CONTENTS

LIST OF TABLES

LIST OF FIGURES

4.7 CREEL SURVEY (AQU 7)

A creel survey was conducted by the Washington Department of Fish and Wildlife (WDFW) on Swift and Merwin reservoirs and the Swift canal as part of the Lewis River Hydroelectric Project relicensing studies for PacifiCorp and Cowlitz PUD. The purpose of the Creel Survey is to document existing fishery conditions, which will aid relicensing decisions.

4.7.1 Study Objectives

The objective of the Creel Survey is to provide information on the success of hatchery stocking programs in the Lewis River basin. Creel surveys are an important tool for fisheries managers to evaluate factors such as the contribution and effectiveness of hatchery stocking programs, fish health, population status, recreational value, and the ability of a fishery to meet angler harvest goals. Surveys also provide a means for disseminating information to the angling public.

The specific objectives of these creel surveys are to quantify angler effort (hours), angler catch rates, and angler harvest by fish species (number of fish) as well as gain biological information (lengths, origins, possibly age) for those fish species.

4.7.2 Study Area

Creel surveys were conducted at Swift Reservoir, Swift canal, and Lake Merwin.

4.7.3 Methods

Task 1: Swift Reservoir and Swift No. 2 Power Canal

The WDFW will conduct a creel survey to estimate monthly angler effort and harvest by species from April 24 through October 1999 for Swift Reservoir and the Swift No. 2 power canal. Survey methods will be similar to those employed in a 1995 WDFW study on Lake Merwin (Tipping 1996) and ongoing studies at Mayfield and Riffle reservoirs and Swofford Pond. Briefly, boat and shore anglers were counted every 2 hours from one hour after first light to one hour before dark for 4 randomly assigned weekdays and 4 weekend and holiday days per month. In addition, for opening day weekend in April, the Brown (1978) methodology will be used to estimate harvest each day.

Boats will be counted from shore every 2 hours and secondly, boat trailers in the parking lot will be counted and adjusted for anglers not fishing after the owners are interviewed. On a monthly basis, we will pass through the reservoir in a boat, counting anglers to develop a correction factor for anglers not observed from shore.

In between counts, anglers will be interviewed for hours fished and catch by species. Lengths of fish caught will be recorded. Anglers will be asked to state their county of residence. Daily weekend and weekday effort will be extrapolated for the month. Catch rates will then be applied to provide an estimate of harvest. Mean and standard deviation of catch rates will be presented.

Fishing gear and fishing areas will be noted for anglers possibly targeting bull trout. Anglers will be asked about incidental hooking of bull trout. Starting in late July 1999, anglers have been asked to answer a series of questions regarding identification of bull trout and other species (with the questions, forms, and protocol provided by the ARG).

A bull trout survey is an additional component to the creel survey currently underway on Swift Reservoir. This protocol, however, can be used for other creel surveys to reach additional anglers in the basin. The survey is designed to be both a data gathering tool as well as an information outreach to the fishing public.

The survey protocol consists of 2 elements: (1) a "key-chain" of 6 color pictures (4x8) of resident fish species occurring in project reservoirs, and (2) a simple questionnaire used to document the ability of anglers to identify bull trout.

Upon completion of the standard creel interview, the angler will be asked a series of questions related to bull trout. The objective of these questions is to increase angler awareness regarding bull trout identification, bull trout regulations, and present population status. The goal is to reduce the number of bull trout harvested from the North Fork Lewis River.

The bull trout survey should be short and include the following:

1. Creel clerk informs angler that we are conducting a bull trout survey and that answers will be used for educational purposes and help direct bull trout management in this area.

2. Creel clerk uses a separate bull trout survey form for each angler. When groups are encountered, only one survey form and one angler needs to be interviewed.

3. After indicating on the form whether the angler is a resident (from creel survey form), amount of angling experience, and whether the angler is alone or in a group, the angler is given the "key chain" cards and asked to identify the bull trout and other species if possible.

4. The angler will be told that all fish on the key chain are from the trout family and reside in one or all of the 3 reservoirs.

5. The creel clerk will mark the survey form accordingly.

After the fish identification:

6. The clerk will inform the angler of incorrect responses and describe the unique characteristic of bull trout (i.e., no black markings on dorsal fin) and other species, if necessary.

7. Inform the angler that bull trout reside in all 3 reservoirs.

8. Inform the angler that bull trout are a federally and state protected species under the Endangered Species Act and fishing for them is prohibited. If caught, bull trout must be released immediately [no exceptions].

9. Angler is given information paper on bull trout (same as bull trout sign).

Any comments regarding the interview can be made on the survey form provided.

A copy of the form that will be used to query anglers regarding bull trout is presented on the following page. In addition to the information provided to anglers, large signs will be placed at the boat launching areas of all 3 reservoirs. The signs provide ways to identify bull trout as well as current information on bull trout.

Observations will also be made for possible severe avian predation (cormorants) on fish, a possible reason for poor survival of rainbow trout in the lake in recent years.

Task 2: Lake Merwin

Starting in November 1999 through October 2000, the WDFW will perform a creel survey on Lake Merwin to estimate monthly angler effort and harvest by species. Of special interest is the sport fishery contribution of marked hatchery kokanee, which were planted in spring 1999. Although excellent kokanee catches occurred in 1998, the origin of the fish was uncertain. The 1999 release has been marked with removal of the adipose fin. In addition to kokanee, hatchery rainbow trout were planted in 1998 and tiger muskies have been planted since 1995. The first legal-sized tiger muskies may enter the fishery in the fall of 1999. Assessment for rainbow trout and tiger muskies is also needed. Creel survey methods will be similar to the Swift Reservoir work. A monthly update of estimated angler effort and harvest, by species, will be provided.

4.7.4 Key Questions

No "key" watershed questions were identified in the Study Plan Document (PacifiCorp and Cowlitz PUD 1999, as amended) that pertain to this study.

4.7.5 Study Results

4.7.5.1 Swift Reservoir Results

Swift Reservoir is uppermost and largest (4,680 acres [1,894 ha]) of 3 impoundments on the Lewis River, created in 1958 by completion of Swift Dam at river mile (RM) 47.9. Turbine intakes are at 178 feet (55 m) and the lake elevation is 1,000 feet (304 m) at full pool.

