OWEB Project Completion Report

Project Name: **Cascade Creek Watershed Monitoring Project**
Project Number: **97-032**
Submitted by: **Tony Stein, ODFW**

1) Project Description:
A smolt trap (rotary screw type) was purchased to monitor the survival and downstream migration of adult and juvenile salmonids. Under the Oregon Plan, the Oregon Department of Fish and Wildlife developed the "Salmonid Life-Cycle Monitoring Project" to: a) estimate abundance of adults and juveniles, b) evaluate marine and freshwater survival rates for juvenile coho and c) evaluate the effects of habitat modification on the abundance of juveniles. Cascade Creek on the Alsea River was one of seven locations chosen for survival monitoring .

2) List of Volunteers:
No volunteers were involved with the project.

3) Other Participants
Mid-Coast Watersheds Council
ODFW STEP Biologist

4) Materials and Methods:
A rotary screw trap was used to capture downstream migrating juvenile salmonids and was generally operated beginning in early March until catches diminished to low levels, usually by mid-June. Traps were checked, cleared of debris and maintained on a regular basis and juveniles sampled and enumerated by species, size, age and development (smoltification).

5) Results:
Generally, populations of juvenile coho and chinook salmon were lower in the spring of 1999 than 1998. Steelhead populations also tended to be lower in 1999 than in 1998, while cutthroat populations were about the same between years. The timing of the downstream migration of juvenile coho and chinook was generally later during the spring of 1999 than in 1998. Coho salmon smolts were larger in 1999 than in 1998 at each survival monitoring site where comparisons were available.
The estimated freshwater survival rate for coho (1997 Brood) in Cascade Creek from egg to smolt was 1.5%. The marine survival rate for coho salmon from smolt to adult will be estimated when the smolts that migrated during the spring in 1998 return as adults in the fall of 2000.
* See the attached *draft* ODFW Salmonid Life-Cycle Monitoring Project Report.

6) Expenditures:

OWEB: Fish Trap	$12,000
ODFW: Trap operation, data analysis	$24,250

7) Other Information:

SALMONID LIFE-CYCLE MONITORING PROJECT

Mario F. Solazzi
Steven L. Johnson
Bruce Miller
Tim Dalton

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Oregon Department of Fish and Wildlife
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Oregon Plan for Salmon and Watersheds
Tillamook Bay National Estuary Program
Oregon Department of Forestry

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PART I. SMOLT AND ADULT MONITORING

Introduction

In 1998, as part of the Oregon Plan for Salmon and Watersheds (formerly the Coastal Salmon Restoration Initiative) the Oregon Department of Fish and Wildlife (ODFW) began a program to monitor survival and downstream migration of salmonid fishes (*Oncorhynchus spp.*) As a part of this program the Salmonid Life-cycle Monitoring project developed three objectives; 1) estimate abundance of adult salmonids and downstream migrating juvenile salmonids, 2) estimate the marine and freshwater survival rates for coho salmon (*Oncorhynchus kisutch)* and 3) evaluate the effects of habitat modification on the abundance of juvenile salmonids in Cummins and Tenmile Creeks.

This report summarizes the juvenile salmonid downstream migration data collected during the spring of 1998 and the spring of 1999 and includes the adult return data from the winter of 1998-99. We also summarize the results from the Cummins and Tenmile Creeks habitat modification project, which began in 1991, and coast-wide sampling of juvenile coho salmon populations, which began in 1998.

In 1998 we chose 7 locations for survival monitoring; N. Fork. Scappoose Creek (Lower Willamette), North Fork Nehalem River, Little Nestucca River, Mill Creek (Siletz Basin), Mill Creek (Yaquina Basin), Cascade Creek (Alsea Basin) and West Fork Smith River. At these locations, we are able to monitor both the downstream migrants (smolts) and returning adults. In 1999, we discontinued operation of the monitoring efforts in the Little Nestucca River due to logistical problems associated with monitoring the adult trap. In addition, we chose eleven locations to monitor downstream migration. We are not able to monitor the numbers of returning adults at these sites due to the lack of adult capture facilities.

Description of Sub-basins

North Fork Scappoose Creek (Lower Willamette)

North Scappoose Creek is approximately 23 km in length with six tributaries that are accessible to anadromous salmonids during winter spawning periods. The adult trapping site at Bonnie Falls is located approximately 14 km upstream from Scappoose Bay. The juvenile trapping site is located 1.5 km downstream from the adult trap. Road density is high and timberlands are generally in second growth consisting primarily of red alder. Recent clear-cuts are numerous throughout the watershed. Above the trapping site, the drainage area is highly dissected hills and mountains. However, there are various reaches of the mainstem and tributaries that provide unconstrained or moderately constrained low gradient habitat. The total area of the watershed is 61.6 km^2. The majority of the watershed is privately owned with over 50% being managed by private timber companies.

