United States Department of the Interior

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M.15 FERC
Big Fork Hydroelectric Project

May 28, 2003

Ms. Magalie R. Salas
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Subject: U.S. Fish and Wildlife Service's Biological Opinion for the Big Fork Hydroelectric Project (FERC Project No. P-2652-007).

Dear Ms. Salas:

This is in response to your letter dated April 12, 2002, requesting formal consultation on re-licensing of the Big Fork Hydroelectric Project (FERC Project No. P-2652-007) (Project) regarding effects on the federally threatened bull trout (*Salvelinus confluentus*). PacifiCorp, located in Portland, Oregon is the applicant for this hydroelectric license. This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion on those effects of the Columbia River population segment of bull trout, in accordance with Section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq.*). On November 29, 2002, the Service published a proposed rule to designate critical habitat within the historic range of bull trout (67 FR 71236). The Swan River below the outlet of Swan Lake to its confluence with Flathead Lake was not proposed as critical habitat therefore none will be affected, and an evaluation to determine whether the Project is likely to result in destruction or adverse modification of proposed critical habitat is not necessary.

This biological opinion is predominately based on information provided in the FERC's July 2002 *Final Environmental Assessment for Hydropower License (FEA)*. Several informal and formal meetings and conference calls involving the stakeholders were conducted throughout preliminary consultation which started in March 2001. The FERC provided supplementary information to the Service throughout the consultation phase including a July 2, 2002, response to a Service request for additional information.

A complete administrative record of this consultation is on file on the Web at http://ferris.ferc.gov as well as in the Service's Kalispell Montana office. Should the FERC have any additional questions or concerns please contact Paul Hanna at (406) 758-6871.

Sincerely,

R. Mark Wilson

R. Mark Wilson
Field Office Supervisor

Enclosure

Copy to: AES, R-6, MS 60120 (Attn: Susan Linner)
USFWS, Kalispell, MT (Attn: Tim Bodurtha)
File Number 7759

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION
for
Bull Trout
Bigfork Hydroelectric Project
Bigfork MT
FERC No. 2652-007

Agency:	Federal Energy Regulatory Commission Washington, D.C.
Consultation Conducted by:	U.S. Fish and Wildlife Service Montana Field Office
Date Issued:	May 21, 2003

Consultation History

Throughout the late 1990's the Montana Department of Fish, Wildlife and Parks (MFWP) and the U.S. Fish and Wildlife Service (Service) worked together to help PacifiCorp develop a license application for the Bigfork Hydroelectric Project (FERC No. 2652). In August 2000, PacifiCorp submitted a final application for license of the Bigfork Hydroelectric Project (FERC No. 2652) to the FERC for consideration. On April 17, 2002, the FERC requested to initiate formal consultation on the effects to bull trout from the licensing of the Project. With their request they provided a Draft Environmental Assessment (DEA). On May 21, 2002, the Service informed the FERC that additional information was needed to properly initiate formal consultation on bull trout. The FERC responded on July 9, 2002, with information they determined to be the "best scientific information available." However, the Service determined that the information contained within the FERC's response did not contain all the available information regarding the effects from this project and requested an extension to the consultation so the Service would have time to gather the best scientific information available. That request was dated August 8, 2002. On August 28, 2002, the FERC denied our request for additional time. Subsequently, pursuant to 50 CFR section 402.14(c) the Service initiated formal consultation as stated in a September 18, 2002, letter to the FERC. The initiation date of July 9, 2002, used was based upon the Service's receipt of the FERC's additional information.

Biological Opinion

Description of the Proposed Action

The proposed action is to issue a 50-year license to PacifiCorp to operate and maintain the Big Fork Hydroelectric water power project (FERC No. 2652-007). The existing project consists of a 12-foot-high, 300-foot-long concrete diversion dam which creates an impoundment of 73 surface acres. Maintenance of the forebay including dredging has not been proposed. A water intake structure located adjacent to the dam feeds approximately 600 cubic-feet-per-second (cfs) (during maximum operation) into a 1 mile long intake canal. Manually cleaned trashracks located at the intake to the canal help prevent debris from going into the intake canal. The spacing on the trashracks is currently 3 inch center to center. Water then flows from the intake canal into either the powerhouse, which with three turbines, is capable of generating up to 4.5 Megawatts (MW), or into an overflow/bypass channel which returns the flow into the Swan River immediately upstream of the powerhouse. Several drain channels that lead down into the Swan River are located at various stages of the intake canal. Additionally, a closed fish ladder is located on the north side of the dam. The ladder was closed in the 1980s to prevent upstream migration of non-native fish such as lake trout (*Salvelinus namaycush*).

Water Diversion

The project has five non-consumptive water rights totaling 671.1 cfs. However, operational limitations on the existing powerhouse limit the amount of water diverted to 600 cfs. Any changes allowing the project to divert flows in excess of 600 cfs would require a license amendment. The operation of the dam is Run of the River (ROR) which means that any flows in excess of 600 cfs will go over the dam and into the Swan River below the dam (the bypass reach) and then on into Flathead Lake. FERC is proposing to license the Project to ensure that no less than 70 cfs or 100% of the Swan River flow, whichever is least, will be allowed to flow into the bypass reach throughout the year.

Recreational Flows
Additionally, a plan was developed in conjunction with various stakeholders to allow for recreational flows within the bypass reach during the summer months. This plan, contained within PacifiCorp's "Settlement Agreement Concerning Recreation Resources Related to the Relicensing of the Bigfork Hydroelectric Project (FERC No. 2652)" dated November 7, 2002 (Settlement Agreement), involves maintaining a minimum instream flow of 1,000 cfs during the Bigfork Whitewater festival held annually for a three day period sometime between May 15 and June 15. Additionally, for the first three years of the license the Settlement Agreement establishes instream flow between 5 pm and 9 pm every Wednesday during the months of July and August, equal to inflow into the project when inflow is between 800 and 1,500 cfs and instream flows of at least 1,500 cfs whenever inflow is greater than 1,500 cfs. If inflow is less than 800 cfs instream flow shall be maintained at a minimum of 70 cfs. The Settlement Agreement will be a part of the Project's Recreational Resource Management Plan which will be developed in consultation with MFWP and the Service.

Fish Screen Installment and Operation

PacifiCorp is proposing to install fish screens to reduce entrainment within the hydropower diversion canal. The screens will be installed immediately adjacent to the dam face on the south shore of the forebay. In its letter dated July 30 2001, PacifiCorp proposed to screen the intake of the diversion canal using screens designed to prevent the entrainment and impingement of juvenile (<3.5 inches) bull trout and westslope cutthroat trout. PacifiCorp designed its wedge-wire screens to have a maximum approach velocity of 0.8 feet-per-second with a maximum screen opening of 0.25 inches. The design includes three wedge-wire screen panels 14 ½ feet tall and 14 feet wide facing north and two panels 12 ½ feet tall and 14 feet wide facing east for a total screened surface area of 959 square feet. This design excludes a traditional trashrack; however, it does incorporate a floating log boom approximately 5-10 feet from the screened intake structure within the forebay. PacifiCorp has also proposed to manually clean the fish screens whenever debris accumulates on the screen face. Additionally, in conjunction with the fisheries agencies, they have proposed to develop an effectiveness monitoring plan to include an evaluation of manual cleaning efficacy.

Minimization Measures
PacifiCorp proposes the following measures to protect and enhance environmental resources that may be affected by the project:

- Continue to operate in an ROR mode.

- Continue to release a 70-cfs minimum flow to the bypassed reach from an existing notch in the dam's crest (a calibrated weir).

- Monitor the impoundment water level to confirm the 70-cfs minimum flow.

- Install fish screens on the project intake per PacifiCorp's conceptual fish screen design submitted to the Commission by letter dated July 24, 2001.

- Develop and implement a fish screen and canal operation, maintenance, and monitoring plan(s) in consultation with Service and Montana Fish, Wildlife & Parks (MFWP) to ensure that they are effectively performing within design parameters. Consider installing automatic trash rakes if monitoring indicates such devices are needed.

- In conjunction with the Service, biologists with MFWP, and other interested stakeholders, develop and implement a Recreation Resource Management Plan (RRMP) to include provisions consistent with the Settlement Agreement submitted to the Commission by letter dated November 12, 2002. This plan will include stream temperature monitoring in the bypassed reach during the whitewater feasibility study.

- Implement a Cultural Resources Management Plan (CRMP), including installation of interpretive signage at Pacific Park and re-evaluate the CRMP every 10 years.

- Develop and implement a flow monitoring plan in consultation with the Service, MFWP, and the American Whitewater Affiliation (American Whitewater). The flow monitoring plan would include PacifiCorp's proposal to monitor impoundment water levels, a contingency plan to ensure the continued release of 70 cfs, and a staff gage for independent flow verification and aide to whitewater boaters at the put-in site downstream of the diversion dam.

- Develop and implement a plan to stabilize eroded drain channels in consultation with the Service, Montana Department of Environmental Quality (MDEQ), and MFWP. Develop and implement a noxious weed control plan in consultation with the Service, MFWP, and the Flathead County Weed Control District.

Action Area

The Services' *Endangered Species Consultation Handbook* (Service and NMFS 1998) states that an "action area should be determined based upon consideration of all direct and indirect effects of the proposed action." The action area for the proposed project is the Swan River from the Ferndale Bridge downstream to Big Fork Bay on Flathead Lake; a reach approximately 2.5 miles in length with the upper 1.5 miles being impounded behind Bigfork Dam. Additionally, all lands owned by PacifiCorp, totaling 118 acres within Township 27 North, Range 31 West, Sections 31-33 and 36, (see Figure 1 of FEA) and all lands immediately adjacent to the Swan River within this reach are included in this action area. The action area ends at the mouth of Swan River where it enters Big Fork Bay, but does not include Big Fork Bay because effects on water quality from the operation and maintenance of the hydropower facility would be indistinguishable from effects on the lake environment.

STATUS OF THE SPECIES

The Columbia River Distinct Population Segment (DPS) of bull trout was listed as a threatened species pursuant to the Endangered Species Act, on June 10, 1998 (63 FR 31647) by the U.S. Department of Interior (USDI) (USDI 1998a). Subsequently, on November 1, 1999, with the listing of the Coastal-Puget Sound and St Mary-Belly River DPSs, the entire coterminous population of bull trout was listed as threatened (64 FR 58910) (USDI 1999) pursuant to the Act. This listing encompasses five recognized interim distinct population segments of bull trout defined as the: Klamath River, Columbia River, Jarbidge River, Coastal-Puget Sound, and St. Mary-Belly River. On November 29, 2002, a proposed rule was published listing critical habitat throughout the historic range of bull trout (67 FR 71236). While the action area is within the historic range of bull trout and is currently occupied by bull trout, the action area is not currently proposed as critical habitat for bull trout. The area is within the proposed Swan River Critical Habitat Subunit, however the proposed critical habitat is defined as waters upstream of the Swan Lake outlet. Additionally, the *Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan* (Service 2002) (Recovery Plan) identified that the action area falls within the Flathead Recovery Subunit contained in chapter 3 of the draft Recovery Plan.

Species Description

Bull trout is a federally threatened char, endemic to the Pacific northwest and western Canada. A member of the family Salmonidae, bull trout and dolly varden (*Salvelinus malma*) were previously considered the same species, however the American Fisheries Society in 1980 formally recognized bull trout as a distinct species from dolly varden (Robbins and others 1980 as cited in USDI 1998a). While occupying similar habitat in western Washington, there appears to be little evidence of introgression (Haas and McPhail 1991) between the two species.

Characteristics distinguishing the two species as well as a taxonomic description of bull trout are presented by Haas and McPhail (1991). Two of the most useful characteristics in separating the two species are the shape and size of the head (Cavender 1978). The head of a bull trout is more broad and flat on top, being hard to the touch, unlike Dolly Varden. Bull trout have an elongated body, which is somewhat rounded and slightly compressed laterally. The mouth is large with the maxilla extending beyond the eye and with well-developed teeth on both jaws and head of the vomer (none on the shaft). Although they are often olive green to brown with paler sides, color is variable with locality and habitat. Their spotting pattern is easily recognizable showing pale yellow spots on the back, and pale yellow and orange or red spots on the sides. Bull trout fins are tinged with yellow or orange, while the pelvic, pectoral, and anal fins have white margins. Bull trout have no black or dark markings on the paired fins and have opaque dorsal fins.

