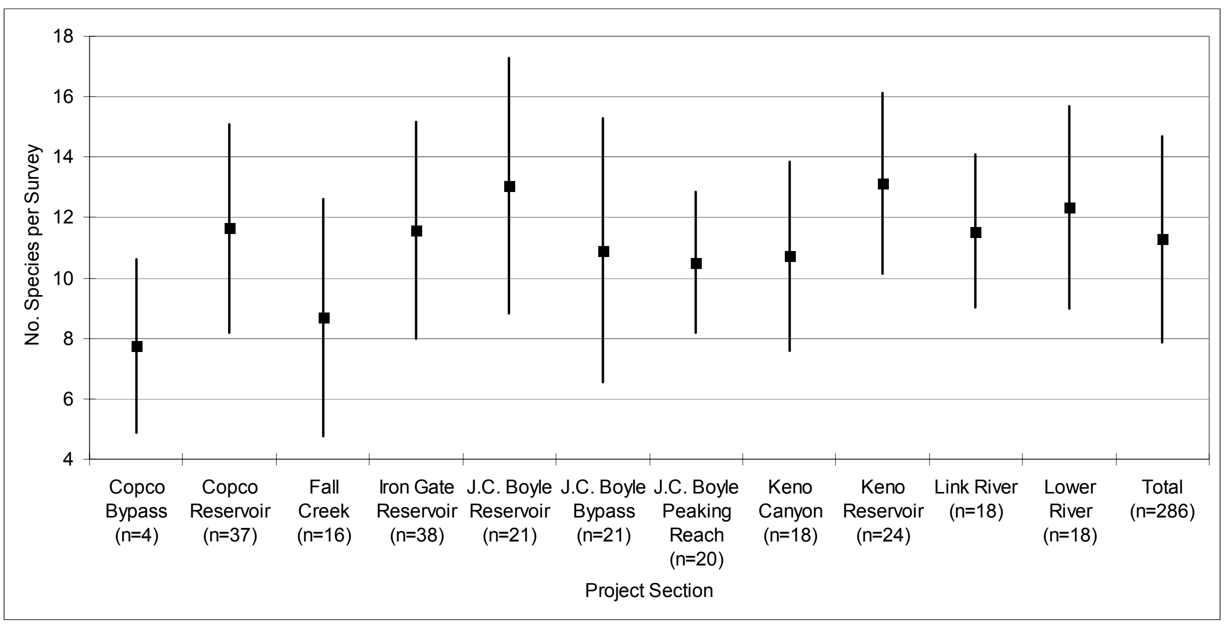


Figure 7.7-3. Relative species diversity (average number of bird species per survey) across Project sections and general plot habitat types. (Bars represent standard deviations.)

Table 7A-3 (in Appendix 7A) provides data on individual avian species relative abundance by Project section for all species detected during avian plot surveys listed in order of decreasing total relative abundance. In general, species found to be most abundant were associated with open water habitat. For instance, large numbers of cliff swallows, white pelicans, and cormorants often would be detected foraging above or resting on Project reservoirs and these detections largely skew results across Project sections. Species found in riparian and wetland habitats peripheral to Project reservoirs and river reaches also appear to influence results across Project sections. Birds flying over the plot were included only if they were actively foraging in the area (e.g., swallows). Species found to be relatively abundant Project-wide including the red-winged blackbird, song sparrow, and yellow warbler—the latter two designated as RFS (see Section 7.7.2)—were particularly abundant in wetland and riparian habitat occurring along Project reservoirs and river reaches.

Seven species were found to be ubiquitous during plot surveys across all 11 Project sections. In order of total relative abundance, the seven avian species detected during plot surveys in each Project section are the western wood pewee, song sparrow, Brewer's blackbird, yellow warbler, brown-headed cowbird, black-headed grosbeak, and mourning dove (Table 7A-3 in Appendix 7A,). Notably, three of these seven species—song sparrow, yellow warbler, and black-headed grosbeak—are designated RFS. All of these seven species are associated with riparian and/or wetland habitat, providing an indication of the importance of these habitat types to wide-ranging, abundant species occurring in the Project vicinity. Brown-headed cowbird, a nest parasite of native passerines, appears to be well established throughout much of the study area, especially in areas with human activity (both Project and non-Project).

<u>Facility Surveys</u>

Results from facility surveys provide information on a representative sample of avifauna occurring in the immediate vicinity of Project facilities. Typically, birds detected during facility surveys were located in the margins of disturbed/developed areas existing around Project facilities or in contiguous surrounding habitat—most notably the aquatic habitat of the reservoirs themselves. Specific habitat associations were not documented for avian detections recorded during facilities surveys.

Table 7A-4 (in Appendix 7A) provides results of avian facility surveys by surveyed facility site listed in order of decreasing species detections. Because facility surveys were neither time- nor area-constrained, relative abundance figures were not calculated. In general, a notable large degree of variance between and among species across facility survey sites is evident in the facility survey results. This variance likely reflects the extreme variation in the facility survey sites and surrounding habitat and the difference in the range of detections and local avian populations detected at each site.

Other than the presence of waterfowl associated with aquatic habitat typically located near Project facilities, the composition and distribution of species detected during facility surveys was found to be similar to species detected during plot surveys in each Project section. Common species detected during facility surveys include the cliff swallow, Brewer's blackbird, red-winged blackbird, and brown-headed cowbird. The brown-headed cowbird, a native parasitic nesting species that often causes declines in productivity among other passerines, was found to be relatively common and abundant throughout the study area during both plot surveys (0.74 bird per plot survey; Table 7A-3 in Appendix 7A). Cowbirds were detected only immediately adjacent to four of 15 Project facilities that were surveyed in 2002 (Table 7A-4 in Appendix 7A). Cliff swallow nests were commonly found on bridge abutments in the study area.

Reservoir Surveys

Reservoir surveys resulted in a combined total of 11,836 avian detections. Table 7A-5 (in Appendix 7A) provides data on avian detections collected during reservoir surveys including: individual species and combined number of detections recorded during each reservoir survey; combined total number of bird detections recorded on each Project reservoir; and average number of birds detected per survey for each reservoir and Project-wide.

Among Project reservoirs, the largest number of birds was recorded on Keno reservoir with 5,372 total detections and an average of 895.33 detections per survey (Table 7A-5 in Appendix 7A). It should be noted, that because of the large and disparate sizes of the areas surveyed (the duration of each reservoir survey ranged from 2.5 to 4.5 hours), reservoir survey results are associated with a larger potential for variance. With reservoir surveys, there is an increased probability of missing or duplicating avian detections as birds continually move within, into, and out of the reservoir survey area. Still, reservoir survey results provide an indication of trends, potential differences, and relative use of reservoirs and peripheral habitat by wildlife across Project sections.

Reservoir survey results varied greatly across seasons. During the late summer, the abundance and composition of avian species was greatly influenced by large numbers of gulls and terns found on all Project reservoirs. Wintering birds noted on Copco and Keno reservoirs in January and February 2003 largely affected the combined results on species composition and abundance. In particular, large aggregations of American coots were found to over-winter on Copco reservoir, making the coot the most abundant species detected during all reservoir surveys. In contrast to Copco reservoir, which evidenced a large discrepancy between bird abundance across seasons, Keno reservoir was found to support a large abundance and diversity of birds regardless of season. This diversity and abundance likely reflects the size and diversity of the reservoir as well as the abundance of diverse aquatic, wetland, and riparian habitat surrounding Keno reservoir and its proximity to a major flyway in the Klamath basin.

KBO Long-Term Regional Bio-Monitoring

To compare PacifiCorp's point count data collected in 2002 to the long-term (1998-2002) data collected by KBO in and near the study area, plot data collected during the 5-minute point count portion of the plot surveys were summarized separately to be consistent with KBO point count data collection methods. The relative abundance of birds detected during PacifiCorp point count surveys in 2002 is presented by general cover type in Table 7A-6 (in Appendix 7A), while KBO data collected at plots inside and outside of the study area are summarized in Tables 7A-7 and 7A-8 (in Appendix 7A), respectively. In addition, data collected by KBO at its six ROI stations are summarized in Table 7A-9 (in Appendix 7A). The following sections examine the KBO data collected.

Point Count Data Collected Inside the Klamath Study Area. KBO provided data for 68 of its point count plots that are located near the primary study area. The data include a total of 191 individual surveys during a 5-year period. KBO documented 80 species of birds during the 4 years of point count surveys (Table 7A-7 in Appendix 7A) (KBO, unpublished data). These data were used to qualitatively evaluate the avian abundance patterns detected during PacifiCorp's surveys near the Project. The following is a brief summary of the comparison. Twelve bird species—the American kestrel, American redstart, Cooper's hawk, common nighthawk, great-horned owl, green-tailed towhee, pine siskin, red crossbill, red-naped sapsucker, Townsend's solitaire, western bluebird, and white-headed woodpecker—were documented by KBO that were not detected during the point count portions of the surveys conducted by PacifiCorp in 2002. Of these, however, only the red-naped sapsucker, American redstart, common nighthawk, and Townsend's solitaire were not detected in the Klamath study area in 2002 during all wildlife surveys conducted by PacifiCorp; all of these species had low relative abundance values.

Twenty seven land bird species and 17 water, shore, or wading bird species were documented by PacifiCorp at one or more of the point count plots surveyed in 2002 that were not detected at any of the KBO point count plots during the 5 years of survey (note that many of these species were documented by KBO either during constant effort mist-netting, ROI surveys, or point count conducted in the watershed, but outside of the PacifiCorp study area). Much of the difference in species detected by KBO and PacifiCorp is likely the result of PacifiCorp placing greater emphasis on sampling wetland and riparian habitats, sites immediately along Project reservoirs and river reaches, and areas near Project facilities. This also accounts for the detection of numerous aquatic bird species by PacifiCorp at survey plots centered in upland cover types that clearly do not support aquatic birds (Table 7A-6 in Appendix 7A).

The results of the KBO sampling at the 68 plots located near the primary study area indicate that annual grassland and ponderosa pine tended to have the greatest total avian relative abundance of the eight habitats covered by KBO (Table 7A-7 in Appendix 7A). PacifiCorp also found high avian relative abundances in grassland and ponderosa pine cover types (Table 7A-6 in Appendix 7A). Other cover types surveyed by PacifiCorp, but not specifically surveyed by KBO, such as pastures, emergent wetlands, sagebrush, riparian grass, and riparian forest and shrubs, also had high total relative abundance values in PacifiCorp's data.

Within grassland habitat, KBO documented a total of 47 species during 31 surveys (Table 7A-7 in Appendix 7A) compared to 46 species documented during 18 5-minute point count surveys conducted by PacifiCorp during 2002 (Table 7A-6 in Appendix 7A). Both KBO and PacifiCorp found the western wood peewee to be one of the most common species. However, the other most common species found in grasslands differed. KBO found western tanager, house sparrow, and song sparrow to be relatively abundant at their plots, while PacifiCorp surveys found red-winged blackbirds, Brewer's blackbirds, and cedar waxwings to be common. The abundance of blackbirds in the PacifiCorp plots likely was the result of the proximity to reservoirs and river reaches.

Juniper woodland plots were found to support 34 species in both KBO and PacifiCorp plots (Tables 7A-6 and 7A-7 in Appendix 7A). Juniper woodland plots surveyed by KBO had the greatest relative abundances for American robin, brown creeper, western tanager, and western wood peewee (Table 7A-7 in Appendix 7A). In comparison, plots surveyed by PacifiCorp in 2002 had red-winged blackbird, Brewer's blackbird, black-headed grosbeak, and violet-green swallow as the most common species in juniper woodlands (Table 7.7-6 in Appendix 7A). Again, the proximity to water likely plays a role in this trend.

Plots surveyed by KBO in Klamath mixed-conifer forest were found to support 23 species (Table 7A-7 in Appendix 7A) while PacifiCorp surveys resulted in the detection of 15 different species (Table 7A-6 in Appendix 7A). Three species were found to be most common in Klamath mixed-conifer forests by both studies: western tanager, yellow-rumped (Audubon's) warbler, and black-headed grosbeak (Tables 7A-6 and 7A-7 in Appendix 7A). PacifiCorp surveys resulted in the detection of a relatively large number of dark-eyed juncos, while KBO detected no juncos in the PacifiCorp study area (KBO did report juncos from areas outside but near the PacifiCorp study area).

Only one plot surveyed by KBO was located in montane hardwood oak habitat. Four species were found at this one survey plot (Table 7A-7 in Appendix 7A). PacifiCorp surveys documented 35 species in montane hardwood oak habitat (Table 7A-6 in Appendix 7A). The black-headed grosbeak was the only species ranking as one of the four most common species in montane hardwood oak plots in both studies (Tables 7A-6 and 7A-7 in Appendix 7A). PacifiCorp plots found the tree swallow, American robin, Wilson's warbler, and Bullock's oriole to be most common along with the grosbeak. The KBO plot had more Lazuli buntings, warbling vireos, and western tanagers (Table 7A-7 in Appendix 7A).

Within the Klamath study area, PacifiCorp found 26 species in montane hardwood oak/conifer habitat during 2002 (Table 7A-6 in Appendix 7A). In comparison, KBO detected 64 species during 83 surveys of this habitat during a 5-year period (Table 7A-7 in Appendix 7A). Montane hardwood oak/conifer plots had close agreement in the most commonly detected species. Western tanager, western wood peewee, yellow-rumped (Audubon's) warbler, and black-headed grosbeaks were found to be abundant species (Tables 7A-6 and 7A-7 in Appendix 7A). KBO plots also had large numbers of American robins.

PacifiCorp found 35 species in montane hardwood oak/juniper plots (Table 7A-6 in Appendix 7A) while KBO surveys detected 40 species during 5 years of surveys (Table 7A-7 in Appendix 7A). Two species—western wood peewee and western tanager—were commonly detected in both KBO and PacifiCorp surveys of montane hardwood oak/juniper stands (Tables 7A-6 and 7A-7 in Appendix 7A). However, PacifiCorp plots had violet-green swallows and bushtits as common species, while KBO plots had black-headed grosbeaks and American robins as common species.

A total of 41 species were detected in KBO plots (n=13) in mixed chaparral plots (Table 7A-7 in Appendix 7A). PacifiCorp surveys in 2002 found 35 species in mixed chaparral habitat (Table 7A-7 in Appendix 7A). Two species—the Lazuli bunting and western wood peewee—were commonly detected during both KBO and PacifiCorp surveys in mixed chaparral plots (Tables 7A-6 and 7A-7 in Appendix 7A). Both studies had a woodpecker as a dominant species. KBO found white-headed woodpeckers to be relatively common, while PacifiCorp noted a large number of acorn woodpecker detections. PacifiCorp surveys found Bullock's oriole to be common while KBO plots had large numbers of black-headed grosbeaks and house wrens.

The number of species detected in ponderosa pine plots was similar between 2002 PacifiCorp surveys and 1998-2002 KBO plots surveyed in the study area. Surveys by KBO confirmed 38 species in ponderosa plots while PacifiCorp found 39 species (Tables 7A-6 and 7A-7 in Appendix 7A). As in several other cover types, the western wood peewee, western tanager, and yellow-rumped warbler were common species in both KBO and PacifiCorp surveys of ponderosa pine stands (Tables 7A-6 and 7A-7 in Appendix 7A). The PacifiCorp surveys found chipping sparrow, red-shafted flicker, mountain chickadee, and brown-headed cowbird to be common. KBO plots had American robin, Cassin's vireo, and black-headed grosbeak as common species.

One of the species that was absent from the KBO plots, but present in relatively high abundance at PacifiCorp plots, was the non-native and aggressive European starling. During 2002, this species was documented by PacifiCorp in eight different cover types including riparian/wetland habitat (highest relative abundance), open areas, and in juniper woodland. It was the fourth most commonly detected species in riparian forest/shrub habitat. The high detection rate of starlings in PacifiCorp's plots could be the result of PacifiCorp's focus on sampling riparian forest, differences in habitat quality, or presence of more development near the Project compared to sites studied by KBO.

Another common species was the nest parasite brown-headed cowbird. Brown-headed cowbird brood parasitism reduces productivity of some native passerine species (Mayfield, 1977; Brittingham and Temple, 1983; Robinson et al. 1993). Some research has shown that habitat fragmentation, such as is caused by ROW, roads, and other development, may increase edge habitat benefiting cowbirds. The presence of artificial structures, such as transmission line poles and wires, also may provide perches that allow female cowbirds to locate host nests in nearby habitats for laying eggs (Robertson and Norman, 1976). This species is most common in urban, cropland, pasture, and orchard-vineyard habitats and generally absent from higher montane habitats in Cascade Range and Sierra Nevada (CWHRS website). PacifiCorp surveys found cowbirds in all Project segments with detections being most common in the Keno reservoir and Copco No. 2 bypass segments. In the case of Keno reservoir, the cowbird abundance likely is related to the predominance of agricultural areas surrounding the reservoir. Several of the survey stations in the Copco No. 2 bypass were close to Project facilities and housing complexes, which could increase habitat for cowbirds. Cowbird abundance was relatively low along Iron Gate, Copco, and J.C. Boyle reservoirs and the Fall Creek canal.

Two other species found during PacifiCorp surveys, but not documented in KBO plots include the willow flycatcher and the ash-throated flycatcher. The willow flycatcher was found during 2002 in five cover types (mostly wetland and riparian) at low relative abundance. Ash-throated flycatchers were documented in eight different cover types and were relatively common (relative abundance of 0.33) in montane hardwood oak/juniper habitat.

<u>KBO Data Collected Outside of the Klamath Study Area.</u> Between 1998 and 2002, KBO conducted 301 point count surveys in areas close to the Klamath River, but outside of PacifiCorp's study area. These KBO surveys documented a total of 106 bird species in different habitats as defined by Landsat image analysis (Table 7A-8 in Appendix 7A) (unpublished KBO data). Qualitative comparison of KBO data collected at survey plots located inside versus outside of the terrestrial study area indicates that surveys inside of the Klamath study area resulted in the detection of 14.4 birds/survey compared to an average of 11.8 birds/survey detected during surveys conducted outside of, but close to, the Klamath study area. As expected, some species are more common in PacifiCorp's study area, some were detected at higher rates outside of the study area, and other species had relatively equal relative abundances inside and outside of the study area (Tables 7A-7 and 7A-8 in Appendix 7A). Of the eight RFS, KBO detected six species—yellow warbler, song sparrow, yellow-breasted chat, warbling vireo, black-headed grosbeak, and Lewis' woodpecker—both inside and outside of PacifiCorp's Klamath study area.

Of these six species, all but the yellow-breasted chat were found to have a greater relative abundance inside of the study area than outside of the study area.

KBO ROI Surveys. Data collected by KBO at the Frain Ranch (Topsy) CES site indicate that fall migration begins in early August and continues through late September (Table 7A-9 in Appendix 7A). Therefore, to gather data on migration and juvenile dispersal in the study area, KBO conducted six ROI surveys in late August and early September 2002. A total of 1,521.8 net-hours of mist-net surveys were conducted in 2002 at the six sites located in the primary study area: (1) just downstream of Iron Gate dam, (2) in the lower portion of Scotch Creek, (3) in the Copco No. 2 bypass, (4) in the lower portion of Shovel Creek, (5) Frain Ranch, and (6) Link River. A total of 69 bird species was documented during KBO's mist-net surveys (Table 7A-10 in Appendix 7A). The greatest species richness was detected at the Frain Ranch site, which KBO sampled also as a CES site. At the Frain Ranch site, 38 species were documented during the breeding season and 36 species were documented during the migration season. Twenty-five of these species were documented specifically during the ROI survey effort early in the migration season. Scotch Creek had a species richness of 25 species, while the Iron Gate-Shasta River site had 21 species. The Copco No. 2 and Shovel Creek ROI sites yielded the lowest species richness, with only nine species each (six species/1,000 net-hour). When standardized for the level of effort, the greatest species richness was found at the site just downstream of the Iron Gate dam (16 species/1,000 net-hour). This was followed closely by the site in Scotch Creek, which had 15 species/1,000 net-hour.

In terms of total number of birds captured per 1,000 net-hours of survey effort, the Scotch Creek and Frain Ranch sites were found to be similar, with between 912 and 1,038 birds/1,000 net-hours (Table 7A-10 in Appendix 7A). Copco No. 2 bypass and Shovel Creek sites resulted in low capture rates of 80 to 127 birds/1,000 net-hours. Of the eight RFS, all but the Lewis' woodpecker were caught at one or more of the sites. The Frain Ranch ROI site was the only one of the six stations at which all seven of the RFS were detected. Yellow warblers were particularly common at the site below Iron Gate dam, but were caught at all but the Copco No. 2 bypass and Shovel Creek sites. Willow flycatchers were caught most often at the Iron Gate, Scotch Creek, and Copco No. 2 bypass reach sites. Yellow-breasted chats were only noted at the Frain Ranch, and Shovel Creek sites during ROI sampling. Warbling vireos were most common at Frain Ranch, but also were found at Link River, below Iron Gate dam, and in Scotch Creek. Swainson's thrush, a species that is not actually tied to riparian habitat in much of its range, was only noted during ROIs at the Frain Ranch site during the fall migration period. Song sparrows were caught at high abundance at the Frain Ranch site, especially late in the breeding season. Song sparrows were also relatively common at the Link River. Black-headed grosbeaks were not commonly caught in the ROI nets, although they were detected at all sites except the one below Iron Gate dam and the Scotch Creek site.

According to unpublished data provided by KBO, 442 birds were captured in mist-nets during the six ROI surveys. Numbers of birds captured ranged from a high of 175 at the Scotch Creek ROI site to a low of 12 birds captured at the Shovel Creek site.