North Fork Nehalem River

The North Fork Nehalem River is approximately 71 km. in length with numerous tributaries that are accessible to anadromous salmonids. The adult salmonid trapping and tagging site at Waterhouse Falls is located approximately 20 km upstream from Nehalem Bay. The juvenile trapping site is approximately 0.2 km downstream from the adult trap. Above the trapping sites, the drainage area is highly dissected with hills and mountains constraining the river. However, many reaches of the river and its tributaries provide low gradient, gravel-rich habitat. Almost the entire watershed (112.6 km^2) is managed for timber production. Land ownership is a mix of private timber lands and state forest managed by the Oregon Department of Forestry. Road density is high and the timberlands are generally in second growth with numerous recent clear-cuts.

Little North Fork Wilson River

The Little North Fork Wilson River and its tributaries have approximately 16 km of stream accessible to anadromous salmonids, almost all of which is constrained or in narrow valleys among hills and mountains. Many reaches, particularly in the lower mainstem, provide low gradient, gravel-rich habitat. The juvenile trapping site is located approximately 1.6 km upstream from the confluence with the mainstem Wilson River. The Oregon Department of Forestry and the Bureau of Land Management manage the entire watershed (46.5 km^2) for timber production. Approximately 1.6 km of the river runs through an old growth coniferous forest of almost a square kilometer. Otherwise, timber is second growth with a few recently cut stands, as well as considerable areas dominated by red alder

Little South Fork Kilchis River

The Little South Fork Kilchis River is approximately 12 km in length with one major tributary, Sam Downs Creek, that is accessible to anadromous fish. Only the highest reaches are inaccessible. The juvenile trapping site is located about 1.6 km upstream from the confluence with the mainstem Kilchis River. Above the trapping site, the drainage area is highly dissected with steep hills and mountains. All but a few reaches, mostly in the lower mainstem, are moderate to high gradient and all reaches are constrained or in narrow valleys. The entire watershed is managed for timber production. The Oregon Department of Forestry is the major landowner but the Bureau of Land Management manages a small area. Roads are all gravel, and density is particularly high in the higher elevations. Most timber is young, with a few recent clear-cuts and the basin has a considerable area dominated by red alder.

Little Nestucca River

The Little Nestucca River is approximately 100 km in length with numerous tributaries. Only the upper reaches of the mainstem and the upper reaches of most tributaries are inaccessible to anadromous fish. The adult and juvenile trapping site at Upton Falls is located 5.2 km upstream from the confluence with Nestucca Bay, and less than a kilometer above the lowland floodplain. The Little Nestucca River basin encompasses approximately 118 square km^2, and above the trapping site, the drainage area is highly dissected hills and mountains. However, there are various reaches of the mainstem and tributaries that provide unconstrained or moderately constrained low gradient habitat. Much of the land along these reaches is in private ownership, mostly rural residential, agriculture, and small wood-lots. The balance of the watershed is managed for timber production, with ownership/management in descending order by the US Forest Service, industrial timber companies, the Oregon Department of Forestry and the Bureau of Land Management. Road density, mostly gravel, is high and most of the timberlands are in an early seral stage.

Mill Creek (Siletz)

Siletz Mill Creek is a third order stream that flows into the Siletz River just upstream from the town of Logston, Oregon. The Siletz Mill Creek basin is 33.8 km^2 and has approximately 18.5 km of stream available for anadromous fish use. The Mill Siletz Creek watershed is primarily in private ownership. The lower 3 km of stream runs through rural residential and agricultural lands. The remainder of the watershed is managed as timberlands.

Bales Creek (Yaquina)

Bales Creek is a third order tributary to the Yaquina River. Bales Creek basin is approximately 6.2 km^2 and has about 8 km of habitat available to anadromous salmonids.

Average summer wetted width of the stream channel is 2.0m. Substrate is composed mainly of sand and gravel with some cobble and bedrock present. Most of the stream channel is either terrace or hillslope constrained. Land ownership is entirely private and managed as timberland.