Historical and Current Distribution

Bull trout are native to North America and are distributed from 41° to 60° North latitude along the Cascade and Rocky Mountain ranges (Meehan and Bjornn 1991). South of the 49th parallel, bull trout occur mainly west of the continental divide in river systems that drain the Columbia River basin, with exceptions found in Montana and Oregon (Platts and others 1993). The historical range of bull trout was restricted to North America (Cavender 1978; Haas and McPhail 1991).

Genetic variation suggests an extended and evolutionarily important isolation between populations in the Klamath and Malheur basins and those in the Columbia River basin (Leary and others 1993). Populations within the Columbia River basin are more closely allied and are thought to have expanded from common glacial refugia or to have maintained higher levels of gene flow among populations in recent geologic time (Williams and others 1997). Bull trout are estimated to have historically occupied about 60 percent of the Columbia River basin (Quigley and Arbelbide 1997).

It is unlikely that bull trout occupied all of the accessible streams at any one time. Distribution of existing populations is often patchy even where numbers are still strong and habitat is in good condition (Rieman and McIntyre 1993; Rieman and McIntyre 1995). Habitat preferences or selection is likely important (Dambacher and Jones 1997; Goetz 1994; Rieman and McIntyre 1995) but more stochastic extirpation and colonization processes may influence distribution even within suitable habitats (Rieman and McIntyre 1995).

The Columbia River distinct population segment encompasses the entire Columbia River basin and all its tributaries, excluding the isolated bull trout populations found in the Jarbidge River. The Service recognizes 141 subpopulations in the Columbia River DPS within Idaho, Montana, Oregon, and Washington with additional subpopulations in British Columbia (USDI 1998a).

Bull trout are currently distributed throughout the Upper Columbia River geographical area (Kootenai, Flathead, Clark Fork, Blackfoot, Pend Oreille and Swan drainages). Bull trout are most widely distributed in the Swan, Blackfoot, Kootenai, and Clark Fork River basins. Bull trout may be found within the action area. The action area spans two Core areas; Flathead Lake Core Area and the Swan Lake Core Area (Service 2002).

Biological Status

Rangewide, populations are generally isolated and remnant. The Columbia River DPS has declined in range and numbers. Though still widespread, there have been numerous extirpations reported throughout the Columbia River basin. Migratory life histories have been lost or limited throughout the range (Goetz 1994; Jakober 1995; Montana Bull Trout Scientific Committee, 1998; Pratt and Huston 1993; Ratliff and Howell 1992; Rieman and McIntyre 1993, 1995) and fluvial bull trout populations in the upper Columbia River portion of the distinct population segment appear to be nearly extirpated. Resident populations existing in headwater tributary reaches are isolated and generally low in abundance (Thomas 1992). Bull trout in Flathead Lake and Lake Pend Oreille appear to be declining, while the Swan Lake adfluvial population appears to be the healthiest remaining population and is increasing.

Generally, where status is known and population data exists, bull trout populations in the entire Columbia River DPS are declining (Thomas 1992; Pratt and Huston 1993). Presently bull trout in the Columbia River basin occupy about 45 percent of their estimated historic range (Quigley and Arbelbide 1997). The Columbia River DPS is composed of 141 subpopulations, which indicates the level of habitat fragmentation and isolation. Of the 141 subpopulations, 75 are at risk of natural extirpation through physical isolation. Many of the remaining bull trout occur as isolated local populations in headwater tributaries, or in tributaries where the migratory corridors have been lost or restricted. Few bull trout local populations are considered "strong" in terms of relative abundance and subpopulation stability. Those few remaining strongholds are associated with large areas of contiguous habitats such as portions of the Snake River basin in Central Idaho, the South Fork Flathead River and the Swan River in Montana, and the Blue Mountains in Washington and Oregon (USDI, 1998a).

Life History Characteristics

Two distinct life-history forms, migratory and resident, occur throughout the range of bull trout (Pratt 1992; Rieman and McIntyre 1993). Migratory forms rear in natal tributaries for several years before moving to larger rivers (fluvial form), lakes (adfluvial or lacustrine form), or the ocean (anadromous) to mature (Goetz 1989; Brown 1992; Rieman and McIntyre 1993). Migratory bull trout may use a wide range of habitats ranging from first to sixth order streams and varying by season and life stage. Resident populations are generally found in small headwater streams where they spend their entire lives. Stream-resident bull trout occupy small, high-elevation streams. They rarely move and are seldom larger than 30 centimeters (Goetz 1989). Many "resident" local populations were once migratory, but now they only occupy remnants of their range.

Migratory bull trout become sexually mature from 4 to 9 years old (Shepard and others 1984). Most bull trout spawning occurs between late August and early November (McPhail and Murray 1979; Pratt 1992; Shepard and others 1984). Bull trout require a long period of time (over 220 days) from deposition of eggs until emergence. Hatching occurs in winter or early spring, and alevins may stay in the gravel for extended periods. Growth is variable with different environments, but first spawning is often noted after age four, and the fish may live 10 or more years (McPhail and Murray 1979; Pratt 1992; Rieman and McIntyre 1993). Bull trout can spawn in consecutive or multiple year cycles (Shepard and others 1984; Pratt 1992).

Juveniles may move upstream of reaches used by adults for spawning, presumably to forage in other accessible waters (Fraley and Shepard 1989). Although some individuals may spend their entire life in a small segment of a stream, most are highly migratory, traveling to headwater streams to spawn and later migrate back to larger stream segments or lakes to rear (McPhail and Murray 1979). Seasonal movements by adult bull trout may range up to 300 km as migratory fish move from spawning and rearing areas into overwinter habitat in the downstream reaches of large sub-basins (Shepard and others 1984).

Adfluvial bull trout mature in lakes or reservoirs and spawn in tributary streams. Fluvial forms have a similar life history as adfluvial forms, except they move frequently between mainstem rivers and smaller tributary streams. Juveniles remain between 1 to 6 years in nursery streams before migrating downstream to either rivers (i.e., fluvial forms) or lakes (i.e., adfluvial forms) (Fraley and Shepard 1989; Brown 1992).

Even though bull trout may move throughout whole river sub-basins seasonally, spawning and juvenile rearing appear to be limited to the coldest streams or stream reaches. The patterns indicate that spatial and temporal variation in climate may strongly influence habitat available to bull trout. While temperatures are probably suitable throughout much of the northern portion of the range, predicted spawning and rearing habitat are restricted to increasingly isolated high-elevation or headwater "islands" toward the south (Goetz 1994; Rieman and McIntyre 1995). Although bull trout may be present throughout large river sub-basins, spawning and rearing fish are often found only in a portion of available stream reaches.

Habitat Component Requirements

Rieman and McIntyre (1993) stated that bull trout appear to have more-specific habitat requirements than other salmonids. They list the habitat characteristics of temperature, cover, substrate composition, channel stability, and migratory corridors as important influences in bull trout distribution and abundance. In designating critical habitat, the Service identified the following primary constituent elements essential to the conservation of bull trout: Permanent water with low levels of contaminants, adequate water temperatures depending upon life stage, complex stream channels, adequate substrate to ensure spawning success, a natural hydrograph, groundwater sources, migratory corridors, an abundant food base and few or not predators or interbreeding non-native species (USDI 2002). Bull trout growth, survival, and long-term population persistence appear to be dependent upon these nine habitat characteristics. In general, it is believed bull trout need habitat providing cold, clean water, complex cover, stable substrate with a low percentage of fine sediments, high channel stability, and stream/population connectivity. Although bull trout may be present throughout large river sub-basins, spawning and rearing fish are often found only in a portion of available stream reaches. Shepard and others (1984) reported that only 28% of the available spawning reaches in the Flathead River system were used by bull trout for spawning.

Bull trout are strongly associated with various components of habitat complexity, including cover in the form of large woody debris, side channels, undercut banks, boulders, pools, and interstitial spaces in coarse substrate (McPhail and Murray 1979). Bull trout occupy a variety of habitat types during their life but are strongly associated with pools and large woody debris in the stream. Large pools, consisting of a wide range of water depths, velocities, substrates, and cover are characteristic of high-quality bull trout habitat (Watson and Hillman 1997). Bull trout typically spawn in cold, low-gradient second- to fourth-order tributary streams, over loosely compacted gravel and cobble having groundwater inflow (Shepard and others 1984; Brown 1992). Spawning sites also seem to be near cover (Brown 1992) such as logs, undercut banks, and boulders. Preferred bull trout rearing habitat occurs in small headwater and tributary streams. Juveniles (less than 100 mm) are primarily bottom-dwellers, occupying positions above, on, or below the bottom and require cold-water tributaries with good cover (rocks and debris) and relatively little streambed sediment. Fry may be found in shallow, slow, backwater side-channels and eddies (Shepard and others 1984).

As bull trout mature they move from slow backwater areas with large woody debris into deeper and faster water, such as runs and mainstream pools, but these pools are typically associated with large woody debris. Cover includes undercut banks, large woody debris, boulders, and pools which are used as rearing, foraging, and resting habitat, and protection from predators (MBTSG 1998). Deep pools also help minimize and moderate stream temperatures and offer refuge from warmer water temperatures during summer low-flow conditions. Stream temperatures and substrate types are especially important to bull trout. Spawning occurs in the upper reaches of clear streams in areas of flat gradient, uniform flow, and uniform gravel or small cobble. Spawning fish require hiding cover such as logs and undercut banks. Strict habitat requirements make spawning and incubation habitat for bull trout limited and valuable (Fraley and Shepard 1989).

Temperature

Rieman and McIntyre (1993) state that water temperature is consistently recognized by researchers more than any other factor as influencing bull trout distribution. Thermal barriers have contributed to the disruption and fragmentation of bull trout habitat (MBTSG 1998). Cold water temperatures are required for successful bull trout spawning and development of embryos and juveniles; cold water temperature also influence the distribution of juveniles (Bjornn and Reiser 1991; Goetz 1989; McPhail and Murray 1979; Pratt 1992; Fraley and Shepard 1989). Bull trout are associated with the coldest stream reaches within sub-basins. Bull trout spawning typically occurs in areas influenced by groundwater (Allan 1980; Shepard and others 1984; Ratliff 1992; Fraley and Shepard 1989). In a recent investigation in the Swan River drainage, bull trout spawning-site selection occurred primarily in stream reaches directly influenced by groundwater upwellings or directly downstream of these upwelling reaches (Watson and Hillman 1997). Warmer summer stream temperatures, as well as extreme winter cold temperatures that can result in anchor ice, may be moderated by groundwater upwellings. Distribution is thought to be limited by temperatures above 59 °F, while optimum incubation and rearing temperatures are thought to be much lower, 35.6 - 39.2 °F and 39.2 - 46.4 °F, respectively (Goetz 1989; Pratt 1992). Water temperature seems to be an important factor in determining survival in the early life history of juvenile bull trout, with cool water temperatures resulting in higher egg survival and faster growth rates for fry and juveniles (Pratt 1992).

In one study by Goetz (1994), juvenile bull trout were not found in water temperatures above 53.6 °F. Some studies have indicated that temperatures must drop below 50 °F before spawning occurs (McPhail and Murray 1979). Egg survival decreases as water temperature increases, with higher survival levels documented at 35.6 - 39.2 °F (McPhail and Murray 1979). The best bull trout habitat in several Oregon streams had temperatures which seldom exceeded 59 °F (Buckman and others 1992; Ratliff 1992). Maintaining cold water temperatures is important for bull trout. Water temperature is controlled not only by shade (as influenced by canopy coverage of adjacent riparian stands), but by groundwater sources, sedimentation, influx of water from upstream areas, presence of large woody debris, elevation, and other factors.

In a laboratory study, McMahon and others (1998) concluded that bull trout can survive in water temperatures up to 20°C for a period of 60 days but above that the likelihood for survival decreases rapidly. Additionally, they concluded that optimal growth rate for juvenile bull trout fed to satiation was 13.6°C and the upper growth limit was 20.7°C. In 1999, they reported that the upper incipient lethal temperature for juvenile bull trout was 20.8°C for a 60 day exposure and between 22 and 23°C over a 7 day exposure (McMahon and others 1998).

Sediment

Sedimentation is shown to cause negative effects on bull trout, although no thresholds can be set as clear tolerance limits for population maintenance (Rieman and McIntyre 1993). Preferred spawning habitat includes low-gradient streams with loose, clean gravels (Fraley and Shepard 1989). Because bull trout eggs incubate about seven months in the gravel, they are especially vulnerable to fine sediments and water-quality degradation (Fraley and Shepard 1989). Juveniles can be similarly affected, as they also live on or within the stream-bed cobble (Oliver 1979; Pratt 1984).

