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4.6 EVALUATION OF FISH ENTRAINMENT AT THE SWIFT NO. 1 HYDROELECTRIC PROJECT (AQU 6)

4.6.1 Background

The involuntary movement of fish over a hydroelectric project spillway or through a project's intake and turbine(s) is called entrainment. Entrainment can cause direct injury or mortality to fish. According to Bell (1991), fish diverted into power turbines can experience up to 40 percent mortality as well as injury, disorientation, and delay of migration. In addition, entrainment can isolate fish from upstream habitats that may be critical to the completion of their lifecycle (i.e., spawning habitat and seasonal rearing habitat). Entrainment at the Swift No. 1 Hydroelectric Project has the potential to adversely affect adult and sub-adult life stages of bull trout (*Salvelinus confluentus*), a federal Endangered Species Act (ESA) listed species, as well as many other game and non-game fish species. Adverse effects may include isolation, injury, and mortality of individual fish. Loss of individual fish can affect the total population, especially if the effective population size is relatively small. Population consequences from entrainment can include reduced population productivity and loss of genetic variation.

Existing information about entrainment at the Swift No. 1 Project is largely qualitative. Graves (1983) noted rainbow trout from Swift Reservoir in the Swift bypass reach and the Swift canal. In July 2000, the Swift surge tank was sampled and shown to contain several rainbow trout and one bull trout (Lesko 2001). Occasional catches of bull trout have also been observed in Swift canal (Tipping 2001). Although these studies demonstrated that entrainment likely occurs, they do not provide valid estimates of species composition or relative abundance; nor do they show how these indices might differ on a seasonal basis. Therefore, the Aquatic Resources Group (ARG) developed this study (AQU 6) to evaluate the seasonal occurrence and relative abundance of fish species entrained by the Swift No. 1 Project.

4.6.2 Study Objectives

The objectives of this study are to:

- Assess species composition and relative abundance of fishes entrained through the Swift No. 1 Project.
- Describe changes in species composition and relative abundance on a seasonal basis.
- Describe species composition and relative abundance of fishes present in the Swift canal.

Entrainment can affect aquatic species abundance, fishing opportunity, and genetic diversity within a population. It is thus very important to evaluate the effects of entrainment on fish populations in Swift Reservoir. By describing the species composition and relative abundance of entrained fish over time, information is gained to help determine appropriate actions to minimize the potential negative impacts of entrainment. Of particular importance is bull trout (listed as "threatened" under ESA). Ongoing monitoring efforts in Swift Reservoir have provided over 10 years of spawning population data for bull trout. Entrainment of bull trout at the Swift No. 1 Project has implications in assessing the health and management of bull trout "populations" in Swift and Yale reservoirs.

4.6.3 Study Area

The study area includes the Swift No. 1 surge tank, powerhouse and Swift canal (Figure 4.6-1).

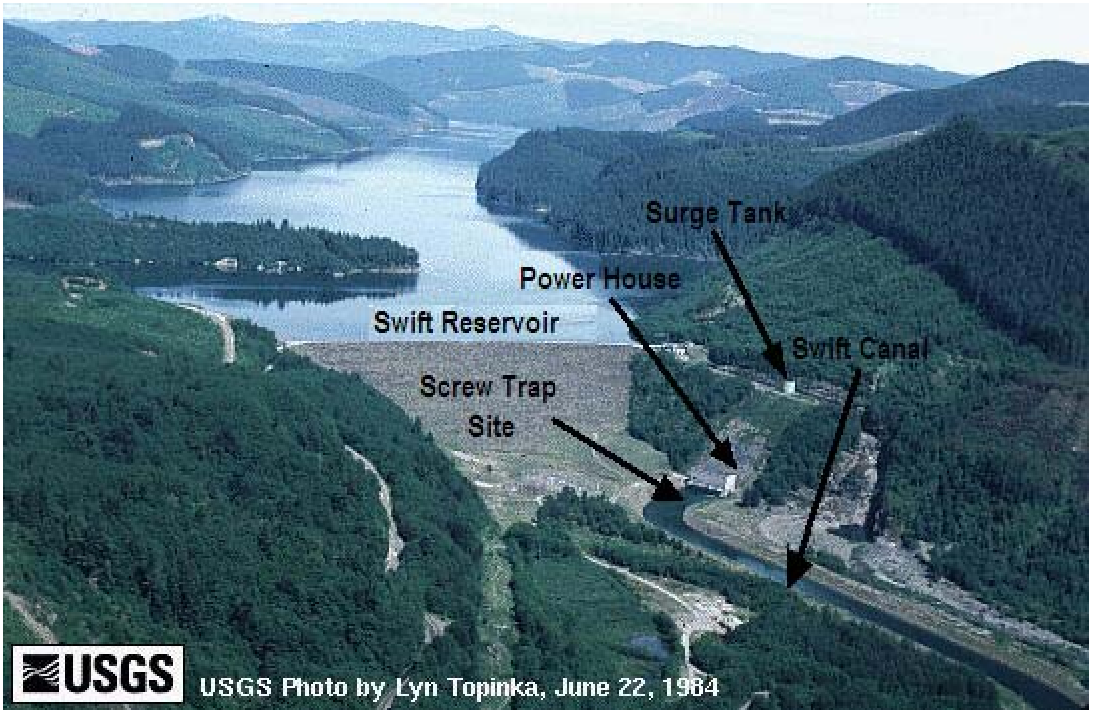
4.6.4 Methods

Fish passing through the intake and turbines at Swift Dam were collected using an 8-foot-diameter rotary screw trap (EG Solutions, Inc.) placed in the Swift canal, approximately 200 feet downstream of the Swift No. 1 powerhouse (Figure 4.6-2). Swift canal was also sampled with seine nets from late April through June 2002 after failure of a section of the canal embankment on April 21, 2002.

4.6.4.1 Screw Trap Operation

The screw trap was installed by PacifiCorp staff in Swift canal. The trap was anchored using ecology blocks placed on both sides of the canal. Two-10,000 pound winches and 1-5 ton pulley were fastened to the ecology blocks and were used to move the trap position once deployed in the tailrace. Trapping was scheduled to occur for 1-year but was later reduced to between February 1, 2002 and November 30, 2002 by the ARG due to maintenance requirements, lack of captures, and anticipated high runoff schedule at Swift canal, which would make wintertime access dangerous.