PacifiCorp funds the WDFW to rear and stock about 800,000 rainbow trout (*Oncorhynchus mykiss)* fingerlings each spring in the lake for sport harvest the following year. Some trout are thought to flush from Swift into Yale Lake, as evidenced by harvest of rainbow trout there. Rainbow trout are not stocked in Yale (Harza 1997). Wild fish in Swift Reservoir include cutthroat trout *(O. clarki)*, threatened bull trout *(Salvelinus confluentus)*,

mountain whitefish *(Prosopium williamsoni)*, sucker *(Catostomus* sp.*)*, and sculpins *(Cottus* sp.*)*. Kokanee salmon *(O. nerka)* were planted in the reservoir in the 1960s but did not establish themselves.

The angling season is open from late April through October. Angling regulations allow a limit of 5 fish with no minimum size. The lake was closed to fishing for bull trout in 1992 because of an apparent decline in numbers.

Major access points include Swift Dam, a boatramp about 3/4^{ths} of the way up the lake, and another access where the Lewis River enters the lake at Eagle Cliff. There are also private docks at the upper end of the lake. Other access is moderately difficult due to steep banks along the lake.

In total, 496 anglers were interviewed who had fished a total of 1,800 hours (943 hours by boat and 857 hours by shore) and harvested 411 fish (252 by boat and 159 by shore). Total estimated angler effort was 7,521 hours to harvest 1,504 fish (Table 4.7-1). Six correction factor counts conducted from June through August included 27 shore anglers and 30 boats from shore observation points. Thirty shore anglers and 30 boats were observed from a boat.

Table 4.7-1. Estimated angler hours and fish harvested from Swift Reservoir for 1999.

Month	Angler Hrs	Rainbow	Cutthroat	Coho
April	589	131	25	7
May	1,230	330	60	2
June	1,377	203	35	0
July	2,184	221	72	0
August	1,082	128	7	0
September	708	96	10	0
October	351	165	12	0
Total	**7,521**	**1,274**	**221**	**9**

Rainbow trout and cutthroat trout comprised 84.7 percent and 14.7 percent of fish harvested, respectively. A few coho salmon *(O. kisutch)* were observed in the creel, apparently accidentally mixed in with hatchery rainbow fingerlings released in the lake. Mean length of coho salmon in the creel was 23.0 cm (n=4). Three bull trout were reported as caught and released but were not observed.

Mean length of harvested rainbow trout averaged 20.8 cm in April and increased to 29.3 cm in September; lengths declined in October as the next year-class of fingerlings recruited to the fishery (Table 4.7-2). The length-frequency of rainbow trout had a bimodal distribution with one peak at about 21 cm and another at about 28 cm, which appears to represent 2 year-classes (Figure 4.7-1). Scale analysis indicated age 1+ fish averaged 25.1 cm (n=23) while age 2+ fish were 28.4 cm (n=5). Four age 0+ fish were sampled in September at a mean length of 21.5 cm. The length-frequency distribution of cutthroat trout indicated several year-classes were present (Figure 4.7-2). Scale analysis revealed age 2+ cutthroat averaged 25.0 cm (n=4) in length while age 3+ fish averaged 30.5 cm (n=4).

Table 4.7-2. Mean length of sport harvested rainbow and cutthroat trout by month for Swift Reservoir, 1999.

Month	Mean length in cm (n) [1]			
	Rainbow		Cutthroat	
April	20.8	(47)	28.3	(7)
May	24.8	(92)	27.9	(20)
June	25.3	(47)	27.3	(10)
July	24.4	(17)	27.7	(3)
August	27.4	(44)	32.0	(1)
September	29.3	(3)	37.0	(1)
October	26.8	(32)	30.5	(2)

[1]n = sample size, shown in parentheses

Harvest rates in Swift Reservoir averaged 0.15 fish/hour for shore anglers and 0.28 fish/hour for boat anglers, with a combined harvest rate of 0.21 fish/hour (Table 4.7-3). April (0.31 fish/hour) was the most successful month for shore anglers, while May and October were the most successful months for boat anglers.

Table 4.7-3. Mean (sd)[1] harvest per hour for all species combined for anglers fishing Swift Reservoir in 1999.

Month	Angler type				Anglers interviewed
	Shore		Boat		
April	0.31	(0.47)	0.00	(0.00)	65
May	0.20	(0.40)	0.43	(0.49)	127
June	0.12	(0.17)	0.26	(0.31)	85
July	0.01	(0.11)	0.20	(0.27)	90
August	0.00	(0.00)	0.26	(0.41)	70
September	0.00	(0.00)	0.19	(0.33)	47
October	0.00	(0.00)	0.53	(0.38)	12
Mean	**0.15**	**(0.35)**	**0.28**	**(0.38)**	**496**

[1]sd = standard deviation, shown in parentheses

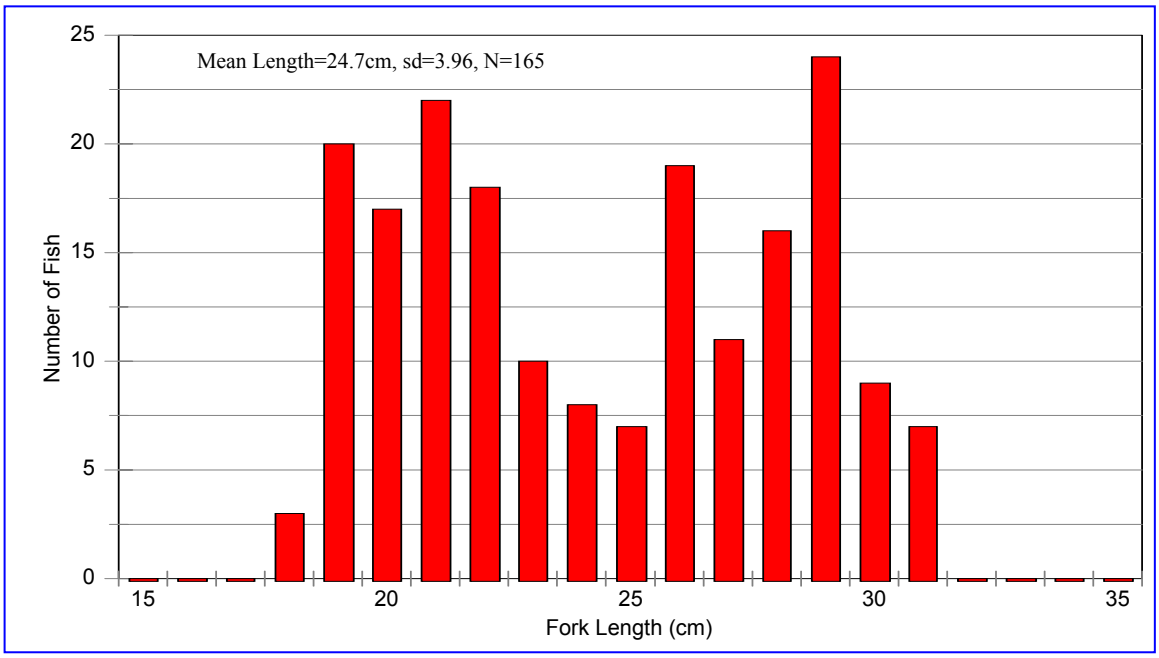

Figure 4.7-1. Length frequency of rainbow trout caught from Swift Reservoir, 1999.