Bull trout are more strongly tied to the stream bottom and substrate than other salmonids (Pratt 1992). Substrate composition has repeatedly been correlated with the occurrence and abundance of juvenile bull trout (Rieman and McIntyre 1993) and spawning-site selection by adults (Graham and others 1981; McPhail and Murray 1979). Fine sediments can influence incubation survival and emergence success (Weaver and White 1985) but may also limit access to substrate interstices that are important cover during rearing and overwintering (Goetz 1994; Jakober 1995). Emergence success of fry appears to be affected by the proportion of sediment in the substrate (Pratt 1992). Rearing densities of juvenile bull trout have been shown to be lower when there are higher percentages of fine sediment in the substrate (Shepard and others 1984). Due to this close connection to substrate, bed-load movements and channel instability can also negatively influence the survival of young bull trout.

Channel Complexity/Stability

Bull trout distribution and abundance is also positively correlated with complex forms of cover and with pools (Rieman and McIntyre 1993). Cover that bull trout are usually associated with consists of large or complex woody debris and undercut banks, but may also include coarse substrates (cobble and boulder). Juvenile and adult bull trout frequently inhabit areas of reduced water velocity, such as side channels, stream margins, and pools. These areas can be eliminated or degraded by management activities (Rieman and McIntyre 1993).

The association with substrate appears more important for bull trout than for other species, bull trout usually associate with complex forms of cover and with pools. Juveniles live close to in-channel wood, substrate, or undercut banks. The association with substrate suggests that highly variable stream flows, bed-load movements, and channel instability will influence the survival of young fish. Older fish use pools and areas with large or complex woody debris and undercut banks. Woody debris and habitat complexity (e.g., boulders and large rubble) has been significantly correlated with bull trout density estimates.

Migratory Corridors

Migratory bull trout ensure interchange of genetic material between populations, thereby promoting genetic variability. Unfortunately, migratory bull trout have been restricted or eliminated due to stream-habitat alterations, including seasonal or permanent obstructions, detrimental changes in water quality, increased temperatures, and the alteration of natural stream-flow patterns. Migratory corridors tie seasonal habitat together for anadromous, adfluvial, and fluvial forms, and allow for dispersal of resident forms for re-colonization of recovering habitats (USDA and others 1993). Dam and reservoir construction and operation have altered major portions of bull trout habitat throughout the Columbia River basin. Dams without fish passage create barriers to fluvial and adfluvial bull trout which isolates populations, and dams and reservoirs alter the natural hydrologic regime, thereby affecting water temperature, water quality, and forage (USDA and USDI 1998). The Montana Bull Trout Science Group did identify a need to maintain barriers if non-native species below a barrier may threaten the persistence of bull trout upstream of a barrier (MBTSG, 1996).

Factors Affecting Viability

Factors limiting bull trout populations are complex and in some cases dependent upon the activities occurring within a particular watershed or sub-basin. Throughout all sub-basins, it appears that habitat destruction or modification is the most common factor affecting bull trout populations, followed by inadequate streamflow and water quality. Bull trout are sensitive to environmental disturbance at all life stages. Habitat degradation, impoundments and diversions, overharvest, and introduced species have each impacted bull trout in some way, and pose risks to bull trout in the Columbia River DPS.

Habitat Degradation

Bull trout are threatened by land-management activities and water-management activities which destroy, modify, or preclude use of their habitat. Logging and road-building activities affect bull trout through increased sediment production and delivery to streams, loss of large pools, increased stream temperatures, and loss of large woody debris.

Grazing can impair the function of riparian and aquatic habitats by promoting streambank erosion and sedimentation. Grazing can drastically limit the growth of riparian vegetation important for temperature control, streambank stability, fish cover, and detrital input, and can increase input of organic nutrients into streams (Platts 1991).

Watershed disruption has played a role in the decline of bull trout. Intermountain lakes and rivers at lower elevations which serve as overwintering habitat have been especially degraded by human activities, resulting in fragmented, isolated, local bull trout populations (MBTSG 1998). Consequently, bull trout have been more strongly associated with pristine or lightly disturbed sub-basins (Brown 1992; Clancy 1993; Cross and Everest 1995; Ratliff and Howell 1992). Thurow and others (1997) determined that increasing road densities and their related effects are associated with declines in four non-anadromous salmonid species (including bull trout). They found that most sub-watersheds with strong salmonid communities have no roads or very low road densities. The remaining strong populations are generally located in areas with low-density road systems. They concluded, therefore, that addressing impacts from roads is extremely important when trying to protect critical bull trout habitat requirements through the development of land-management guidelines. However, they did not establish a causal linkage to roads. Roads may have been associated with other factors such as ownership patterns, topography, and access which also are known to affect bull trout in various ways.

Population Structure

There are two ways that the above impacts of habitat land-use activities, water-management activities, overharvest, and introduced species might manifest themselves: 1) direct impacts to a given population or 2) affecting the link between populations.

Changes in sediment delivery; aggradation and scour; wood loading, riparian canopy and shading, or other factors influencing stream temperatures; and the hydrologic regime (winter flooding and summer low flow) are all likely to affect some, if not most, populations. Significant long-term changes in any of these characteristics or processes represent important risks for many remaining bull trout populations. Populations are likely to be most sensitive to changes that affect critical spawning and rearing reaches, existing population strongholds, or habitats supporting remnant (relictual) resident populations. Important refuge habitats are currently found primarily in undisturbed headwater areas and are a high priority for protection.

Isolation and Fragmentation

Historically bull trout populations were well-connected throughout the Columbia River basin. Habitat available to bull trout has been fragmented, and in many cases populations have been isolated. Dams have isolated sub-basins (Brown 1992; Pratt and Huston 1993; Rieman and

McIntyre 1993). Irrigation diversions, culverts, and degraded mainstem habitats have eliminated or seriously depressed migratory life-forms effectively isolating resident populations in headwater tributaries (Brown 1992; Ratliff and Howell 1992; Rieman and McIntyre 1993). Introduced species like brook trout may displace bull trout in lower stream reaches, further reducing the habitat available in many remaining headwater areas (Adams 1994; Leary and others 1993). Loss of suitable habitat through watershed disturbance may also increase the distance between good or refuge habitats and strong populations, thus reducing the likelihood of effective dispersal (Frissell and others 1995). Because many of the bull trout populations in the Columbia River basin have been fragmented and isolated, those that remain are now very important for the conservation of the species. Of special importance are those populations that are documented to be reproducing, for which there is limited knowledge. Lack of connection places isolated stocks at greater risk to episodic and catastrophic events and stochastic localized extirpation without re-colonization from nearby stocks. Migratory pathways allowing connections between these isolated strongholds or refugia or between key spawning and rearing reaches are necessary for the persistence and interaction of local populations as well as for long-term survival and recovery of the species. Disruption of migratory corridors can increase stress, reduce growth and survival, and lead to the loss of migratory life-history forms.

Rangewide Conservation Needs of the Bull Trout

Recovery of bull trout in the Columbia River DPS is likely to be enhanced through future reductions in the adverse effects resulting from timber harvest and road building, including remedying effects from past activities. Improved grazing practices will benefit bull trout in the Klamath and Columbia River DPSs. Providing for both upstream and downstream passage at dams and culverts of all sizes will facilitate re-colonization of previously occupied habitat and promote genetic exchange throughout the Columbia River, Coastal-Puget Sound, Jarbidge, and St. Mary-Belly River DPSs. Screening water diversions will prevent entrainment of bull trout throughout the Columbia River, Klamath River, and St. Mary-Belly River DPSs. Improvement of agricultural practices affecting water quality will benefit bull trout within the Columbia River, Klamath River, and Coastal-Puget Sound DPSs. Similarly, improved approaches to increased urbanization, such as requiring setbacks from stream banks and avoiding contamination of streams, will contribute to the recovery of the Coastal-Puget Sound and Columbia River DPSs.

Relative to other salmonids, bull trout survival is likely to be more dependent on habitat conditions that more closely resemble the historical, undisturbed environment because 1) they are top carnivores that are more vulnerable to environmental disturbances and more prone to extinction than species at lower trophic levels (Gilpin 1996); 2) their delayed sexual maturity (5 to7 years; Rieman and McIntyre 1993) is likely to prolong recovery time from the effects of adverse actions; 3) unlike anadromous salmon, bull trout display little or no anadromy (i.e., none for the Columbia River, Jarbidge River, St. Mary-Belly River, and Klamath River DPSs) and, therefore, spend their entire life cycle in freshwater habitat, making them especially vulnerable to habitat disturbance; 4) bull trout require a long incubation and nursery period of time (220+ days) prior to fry emergence, making them especially vulnerable to water temperature changes, sediment deposition, and bedload movement; 5) bull trout juveniles are strongly associated with cover, including the interstitial spaces in the substrate, which makes them especially vulnerable to effects of sediment deposition, bedload movement, and changes in channel morphology (Weaver and Fraley 1993); 6) bull trout are vulnerable to hybridization with brook trout, a widely introduced species, as well as competition with other introduced exotics (e.g., lake trout) that can displace native bull trout; and 7) bull trout require colder water temperature than other native salmonids (Rieman and McIntyre 1993), thus restricting the available habitat compared to other salmonids and making them especially vulnerable to habitat alterations that affect stream temperatures.

Relationship of Local Populations to Survival and Recovery of Bull Trout in a DPS

Leary and Allendorf (1997) reported evidence of genetic divergence among bull trout local populations, indicating relatively little genetic exchange between them. Re-colonization of habitat where isolated bull trout local populations have been lost is either unlikely to occur (Rieman and McIntyre 1993) or will only occur over extremely lengthy time periods. Remnant or regional populations without the connectivity to re-found or support subpopulations have a greater likelihood of extinction (Rieman and McIntyre 1993; Rieman and others 1997; MBTSG 1998).

Healy and Prince (1995) reported that, because phenotypic diversity is a consequence of the genotype interacting with the habitat, the conservation of phenotypic diversity is achieved through conservation of the local population within its habitat. They further note that adaptive variation among salmonids has been observed to occur under relatively short time frames (e.g., changes in genetic composition of salmonids raised in hatcheries; rapid emergence of divergent phenotypes for salmonids introduced to new environments). Healy and Prince (1995) conclude that while the loss of a few local populations within an ecosystem might have only a small effect on overall genetic diversity, the effect on phenotypic diversity and, potentially, overall population viability could be substantial. This concept of preserving variation in phenotypic traits that is determined by both genetic and environmental (i.e., local habitat) factors has also been identified by Hard (1995) as an important component in maintaining intraspecific adaptability (i.e., phenotypic plasticity) and ecological diversity within a genotype. He argues that adaptive processes are not entirely encompassed by the interpretation of molecular genetic data; in other words, phenotypic and genetic variation in adaptive traits may exist without detectable variation at the molecular genetic level, particularly for neutral genetic markers. Therefore, the effective conservation of genetic diversity necessarily involves consideration of the conservation of biological units smaller than taxonomic species (or DPSs). Reflecting this theme, the maintenance of local populations has been specifically emphasized as a mechanism for the conservation of bull trout (Rieman and McIntyre 1993).

Based on this information, the Service concludes that each bull trout local population is an important phenotypic, genetic, and distributional component of its respective DPS. Therefore, adverse effects that compromise the functional integrity of a bull trout subpopulation could potentially be considered an appreciable reduction in the likelihood of survival and recovery of the DPS by reducing its distribution and potential ecological and genetic diversity.

Environmental Baseline

Bull Trout Status in the Columbia River Basin DPS

Currently, of the 141 subpopulations of bull trout identified during the listing process, 71 appear to be at risk of extirpation from naturally occurring events due to their depressed status (USDI 1998a). The listing rule characterizes the Columbia River DPS as having some strongholds, including the Swan Lake subpopulation, but generally occurring as isolated subpopulations, without a migratory life form to maintain the biological cohesiveness of the subpopulations, and having trends in abundance declining or of unknown status.

Extensive habitat loss and fragmentation of subpopulations have been documented for bull trout in the Columbia River basin and elsewhere within its range (Rieman and McIntyre 1993). In the Columbia River reductions in the amount of riparian vegetation and increases in road construction basin due to timber harvest, grazing, and agricultural practices have contributed to habitat degradation through elevated stream temperatures, increased sedimentation, and channel embeddedness. Mining activities have further compromised habitat conditions by discharging waste materials into streams and diverting and altering stream channels. Residential development has also threatened water quality by introducing domestic sewage and altering riparian conditions. Dams of all sizes (i.e., mainstem hydropower and tributary irrigation diversions) have severely limited migration of bull trout in the Columbia River basin.