According to the Study Plan (PacifiCorp and Cowlitz PUD 2001), screw trap operation was to follow a random sampling protocol whereby sampling blocks (24 hours in duration) were to be selected during 4 seasonal periods for one year. Sampling blocks were to be stratified into the following seasonal periods: spring (March – May), summer (June – August), fall (September – November), and winter (December – February). Sampling dates were to consist of 30 randomly chosen sampling blocks (one block equals one 24-hour day) for each seasonal period. However, the Study Plan protocol was modified during implementation, increasing the total number of sampling blocks, but reducing sampling randomness. Technicians generally sampled the Swift No. 1 screw trap every other day from February 11 to April 19, 2002; almost every day from April 29 to June 27; 4 days in July; and only one day was sampled in November (according to the field data sheets). In addition, according to the field data sheets, there is no record of sampling in August, September and October. PacifiCorp staff have indicated that sampling was conducted during these months and no fish were captured; however, dates and hours sampled (i.e., effort) are unknown at this time (Pers. comm. E. Lesko, PacifiCorp Biologist, 2003). Of note is that failure of the canal embankment resulted in no trapping from April 22 until April 29, 2002. Table 4.6-1 lists the number of known blocks sampled during each seasonal period (based on the field data sheets).



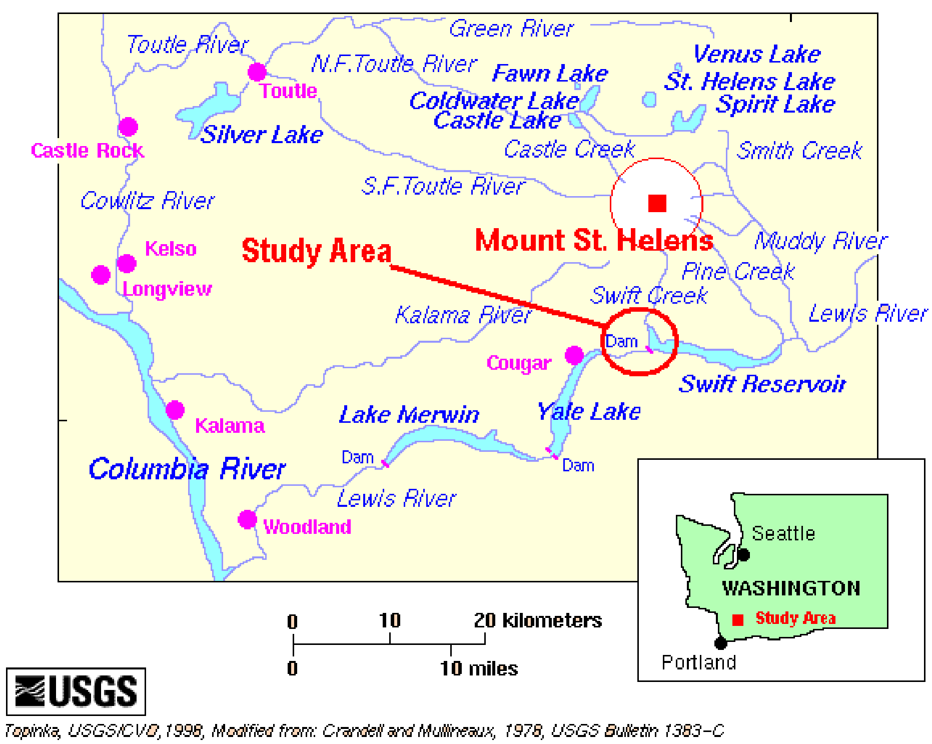


Figure 4.6-1. Swift No. 1 study area.

Figure 4.6-2. Photographs of the Swift No. 1 screw trap sampling location.

Table 4.6-1. Swift No. 1 screw trap sample block timing.

Season	Seasonal Period	No. of Sample Blocks	
Winter	December 2001 – February 2002	8	9%
Spring	March – May 2002	54	60%
Summer	June – August 2002	27	30%
Fall	September – November 2002	1	1%
Total:		**90 Blocks**	

Trap Operation Critical Assumptions

Effective trapping in Swift canal is key to accurately describing species composition and relative abundance of entrained fish at Swift No. 1. Assumptions necessary to accept estimates of species composition and relative abundance include:

- All entrained species have the same probability of capture.
- All fish, regardless of size, have the same probability of capture.
- Entrainment mortality does not affect capture probability (i.e., live and dead fish have the same probability of being caught in the trap).
- Entrainment into each of the 3 turbine units is randomly distributed.

4.6.4.2 Screw Trap Efficiency Test

An efficiency test was conducted for the screw trap on July 22, 2002. The intent of the test was to determine the efficiency of the trap at different discharge rates from the Swift No. 1 Project. A total of 519 hatchery rainbow trout obtained from the Merwin Hatchery were used as test fish. Five separate release groups with a distinct group mark were released at 4 discharge rates.

Test Fish Attributes

Test fish (519 rainbow trout at 117 fish/kg, approximately 90 mm in length) were netted from rearing raceways at the Merwin Hatchery on July 22, 2002 and transferred to coolers equipped with portable aerators. The fish were immediately transported to the Swift canal test site. No mortalities were observed during transportation or during the trap efficiency test. Fish were separated into 5 groups, each with a unique group mark, except the last group which had no mark. Swift Reservoir had not been planted with its annual allotment of rainbow trout prior to the trap efficiency evaluation; therefore, the lack of a mark on Group 5 effectively differentiated these fish, as all other groups had some form of mark. Fin clips were used for marking and were done by hand with cuticle scissors.

Release Method

A predetermined discharge schedule was used to compare efficiencies from various discharge rates. Only two release sites at Units 11 and 13 were used in the trap efficiency test. Unit 12 was down for maintenance and not used. During normal operations, Unit 11 is used most often for generation, reserve needs, and station service. Therefore, most of the evaluation focused on Unit 11, which provides the most discharge on a regular basis. The two release sites in Swift canal, directly above the discharge plume of Unit 11 and Unit 13, are subsequently referred to as Site A and Site B, respectively.