As anticipated, because ROI surveys were timed to sample during the beginning of avian migration and juvenile dispersal, the large majority of birds was juveniles, with 76 percent of birds captured in mist-nets (335 of 442) positively identified as hatch-year birds. Seventeen percent (75 of 442) of captured birds were identified as adults, and the remainder (7 percent) could not be aged with validity. In part because of the difficulty of determining the gender of hatch-year birds, 56 percent of all mist-netted birds could not be reliably sexed, while birds identified to gender were evenly split at 22 percent of all captured birds (22 percent male and 22 percent female).

Project ROI mist-netting and censuses resulted in the detection of two bird species not detected during other relicensing field studies. American bitterns (*Botaurus lentiginosus*) were detected during ROI censuses at the Link River and the Iron Gate-Shasta River sites, and a single adult female chestnut-sided warbler (*Dendroica pensylvanica*) was captured in the mist-nets during the Scotch Creek ROI. The American bittern is a furtive marsh species that is often difficult to detect, but likely occurs throughout suitable habitat in the Project vicinity. The chestnut-sided warbler occurs throughout eastern North America during the breeding season. The species occurs as a rare migrant in the western United States, and the Scotch Creek detection likely represents a stray.

<u>KBO CES Data.</u> Since 1997, KBO has operated eight constant effort mist-netting stations that emphasize riparian habitat in and around the Upper Klamath basin. One of the sites is at Frain Ranch (Topsy). This long-term monitoring documented that the Frain Ranch site had an average species richness of 17.2 species during the breeding season and 13.3 species during the fall migration (Alexander et al. 2001). Between 1998 and 2001, KBO documented 64 species during constant effort mist-netting at the Frain Ranch site in the breeding season and 57 species during migration (Alexander and Ralph, 2001). The purple finch was the most commonly captured bird species during the breeding season, while the song sparrow, an RFS, was most common during the migration season. In addition to the song sparrow, other RFS detected during the constant effort surveys conducted by KBO include the yellow warbler, warbling vireo, black-headed grosbeak, and yellow-breasted chat (Alexander and Ralph, 2001).

7.7.1.2 Amphibian and Reptile Field Studies

Field surveys targeting specific amphibian and reptile species and unique habitat sites were completed by PacifiCorp during the 2002 and 2003 field seasons. In 2002, surveys included amphibian breeding habitat surveys in selected wetland habitats, surveys of selected riverine habitat, and searches of avian survey plots. In 2003, specific targeted protocols included surveys of isolated wetlands and potential snake hibernacula sites as well as surveys for special status herptiles including the spotted frog, foothill yellow-legged frog, and western pond turtle. Data from these specific surveys are presented in Section 4.7 and are used to supplement existing data on amphibian and reptile occurrence and distribution across various habitat types and Project sections in the study area.

Four amphibian and 15 reptile species were detected in the Klamath study area during relicensing field surveys in 2002 and 2003; a sixteenth reptile species, the rubber boa, was documented only by the BLM. Species detected included one TES amphibian and all five of the TES reptile species originally identified as potentially occurring in the Project vicinity. Amphibian detections were limited to wetland and riparian habitat located peripheral to Project reservoirs and river reaches (Table 7A-1 in Appendix 7A). However, amphibian species diversity was found to be relatively limited in the study area. Conversely, the warm, dry climate and varied upland cover types in the Project vicinity provided ample suitable habitat for terrestrial reptile species. Reptiles were documented in many habitat types in the study area (Table 7A-1 in

Appendix 7A). Nine reptile species were documented in wetland/riparian habitats (see Section 4.7). The large majority of reptile detections (excluding western pond turtle detections) was recorded during terrestrial reptile plots surveys and incidental to small mammal trapping conducted in spring and summer along the J.C. Boyle canal, although reptiles were detected in wetland and riparian habitat types as well. Comprehensive amphibian and reptile field survey results are presented in Section 4.7. Specific information on the 12 potentially occurring TES amphibian species and five potentially occurring TES reptile species is included in Section 5.6.2.

7.7.1.3 Mammalian Field Studies

Mammal species occurrence data were obtained from track and bait station surveys conducted near Project facilities as well as incidental observations of mammals recorded throughout the Project vicinity. In addition, small mammal trapping conducted in the summer of 2003 on each side of the Westside, J.C. Boyle, and Fall Creek canals.

A total of 30 mammalian wildlife species is known to occur in various habitats in the study area (Table 7A-1 in Appendix 7A). The species and numbers of mammals observed by Project segment during relicensing studies are shown in Table 7A-11 (in Appendix 7A). Black-tailed jackrabbit, deer, and California ground squirrels were ubiquitous in every Project section and rarely were recorded on datasheets. Striped skunk, raccoon, muskrat, mink, river otter and beaver are all riparian-habitat-associated species (Csuti et al. 1997). The following sections present data on mammalian detections that occurred during tracking surveys, bait stations, and general canal surveys. Data collected from small mammal trapping are provided in Section 6.0.

<u>Bait Station and Winter Track Surveys</u>

A total of eight wildlife and three domesticated mammalian species was detected during winter track surveys (Table 7A-12 in Appendix 7A). Specific results for this study are provided in Section 6.7.2.2. Only two carnivore species were detected during 7 weeks of bait station surveys; bobcat and mountain lion (Table 7A-12 in Appendix 7A). The most common carnivore species detected, the bobcat, was detected in low abundance on three track survey transects, and at all three bait stations. Many deer tracks were detected during all track surveys. Mammals specifically associated with aquatic and riparian habitat were detected only during track surveys conducted along Keno dam. These detections included one mink, one muskrat, and one raccoon. During all Klamath River relicensing studies, Keno reservoir and Keno Canyon Project sections accounted for 60 percent of mink detections, and 80 percent of muskrat detections (Table 7A-13 in Appendix 7A).

Domestic dogs and cats were commonly detected on track surveys, especially in the Link River and Keno dam areas, and cattle were commonly noted during the Fall Creek surveys. The abundance of dogs, cats, and cattle in all of the track survey routes may affect wildlife use of these areas.

<u>Canal Surveys</u>

Few mammalian species were observed while conducting general canal searches. These species have been included in the general mammalian detection table (Table 7A-11 in Appendix 7A). More detailed canal survey results are reported by Project canal in Section 6.7.2.

Small Mammal Trapping

Small mammal trapping was conducted along Project canals during the 2003 field season at four locations: along the Fall Creek canal; along the J.C. Boyle canal upstream near the J.C. Boyle dam; along the J.C. Boyle canal downstream toward the powerhouse; and at the Link River along the Westside canal. Specific results for this study are provided in Section 6.7.2. A total of 292 small mammals, including nine distinct species, was captured during this trapping study. Because the trapping focused on disturbed areas and natural habitat in close proximity to disturbed areas, it was not surprising that the deer mouse was the most commonly trapped small mammal species along the Westside, J.C. Boyle, and Fall Creek canals. Specific details on methodology, results, and implications of analysis for this study are provided in Section 6.0.

7.7.2 Riparian Focal Species Studies

All ten designated RFS were detected in the study area during relicensing field studies (including all four of the aquatic fur-bearing mammal species). The western pond turtle was found to be abundant in specific, localized open water habitat on the reservoirs and the Iron Gate-Shasta River, and J.C. Boyle peaking river reaches (Sections 7.7.2.2 and 4.7.1.5). In general, avian RFS were found to be abundant across Project sections with the Lewis' woodpecker, yellow warbler, and song sparrow included in a group of only seven species detected in each of the 11 Project sections (Table 7A-3 in Appendix 7A). Information on the occurrence and distribution of the aquatic fur-bearing mammals—mink, river otter, muskrat and beaver—is largely based on existing literature because observations of these secretive mammals were less abundant relative to other RFS species groups. The sections below provide results of surveys specifically targeting RFS as well as species accounts documenting RFS occurrence, distribution, and potential habitat in the study area.

7.7.2.1 RFS Targeted Surveys

Surveys conducted as part of relicensing specifically targeting RFS included western pond turtle and ROI surveys. Data collected during western pond turtle surveys were limited only to the western pond turtle, whereas ROI surveys resulted in data on the eight avian RFS as well as information on the occurrence, distribution, and abundance of all avian species found in wetland and riparian habitat at the beginning of the fall migration period in the Project vicinity. The sections below present specific results from surveys targeting RFS.

ROI Surveys

A qualitative comparison of ROI results versus data from all avian field studies and wetland and riparian plot survey results presented in Appendix 7B indicates a correspondence in passerine (songbird) species composition and abundance across datasets. In addition, seven of the eight avian RFS were detected during ROI surveys. The Swainson's thrush was not detected during ROI surveys, likely reflecting the species' less pronounced association with riparian and wetland habitats versus other avian RFS. Swainson's thrushes use riparian forest as secondary habitat and typically occur in riparian areas if tree density and over-story cover is sufficient (Csuti et al. 1997). The absence of detections of Swainson's thrushes during ROI surveys also could be attributed to early migration. Generally, larger species are more difficult to capture using low- and mid-canopy mist-netting methodology and, thus, the Lewis' woodpecker was detected only during ROI censuses and was not mist-netted during ROIs. All other avian RFS—willow flycatcher, warbling vireo, yellow warbler, yellow-breasted chat, song sparrow, and black-headed grosbeak—were captured during ROI mist-netting.

7.7.2.2 RFS Status Distribution and Abundance

All data on avian RFS detections recorded during plot surveys are provided in Appendix 5F. Relative abundance (birds per survey) values resulting from avian RFS plot survey detections are presented in Appendix 5G. Table 7A-14 (in Appendix 7A) provides relative abundance data for avian RFS detected during surveys conducted in riparian and wetland survey plots (i.e., survey plots with a general habitat designation of emergent wetland, riparian/wetland forest, riparian/wetland scrub-shrub, riparian grass, or riparian mixed). Data from Table 7A-14 (in Appendix 7A) are used in the specific RFS accounts below to assess the strength of each species' association with study area wetland and riparian habitats.

The highest combined relative abundance of RFS across Project sections was found in Keno Canyon with an average of 7.36 ± 3.95 avian RFS detected per survey (Table 7A-14 in Appendix 7A). The lowest total avian RFS relative abundance was found along Copco reservoir with 0.87 ± 1.25 RFS detected per survey in this Project section. Trends in RFS relative abundance across Project sections (Table 7A-14 in Appendix 7A) generally reflect trends in relative abundance for all avian species (Table 7A-3 in Appendix 7A). However, the ranking in the average relative abundance of RFS across Project sections is not directly consistent with relative abundance rankings for all avian species. The highest relative abundance of avian species in general was found along Keno reservoir (58.57; Table 7A-3 in Appendix 7A), while RFS were found to be most abundant in Keno Canyon (Table 7A-14 in Appendix 7A). This difference is, no doubt, attributable to the RFS species selected and habitat differences. The large aggregations of birds detected in the Keno reservoir Project section generally were associated with the aquatic habitat of the reservoir, while the abundance of RFS in Keno Canyon reflects the relative proportion of suitable riparian willow shrub habitat preferred by many avian RFS (see below).

<u>Western Pond Turtle</u>

The western pond turtle is a designated TES reptile species and, as such, is addressed in Sections 5.6.2.2 and 4.7.1.5. Table 4.7-7 (in Section 4.0) provides results of pond turtle surveys conducted as part of relicensing field studies. Figure 4.7-1 (in Section 4.0) provides an assessment of potential pond turtle habitat along all Project reservoirs and river reaches. In general, the combination of relatively low-gradient flow, adequate food supplies, presence of adequate basking structures (emerging boulders, mats of emergent vegetation, or logs), and access to suitable nesting habitat is required for consistent pond turtle use. As turtles require open canopy sites with loose soil for nesting, most of the river corridor provides accessible nesting habitat. However, surveys conducted in 2002 and 2003 failed to detect turtles in the Keno Canyon and J.C. Boyle bypass reaches. These two reaches are confined by steep terrain and probably do not provide much suitable habitat for turtles, if they occur at all.

During pond turtle surveys, the largest numbers of western pond turtles consistently were detected in the open water and peripheral wetland and riparian habitat associated with Keno reservoir. In particular, pond turtles were most numerous in habitat located in the downstream reaches of Keno reservoir below the Highway 66 bridge. More than 260 pond turtles were detected in this portion of Keno reservoir compared to a high of 23 turtles detected on any other Project reservoir. There were widely scattered sites along the J.C. Boyle peaking and Iron Gate to Shasta River reaches (primarily low-gradient sections) where basking pond turtles were observed. No turtle basking was noted in the J.C. Boyle bypass and Keno Canyon reaches.

Lewis' Woodpecker

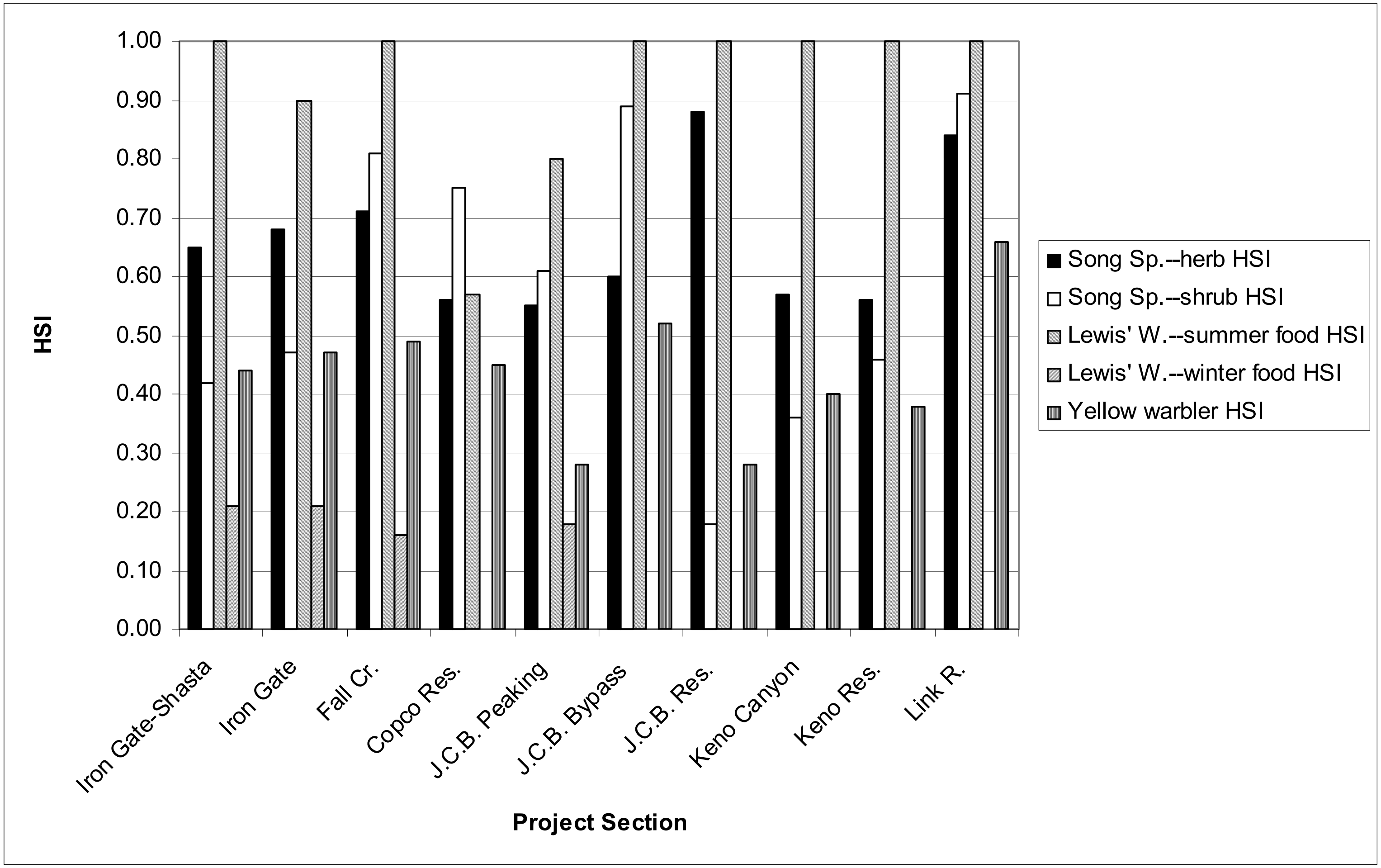
The Lewis' woodpecker is a designated TES species and, as such, is addressed in Section 5.0. Section 5.7.2.3 provides a detailed species account and data on all Lewis' woodpecker detections recorded during relicensing field studies can be found in Table 5A-19 (in Appendix 5A).

Seven Lewis' woodpecker detections were recorded during avian surveys in wetland and riparian survey plots (Appendix 7B). All detections were recorded in the Iron Gate reservoir (one) and Iron Gate-Shasta (six) Project sections amounting to relative abundance values of 0.04 ± 0.19 and 0.33 ± 0.69 detections per survey for each Project section, respectively (Table 7A-14 in Appendix 7A). Average relative abundance of Lewis' woodpeckers in wetland and riparian plots was found to differ significantly between Project sections (one-way ANOVA; $p \leq 0.01$). However, species occurrence in the Iron Gate-Shasta and Iron Gate reservoir Project sections may reflect habitat adjacent to survey plots and not actual riparian/wetland habitat associations for the species. Lewis' woodpeckers often are associated with oak woodlands and oak-dominated habitat (Csuti et al. 1997). Wetland and riparian areas along Iron Gate reservoir and the Iron Gate-Shasta River section often run contiguous with open woodlands or grasslands with a notable oak component. Incidental to other field activities, Lewis' woodpeckers were observed periodically on PacifiCorp property associated with the Beswick Ranch in the peaking reach. In that area, Lewis' woodpeckers most often were seen using scattered oaks, willows, alders, and black cottonwood trees among the irrigated hayfields and pastures. The BLM has stated that the cottonwood forest along the lower portions of Shovel Creek may be important, especially during the winter.

A comparison of HSI model parameters against existing habitat structural data (Figure 7.7-4) reveals high calculated summer food HSIs in most Project sections with low winter food HSIs. Thus, according to existing HSI models, in general the study area should provide suitable habitat for Lewis' woodpeckers during the summer breeding season with only restricted amounts of suitable habitat during the winter. Species occurrence in the study area is likely not consistent with these HSI predictions as Lewis' woodpeckers remain in the study area year-round with localized populations exhibiting only local seasonal movements.

Willow Flycatcher

The willow flycatcher is a designated TES species and, as such, is addressed in detail in Section 5.0. Section 5.7.2.3 provides a detailed species account. Data on all willow flycatcher detections recorded during relicensing field studies can be found in Table 5A-22 (in Appendix 5A).



* Riparian vegetation data were not collected in Copco No. 2 bypass and, therefore, were not included in the comparison.
HSI = Habitat Stability Index.

Figure 7.7-4. Comparison of Project section riparian habitats by HSI model parameters*.

Twelve willow flycatcher detections were recorded during surveys in riparian and wetland plots (Appendix 7B) with the highest relative abundance (0.25 ± 0.50) found in the J.C. Boyle reservoir Project section (Table 7A-14 in Appendix 7A). Results of a one-way ANOVA indicated no significant difference between willow flycatcher relative abundance resulting from surveys in wetland and riparian plots among Project sections. All willow flycatchers detected during plot surveys were recorded in riparian or wetland habitat located peripheral to a reservoir or river reach, and 69 percent of all willow flycatcher detections (including all plot and facility surveys) were recorded in riparian/wetland scrub-shrub habitat (Section 5.0, Table 5A-22 in Appendix 5A). Willow flycatchers are known to be associated with dense riparian shrub habitat, specifically, dense willow thickets located near a stream, river, or water body (Csuti et al. 1997). Results of relicensing field studies indicate this notable habitat species association exists throughout the study area.

Swainson's Thrush

A total of 11 Swainson's thrush detections was recorded in the study area during relicensing field studies (Appendix 5F). All detections were recorded during avian plot surveys. The distribution of Swainson's thrush detections across study area habitats (Appendix 5F) likely provides a telling indication of the general habitat association for this species. Although the Swainson's thrush may be found in riparian habitats, in western Oregon, the species is found throughout dense, moist lowland forests (Csuti et al. 1997). As indicated in Appendix 5F, more than half of the Swainson's thrush detections (six; 55 percent) were recorded in coniferous forest habitat, while the four detections recorded in riparian forest amounted to 36 percent of all recorded detections.

A comparison of data from Appendix 5F with data from Appendix 7B and Table 7A-14 (Appendix 7A) provides an analysis of the Swainson's thrush's association with riparian habitat in the study area. A total of four Swainson's thrush detections was recorded during avian surveys in wetland and riparian plots (Appendix 7B). All of these detections were recorded in riparian forest around Iron Gate reservoir. However, 64 percent of all Swainson's thrush plot detections were recorded in or around upland forests with a coniferous overstory component. Thus, it appears that in the study area, trends in habitat association for Swainson's thrushes are consistent with the general Project region: the species typically occurs in dense forests habitat, but may be found in riparian areas if tree density is sufficient.

Warbling Vireo

The distribution of habitat types in which warbling vireo detections were recorded in the study area provides an indication of the relatively varied habitat associations for the species. Sixteen warbling vireo detections were recorded in the study area during relicensing field studies with all but one recorded during avian plot surveys (Appendix 5F). Approximately half of all warbling vireos detections were recorded in forested riparian habitat and half in a variety of upland forest habitats. In the Project region, warbling vireos are known to be associated with both riparian and upland forests and are especially likely to occur along the edge, but typically not within, dense stands of contiguous forest (Csuti et al. 1997).