Bull Trout Status in Flathead Sub-basin

Flathead Lake is the largest natural freshwater lake in the west with a surface area of 197 mi^2. Major tributaries to the lake are the North, Middle and South Forks of the Flathead River and Swan River. The Whitefish and Stillwater Rivers combine to flow into the Flathead River approximately 22 miles upstream of the inlet to Flathead Lake. Anecdotal information from the early 1900s indicate that bull trout were once common in these two rivers; however, MBTSG (1995) determined that these rivers were low priority for recovery due to high level of degradation and the long-term nature of the decline. The Whitefish and Stillwater Rivers are thought to be too warm during the summer months and therefore not suitable for bull trout use (Service 2002). Upstream fish migration into the Swan and South Fork Flathead Rivers is prevented by hydroelectric dams (Big Fork Dam 1902, and Hungry Horse Dam 1953, respectively) which effectively reduced the available habitat of Flathead Lake migratory bull trout by half (Zubik and Fraley 1987; Deleray and others 1999). A fish ladder was installed at the Big Fork Dam in the 1920s and closed at the request of MFWP and the Service in the 1990s to prevent the upstream movement of lake trout from Flathead Lake. The bull trout subpopulation of Flathead Lake and North and Middle Forks of Flathead River has shown declines since 1982 (Deleray and others 1999). Several reasons for this are postulated including an increase in predation by lake trout on juvenile and sub-adult bull trout as well as a reduced spawning occurrence due to a) fewer numbers of bull trout reaching maturity and/or b) habitat degradation in spawning streams.

In the late 1960's and 1970s fishery managers introduced the opossum shrimp (*Mysis relicta*) into several lakes in the Flathead River basin. *M. relicta* were first identified in Flathead Lake in 1981 and densities peaked in 1986. *M. relicta* have become a dominant predator of the zooplankton community in the lake out-competing planktivorous fishes such as juvenile kokanee salmon. Benthic fish such as lake trout and mountain whitefish are benefitting from the increase in *M. relicta* densities due to the overlap of habitat preferences and as a result their population numbers have increased. Several species of fish have declined since *M. relicta* introduction including kokanee and bull trout (Deleray and others 1999). Deleray and others (1999) concluded that because of their high abundance, predator species such as lake trout may result in a significant source of mortality of bull trout.

Core areas are those areas containing the strongest population of bull trout within a watershed and therefore should have the most stringent levels of protection. Core areas within the Flathead River watershed identified by the MBTSG (1995) are the Big, Coal, Whale, Trail, Red Meadow, Howell and Cabin Creek watersheds in the North Fork and Nyack, Park, Ole, Long, Granite, Morrison, Schafer, Clack, Strawberry and Bowl Creek watersheds in the Middle Fork. Howell and Cabin creek watersheds are found in the Canadian portion of the North Fork Flathead River. In its April 2000, Middle and North Fork Flathead River watershed assessment, the Forest Service identified the watersheds of Big, Coal, Whale and Red Meadow in the North Fork Flathead watershed, as "Functioning at Unacceptable Risk" for an integration of the population and habitat indicators as defined in the "*A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale*" (Framework) (USDI 1998b). Trail Creek in the North Fork and Long, Granite, Morrison, Schafer, Clack, Strawberry and Bowl Creek watersheds in the Middle Fork were "Functioning at Risk" (U.S. Forest Service 2000a). MBTSG (1995) identified the North and Middle Forks of the Flathead River, the upper mainstem of the Flathead River and Flathead lake nodal, overwintering and migratory habitat for bull trout. The Forest Service (2000a) using McNeil core samples throughout the basin determined that habitat conditions for spawning and rearing habitat are as strong as they were at any time since sediment monitoring began in the early 1980s (Forest Service 2000a). However, that assessment was based on standards which were less stringent than those of the Framework. Population trends described below may be a better indicator of overall sustainability of the bull trout population of the Flathead River basin.

MBTSG (1995) indicated that highest risk to bull trout persistence in the Flathead River watershed are the presence of non-native species such as lake trout and brook trout. In the same report, fisheries management and the incidental catch of bull trout mistakenly identified as lake trout was also identified as a very high risk to bull trout persistence.

Several long term surveys are currently being conducted throughout the lake and basin including spring gill net surveys in Flathead Lake and surveys for bull trout redds on index streams in the North Fork and Middle Fork of the Flathead River.

Gill Net Surveys

Spring gill net surveys were initiated on Flathead Lake in 1981 and conducted for three years. They resumed in 1990 and continue through 2002. Protocol used was similar in the periods of 1981-1983 and 1996-present. In 1983 bull trout comprised 10.7% of the fish caught in the sinking net surveys while lake trout comprised 0.9% (Deleray and others 1999). By 2002 the species composition of the sinking net survey had shifted to 1.2% bull trout and 9.2 % lake trout (MFWP unpublished data).

Redd Surveys

Redd surveys have been conducted annually on 8 index streams in the North Fork and Middle Fork Flathead River basins since 1980. In the North Fork the index streams are Big, Coal, Whale and Trail Creeks; and in the Middle Fork they are Morrison, Granite, Lodgepole and Ole Creeks. Similar trends to the gill net surveys are evident showing the decline of bull trout. The total number of redds in the North Fork in 1982 was 406, declining to 109 redds in 2002. The 23-year average of redds in the North Fork is 152. The number of redds in the Middle Fork has also declined from 194 redds in 1982 to 81 redds in 2002 with the 23 year average being 109 redds. In 2002 the number of redds for the North and Middle Forks was down about 18% from the previous two years which recorded the highest numbers of redds since in 1991. MFWP (unpublished data) estimates that the 8 index areas in the North and Middle Forks streams support approximately 45% of all Flathead Lake migratory bull trout spawning.

Bull Trout Status in Swan Lake and Upper Swan River Sub-basin

After flowing approximately 66 miles through a heavily forested relatively flat valley, the Swan River empties into Swan Lake. The Department of Interior (1998a) characterized the Swan River drainage as one of the two strongholds for bull trout in the upper Columbia River basin. Swan River's three subpopulations of bull trout have effectively been isolated, from the remainder of the Flathead Lake system, by the Big Fork Dam since 1902. Swan Lake and Swan river are one of three currently recognized sub-populations in the drainage with the other two (Holland and Lindbergh Lakes) being thermally isolated from the Swan Lake sub-population. This project is not expected to have any impacts on the Holland and Lindbergh Lakes disjunct subpopulations.

Land ownership within the Swan drainage is approximately 45% U.S. Forest Service, 20% Plum Creek Timber Company (PCT), 10% Montana Department of Natural Resources and 25% private landowners (MBTSG 1996). Core areas are those areas containing the strongest population of bull trout within a watershed and therefore should have the most stringent levels of protection. Core areas within the Swan River watershed identified by the MBTSG (1996) are the Elk, Goat, Squeezer, Lion, Piper, Jim, Lost, Woodward and Cold Creek watersheds. In its May 2000, Swan River watershed assessment, the Forest Service identified the watersheds of Elk and Lion as "Functioning Appropriately" for an integration of the population and habitat indicators as defined in the Framework; the remaining core areas were rated as "Functioning At Risk" for the same level of integration (Forest Service 2000b).

The MBTSG (1996) identified both legal and illegal introduction of non-native species (e.g. lake and brook trout) as the greatest potential threat to bull trout persistence in the Swan Lake watershed (MBTSG 1996). The Forest Service (2000b) reported anecdotal reports of several adult lake trout captured in Swan Lake. In the same report the Forest Service (2002b) reported that brook trout are widespread in tributary streams to the upper Swan River and "are found in virtually every tributary especially in lower gradient areas where bull trout spawn and rear."

The reach between the outlet of Swan Lake to the upper boundary of the project area is approximately 14 miles in length. This reach's determining characteristic is the warmer waters leaving Swan lake which may affect current and historical bull trout migration (Service 2002). The slow, meandering, wide reach may undergo some cooling due to the influence of over a dozen tributaries within this reach. The Forest Service has electrofished the four tributaries known to contain fish and failed to find any bull trout (Forest Service 2000b). This reach is thought to primarily serve as nodal or migratory habitat for bull trout. No effects from the operation and maintenance are anticipated to occur within this reach.

Several long term surveys for bull trout are currently being conducted throughout the lake and basin including spring gill net surveys in Swan Lake and surveys for bull trout redds in tributaries to Swan River (Goat, Elk, Squeezer and Lion Creeks).

Gill Net Surveys

Gill net surveys have been conducted in the springtime on Swan Lake since 1995. In 1995 the first year of the survey bull trout comprised 9.7% of the fish caught whereas in 2001 they comprised 59%. The mean species composition for the period of 1995-2001 shows that bull trout constitute 17% of the annual catch in the gill nets. However, the total number of fish captured by the nets has declined from 124 in 1995 to 49 fish in 2001. Lake trout have not been sampled in the gill net surveys.

Redd Surveys

Redd surveys have been conducted in Swan River tributaries (Goat, Elk, Squeezer and Lion Creeks) since 1982. Since the 20 year low of 109 redds in 1985, numbers have shown a steady increase to a high in 1998 of 612 redds. Since 1998, numbers have decreased to 430 redds in 2002. The 20 year average is 385 redds for the four index streams which is still lower than the current number of redds. During the 8 year period between 1991-1998, bull trout redds increased an average of 43 redds each year. However three of the past four years have shown declines in the number of redds averaging a loss of 45 redds each year for the four years. MFWP (2002) estimates that these four index areas constitutes 70% of all Swan Lake bull trout spawning.

Bull Trout Status in the Action Area

The action area consists of the Swan River from Ferndale bridge downstream to Bigfork Bay on Flathead Lake. It is broken into two distinct reaches, the reach between the Ferndale bridge and the dam and the reach downstream of the dam to Bigfork Bay. Bigfork Bay is not included in the action area.

Ferndale Reach

This reach consists of a 109 acre-feet impoundment covering 73 surface acres which is created by the dam. This impoundment continues upstream of the Bigfork Dam approximately 1.5 miles in length and is contained within a confined valley bottom. Immediately upstream of the forebay the valley opens to a less confined area. At full pool the average depth of the impoundment is 8 feet with a maximum depth of 18 feet. The lack of significant flow due to the continued operation of the dam leads to an area which undergoes significant temperature increases in the summer months. The temperature differential between the water entering and the water leaving the impoundment averaged 7°F (3.9°C) warmer during the month of August 1999. The impoundment does not stratify and therefore maintains the same temperature throughout the water column precluding thermal refugia availability. It is unknown whether any groundwater influences this reach nor are there any significant tributaries to this reach.

MFWP (as reported on MFWP's website) conducted fisheries surveys in the reach upstream of the impoundment from 1988 to 1994 and failed to find any juvenile bull trout. Fisheries surveys have not been conducted within the impoundment. Water quality data collected for the purposes of re-licensing during the summer of 1999 indicate that water entering the action area may be warmer than preferred by bull trout (FERC 2002). Average daily temperatures in the Swan River at the upstream boundary of the impoundment exceeded 64.4 °F (18 °C) during August 1999 which may preclude juvenile use of this reach of the Swan River for rearing habitat during periods of high water temperatures in late summer. Periodic late summer-early fall sampling efforts within the diversion channel by MFWP between 1988 and 1997 (sampling did not occur in 1992 and 1995) found one sub-adult sized bull trout in 1989, 1993 and 1997. These fish were in all likelihood downstream migrants due to the inability of fish to move upstream of the dam.

The availability of Swan Lake in close proximity likely precludes the use of this reach for rearing and overwintering habitat. During the summer the warmer water temperature and the shallower depths result in conditions less suitable for rearing bull trout. Overwintering use is available due to the greater depth of this reach in relation to stream depths elsewhere in the Swan River downstream of Swan Lake. However, bull trout use of this reach is probably limited to migratory habitat due to the high temperatures found within this reach during the summer months and the availability of the preferred overwintering habitat in Swan Lake.

Bypass Reach

The bypass is located below the dam downstream to but not including Bigfork Bay on Flathead Lake. Very little information is available regarding the habitat characteristics within the bypass.