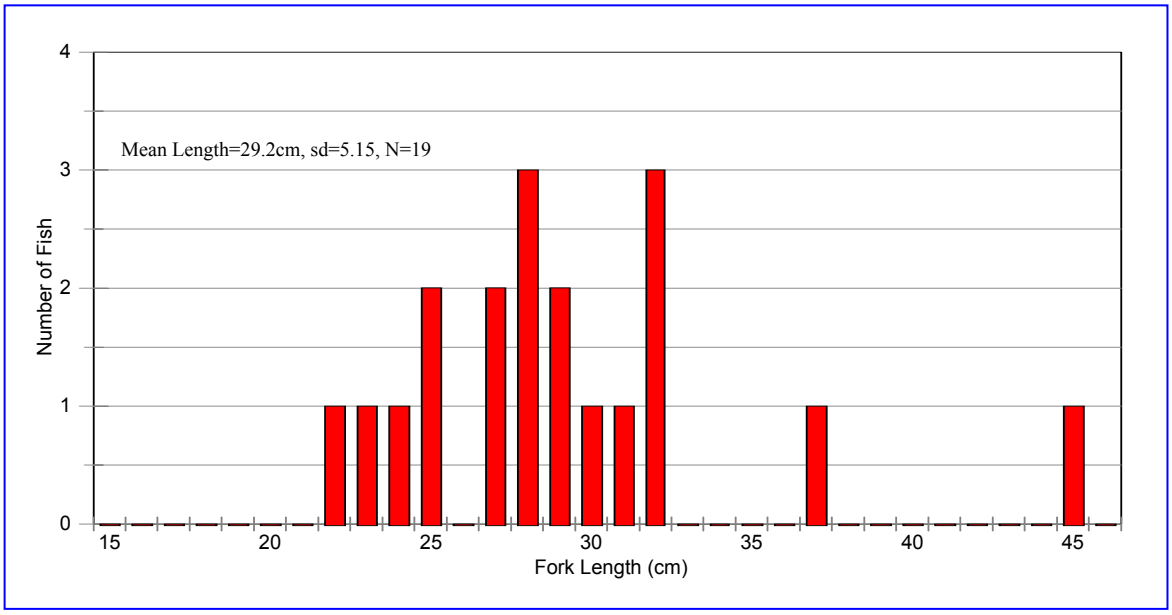

Figure 4.7-2. Length frequency of cutthroat trout caught from Swift Reservoir, 1999.

Angler response to the fish identification pictures showed that most people identified rainbow trout (84.4 percent) but were less skilled in identifying other species (Table 4.7-4). Of particular concern, bull trout were correctly identified by only 38 percent of anglers. Most anglers resided in Clark (61 percent) and Cowlitz (26 percent) counties, with few from other areas (Table 4.7-5).

Table 4.7-4. Fish identification survey response, Swift Reservoir and Swift Canal (n=45).

	Percent with correct identification
Rainbow Trout	84.4
Cutthroat Trout	53.3
Brook Trout	46.7
Bull Trout	37.8
N. Pikeminnow	46.7
Kokanee	17.8

Table 4.7-5. County of residence for Swift Reservoir and Swift Canal anglers (N=556).

County	Percent	County	Percent
Clark	61.3	Snohomish	1.2
Cowlitz	25.6	Pierce	0.3
Skamania	6.5	Thurston	0.2
King	3.1	Lewis	0.2
Out-of-state	1.7		

The 1999 Swift Reservoir fishery was poor. Angler effort was impaired by low fish catch rates, poor boat access in spring due to low reservoir levels, and inclement weather. Prior to 1996, the lake provided excellent harvests and large amounts of angler effort. Opening day catches from 1984 through 1995 averaged 4.4 fish per angler compared to 0.8 fish per angler from 1996 through 1999. Graves (1983) estimated that Swift Reservoir anglers spent 36,222 and 92,045 hours in 1978 and 1979 to harvest 36,312 and 139,634 fish for those same years, respectively. The 1999 effort and harvest was 11 percent and 1.7 percent, respectively, of the 1978-79 average. A concurrent creel study at Riffe Lake on the Cowlitz River from May through October 1999 showed that effort and harvest was 85 percent and 56 percent, respectively, of that in 1986 (Tipping 1988; Tipping and Harmon 2000). This suggests that effort and harvest may have declined regionally since the 1980s, but not by the magnitude reflected in the 1999 Swift harvest.

Reasons for the decline in fish abundance are uncertain but could include turbidity-induced reductions in lake plankton production; angler over harvest in the lake; spilling fish from the reservoir; or mortality from disease or predation. However, extreme turbidity in the lake was also encountered as a result of floods. Avian predators were not observed in large numbers during the study, although most double-crested cormorants move to inland waters in winter and early spring.

Since fish size reflects food abundance and the April 1999 harvest of 20 cm rainbow trout were considerably smaller than the 25 cm average observed in spring 1979 and 1990 (Graves 1983; PacifiCorp 1996), less food was probably available in 1998-1999. Length-frequencies also show the presence of 26-31 cm trout, relatively small carryovers from the 1997 release. The small size of both year-classes in 1999 suggests that insufficient

food was present or turbidity prevented effective food location. The 1999 release of rainbow trout was reduced to 500,000 fish in hopes of improving growth and survival for 2000.