Of the 16 total warbling vireo detections, eight were recorded during surveys in wetland and riparian plots with three detections recorded along Fall Creek and five recorded in the J.C. Boyle peaking reach (Appendix 7B). These detections amounted to a relative abundance for the species of 0.25 ± 0.62 and 0.17 ± 0.46 detection per survey conducted in wetland and riparian plots in the Fall Creek and J.C. Boyle peaking reach Project sections, respectively (Table 7A-14 in Appendix 7A). A one-way ANOVA revealed no significant differences in average warbling vireo detections among Project sections. Warbling vireos breed in forested habitats throughout most of North America and winter from Mexico south (Ehrlich et al. 1988).

Yellow Warbler

The yellow warbler is a designated TES species and, as such, is addressed in Section 5.0. Section 5.7.2.3 provides a detailed species account and data on yellow warbler detections recorded during relicensing field studies can be found in Table 5A-23 (in Appendix 5A).

Data on yellow warbler plot detections (Appendix 5F) emphasize the notable association between yellow warblers and wetland and riparian habitats—specifically wetland and riparian scrub-shrub. Appendix 7B indicates that 197 yellow warbler detections were recorded during surveys in wetland and riparian plots with the largest numbers of detections recorded in the Keno Canyon (47), Link River (34) and J.C. Boyle peaking reach (27) Project sections. Relative abundance data for wetland and riparian plot detections (Table 7A-14 in Appendix 7A) indicate that the relative abundance of yellow warblers was found to be highest along Keno Canyon at 3.36 ± 2.06 birds per survey. Yellow warblers were noted to establish breeding territories in particularly high densities in the willow shrubs existing along the periphery of the river reach at the base of Keno Canyon.

An assessment of habitat suitability for the yellow warbler based upon an existing HSI model (Schroeder, 1982) indicates that habitat along the Link River is likely to be most suitable for the species (HSI=0.66) while habitat along J.C. Boyle reservoir is likely to be least suitable (HSI=0.28) relative to other Project sections (Figure 7.7-4). Overall, trends in yellow warbler relative abundance for all plot surveys (Section 5.0, Table 5A-8 in Appendix 5A) and for surveys conducted in wetland and riparian plots alone (Table 7A-14 in Appendix 7A) are generally consistent—but not fully corresponding—with relative HSI model predictions for each Project section. Consistent with HSI habitat calculations, yellow warbler relative abundance per survey in Link River wetland and riparian plots was found to be relatively high at 2.43 ± 1.60 birds per survey. However, the relative abundance of yellow warblers along the J.C. Boyle reservoir also was found to be relatively high (1.25 ± 1.50 birds per survey), likely reflecting micro-habitat patches of peripheral willow often used by breeding yellow warblers, but not included in riparian vegetation sampling.

Yellow-Breasted Chat

The yellow-breasted chat is a designated TES species and, as such, is addressed in Section 5.0. Section 5.7.2.3 provides a detailed species account and data on yellow-breasted chat detections recorded during relicensing field studies can be found in Table 5A-24 (in Appendix 5A).

An analysis of yellow-breasted chat detections recorded during relicensing field studies (Section 5.0, Table 5A-24 in Appendix 5A) indicates that only two of the 22 total detections were recorded in upland habitat while 20 yellow-breasted chat detections were recorded during surveys in wetland and riparian plots. Data in Table 7A-14 (in Appendix 7A) indicate that, among the four Project sections in which wetland and riparian chat detections were recorded (J.C. Boyle peaking reach, Fall Creek, Copco reservoir, Iron Gate-Shasta), the highest relative abundance for chats (0.67 ± 1.19) was found along the Iron Gate-Shasta reach. The large variance (SD 1.19) likely reflects the extremely high densities of chats found in localized areas along the Iron Gate-Shasta River section where contiguous areas of dense willow shrub are present. ROI data from KBO also reflect this trend in study area chat distribution. The species was detected only at the Shovel Creek ROI station in dense riparian willow shrub vegetation. Results from all avian surveys imply chats typically occur in the study area only in riparian shrub habitat, but the species' breeding distribution is highly localized to a few isolated portions of Project river reaches.

Song Sparrow

Although song sparrows are known to be strongly associated with riparian and wetland habitat, the species also is known to be a relatively ubiquitous habitat generalist. Results from avian field studies emphasize both the species' association with riparian and wetland systems, and its occurrence in a variety of habitat types. The song sparrow is one of only seven species to be detected in all 11 Project sections, and song sparrows were detected in all but three habitat types (Appendix 5F). However, song sparrows also were found to be the most abundant passerine directly associated with riparian and wetland habitat (Appendix 7B).

Data on song sparrow relative abundance resulting from surveys in riparian and wetland plots (Table 7A-14 in Appendix 7A) indicate that the song sparrow was the most abundant avian RFS at 1.23 ± 1.57 birds per survey detected Project-wide. The highest average detection densities were noted in Keno Canyon (3.29 ± 1.86 birds per survey) with the lowest densities found along Copco reservoir (0.04 ± 0.21 bird per survey) (Table 7A-14 in Appendix 7A). These results are largely inconsistent with the HSI assessment of habitat suitability across Project sections (Figure 7.7-4). HSI calculations showed song sparrow habitat quality in riparian herbaceous habitats to be moderate varying between 0.55 and 0.88 (Figure 7.7-4). Shrub habitat quality for song sparrows was found to be much more variable, ranging from 0.18 (J.C. Boyle reservoir) to 0.91 (Link River). In general, song sparrow occurrence and distribution in the study area were found to largely correspond with that of the yellow warbler: the species was found to establish dense breeding territories wherever brushy riparian willow shrub vegetation occurred along Project reservoirs and river reaches.

Black-Headed Grosbeak

In general, black-headed grosbeak detection data indicate the species is highly associated with riparian habitat, but may be found in a variety of habitats throughout the Project vicinity. Black-headed grosbeaks were found in all but five habitat types and individuals were detected in all Project sections except the J.C. Boyle reservoir (Appendix 5F). A total of 118 black-headed grosbeaks detections was recorded during surveys in wetland and riparian and plots constituting the third most abundant RFS species detected in such plots (Appendix 7B).

Data on RFS relative abundance resulting from surveys in wetland and riparian plots (Table 7A-14 in Appendix 7A) indicate that black-headed grosbeaks were found to be most abundant along the Iron Gate-Shasta River section at an average of 1.61 ± 1.54 birds recorded per survey. Large average densities of black headed grosbeaks also were noted in the Copco No. 2 bypass and J.C.

Boyle peaking reach with 1.50 ± 2.12 and 1.10 ± 1.32 birds detected per survey in each Project section, respectively (Table 7A-14 in Appendix 7A). The large degree of variance associated with these high relative abundance values likely reflects localized areas with high densities of breeding territories. Similar to apparent habitat features affecting the local occurrence and distribution of the yellow warbler and song sparrow, black-headed grosbeaks seem to occur in high densities where dense contiguous patches of bushy willows occur along the periphery of Project reservoirs and river reaches.

Aquatic Fur-Bearing Mammals

Although no surveys specifically targeting aquatic fur-bearing mammals were conducted, multiple observations were documented during relicensing field studies. Most traditional mammal survey methods, such as bait stations and track surveys, generally are considered ineffective or cost-prohibitive for studying aquatic mammals. Results and detection data on the four aquatic fur-bearing mammal RFS are presented together because the species were found to share similar ecologies and habitat requirements. Overall, a total of five muskrat, 21 beaver, seven river otter, and 11 mink detections were recorded during relicensing field studies in 2002 and 2003 (Table 7A-13 in Appendix 7A). All of these species are known to range throughout the western United States and the Project vicinity, and are associated closely with aquatic and riparian habitats including banks of rivers, streams, lakes, ditches, and marshes (Csuti et al. 1997). Presence of these species is strongly dependent on wetland and riparian habitats (Chapman and Feldhamer, 1982). These mammals were detected only in riparian and wetland habitats during relicensing field studies indicative of the strong habitat association for these mammalian RFS.

Muskrats are known to be present, and are commonly seen, at the Klamath Wildlife Area, which includes portions of the Keno reservoir Project section (ODFW, 2000). Anecdotal information from trappers familiar with the area indicate that mink, beaver, and river otter are present in the upper portion of the J.C. Boyle peaking reach. River otters and beavers are known to be present, but are seen only occasionally in the Klamath Wildlife Area and throughout the vicinity of Lake Ewauna and Keno reservoir (ODFW, 2000). Incidental to other field surveys, a group of four river otters was seen in the J.C. Boyle bypass reach moving upstream just above the emergency spillway during the summer of 2003. Beaver signs were common throughout all of the river reaches. Mink are reported as uncommon in the Klamath Wildlife Area, but are consistently sighted from year-to-year (ODFW, 2000). Mink may move as far as 50 miles down a watercourse, and males are known to travel great distances over land during the breeding season (Csuti et al. 1997). All mammalian RFS are likely to occur in aquatic habitat throughout the Project vicinity. All of these species are affected by aquatic and riparian habitat quality. Both beaver and mink require dense cover along shoreline habitat (Csuti et al. 1997).

7.8 SYNTHESIS DISCUSSION

The following synthesis discussion provides an analysis of the general status, occurrence, and local distribution of all species known to occur in the Project vicinity. The sections below specifically describe wildlife species occurrence, distribution, and abundance in the study area across Project sections and habitat types. The synthesis discussion focuses on RFS, aquatic, riparian and wetland habitats, and other wildlife species and portions of the study area likely to be influenced by continued and future Project operations.

7.8.1 Assessment of Existing Conditions

The combination of surveys conducted by PacifiCorp and the review of existing data documented a high diversity of wildlife species in the equally diverse habitats in the Project vicinity (Table 7A-1 in Appendix 7A). Between nine and 107 species were documented in each of the 20 different vegetation cover types in which wildlife were observed. Individual species were found in from one to 18 of the 20 cover types. American robin, western fence lizard, brown-headed cowbird, European starling, western tanager, western wood-pewee, red-shafted flicker, and song sparrow all were found in at least 15 of the vegetation cover types.

Data on general wildlife occurrence and distribution are influenced largely by the abundance of avian detections recorded in the study area in comparison to all other species groups. More than 20,000 avian detections were recorded in the Project vicinity during relicensing in comparison to a combined total of fewer than 1,000 detections for all other species groups combined.

The three cover types that have oak as a major component—montane hardwood oak, montane hardwood oak/conifer, and montane hardwood oak/juniper—were found to support between 64 and 69 wildlife species. Given the extensive coverage and interspersion of these habitats in the study area, they represent a substantial wildlife habitat resource for a great diversity of species throughout the area. Little acreage of these habitats is directly affected by the Project or its operations. The only ongoing effects of the Project on the oak habitats are associated with vegetation maintenance along the perimeter of facilities (powerhouses, penstocks, canals, transmission lines, roads, and recreation facilities). This activity results in additional habitat "edges," which may increase predation rates and occurrence of either non-native wildlife species or brood parasites, such as brown-headed cowbirds.

Clearly, the Project reservoirs provide habitat for many species of wildlife. In total, the lacustrine habitat was found to support 62 wildlife species, with each reservoir having a slightly different mix of species. The greatest total number of avian detections across Project sections (1,357) was recorded along Keno reservoir where large aggregations of waterfowl and waterbirds were found to congregate throughout the year. A large number of TES wildlife species also was associated with Keno reservoir, which has generally low-lying topography and experiences minimal water level fluctuations that may add stability to wildlife habitats along the reservoir. Keno reservoir also is situated near several other wildlife-rich areas—Upper Klamath Lake, Klamath Wildlife Area, Lower Klamath National Wildlife Refuge—and likely receives a substantial amount of wildlife use by birds that are moving among these various protected areas as well as through the area in general during migration. The other Project reservoirs also receive substantial use by waterfowl and waterbird use as well, but show greater seasonal differences. Although reservoirs provide habitat for numerous native wildlife species, the Project reservoirs also provide suitable habitat for non-native species such as bullfrogs. A large bullfrog population likely has a direct adverse effect on native amphibian and reptile (especially pond turtles) through predation. See Section 6.7 for additional discussion of the effects of Project reservoirs and associated development on habitat connectivity and suitability for native wildlife species.

Of the 20 habitats where wildlife observations were recorded in the study area, riparian/wetland shrub and riparian/wetland forests support the most wildlife species—107 and 86 species, respectively. These habitats are also those that are most directly associated with Project operations. Avian use of riparian and wetland habitats by RFS along some Project (particularly

Iron Gate and Copco) reservoirs tended to be much lower than that found in the various river reaches (Table 7A-14 in Appendix 7A). This pattern also was noted for amphibian and reptile detections (Section 4.0). Thus, it is possible that the patches of wetland and riparian habitat along the reservoirs are either too small and isolated for effective use by wildlife or lack necessary structural elements. The one exception is the large wetland complex along Keno reservoir where the Klamath Wildlife Area and the undiked habitat to the south provide habitat for large numbers of wildlife. In many areas along the Iron Gate-Shasta River section and Iron Gate and Copco reservoirs, riparian and wetland habitat has been degraded by development, and livestock grazing. There are also several sites in the J.C. Boyle peaking reach that are affected by livestock grazing.

Among the river reaches, the relative abundance of RFS species was found to be highest in Keno Canyon. This finding was largely influenced by large numbers of song sparrow and yellow warbler detections in this reach. Given the limited amount of riparian and wetland habitat available in Keno Canyon relative to other Project sections, this finding likely indicates a distinct difference in the quality or nature of habitat suitable for avian RFS in this reach. These species prefer to breed in large contiguous areas of dense, shrubby willow. This specific habitat is well represented in Keno Canyon, where the river is bordered by riparian shrub vegetation along the entire reach. This shrub edge occurs between the narrow riparian herbaceous vegetation and the adjacent upland habitat types.

Other Project sections found to support high densities of RFS include the Klamath River below Iron Gate dam and the Link River. Again, RFS relative abundance in these sections is likely influenced by the presence of dense, and in some places complex, riparian vegetation. Along the Iron Gate-Shasta section, the presence of oak woodlands and other upland forest habitats adjacent to riparian areas likely increases the probability for occurrence of those RFS that are not riparian and wetland habitat obligates (i.e., Lewis' woodpecker, Swainson's thrush, and warbling vireo).

The current hydrologic patterns of the J.C. Boyle peaking and J.C. Boyle bypass reaches likely influence the riparian habitat that borders these river sections (see Section 3.0). Any effects on riparian areas and wetlands, in turn, can affect wildlife species dependent on these habitats. However, the relative abundance of avian RFS in these reaches was found to be comparable to avian RFS abundance in other river sections indicating that current flow regimes may provide conditions suitable for sustaining necessary riparian and peripheral wetland habitat for RFS. Overly dense reed canarygrass also may indirectly reduce habitat quality for some riparian dependent species through the exclusion of more beneficial herbaceous and shrub species. See Section 6.7 for additional discussion of habitat connectivity.

7.8.2 Assessment of Future Conditions

In general, Project reservoirs will continue to support the large numbers of wildlife species that rely on large open-water areas and aquatic habitat. Recreational activity in the study area is projected to increase by approximately 3,000 additional recreation days per year during a 30-year period (PacifiCorp, 2003). This likely will result in increased disturbance to wildlife associated with Project reservoirs, especially during the April-September boating season. Impacts are anticipated to be greatest near existing recreational facilities. The greatest impact is likely to be on species that use riparian areas near recreation facilities for breeding. PacifiCorp's plans to upgrade existing recreation facilities may eliminate small amounts of additional wildlife habitat, but also may provide an opportunity to reduce ongoing adverse impacts (e.g., trampling) in the riparian zone at these sites.

Preservation of Klamath River aquatic systems and associated peripheral wetland and riparian habitat will be critical to the maintenance of wildlife populations currently existing in and around the study area. Overall, wildlife habitat quantity and quality is likely to decline in the future through a combination of private development, increased recreation use, continued cattle grazing, and timber harvest. Private development seems most likely to increase near the Iron Gate-Shasta River section, and Iron Gate and Copco reservoirs. It is impossible to predict which habitats would be most affected. However, if unprotected, wetland and riparian habitat along shorelines is likely to decline in the future. Some additional wetland and riparian habitat is likely to develop along Project reservoirs as slumping shorelines provide appropriate inundation for willow growth. However, depending on which combination of water level management, wave action, and adjacent land uses (e.g., grazing and agriculture) continues to occur, habitat along Project reservoirs likely will continue to be relatively thin and non-diverse botanically without management actions specifically targeting enhancement of these areas.

8.0 NOXIOUS WEED INVENTORY

8.1 DESCRIPTION AND PURPOSE

The purpose of the noxious weed and non-native invasive plant species inventory is to determine the occurrence of noxious weeds near the Klamath Hydroelectric Project. This study also describes the potential for non-native species from the study area to spread to USFS/BLM lands and waters. Potential measures for suppressing exotic and invasive weeds on PacifiCorp-owned lands will be described in the license application.

8.2 OBJECTIVES

The objectives of this study include the following:

- Map noxious weeds and non-native plant species occurrences in the study area.

- Provide noxious weed and non-native plant species data to land management agencies in and adjacent to the study area (BLM, USFS, and states of Oregon and California).

- Coordinate this study with the riparian and wetland characterization study to identify Project operation effects on the maintenance of non-native plant species along reservoir shorelines and riverine sections

- Collect data that will be used in development of PM&E measures to enhance botanical and wildlife resources in the study area.

8.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

California, Oregon, and the BLM have regulations that address the spread and control of noxious weeds. Agency objectives are to contain or reduce noxious weed infestations in their jurisdiction and to avoid spreading weeds from other areas. Management objectives for control of noxious weeds in the study area will be addressed in the license application.

8.4 METHODS AND GEOGRAPHIC SCOPE

This study focused on areas directly affected by Project operations within the vegetation cover type mapping study area (Section 2.4). The noxious weed inventory fieldwork emphasized areas around all Project facilities, roads, transmission lines, and reservoirs, riverine shorelines, and riparian areas from the Link River to the mouth of the Shasta River.

To ensure that noxious weed and non-native invasive plant populations are described adequately for lands surrounding the Project, PacifiCorp integrated data collected during field surveys with existing data obtained from resource agencies to generate maps of noxious weeds and non-native invasive plant populations in the entire vegetation mapping study area. This area includes a 0.25-mile-wide (0.4-km-wide) buffer around the Project structures, reservoirs, and affected river reaches; all PacifiCorp lands; and the canyon between J.C. Boyle dam and Copco Lake.

- Before conducting the field surveys, botanists familiarized themselves with the species potentially occurring in the area. A target list of noxious weed species potentially occurring in the study area was developed through consultation with the resource agencies and other sources of information and is presented in Table 8.4-1. The list of target species includes information obtained from the following sources:

- Siskiyou County, California, and Klamath County, Oregon, lists of noxious weeds
- Oregon's Noxious Weed Policy and Classification System (ODA, 2001)
- California Department of Food and Agriculture
- Consortium of Northeastern California Weed Groups (Siskiyou County)
- BLM and USFS data and consultation with agency botanists

Inventory efforts were integrated with BLM to the extent possible. PacifiCorp reviewed database standards for BLM's noxious weed database to maintain compatibility.

The noxious weed field inventory was completed in conjunction with the TES species plant surveys (May through July 2002); vegetation cover type verification (April through November 2002); and the vegetation characterization plots and riparian/wetland vegetation characterization studies (August through November 2002); and was supplemented by incidental observations during 2002 and 2003. Maps or the GPS were used to document locations of noxious weed populations. A GIS coverage and database were produced that identifies noxious weed occurrences by species.

The mapped data were evaluated in relation to Project operations and maintenance, Project roads, recreation use patterns, and grazing evidence to determine whether Project operations may be affecting the distribution of the target species.

The findings of this study present noxious weed and non-native invasive plant species that are considered widespread species and those that are localized in their distribution and mapped as distinct occurrences (Table 8.4-1). Information on widespread species as well as mapped species is presented in the context of their presence (percent frequency) and abundance in plot data collected for the vegetation characterization study (Section 2.7.2) and the riparian/wetland characterization study (Section 3.7). This included 295 plots distributed among 23 cover types and 113 riparian/wetland sampling sites. The locations of plots or sampling sites that documented the occurrence of noxious weed and non-native invasive species also were mapped.

Table 8.4-1. Noxious weed and non-native invasive plant species potentially occurring in the study area.

Scientific Name	Common Name	California Weed Rating[1]	Oregon Weed Rating[2]
Acroptilon repens	Russian knapweed	B	B
Bromus tectorum[3]	Cheatgrass	na	na
Cardaria draba	Hoary cress	B	na
Carduus acanthoides	Plumeless thistle	A	A
Carduus nutans	Musk thistle	A	B
Carduus pynchnocephala	Italian thistle	C	B

Table 8.4-1. Noxious weed and non-native invasive plant species potentially occurring in the study area.