The presence of Swan lake 14 miles upstream effectively limits the size of the watershed affecting the bypass and Ferndale reaches to 65 mi^2. Based upon personal observations the bypass is dominated by larger substrate (small boulder size), lacks an appropriate pool to riffle ratio and lacks a significant amount of large woody debris. The bypass has two different habitat types. The upper and lower thirds are characterized by having a strictly confined channel and slightly higher gradients than the middle third. The upper segment has a gradient of approximately 5% and is dominated by riffles, runs and cascades and has several well-defined pools and pocket pools (surface area of approximately 20 ft^2 and variable depths greater than estimated average channel depth). This habitat type has a wetted width of approximately 90 feet and an estimated flood prone area of 120 feet. The steep flood prone area has some forbes and grasses present but generally speaking is dominated by a hard armoring of rock resulting in stable channel banks. Mature trees (cottonwoods, and conifer) are present on a bench 5-10 feet above the flood prone area. The vegetation on the bench provides limited overhanging vegetation and shading on the margins of the river.

The habitat type of the middle segment is shallower (approximate average depth 2 feet) and dominated by riffle and run-type habitat (<2% gradient). Well defined pools were absent within this reach. Several willow dominated islands were present at flows of approximately 70 cfs. The wetted width of this section was 130 feet with an estimated flood prone area of 190 feet. The flood prone area in this reach has a well established community of willows present along with some grasses and other forbes. Some overhanging vegetation in the form of willows was present providing little cover and thermal regulation. A debris jam was present on one island possibly acting as refugia and cover during higher flows. This segment seemed to lack a level of cover adequate for bull trout rearing since it was dominated by shallower riffles and runs.

The precise level of fine materials and degree of substrate embeddedness (measures that indicate adequacy of spawning habitat) are unknown. Generally speaking, based upon personal observations, the substrate has few fines and is dominated by small well-rounded boulders with a low degree of embeddedness throughout the bypass. In all likelihood most fine material suspended in the Swan River falls out within the impoundment. The lack of embeddedness provides ample habitat for macroinvertebrates; however, no surveys have been conducted. Large woody debris recruitment is limited due to the size of the watershed, the shallow valley slope of the river below Swan lake and spring runoff flows. With the exception of a debris jam located on an island in the middle reach, very little large woody debris was identified within the bypass reach.

PacifiCorp (2000) identified a spring which feeds into the bypass immediately downstream of the dam. PacifiCorp conducted a survey for potential spawning substrate and found a 100-yard reach just below the outlet of the powerhouse with suitable substrate; however, water temperatures in the bypass are high enough to likely preclude any spawning within this reach. The east-west aspect of the bypass and the presence of a steep slope on the south side contribute to provide some shading to the bypass reach. However, water temperatures entering the action area in September and October are believed to be warmer than the preferred spawning temperatures

(FERC's letter dated July 2, 2002). The running 7-day average daily maximum (7DADM) water temperature within the bypass reach never dropped below 54°F(12°C) during the September 15-October 31, 1999, spawning period.

Four electrofishing surveys in September 1994 failed to find any bull trout within the bypass reach. It is unknown whether juvenile rearing occurs in either the impoundment or in the river below the dam. In the 1920s a fish ladder was built adjacent to the dam to allow for fish migration. Sampling by MFWP in the fish ladder during the springs of 1969 through 1973 found 2 bull trout (size unknown) in 1970. The fish ladder was sealed in the early 1990s at the request of the Service and MFWP to prevent upstream migration of lake trout thereby eliminating the upstream migration of bull trout. However, the adequacy of the ladder to pass fish was questioned by the Forest Service in a 1948 report (MBTSG 1996). Downstream movement of juvenile and adult bull trout is still possible over the dam face or through the notch in the dam used to provide instream flow at all times of the year. In the early 1980s an adult bull trout was tagged in a tributary to the Swan River upstream of Swan Lake and tracked down past the dam and intake into Flathead Lake and was then recaptured 34 miles upstream in the Flathead River (Leathe and Enk 1985). Based upon limited survey work in the bypass reach, fish ladder, and diversion canal it is likely that bull trout use the lower Swan River as a migratory corridor between Swan Lake and Flathead Lake especially during periods of high flows.

Based upon a limited habitat survey conducted at 70 cfs, the failure to capture any bull trout within the bypass reach and lack of any anecdotal reports of bull trout within the bypass reach it is unlikely bull trout currently use this reach as rearing or spawning habitat. Bull trout rearing and refugial habitat availability is limited during the lower flow periods of late-August to late-March to shallower runs and the smaller pools of the upper third segment. However, higher water temperatures in August and September likely preclude the use of this reach during these months. During periods of higher flows bull trout may use this reach when pool and run depth is increased providing both increased foraging, rearing and refugial habitat. Bull trout may enter the bypass reach from either upstream over the dam face or from Flathead Lake. As water temperatures increase in the bypass reach habitat values within the reach are minimized and bull trout may move downstream into Flathead Lake. The historical presence of bull trout in the ladder and in the diversion canal indicate that bull trout may attempt to migrate in both directions through the project area. The Service believes this reach is currently "Functioning at Unacceptable Risk" as defined by the Framework (USDI 1998b), based upon the higher water temperatures during the summer months and the reduced availability of rearing and refugial habitat during the fall and winter months.

Effects of the Action

The rule listing the entire coterminous population determined that each DPS, due to its isolation from the other DPSs, would serve as interim recovery units for the purposes of consultation and recovery planning. The Services' *Endangered Species Consultation Handbook* (Service and NMFS 1998), allows for a jeopardy analyses for actions under formal consultation to be done at the DPS level as opposed to the entire coterminous United States range of this species. Therefore, this action has been analyzed within the Columbia River DPS.

For purposes of consultation under section 7 of the Act, the "action area" is defined by 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area, for purposes of this effects analysis, consists of PacifiCorp lands between Ferndale bridge and Bigfork Bay on Flathead Lake.

Direct and Indirect Effects

Direct effects encompass the direct or immediate effects of the project on the species or its habitat. Indirect effects are those that are caused by the proposed project and are later in time, but are still reasonably certain to occur.

Degradation of water quality, particularly water temperature, in both the impoundment and the bypass reach may occur from the impoundment of water behind the dam and the intake diversion. The diversion of up to 600 cfs of flow may affect bull trout and its habitat within the bypass reach. Increases in sediment from the dewatering of drainage channels may also occur in the bypass reach. In general, fish screens are not 100% effective in preventing fish entrainment and impingement of downstream migratory fish (Office of Technology Assessment 1995). Consequently, the proposed fish screens will likely be unable to prevent some lower level of entrainment and cause some degree of impingement on downstream movement of bull trout. Additionally, upstream migration between the Flathead Lake subpopulation and the Swan Lake subpopulation has been blocked by the dam. The fish ladder adjacent to the dam was sealed at the request of state and federal agencies to prevent the introduction of lake trout into Swan Lake. Changes in the flow regime due to operations and maintenance may affect bull trout by reducing rearing opportunities within the bypass reach.

Water Quality

Water quality data is based upon a single year of water temperature data collected between March 1999 and April 2000. The proposed continued operation of the diversion and hydroelectric facilities will likely maintain the existing water quality degradation within the impoundment and bypass reach. This degradation is probably caused by diverting significant flows from the river thereby reducing the bypass instream flow, as well as impounding the river thereby altering the natural flow regime and increasing the amount of time water is exposed to solar irradiation. This results in high water temperatures and potentially low dissolved oxygen levels in both the bypass reach and the impoundment, which may be detrimental to bull trout. Poor water quality may result in avoidance behavior, a reduced feeding rate, or a reduced condition level increasing the susceptibility to disease, or predation (Moyle and Cech 1996).

<u>Spawning</u>

Suitable spawning temperatures are between 41 and 48°F (5-9°C) in the late summer or early fall (Goetz 1989). Based upon one year of water temperature data, differences between the 7DADM water temperature entering the action area and the 7DADM water temperature at the downstream end of the bypass reach averaged 7°F (2.8°C); (maximum difference was 9°F [3.8°C] on October 30) showing a warming trend during the period of September 15-October 31, 1999; a time when bull trout are most likely to be spawning. Water temperature data collected by PacifiCorp over one season of spawning suggest the bypass reach is unsuitable as bull trout spawning habitat; because these water temperatures are significantly higher than those bull trout are generally thought to prefer. Further, spawning habitat is very limited within the bypass reach.

Rearing/Migratory

Water temperatures which exceed 59°F (15°C) tend to limit bull trout distribution (Fraley and Shepard 1989; Rieman and McIntyre 1995). Additionally, in a controlled laboratory study, McMahon and others (1998) found a 0% survival rate of bull trout juveniles at water temperatures exceeding 72°F (22°C) after 38 days. The same study found a survival of 79 % of juvenile bull trout after 60 days in water temperatures of 68°F (20°C) but survival decreased rapidly at higher temperatures. Growth rates measured in the same study were maximized (69.5 grams) at 56°F (13.2°C) whereas at 68°F (20°C) growth rates declined to 3.4 grams. Baxter and McPhail (1996) concluded that increasing stream temperatures especially maximum summer temperatures could reduce the amount of habitat available to juvenile bull trout due to temperature preferences even though the physical habitat may still be available.

Figure 1 shows the 7DADM (the preceding 7 days) for water temperatures entering the action area and water temperatures at the downstream end of the bypass reach and the 68°F (20°C) thermal tolerance threshold identified by McMahon and others (1998). The running 7DADM water temperature entering the action area met or exceeded the 68°F (20°C) threshold for a period of 7 days in mid-August and again for three days at the end of August. Whereas, the running 7DADM water temperature within the bypass reach met or exceeded the 68°F (20°C) threshold throughout the 52-day period between July 16 to September 5, 1999. The bypass reach showed an average warming trend of 7°F (3.0°C) over a period of June 15-September 30, 1999, based upon the average of the difference between the running 7DADM water temperature entering the action area and the running 7DADM water temperature within the bypass reach. During the summer of 1999, daily mean flows as measured at the USGS flow gauge, located at the mouth of Swan Lake (Station # 1237000), met or exceeded the 79-year average daily mean flow 64% of the time indicating a higher flow than normal for a significant portion of the summer. For 68 days between June 18 and August 24, 1999, the daily mean flows met or exceeded the 79-year average daily mean.

With data indicating that water temperatures may be raised for a sustained period of time above the 68°F (20°C) threshold for bull trout by the proposed continued operation of the diversion and hydroelectric facility, effects to bull trout may be anticipated. These effects include: 1) avoidance of the bypass reach by juveniles and adults in Flathead Lake, 2) a reduced level of fitness, 3) a reduction in feeding rates and available prey base, and 4) increased potential

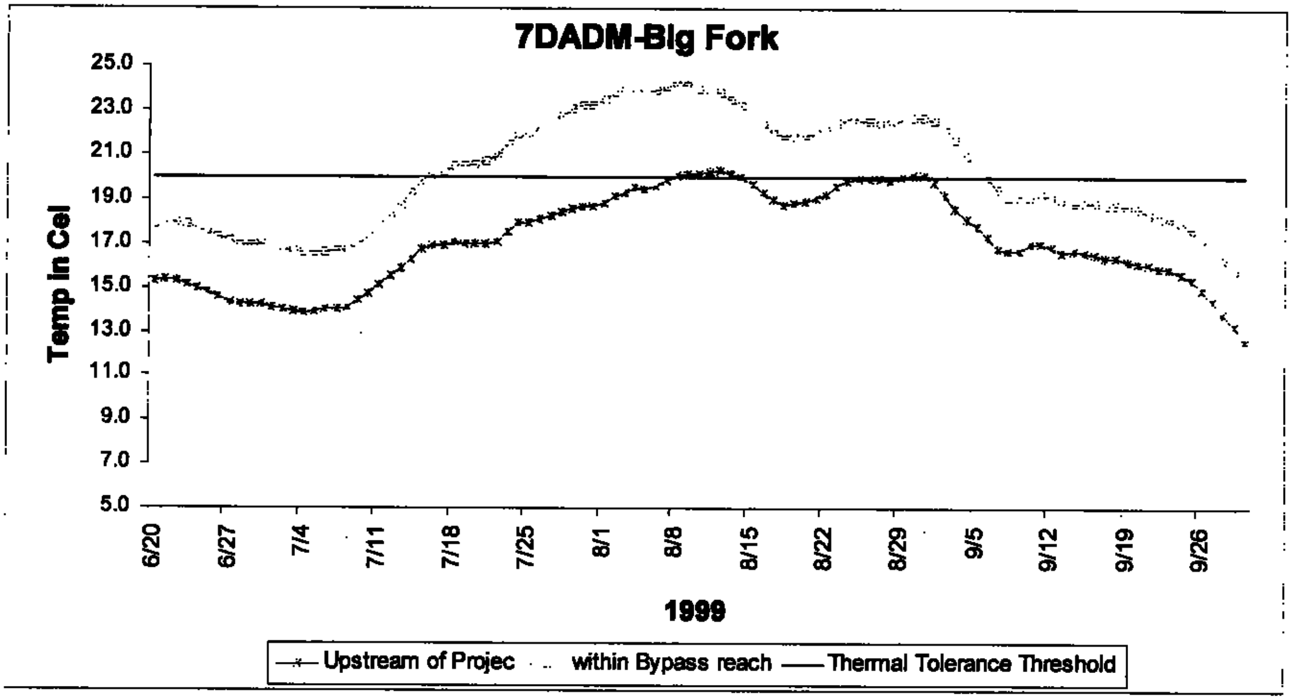

Figure 1: The Running 7DADM water temperatures upstream of the project and within the bypass reach showing the effect of the project on water temperatures. Based upon data collected in 1999 and provided by PacifiCorp.

mortality should bull trout remain in the bypass reach for prolonged periods of time. All water temperature analysis is based only upon one year of data collection in 1999. McCullough (1999) cautioned using less than 2 years of water temperature data to draw conclusions due to the variability of the summer thermal regime. Conclusions on the quality of water chemistry are difficult to draw based upon one summer's data and further information should be collected to adequately determine effects that changes in the hydrology of the bypass reach might have on water temperatures.