Mill Creek (Yaquina)

Yaquina Mill Creek is a third order stream that flows into the Yaquina River between Toledo and Elk City, Oregon. The Yaquina Mill Creek basin is 21.2 km^2 and has approximately 16 km of stream available for anadromous fish use. The Yaquina Mill Creek watershed is primarily in private ownership. There is a dam in the upper portion of the watershed. The stream above the dam is constrained by hillslopes within a steep V-shaped valley. The average summer wetted width is 3.6m. Substrate is composed mainly of gravel, cobble and sand. The impoundment serves as the water supply for the town of Toledo during the winter. A fish ladder at the dam allows passage of adult salmonids into the reservoir. These fish eventually migrate through the reservoir and spawn in one of two tributary streams that feed the reservoir. Adult fish are trapped as they move through the fish ladder and into the reservoir. At this site, the trap catch represents the total number of adult spawners migrating upstream of the trap location. Therefore, adult salmon are not tagged at this site, and no spawning fish surveys are completed above the trap site. Juvenile migrants are trapped just below the dam.

Cascade Creek (Alsea)

Cascade Creek is a third order tributary to Five Rivers in the Alsea basin. There is approximately 11.5 km of habitat available to anadromous salmonids and the basin area is approximately 14.2km^2. Scour pool and riffles are the most common habitat features and sand and gravel dominate the substrate. Land use is almost entirely timber production. The U.S. Forest Service manages the entire drainage.

East Fork Lobster Creek (Alsea)

East Fork Lobster Creek is a tributary to the Alsea River and has approximately 3.5 km of habitat available for use by anadromous salmonids. Basin area is approximately 14 km^2. Average stream gradient is 4.0% and substrate composition is primarily gravel and cobble. The stream has an average wetted width of 3.3 m and is approximately 80% shaded. In the summer of 1999, a habitat restoration project was completed which resulted in the addition of 265m^3 of large wood to the stream channel. This wood was distributed into seven in-channel debris jams. In addition, the BLM has planted conifers in the riparian area and has several ongoing silviculture research projects underway. The BLM is the primary landowner.

Upper Mainstem Lobster Creek (Alsea)

Upper Mainstem Lobster Creek is a tributary to the Alsea River and has approximately 4.7 km of habitat available for use by anadromous salmonids. The basin area is approximately 12.4 km^2 and the stream has an average gradient of 2.6%. Substrate composition is primarily gravel, cobble and silt and the stream has an average summer wetted width of 3.2 m. This stream has large areas affected by an instream habitat improvement project that was completed in the summer of 1991. This project involved the construction of several off channel alcoves and the addition of large wood to the stream channel. The BLM is the primary landowner in this basin.

West Fork Smith River

The West Fork Smith River forms a sixth order tributary to the Smith River, a major tributary of the Umpqua River. The mouth of Smith River lies within tidewater just north of the town of Reedsport, Oregon. The West Fork Smith River has 297 km of stream network and a drainage area of 69 km^2. The Bureau of Land Management (BLM) manages 68 % (46.9 km^2) of the watershed and the remainder is divided between private timber companies and the U.S. Forest Service.

Elevations above sea level range between 61 m at the mouth and 871 m at Roman Nose Mountain. The climate is characterized by mild, wet winters and cool, dry summers. The hydrology of this sub-basin is controlled by precipitation in the form of rain, with an average annual total of 240 cm. Most of the precipitation falls in the six-month period October to March and approximately 50% of the total occurs between November and January. The distribution of annual precipitation determines the pattern of streamflow, with highest mean monthly flows in December and January and lowest flows in August and September.

Stream channels, primarily the mainstem, have been modified by past land use practices. Removal of large wood and at least two splash-dam log drives took place before 1920. Splash damming had already degraded the mainstem by 1900. More recent timber harvest (1960s to 1980s) left excessive logging debris in tributary streams, but stream cleaning and lump sum sales in the 1970s along lower reaches of some tributaries resulted in removal of logging slash and naturally occurring large wood. As a result, the mainstem and lower reaches of some tributaries are deficient in wood. Although logging started in the basin before 1900, the road along the mainstem was not built until the 1950s. Additional roads along the major tributaries were constructed during the 1970s and '80s to access timber. Road construction along the mainstem affected the channel's ability to dissipate energy and has resulted in many reaches that are down-cut to bedrock. This down cutting has led to lateral bank erosion, which has widened the stream channel and reduced pool habitat.