Scientific Name	Common Name	California Weed Rating[1]	Oregon Weed Rating[2]
Cenchrus spp.	Sandbur grass	C	na
Centaurea diffusa	Diffuse knapweed	A	B
Centaurea maculosa	Spotted knapweed	A	T
Centaurea solstitialis[3]	Yellow starthistle	C	T
Centaurea squarrosa	Squarrose knapweed	A	T
Chorispora tenella	Purple mustard	B	na
Chondrilla juncea	Rush skeletonweed	A	B
Cirsium arvense	Canada thistle	B	B
Cirsium ochrocentrum	Yellowspine thistle	A	na
Cirsium vulgare[3]	Bull thistle	na	B
Crupina vulgaris	Common crupina or bearded creeper	A	B
Cytisus scoparius	Scotch broom	C	B
Euphorbia esula	Leafy spurge	A	T
Gypsophila paniculata	Baby's breath	B	na
Halogeton glomeratus	Halogeton	A	B
Hypericum perforatum	Klamath weed or St. John's wort	C	B
Isatis tinctoria	Dyer's woad or Marlahan mustard	B	B
Lepidium latifolium	Perennial pepperweed or tall whitetop	B	B
Linaria dalmatica[3]	Dalmatian toadflax	A	B
Lythrum salicaria	Purple loosestrife	B	T
Onopordum acanthium	Scotch thistle	A	B
Onopordum tauricum	Taurium thistle	A	na
Physalis virginiana var. subglabrata	Smooth ground cherry	na	na
Polygonum cuspidatum	Japanese knotweed	B	B
Polygonum sachalinense	Giant knotweed	B	B
Salsola sp	Russian thistle	A or C[4]	na
Salvia aethiopis	Mediterranean sage	B	B
Senecio jacobea	Tansy ragwort	B	T
Sonchus arvensis	Perennial sowthistle	A	na
Sorghum halpense	Johnson grass	C	B
Taeniatherum caput-medusae3	Medusahead	C	B
Tribulus terrestris	Puncture vine	C	B
Xantium spinosum	Spiny cocklebur	na	B

[1] Oregon noxious weed control rating system

"A" designated weed—a weed of known economic importance which occurs in the state in small enough infestations to make eradication/containment possible; or is not known to occur, but its presence in neighboring states make future occurrence in Oregon seem imminent (Table 1).
RECOMMENDED ACTION: Infestations are subject to intensive control when and where found.

Table 8.4-1. Noxious weed and non-native invasive plant species potentially occurring in the study area.

Scientific Name	Common Name	California Weed Rating[1]	Oregon Weed Rating[2]

"B" designated weed—a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties (Table 2).Where implementation of a fully integrated statewide management plan is not feasible, biological control shall be the main control approach ("B" weeds targeted for biological control agents are identified with an asterisk).
RECOMMENDED ACTION: Limited to intensive control at the state or county level as determined on a case-by-case basis.

"T" designated weed—a priority noxious weed designated by the State Weed Board as a target weed species on which the Department will implement a statewide management plan (Table 3).

[2] California noxious weed control rating system.

"A"- Eradication, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.

"B" - Eradication, containment, control or other holding action at the discretion of the commissioner.

"C" - State endorsed holding action and eradication only when found in a nursery; action to retard spread outside of nurseries at the discretion of the commissioner; reject only when found in a crop seed for planting or at the discretion of the commissioner.

[3] Common or widespread in study area.

[4] *Salsola tragus* is a category C weed and S*alsola vermiculata* is a category A weed in California.

8.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

The noxious weed and non-native plant species inventory will help meet regulations for controlling the spread of these species. The state Noxious Weed Control Board regulations were used to help prioritize PM&E measure development.

8.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders on January 17, March 28, April 24, June 6, and July 11, 2002, and February 4, 2003, were conducted to discuss various elements of this study. Several comments received from stakeholders were incorporated into the Final Study Plan. Stakeholder comments and requests have been resolved.

8.7 STUDY OBSERVATIONS AND FINDINGS

Of the 39 target weed species, the following 17 were found in the study area:

- Bull thistle (*Cirsium vulgare*)
- Canada thistle (*Cirsium arvense*)
- Cheatgrass (*Bromus tectorum*)
- Diffuse knapweed (*Centaurea diffusa*)
- Dalmatian toadflax (*Linaria dalmatica*)
- Dyer's woad (*Isatis tinctoria*)
- Hoary Cress (*Cardaria draba*)
- Mediterranean sage (*Salvia aethiopsis*)
- Medusahead (*Taeniatherum caput-medusae*)
- Perennial pepperweed (*Lepidium latifolium*)

- Puncture vine (*Tribulus terrestris*)
- Russian knapweed (*Acroptilon repens*)
- Scotch thistle (*Onopordum acanthium*)
- Scotch broom (*Cytisus scoparius*)
- Spiny clotbur (*Xanthium spinosum*)
- St. John's wort (*Hypericum perforatum*)
- Yellow starthistle (*Centaurea solstitialis*)

Noxious weeds and non-native invasive plants in the study area exhibit two patterns of occurrence; localized and widespread. The following are descriptions of these occurrence patterns:

- Localized Species: These noxious weed and invasive species were documented and mapped as individual infestations and their distribution is considered to be more restricted in the study area. In most cases, the larger infestations of these species were mapped. Some species have a propensity to occur as relatively large, dense infestations and as individual plants or as groups of thinly dispersed plants, which made detailed mapping infeasible. These species include St. John's wort, hoary cress, Canada thistle, Dyer's woad, and Mediterranean sage. However, smaller infestations associated with Project facilities, roads, recreation areas, or other land use that might contribute to the spread of the noxious weed and non-native invasive species were mapped whenever they were observed.
- Widespread Species: These species are described by their general range of distribution in the study area. Cheatgrass, Dalmatian toadflax, medusahead, yellow starthistle, and bull thistle are considered to be widespread noxious weed and non-native invasive species in the study area (Table 8.4-1). The distribution of these species was not mapped with two exceptions. Some outlying occurrences of yellow starthistle were mapped in the J.C. Boyle peaking reach. Dalmatian toadflax infestations were mapped at Keno reservoir because they were easy to see from the reservoir when the plants were in flower; the presence of this species in other Project sections was minimal.

8.7.1 General Noxious Weed Distribution

There were 60 infestations mapped in the study area resulting from surveys completed in 2002. Fifty-two infestations were mapped on the basis of BLM's noxious weed database. A total of 14 noxious weed species and 112 infestations covered more than 558 acres (226 ha) in the study area (Table 8.7-1; Figure 8.7-1). Infestations documented in the BLM database not on the target list were not included on the noxious weed map and are not discussed here. These species include common flax (*Linaria vulgaris*), Himalayan blackberry (*Rubus discolor*), poison hemlock (*Conium maculatum*), and salt cedar (*Tamarix ramosissima*).

Table 8.7-1. Noxious weed acreage and infestation frequency by Project section.

Species	Project Section: Iron Gate-Shasta	Iron Gate Reservoir	Copco No. 1 and No. 2	J.C. Boyle Peaking Reach		J.C. Boyle Bypass	J.C. Boyle Reservoir		Keno Reservoir	Link River	Total
	PC[1]	PC	PC	BLM[2]	PC	BLM	BLM	PC	PC	PC	
Canada Thistle											
Acres									110.1		110.1
Number of Infestations									10		10
Diffuse Knapweed											
Acres							0.02				0.02
Number of Infestations							1				1
Dalmatian Toadflax											
Acres									0.2	8.4	8.6
Number of Infestations									3	5	8
Hoary Cress											
Acres	42.4	0.1			12			4.4	4.2	0	63.9
Number of Infestations	15	1			3			4	1	1	20
Dyers Woad											
Acres	7.7	4.2									11.9
Number of Infestations	1	5									6
Mediterranean Sage											
Acres									11.1		11.1
Number of Infestations									3		3
Perennial Pepperweed											
Acres									33.3		33.3
Number of Infestations									3		3
Puncture Vine											
Acres		0.2	0.001	0.7							0.99
Number of Infestations		1	1	1							2
Russian Knapweed											
Acres				0.2							0.2
Number of Infestations				1							1
Scotch Thistle											
Acres									18.8		18.8

Table 8.7-1. Noxious weed acreage and infestation frequency by Project section.

Species	Project Section										
	Iron Gate-Shasta	Iron Gate Reservoir	Copco No. 1 and No. 2	J.C. Boyle Peaking Reach		J.C. Boyle Bypass	J.C. Boyle Reservoir		Keno Reservoir	Link River	Total
	PC[1]	PC	PC	BLM[2]	PC	BLM	BLM	PC	PC	PC	
Number of Infestations									3		3
Scotch Broom											
Acres						0.02					0.02
Number of Infestations						1					1
Spiney Cotlbur											
Acres		0.001			0.2						0.25
Number of Infestations		1			1						1
St. John's Wort											
Acres				8.4	3.7	2		6.7			21
Number of Infestations				12	5	3		2			22
Yellow Starthistle											
Acres				198.5		79.7					278.2
Number of Infestations				31		3					34
Grand Total											
Acres	50.9	4.7		207.6	15.6	81.7	0.02	11.1	177.8	8.6	558
Number of Infestations	8	7		45	9	7	1	6	23	6	112

[1] Source: 2002-2003 PacifiCorp surveys.

[2] Source: BLM GIS Data, Klamath Falls.

Figure 8.7-1. Noxious weed locations.

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Figure 8.7-1. Noxious weed locations.

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Yellow starthistle is by far the most abundant of the mapped noxious weed species in the study area. The only yellow starthistle that was mapped in the J.C. Boyle peaking reach was done by the BLM (Table 8.7-1). The J.C. Boyle peaking reach infestations are considered “outliers” in the sense that the majority of yellow starthistle occurs downstream of J.C. Boyle peaking reach. Canada thistle was mapped in 100 acres (44.6 ha) at Keno reservoir, but is actually more widespread at that location and elsewhere in the study area in small patches that are too numerous to map. The best estimation of the abundance and distribution of Canada thistle is made by evaluating the plot data collected for the vegetation characterization study (Section 2.7.2) and the riparian/wetland characterization study (Section 3.0). This is true for a variety of the more ubiquitous species that are relatively sparse (bull thistle, Dalmatian toadflax, hoary cress, St. John’s wort, and Dyer’s woad) when compared to species such as cheatgrass, medusahead, and yellow starthistle.

8.7.2 Vegetation Characterization Plot Data

The noxious weed species that were detected in the 295 vegetation characterization plots include Canada thistle, bull thistle, Dalmatian toadflax, hoary cress, St. John’s wort, Dyer’s woad, cheatgrass, medusahead, and yellow starthistle (Table 8.7-2; Figure 8.7-1). Noxious weed and non-native invasive plants occurred in 74 percent of the vegetation characterization plots, with a low of 42 percent at J.C. Boyle reservoir and a high of 95 percent along the Iron Gate-Shasta.

Table 8.7-2. Frequency[1] and average[2] cover of noxious weed and non-native plants in vegetation characterization plots by Project section.

Project Section		Cheat-grass	Hoary Cress	Yellow Star-thistle	Canada Thistle	Bull Thistle	St. John’s Wort	Dalmatian Toadflax	Dyers Woad	Medusa-head
Iron Gate-Shasta	freq =	31.8%		59.1%						81.8%
% of plots[3] = 95%	avg =	3.0		2.9						3.4
n = 22	sd =	1.7		1.0						1.1
Iron Gate Reservoir	freq =	51.4%		43.2%	5.4%	10.8%				29.7%
% of plots[3] = 76%	avg =	1.9		1.6	2.0	1.3				2.9
n = 37	sd =	0.7		0.9	1.4	0.5				1.2
Copco No. 2 Bypass	freq =	52.6%	5.3%	36.8%	5.3%	15.8%				31.6%
% of plots[3] = 84%	avg =	1.5	2.0	1.0	1.0	1.3				2.2
n = 19	sd =	0.7	na	0.0	na	0.6				0.8
Copco Reservoir	freq =	48.7%	2.6%	33.3%	7.7%	17.9%	2.6%	2.6%		20.5%
% of plots[3] = 79%	avg =	1.9	2.0	1.6	1.3	1.1	1.0	1.0		1.8
n = 39	sd =	0.7	na	1.1	0.6	0.4	na	na		0.9
Fall Creek	freq =	28.6%		23.8%	4.8%	23.8%	4.8%			23.8%
% of plots[3] = 67%	avg =	1.5		1.6	1.0	1.0	1.0			2.4
n = 21	sd =	0.5		0.9	na	0.0	na			1.1
J.C. Boyle Peaking Reach	freq =	34.2%		6.8%	8.2%	16.4%		1.4%		9.6%
% of plots[3] = 67%	avg =	1.7		1.6	1.3	1.2		1.0		1.4
n = 73	sd =	0.8		1.3	0.5	0.4		na		0.5

Table 8.7-2. Frequency[1] and average[2] cover of noxious weed and non-native plants in vegetation characterization plots by Project section.

Project Section		Cheat-grass	Hoary Cress	Yellow Star-thistle	Canada Thistle	Bull Thistle	St. John's Wort	Dalmatian Toadflax	Dyers Woad	Medusa-head
J.C. Boyle Bypass	freq =	43.5%		17.4%	8.7%	17.4%		4.3%	8.7%	17.4%
% of plots[3] = 70%	avg =	1.8		1.3	2.0	1.0		1.0	1.0	1.0
n = 23	sd =	0.6		0.5	1.4	0.0		na	0.0	0.0
J.C. Boyle Reservoir	freq =	15.8%		10.5%	5.3%	15.8%	5.3%	5.3%		10.5%
% of plots[3] = 42%	avg =	1.3		1.0	2.0	1.0	1.0	1.0		1.0
n = 19	sd =	0.6		0.0	na	0.0	na	na		0.0
Keno Canyon	freq =	27.3%		27.3%	9.1%	36.4%	9.1%			27.3%
% of plots[3] = 82%	avg =	1.0		1.0	1.0	1.0	1.0			1.0
n = 11	sd =	0.0		0.0	na	0.0	na			0.0
Keno Reservoir	freq =	47.6%	4.8%	19.0%	19.0%	38.1%	9.5%	4.8%		9.5%
% of plots[3] = 86%	avg =	1.7	1.0	1.0	2.0	1.1	1.0	1.0		1.5
n = 21	sd =	0.7	na	0.0	0.8	0.4	0.0	na		0.7
Link River	freq =	40.0%		10.0%		30.0%	10.0%			20.0%
% of plots[3] = 80%	avg =	1.5		3.0		1.3	1.0			1.0
n = 10	sd =	1.0		na		0.6	na			0.0
Grand Total										
% of plots[3] = 74%										
n = 295	freq =	39.3%	1.0%	24.7%	7.1%	18.0%	2.4%	1.7%	0.7%	23.1%

1 The sum of weed frequencies or percentages for individual species within a Project section exceeds 100 percent because more than one species of weed occurred in some plots (see footnote 3).

2 Average and standard deviation are calculated for plots in which weeds were present; plots with zero values for weeds not included. Cover classes were not converted to mid-point cover values – average and standard deviation calculations are intended only as a gross estimate.

3 Percentage of plots in a Project section with at least one weed species present.

4 Small "n" equals the number of plots in which a noxious weed species were present.

Cheatgrass, yellow starthistle, and medusahead were the most widespread noxious weed species occurring in 39 percent, 25 percent, and 23 percent of all 295 plots, respectively, across all 11 Project sections (Table 8.7-2).

Bull thistle was present in 18 percent of all sampled plots from Iron Gate reservoir to the Link River. Canada thistle was present in 7 percent of all sampled plots, but was not documented along the Iron Gate-Shasta and along the Link River.

A comparison of the presence of noxious weed and non-native invasive plant species, and evidence of grazing in the 295 vegetation characterization plots is provided in Figure 8.7-2. Noxious weed and non-native invasive plants were recorded in 74 percent of the vegetation characterization plots. Evidence of grazing was observed in 28.6 percent of the plots that also had noxious weed and non-native invasive plants. Evidence of grazing was observed in 38.4 percent of sampled vegetation characterization stands.

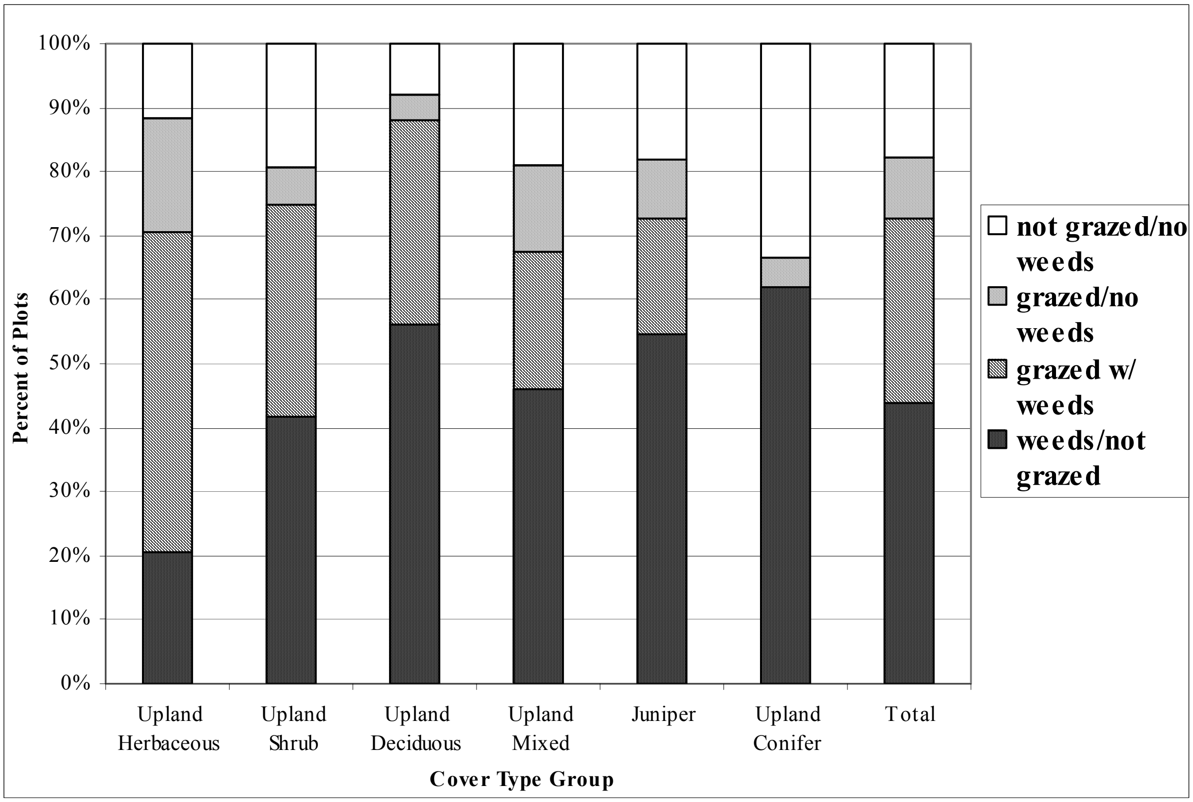

Figure 8.7-2. A comparison of the presence of noxious weed and non-native invasive plant species and evidence of grazing in the most abundant upland vegetation cover types.

The frequency of weeds was highest in the upland deciduous habitats, primarily Oregon oak woodlands occurring in 88 percent of the sampled stands. The highest frequency of association between evidence of grazing and the presence of weeds occurred in the upland herbaceous habitats at 50 percent. This high association was primarily in the annual grassland cover type around Iron Gate and Copco reservoirs. The upland conifer habitat, excluding juniper woodlands, demonstrated no association between evidence of grazing and the presence of noxious weed and non-native invasive plant species. The upland conifer habitat, which primarily consisted of Klamath mixed conifer and ponderosa pine stands, had weeds in 61.9 percent of the sampled stands while grazing was observed in 4.8 percent of sampled stands.

8.7.3 Riparian/Wetland Transect Data

The noxious weed and invasive plant data compiled from the riparian wetland data (Table 8.7-3) were based on the number of sampling sites in which a species occurred. There are 113 samplings sites where transects were placed, with one transect per sampling site. The number of riparian/wetland plots varied from site to site depending on the dimensions of the site. Because the plots were laid out along the transect from below the normal water level to "upland" habitat, the relative location of weeds could be determined. A significant number of the noxious weeds and non-native invasive plant occurrences in the riparian/wetland sampling sites were in the last "upland" plot, especially for species such as medusahead, yellow starthistle, and cheatgrass. Noxious weed and non-native invasive plant species occurred in 145 or 14.1 percent of the 1,027 plots that were positioned in the riparian and wetland habitats along all 113 of the riparian/wetland transects. Whereas, noxious weed species occurred in 62 or 56.4 percent of the 109 "upland" plots along the riparian/wetland transects. Approximately 30 percent of the noxious weed detections in riparian/wetland plots occurred in just 10.0 percent of the 1,136 plots sampled.

Table 8.7-3. Frequency[1] and average[2] cover of noxious weed and non-native plants in riparian/wetland characterization transects by Project section.

Project Section		Medusa-head	Yellow Star-thistle	St. John's Wort	Hoary Cress	Cheat-grass	Bull Thistle	Canada Thistle
Iron Gate-Shasta								
	freq =	32.0%	16.0%		4.0%	16.0%		8.0%
% of transects[3] = 60%	avg =	1.8	1.4		2	1.3		1.3333
n = 25	sd =	0.7	0.5		na	0.5		0.5164
Iron Gate Reservoir								
	freq =	57.1%						
% of transects[3] = 93%	avg =	2.6	2.3			1.9	1.7	2
n = 15	sd =	1.2	1.0			0.7	0.6	na
Copco No. 2 Bypass								
	freq =					3.9%		
% of transects[3] = 33%	avg =					1.0		
n = 3	sd =					na		
Copco Reservoir								
	freq =	58.3%	66.7%			8.3%	8.3%	
% of transects[3] = 67%	avg =	2.5	2.2			2.0	2.0	
n = 12	sd =	0.7	0.8			na	na	
Fall Creek								
	freq =	25.0%				25.0%		
% of transects[3] = 100	avg =	1.0				1.0		
n = 3	sd =	na				na		
J.C. Boyle Peaking Reach								
	freq =	21.1%	5.3%	5.3%		5.3%	15.8%	
% of transects[3] = 32%	avg =	2.4	1.0	2		1.3	1.3	
n = 19	sd =	0.5	na	na		0.6	0.5	
J.C. Boyle Bypass								
	freq =					16.7%		
% of transects[3] = 17%	avg =					2.0		
n = 6	sd =					na		
J.C. Boyle Reservoir								
	freq =					44.4%	44.4%	11.1%
% of transects[3] = 67%	avg =					1.6	1.8	1
n = 9	sd =					0.5	0.4	na

Table 8.7-3. Frequency[1] and average[2] cover of noxious weed and non-native plants in riparian/wetland characterization transects by Project section.