The catch rate observed in Swift Reservoir in 1999 (0.21 fish/hour) was the lowest reported at any time for all 3 Lewis River reservoirs. Catch rates for Swift were 0.92 fish/hour in 1978, 1.5 fish/hour in 1979 (Graves 1983), and 0.83 fish/hour in 1990 (PacifiCorp 1996). Catch rates in Yale Lake were 0.65 fish/hour for 1978, 0.80 fish/hour for 1979 (Graves 1983), and 0.30 fish/hour for 1997 (Harza 1997). Catch rates in Lake Merwin were 0.39 fish/hour for 1978, 0.61 fish/hour for 1979 (Graves 1983), and 1.06 fish/hour for 1995 (Tipping 1995). Riffe Lake, a Cowlitz River impoundment, averaged 0.52 fish/hour in 1986, 0.53 fish/hour in 1987 (Tipping 1988), and 0.31 fish/hour in 1999 (Tipping and Harmon 2000). Catch rates tend to equilibrate at an unspecified threshold level, and this affects angler effort; if catch rates are high, angler effort will increase until catch rates decline to marginal levels. Conversely, if catch rates are low, anglers will not participate until the rates increase. The low catch rate observed on Swift Reservoir in 1999 was below the acceptable threshold level and, subsequently, angler effort was greatly depressed from prior years.

The relative abundance of wild cutthroat trout does not appear to have declined; the number of cutthroat harvested in 1999 (221) was similar to the 315 fish and 432 fish harvested in 1978 and 1979, respectively.

The inability of 62 percent of Swift Reservoir anglers to correctly identify endangered bull trout may confound efforts to protect the species. The incorrect identification response rate would probably have been higher if all anglers, rather than the group leader, were questioned. Additional educational signs in the area are warranted.

Additional work and monitoring needs to be done if a basin goal is to return the Swift Reservoir fishery to higher angling levels. If the ongoing planting reduction investigation fails to show positive results, other management approaches available to WDFW may include using different stocks of rainbow trout and other species of salmonids, such as coho salmon or kokanee.

Results from Opening Day 2000

Opening day of fishing season was sampled in April 2000. Results in Swift Reservoir indicated a substantial improvement over conditions in 1999. Estimated angler effort was 1,570 hours compared to 355 hours in 1999, and estimated harvest was 605 fish compared to 68 fish in 1999. Part of the increased angler effort may have been due to the boat ramp being usable in 2000. Mean length of the rainbow trout caught was 29.9 cm (n=46) compared to 20.8 cm in 1999. Fish survival may have greatly improved in 2000, although the fishery has not returned to levels observed in the 1980s and earlier.

At request of the WDFW, Fish Health Specialist Larry Durham examined fish caught from the reservoir on April 18, 2000 for pathogens. Of specific concern was *Diphyllobothrium* since that pathogen has debilitated rainbow trout in some western Washington waters. *Diphyllobothrium* in fish is a juvenile stage of a cestode tapeworm.

The larvae may be found loose in the viscera or burrowed into the musculature; when abundant, parasitized fish may be listless and swim near the surface, where they may be easily caught (Warren 1991). Relatively few *Diphyllobothrium* infected fish were found in Swift Reservoir (AQU7 Appendix 1).

4.7.5.2 Swift Canal Results

Swift canal, built in 1958, begins in the tailrace of the Swift No.1 powerhouse and is 3.2 miles long, with a surface area of only 100 acres. Fish exclusion screens do not exist on the Swift No. 1 powerhouse intake, and fish entering the canal are unable to re-enter Swift Reservoir (pers. comm., Erik Lesko, PacifiCorp, Portland, OR). A full season assessment of angler effort and harvest has not been conducted on the canal, although it is uncertain if it was included in the Swift Reservoir study by Graves (1983).

WDFW released an average of 1,006 rainbow trout in June of 1997-1999 in the canal for sport anglers. Angling regulations are identical to those in place on Swift Reservoir.

In total, 292 anglers were interviewed who had fished 691 hours to catch 153 fish, a harvest rate of 0.2 fish/hour. Total estimated effort and harvest was 3,108 hours and 656 fish, respectively (Table 4.7-6). The harvest was comprised of 96 percent rainbow trout, 2 percent cutthroat trout, and 1 percent bull trout. One kokanee, probably mixed at the hatchery with rainbow trout planted in Swift Reservoir, was observed in the creel. Fish caught from the canal were thought to originate from Swift Reservoir since the canal was not planted with trout until June. Harvest increased in June after fish were planted.

Table 4.7-6. Estimated angler hours and fish harvested from Swift canal, 1999.

Month	Angler Hrs	Rainbow	Cutthroat	Bull Trout	Kokanee
April	677	173	10	7	3
May	577	103	6	0	0
June	840	280	0	0	0
July	471	15	0	0	0
August	446	44	0	0	0
September	97	15	0	0	0
October	0	0	0	0	0
Total	**3,108**	**630**	**16**	**7**	**3**

Mean length of rainbow trout in April/May was around 22 cm, increasing as the season progressed (Table 4.7-7). Cutthroat trout and bull trout were only observed in the creel early in the season. Two bull trout were observed in the creel on opening weekend. A few other bull trout were later reported as caught and released. Similar to Swift Reservoir, the length-frequency profile of rainbow trout from the canal showed a bimodal distribution, with one apparent year-class centered around 21 cm and the other around 26 cm (Figure 4.7-3). Scale analysis of rainbow trout showed that age 1+ fish averaged 19.6 cm (n=7) while age 2+ fish averaged 26.0 cm (n=2).

Table 4.7-7. Mean length (cm) (n)[1] of sport-harvested fish from Swift canal, 1999.

Month	Rainbow Trout	Cutthroat Trout	Bull Trout	Kokanee
April	23.6 (42)	25.0 (3)	19.0 (2)	21.0 (1)
May	20.7 (50)	24.3 (3)	–	–
June	24.1 (43)	–	–	–
July	27.2 (5)	–	–	–
August	28.0 (6)	–	–	–
September	27.5 (2)	–	–	–
October	–	–	–	–

[1]n = sample size, shown in parentheses

Harvest rates were highest in April and June and declined through summer (Table 4.7-8). Few anglers were observed by late summer and fall.

The fish identification questionnaire was presented to anglers fishing in the canal. Results were combined with the Swift Reservoir data in Table 4.7-4. Only 37.8 percent of anglers correctly identified bull trout.