A 4-inch-diameter PVC tube approximately 3-feet in length and closed at one end was used to release fish, at depth, in the canal. Two lines were fastened to the tube: the top line to hold and lower the tube into the canal, and the other line was fastened to the bottom of the tube to enable the tube to be inverted after submerged to depth. While not very precise in terms of exact release depth, it was effective in releasing fish at submerged depths, and a substantial improvement over dispensing the fish to the canal with a bucket. All releases were done this way, and at approximately the same depth (between 5 and 10 feet).

Trap Efficiency Test Critical Assumptions

Accuracy and precision for the estimates of trap efficiency depend on several critical assumptions and include:

- All marks used to differentiate test fish are distinguishable upon recapture.
- All marked fish travel downstream past the screw trap.
- All test fish survive release or marked live fish have the same probability of capture as marked dead fish.
- All marked fish have an equal probability of capture regardless of depth or location of release above the trap.
- The test species has the same probability of capture as all entrained species.

4.6.4.3 Tailrace Canal Netting

Although included in the original study plan (PacifiCorp and Cowlitz PUD 2001), tailrace netting was not conducted before or during screw trap sampling. However, fish salvage operations were conducted in the canal in late April through June after the breach of the canal. The relative abundance of fish salvaged in the canal was compared to the relative abundance of fish captured in the screw trap. Comparing relative abundance of trapped fish to salvaged fish can give an appropriate verification of trapping and efficiency assumptions. For example, if relative abundance of trapped fish compared to salvaged fish is similar, then the critical assumptions would be validated. However, if comparison of relative abundance yields differences, then one or more of the critical assumptions was likely violated.

4.6.4.4 Floy Tagging

The Study Plan indicates that fish caught in the screw trap would be marked with floy tags and released downstream of the trap, and that all fish captured in tailrace netting would be marked before release. Although, the tailrace netting did not occur, 104 fish captured in the screw trap were marked with floy tags and released back into the canal.

4.6.4.5 Surge Tank Sampling

The surge tank was surveyed for the presence of fish on July 22 and August 8, 2002. Only a few rainbow trout were seen on each occasion. This is much different than the hundreds observed in previous years. No bull trout were seen on either occasion. Because only a few fish were present in the tank, no attempt was made to sample and mark them, as stipulated in the original study plan. According to PacifiCorp biologists, the surge tank will continue to be surveyed periodically to document the presence or absence of bull trout and other fish species.

4.6.5 Key Questions

No key watershed study questions were identified for AQU 6 in the Study Plan (PacifiCorp and Cowlitz PUD 2001).

4.6.6 Results and Discussion

4.6.6.1 Screw Trap Efficiency Test

The screw trap efficiency test was conducted on July 22, 2002 using 5 differentially marked test groups of rainbow trout (Table 4.6-2). During the efficiency testing, the pooled trap efficiency for all generation levels and for all groups was 2.3 percent. However, it should be noted that trap efficiency was highly variable, ranging from 6 percent for Group 1 to 0.7 percent for Group 5. This variability can be attributed to a number of factors, but it is most likely related to a non-random distribution of fish released in the canal or trap position. In addition, sampling error results from the small volume of water sampled, estimated to be less than 2 percent of the total volume passing the trap (Pers. comm. E. Lesko, PacifiCorp Biologist, 2002). The lack of release replicates by location and discharge also results in low statistical power, which reduces the ability to detect differences in recapture rates of released fish when comparing release sites and/or discharges.

The difference in observed screw trap efficiency between sites A and B may be related to the orientation of the screw trap in the canal. The screw trap was positioned to maximize the capture efficiency for fish exiting Unit No. 11 (Site A), as this unit is used most frequently for generation. However, with only one test run at the same discharge to compare sites A and B, the power (ability) to detect a difference in the recapture rate of fish released at Site A compared to Site B is extremely low. This is also true for comparing recapture rates at various discharges for Site A, as only one group was released per discharge rate. Therefore, comparing the difference of recapture rates (trap efficiencies) between discharge rates and between release sites is of limited value given the data collected. The conclusion of this efficiency test is that trap efficiency is relatively low for rainbow trout approximately 90 mm in length, regardless of discharge or releases site. This conclusion is supported by the very small portion of water volume actually sampled by the trap, estimated to be less than 2 percent of the total water volume passing the trap. It is unknown how this test of rainbow trout applies to other species and sizes of fish, although it is widely thought that larger fish avoid screw traps to a greater degree than smaller fish.

Table 4.6-2. Attributes of release groups and recoveries of fish released immediately downstream of Swift Dam in the Swift canal during trap efficiency testing on July 22, 2002.

Test Group	Time of Release	No. Released	Mark Type (clip)	Release Site	Units On-line	Generation (mw)	Recoveries	Trap Efficiency (percent)
1	10:30	50	Adipose	Site A	Unit 11	45 MW	3	6.0
2	11:00	102	Lower Caudal Lobe	Site A	Unit 11	50 MW	3	2.9
3	11:30	100	Upper Caudal Lobe	Site A	Unit 11	75 MW	3	3.0
4	13:20	121	Anal Fin	Site A	11 and 13	75 MW each	2	1.7
5	13:30	146	No Clip	Site B	11 and 13	75 MW each	1	0.7
Total:		**519**					**12**	**2.3***

* Efficiency calculated for all releases pooled.

4.6.6.2 Trap Retention Test

As a component of screw trap sampling, fish were placed in the live box of the screw trap to determine trap retention of captured fish. On July 19, 2002, 47 marked fish were placed in the live box of the trap. The fish used for this test were collected from the Eagle Cliff and Swift No. 1 screw traps on July 19. Fish collected from the Eagle Cliff trap were transported to the Swift No. 1 screw trap site (Pers. comm. E. Lesko, PacifiCorp Biologist, 2003). Size of test fish ranged between 90 and 200 mm and all fish were rainbow trout (Pers. comm. E. Lesko, PacifiCorp Biologist, 2003). The Swift No. 1 screw trap was rechecked on July 22, 2002. A total of 42 marked fish were still in the trap box, including two mortalities. Therefore, trap retention efficiency equals 42/47 or 89 percent.