Project Section		Medusa-head	Yellow Star-thistle	St. John's Wort	Hoary Cress	Cheat-grass	Bull Thistle	Canada Thistle
Keno Canyon								
	freq =				25.0%			
% of transects[3] = 33%	avg =				2			
n = 3	sd =				0			
Keno Reservoir								
	freq =					25.0%	41.7%	83.3%
% of transects[3] = 92%	avg =					2.0	1.6	2.2174
n = 12	sd =					0.0	0.5	0.7359
Link River								
	freq =						50.0%	25.0%
% of transects[3] = 75%	avg =						1.3	2
n = 4	sd =						0.6	0
Grand Total								
% of transects[3] = 62%	freq =	25.5%	19.1%	0.9%	1.8%	21.8%	15.5%	13.6%

1 The sum of weed frequencies or percentages for individual species within a project section exceeds 100 percent because more than one species of weed occurred in some plots (see footnote 3). n = 113

2 Average and standard deviation are calculated for plots in which weeds were present; plots with zero values for weeds not included. Cover classes were not converted to mid-point cover values – average and standard deviation calculations are intended only as a gross estimate.

3 Percentage of plots in a Project section with a weed species present.

4 Number of transects with weeds.

The noxious weed and invasive plant species detected in the 113 riparian/wetland transects (including all 1,136 plots) include medusahead, yellow starthistle, St. John's wort, hoary cress, cheatgrass, bull thistle, and Canada thistle (Table 8.7-3). Noxious weed and non-native invasive plants occurred in 62 percent of the sampled riparian/wetland sites and ranged from a low of 16.7 percent at J.C. Boyle reservoir to 93.3 percent and 91.7 percent at Iron Gate reservoir and Keno reservoir, respectively. The riparian/wetland plots that had at least one occurrence of noxious weed and non-native plant species are mapped in Figure 8.7-1.

Cheatgrass was the most widespread species occurring in eight of ten sampled Project sections and 21.8 percent of sampled riparian and wetland sites. Medusahead occurred in 25.5 percent of sampled sites, but only in five Project sections from the Iron Gate-Shasta through the J.C. Boyle peaking reach. Yellow starthistle had a similar distribution in riparian/wetland sample sites, but did not occur in Fall Creek and was present in 19.1 percent of sampled sites. Bull thistle and Canada thistle occurred in 15.5 percent and 13.6 percent of sampled riparian/wetlands sites, respectively.

8.7.4 Species Summary

The following sections provide information on each noxious weed and non-native invasive plant species. A brief description of the ecology of each species is presented along with a description of its distribution in the study area.

8.7.4.1 Bull Thistle

Bull thistle is a spiny biennial herb that grows up to 5 feet (1.5 m) tall, with many spreading branches. Bull thistle is a native of Eurasia and is widely established in North America, often introduced as a seed contaminant. It is a highly competitive weed found in pastures, roadsides, and disturbed sites (Whitson et al. 1996).

Bull thistle was observed in a wide variety of habitats including palustrine forested wetland, riparian grassland, montane hardwood oak, perennial grassland, montane hardwood oak-juniper, mixed chaparral, and palustrine emergent wetland. Bull thistle was present in the 18 percent and 16 percent (Tables 8.7-2 and 8.7-3) of the vegetation characterization plots and riparian/wetland transects, respectively, in all Project sections.

8.7.4.2 Canada Thistle

Canada thistle is a colony-forming perennial that has deep and extensive horizontal roots. Stems are from 1 to 4 feet (0.3 to 1.2 m) tall. Canada thistle occurs primarily in more mesic and often disturbed habitats with deep, loamy soils next to Project river reaches and reservoirs. The generally dry climate and habitat conditions away from Project reservoirs and river reaches appears to limit the distribution of this species in the study area.

Canada thistle was detected in palustrine emergent wetland habitat, palustrine forested wetland habitat riparian deciduous habitat, and in relatively mesic, deeper soils in mixed chaparral, exposed rock, perennial grassland, and ponderosa pine habitat types. Approximately 100 acres (40 ha) of Canada thistle were mapped along the reservoir and in low-lying areas around Keno reservoir (Figure 8.7-1); these are some of the most densely infested Canada thistle patches in the study area. Canada thistle proved to be more widespread in the study area, but not as abundant as cheatgrass, medusahead, and yellow starthistle. Canada thistle was present in 7 percent and 14 percent (Tables 8.7-2 and 8.7-3) of the vegetation characterization plots and riparian/wetland transects, respectively, with plots distributed in all Project sections.

8.7.4.3 Cheatgrass

Cheatgrass is a non-native annual grass that is widespread throughout Canada, the United States, and northern Mexico (Sheley and Petroff, 1999). This species was introduced to the United States from Eurasia in soil used as ship ballast in the 1850s (Mack, 1981). This species is truly widespread in the study area in a wide variety of cover types. Cheatgrass habitat is created and maintained by so many different types of land use activities that control of this species is possible only on a limited scale. Other non-native annual brome species that occur alongside cheatgrass and, in places, are more abundant in the study area include hairy brome (*Bromus japonicus*) and ripgut brome (*Bromus diandrus*).

Cheatgrass was observed most frequently in mixed chaparral habitat, montane hardwood oak habitat, palustrine emergent wetland habitat, riparian deciduous habitat, palustrine forested wetland habitat, and annual grassland habitat. Cheatgrass was present in the 39 percent and 26 percent (Tables 8.7-2 and 8.7-3) of the vegetation characterization plots and riparian/wetland transects, respectively, in all Project sections.

8.7.4.4 Diffuse Knapweed

Diffuse knapweed is a biennial, annual, or short-lived perennial and grows 1 to 3 feet (0.3 to 0.9 m) tall from a deep taproot. Diffuse knapweed is native to grasslands and shrub steppe in eastern Europe and western Asia and is capable of invading a wide range of disturbed habitats resulting from natural or human-caused disturbances (Sheley and Petroff, 1999). Diffuse knapweed disperses by tumbling like Russian thistle (*Salsola* sp.) and tumble mustard (*Sisymbrium altissimum*); this characteristic makes dispersal possible by a variety of different avenues including wind, rivers, irrigation systems, or by vehicle (Sheley and Petroff, 1999).

One occurrence of diffuse knapweed was mapped by the BLM in one location in the J.C. Boyle bypass Project section. The mapped site is approximately 0.2 acre (0.08 ha) and resides under a transmission line at the edge of the study area east of J.C. Boyle dam.

8.7.4.5 Dalmatian Toadflax

Dalmatian toadflax is an herbaceous colony-forming perennial with stems up to 3.9 feet (1.2 m) tall. The species often is associated with coarse-textured, well-drained soils in open areas along roadsides and in rangelands (Sheley and Petroff, 1999). The species was first introduced to California as an ornamental from Europe, and is known to tolerate a broad range of climatic conditions and soil types. However, it is often unable to survive rapid or extreme temperature changes. Initially, seedlings are poor competitors, but, once established, plants compete strongly for limiting resources (CDFA, 2003).

All 8.6 acres (3.5 ha) of the mapped (Figure 8.7-1) occurrences of Dalmatian toadflax are located around Keno reservoir and the Link River. However, this species was present in 1.7 percent of vegetation characterization plots in the Keno reservoir, J.C. Boyle reservoir, J.C . Boyle bypass reach, J.C. Boyle peaking reach, and Copco reservoir Project sections. Dalmatian toadflax occurred most frequently along levy and road banks and in disturbed portions of palustrine emergent wetland habitat, ponderosa pine habitat, and riparian deciduous habitat.

8.7.4.6 Dyer's Woad

Dyer's woad is a highly competitive biennial that grows up to 3.9 feet (1.2 m) tall, and frequently grows in dense colonies. The species often grows on dry, rocky, or sandy soils, and taproots penetrate the soil to an average depth of about 3.3 feet (1 m). A native to southeastern Russia, the species was cultivated for several centuries in Europe as a source of blue dye (Sheley and Petroff, 1999). It was first discovered in Siskiyou County, California, in the Scott Valley and is believed to have been imported in contaminated alfalfa seed from Ireland in the early 1900s (Sheley and Petroff, 1999). It is found in disturbed and undisturbed areas including roadsides, fields, pastures, grain and alfalfa fields, forest, and rangelands in the intermountain west region of the northwestern United States (CDFA, 2003).

Dyer's woad was observed primarily in rocky habitat along roads and reservoir margins in a variety of cover types including palustrine emergent wetland habitat, Klamath mixed conifer, montane hardwood oak habitat, and annual grassland habitat. Approximately 11.9 acres (4.8 ha) of Dyers woad was mapped primarily along the Iron Gate-Shasta and Iron Gate reservoir. Dyer's woad also was documented in two of the vegetation characterization plots in the J.C. Boyle peaking reach.

8.7.4.7 Hoary Cress

Hoary Cress is a vigorous perennial introduced from Eurasia. It grows to 1.3 feet **(**0.4 m) tall, and has creeping tap roots that can reach depths of 9.8 inches **(**25 cm) and lateral roots with shoot buds within 1 month (CDFA, 2003). It is a native of the former USSR, northern Iran, and Afghanistan and has been introduced to Argentina and North America (Sheley and Petroff, 1999). Hoary cress is found in natural and disturbed sites including irrigated crops, orchards, vineyards, roadsides, and ditches. It often grows in moderately moist, alkaline to saline soils, but tolerates a wide range of soil types and moisture conditions (Sheley and Petroff, 1999).

Hoary cress is mapped in more Project sections than any other noxious weed and non-native invasive species. The infestations cover 63.91 acres (25.9 ha) in the Iron Gate-Shasta, Iron Gate reservoir, J.C. Boyle peaking reach, J.C. Boyle reservoir, Keno reservoir, and Link River Project sections. Hoary cress was observed primarily in dry and irrigated pastures near the Klamath River, but also was detected in flat, disturbed sites in pasture, montane hardwood oak-conifer habitat. and, oddly, in an exposed rock outcrop habitat where there was some evidence of least ephemeral moisture for part of the growing season. Hoary cress was present in the 1.0 percent and 1.8 percent of the vegetation characterization plots and riparian/wetland transects, respectively, in five Project sections including Copco No. 2 bypass and Copco reservoir.

8.7.4.8 Mediterranean Sage

Mediterranean sage is a perennial to biennial herb, native to Europe, commonly found in Oregon and California pastures, meadows, rangelands, and roadsides (Whitson et al. 1996). It often grows up to 3.3 feet (1 m) tall and is associated with warm, dry, disturbed sites, often south-facing slopes. Established in Klamath County by 1949, the species has spread to northern California and the greater part of southeastern Oregon, including Klamath and Siskiyou counties (Sheley and Petroff, 1999). Mediterranean sage was mapped on 11.1 acres (4.5 ha) at three locations around Keno reservoir, although individual plants were observed in several other locations around Keno reservoir. Mediterranean sage always was observed in weedy, disturbed sites with deep soils along levies, irrigation canal, pastures, native grasslands, and reservoir margins.

8.7.4.9 Medusahead

Medusahead is an annual grass with characteristically long awns that become twisted and divergent at maturity. Medusahead matures somewhat later than sympatric annual grasses and perennial grasses, such as bulbous bluegrass (*Poa bulbosa*), in the study area. Medusahead thrives in clay and clay-loam soils, but becomes generally less abundant on coarser grained soil (Bossard et al. 2000).

Medusahead was observed in many habitats with deep clay-loam soils including mixed chaparral, palustrine emergent wetland, montane hardwood oak-juniper, riparian deciduous, riparian shrub, annual grassland, palustrine scrub-shrub, and montane hardwood oak. Medusahead was present in the 23.1 percent and 25.5 percent of the vegetation characterization plots and riparian/wetland transects, respectively, in all Project sections.

8.7.4.10 Perennial Pepperweed

Perennial pepperweed is a perennial herb, native to Eurasia, with a deep and spreading underground root system that grows up to 7.9 feet (2.4 m) tall. This species' roots do not hold soil together well, and may allow the erosion of river, stream, or ditch banks. It typically grows on moist or seasonally wet sites, including wetlands, riparian areas, meadows, salt marshes, roadsides, agronomic crops and irrigated pastures (CDFA, 2003). Perennial pepperweed was observed growing disturbed areas with deep soil and a shallow water table. Perennial pepperweed was mapped on 33.3 acres (13.5 ha) at three locations around Keno reservoir.

8.7.4.11 Puncture Vine

Puncture vine is a mat-forming summer annual with stout-spined burrs, deep taproots, and trailing stems that grow up to 7.9 feet (2.4 m) long (Whitson et al. 1996). The species is native to southern Europe and is most prevalent in areas with hot summers and dry sandy soils, and is associated with disturbed areas such as roadsides, railways, and cultivated fields (Whitson et al. 1996). Three occurrences of puncture vine covering approximately 0.7 acre (0.3 ha) are mapped in the J.C. Boyle peaking and Copco No. 2 Project sections. One occurrence is located in the compacted soils at the parking lot at the Copco No. 2 bunkhouse parking lot, one occurrence is near the Copco dam road, and the other is located near a ranch residence near RM 207.3.

8.7.4.12 Russian Knapweed

Russian knapweed is an aggressive perennial, native to Eurasia, and often grows in dense colonies in cultivated fields, pastures, and roadsides (Whitson et al. 1996). This species' dark, frequently branching rhizomes can penetrate up to 8 feet (2.4 m). Russian knapweed is found throughout California, except in extreme wet areas of the northwest and extreme dry regions of the Great Basin and Mojave and Sonoran Deserts. One BLM occurrence of Russian knapweed is mapped along a compacted roadside in the J.C. Boyle peaking reach near RM 219.

8.7.4.13 Scotch Thistle

Scotch thistle is a biennial with sharp spines, which forms stout taproots and can grow up to 9.8 feet (3 m) tall. Scotch thistle is native to Europe and Asia and is found in most U.S. western states. The species favors dry climates with high soil moisture content, and frequently is associated with waterways (Sheley and Petroff, 1999). Severe infestations can form tall, dense, impenetrable stands, especially in fertile soils. Buried seeds may persist for up to 20 years, therefore, several consecutive years of treatment may be necessary (CDFA, 2003). The habitat where Scotch thistle grows at Keno reservoir has compacted soil that is trampled and grazed by cattle and also has a high areal cover of bare ground among the often densely packed plants. Scotch thistle was mapped a three locations around Keno reservoir covering 18.8 acres (7.6 ha).

8.7.4.14 Scotch Broom

Scotch broom is native to central and southern Europe and the British Isles, and is well established in the Pacific Northwest on well-drained sites over a wide range of precipitation regimes (Hitchock and Cronquist, 1973). The success of Scotch broom is a result of its tolerance of a wide range of soil conditions, its ability to fix nitrogen and grow for most of the year given adequate precipitation and mild climate, and its abundant production of long-lasting viable seeds (Hoshovsky, 1998). It is a woody perennial in the pea family that grows to 10 feet (3 m) and often pioneers disturbed sites. One BLM occurrence of Scotch broom is mapped by the BLM in the J.C . Boyle bypass reach just downstream of the J.C. Boyle powerhouse.

8.7.4.15 Spiny Clotbur

Spiny clotbur is a stoutly branched annual herb, native to Europe, which grows up to 3.3 feet (1 m) high. It is common throughout North America in disturbed sites with full sun and moist soil on grazing land, roadsides, riverbanks, and waste grounds (South Coast Weeds website, 2003). The fruit bears a beak with hooked bristles (Whitson et al. 1996). One small patch of this species was observed behind the barn at Shovel Creek; the size of the patch was approximately 0.2 acre (0.08 ha). A new small infestation was noted in 2003 at the PacifiCorp gate on the Project road leading to the Copco No. 2 Village. These plants were not present at this site in 2002.

8.7.4.16 St. John’s Wort

St. John’s wort is a common weed native to Europe that often is found on sandy or gravelly soils in the Pacific Northwest. It is a perennial that reproduces by seeds or by short runners with stems that are 1 to 3 feet (0.3 to 0.9 m) tall (Whitson et al. 1996). St. John’s wort is mapped in 22 locations covering approximately 21 acres (8.5 ha) in the J.C. Boyle peaking reach, J.C. Boyle bypass, and J.C. Boyle reservoir sections.

St. John’s wort was observed growing primarily along disturbed roadsides in montane hardwood oak habitat, palustrine emergent wetland habitat, mixed chaparral habitat, ponderosa pine habitat, riparian mixed coniferous-deciduous habitats, and riparian shrub habitat. St. John’s wort was present in 2.4 percent and 0.9 percent of the vegetation characterization plots and riparian/wetland transects, respectively, in seven Project sections including Copco reservoir, Fall Creek, Keno Canyon, Keno reservoir, and Link River. Many of the mapped locations of St. John’s wort occur along dirt roads and disturbed areas adjacent to roads.

8.7.4.17 Yellow Starthistle

Yellow starthistle is a highly competitive annual herb that develops dense, impenetrable stands, and can grow to 6.6 feet (2 m) tall (CDFA, 2003). Native to southern Europe and the Mediterranean region, this species initially was introduced to California from South America via alfalfa seed contaminant around 1850 (University of California Statewide Integrated Pest Management Program website, 2003). It currently infests 9.25 million acres (37,433 km^2) of rangeland in the western United States, including 8 million acres (32,375 km^2) in California and 10,000 acres (40.4 km^2) in Oregon (Westbrooks, 1998). It is found in open, disturbed sites; grasslands; rangeland; open woodlands; fields; pastures; roadsides; and waste places (Sheley and Petroff, 1999). This species’ flower heads are armed with sharp thorns, and taproots grow deep into the soil to depths up to 3.3 feet (1 m), allowing the plant to survive dry summers (CDFA, 2003).

Thirty four occurrences covering 278.2 acres (112.6 ha) were mapped by the BLM in the J.C. Boyle peaking reach and J.C. Boyle bypass sections. Additional occurrences of yellow starthistle were not mapped as a result of surveys in 2002. However, yellow starthistle was present in the 24.7 percent and 19.9 percent of the vegetation characterization plots and riparian/wetland transects, respectively, in all Project sections. This species covers hundreds of acres in the downstream Project sections, especially in the mixed chaparral habitat, annual grassland habitat, and montane hardwood oak and montane hardwood oak-juniper habitat around Copco and Iron Gate reservoir Project sections.

8.8 DISCUSSION

The following sections describe the existing and future conditions for noxious weeds and non-native invasive plants in the study area.

8.8.1 Characterization of Existing Conditions

Noxious weeds and non-native invasive plant species are well established in the study area. Many of the weed species occur in uplands or near the riparian/upland interface; there are no aquatic weed infestations. Many of the weed species found in the study area are widespread species that occur throughout the western United States and are spread by various landscape-wide land uses.

The combination of past and present land use activities in and around the Project area have contributed and will continue to facilitate the creation of the degraded, weedy habitats that occur in the study area today. However, the complexity and diversity of historical and current land use activities in the study area create a problem for teasing out the potential effects of more recent or present-day Project operations and maintenance on distribution and spread of noxious weed and non-native invasive species.

It is well known that many types of land uses contribute to the invasion and spread of noxious weeds and non-native invasive species including any and all ground-disturbing activities as well as any activities that promote the dispersal of weed seed. Roads, railroads, agriculture, ranching, recreation, residential developments, and industrial developments all contribute to the problem. Certainly, the ongoing Project-related vegetation management that occurs near Project facilities (dams, canals, penstocks, powerhouses, transmission lines, roads, and Project buildings) has the potential to cause the introduction and spread of weeds. The spread of weeds could occur as a result of vehicles or machinery spreading weed propagules throughout the area. Any management activities that create bare ground can provide substrate for weed seeds to germinate. Individual landowners, such as PacifiCorp, can do their part to define the distribution of weeds on the lands they manage and to identify aspects of the operation and maintenance of their projects that directly influence the potential invasion and distribution of noxious weed and non-native invasive plants in the Project area.

There are specific locations where Project operation and maintenance probably has the greatest potential influence on noxious weed invasion and distribution (Table 8.8-1). The following is a brief discussion of noxious weed populations associated with Project segments.

Table 8.8-1. Noxious weed and non-native plant species infestations most likely to be affected by Project operations.

Species	Iron Gate Reservoir[1]	Copco No. 1	J.C. Boyle Bypass[2]	Link River[1]
Dalmatian Toadflax				2, 3, 7, 8
Hoary Cress	16			
Puncture Vine	1	2		
Scotch Broom			206	
St. John's Wort			6, 9, 10	
Yellow Starthistle			4, 259	
Spiny Clotbur	2			
Total Infestations	4	1	6	4

[1] Unique infestation number for PacifiCorp infestations.

[2] "Synsite_id" number for BLM occurrence records.

Noxious weeds were detected in 75 to 80 percent of sampled stands along the Link River Project section (Tables 8.7-2 and 8.7-3). There were also six mapped occurrences of noxious weeds, five infestations of Dalmatian toadflax, and one infestation hoary cress. Dalmatian toadflax (LIDA-2) is growing along the levy that is adjacent to the West Side canal along the Link River. LIDA-3 is a thinly dispersed infestation growing primarily along the west side of the West Side canal. LIDA-8 is growing at the East Side forebay and LIDA-7 is growing at the East Side powerhouse. Vegetation management activities and facility maintenance conducted by PacifiCorp could facilitate the spread of Dalmatian toadflax by spreading seed and disturbing soil near roads, transmission line ROWs, and other facilities. Also, the community trail that runs along the canal frequently is used by local residents and potentially could lead to the spread of this species to new locations through human dispersal.