Dissolved Oxygen

Dissolved oxygen (DO) is closely associated with water temperatures. As water temperatures increase, oxygen solubility in water decreases which may lead to lower DO levels during the summer months (USACE 1991). Generally speaking, fish in warmer water waters need a higher level of oxygen due to the increase in their oxygen consumption rates (Moyle and Cech 1996). Growth rates, embryonic development, and activity levels of fish may be reduced should oxygen levels fall slightly below saturation levels (Katz and others 1968, cited in USACE 1991). An oxygen rating curve used to determined oxygen saturation has not been developed for this reach. DO levels within the bypass reach were measured on June 25 and October 14, 1998, and January 13, and April 13, 1999. DO levels never dropped below Montana's water quality standard of 6.5 milligrams per liter (mg/L). Based upon four samples, the lowest DO level coincided with the highest water temperature of the four samples and vice versa. The increased water temperatures within the bypass reach during the summer months of 1999 may have resulted in lower dissolved oxygen levels. Should oxygen levels be low, bull trout may avoid the area, have reduced growth rates and a reduced swimming capability. Due to lack of sampling during the periods of warmest water temperatures an accurate analysis of the DO levels is unavailable until sufficient data is collected.

Water Quantity

Instream flow is a determining factor for reach health and stability. Ensuring a seasonally consistent and adequate flow regime allows streams to form stable channels, develop an appropriate pool to riffle ratio and develop an adequate stream channel meander pattern (Rosgen 1996). Stream channel stability ensures riffle and pool habitat is available appropriate to the given channel morphology, as well as minimizes streambank erosion. During the summer months, food availability is generally the limiting factor for fish population size; whereas during winter months habitat availability particularly pool and cover habitat becomes the limiting factor (Leathe and Nelson 1989). Leathe and Nelson (1989) also concluded that instream flows in the winter months may be less than summer months as long as the basic needs of those months are maintained: maximum sustained wetted riffle habitat during the summer months and maximum pool and cover availability during the winter months. Low summer flows also reduces the amount of available cover habitat from overhanging vegetation and undercut banks. This lack of cover increases the susceptibility of juvenile bull trout to predation from piscivorous fish such as adult bull trout and lake trout as well as terrestrial animals such as kingfishers, minks and otters. Lack of adequate sustained wetted riffle habitat reduces the availability of prey species thereby affecting bull trout by a reduced growth rate and a reduced condition level.

Based upon the 79-year average of the daily mean flows as measured at the USGS flow gauge, the Service anticipates that spill (flows in excess of the proposed 600 cfs diversion plus the 70 cfs instream flow) will occur late March through mid-August. PacifiCorp's proposal to maintain a minimum flow of 70 cfs within the bypass reach may result in the diversion taking at least 87% of the instream flow during the months of August through March using the 79-year average monthly flow as measured at the USGS flow gauge. During the spring runoff period of late March through mid-August the average would be 29% of the flow. Although, habitat loss and effects to bull trout may occur year round, the Service anticipates the majority of effects to bull trout habitat availability and prey base from a minimum instream flow regime of 70 cfs will be limited to the late summer through winter seasons (usually August through March). Lack of a sustained riffle habitat may occur in August and September reducing the availability of prey for bull trout. Additionally, instream flows may reduce the availability of cover habitat for bull trout during the winter months period. While a diversion of 600 cfs in the spring runoff season has a lesser impact than during periods of low flow, effects are still possible. A loss of flooded vegetation potentially results in a loss of associated refugial habitat, a loss of organic nutrient input and a loss of large woody debris recruitment potential. Therefore, a habitat assessment relating seasonal flows to available habitat may be necessary to adequately characterize and determine instream flow needs.

Based upon the State of Montana's Wetted Perimeter Inflection Point Method (WPIPM) (Nelson 1989), PacifiCorp (2000) determined that an instream flow of 70 cfs "represented the provision of a high level of aquatic habitat potential in the bypass reach." WPIPM is used to qualify the production capability of the stream's macroinvertebrate community within the riffle habitat. It assumes that ensuring the adequacy of the riffle habitat will maintain spawning and rearing habitat (FERC 2002). The analysis conducted by PacifiCorp, based on six transects in the upper third of the bypass reach, concluded that 70 cfs is the last inflection point where any additional instream flow would have an incrementally lower benefit to instream habitat. The use of the WPIPM is based upon the assumption that food supply can be the limiting factor in the fish population of a given reach. Therefore, the applicability of the WPIPM to the bypass reach may be inappropriate due to the limiting factor of the hydrology being fall-winter low flow periods. Additionally, the wetted perimeter inflection method underestimates fish flow needs in a riffle-run dominated system like the bypass reach (Randolph 1984, cited in Leathe and Nelson 1989). Fish populations tend to be more closely associated with riffle depth than changes to the amount of wetted perimeter (Leathe and Nelson 1989). In its letter dated December 7, 1998, MFWP questioned the applicability of the WPIPM when evaluating instream habitat types such as pools, runs and other habitat types. Additionally, PacifiCorp and FERC did not provide any other relevant field data such as abundance of fish and macroinvertebrates, availability of various habitat types such as pools and cover nor was a comparison made of the effects that different flow regimes would have on these parameters.

The Service is uncertain whether 70 cfs may provide the optimum minimum flow for all life stages of bull trout, particularly juvenile bull trout using the bypass reach as rearing habitat. An adequate flow versus habitat availability relationship is not currently available and the WPIPM seems to lack the flexibility to address various life stages and flow regimes for the given habitat conditions contained within the bypass reach. While the Service agrees that flows lower than 70 cfs would increase impacts to bull trout, further evaluation using water quality and habitat availability monitoring indices may be necessary to determine adequacy of instream flows for bull trout within the bypass reach. Stalnaker and others (1995) concluded that "a minimum flow is almost always less than optimal".

Sedimentation

Burns (1970, cited in MBTSG 1998) reported that surface erosion from roadbeds, and drainage ditches can be a primary source of sediment in streams depending upon the soil types. Mass movement of landforms and road failures are often the primary means of sediment delivery to stream systems (MBTSG 1998).

Increased embeddedness from sedimentation may result in decreased aquatic insect production and diversity. Juvenile bull trout feed primarily on aquatic macroinvertebrates and the distribution of aquatic macroinvertebrates inhabiting running water environments is highly dependent on substrate particle size (Cummins and Lauff 1968). Increased levels of deposited sediment reduce the quantity of the food base for bull trout resulting in slower growth rates, higher mortality, and reduced fecundity of bull trout. Sedimentation could also reduce the amount of rearing habitat available to juvenile and sub-adult bull trout as well as adult bull trout by decreasing the availability and quality of the necessary pool habitat and the interstitial spaces.

A temporary increase in sediment within the bypass reach may result from any dewatering activities of the intake canal. Three channels exist to provide dewatering capability of the intake canal. They are approximately 300 feet long and are bare earth or vegetation. Frequency of dewatering is unknown but is expected to occur whenever PacifiCorp determines maintenance is necessary on the canal or powerhouse equipment for the life of the license period (FERC 2002). FERC had proposed to ensure that PacifiCorp develop in conjunction with the Service a plan to stabilize the dewatering channels and reduce sedimentation in the bypass reach.

Entrainment and Impingement of Bull Trout

Entrainment is the hydraulic capture and subsequent passage of fish and other planktonic organisms through the diversion. Once the screen is installed, the organisms entrained are typically egg, larval and juvenile life stages, unable to avoid the screens, and capable of passing through the mesh of the intake screens. It is not anticipated that egg and larval bull trout would be present in the vicinity of the Bigfork Hydroelectric Project at any time. Additionally, fish can pass the screen using any gaps around the edges as well a gaps in a damaged screen face. As the entrained fish pass through the diversion, they can be exposed to several types of stresses, including mechanical, pressure, shear, thermal, and chemical. The potential impact of entrainment is a function of the number of fish that do not survive passage through the diversion and subsequent hydroelectric turbines. Bull trout moving downstream from Swan Lake may be entrained within the diversion canal and potentially the hydropower turbines in the powerhouse or impinged upon the proposed screens designed to prevent entrainment. It is anticipated that entrainment may cause bull trout significant harm or mortality from all the aforementioned stresses, should they pass through the screens and into the diversion canal and associated hydropower turbines (USACE 1991).

Entrainment of one bull trout each year was documented by MFWP during surveys of the intake canal in October 1989, September 1993 and in August 1997 (PacifiCorp 2000). No bull trout were found during surveys in September and October 1988, 1990, 1991 and 1994. It is expected that additional entrainment has occurred at an unknown level. It is anticipated that bull trout will be entrained within the diversion at an unknown level. Vortex or turbulent flow patterns from structures such as the dam or screen support structures may impede normal flow patterns resulting in bull trout becoming entrapped in the vicinity of the screen face. Gaps in the screen face or along the edges of the screen provide opportunity for escapement into the diversion for any bull trout impinged or otherwise entrapped in the vicinity of the screen face.

Impingement occurs when an organism is held against, or come in contact with, the screens. The survival of impinged fish depends on the species, life stage, and size and condition of the organism. Fish susceptible to impingement in the vicinity of Bigfork Dam are either small or larger juveniles and adults in a weakened condition. Other factors influencing impingement survival include the duration of impingement and seasonal water-body characteristics, such as water temperature and dissolved oxygen content. Effects to impinged fish include mortality or significant harm from the abrasive forces of the screen face. The Service concluded that the approach velocity criteria for bull trout fry should be 0.4 feet per second (fps) at 6°C (43°F) to reduce the level impingement of bull trout fry (Zydlewski and others 2000). In a laboratory study, they found that bull trout fry had the swimming ability to escape the screen face when the approach velocity was 0.4 fps. Bull trout fry are not anticipated to be found within the project area at any time. Based upon this research the Service determined that using criteria similar to other salmonids would be appropriate to minimize impingement and entrainment.

Potential for impingement increases with the duration bull trout are found in the vicinity of the screen face, the velocity water passes through the screen face and the percentage of the water column passing through the screen face. PacifiCorp has proposed to install screens with an approach velocity of 0.8 fps which is believed by the Service to be adequate to minimize impingement of salmonids including bull trout. The lack of adequate sweeping flows will hinder any impinged fish from moving away from the screen face. Debris on the screen face can damage the screen or prevent water flow from using the entire surface of the screen thereby resulting in a potentially higher approach velocities on the screen face. Lack of a sweeping flow may also prevent bull trout from moving away from the screen face in a timely manner thereby increasing the potential for impingement or entrainment.

The level of impingement and entrainment is contingent upon the percentage of flow captured by a given diversion, the density of fish found within the flow and the swimming ability of the fish intended to be excluded. While little information is available on the swimming performance of bull trout at various temperatures, Bates (1988) reported that for anadromous salmonids swimming stamina was positively correlated for the 39°F to 59°F (4°C to 15°C) temperature range. PacifiCorp's proposal to maintain a minimum flow of 70 cfs within the bypass reach may result in the diversion taking at least 87% of the instream flow during the months of August through March using the 79-year average monthly flow as measured at the USGS flow gauge. During the spring runoff months of April through July the average would be 29% of the flow.