4.6.6.3 Species Composition

<u>Screw Trap Catch</u>

A total of 1,527 fish representing 10 different species were collected during screw trap sampling in the Swift canal. Stickleback was the most common species captured during the study, representing over 65 percent of all fish captured, followed by rainbow trout (16.0 percent), sculpin (9.2 percent), coho (4.5 percent), sucker (3.0 percent), Chinook

(1.0 percent), steelhead (0.3 percent), bull trout (0.3 percent), cutthroat trout (0.1 percent), and whitefish (0.1 percent). Of the 340 salmonids captured during sampling, rainbow trout was the most common, accounting for 72.1 percent of all trapped salmonids (Table 4.6-3). Although records are available for total numbers of sucker, stickleback, and sculpin caught in the trap, they were not summarized by season; therefore, these species are discussed no further. For the record, the screw trap caught more than 1,000 stickleback, 141 sculpin, and 46 sucker during the sampling period. According to the PacifiCorp field data sheets, 104 fish captured in the screw trap were marked with a floy tag and released downstream of the screw trap in the Swift canal during the sampling period, consisting of 95 rainbow trout, 6 Chinook, 2 steelhead, and 1 coho.

Table 4.6-3. Salmonid species composition by season.

Species	Winter		Spring		Summer		Fall		Total	
Bull Trout	0	0	3	1%	1	7%	0	0	4	1%
Coho	7	9%	61	25%	0	0	1	100%	69	20%
Cutthroat	0	0	1	<1%	0	0	0	0		<1%
Mountain Whitefish	0	0	1	<1%	0	0	0	0	1	<1%
Rainbow	65	83%	170	69%	10	67%	0	0	245	72%
Chinook	3	4%	9	4%	4	27%	0	0	16	5%
Steelhead	3	4%	1	<1%	0	0	0	0	4	1%
Total:	**78**	**23%**	**246**	**72%**	**15**	**4%**	**1**	**<1%**	**340**	

Note: The first number represents total number captured and the adjacent number to the right represents percent captured.

The majority of salmonids were trapped during the spring sampling period, which accounted for 72 percent of all salmonids trapped; however, the spring sampling period also contained the largest number of sample blocks (approximately 60 percent of all sample blocks). In an effort to determine trends in catch over time, catch per month and catch per seasonal period were standardized per unit effort (sample block), referred to as catch per unit effort (CPUE) (Table 4.6-4).

Although total catch was highest in the spring, CPUE was highest in the winter, and generally declined from winter through summer. However, it should be noted that discharge (indexed in Table 4.6-4 as generation rate) was highly variable during the sampling period, fluctuating on a daily, monthly, and seasonal basis. Figure 4.6-3 shows the distribution of sampling dates (unknown for August, September, and October) and the corresponding generation and Swift Reservoir elevation. Swift Reservoir water surface elevations ranged between 950 and 960 feet during the first half of the sampling period. During the second half of the sampling period, reservoir elevations ranged between 990 and 1000 feet. Total generation was more variable during the first half of the sampling period, and more stable during the second half.

Table 4.6-4. Monthly count and catch per unit effort of salmonids trapped in the Swift canal.

Month	Number of Fish Trapped	Number of Sample Blocks	Catch Per Unit Effort	Average Generation During Sample Blocks (kw)	CPUE Normalized With Generation
December	Not sampled	0	N/A	N/A	N/A
January	Not sampled	0	N/A	N/A	N/A
February	78	8	9.8	106	9.2
Winter Total:	**78**	**8**	**9.8**	**106**	**9.2**
March	98	17	5.8	79	7.3
April	99	15	6.6	110	6.0
May	49	22	2.2	121	1.8
Spring Total:	**246**	**54**	**4.6**	**105**	**4.4**
June	6	23	0.26	98	0.27
July	9	4	2.25	65	3.5
August	0	Unknown	0	Unknown	0
Summer Total:	**15**	**27**	**0.6**	**93**	**0.6**
September	0	Unknown	0	Unknown	0
October	0	Unknown	0	Unknown	0
November	1	1	1	53	1.9
Fall Total:	**1**	**1**	**1**	**53**	**1.9**

Note: At this time it is unknown how many sample blocks occurred in August, September, and October, as data sheets are missing. However, PacifiCorp staff has indicated that sampling did occur during these months, but no fish were captured (Pers. comm. E. Lesko, PacifiCorp Biologist, 2003).