There are currently no active timber harvest activities on private timberlands and no planned timber sales on lands managed by BLM. Current use in the basin is limited to recreation, harvest of special forest products and rock quarrying. BLM has ongoing habitat improvement projects focused on the mainstem, including construction of boulder weirs and placement of trees and large woody debris. These projects are intended to retain gravel, increase spawning habitat, and improve habitat complexity.

ODFW conducted habitat surveys on the mainstem and all spawning tributaries in 1994, 1998 and 1999. These surveys included characterization of stream channel and riparian areas, an assessment of gravel for spawning habitat, and quantification of wood within the channel. Ratings of overall condition were either "fair" (mainstem, Crane Creek, Gold Creek) or "good" (Coon Creek, Moore Creek, Beaver Creek).

Winchester Creek (Coos)

Winchester Creek is a third order stream that forms the principal drainage in South Slough, a major estuarine arm of Coos Bay. South Slough is situated 3 km from the mouth of Coos Bay and is separated from tributaries further upriver by a long reach that is predominantly under marine or estuarine influence. Approximately 7 km above the confluence with Coos Bay, South Slough narrows from a broad expanse of salt marsh and tidal channels to a more confined channel, which defines the lower reach of Winchester Creek. Tidal influence extends upstream to a short distance above Anderson Creek, but the extent of salt intrusion varies according to streamflow and tidal range. The watershed drains a total of 24.1 km^2, including Cox Canyon Creek. Mean monthly discharge ranges from 6 cfs in August to over 230 cfs.

The stream channel contains both unconstrained and terrace constrained reaches. The channel has an average summer wetted width of 3.5 m and approximately 8 km of habitat is available to anadromous salmonids. Average stream gradient is near 0%. Substrate is composed mainly of silt and sand. Gravel is uncommon, located primarily in the upper reach, where it provides some areas suitable for anadromous fish spawning.

Juvenile (sub-yearling) coho salmon are found throughout the mainstem and West Fork, and in the lower reaches of other tributaries. Coho spawning appears limited to the West Fork, thus it is likely that juvenile coho ascend the other tributaries and utilize the lower reaches as rearing areas. Sea-run cutthroat trout are found throughout the system. There are no significant barriers to cutthroat trout migration in any of the spawning tributaries. Juvenile steelhead trout (age 0+ or 1+) have been observed but in low numbers, thus few adults probably spawn in most years. Because of the predominance of low gradient reaches and beaver ponds in Winchester Creek, limitations to steelhead production may be lack of juvenile rearing habitat, which is typically higher gradient. Beavers are found throughout the system and river otters are common in the lower reaches.

The headwaters of Winchester Creek, including all of the West, Middle and East forks, and the upper portion of Cox Canyon Creek lie within Coos County Forest. Private timber companies own the headwaters of some lower tributaries. All of the County Forest and private lands are managed for timber harvest and are currently a mosaic of clear-cut, re-planted, and forested areas. The lower reaches of the mainstem and some tributaries are within the South Slough National Estuarine Research Reserve (SSNERR). The South Slough Reserve is part of the national system of estuarine reserves and is managed cooperatively by the National Oceanic and Atmospheric Administration and the State of Oregon, Division of State Lands. SSNERR has an ongoing program of resource management and research focused on marsh restoration. In the upper portion of South Slough where Winchester Creek broadens into salt marsh, SSNERR has removed tide-gates and dikes, and re-established tidal channels in former marsh areas that had been altered for grazing early in the 1900s. Similar restoration work is planned for the lower reach of Anderson Creek, a tributary to Winchester Creek near the head of tide. SSNERR is conducting research on the utilization of these restored wetlands by juvenile salmonids and other fishes.

Fall Creek (Coos)

Fall Creek is a tributary of South Fork Coos River approximately 27 km above the head of tidal influence at Dellwood, Oregon. A private timber company owns the entire watershed and principal land use is timber harvest, rock quarrying, and some seasonal recreational use by hunters.

Approximately 14 km of Fall Creek have been identified as suitable rearing habitat for coho salmon and steelhead. Prior to 1997 all fish passage was blocked by a natural falls of 12 m vertical drop located one km above the mouth. In 1987 a fish-way was constructed to allow fish passage around the falls, but completion of steps in the ladder did not occur until 1997. The ladder has functioned continuously since fall of 1997, although debris jams within the ladder have occasionally prevented fish passage for short periods.