It is difficult to predict the effects existing entrainment has on the bull trout migration from Swan Lake due to the lack of surveys; however, Fraley and Shepard (1989) reported that juvenile bull trout began their emigration from their natal streams between June and September arriving in Flathead Lake in August and September. This may result in migrating juvenile bull trout arriving in the vicinity of the Project during the period of the highest percentage of withdrawal from the river coupled with the annual period of the warmest water in the impoundment. The density of bull trout within the impoundment of Bigfork Dam is unknown but it is anticipated to be a very small number due to the infrequent and transitory use of the area by bull trout.

Minimization Measures

Entrainment of bull trout within the diversion and subsequent turbines may result in mortality or significant harm as fish pass through the turbines. PacifiCorp has proposed to screen the diversion canal to prevent entrainment. Screening will significantly reduce the incidental take of bull trout by entrainment. This screening may, however, result in the impingement of a small number of fish on the screen face as described above. Fish screens are not 100% effective at preventing entrainment nor does the design criteria guarantee to prevent impingement for reasons stated above.

PacifiCorp has developed and proposes to install fish screens using some of the design criteria developed by the Service to minimize the level of effects from entrainment and impingement. The screen panels are designed to prevent entrainment of fish greater than 3.5 inches in length and have a minimum opening size of 0.25 inches. Additionally, the panels were designed to ensure that the approach velocity to the screen face was 0.8 fps to reduce the risk of impingement. It is anticipated that the approach velocity will be approximately 0.7 fps or less even at the maximum diversion rate of 600 cfs. These are methods PacifiCorp is proposing to minimize the impacts to bull trout. The level of effect is difficult to quantify, but is likely to be low. To assess the success of the fish screens, PacifiCorp also proposes to have additional monitoring to ensure the effectiveness and efficiency of the screens to prevent future entrainment of bull trout and will develop a monitoring plan in conjunction with the Service and fisheries biologists with MFWP.

Migration
The Big Fork Dam was built in 1902 effectively isolating the Swan Lake sub-basin from the Flathead Lake sub-basin. Anecdotal information around 1900 indicated that the mouth of the Swan River was a very popular fishing spot in the spring for bull trout and westslope cutthroat trout; but it is uncertain whether those fish migrated upstream into Swan Lake or whether they were drawn there for the foraging opportunities (Service 2002). A fish ladder was built into the dam in the early 1900s. Spring sampling (1969-1973) in the fish ladder found 2 bull trout (size unknown) and sampling in the bypass reach found one sub-adult in 1989 and 1993 and one bull trout (size unknown) in 1997 indicating movement through the system still occurs on a sporadic basis. In 1993 PacifiCorp sealed the ladder at the request of MFWP to prevent introduction of the non-native lake trout into the Swan Lake sub-basin. PacifiCorp is proposing to keep the ladder closed until the MFWP and the Service both request that the ladder be reopened. Should the ladder be reopened, additional information regarding habitat availability and instream flows may be necessary to adequately address effects.

Changes in Flow Regime
FERC is proposing to implement the Settlement Agreement which provides recreational flows maintaining a minimum instream flow of 1,000 cfs during the Bigfork Whitewater festival held annually for a three day period sometime between May 15 and June 15. Additionally, for the first three years of the license the Settlement Agreement establishes instream flow between 5 pm and 9 pm every Wednesday during the months of July and August, equal to inflow into the project when inflow is between 800 and 1,500 cfs and instream flows of at least 1,500 cfs

whenever inflow is greater than 1,500 cfs. If inflow is less than 800 cfs instream flow shall be maintained at a minimum of 70 cfs. These flows are intended to provide whitewater boating opportunities and will be implemented on a conditional basis for the first three years of the license; and, depending upon results of a whitewater feasibility study may become a permanent condition of the license. Effects from drastically altering the flow regime include stranding of fish trapped in pools due to rapidly falling water levels. Additionally, fish may be flushed out of the system if they are unable to find adequate cover. Based upon a site visit by Service personnel conducted in April 2002, stranding of fish may occur because pools containing fish could lose connectivity to the river. In conjunction with the Service and MFWP fisheries biologists, PacifiCorp has proposed to develop a Recreational Resource Management Plan to include monitoring to determine effects of stranding from the recreational flow releases.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions affecting listed species and their critical habitat that are reasonably certain to occur in the area considered in this biological opinion. Future federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act. Other actions affecting bull trout within the area consist of the take of bull trout when private anglers targeting lake trout keep a bull trout due to misidentification. Additionally, MFWP conducts gill-netting surveys in Swan Lake and Flathead lake to ascertain the population level. Stream and lakeside development throughout the Bigfork area contributes to the loss and/or degradation of aquatic habitat.

Conclusion

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of bull trout in the Columbia River DPS. No critical habitat has been designated for this species within the action area, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary for listed species in this opinion and must be implemented by FERC so they become binding conditions of any grant or permit issued to the applicant, as applicable, in order for the exemption in section 7(o)(2) to apply. The FERC has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Federal agency (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates that activities associated with the proposed action will result in some small amount of incidental take of bull trout over the duration of the project license period in the form of harm, harassment or mortality related to expected degradation of aquatic habitat parameters including rearing habitat and food supply and the related risk to bull trout life history stages. Temporary increases in sedimentation, operation and maintenance of the fish screens, entrainment and impingement on all life stages present and degradation of water quality related to the proposed action are anticipated to adversely affect and likely result in take of adult and juvenile bull trout by harming or impairing feeding, breeding and sheltering patterns of adult and juvenile bull trout. Further, the FERC in proposing to issue a 50-year license anticipates that the annual activities, involving the operation and maintenance of the Project with the likelihood of harm and harassment, will continue for 50 years. Due to the implementation of the minimization measure proposed, the Service anticipates that those effects related to operation and maintenance of the fish screens, entrainment, impingement and sediment input will be appreciably reduced but may last the entire permit cycle as will those effects related to instream water quality and quantity.

The amount of take expected in the Flathead Lake and the Swan Lake sub-basin is difficult to quantify due to: the wide ranging distribution of bull trout, inability to identify and detect dead or impaired species at the egg and larval stages, seasonal fluctuations in numbers, and the difficulty in ascribing aquatic habitat modifications to a particular source, especially in degraded watersheds. The Service expects the level of incidental take of the proposed project to be minimal due to the proposed measures to minimize impacts to bull trout. Therefore, even though the Service expects incidental take to occur from the effects of the proposed action, the expected level of take is "unquantifiable," although anticipated to be very small to absent on an annual basis.

Due to the small level of take anticipated to occur from the licensing of the Bigfork Hydroelectric Dam, and the limited area of the effects to bull trout, the Service determined that this project will not jeopardize the continued existence of bull trout throughout the DPS. The Services' *Endangered Species Consultation Handbook* (Service and NMFS 1998) allows for a jeopardy analyses for actions under formal consultation to be done at the DPS level.

This take statement is based on the implementation of the project description, including the mitigation measures, as provided by the FERC through formal consultation and described in the project description of this biological opinion. To ensure protection for a species assigned an unquantifiable level of take due to activities related to the proposed action, reinitiation is required if the Terms and Conditions are not adhered to and/or the magnitude of the proposed activities exceed the scope of this opinion. Determination of reinitiation of consultation pursuant to the Act will depend upon the nature and extent of any noncompliance with the implementation of the project description, and the terms and conditions of this incidental take statement, and may result in loss of take exemption from the prohibitions of section 9 of the Act.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of bull trout:

1. The FERC shall minimize impacts to bull trout from the operation of the Project.
2. The FERC shall minimize impacts to bull trout from the maintenance of the Project.
3. The FERC shall implement reporting and consultation requirements as outlined in the following terms and conditions.

In order to be exempt from the prohibitions of section 9 of the Act, the FERC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions implement the reasonable and prudent measure number 1 above *(The FERC shall minimize impacts to bull trout from the operation of the Project.)*:

A. The FERC shall ensure that the minimum instream flow monitoring plan is in place no later than 6 months after the license is issued. This plan will be developed in conjunction with the MFWP and the Service and submitted to the Service for review and approval. The plan should include measures to report any instream flow monitoring results.

B. The FERC shall ensure that a water quality monitoring plan is developed in conjunction with fisheries biologists from MFWP and the Service and submitted to the Service for review and approval no later than 6 months after the license is issued. The monitoring plan will focus on water quality (temperature and DO levels) within the bypass reach during the summer months (July through September). The measurements should be recorded with sufficient periodicity to adequately determine if the water quality within the bypass reach during the summer months meets Montana State water quality standards. The monitoring plan should at a minimum be implemented for three consecutive summer flow seasons with criteria in place to determine if further water quality evaluation is necessary.

C. The FERC shall ensure a Recreational Resource Management Plan is developed in conjunction with fisheries biologists from MFWP and the Service. The plan shall be developed and submitted to the Service for review and approval no later than one year after the license is issued. The plan will include details regarding the recreational flows as described in the Settlement Agreement such as ramping rates and water quality monitoring.

The following terms and conditions implement the reasonable and prudent measure number 2 above *(The FERC shall minimize impacts to bull trout from the maintenance of the Project.)*:

A. The FERC shall ensure that a diversion channel erosion control plan is developed and submitted to the Service for review and approval no later than 6 months after the license is issued.

B. The FERC shall ensure that fish screens are installed consistent with the proposed action no later than one year after the license is issued. A screen maintenance and operation plan and a screen effectiveness monitoring plan shall be developed and submitted to the Service for review and approval no later than one year after license is issued. The plan should include provisions for quick replacement of any damaged sections of screen and detail how the entrainment of fish will be minimized during any maintenance and repair activities as well as an evaluation of the effectiveness of manual screen cleaning during periods of high debris loads.

C. The FERC shall ensure that the Canal Operation and Maintenance Plan is developed in conjunction with fisheries biologists from MFWP and the Service and submitted to the Service for review and approval no later than one year after license is issued. The plan should provide an estimated schedule of any canal dewatering activities as well as minimization measures intended to reduce the effects to bull trout from changes in bypass flow or dewatering of the canal. The plan should include provisions to notify the Service, along with any anticipated effects, of any unscheduled non-emergency maintenance activities with at least 45 day prior notification.

D. The FERC shall ensure that the existing fish ladder be maintained sufficiently to prevent upstream movement of fish. The fish ladder will be closed until such time as the MFWP and the Service in conjunction with the applicant deem it necessary to provide upstream fish passage.

The following terms and conditions implement the reasonable and prudent measure number 3 above *(The FERC shall implement reporting and consultation requirements as outlined in the following terms and conditions.)*:

A. Upon locating dead or injured bull trout or upon observing destruction of redds, the FERC shall ensure notification be made within 24 hours to the Montana Field Office at 406-449-5225. Record information relative to the date, time, and location of dead or injured bull trout when found, and possible cause of injury or death of each fish and provide this information to the Service.

B. All reports described within the monitoring plans in Terms and Conditions 1A, 1B and 1C and 2A, 2B, 2C will be submitted collectively within one month of the end of each calendar year, for the duration as detailed in the individual plans, to the Service's Kalispell, Montana office.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. With implementation of these measures, the Service expects that take of bull trout will be a result of the impacts to instream habitat associated with increases in sediment, modifications to water quality, and modifications of instream habitat conditions for the life of the proposed action.

If, during the course of the action, the project descriptions are not adhered to, the level of incidental take anticipated in the biological opinion may be exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends that the FERC implement the following conservation recommendations:

A. Continue to monitor, inventory, investigate and document the bull trout populations and spawning activities throughout the entire action area.

B. Upon finalization of the Service's Bull Trout Recovery Plan, the FERC and PacifiCorp should consider implementation of applicable recovery tasks.

Reinitiation Statement

This concludes formal consultation on the action(s) outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) the amount or extent of incidental take is exceeded;

(2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;

(3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion to include impoundment dredging activities, or continued beyond the dates detailed in the "Amount or Extent of Take" and the "Reasonable and Prudent Measures" sections of this Biological Opinion; or

(4) a new species is listed or critical habitat designated that may be affected by the action.

Non-compliance with the proposed action or failure of any proposed minimization measure may trigger reinitiation of consultation. The Service retains the discretion to decide when consultation should be reinitiated and the protection of the incidental take statement should be withdrawn because of non-compliance with the proposed action.

LITERATURE CITED

Allan, J.H. 1980. Life history notes on the dolly varden char (*Salvelinus malma*) in the Upper Clearwater River, Alberta. Manuscript Report. Energy and Natural Resources, Fish and Wildlife Division. Red Deer, AB. 58 pp.