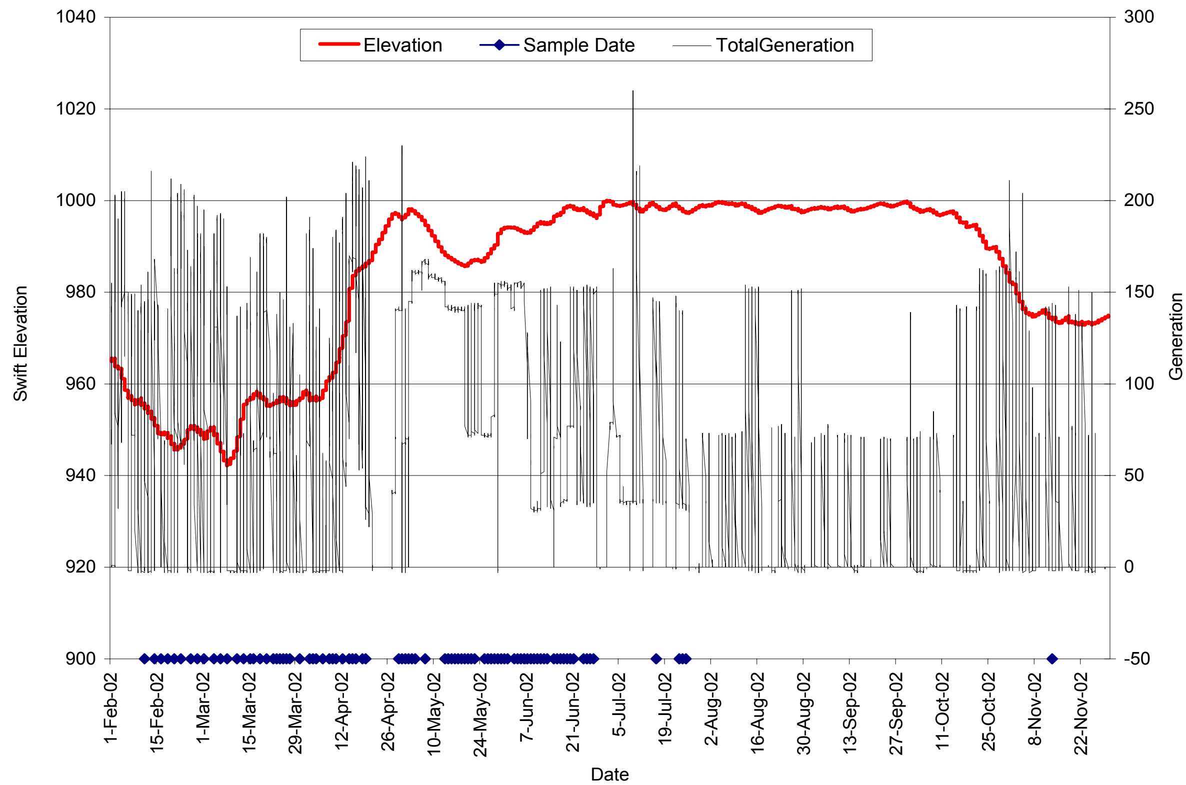


Figure 4.6-3. Swift Reservoir elevation, Swift generation and sample dates.

Discharge rate can affect the number of fish entrained; therefore, CPUE was normalized by indexing to discharge (generation) for each sample block. Sample blocks per month were then averaged, and pooled per seasonal period (listed in Table 4.6-4). Assuming a consistent and relatively low trap efficiency at all discharges, which is valid in this case because the screw trap sampled such a small volume of water compared to the total canal cross section, total numbers of fish entrained decreased from winter through summer and decreased as discharge decreased. However, since there were no sample blocks in December and January, and sampling effort for August, September, or October is not known, trends in seasonal entrainment are suspect and should be viewed with caution.

Fish Salvage Results Compared with Screw Trap Catch Results

Following the catastrophic failure of the Swift canal on April 21, 2002, biologists from the U.S. Fish and Wildlife Service, WDFW, Cowlitz PUD, and PacifiCorp conducted several fish salvage operations to rescue fish that were trapped in isolated pools located in the dewatered canal. A total of 10 canal salvage operations were conducted from late April through mid-June. All live fish collected were transported out of the canal and released into either Yale Lake or Swift Reservoir. The number and relative abundance of each species salvaged from the canal in 2002 compared to the relative abundance of species captured in the screw trap is presented in Table 4.6-5.

Table 4.6-5. The total number of fish, and percent of each species salvaged in the Swift canal compared with screw trap catch results.

Species	Number salvaged (n = 2,143 excluding crayfish)	Percent of total salvaged, (excluding crayfish)	Percent of total captured in the screw trap	Comparison of relative abundance* (percent of total captured)	
				Fish Salvage	Screw Trap
All *O. mykiss* (pooled)	579	27.0	16.3	29.4	73.2
Rainbow	229	10.7	16.0	27.8	72.1
Steelhead	13	0.6	0.3	1.6	1.2
Triploid Rainbow (stocked in canal)	337	15.7	none	excluded	none
Whitefish	510	23.8	0.1	62.0	0.3
Stickleback	378	17.6	>65	excluded	excluded
Sculpin	346	16.1	9.2	excluded	excluded
Bull Trout	42	2.0	0.3	5.1	1.2
Cutthroat Trout	9	0.4	0.1	1.1	0.3
Coho	11	0.5	4.5	1.3	20.3
Chinook	3	0.1	1.0	0.4	4.7
Brook Trout	5	0.2	none	0.6	none
Hybrid bull x brook?	1	<0.1	none	0.1	none
Sucker	253	11.8	3.0	excluded	excluded
Dace?	6	0.3	none	excluded	excluded
Crayfish	339	excluded	none	excluded	excluded

*Excluding stocked triploid hatchery rainbow trout. Since they are only stocked in the Swift canal, the inclusion of their numbers would bias estimates of relative abundance for entrained rainbow trout.

The screw trap captured 10 of the 15 species found during the fish salvage operation (Table 4.6-5). Although this comparison of all species captured in the screw trap and from salvage operations shows that species composition is dissimilar, some species should be excluded from the comparison. Triploid hatchery rainbow are only stocked in the Swift canal. The screw trap was operated to capture fish passing the Swift Dam, and therefore, was not expected to catch fish stocked in the Swift canal. Screw traps are not designed to capture benthic organisms such as crayfish. Bull x brook trout hybrids can be difficult to visually differentiate from either pure brook or bull trout, and should be lumped with either bull or brook trout. Excluding triploid hatchery trout, crayfish, and bull x brook trout hybrids, the screw trap captured 10 of 12 species found during the fish salvage operation, which shows that species composition was similar.

Although species composition was similar, species relative abundance was very dissimilar between the screw trap catch and fish salvage operation. Whitefish were the most dominant species collected during the fish salvage, accounting for 23.8 percent of all fish salvaged, and 62 percent of all salmonids salvaged (excluding stocked triploid hatchery trout). However, whitefish only represented 0.1 percent of all fish caught in the screw trap and 0.3 percent of salmonids. Stickleback was the most abundant species in the screw trap catch, representing more than 65 percent of the total catch. In addition, rainbow trout were the most abundant salmonid in the screw trap catch, representing 72.1 of all salmonids, compared to only 27.8 percent of salmonids recovered in the fish salvage operation (excluding stocked triploid hatchery trout).

Fish size may account for some difference in species composition estimates between the screw trap and fish salvage operations. Some large bull trout, whitefish, and rainbow trout were rescued during the fish salvage operation, and many fish salvaged were much larger than the respective species captured in the screw trap. For example, 14 of the 42 bull trout salvaged were over 400 mm (maximum of 635 mm) in length; however, the largest bull trout captured in the screw trap was less than 350 mm in length. Large fish are thought to exhibit greater avoidance of screw traps compared to small fish. Therefore, the screw trap catch is likely biased toward catching smaller fish and would tend to under-represent entrainment of larger fish, such as larger adult rainbow, bull trout and whitefish. In addition, whitefish may be able to reproduce in the Swift canal, which could lead to over-estimation of whitefish entrainment.