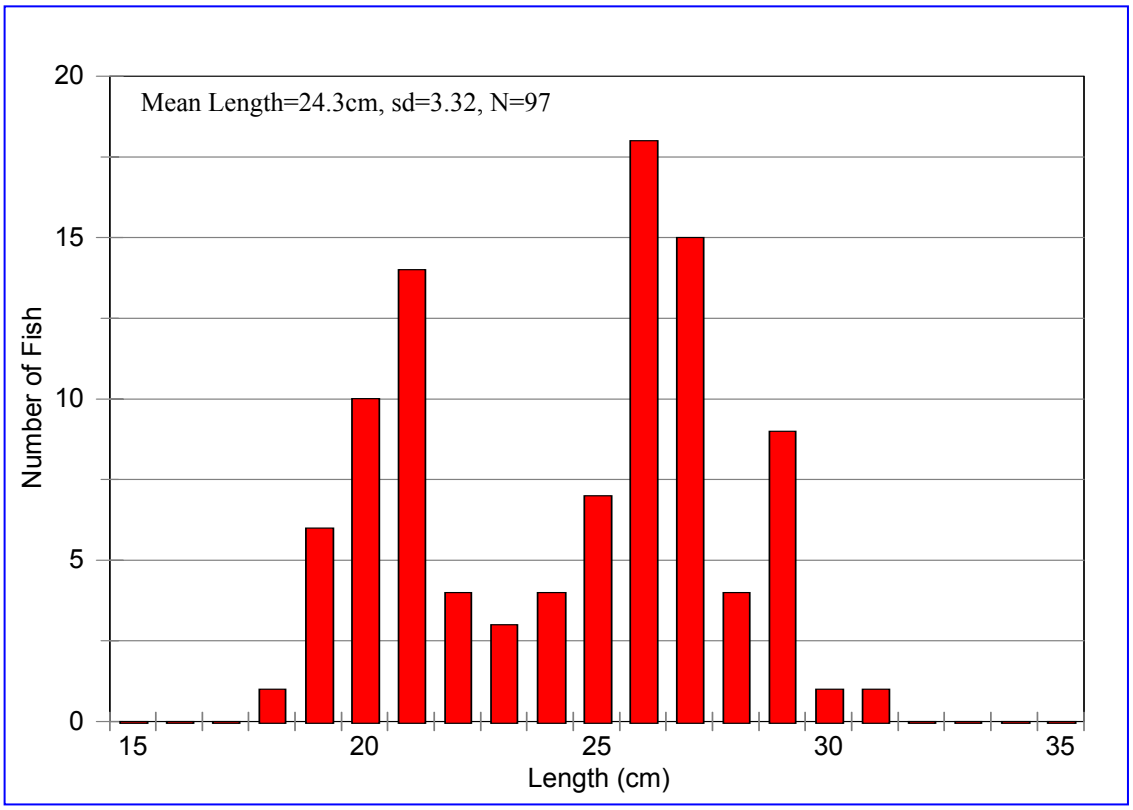

Figure 4.7-3 Length-frequency histogram of rainbow trout caught from Swift canal in 1999.

Table 4.7-8. Mean (sd)[1] harvest per hour for all species combined for anglers fishing Swift canal, 1999.

Month	Catch per hour	Anglers interviewed
April	0.34 (0.76)	101
May	0.19 (0.39)	85
June	0.27 (0.33)	52
July	0.04 (0.05)	31
August	0.09 (0.07)	15
September	0.11 (0.12)	8
October	0.00 (0.00)	0
Average	**0.20 (0.47)**	

[1]sd = standard deviation, shown in parentheses

Discussion

The Swift canal sport fishery in 1999 was poor, with low harvest, harvest rates, and angler effort. This condition undoubtedly reflects poor fish survival in Swift Reservoir since fish enter the canal from the reservoir. Of concern was the presence of bull trout in the canal due to their threatened status and their inability to return to Swift Reservoir and tributary spawning grounds.

Since fish recruit to the canal from Swift Reservoir, improving fish survival in the reservoir might enhance the canal fishery. Another management option to improve the recreational fishery would be to plant additional legal size trout in the canal throughout the summer.

4.7.5.3 Lake Merwin Results

Lake Merwin is the most downstream of 3 Lewis River impoundments. The 12-mile (19 km) long, 4,000-acre (1,618 ha) lake was created with completion of Merwin Dam in 1932. Historically, the lake has provided a modest salmonid sport fishery. Fish species present in the lake include northern pikeminnow *(Ptychocheilus oregonensis)*, kokanee salmon, rainbow trout, cutthroat trout, coho salmon, Chinook salmon *(O. tshawytscha)*, steelhead *(O. mykiss)*, tiger muskie (northern pike *Esox lucius* x muskellunge *E. masquinongy* cross), bluegill *(Lepomis macrochirus)*, largemouth bass *(Micropterus salmoides)*, brown bullheads *(Ictalurus nebulosus)*, carp *(Cyprinus carpio)*, suckers, and sculpins.

Northern pikeminnows historically have been abundant in the lake. In 1961, Hamilton et al. (1970) estimated that 350,000 20+cm (predator-size) pikeminnows were present. From 1961 to 1964, over 100,000 predator-size pikeminnows were removed using traps, gillnets, explosives, and rotenone. However, a follow-up survey found the abundance persisted.

From about 1983 through 1995, about 200,000 hatchery coho juveniles (20/lb) were planted annually in Lake Merwin for a resident sport fishery. In 1995, a May through August creel survey indicated that 19,337 angler hours were expended to catch 3,068 kokanee, 511 coho, 20 rainbow trout, and 20,764 northern pikeminnows (Tipping 1995). The coho harvest represented a return to the creel of 0.24 percent. Thereafter, the coho program was terminated and replaced with kokanee.

Kokanee have contributed substantially to the Merwin sport fishery, entering Merwin from Yale Lake in years of spill over the dam. In addition, some spawning occurs in Speelyai and Canyon creeks. Graves (1983) estimated that 26,388 hours were expended in 1978 to catch 10,174 fish, and in 1979 that 31,873 hours were expended to harvest 19,535 fish. Eddy and Meyers (1985) reported that from May 12 through October 26, 1984, an estimated 17,144 angler hours were expended to catch 8,296 salmonids, mostly kokanee. A hatchery kokanee program was initiated in 1997, with 41,560 fish planted. Currently, about 60,000 kokanee are released per year, split between fall and spring releases. In addition, tiger muskie were introduced to the lake in 1995 as a biological control on northern pikeminnows and to provide recreation opportunities. About 1,700 tiger muskie yearlings are released annually. Since 1995, excess hatchery fish from the Lewis River Hatchery have been released in Lake Merwin. Salmonid releases in 1999 are presented in Table 4.7-9, while tiger muskie releases are in Table 4.7-10.