Adams, S.B. 1994. Bull trout distribution and habitat use in the Weiser River drainage, Idaho. M.S. Thesis. University of Idaho, Moscow, Idaho.

Bates, K. 1988. Screen Criteria for Juvenile Salmon. Washington State Department of Fisheries. Olympia, Washington.

Baxter, J.S. and J.D. McPhail. 1996. Bull trout spawning and rearing habitat requirements: Summary of the literature. Fisheries Technical Circular No. 98, B.C. Ministry of Environment, Lands, and Parks; Fisheries Branch, Vancouver.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams: influences of forest and rangeland management on salmonid fishes and their habitats. W.R. Meehan, ed., American Fisheries Society Special Publication 19:83-138.

Brown, L.G. 1992. On the zoogeography and life history of Washington native char Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*). Washington Department of Wildlife, Fisheries Management Division Report. Olympia, Washington.

Buckman, R.C., W.E. Hosford and P.A. Dupee. 1992. Malheur river bull trout investigations. Pages 45-57 *in*: Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Cavender, T.M.1978. Taxonomy and Distribution of the Bull Trout, *Salvelinus confluentus* (Suckley), from the American Northwest. California Fish and Game 64:139-174. (As referenced in USDI 1998).

Clancy, C.G. 1993. Statewide fisheries investigations: Bitterroot Forest inventory, Montana Fish, Wildlife, and Parks, Job Completion Report, Project F-46-R-4-Ij, Helena, Montana.

Cross, D. and L. Everest. 1995. Fish habitat attributes and managed watersheds with special reference to the location of bull char spawning sites in the Upper Spokane river ecosystem. Fish Habitat Relations, Technical Bulletin No. 17.

Cummins, K.W. and G.H. Lauff. 1968. The influence of substrate particle size on the microdistribution of stream benthos. Hydrobiologia 34: 145-181.

Dambacher, J.M. and K.K. Jones. 1997. Stream habitat of juvenile bull trout populations in Oregon and benchmarks for habitat quality. *In*: Mackay, W.C., M.K. Brewin and M. Monita, Friends of the Bull Trout Conference Proceedings. May 1994. Calgary, Canada.

Deleray, M., L. Knotek, S. Rumsey, and T. Weaver. 1999. Flathead Lake and River system fisheries status report. Montana Fish, Wildlife and Parks, Kalispell.

[FERC] Federal Energy Regulatory Committee. 2002a. Final Environmental Assessment for Hydropower License: Bigfork Hydroelectric Project FERC Project No. 2652-007 Montana. Federal Energy Regulatory Committee, Washington D.C.

Forest Service (see U.S. Forest Service)

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Frissell, C.A., J. Doskocil, J.T. Gangemi, and J.A. Stanford. 1995. Identifying priority areas for protection and restoration of aquatic biodiversity: A case study in the Swan River basin, Montana. Biol. Stn. Open File Report No. 136-95, Flathead Lake Biological Station, Univ. of Montana, Polson, Montana.

Gilpin, M. 1996. Analysis towards a PVA for the bull trout in western Montana: A progress report for the Montana Bull Trout Science Group. Bozeman, Montana.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. Willamette National Forest, Eugene, Oregon.

Goetz, F. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. Master's Thesis. Oregon State University, Corvallis, Oregon.

Graham, P.J., B.B. Shepard, and J.J. Fraley. 1981. Use of stream habitat classifications to identify bull trout spawning areas in streams. Pages 186-192 in N.B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. 1982. Western Division of the American Fisheries Society, Bethesda, Maryland.

Haas, G.R. and J.D. McPhail. 1991. Systematics and distributions of dolly varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48: 2191-2211.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-326.

Healy, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-184.

Jakober, M. 1995. Autumn and winter movement and habitat use of resident bull trout and westslope cutthroat trout in Montana. Masters Thesis, Montana State University, Bozeman, Montana.

Leary, R.F. and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation Genetics of Bull Trout in the Columbia and Klamath River Drainages. Conservation Biology. 7:856-865. (as referenced in U.S. Department of the Interior 1998a)

Leathe, S.A. and M.D. Enk. 1985. Cumulative effects of microhydro development on the fisheries of the Swan River drainage, Montana. I. Summary Report. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

Leathe, S. and F. Nelson, 1989. A literature review of Montana's wetted perimeter inflection point method for deriving instream flow recommendations. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

MBTSG (see Montana Bull Trout Scientific Group).

McCullough, D.A. 1999. Technical issues regarding bull trout temperature standards. Responses to EPA questions. Peer review document. EPA, Boise.

McMahon, T., A. Zale, J. Selong, and R. Barrows. 1998. Growth and survival temperature criteria for bull trout - annual report 1998. Montana State University, Bozeman.

McMahon, T., A. Zale, J. Selong, and R. Barrows. 1999. Growth and survival temperature criteria for bull trout - annual report 1999. Montana State University, Bozeman.

McPhail, J.D. and C.B. Murray. 1979. The early life-history and ecology of dolly varden (*Salvelinus malma*) in the Upper Arrow Lakes. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, British Columbia.

Meehan, W.R. and T.C. Bjornn. 1991. Salmonid distribution and life histories. Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19, Bethesda, Maryland.

[MBTSG] Montana Bull Trout Scientific Group. 1995. Flathead River Drainage Bull Trout Statue Report (Including Flathead Lake, the North and Middle Forks of the Flathead River and the Stillwater and Whitefish Rivers). Unpubl. Report prepared for the Montana Bull Trout Restoration Team, Helena, Montana.

[MBTSG] Montana Bull Trout Scientific Group. 1996. Swan River drainage bull trout status report (including Swan Lake). Unpubl. Report prepared for the Montana Bull Trout Restoration Team, Helena, Montana.

[MBTSG] Montana Bull Trout Scientific Group. 1998. The relationship between land management activities and habitat requirements of bull trout. Unpubl. Report prepared for the Montana Bull Trout Restoration Team, Helena, Montana.

Moyle, P.B. and J. Cech, 1996. Fishes: An introduction to Ichthyology 3rd Edition. New Jersey, Prentice Hall. 590 pp.

Nelson, F.A. 1989. Guideline for Using the Wetted Perimeter (WETP) Computer Program of the Montana Department of Fish, Wildlife and Parks. Montana Department of Fish, Wildlife and Parks, Bozeman MT.

Office of Technology Assessment. 1995. Fish Passage Technologies: Protection at Hydropower Facilities, OTA-ENV-641. Washington DC: U.S. Government Printing Office.

Oliver, C.G. 1979. Fisheries investigations in tributaries of the Canadian portion of the Libby Reservoir. Fish and Wildlife Branch, Kootenay Region.

PacifiCorp, 2000. Final Application for License for Major Water Power Project 5 Megawatts or Less: Bigfork Hydroelectric Project (FERC No. 2652) Volume I and II. PacifiCorp, Portland Oregon.

Platts, W.S. 1991. Livestock Grazing. *In* Meehan, W.R. (editor). Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19, Bethesda, Maryland.

Platts. W., M. Hill, W. Hillman, and Miller. 1993. Preliminary status report on bull trout in California, Idaho, Montana, Nevada, Oregon, and Washington.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5 - 9 *in:* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Pratt, K.L. and J.E. Huston. 1993. Demographic and habitat requirements for conservation of bull trout. USDA, Forest Service, Intermountain. Research. Station, GTR-302, Ogden, Utah.

Quigley, T.M. and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the interior Columbia basin and potions of the Klamath and Great Basins: volume III. General Technical Report PNW- GTR-405. U.S. Department of Agriculture, Forest Service, and U.S. Department of the Interior, Bureau of Land Management.

Ratliff, D.E. 1992. Bull trout investigations in the Metolious River-Lake Billy Chinook system. Pages 37-44 *in* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Ratliff, D. E. and P. J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 *in* Howell, P.J. and D.V. Buchanan, eds., Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Rieman, B.E. and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. USDA Forest Service, Intermountain Research Station, GTR INT-302, Ogden, Utah.

Rieman, B.E. and J. D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124(3): 285-296.

Rieman, B.E., D.C. Lee, and R.F. Thurow. 1997. Distribution, status, and likely future trends of bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology. Printed Media Companies, Minneapolis, Minnesota.

Shepard, B.B., K.L. Pratt, and P.J. Graham. 1984. Life histories of westslope cutthroat trout and bull trout in the upper Flathead River Basin, Montana. Unpubl. Report, Montana Department of Fish, Wildlife, and Parks, Helena, Montana.

Stalnaker, C., B.L. Lamb, J. Henriksen, K. Bovee, and J. Bartholow. 1995. The Instream Flow Incremental Methodology: A Primer for IFIM. National Biological Service, Washington D.C.

Thomas, G. 1992. Status report: bull trout in Montana. Report prepared for Montana, Fish, Wildlife, and Parks, Helena, Montana.

Thurow, R.F., D.C. Lee, and B.E. Rieman. 1997. Distribution and status of seven native salmonids in the Interior Columbia River Basin and portion of the Klamath River and Great Basins. North American Journal of Fisheries Management 17:1094-1110.

[USACE] U.S. Army Corps of Engineers, 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria. Fish Passage and Development Program. Portland, OR.

[USDA and USDI] U.S. Department of Agriculture and U.S. Department of the Interior. 1998. Biological assessment: effects to bull trout, shortnose sucker, Lost River sucker, and Warner sucker of Land and Resource Management Plans, and associated federal actions on National Forest and Bureau of Land Management Resource Areas in the Columbia River, Klamath River, and Jarbidge River basins. Forest Service and Bureau of Land Management.

U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of Commerce, and Environmental Protection Agency. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team [FEMAT]. Forest Service, Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, Bureau of Land Management, Environmental Protection Agency, Portland, Oregon.

[USDI] U.S. Department of the Interior. 1998a. Endangered and threatened wildlife and plants; determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. U.S. Fish and Wildlife Service, June 10, 1998. Federal Register 63(111): 31647-31674.

[USDI] U.S. Department of the Interior. 1998b. A framework to assist in making endangered species act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. U.S. Fish and Wildlife Service.

[USDI] U.S. Department of the Interior. 1999. Endangered and threatened wildlife and plants: proposal to list the Coastal-Puget Sound Population Segment of bull trout as Threatened Species (June 10, 1998). U.S. Department of the Interior, Fish and Wildlife Service. Federal Register 64 (210) 58910-58933.

[USDI] U.S. Department of Interior. 2002. Endangered and Threatened Wildlife and Plants; Proposed Designation of Critical Habitat for the Klamath River and Columbia River Distinct Population Segments of Bull Trout (November 29, 2002). U.S. Department of Interior, Fish and Wildlife Service. Federal Register 67 (230) 71236-71438.

U.S. Forest Service. 2000a. Bull Trout Watershed Baselines, Middle and North Fork Flathead River Drainages. Prepared by Flathead National Forest, April, 2000.

U.S. Forest Service. 2000b. Baseline Condition for Bull Trout (*Salvelinus confluentus*), Swan River Drainage, including disjunct populations of Holland Lake and Lindbergh Lake. Prepared by Flathead National Forest, April, 2000.

[Service] U.S. Fish and Wildlife Service, 2002. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

[Service and NMFS] U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook (Final). Procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act. U.S. Fish and Wildlife Service and National Marine Fisheries Service.

Watson, G. and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252.

Weaver T. M. and J. J. Fraley. 1993. A method to measure emergence success of westslope cutthroat trout fry from varying substrate compositions in a natural stream channel. North American Journal Fisheries management 13: 817-822.

Weaver, T.M. and R.G. White. 1985. Coal Creek fisheries study no. III. Montana State Cooperative Fisheries Research Unit, Bozeman, Montana. 94 pp.

Williams, R.N., R.P. Evans and D.K. Shiozawa. 1997. Mitochondrial DNA diversity patterns of bull trout in the upper Columbia River Basin. *In*: Mackay, W.C., M.K. Brewin and M. Monita, eds., Proceedings - Alberta Friends of the Bull Trout, May 1994. Trout Unlimited, Bull trout Task Force. Calgary, Canada.

Zydlewski, G.B., J. Johnson, J. Stow, and C. Burger. 2000. Validation of existing fish screen criteria for juvenile bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Abernathy Fish Technology Center, Technical Information Leaflet No. AB-00-01, Longview, WA.

Zubik, R. H. and J.J. Fraley. 1987. Determination of fishery losses in the Flathead system resulting from the construction of Hungry Horse Dam. Prepared for Bonneville Power Administration, Portland, Oregon by Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.