4.6.6.4 Salmonid Timing and Size Class Distribution

Following are figures representing timing and size class distributions for each salmonid species captured in the screw trap. In general, more fish were caught in the winter and spring, with catches tapering off through summer. Rainbow trout (1+ year old fish) were most abundant in February, March and April. Coho (1+ year old fish) were second most abundant over the same time period. Young-of-the-year coho were captured between March and May; however, young-of-the-year rainbow were only captured in April and May. Chinook juveniles captured were evenly distributed from February through May. Very few steelhead, cutthroat, whitefish, and bull trout were captured, and these species were only captured from February through April.

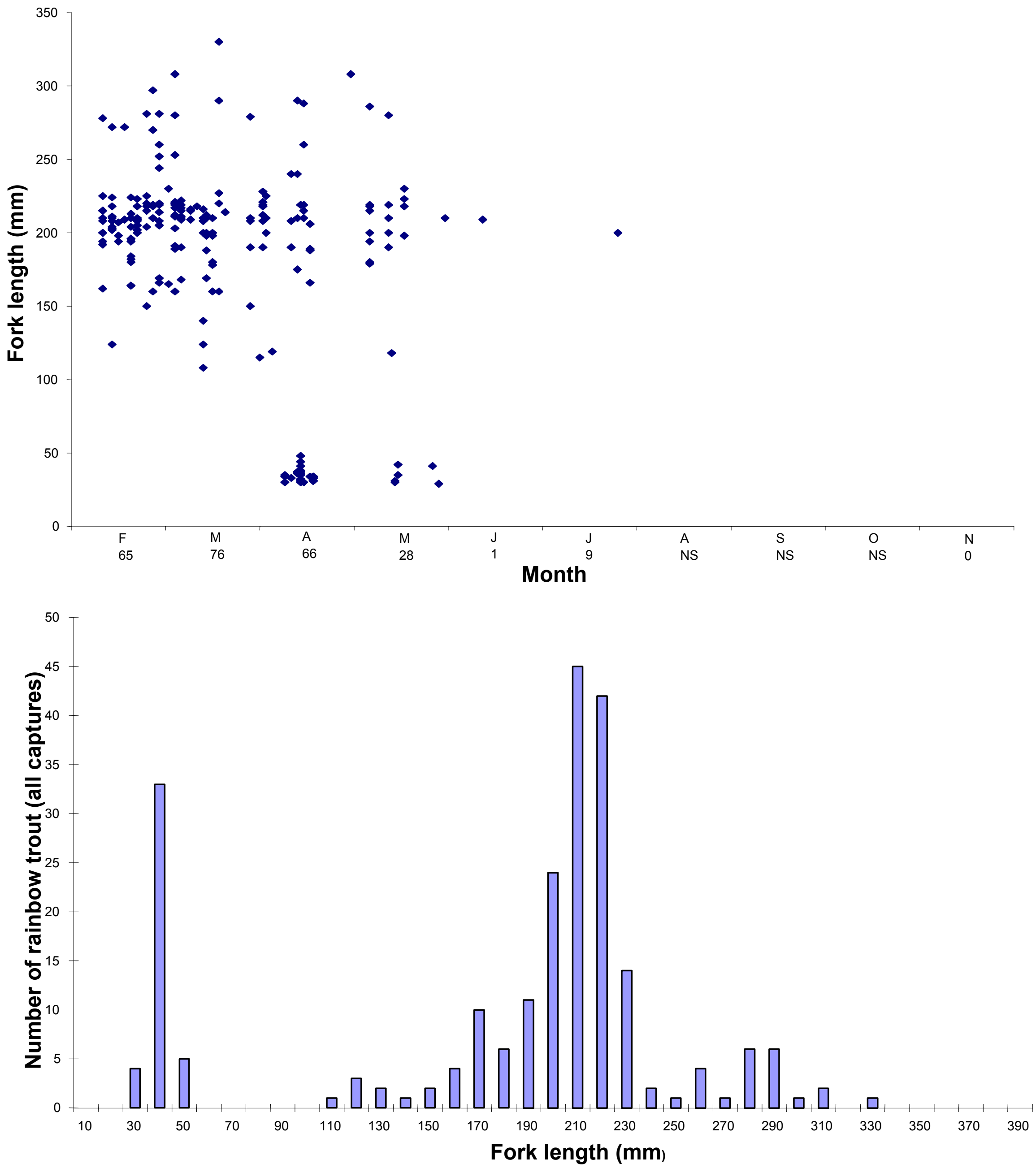


Figure 4.6-4. Numbers and lengths of rainbow trout captured in the screw trap, including live and dead fish. Monthly totals are shown under corresponding months and NS means "no sample data".

The majority of rainbow trout collected in the screw trap were captured in February, March, and April. At least 3 age/size classes of fish were captured. Larger fish (approximately 1+ and 2+ year old fish) were predominant in February and March. Young-of-the-year fish (less than approximately 50 mm in length) appeared in April and May.