Beginning in 1982 hatchery coho salmon pre-smolts have been released in Fall Creek above the falls to increase the distribution of spawners in the Coos River and take advantage of rearing habitat above the falls. After 1982, both coho and steelhead were released into Fall Creek as hatchbox fry to supplement production from natural spawners. These releases were made in anticipation of a functional fish ladder, but adults from these releases could not ascend Fall Creek until 1997. Releases of coho fry were made through 1996 and releases of steelhead fry were made through 1997.

Bottom Creek (Coos)

Bottom Creek is a tributary of South Fork Coos River approximately 13 km upstream from Fall Creek. A private timber company owns the entire watershed and principal land uses are timber harvest and seasonal recreational use by hunters.

North Fork Coquille River

The Coquille River watershed encompasses 2,740 km^2, making it the fourth largest drainage area in Oregon and the largest river in the state with a drainage basin entirely within the coastal area. Elevations range from sea level to over 1500 m. All 58 km of the mainstem is tidally influenced, with head of tide at river km 66, just above the town of Myrtle Point. The North Fork Coquille, which enters the mainstem just downstream from Myrtle Point, is the second longest (86 km) of the four principal forks of the Coquille River and drains an area of approximately 399 km^2. The juvenile trapping site was located 60 km above the confluence with the mainstem.

The mainstem flows through a broad coastal plain with a very low gradient of about 0.15 m per km. Average gradient of the North Fork is 5.7 m per km, but the lower reach has considerably less gradient. High stream flows occur in winter and generally follow rainfall patterns, with little influence from snowmelt. Steep slopes and low infiltration rates result in high variation in winter stream flows. Low ground-water storage capacity and little rainfall during summer result in very low summer flows.

Land use is primarily residential and agricultural within the narrow valley of the lower reaches of the North Fork, and timber production on slopes adjacent to the river and along the upper reaches. A timber company holds most private land and the U.S. Bureau of Land Management has holdings on the upper-most reaches of the North Fork.

Fish habitat in the lower reaches is generally in poor condition with a predominantly bedrock streambed, little in-stream wood debris, and limited riparian vegetation. This stretch is primarily pasture land with willows or low brush along the bank. The upper reaches have better fish habitat with good spawning areas, in-stream structure, and riparian cover. Summer flows reach a minimum of 1.9 to 2.3 m^3 per second, while winter flows may exceed 1800 to 2800 m^3 per second (highest recorded flow was 3570 m^3 per second in Dec. 1964). Maximum water temperatures may reach 20 to 22 C during summer months.

Anadromous salmonids are found in all four forks of the Coquille River, including chinook and coho salmon, and winter steelhead and coastal cutthroat trout. Non-migratory populations of cutthroat trout can be found in some upper reaches above barriers to migration. Other species include speckled dace, several species of sculpin, large-scale suckers, and Pacific lamprey.

Methods for Estimating Abundance of Migrating Juvenile Salmonids

A rotary screw trap was used at most sites to capture downstream migrating juvenile salmonids and was generally operated beginning in early March until catches diminished to low levels, usually by mid June. The traps were normally checked and cleared of fish and debris once a day, although, to ensure fish safety, visits were more frequent during storm events and high debris periods. Fish were anesthetized with MS-222 and enumerated by species, size, age, and development (smoltification) class as indicated by visible brightness.

Species were classified by age or size group. Coho salmon *(Oncorhynchus. kisutch)* were identified as fry (age 0+) or smolts (age 1+). All chum salmon (*O. keta*) captured were fry (age 0+). Chinook salmon (*O. tshawytscha*), also age 0+, were identified as fry that migrated soon after emergence (<60 mm fork-length) and fingerlings that remained to rear until ≥60 mm. Trout species were classified into size classes that roughly correspond to age classes, the largest class for each species containing smolts, the smaller classes parr. Fry (<60 mm) were not differentiated to the species level. Additional size classes were 60-89, 90-119 and ≥120 mm for steelhead (*O. mykiss*), and 60-89, 90-119, 120-159 and ≥160 mm for cutthroat trout (*O. clarki*). Sea-run trout migrate to sea at various ages according to individual smoltification maturity, steelhead usually at ages 1+ or 2+, cutthroat at 2+, 3+, and 4+; however, both can migrate at any age.