Noxious weeds were detected in 86 to 91.6 percent of sampled stands along the Keno reservoir Project section (Tables 8.7-2 and 8.7-3). There are 23 weed occurrences around Keno reservoir. The abundance of weeds at Keno reservoir is primarily the result of years of agricultural development via introductions of contaminated seed and the further spread and maintenance of weeds through widely used agricultural practices. The levies are designed, in part, to keep water out of the surrounding agricultural fields, pastures and the wildlife refuge. These levies are prime weed habitat and support most of the weed occurrences around the reservoir.

Despite the fact that most weed species occur along the reservoir margin, the direct effects of the operation of Keno reservoir are minimal because nearly all of the adjacent lands are controlled by other land managers/owners and no weed species are located in the reservoir fluctuation zone. However, the presence of the reservoir may facilitate irrigation withdrawals by local farmers and thus promote more intensive agricultural development in the vicinity. This intensive development corresponds to the creation of more habitat for noxious weed species based on the current management strategies observed in the vicinity. A major factor contributing to the invasion and spread of noxious weeds at Keno reservoir is the abandoned agricultural lands and degraded pastures as well as derelict industrial developments.

There were no infestations mapped in Keno Canyon section, but infestations of widespread weeds were detected in 82 percent of the general vegetation characterization plots (Table 8.7-2); only 25 percent of the riparian/wetland transects had weeds present. The absence of Project facilities that require maintenance in Keno Canyon means that there is little potential for the Project to directly affect noxious weed and non-native invasive plants in this Project section.

J.C. Boyle reservoir has among the lowest frequency of noxious weeds in sampled stands occurring in 42 percent and 66 percent of vegetation characterization plots and riparian/wetland transects, respectively. Along the riparian/wetland transects, cheatgrass, bull thistle, and Canada thistle were found to have less than 2 percent cover (Table 8.7-3). The seven mapped infestations at J.C. Boyle reservoir are out of the reservoir fluctuation zone. The infestations at J.C. Boyle reservoir occur at the Sportsman's Park, recreation areas at Spencer Creek, under a non-project transmission line and along tributary creeks at the southeastern portion of the reservoir and are not directly affected by Project operations.

Only 17 percent of the riparian/wetland transects in the J.C. Boyle bypass reach had noxious weeds (Table 8.7-3). Flow management does not contribute to the spread of the only noxious weed—cheatgrass—found in the riparian/wetland transects in this reach. The J.C . Boyle bypass reach has seven mapped infestations based on the BLM's weed occurrence database. Scotch broom (one), St. John's wort (three), and yellow starthistle (three) are located near Project facilities including an abandoned Project residential area, the J.C. Boyle penstock, a Project access road, and J.C. Boyle canal. Six of the seven populations potentially are directly affected by Project operations. The only Scotch broom population in the study area occurs near an abandoned Project residential facility just downstream of J.C. Boyle powerhouse. The three St. John's wort infestations are located adjacent to the J.C. Boyle tunnel in disturbed areas near the intake for the tunnel, and along the road to the J.C. Boyle powerhouse above the J.C. Boyle canal. There are three infestations of yellow starthistle between RM 220 and RM 223. Two of the three occurrences potentially are affected by the Project. One particularly large occurrence overlaps, in part, the J.C. Boyle penstock and extends into the J.C. Boyle peaking reach Project section and another, much smaller occurrence was recorded on the long fill slope of the J.C. Boyle canal. Maintenance of the J.C. Boyle penstock corridor, J.C. Boyle canal banks and roads, the disturbed areas around the J.C. Boyle tunnel intake and Project access roads are potentially a source of weed seed that Project maintenance workers could pick up and disperse into new areas.

There are 45 occurrences of weeds in the J.C. Boyle peaking reach. In addition, the presence of weeds in the riparian/wetland data (31 percent) and the vegetation characterization data (67 percent) indicate many additional weed locations in this Project section (Tables 8.7-2 and 8.7-3). Nearly all of the mapped occurrences are located near non-project roads, campgrounds, river access points, and agricultural areas including rangeland, pastures and irrigated hayfields. The absence of Project facilities that require maintenance in the J.C. Boyle peaking reach means that there is little potential for the Project to directly affect noxious weed and non-native invasive plants in this Project section.

Although there are no mapped occurrences (i.e., small populations) of noxious weeds and non-native invasive plants in the Copco reservoir, Copco No. 2 bypass, and Fall Creek Project sections, eight widespread weeds were detected in the vegetation characterization data. These ranged in frequency of occurrence from 67 to 84 percent. Cheatgrass, hoary cress, yellow starthistle, Canada thistle, bull thistle, St. John's wort, Dalmatian toadflax, and medusahead were present is these Project sections; all but hoary cress and Canada thistle are considered widespread species that did not require mapping. The detected occurrences of hoary cress and Canada thistle are restricted in area, consist of few plants, and were not mapped. None of these occurrences was in a location near Project facilities. Within the Copco No. 2 bypass reach, the only noxious weed species found along three riparian/wetland transects was cheatgrass, which occurred in two of 51 plots.

Approximately 93 percent of the riparian/wetland transects along Iron Gate reservoir had some noxious weeds (Table 8.7-3). Most of this was the result of weedy species occurring in the upland-riparian transitional zone that is influenced by a combination of water level management and adjacent land uses. There were seven occurrences of noxious weeds and non-native invasive species mapped around Iron Gate reservoir. Five of these occurrences are Dyer's woad, which grows in rocky habitats some of which are near the reservoir, but clearly out of any influence of the reservoir. Puncture vine is present at the Copco No. 2 village parking lot and is in a position to be widely dispersed by PacifiCorp vehicles. One occurrence of hoary cress was mapped at the reservoir margin near the mouth of Long Gulch Creek. Potential habitat for this species is available along the highly disturbed banks of Long Gulch Creek and the spread of this species by cattle and other natural dispersal mechanisms is likely. The reservoir pool level definitely influences this site and probably has increased the available habitat for more hydrophilic species along this portion of low gradient shoreline. There is potential for the Project to carry seed from this site to other low-gradient shorelines around the reservoir.

There were noxious weeds in 60 percent of the riparian/wetland transects along the Iron Gate-Shasta River segment (Table 8.7-3). The Iron Gate-Shasta segment has eight mapped infestations of noxious weeds and non-native invasive species; 12 occurrences of hoary cress are located in abandoned or degraded pastures, along railroad tracks, and along the dirt roads adjacent to the river. One occurrence of Dyer's woad is located in a rocky habitat well away from the river. The Project has no direct effect on any of these infestations.

8.8.2 Characterization of Future Conditions

Continued Project operation has the potential to facilitate the spread of noxious weeds and non-native invasive plants in the study area. In particular, weeds located at J.C. Boyle penstock, Copco No. 2 village, and at the Link River are susceptible to dispersal into new areas by Project-related vehicular traffic, vegetation management, and maintenance activities. Yellow starthistle, in particular, is widespread in the study area, but it is not equally abundant across the study area. The occurrence of this species in the J.C . Boyle bypass reach is the most upstream distribution of this species where plants are relatively abundant. This infestation may be an appropriate target for potential control measures to help prevent or slow the spread of this species in the direction of the City of Klamath Falls. To be effective, however, the effort would need to be coordinated among land management agencies and private resources in the region to address the problems associated with the invasion and spread of noxious weeds and non-native invasive plants.

The remaining noxious weed and non-native invasive species occurrences (Table 8.7-1) have little potential to be affected directly by Project operations and maintenance. In summary, the above discussion has focused on areas where Project-related operation and maintenance activities are concentrated around Project facilities; these are areas where the Project is clearly and directly responsible for the management of noxious weeds and non-native invasive plants.

The Project's water management may contribute to the creation of suitable moisture regimes for some of the noxious weed and non-native invasive species along the Project river reaches and reservoirs. The effects of river flows managed by the Project probably differ little from the effects of natural river flows with respect to the river being a transport mechanism for weed seeds and to the 17 noxious weed and non-native invasive plant species (Section 8.7) documented in the study area.

However, the non-Project land uses (roads, railroads, agriculture, ranching, recreation, residential developments, and industrial developments) adjacent to Project facilities often determine the level of ground disturbance and potential weed ecology at these sites. In situations where Project-related vehicles use public and private roads to access Project facilities, the responsibility for weed management becomes unclear. The use of these roads by non-Project vehicular activities far exceeds the use by Project-related vehicles and thus the appropriate land managers should carry at least the bulk of the responsibility for management of noxious weed and non-native invasive plants. A coordinated effort among different land management entities is required to develop an effective weed management strategy for the Project area and the surrounding lands. Currently, PacifiCorp is in a position only to coordinate and develop a vegetation and weed management plan for Project lands under its management.

9.0 GRAZING ANALYSIS

9.1 DESCRIPTION AND PURPOSE

The purpose of this analysis is to provide information on current grazing practices near the Klamath Hydroelectric Project. The information is being included to help frame the description of the botanical and wildlife resources and land use in the FERC license application. Livestock grazing is argued by many researchers as having the most widespread influence on native ecosystems. Much of the land surrounding the Project is subject to open range grazing. Grazing impacts associated with open range grazing, federal grazing allotments, and corporate agricultural leasing are not considered to be an effect of the Project. The following assessment includes a discussion of the extent to which livestock grazing occurs on Project land and a description of current allotments and PacifiCorp's corporate agricultural and grazing leases as well as cooperative fencing and other conservation efforts.

9.2 OBJECTIVES

The objectives of this study were the following:

- Describe the condition of all grazed land within the existing FERC Project boundary (which includes various ownerships) and on PacifiCorp-owned land near the Project. This includes reviewing the linkages between historical grazing pressure and current ecological conditions.

- Attempt to identify important interactions of grazing activities with Project facilities or operations and the resultant effects on botanical and wildlife resources (e.g., grazing impacts on shoreline erosion or riparian vegetation).

- Integrate the grazing practices information with other botanical and land use analyses for an overall assessment of grazing-related land use on Project land.

- Summarize information that would be useful for identifying potential PM&E measures on PacifiCorp land that protect botanical, wildlife, cultural, and recreation resources.

9.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

The grazing practices that occur on PacifiCorp land and adjacent land have the potential to greatly affect botanical and wildlife resources (particularly wetlands and riparian areas) in the FERC study area. Information from the grazing assessment provides added perspective for describing resources in the study area, evaluating Project impacts, and developing PM&E measures.

9.4 METHODS AND GEOGRAPHIC SCOPE

The following sections describe the documents and field surveys and background information used to assess current and historic grazing use. These sections also briefly describe the methods used to gather and interpret the field survey data.

9.4.1 Current and Historic Grazing Use

The past and existing livestock grazing levels and systems employed on PacifiCorp and adjacent land was summarized by reviewing information provided in existing grazing assessments such as Korpela (1995), BLM (2000), and available information from the Klamath River Plan (BLM, 2003). Regional grazing practices are described first, followed by PacifiCorp's grazing practices, which were designed to fit within the regional allotment management, range utilization capacity, and pastures. The background information was provided by the following documents:

- U.S. Bureau of Land Management's (BLM) Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary (BLM, 1995)
- Redding Resource Management Plan and Record of Decision (BLM, 1993)
- Topsy/Pokegama Landscape Analysis (BLM, 1996)
- Edge Creek Allotment: Rangeland Health Standards Assessment (BLM, 2000)
- Draft Klamath River Wild and Scenic River Management Plan (BLM, 2003)

In addition, the assessment drew on observations made during field investigations in 2002-2003.

9.4.2 Field Observations

The documentation of grazing evidence in vegetation communities and wildlife habitat focused on the study area where there is the greatest likelihood of potential impacts associated with Project operations and maintenance. The study area included the area within a 0.25-mile-wide (0.4-km-wide) buffer around the Project facilities; Project roads and associated transmission lines; the Klamath River reaches from Link River to Iron Gate dam; and the riparian community along the Klamath River from Iron Gate dam to the confluence with the Shasta River.

Upland and riparian vegetation surveys were conducted during the 2002 and 2003 field seasons (Sections 2.4 and 3.4). PacifiCorp documented evidence of grazing in riparian and wetland habitats as part of the riparian/wetland characterization study (Section 3.4) and upland habitats during the vegetation cover type mapping and characterization study (Section 2.4). In the riparian study, evidence of grazing impacts was recorded while sampling the 113 riparian/wetland vegetation characterization transects sampled in 2002-2003. Observations of grazing also were documented at the 295 vegetation characterization plots distributed among all cover types throughout the study area. Evidence of grazing included: livestock trails, vegetation trampling, and obvious signs of grazed vegetation. Grazing effects were considered to be significant at a site if there was erosion, severely grazed or trampled vegetation, or low total vegetative ground cover. Grazing effects were summarized by Project section and cover type by calculating the percent of plots with evidence of grazing effects. Plots were characterized according to the severity of impact and grouped into three categories: (1) those plots with signs of heavy grazing impacts; (2) plots with light to moderate signs of impacts; and (3) plots that had no obvious signs of grazing. Where possible, information in the BLM rangeland health evaluation (BLM website) was considered in the assessment. Section 2.7.4 summarizes the percent of plots of each cover type and within each Project section that had evidence of grazing, erosion, and recreation-related impacts.

9.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

Because the Project is in an "open range," grazing practices will need to be coordinated with practices on federally managed lands adjacent to PacifiCorp's land. The BLM in Oregon administers several grazing allotments that border the river and reservoirs from Keno to the Oregon-California border (BLM, 1994) and assists with administration of some of the grazing areas in California for the Redding District. BLM's Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary (BLM, 1995), Redding Resource Management Plan and Record of Decision (BLM, 1993), and Draft Klamath River Wild and Scenic River Management Plan (BLM, 2003) contain overall grazing practices guidelines.

9.6 TECHNICAL WORK GROUP COLLABORATION

Meetings with stakeholders were held on the following dates: January 17, March 28, April 18, June 6, November 8, and December 10, 2002, and February 4, 2003. At each of these meetings, PacifiCorp received comments that have been incorporated into the Final Study Plan.

9.7 THE STUDY OBSERVATIONS AND FINDINGS

The following sections describe current range conditions and summarize PacifiCorp vegetation plot data.

9.7.1 Current and Historic Grazing Use

The following sections describe the division and use of various grazing allotments and pastures in the study area.

9.7.1.1 BLM Allotments

The BLM authorizes livestock grazing on the public lands in accordance with laws established by the U.S. Congress. The major legislation and regulations directing livestock grazing are: Taylor Grazing Act, FLPMA, Public Rangelands Improvement Act, Executive Order 12548, National Environmental Policy Act (NEPA), and Code of Federal Regulations (CFR). The BLM administers the grazing program through regulations at 43 CFR 4100.

The Taylor Grazing Act (43 U.S.C. §§ 315-3160, June 28, 1934, as amended 1936, 1938, 1939, 1942, 1947, 1948, 1954, and 1976.) was the first federal effort to regulate grazing on federal public lands. It establishes grazing districts and uses a permitting system to manage livestock grazing in the districts. Recognizing that public rangelands were producing less than their potential, Congress enacted the Public Rangelands Improvement Act (PRIA) of 1978 to reaffirm a national policy and commitment to manage, maintain, and improve the condition of the public rangelands so that they become as productive as feasible for all rangeland values. PRIA requires rangeland inventories to assess current conditions and trends. It also implemented a new grazing fee formula, on an experimental basis, for domestic livestock grazing on the public rangelands that took production costs into consideration. The BLM has administered public land grazing under the new regulations since August 21, 1995. Standards for Rangeland Health and Guidelines for Livestock Grazing Management for Public Lands in Oregon and Washington

(BLM website) provide general guidelines for documenting and monitoring rangeland health, proper grazing management, and rangeland rehabilitation.

This section describes the six current BLM grazing allotments that border or are included in the study area (147-Grub Springs; 107-Dixie; 102-Edge Creek; 101-Chase Mountain; 141-Chicken Hills; and 155-Laubacher) (BLM, 1996) (Figure 9.7-1; Table 9.7-1). All of these allotments contain BLM lands as well as a mix of various private lands. The largest private landowners included in these allotments are PacifiCorp and U.S. Timberlands. Three management categories exist for BLM grazing allotments: improve (I); maintain (M); and custodial (C) (BLM, 1996).

Table 9.7-1. Size, production, and season of use for BLM grazing allotments.

Allotment Name	Acreage	AUMs Authorized[1]	Season of Use
Chase Mountain (public)	8,823	194[2]	No season
Chase Mountain (private)	19,680	239	No season
Edge Creek (public and private)	38,260	1209	5/1 to 9/15
Dixie (public)	5,547	320	5/1 to 8/15
Dixie (private)	22,260	825	No season
Chicken Hills (public)	3,422	82	5/15 to 9/15
Chicken Hills (private)	5,340	383	5/15 to 9/15
Grub Springs (public and private)	38,144	629	5/1 to 9/15
#155 BLM (public)	1,841	92	4/15 to 6/14

1 Animal unit month (AUM) has been defined as 27 pounds (lbs) of forage per day for a month resulting in a total use of 800 lbs of forage per cow per month (Korpela, 1995).

2 Reflects maximum historic use. Currently, there is no legal cattle grazing on these lands.

Chase Mountain Allotment (#101)—The Chase Mountain allotment is bordered on the north by Keno Canyon and on the west by J.C. Boyle reservoir and the Klamath River as far as Big Bend in the J.C. Boyle bypass (Figure 9.7-1). The allotment stretches south well out of the study area to the Oregon-California border. The last livestock lease was cancelled in 1993. No grazing activities are scheduled currently and this allotment is considered a category "C" for management purposes.

Edge Creek Allotment (#102)—The Edge Creek allotment is situated between the Klamath River and Highway 66, and stretches from near Long Prairie Creek on the west to the J.C. Boyle dam on the eastern end (Figure 9.7-1). The base property for the livestock lease on this allotment is the Beswick Ranch, which is owned by PacifiCorp. The Edge creek allotment uses landscape features as its boundary. This includes the Klamath River on the south and east, Highway 66 to the north, and Jenny Creek to the west. The result of this fenceless allotment is that the cattle spend approximately 90 percent of their time in the Edge Creek allotment and 10 percent elsewhere, primarily in the Dixie allotment to the west. A fence was installed recently at the Oregon-California state line to contain livestock. This allotment is considered a category "I" for management purposes.

Figure 9.7-1. Grazing management units, allotments, and fences in the study area.

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Figure 9.7-1. Grazing management units, allotments, and fences in the study area.

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Dixie Allotment (#107)—The Dixie allotment is located directly west of the Edge Creek allotment (Figure 9.7-1). The northern boundary is Highway 66, the southern boundary is the Oregon-California border, and Jenny Creek serves as the western edge. The base property for the livestock lease on this allotment is the Fall Creek Ranch. This allotment was first licensed for grazing by the BLM in 1950. The Weyerhaeuser exchange-of-use lease was cancelled in 1994. The only grazing that remains is on the BLM-administered lands. This allotment is considered a category “I” for management purposes.

Chicken Hills Allotment (#141)—The Chicken Hills allotment is located on the east side of the Klamath River from the southern end of Big Bend of the J.C. Boyle bypass to the Oregon-California border (Figure 9.7-1). The current base property for this allotment is a private lease with Bart Hardwick. This allotment is considered a category “C” for management purposes. Currently, no monitoring studies are being conducted on this allotment.

Grub Springs Allotment (#147)—The Grub Springs allotment is located primarily outside of the Topsy/Pokegama Landscape Analysis Watershed. It is located north and west of Keno Canyon and the Chase Mountain allotment. This allotment includes land on the northern end of J.C. Boyle reservoir, and is considered a category “C” for management purposes. Grazing use was by sheep until the early 1970s, however, current use is by cattle.

Allotment #155 (formerly the Laubacher allotment)—Allotment #155 is the only BLM allotment near the study area that is located in California. The allotment consists entirely of public lands (BLM and USFS), and it exists on both sides of the Klamath River near Shovel Creek and the Beswick Ranch. This allotment is within the Redding BLM district, but it is managed by the BLM’s Klamath Falls Resource Area. No monitoring data have been collected on this allotment.

9.7.1.2 PacifiCorp Leases

PacifiCorp has three grazing leases that include lands in the study area. The largest is associated with the Beswick Ranch and is described in Klamath River Rangelands: Inventory, GIS Model Development, and Grazing Management Plan (Korpela, 1995). The other two leases include lands south of Iron Gate reservoir (currently the Fitzgerald lease) and in the Copco Road/Fall Creek area (Jerry Barry lease). PacifiCorp has not developed management plans for these two leases. The PacifiCorp lease area is divided into eight grazing management units (GMUs), based on ownership patterns, management emphasis, or topography (Figure 9.7-1). These include the South Canyon, North Canyon, Flume, Shovel Creek, Long Prairie, Spannaus, Iron Gate, and River GMUs (Korpela, 1995). These management units overlap the existing BLM grazing allotments. Grazing limits and leases are managed by the BLM, USFS, or private landowners, such as Sierra Pacific, using the boundaries of their allotments as boundaries.