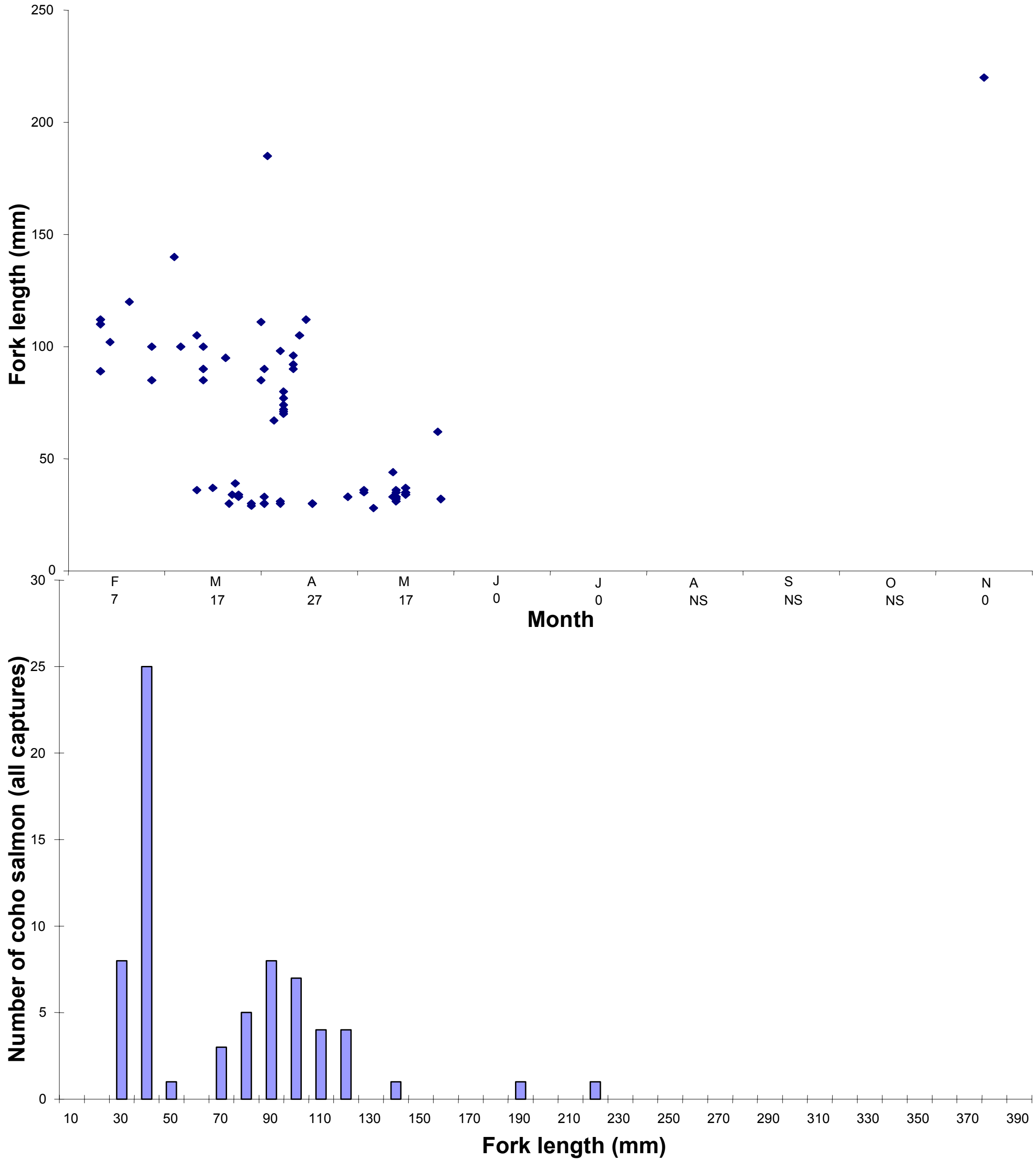


Figure 4.6-5. Numbers and lengths of coho salmon captured in the screw trap, including live and dead fish. Monthly totals are shown under corresponding months and NS means "not sample data".

Coho salmon catches peaked in April. Two, possibly three, age classes were present. Larger fish (approximately 1+ year old fish) were predominant in February. Young-of-the-year fish (less than approximately 50 mm in length) appeared in March and were the only age class in May.

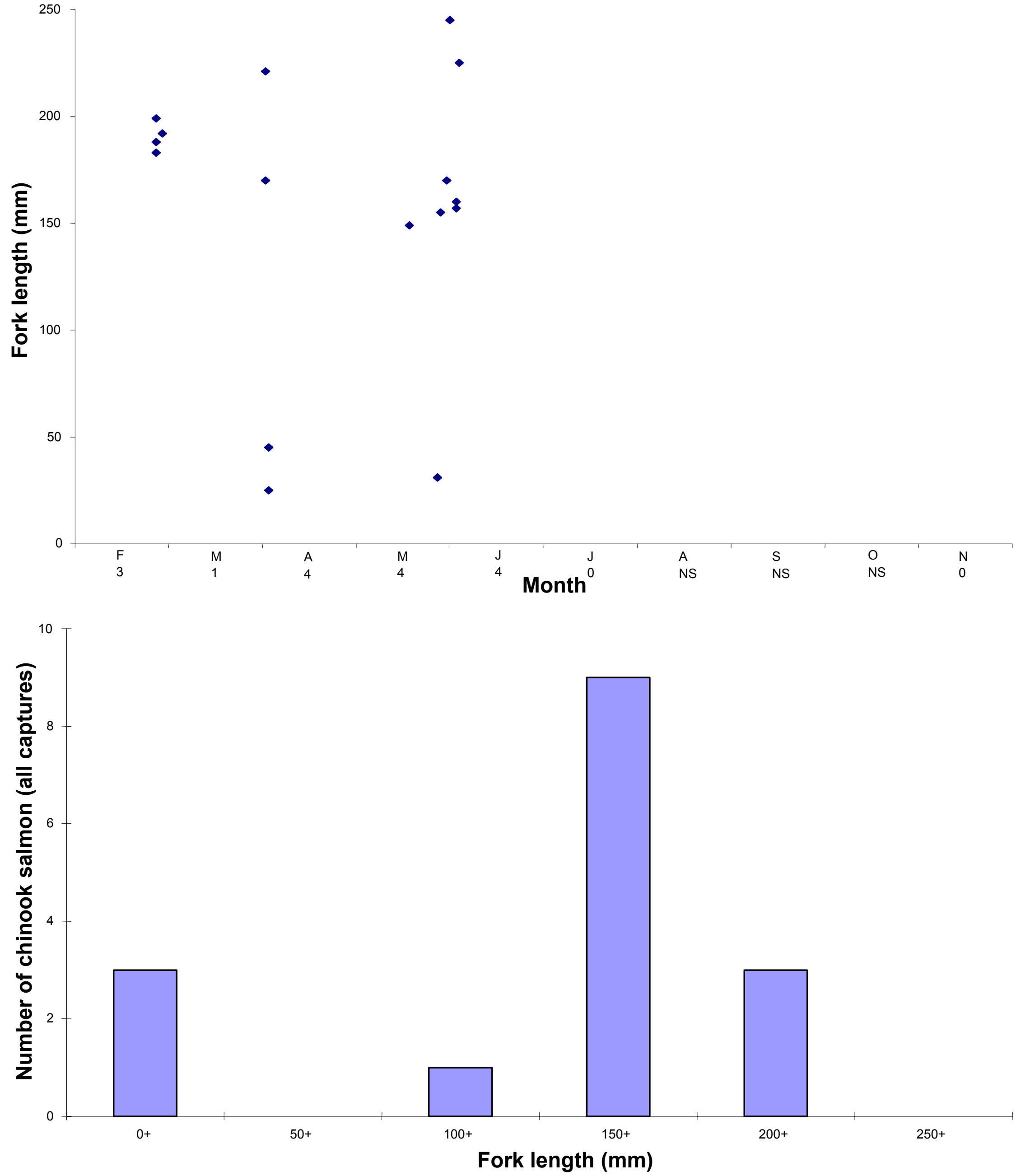


Figure 4.6-6. Numbers of Chinook salmon captured in the screw trap, including live and dead fish. Monthly totals are shown under corresponding months and NS means "not sample data".