To calibrate the efficiency of the traps and to estimate total outmigration, each day up to 25 fish of each species and size class were marked with a small clip on their caudal fin then released upstream of the traps for recapture. Marked fish were released at dusk from a floating timer-actuated release device (Miller et al. In press). The number of fish marked varied by species. For example, up to 25 chum salmon, all fry, were marked and released each day. In contrast, up to 100 cutthroat trout (4 size classes) might be marked and released, in addition to marked trout fry of undifferentiated species. Recaptured marked fish were likewise enumerated by species and size class, and estimates of total outmigration were made by expanding trap catches using the following equations:

$$N = n_i / E_i,$$

and

$$E_i = r_i / m_i,$$

where N = total outmigrant estimate, n_i = number of fish captured, E_i = estimated trap efficiency, r_i = number of recaptured marked fish, and m_i = number of marked fish released. Values used in these estimates were usually weekly totals. However, when recaptures were infrequent weeks were pooled. Weekly estimates were summed to estimate total outmigrants for the season. Population estimates were not calculated if less than five marked fish of the particular species and size class were recaptured.

The protocols described above were followed at each trap site. Yaquina Mill Creek and Winchester Creek present unique sampling situations and some modifications to the protocols (described below) were necessary.

Yaquina Mill Creek

Downstream migrants can leave the Yaquina Mill Creek Reservoir through the fish ladder or over the spillway of the reservoir. Juvenile salmonids were trapped using a floating and revolving incline plane trap that continually sampled a portion of the stream throughout the spring. This trap was located approximately 30 meters downstream of the confluence of water leaving the fish ladder and water leaving the spillway of the reservoir. To increase the total number of fish captured, a second trap was also installed directly in the fish ladder, which captured all fish migrating down the ladder. The juvenile traps ran from March 2 through June 20. Standard sampling protocols were used to calculate trap efficiencies and estimate the total number of downstream migrants passing the incline plane trap. Fish captured in the fish ladder trap were counted and released below the incline plane trap. The number of fish caught in the fish ladder trap was added to the estimate of the incline plane trap to provide a total estimate of downstream migrants for each species.

Winchester Creek

A rotary screw trap was installed in Winchester Creek between the mouths of Cox Canyon Creek and Wasson Creek and operated from February 5 to May 27, 1999, when streamflows became too low for the trap to function. This site is below the head of tide and has up to a one-meter tidal exchange. Installation was restricted to this reach due to access limitations. Because the trap was placed below the head of tide, the hours of operation each day were a function of streamflow. During low streamflow, the trap sampled only during ebb flow and low tide, approximately 12 hours per day. During high streamflows, the trap operated continuously.

The trap was sampled daily except for May, when the trap was sampled every other day. Standard protocols were followed with the following exceptions. Starting March 19, all coho and juvenile cutthroat trout captured were dye-marked. Two subcutaneous injections of India ink were made with a syringe at different locations on the ventral surface between the pectoral and ventral fins. A sub-sample of 15 fish was held for two weeks to measure handling mortality due to the marking technique. Combinations of marks were changed at seven-day intervals. Marking with unique marks provided a means of estimating how long juveniles may have delayed migration back down to the smolt trap when released upstream. Marking with a combination of marks also permitted us to determine whether fish that passed downstream of the trap subsequently return upstream and are subject to re-capture.

Methods for Estimating Abundance of Returning Adult Salmonids

North Fork Scappoose Creek

Adult salmonids were trapped in a fish ladder located at Bonnie Falls. The fish ladder provides passage around a waterfall that is considered a complete barrier to adult salmon and steelhead upstream migration. The trap was installed the first week of January 1999 and was fished continuously through June 1999. Flows in the summer are too low to run the trap. From historical records, coho, winter steelhead and cutthroat were believed to migrate into the stream. All fish entering the trap were examined for marks, identified as male or female, measured for fork length, given a lower caudal punch then released upstream from the trap. The caudal punch was used to determine if any fish had fallen back over the falls.

North Fork Nehalem River

Adult salmonids were trapped and tagged in the fish ladder that provides passage around Waterhouse Falls, a partial barrier to adult salmonid upstream migration. The trap was first set to fish overnight on October 3, 1998 and was operated through June 13, 1999. However, high water levels sometimes made the trap unworkable, at which times it was opened to allow fish passage. Even on high flow days when the trap could still be operated, it was usually inefficient. This was because the relative attraction of the water that could be passed through it was low compared to that going over the falls, and because higher flows greatly increased the ability of fish to pass over the falls. Such high flows were common in late November and late December, as well as throughout January and February.