In 1994-1995, an inventory of range resources associated with the PacifiCorp lands along the Klamath River was conducted and a grazing management plan was developed (Korpela, 1995). Although only partially implemented (not all sub-pasture fences or improvements have been installed), the grazing plan continues to provide the basis for management of the PacifiCorp grazing lease associated with the Beswick Ranch. Korpela (1995) identified several goals of grazing management on PacifiCorp lands. These include the following:

- Maintaining consistency with agency management plans for the area

- Limiting herd size to a level that is close to hay production capacity to support the herd during the winter

- Maintaining economic viability by having a minimum herd of approximately 400 mother cows

- Including adequate (47 percent) pasture rest to create a forage buffer in drought years and to enhance range conditions

- Leaving adequate residual vegetation for watershed protection

- Allocating a proportion (25 percent) of annual forage production for wildlife

Korpela (1995) also suggested improvement practices, such as additional fencing and the addition of at least three water developments for livestock that would take water from springs.

The following sections describe grazing use in the eight GMUs that were defined by Korpela (1995). Table 9.7-2 presents a summary of grazing capability in animal unit month (AUMs) in each PacifiCorp GMU.

Table 9.7-2. Summary of grazing capacity (AUMs) in each PacifiCorp grazing management unit (GMU).[1]

GMU	Normal Year AUMs	Drought Year AUMs
South Canyon	419	72
North Canyon	350	0
Flume	462	172
Shovel Creek	218	139
Long Prairie	793	0
Spannus	174	1
Iron Gate	1,882	83
River	2,561	2,311
Total	**6,859**	**2,778**

[1] Source: Korpela (1995).
AUM = Animal unit month.

South Canyon GMU—The South Canyon GMU extends from the Frain Ranch down to Shovel Creek on the southeast side of the Klamath River excluding fenced irrigated hayfields and meadows (Figure 9.7-1). The GMU spans the Oregon-California border. Major landowners within the GMU boundary include PacifiCorp, the BLM, the State of Oregon, U.S. Timberlands, Boise Cascade, and other private landowners. As many as 150 cattle graze the pastures throughout the season, working their way up from lower annual grasslands to higher elevation meadows below Secret Spring Mountain and at the Frain Ranch. This GMU has been divided (a fence was recently built by PacifiCorp and the BLM) to fence off the Frain Ranch area. Management suggestions include rotating the grazing livestock through the Frain Ranch area with only 60 to 70 percent utilization (Korpela, 1995). The easternmost pasture in this unit (includes Frain Ranch) has been rested for the past few years. The BLM has monitored vegetation trends in the Frain Ranch area since 1991 and has documented some improvement in cover of native perennial grasses (BLM, 2000).

North Canyon GMU—The North Canyon GMU extends from the furthest upstream portion of the Frain Ranch downstream to the Hoover Ranch along the north side of the Klamath River Canyon (Figure 9.7-1). The GMU is located entirely in Oregon and the Pokegama Wildlife Management Unit. The primary landowners include PacifiCorp, the BLM, and a few private landowners. Typically, livestock graze the entire GMU from May 1 to July 15. When in use, because of a lack of fencing and general livestock control, cattle may be found anywhere in the GMU at any time of the year (Korpela, 1995). This unit has been rested for the past few years.

Flume GMU—The Flume GMU consists of separately fenced pastures located on the north side of the Klamath River canyon extending from the Hoover Ranch to land opposite Shovel Creek (Figure 9.7-1). The Flume GMU does not include irrigated hayfields adjacent to the river. Current management allows for the southern and eastern pastures in the Flume GMU to be grazed in the early spring and then again in the fall. Korpela (1995) suggests that shrub fields should be monitored for overuse by livestock, which would cause deer winter range degradation. A new cross fence recently was added to the northern portion of this pasture to facilitate livestock management.

Shovel Creek GMU—The Shovel Creek GMU is located on the south side of the river where Shovel Creek joins the Klamath River (Figure 9.7-1). This unit is located entirely in California and contains portions of the BLM Allotment #155. The allotment is divided into three pastures (power ditch, oak tree field, and Shovel Creek riparian). The power ditch pasture is grazed as needed, the oak tree field is hayed, and the aftermath is grazed, and the Shovel Creek riparian pasture is grazed primarily in the spring. A few cattle remain throughout the year in the riparian pasture, which has no restrictions of livestock movement in or out (Korpela, 1995). Fences exclude cattle from Shovel Creek. Additional riparian exclusion fences were added in 2001 to exclude cattle from the upper portions of Shovel Creek and side slopes of the canyon.

Long Prairie GMU—The Long Prairie GMU consists of two fenced pastures on the north canyon rim between the edge of the rim and the Oregon-California border along Long Prairie Creek (Figure 9.7-1). This GMU does not border the Klamath River, but does include Long Prairie Creek. Ownership is primarily PacifiCorp, with some USFS land and some other private landowners. Currently, these pastures are grazed in the spring and the fall by about 200 cows. Use is rotated between the two pastures during the grazing period. These pastures have been designated as critical wintering habitat for deer (City of Klamath Falls, 1990). Additional grazing pressures by wild horses also may exist in this area (Korpela, 1995).

Spannaus GMU—The Spannus GMU is located on the south side of the Klamath River Canyon just south of the irrigated hayfields associated with the River GMU (Figure 9.7-1). The lands are owned by PacifiCorp and the USFS. PacifiCorp had a special use permit with the USFS for the use of its land. This GMU has approximately 120 cattle grazing it when permitted. The lack of adequate water sources and a fence along the southern boundary of the GMU pose the most significant management concerns. Cattle on these pastures commonly may venture onto adjacent USFS or Sierra Pacific lands located south of the GMU (Korpela 1995).

Iron Gate GMU—The Iron Gate GMU is located along the entire north and west sides of Iron Gate reservoir. A pasture associated with the GMU also is located south of Copco No. 2 village on the south side of the Klamath River (Figure 9.7-1). The northern boundary is the Oregon-California border, and much of the western boundary is the HRWA. Ownership is mixed, with land being held by PacifiCorp, the BLM, and several private landowners. These pastures are in deer winter range and abut Horseshoe Ranch. Shrubland management for winter deer forage is critical in these areas. Cattle grazing for long periods of time and in certain areas could be detrimental to deer winter range. In other areas of the study area, the BLM has indicated that late summer-fall livestock grazing in wedgeleaf ceanothus habitats can result in overutilization of shrub forage (BLM, 2000). This GMU is grazed in the fall, winter, and spring until cattle are moved in mid-May to the Soda Mountain BLM allotment or to pastures farther upriver. Because of the lack of fencing or other control over livestock in the GMU, cattle freely roam through the entire area (Korpela, 1995). However, PacifiCorp installed a fence at the mouth of Jenny Creek and in gaps of the rimrock as an improvement project to exclude cattle from the lower portion of the creek. Designation of Jenny Creek as an area of critical environmental concern has resulted in exclusion of livestock along the upper portions of the creek on BLM land in California (Korpela, 1995).

River GMU—The River GMU consists of all of the irrigated lands and associated small pastures in close proximity to the Klamath River upstream of Copco Lake and downstream of the Oregon-California border. Ownership is entirely PacifiCorp, with the exception of three inaccessible areas that belong to the BLM, USFS, and one private landowner. These irrigated pastures are the core lands for the grazing enterprises on the Upper Klamath River. The main concern with these grazing areas is riparian habitat degradation and water quality issues on the Klamath River (Korpela, 1995).

9.7.1.3 Others (USFS; Sierra Pacific)

Two other allotments exist near the study area that are not managed by the BLM. These include a small piece of the Klamath National Forest labeled as the Beswick allotment, and a larger section of Sierra Pacific land referred to as the Black Rock allotment. Currently, both of these properties are grazed by cattle owned by the leasee of the Beswick Ranch. The lands border the Spannaus GMU to the south (Figure 9.7-1)

9.7.2 Field Observations

The following sections describe observations of grazing evidence and summarize upland and riparian plot data. Locations of grazing evidence are summarized in Figure 9.7-2.

9.7.2.1 Upland Vegetation Condition

A total of 98—33.2 percent—of the 295 general vegetation plots sampled as part of the vegetation characterization study (Section 2.7) had some sign of grazing activity (Table 9.7-3). There were 22 plots (7.5 percent) that were heavily grazed. The Iron Gate and Fall Creek Project sections had the highest percentage of plots with signs of grazing—51 and 57 percent, respectively. However, the Iron Gate-Shasta and Copco No. 2 bypass segments had a greater percentage of plots with heavy grazing sign—23 and 16 percent, respectively.

Figure 9.7-2. Evidence of grazing in study area.

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Figure 9.7-2. Evidence of grazing in study area.

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Table 9.7-3. Percent of grazed upland plots by Project section.

Project Section	Number of Plots with Grazing Evidence	Total Number of Plots	Percent of Plots with Grazing Evidence
Iron Gate-Shasta	9	22	40.9
Iron Gate	19	37	51.4
Fall Creek	12	21	57.1
Copco No. 2 Bypass	8	19	42.1
Copco Reservoir	11	39	28.2
J.C. Boyle Peaking Reach	26	72	36.1
J.C. Boyle Bypass	0	22	0.0
J.C. Boyle Reservoir	3	21	14.3
Keno Canyon	1	11	9.1
Keno Reservoir	7	21	33.3
Link River	0	10	0.0
Total	**98**	**295**	**33.2**

As expected, irrigated hayfield and pasture plots had the highest percentage of plots with grazing evidence—89 percent (Table 9.7-4). Of the 21 annual grassland plots, 85.7 percent showed signs of recent or current grazing (Table 9.7-4). Other habitat types showing a high percentage of grazed plots include palustrine scrub-shrub wetland, montane hardwood-oak/juniper, and sagebrush/rabbitbrush (Table 9.7-4). Mixed chaparral, annual grassland, perennial grassland, and pasture plots all had higher than average occurrences of heavy grazing.

It should be noted that the evidence of even heavy grazing does not necessarily mean a site is in an unhealthy or non-functioning overall condition, only that there is a potential of such conditions. Also, because observations were made during the spring, summer, and fall of 2002, they may not account for the condition present during the wettest time of year or during time of heaviest grazing.

Table 9.7-4. Percent of grazed plots by cover type.

Habitat Grouping	Cover Type	Number of Plots with Grazing Evidence	Total Number of Plots	Percent of Plots with Grazing Evidence
Upland Deciduous				
	Montane hardwood-oak	9	25	36.0
Upland Deciduous/Conifer				
	Montane hardwood-oak/conifer	4	17	23.5
	Montane hardwood-oak/juniper	9	20	45.0

Table 9.7-4. Percent of grazed plots by cover type.

Habitat Grouping	Cover Type	Number of Plots with Grazing Evidence	Total Number of Plots	Percent of Plots with Grazing Evidence
Conifer Forest				
	Ponderosa pine	1	14	7.1
	Lodgepole pine	0	1	0.0
	Juniper	3	11	27.3
	Klamath mixed conifer	0	6	0.0
Upland Shrub				
	Rabbitbrush	1	2	50.0
	Sagebrush	2	4	50.0
	Mixed chaparral	11	30	36.7
Upland Herbaceous				
	Annual grassland	18	21	85.7
	Perennial grassland	5	13	38.5
Agriculture and Developed				
	Irrigated hayfield/pasture	8	9	88.9
Wetland				
	Emergent wetland	9	25	36.0
	Forested wetland	2	20	10.0
	Palustrine scrub-shrub wetland	7	16	43.8
Riparian				
	Riparian deciduous	5	19	26.3
	Riparian grassland	1	12	8.3
	Riparian mixed deciduous/coniferous	1	5	20.0
	Riparian shrub	1	13	7.7
Barren Habitats				
	Talus	0	4	0.0
	Exposed rock	0	6	0.0
Aquatic Habitats				
	Riverine unconsolidated shore	1	2	50.0
Total		**98**	**295**	**33.2**

9.7.2.2 Riparian Vegetation Condition

Evidence of grazing was evaluated at the 86 riparian/wetland sampling sites distributed along Project reservoirs and river reaches (Section 3.7). Data were collected on any past or current grazing that was observed. In total, 37.2 percent of all riparian transects had evidence of cattle grazing (Table 9.7-5). Sections of the study area where plot grazing observations were above average included the Iron Gate-Shasta, Iron Gate reservoir, Fall Creek, and J.C. Boyle peaking reach (mostly downstream of the Oregon-California border). Heavy grazing was recorded in 11.6 percent of all riparian plots. The downstream portion of the J.C. Boyle peaking reach and the northern shoreline of Iron Gate reservoir both contained higher percentages of plots with heavy grazing observed (28.6 percent and 27.3 percent, respectively) than the overall average of 11.6 percent. In most areas, the impacts in riparian areas were limited to short sections of shoreline ("water gaps") where cattle access the river or reservoirs for water. Along the Beswick Ranch in the J.C. Boyle peaking reach, riparian fencing installed by PacifiCorp has reduced impacts. Nonetheless, there currently are several sites where banks are devoid of vegetation, bank erosion is occurring, and riparian shrubs have been significantly browsed or trampled by cattle. Sites where grazing at least contributes to the current riparian vegetation condition are shown in Figure 9.7-2.

Table 9.7-5. Percent of grazed riparian sites by Project section.

Project Section	Grazed Sites	Total Number of Sites	Percent of Sites with Grazing Evidence
Iron Gate-Shasta	11	20	55.0
Iron Gate Reservoir	5	11	45.5
Fall Creek	1	1	100.0
Copco No. 2 Bypass	0	1	0.0
Copco Reservoir	2	10	20.0
J.C. Boyle Peaking Reach	8	14	57.1
J.C. Boyle Bypass	0	3	0.0
J.C. Boyle Reservoir	3	9	33.3
Keno Canyon	0	4	0.0
Keno Reservoir	2	10	20.0
Link River	0	3	0.0
Total	**32**	**86**	**37.2**

9.8 DISCUSSION

The following sections describe existing conditions referring to allotment information and PacifiCorp data listed in Section 9.7, as well as probable trends in conditions in the study area.

9.8.1 Characterization of Existing Conditions

There are 2,987 acres (1,209 ha) of upland, riparian, and wetland habitat within the existing FERC Project boundary that are in an existing grazing allotment or GMU. Within the terrestrial resources study area, approximately 26,206 acres (10,605 ha) are in grazing allotments. Approximately 33 to 38 percent of the upland and riparian plant communities had evidence of grazing. However, it should be noted that the evidence of even heavy grazing does not necessarily mean a site is in an unhealthy or non-functioning overall condition, only that there is a potential of such conditions.

An analysis of noxious weed occurrence relative to grazing evidence is presented in Section 8.7 and indicates that only in the upland herbaceous vegetation communities is there more than 30 percent of plots that had evidence of both grazing and presence of at least one noxious weed species (approximately 50 percent of the plots). In these grassland areas, where historical grazing levels have been high, approximately 71 percent of the plots had noxious weeds, of which, about 70 percent also showed evidence of recent grazing. In juniper, deciduous woodland, mixed forests, and shrubland general habitats, between 26 and 44 percent of the plots that had noxious weeds had evidence of recent grazing. In conifer forests, about 61 percent of the plots had weeds, but none of the plots had evidence of recent grazing. Therefore, it is clear that there are probably a number of factors (past and present) that affect weed distribution and that grazing may contribute, but does not necessarily result in the spread of noxious weeds in all habitats or locations.

The grazing of livestock is argued to have a greater influence on native ecosystems than most other forms of disturbance (Madany and West, 1983). Livestock grazing has been occurring on the Klamath River since the late 19th century (BLM, 1996). However, the Taylor Grazing Act of 1934 began to increase public awareness of the pressures that livestock were putting on fragile natural ecosystems. Before the act went into effect, there were no controls on grazing on federal lands. Currently, BLM allotments are grazed one fifth as much as they were in the 1930s and 1940s when grazing was at its peak in the study area (BLM, 1996). The following sections outline the effects of grazing on upland and riparian habitats as well as local wildlife species in the Klamath River study area.

9.8.1.1 Assessment of the Effect of Grazing on Upland Plant Communities

Decades of heavy grazing have significantly altered upland plant communities throughout the study area. Species composition of plant communities are significantly affected by livestock in two ways: (1) active selection by herbivores for or against a specific taxon, or (2) differential vulnerability of plant species to grazing or trampling (Fleischner, 1994). In some areas, increased grazing pressure has led to structural changes in forested habitats by decreasing grass competition and aiding the regeneration of conifer seedlings (BLM, 1996). Forested areas with higher numbers of young trees result in more fuel for high-intensity stand-replacement wild fires, and a higher likelihood of shade tolerant species becoming dominant (BLM, 1996).

PacifiCorp's data indicate that approximately 33 percent of upland plots have evidence of grazing and are likely affected to some degree. However, these data do not necessarily indicate that that all grazed areas are in poor condition. In recent years, the levels of grazing have been reduced significantly on BLM and PacifiCorp lands and, in some areas, may allow for improvement in range conditions. Korpela (1995) indicated that PacifiCorp GMUs currently are grazed at levels well below the overall carrying capacity. The BLM also indicated that grazing pressure on its Edge Creek allotment currently is not a significant factor in the spread of noxious weeds, but that historical levels clearly contributed to the existing problem (BLM, 2000).

Other agricultural practices related to grazing, such as irrigation, can greatly influence plant communities. Some of the pastures grazed under PacifiCorp's leases produce only about 50 percent of their capability when there is inadequate or no irrigation (Korpela, 1995).

Upland areas in the study area where grazing impacts interact with Project-related operation and maintenance activities include: the FERC transmission line ROW along the north side of Iron Gate reservoir, which is managed for early-successional stage vegetation; and uplands surrounding Project recreation facilities and Copco No. 2 village facilities. In these areas, periodic vegetation control and grazing combine to reduce vegetative cover.

9.8.1.2 Assessment of the Effect of Grazing on Riparian Plant Communities

In the summer, livestock seek shade and greener forage that exists in riparian zones. Historically, livestock grazing near the study area focused on riparian areas (BLM, 1996) that resulted in overgrazing and trampling of herbaceous and shrub vegetation. Even though stocking levels have been reduced compared to historical levels, riparian plant communities in the study area still have more grazing pressure than do most upland areas (Section 9.7.2.2). Up to 57 percent of all riparian sites in the J.C. Boyle peaking reach and Iron Gate-Shasta segments had evidence of grazing. No evidence of grazing was found in the Link River, J.C. Boyle bypass, Copco No. 2 bypass, and Keno Canyon riparian sampling sites.

The historical grazing cycle in riparian areas has caused major changes in water quality and plant species composition in many watersheds in the western states (BLM, 1997; Belsky et al. 1999).

During field studies, several riparian areas were noted that appeared to have above-average grazing pressure resulting in erosion or trampling (Figure 9.7-2). Of these sites, areas immediately along the river and reservoirs are affected by a combination of grazing and water level management. For example, there were several areas along J.C. Boyle, Copco, and Iron Gate reservoirs where livestock were observed grazing in shrub- or tree-dominated habitats immediately adjacent to the shoreline.

It has been argued that riparian recovery is dependent on total rest from any grazing pressure (Belsky et al. 1999; Belsky and Gelbard, 2000). To achieve this goal, PacifiCorp and the BLM have, in the last several years, installed fencing to exclude livestock from riparian and wetland areas. Some of these locations include the 0.5-mile (0.8-km) stretch of the Klamath River from the Spannus Ranch upstream to the old bridge, a wet meadow on the north canyon rim across from the Salt Caves, the Klamath Hot Springs area near the mouth of Shovel Creek, Jenny Creek, Long Prairie Creek above the north canyon rim, and near the Oregon-California border.

9.8.1.3 Assessment of the Effect of Grazing on Wildlife Populations

Cattle grazing has direct and indirect impacts on local wildlife communities. Indirect impacts to wildlife from cattle grazing in the study area include the potential for introduction and rapid take-over of invasive weeds, the trampling and overuse of sensitive habitats, and affected water quality. Wedgeleaf ceanothus, which is a significant component of the mixed chaparral habitat, is an important deer forage species in the study area (City of Klamath Falls, 1990). Mixed chaparral habitats had above-average incidences of grazing and heavy grazing (Table 9.7-4). Over-grazing in these habitats can lead to species composition changes and the reduction of deer winter forage (Belsky and Gelbard, 2000). Direct impacts on wildlife include competition with various herbivores for limited forage in winter months and trampling of individual amphibians, reptiles, mollusks, and small mammals.

Range fences can pose a direct threat to many wildlife species by entangling wildlife. However, no such evidence was found in any portions of the study area. Older fences often have four strands of barbed wire and inadequate spacing to allow deer (especially fawns) to safely cross. There are many miles of old barbed wire throughout the various grazing allotments. Dispersed among the fences are some sections that appear to have inadequate ground clearance for wildlife, although in most areas, there are places where the bottom strand of wire is elevated (or the ground has low spots) allowing wildlife to pass safely. All new range fences installed by PacifiCorp are constructed to meet design specifications with minimum ground clearance and a smooth bottom strand of wire.

Approximately 15,962 acres (6,460 ha) of upland habitat in the terrestrial resources study area were characterized as having a significant coverage of wedgeleaf ceanothus and birchleaf mountain mahogany, two important forage species for deer. Grazing occurs in most if not all of this land and could affect big game winter range habitat quality. As indicated previously, late-season grazing, if not managed properly, can directly decrease forage availability for elk and possibly deer in the chaparral habitat (BLM, 2000).

9.8.2 Characterization of Future Conditions

Historic livestock grazing across the study area clearly has affected upland and riparian plant communities, but in many areas the recent trend has been improved range management. The BLM reported that in the Edge Creek allotment, all drainages are either in Proper Functioning Condition (PFC) or, if not, are improving (BLM, 2000). Thus, there might be a gradual continued improvement in vegetation resources in riparian and upland sites where the recent improvements (fencing and reductions in grazing levels) implemented by the BLM and PacifiCorp will continue to allow degraded sites to become rehabilitated. Where proper grazing management is not implemented, grazing will be a detrimental factor in the conservation of natural plant communities. Implementing appropriate resource protection measures can go hand-in-hand with Project operations to enhance upland and riparian vegetation resources.