Chinook salmon catches were similar from February through May. Two, or possibly 3, age classes were present. Larger fish (approximately 1+ year old fish) were caught from February through May. Young-of-the-year fish (less than approximately 50 mm in length) were only caught in April and May.

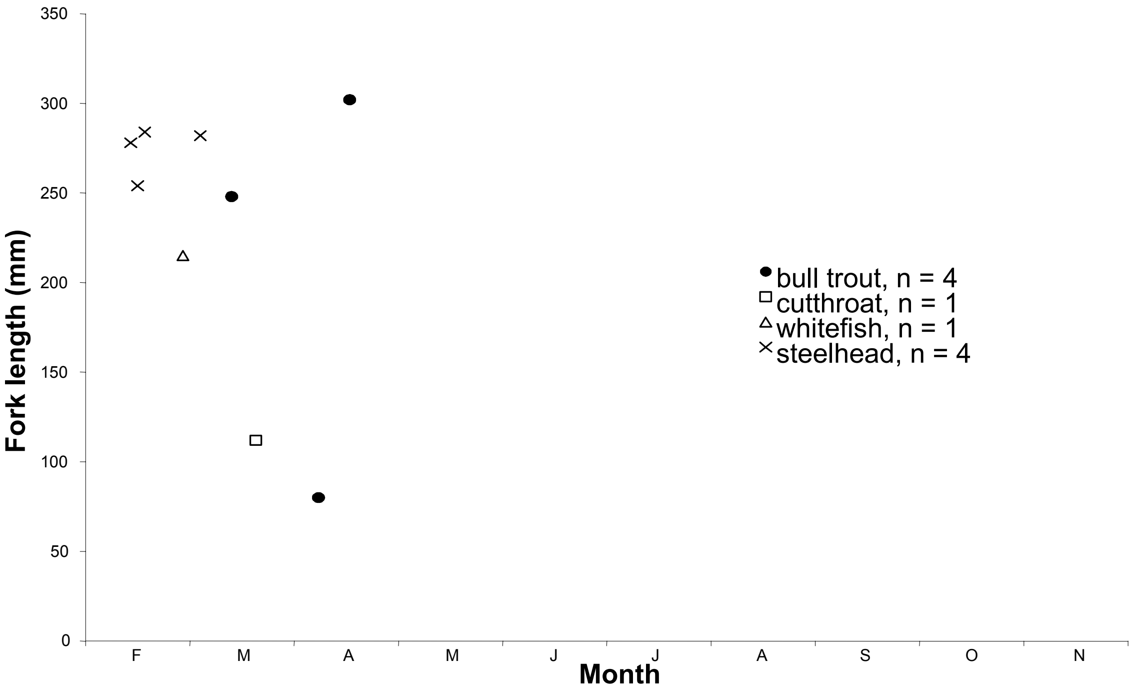


Figure 4.6-7. Numbers and lengths of all other salmonids captured in the screw trap, including live and dead fish. Note that although 4 bull trout were caught, one was dead and not measured to length.

Only a few bull trout, cutthroat, whitefish, and steelhead were captured in the screw trap. Two of the 3 live bull trout captured were likely sub-adults, although mature bull trout measuring less than 150 mm in length have been reported (Hemmingsen et al. 2001). The smallest bull trout was likely a sub-yearling. The steelhead collected in the trap were all of one size class and likely 1+ year old fish. Only one cutthroat and one whitefish were captured. The cutthroat was most likely a 1+ year old fish and the whitefish age is unknown.

4.6.6.5 Mortality Ratio of Trapped Fish

Table 4.6-6. Trapped fish, live and dead.

Species	Live Trap	Dead Trap	Percent Dead
Bull Trout	3	1	25
Coho	69	0	0
Cutthroat	1	0	0
Mountain Whitefish	1	0	0
Rainbow	198	47	19
Chinook	12	4	25
Steelhead	4	0	0

Several dead fish were caught in the screw trap. It is unknown whether fish mortality occurred prior to entrainment, during entrainment, or in the trap. However, some live fish placed in the trap box during the retention efficiency test died. Therefore, there was likely some mortality associated with trapping, in addition to entrainment and natural processes.

4.6.7 Summary

- Ten species of fish were captured in the Swift canal screw trap (entrained) between February 1, 2002 and November 30, 2002, totaling more than 1,527 fish. Species captured included: stickleback (over 65 percent), rainbow trout (16.0 percent), sculpin (9.2 percent), coho (4.5 percent), sucker (3.0 percent), Chinook (1.0 percent), steelhead (0.3 percent), bull trout (0.3 percent), cutthroat trout (0.1 percent), and whitefish (0.1 percent).

- Fifteen species were found in the canal during salvage operations from late-April through mid-June, 2002. Whitefish was the most abundant species captured during the canal salvage, accounting for 23.8 percent of all fish salvaged, and 62 percent of all salmonids salvaged (excluding stocked triploid hatchery trout). Whitefish only represented 0.1 percent of all fish caught in the screw trap and 0.3 percent of salmonids.

- Rainbow trout was the most abundant salmonid captured in the screw trap, representing 72.1 percent of all salmonids collected. Rainbow trout represented only 27.8 percent of all salmonids recovered in the fish salvage operation (excluding stocked triploid hatchery trout).

- Bull trout represented 5.1 percent of all salmonids recovered in the fish salvage operation and 1.2 percent of all salmonids captured in the screw trap (excluding stocked triploid hatchery trout).

- Relative abundance of entrained fish species in the Swift canal is unknown since the two estimates of relative abundance derived from the screw trap sampling and fish salvage operations are conflicting.

- Total number of fish entrained decreased from winter to summer and generally decreased as discharge decreased.

4.6.8 Schedule

This study is complete.

4.6.9 Literature Cited

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