Fish captured by the trap were removed from the water with a dip-net, inspected for marks, identified to species, sex and origin (i.e., hatchery or naturally reared, determined by presence or absence of an adipose fin clip or a coded-wire tag in the snout), and fork-length was measured. Coho salmon less than 50 cm were designated "jacks" (i.e., fish that return to spawn as two-year olds, usually males). For chinook salmon the length used to differentiate jacks and adults was 61 cm. Steelhead were not differentiated thusly. Naturally reared, or "wild", coho and chinook salmon, as well as steelhead, were implanted with one or, usually, two floy tags (tag color varying by species) near the base of the dorsal fin, and were passed upstream. However, fish appearing to be in very poor health were released without tags. Hatchery reared coho salmon were killed, whereas hatchery reared steelhead were floy tagged and transported alive and released down river for "recycling" through the fishery.

A second trap was constructed in a fish ladder located just above the confluence of Fall Creek, approximately 6.5 kilometers upstream from Waterhouse Falls. This trap was operated between October 23 and April 10, and was frequently inoperable due to high flows. Tagged adults caught in this trap or found as carcasses on spawner surveys were pooled as mark recoveries. Their proportion among all adults caught in the upstream trap or found as carcasses was used to estimate trapping and tagging efficiency at the Waterhouse (downstream) trap.

Little Nestucca River

During the summer and early fall of 1998, adult traps were constructed in fish passage ladders at Upton Falls, as well as at Stella falls at approximately river kilometer 6.6. Both ladders are located in highly constrained and incised sections of the river. The Stella ladder, on the east side of the river, was directly approachable from the Little Nestucca Highway. The

Upton ladder, on the opposite bank, was reached by wading during low flows and by a raft attached to a static line during higher flows. Upton falls is considered to present greater passage difficulties, thus requiring a greater number of fish to use the ladder, and it was in this ladder and trap that fish were tagged. The Stella trap was intended to provide data (i.e., the ratio of tagged to untagged fish entering the trap) to estimate the proportion of the total population of each species that were tagged at the Upton trap.

The Upton trap was first set to fish overnight on October 4 and fished continuously, except for one day, until high river levels disrupted operations on November 20. Thereafter, high water levels often made the trap unapproachable or unworkable for periods of days or weeks. Between October 5 and January 30, there were three periods when the trap could be operated on only a day-to-day basis: October 5 to November 19, December 16 to December 26, and January 7 to January 14. The trap was also operated overnight on December 9 to10. When high water levels occurred or appeared imminent, but water levels still allowed a river crossing, the upstream door was secured in an open position so as not to impede fish passage. Whenever flow control, and thus entrance, could be gained, and precipitation did not threaten renewed flooding, the trap was cleared of accumulated sediment and debris, and set to operating.

The Stella trap began operating on October 20, but it soon became apparent that the amount of water that could be diverted through the ladder was small compared to that going through the falls, providing relatively little attraction. Additionally, it appeared likely that, at least during the period in which the trap was operated, the falls, which are actually a cascade or chute, did not significantly impede fish passage. The ladder and trap also became flooded and unworkable at only moderate flows. On November 22, during the storm period that began on November 20, the trap was found to have sustained severe, irreparable damage from high flows, debris and river-borne tree boughs, and the trap was inoperable thereafter. Before that date, no fish was ever seen in the trap or ladder, and the trap was workable for only 17 days, while it was flooded or unworkable for 16 days.

Siletz Mill Creek

Adult salmonids were trapped in a fish ladder near the mouth of Siletz Mill Creek (River Kilometer 0.4). The fish ladder provides passage around a small waterfall that is a partial barrier to adult salmon and steelhead upstream migration. The trap was fished continuously from mid-September 1998 through June 1999. Flows in the summer are too low to run the trap. All adult salmon, steelhead and cutthroat trout entering the trap were examined for marks, identified as male or female, and measured for fork length. All wild salmon and wild steelhead were given a floy tag on each side of the dorsal fin and released upstream. All hatchery coho were killed. If these fish were bright and in good condition, they were taken to local food share organizations, if dark, they were deposited below the trap in the stream. All hatchery steelhead captured in the trap from October through January were given an opercle punch and released below the falls. Hatchery steelhead caught in February – March were either trucked to Ollala Reservoir or used as broodstock for future hatchery releases in the Siletz River.

The waterfall at Siletz Mill Creek is not a complete barrier to upstream migration at all river levels. Therefore, some fish may jump the falls rather than move through the fish ladder and into the trap where they can be counted. In order to estimate the total number of spawners, we conducted spawning fish surveys above the trap site to determine the proportion of tagged and untagged fish.