10.0 SPRING-ASSOCIATES MOLLUSK INVENTORY

10.1 DESCRIPTION AND PURPOSE

The Upper Klamath River drainage includes Upper Klamath Lake, its tributaries, and the Klamath River from the Link River dam to the Cascade Mountain crest. This area supports a great diversity of freshwater mollusks, including numerous endemic mollusk species that are confined to springs (Frest and Johannes, 1995, 1996, 1998). Project operations, grazing, and recreational activity have the potential to adversely affect these habitats. Results of the spring-associated mollusk inventory will be used in the license application to evaluate Project impacts on spring-associated mollusks. The purpose of this study was to document potential habitat for spring-associated aquatic mollusks (snails and bivalves) in the Klamath Hydroelectric Project study area.

10.2 OBJECTIVES

Objectives of this study are the following:

- Identify sites associated with springs and seeps in the study area that represent potential habitat for mollusk species.

- Coordinate with the TES species surveys to document S/M mollusks on federal land near the Project.

- Provide data needed to assess the potential effects of reservoir water level management, instream flows, maintenance activities, and recreational development on mollusk species.

- Provide information that can be used to develop PM&E measures.

10.3 RELICENSING RELEVANCE AND USE IN DECISIONMAKING

Springs provide unique habitat for numerous endemic mollusk species (Frest and Johannes, 1995 and 1996). These habitats can be adversely affected by Project operations, grazing, and recreational activity. In addition, several freshwater mollusk species occur in aquatic habitats. PacifiCorp will use this study in combination with the vegetation mapping; TES and S/M species surveys; fisheries studies; water quality assessment; grazing assessment; and amphibian and reptile surveys to evaluate Project impacts in the license application.

10.4 METHODS AND GEOGRAPHIC SCOPE

The study area for the Spring-Associated Mollusk Inventory was the same as the study area for the plant community mapping study (Section 2.0), but surveys focused on springs potentially affected by Project operations. The inventory of spring habitats focused on the study area, which included the following areas:

- A 0.25-mile-wide (0.4- km-wide) buffer around the Project facilities, reservoirs, roads, associated transmission lines, and the river reaches from Link River to Iron Gate dam

- The riparian/wetland communities along the Klamath River from Iron Gate dam to the mouth of the Shasta River

In addition, springs encountered in the study area (PacifiCorp lands and the J.C. Boyle Canyon outside of the 0.25-mile-wide [0.4-km-wide] buffer) also were included. The Spring-Associated Mollusk Inventory consisted of the following primary tasks:

- Literature Review - The available literature pertaining to aquatic mollusks potentially occurring in the study area was reviewed and summarized. Information on the Oregon portion of the study area was derived from the work of Frest and Johannes (1996, 1998, 2000, 2002). Aquatic mollusk information for the California portion of the Klamath basin was gathered from the CDFG (Taylor, 1981). The information available for the Oregon portion of the basin included site-specific data and, in some cases, multiple years of sampling. The information obtained for California (Taylor, 1981) is not site-specific and is more generalized in nature.

- Mapping - Preliminary data on spring locations were obtained from the vegetation cover type mapping (see Section 2.0) and the BLM, USGS, and other sources. In addition, all records of mollusks in the study area available from the BLM, USFS, and the ONHP were mapped as a data layer in the Project GIS. Springs discovered during field investigations were documented using the GPS and added to the mollusk GIS layer.

- Inventory - Protocol mollusk surveys for species listed as S/M under the Northwest Forest Plan (USFS and BLM, 2001) were not conducted at springs in the study area as part of this study. However, biologists did document presence/absence of aquatic mollusks in all springs visited as part of other field surveys. Species were not identified or collected. In addition, the current condition of springs was documented and any impacts from hydrology, recreation, grazing, or other land uses were noted.

10.5 RELATIONSHIP TO REGULATORY REQUIREMENTS AND PLANS

This study will aid the BLM and USFS in meeting aquatic conservation strategy objectives under the Northwest Forest Plan (USFS and BLM, 2001) and meet S/M species requirements under the Northwest Forest Plan.

10.6 TECHNICAL WORK GROUP COLLABORATION

Two draft versions of the study plan for the spring-associated mollusk inventory were submitted for stakeholder review and comment. Meetings with stakeholders in December 2001, January 2002, and March 2002 were also conducted to discuss various elements of this study. Comments were received from stakeholders that included suggested modifications to the scope of the study plan, or that requested additional studies or study tasks. These comments were reviewed and, in most instances, the study plan was revised to address requested modifications and additional study tasks. Stakeholder comments and requests have been resolved.

Note that stakeholders requested a mussel/filter feeding mollusk study to inventory in-river species. The aquatic mollusks associated with the Klamath River are being addressed to some extent in Section 11.7 of the Water Resources Final Technical Report.

10.7 STUDY OBSERVATIONS AND FINDINGS

The Klamath River basin is a highly diverse region for freshwater mollusk species. Aquatic mollusks may be found in lotic and lentic habitats, with springs containing the most diversity and endism of species. The Upper Klamath River drainage contains 73 mollusk species, including nine species with special status (Frest and Johannes, 1998). Much of this diversity can be attributed to the continuance of Upper Klamath Lake as a Great Basin pluvial lake (Frest and Johannes, 1998, 2002). To add to the evolutionary complexity of this ancient lake system, it is thought that a connection to the Columbia River basin, the Sacramento River system, and the Rogue/Umpqua basin existed sometime in the past (Frest and Johannes, 1998, 2000).

10.7.1 Project Area Mollusk Fauna

Based on literature review, 37 species of aquatic mollusks have been identified within or adjacent to the Project (Frest and Johannes, 1998; Taylor, 1981) (Table 10.7-1). Species composition varies among the river reaches. Highly diverse and endemic populations are associated with springs, which are found adjacent to lotic habitat (spring runs), in the river in the form of seeps (riverine), or as large groundwater accretions within lentic habitats. Endism occurs in the generas *Fluminicola, Juga, Lyogyrus, Pyrgulopsis, Vorticifex, Lanx,* and *Carinifex* (Frest and Johannes, 1998). Less disturbed tributary systems, such as Fall and Jenny creeks in the mid-Klamath River basin contain high numbers (six) of endemic species from the genera *Juga* (Frest and Johannes, 2000). Of the 37 species, eight species are associated with springs (Table 10.7-1). Two of the spring-associated mollusks—*Fluminicola* n. sp. 3 and *Prygulopsis* n. sp. 1—have been identified as in need of some form of protective status.

Distribution of aquatic mollusks in the Klamath River basin has been obtained from sampling that occurred from 1995 through1998 by Frest and Johannes and from earlier work from Taylor (1981) in California (Table 10.7-1). Site identification numbers are available from the work performed by Frest and Johannes (1998, 2000). Taylor's work is presented with less detail and is based only on presence in the basin, with no site-specificity identified. Information collected by Frest and Johannes provides a detailed account of aquatic mollusk distribution and diversity in the Oregon portion of the Klamath River basin. Aquatic mollusks in the California reaches of the Klamath River have not been as well documented. Although the information for the California section is not as robust, a general understanding of the aquatic mollusk faunal distribution can be obtained from the literature. An assessment of aquatic bivalves was conducted in 2003 and is summarized as part of the aquatic resources studies.

In terms of spring-associated species, Frest and Johannes (1998) found *Juga* (Oreobasis) and *Prygulopsis* n. sp. 1 in spring and seep habitats along the western shoreline of the Link River, a short distance upstream of the West Side powerhouse. In the J.C. Boyle ramped reach, *Fluminicola* n. sp. 3, *Gyraulus parvus*, *Juga* (Oreobasis), *Pisidium variable*, and *Stagnicola montanensis* were documented (Frest and Johannes, 1998). J. (Oreobasis) also was found in the Keno River reach in riverine habitat (Frest and Johannes, 1998). Frest and Johannes (1998) reported 16 sites along the Link River with mollusks. Log fleeting and lumber mills along Lake Ewauna probably eliminated historically diverse mollusk habitat in this area (Frest and Johannes, 1998). A series of about six springs near Link River-Lake Ewauna provides refuge and is the reason that mollusks (*Juga* and *Pyrgulopsis*) survive (Frest and Johannes, 1998).

Some general information on California spring-associated mollusk occurrence is available (Taylor, 1981). *Juga acutifilosa* and *J*. (Oreobasis) *nigrina* were reported in the Jenny Creek drainage, along with various river-associated species in other portions of the Klamath River basin. *J*. (Oreobasis) *nigrina* also was documented in the Fall Creek drainage by Frest and Johannes (2000). Taylor (1981) reported *J. acutifilosa* from Shoat Springs, which is associated with Spring Creek, a tributary of Jenny Creek.

Table 10.7-1. Freshwater mollusk distribution: locations within and adjacent to PacifiCorp's Klamath Hydroelectric Project.

Taxon Name	Protective Status	Upper Klamath Lake			Link River (riverine habitat)								Link River (spring habitat)						Keno Canyon (riverine habitat)			J.C. Boyle Peaking Reach (river habitat)		J.C. Boyle Peaking Reach (spring habitat)								Fall Creek Drainage**							Klamath River Basin (California)***
		220[2]	221	222	219	223	218	216	217	211	130	6	178	187	212	213	214	215	100	225	11*	26	10	11	12	13	14	131	132	188	224	10	52	65	96	440	442	443	NA
Anodonta oregonensis	Sp, E																																						X
Carinifex ponsonbyi	NA																																						X
Fluminicola n. sp. 1	Sp, E, ROD	X				X	X				X																												
Fluminicola n. sp. 3	Sp, E, ROD																								X														
Fluminicola n. sp. 10	NA																															X	X	X	X	X	X	X	
Fluminicola n. sp. 11	NA																															X		X	X		X	X	
Fluminicola n. sp. 12	NA																															X		X	X		X	X	
Fluminicola n. sp. 13	NA																															X		X	X	X	X	X	
Fluminicola n. sp. 14	NA																															X	X		X	X	X	X	
Fluminicola n. sp. 15	NA																															X		X		X	X	X	
Gonidea angulata	W[1]																																						X
Gyraulus parvus	NA			X																									X										
Helisoma newberryi	NA																																						X
Helisoma occidentale depressum	NA																																						X
Juga (Oreobasis)	NA																X	X			X		X	X	X	X	X												
Juga acutifilosa	NA																															X							X (Shoat Springs-Jenny Cr.)
Juga O. nigrina	NA																															X	X	X	X	X	X	X	X
Lanx alta	NA																																						X
Lanx klamathensis	Sp, E					X	X			X												X	X																
Lyogyrus n. sp. 3	Sp, E					X	X					X																											
Margaritifera falcata	W[1]																																						X
Physella lordi	NA				X																																		
Physella gyrina	NA										X								X																				
Pisidium ultramontanum	Sp, E																																						X
Pisidium variabile	NA																											X											
Pisidium punctatum	NA																																						X
Planorbella subcrenata	NA			X																																			
Promenetus exacuous	NA			X																																			
Prygulopsis n. sp. 1	Sp, E											X			X	X	X	X																					
Pyrgulopsis archimedis	Sp, E											X																											X (may be extinct in California)
Sphaerium sp.	NA											X																				X	X	X					
Sphaerium patella	NA																																						X
Stagnicola montanensis	NA																												X										
Valvata humeralis	NA			X				X																															
Vorticifex effusus dalli	NA					X		X	X	X	X	X																											
Vorticifex effusus effusus	NA																		X																				X
Vorticifex klamathensis klamathensis	Sp, E	X	X			X	X	X	X	X	X	X																											

* Spring habitat.
** Data obtained from Frest and Johannes (2000).
*** Data obtained from Taylor (1981) - sample locations not available.
[1]Listing considered, but rejected - http://oregonstate.edu/ornhic/T&E_Inverts.pdf (ONHP, 2003).
[2]Numbers in this row correspond to Frest and Johannes (2000) site numbers.

Key
NA Does not apply.
W Watch list (Frest and Johannes, 1995).
Sp Species of Special Concern (Frest and Johannes, 1993).
E Recommended for federal Endangered Species Act (ESA) listing as endangered (Frest and Johannes, 1993, 1995).
ROD Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl (USFS and BLM, 1994).

10.7.2 Project Area Spring Habitat

A combination of mapped information obtained from the USGS, BLM, and Frest and Johannes (1998), along with observations in the field during 2002, indicate that there are approximately 180 individual sites in the study area that have spring or seep habitat (which includes several sections of intermittent tributary stream channels that were surveyed by the BLM) (Figure 10.7-1). Of these, 53 (29 percent) were visited at least once during the 2002 relicensing survey for amphibian/reptile, TES wildlife, or vegetation (Table 10.7-2). Approximately 107 of the springs are located in the J.C. Boyle peaking reach in the study area. There are few springs between the J.C. Boyle bypass and Lake Ewauna, but 18 sites occur near the Link River or along the outlet of Upper Klamath Lake.

Table 10.7-2. Summary of spring habitat visitation during 2002.

Project Section	Total Springs	Visited in 2002	
		No	**Yes**
Iron Gate-Shasta	5	4	1
Iron Gate Reservoir	15	13	2
Copco No. 2 Bypass	1	0	1
Fall Creek	8	1	7
Copco No. 1 Reservoir	11	1	10
J.C. Boyle Peaking Reach	107	79	28
Long Prairie Parcel	7	4	3
J.C. Boyle Bypass	2	1	1
Keno Reservoir	2	2	0
Keno Canyon	1	1	0
Link River	18	18	0
Upper Klamath Lake	3	3	0
Grand Total	**180**	**127**	**53**

Of the 180 springs in the study area, approximately 74 were surveyed for mollusks by the BLM in 2001 (BLM, unpublished data), Frest and Johannes (1998), or during 2002 relicensing studies (Table 10.7-3). Most of the surveyed sites were sampled by the BLM or Frest and Johannes (1998) and are located in the J.C. Boyle peaking reach or near the Link River. However, some sites along the Klamath River from between the lower J.C. Boyle peaking reach to below Iron Gate dam were examined during relicensing studies that were not covered by other surveys. Of the surveyed sites, 45 (61 percent) had at least one species of aquatic mollusks. In addition, mollusks (probably *Juga* sp.) were documented in Fall Creek upstream and downstream of the diversion dam.

The vast majority of the springs known to occur in the study area are located well away from the affected reservoirs and river reaches. There are 65 springs located in areas where there is no obvious direct impact from hydrology, roads, recreation, vegetation management, or extensive livestock grazing. However, the other 115 sites had at least one type of human-induced impact that is potentially degrading habitat for spring-associated mollusks and other wildlife.

Table 10.7-3. Summary of spring mollusk observations in the Klamath Project study area.

Portion of Study Area	Total Springs	Not Surveyed	Mollusks Not Found	Mollusks Present
Iron Gate-Shasta	5	4	1	0
Iron Gate Reservoir	15	13	2	0
Copco No. 2 Bypass	1	0	0	1
Fall Creek	8	3	4	1
Copco No. 1 Reservoir	11	7	2	2
J.C. Boyle Peaking Reach	107	72	16	19
Long Prairie Parcel	7	6	1	0
J.C. Boyle Bypass	2	1	1	0
Keno Reservoir	2	0	2	0
Keno Canyon	1	0	0	1
Link River	18	0	0	18
Upper Klamath Lake	3	0	0	3
Grand Total	**180**	**106**	**29**	**45**

Source: BLM unpublished data; Frest and Johannes (1998); EDAW unpublished data.

A combination of site inspection and review of aerial photos and maps indicates that approximately 41 of the springs/seeps/intermittent stream channels included in this inventory are at least potentially affected by river hydrology or influenced by leakage from upslope project canals/pipelines (Figure 10.7-2). Of these, 14 sites were identified by Frest and Johannes (1998) along the Link River floodplain. In the Link River segment, the hydrologically affected springs range from 0 to 80 feet (0 to 25 m) from the river shoreline. Fourteen of the springs in the J.C. Boyle peaking reach are located on or just above the floodplain and are potentially affected by fluctuating water levels and the influence of warm, nutrient-rich water of the river. The 14 hydrologically affected springs in the J.C. Boyle peaking reach ranged from 0 to 273 feet (0 to 83 m) from the river channel. Analysis of the instream flow habitat data indicates that the wetted river channel fluctuates by between 24 (7 m) and 67 feet (20 m), depending on habitat and section of river, between flows of 400 and 3,000 cfs (11.3 to 85.0 m^3/sec), the range of flows that potentially occurs as a result of changes in J.C. Boyle powerhouse operations. None of the springs appears to be immediately in the varial zone, but the outflow from each spring flows through the varial zone. Thus, the primary effect of the Project is to change the length of the small outflow streams diurnally. In most cases, this would affect between 12 and 33 feet (3.5 and 10 m) at any one spring outflow.

There were five sites in the Fall Creek segment that are directly affected by and may be entirely dependent on seepage from the Fall Creek Canal. The J.C. Boyle bypass and Keno reservoir had two and one springs, respectively, that are potentially affected by river hydrology. The two J.C. Boyle bypass springs were 7 and 33 feet (2 and 10 m) from the river channel, respectively. Virtually all of the springs potentially affected by hydrology outflow are above the river/reservoir level, but have lower elevation spring run-out habitat that is inundated or saturated by peak river discharges during typical Project operations.

Figure 10.7-1. Spring mollusk habitat inventory.

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11 x 17

front

Figure 10.7-1

back

Figure 10.7-1

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front

Figure 10.7-1

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back

Figure 10.7-2. Spring habitat potentially impacted by hydrology.

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11 x 17

front

Figure 10.7-2. Spring habitat potentially impacted by hydrology.

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Figure 10.7-2

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Front

Figure 10.7-2

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Back

Surveys were conducted at all but seven of the potentially hydrologically affected springs. Mollusks were documented in 23 of 34 hydrologically affected springs, although a number of sites had only riverine-associated species (Frest and Johannes, 1998).

There were 47 springs where livestock grazing potentially affects habitat. Twenty-six of these sites were in the J.C. Boyle peaking reach segment; seven additional springs affected by grazing were documented on the PacifiCorp-owned Long Prairie parcel north of the head of Copco No. 1 reservoir. Eight of the 15 springs near Iron Gate reservoir are in areas where grazing likely has some effect, while seven are in rimrock areas that are not grazed. The degree of degradation from grazing varied from minor loss of vegetation to much more severe trampling, erosion, and water quality impacts.

There were nine springs, all in the J.C. Boyle peaking reach, that are located close to recreation sites or trails and may have impacts from pedestrian foot traffic or off-road vehicles. Road crossings or culverts were associated with 31 springs, either crossing just upslope or downslope of the spring. There were ten springs in the Copco No. 1 reservoir segment that were near transmission line (non-FERC) ROW and/or roads.

10.8 DISCUSSION

The following sections summarize the existing and future conditions of mollusk habitat in relation to Project operations.

10.8.1 Characterization of Existing Conditions

Overall populations of mollusks are thought to be declining because of habitat degradation and loss of suitable habitat. The majority of freshwater mollusks are sensitive to pollution (Burch, 1989). Two of the spring-associated genera—*Fluminicola* sp., and *Pyrgulopsis* sp.—have been identified as "cold water biota" along with several other species that occur in riverine habitat (Frest and Johannes, 1998). Distribution of cold water biota aquatic mollusk species in the Klamath River basin is limited to areas with unpolluted, cold, clear, flowing water. These species are intolerant of impoundments, turbid water, slack water, herbicides, pesticides, nitrates or phosphates, high turbidity, unstable substrates, and frequent water surface fluctuations.

Determining impacts to spring-associated species can be approached at the microhabitat level. Habitat requirements for the cold water biota do not seem to directly apply to riverine and reservoir Project areas because of the compromised water quality that is typical during the dry/warmer portions of the year. Although overall conditions required by these species may not be found in large portions of the Klamath River system, these conditions are present in areas with spring refugia, such as the J.C. Boyle bypass and adjacent springs. These highly localized microhabitats provide the clean, clear, cold, well-oxygenated water required by the species recognized as cold water biota. Protection of the riverine springs and adjacent spring runs will continue to provide suitable habitat for these species.

There are as many as 37 springs that are closely associated with reservoir and river shorelines and may warrant additional monitoring and protection measures to minimize future impacts from water level fluctuations, recreation, livestock grazing, and other activities. The numerous cold-water refugia that occur in the study area likely provide the last remaining habitats for spring-associated mollusks. This is especially true as development and land uses in the surrounding area continue to degrade habitat.

Within the J.C. Boyle peaking reach during the summer, daily ramping results in a mostly unvegetated varial zone that extends from exposed cobble/boulder habitat into part of the Klamath River aquatic habitat. The springs that occur immediately upslope of the river have decreased spring run-out habitat as a result of this daily fluctuation. However, this impact is limited to the varial zone where fluctuation occurs. Throughout much of the study area, grazing has had and continues to have adverse effects on vegetative cover, water quality, and substrate conditions in a large number of springs. This is especially true downstream of the Oregon-California border. Recreational activity does not affect many of the springs. Only at Frain Ranch were springs noted to be significantly affected by recreational activity.

10.8.2 Characterization of Future Conditions

In the future, spring habitat for mollusks and other wildlife will continue to decline in quality from the cumulative impacts of hydrology and detrimental land uses. There are several springs/wetlands that have been fenced in the recent past to exclude livestock.

These protected sites can be restored, but if native mollusk species have been extirpated, re-colonization is unlikely because of the isolated nature of spring habitat and the limited mobility of mollusks.

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