Table 4.7-9. Salmonid plants into Lake Merwin, 1999.

Species and Mark	Number	Size (#/lb)
Kokanee (LVAD)[1]	20,234	14
Kokanee (AD)[2]	49,925	5
Kokanee	222,151	461
Spring Chinook	66,175	259
Spring Chinook	10,126	166
Spring Chinook	83,405	54
Spring Chinook	196,434	1,160
Coho	177,072	651
Coho	61,992	126
Coho	267,208	156
Coho	1,359,588	1,160
Summer steelhead	6,256	23
Winter steelhead	9,724	68
Winter steelhead	56,433	40

[1]LVAD = left ventral and adipose fins clipped
[2]AD = adipose fin clipped

Table 4.7-10. Tiger muskies released into Lake Merwin, 1995–2000.

Date	Number	Size (#/lb)
September 1995	1,208	5.8
May 1996	375	2.0
May 1997	1,331	4.0
May 1998	1,945	3.5
October 1998	1,717	10.0
May 1999	1,273	2.9
May 2000	2,096	3.0

The angling season is open year round, with a limit of 5 salmonids of no minimum size. Harvesting bull trout is prohibited. The statewide tiger muskie minimum harvest length of 36 inches (91 cm) applies to Lake Merwin. Major angler access points include the parks and boat ramps at Speelyai Bay, Cresap Bay, and Camper's Hideaway on the reservoir's upper reaches, and the dam at its lower end.

Sport Fishery

In total, 757 anglers were interviewed between November 1999 and October 2000. They fished a total of 3,444 hours (95.3 percent by boat) and harvested 956 fish (98.3 percent by boat). Total estimated angler effort was 32,123 hours to harvest 10,428 fish, including 9,602 kokanee, 448 coho, 161 rainbow trout, 161 Chinook salmon, and 56 cutthroat trout (Table 4.7-11). Although anglers seeking tiger muskies were observed on the lake, and tiger muskies were reported as caught and released, known harvest was only one fish (39 inches [99 cm]). Eight correction factor counts (the difference between anglers counted from a boat versus those counted from shore) were made from June through September 2000; boat weekday corrections averaged 1.08 and weekday corrections averaged 0.97; shore angler counts were 1.0.

Table 4.7-11. Angler hours and fish harvested from Lake Merwin, 1999-2000.

Month	Angler Hrs	Kokanee	Rainbow	Cutthroat	Coho	Chinook
1999						
November	29	0	3	0	0	0
December	74	0	0	0	0	0
2000						
January	13	6	0	0	0	0
February	421	0	0	0	12	0
March	1,581	267	0	0	0	0
April	3,941	521	27	14	22	0
May	4,610	1,359	16	36	81	104
June	6,437	1,577	60	0	127	17
July	10,056	3,816	55	6	150	40
August	2,851	1,367	0	0	12	0
September	1,487	461	0	0	44	0
October	623	239	0	0	0	0
Total	**32,123**	**9,602**	**161**	**56**	**448**	**161**

About half of the kokanee observed were unmarked fish, assumed to be from Yale Lake or naturally produced from Lake Merwin tributaries. For marked fish, return to the creel was 4.03 percent and 6.1 percent for the 1999 and 2000 release of yearlings, respectively, compared to 2.42 percent for the 1999 fall release (Table 4.7-12). The fall 1999 and spring 2000 releases should contribute heavily to the sport fishery in 2001, greatly increasing their returns to the creel. Although the spring releases outperformed the fall release for return to the creel, return per pound of fish released was greater for the fall release, 0.34 fish creeled per pound released versus 0.20 and 0.29 for spring releases.

Length of 1999 yearlings, about 21 cm in May 1999, reached 26 cm in March 2000 and increased to 30 cm by June (Table 4.7-13). Fingerlings released in fall 1999 at about 15 cm entered the sport fishery in April at 20 cm and reached 28 cm in August. The 2000 yearlings grew rapidly from 21 cm at release to 29 cm by fall. Length of coho salmon increased from 20 cm in April to 25 cm in August, much slower than kokanee growth.

Table 4.7-12. Harvest of unmarked and marked kokanee in Lake Merwin in 2000.

Month	Unmarked	AD-clipped	RVAD	LVAD
January	6	0	0	0
February	0	0	0	0
March	204	63	0	0
April	359	148	14	0
May	747	315	164	123
June	808	152	106	511
July	1,968	749	143	955
August	365	528	49	425
September	156	50	0	255
October	78	8	13	140
Total	**4,691**	**2,013**	**489**	**2,409**

Return to Creel	4.03%	2.42%	6.10%
Return/lb released	0.20	0.34	0.29

AD-clipped - 49,925 kokanee released May 1999 @ 5.0/lb (approx 21 cm in length)
RVAD - 20,234 kokanee released Nov 1999 @ 14/lb (approx 15 cm in length)
LVAD - 39,772 kokanee released May 2000 @ 4.8/lb (approx 21 cm in length)

Table 4.7-13. Mean fork length (in cm) of unmarked, marked kokanee, rainbow trout, cutthroat trout, and coho salmon in Lake Merwin in 1999 and 2000. (Number of fish sampled shown in parentheses)

Month	Unmarked	Kokanee AD-clipped	RVAD	LVAD	Rainbow trout	Cutthroat trout	Coho
November 1999	-	-	-	-	29.0 (1)	-	-
December	-	-	-	-	-	-	-
January 2000	30.0 (1)	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	30.4 (15)	26.3 (9)	-	-	-	-	-
April	29.1 (50)	28.0 (18)	20.0 (1)	-	27.0 (2)	29.0 (1)	20.3 (7)
May	29.4 (62)	28.5 (24)	24.1 (16)	23.5 (17)	23.5 (2)	32.3 (4)	22.2 (9)
June	30.3 (35)	30.2 (18)	24.5 (10)	24.8 (45)	26.5 (6)	-	22.5 (15)
July	32.4 (33)	32.5 (24)	26.2 (5)	27.3 (40)	-	26.0 (1)	24.8 (4)
August	32.1 (22)	32.1 (36)	28.0 (4)	26.9 (34)	-	-	23.0 (1)
September	30.5 (13)	34.0 (4)	-	29.3 (15)	-	-	25.2 (5)
October	29.1 (11)	-	26.0 (1)	29.4 (11)	-	-	-
Average	**30.2 (242)**	**30.4 (133)**	**24.8 (37)**	**26.4 (162)**	**26.3 (11)**	**30.7 (6)**	**22.7 (16)**

Catch rates averaged 0.29 and 0.07 fish per hour for boat and shore anglers, respectively (Table 4.7-14). May through August was most productive, with boat anglers averaging about 0.4 fish per hour. Shore angling was generally unproductive, reflected by the lack of shore angling effort.

Table 4.7-14. Mean (sd)[1] harvest per hour for all species combined for anglers fishing Lake Merwin, 1999–2000.

Month	Angler type		Anglers interviewed
	Shore	Boat	
1999			
November	0.15 (.00)	0.00 (-)	2
December	0.00 (-)	0.00 (-)	4
2000			
January	-	0.50 (.00)	1
February	0.04 (.09)	0.03 (.11)	12
March	0.00 (-)	0.10 (.24)	77
April	0.08 (.28)	0.13 (.30)	156
May	0.00 (-)	0.40 (.52)	126
June	0.33 (.62)	0.28 (.51)	143
July	0.00 (-)	0.40 (.50)	111
August	0.00 (-)	0.41 (.45)	70
September	0.00 (-)	0.29 (.36)	30
October	-	0.45 (.76)	25
Mean	**0.07 (.30)**	**0.29 (.47)**	**757**

[1]sd = standard deviation, shown in parentheses

The fish identification survey of Lake Merwin anglers showed that a higher percent correctly identified northern pikeminnows and kokanee than Swift Reservoir anglers, probably due to their greater abundance in Lake Merwin (Table 4.7-15). Conversely, Swift anglers correctly identified cutthroat trout at a higher rate than Merwin anglers. Both groups struggled to correctly identify brook trout and endangered bull trout.

Table 4.7-15. Fish identification survey response, Merwin (n=205) and Swift (n=45).

	Percent w/ correct identification	
	Merwin	**Swift**
Rainbow Trout	93.2	84.4
Cutthroat Trout	23.9	53.3
Brook Trout	38.1	46.7
Bull Trout	42.9	37.8
N. Pikeminnow	85.4	46.7
Kokanee	69.9	17.8

Most anglers' county of residence was Clark (65 percent), followed by Cowlitz (29 percent) (Table 4.7-16). Out-of-state anglers comprised 4.4 percent of the total, most of whom were from Oregon and fishing for tiger muskies.

Table 4.7-16. County of residence for Lake Merwin (n= 827) and Swift Reservoir (n=556) anglers (percent).

County	Merwin	Swift	County	Merwin	Swift
Clark	64.6	61.3	Pierce	0.2	0.3
Cowlitz	28.9	25.6	Thurston	0.0	0.2
Skamania	0.7	6.5	Lewis	0.5	0.2
King	0.5	3.1	Wahkiakum	0.1	0.0
Out-of-state	4.4	1.7	Whitman	0.1	0.0
Snohomish	0.0	1.2	Pierce	0.2	0.0

While gathering kokanee broodstock at Speelyai Hatchery, the number and mean length of various marked and unmarked fish were noted. The counts were not total returns to the hatchery, since broodstock collection was terminated once enough fish were gathered. For 872 fish gathered, 65 percent were marked fish released in spring 1999 (1998 brood); 4.4 percent from the fall 1999 release (1999 brood); 27.9 percent from the spring 2000 release (1999 brood); and 2.9 percent were unmarked fish of uncertain origin (Table 4.7-17). Most of the fall 1999 and spring 2000 releases are expected to return in fall 2001.

Table 4.7-17. Number and mean length (cm) of kokanee recovered at Speelyai Hatchery, 2000.

	Unmarked		AD-clipped		RVAD[1]		LVAD	
	Number	**Length**	**Number**	**Length**	**Number**	**Length**	**Number**	**Length**
Male	20	32.9	212	35.3	33	29.8	222	29.4
Female	5	32.2	354	35.4	5	30.8	21	29.5
Total	**25**	**32.7**	**566**	**35.4**	**38**	**29.9**	**243**	**29.4**

AD-clipped- 49,925 kokanee released May 1999 @ 5.0/lb (approx 21 cm in length)
RVAD - 20,234 kokanee released Nov 1999 @ 14/lb (approx 15 cm in length)
LVAD - 39,772 kokanee released May 2000 @ 4.8/lb (approx 21 cm in length)
[1]RVAD – Right ventral and adipose fins clipped

Lake Merwin angler effort and harvest from May through August 2000 increased by 28 percent and 52 percent, respectively, compared to the average of 4 previous years of creel results (Table 4.7-18). Improvement may be due to the introduction of hatchery kokanee and tiger muskie; however, since both species were introduced concurrently, the exact cause cannot be isolated. Kokanee have thrived in the lake as shown by prior creel estimates. Meanwhile, the abundance of northern pikeminnows, as reflected by boat-shocking in Speelyai Bay, has declined by over 80 percent since the introduction of tiger muskie (Hillson and Tipping 2000). Perhaps kokanee are well suited for the reservoir and are being enhanced by the tiger muskie reduction of pikeminnows. The kokanee spring yearlings released in 2000 had over 6 percent return to the creel in 2000, while the greatest harvest from that release should occur in 2001. The return to the creel of 4 to 6 percent of kokanee released is within the range of expectations and is much better than the 0.24 percent observed for coho in 1995. In the mid-1980s, harvest of fingerling coho in Riffe Lake ranged from 1.5 to 10 percent of fingerlings planted (Tipping 1988).

Table 4.7-18. May through August angler effort and salmonid harvest in Lake Merwin.

Year	Angler Hours	Salmonid Harvest
1978	19,390	6,282
1979	19,945	8,399
1984	16,136	4,576
1995	19,350	3,599
2000	23,954	8,702

Since the abundance of northern pikeminnows continues to decline, survival of the smaller and less expensive fall release of kokanee may improve. WDFW will evaluate a management decision to extend the current program of 20,000 fall released fingerlings and 40,000 spring yearlings until another assessment can be done. Spot creel checks in the summer of 2001 may be conducted to determine relative harvest rates of the fall 1999 and spring 2000 releases.

4.7.5.4 Swift and Merwin Reservoir Fishery Overview

Comparing recent summer sport fishing effort and harvest for Lewis and Cowlitz river impoundments shows that for the 5 larger lakes (Merwin, Yale, Swift, Mayfield, Riffe), angling effort ranged from 4 to 7 hours per acre, the exception being Swift Reservoir with

1 hour per acre (Table 4.7-19). Harvest was about 2 fish per acre, with Mayfield and Swift reservoirs falling behind at less than 0.5 fish per acre.

For the 3 smaller water bodies (Swift canal, Swofford Pond, and Lake Scanewa), Swift canal had an adequate amount of efforts, but harvest per acre was deficient per WDFW. The difference was probably due to Lake Scanewa receiving frequent trout plants and Swofford Pond supporting a substantial warmwater fish community. Additional trout plants would enhance the canal fishery.

Table 4.7-19. May through August angler effort and salmonid harvest per acre for Lewis and Cowlitz river impoundments.

Water	Year	Acres	Effort/acre	Harvest/acre
Lake Merwin	2000	4,090	5.86	2.16
Yale Lake[1]	1996	3,802	4.15	1.05
Swift Reservoir	1999	4,589	128	0.23
Swift Canal	1999	100	23.34	4.48
Mayfield Reservoir[2]	1998	2,200	4.84	0.31
Riffe Reservoir[3]	1999	12,800	7.24	1.91
Swofford Pond[2]	1998	240	68.33	11.63
Lake Scanewa[4]	2000	700	35.52	14.70

[1]Harza (1997). April-May effort and harvest reduced by one-third to remove April data.
[2]Tipping and Harmon (1999).
[3]Tipping and Harmon (2000).
[4]Tipping and Serl (2000). June through September.

4.7.6 Schedule

This study is complete.

4.7.7 References

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4.7.8 Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
WDFW – JIM BYRNE	1	AQU 07	Creel Survey.	A creel survey on Yale Reservoir would have been nice. A creel on Yale Res. Should be conducted in summer of 2002 to try and document presence of rainbows flushed from the Swift Power canal into Yale. If there are large numbers of rainbow in the creel, the power canal is the source. Also the 1000 triploid trout that were planted into the power canal would be easy to identify in the creel. It would help to document the loss and assess damages.	A creel survey was conducted for the Yale project and the results were submitted with the Yale license application to FERC. Current studies are focused on Merwin and Swift projects for analysis of their specific effects. Of the 1000 triploid fish planted in the canal, 337 were recovered from the canal after the breach. Therefore, 663 triploids entered Yale Lake and are probably available for harvest.	Fish identified as triploids were larger than normal rainbow and not necessarily genetically triploid. Subsequent netting of Swift Reservoir reveals many of these so called triploids were actually older age rainbow.

AQU 7 Appendix 1

Pathology Results for Fish Examined from Swift Reservoir in 2000

AQU 7 Appendix 1. Pathology Results for Fish Examined From Swift Reservoir in 2000.

On April 18, 2000, sampling was conducted on Swift Reservoir to determine levels of *Diphyllobothrium* in fish and to determine the significance of the parasite (or other parasites) on fish in the reservoir. Fish were collected using gill nets and angling. Nearly all fish examined were from gill net samples, as fish collected by angling would bias sampling effort towards the healthiest fish in the population. A summary of the sampling for *Diphyllobothrium* is listed in Table 1.

Table 4.7-A1. Occurrence of *Diphyllobothrium* in organs of fish sampled at Swift Reservoir on April 18, 2000. Numbers in parentheses indicate the number of fish examined. An 'x' means the organ was not examined.

Organ	Steelhead (3)	Rainbow trout (18)	Sucker (2)	Whitefish (1)
Gill	0	0	0	0
Feces	0	0	0	0
Stomach	0	1	0	0
Pyloric cecae	0	0	0	x
Liver	0	0	0	0
Kidney	0	0	0	0
Spleen	0	2	0	x
Heart	0	0	0	x
Gall Bladder	0	0	x	x
Viscera	1	12	0	0

Numbers in columns of Table 4.7-A1 indicate the number of fish positive for *Diphyllobothrium*: 15 of 18 rainbow trout examined had some level of *Diphyllobothrium*. The two rainbow trout with the emptiest stomachs had the highest levels of *Diphyllobothrium*. Three of the 18 rainbow trout had significant levels, while the others had low levels or no parasites detected. The steelhead which was positive had an empty stomach, but did not have high levels of the parasite.

No parasites were found on the whitefish examined. Stomach contents consisted mainly of Plecopterans and other insects. Organs examined for parasites on the whitefish included gills, kidney, liver, and feces.

The two suckers examined had no detectable parasites in the liver, kidney, spleen or heart, but one fish had numerous copepods on the gills (unknown genus), and *Hexamita* was detected in the feces of one fish.

The steelhead examined were called steelhead because of they were located in the middle of the reservoir, and they possessed signs of smoltification. These included a band on the caudal fin, a lack of parr marks, and the loss of some scales when compared to the rainbow trout. Parasites found in the steelhead included one unknown encysted structure in the kidney of one fish, and the presence of *Diphyllobothrium* in one fish, as

listed in Table 4.7-A1. Stomach contents of the steelhead showed that one was empty, while the other 2 each had oligochaetes, chironomidae larvae, and some unidentifiable insect parts. There were numerous "egg-like" structures in one stomach, and these were also found in the feces of that fish. The feces of the second steelhead consisted of pieces of wood, and was a mixture of invertebrate debris and plant debris in the third steelhead.

Parasites other than *Diphyllobothrium* found on the rainbow trout included *Tricophrya* on the gills of one fish, a metacercaria of *Sanguinicola* on gills of another fish, and an unidentified encysted structure in the kidney of one fish. No *Nanophyetus* was detected in kidney, gills or skin. Stomach and intestinal contents were examined in 11 of the trout, and the results are listed in Table 4.7-A2.

Table 4.7-A2. Stomach and intestinal contents of rainbow trout collected on Swift Reservoir on April 18, 2000 (11 fish examined).

Item	Stomach	Intestine
Plecoptera	10	10
Insect Fragments	10	11
Fish scales	1	0
Black Fly larvae	2	0
Crayfish	1	0
Empty	1	0

In general, the levels of *Diphyllobothrium* did not appear to be high, and the parasite probably was not affecting the rainbow trout population significantly at the time of sampling. Angling success on the lake was good, with dozens of fish landed in approximately 4.5 hours of fishing.

Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
WDFW - KAREN KLOEMPKEN	1	AQU 07 App p. 1-1	Paragraph under Table 4.7-A1.	The number of rainbow trout that had some level of *Diphyllobothrium* should be 15 of 18 not 14 of 18, according to the numbers in the table.	This correction will be made.	