Eight adult coho salmon spawning surveys in the Siletz Mill Creek watershed were completed weekly from November 1 through January 31, 1999. The total miles for all surveys combined was 12 km, and encompassed the best spawning areas within the watershed. Surveyors counted live and dead adult salmonids in each survey area to determine the tagged to untagged ratio of adult salmonids above the trap site.

Two spawning surveys in the Siletz Mill Creek watershed were completed biweekly from February 1, 1998 through May 15, 1999. The total length of both surveys combined was 3.8 kilometers. Surveyors kept similar information on all dead and live steelhead as described above for coho salmon spawning surveys.

Yaquina Mill Creek

The adult trap was installed in the fish ladder late September 1998, and fished through May 1999. All adult salmonids entering the trap were examined for marks, identified as male or female, and measured for fork length. All fish were given a left opercle punch to determine if fish were falling back down through the reservoir spillway and reentering the ladder and trap. After processing, wild coho and steelhead were placed in the reservoir and allowed to proceed upstream. Hatchery coho (fin clipped fish) were killed. Bright fish in good condition were taken to a local foodshare organization. Dark fish were placed in the stream below the fish ladder. Hatchery steelhead were given a right opercle punch and released below the reservoir. Most of the chinook salmon that entered the trap were retained for ODFW district personnel for the Yaquina River chinook broodstock program.

Cascade Creek

Adult fish were trapped as they moved through a fish ladder near the mouth of Cascade Creek. The fish ladder provides passage for adult salmon and steelhead around a waterfall at River Kilometer 0.15. The falls are believed to be a complete barrier to upstream migration, so the trap catch should represent the total spawners in the basin. Because there was some possibility that fish might jump the falls at the extremely high flows experienced in the winter of 1998-99, we elected to floy tag the adult salmon and steelhead released above the falls. We then conducted spawning surveys to determine the proportion of tagged and untagged fish present on the spawning grounds.

The adult trap was installed in the fish ladder in late September 1998, and fished through May 1999. All adult salmonids entering the trap were examined for marks, identified as male or female, and measured for fork length. All wild salmon and wild steelhead were given a floy tag on each side of the dorsal fin and released upstream. All hatchery coho were killed. If these fish were bright and in good condition, they were taken to food share, if dark, they were deposited below the trap in the stream. All hatchery steelhead were given an opercle punch and released below the falls.

To determine if coho salmon were jumping the falls during high flows in 1998-99, we conducted spawning surveys in Cascade Creek in mid –December of 1998 to determine the proportion of tagged and untagged fish. The total miles for all surveys combined was 8 kilometers, and encompassed the best spawning areas within the watershed. Surveyors counted live and dead adult salmonids in each survey area. For each live fish observed, surveyors also recorded if they (1) observed one or more floy tags on the fish (2) got a good look at the fish and did not observe a floy tag, or (3) could not make a definitive observation about the presence or absence of a tag. For each dead fish observed, surveyors recorded whether they observed a floy tag.

West Fork Smith River

The adult fish trap on the West Fork Smith River is located 1.8 km above the mouth. There are no tributaries below the trap. The trap utilizes a floating weir as a barrier to fish migration. The weir is 6.1 m long by 12.7 m wide and constructed of PVC pipe as pickets with a 32-mm gap between pickets. The weir pivots from a cable that is attached at the upstream edge of the weir to a concrete sill placed perpendicular to streamflow. The weir pickets are sealed at both ends and thus buoyant. An adjustable-angle 'resistance-board' is attached to the under-face of the weir at the downstream end. This board angles into the current flowing through the weir pickets and provides lift to the downstream end of the weir. The weir pivots between a

Table 1. The estimated number of downstream migrant salmonid smolts and juveniles at seven survival monitoring sites in the Oregon coast range, spring 1998 and 1999.

Location	Estimated number of downstream migrants			
Year	Coho	Chinook[a]	Steelhead[b]	Cutthroat[c]
N. Scappoose				
1999	1,453	--	407	346
N. Nehalem				
1998	42,427	984,449	6,706	724
1999	21,702	496,371	4,572	633
L. Nestucca				
1998	3,672	80,844	7,957	565
Mill Cr. Siletz				
1998	9,534	--	1,017	514
1999	8,409	--	240	686
Mill Cr. Yaquina				
1998	6,698	7,063	240	36
1999	2,225	34	347	32
Cascade Cr.				
1998	1,404	26	110	168
1999	557	1	50	153
W. Fk. Smith				
1998	22,412	127,726	6,388	--
1999	10,942	10,349	2,895	75[d]

[a] Chinook $\leq$ 60 mm.
[b] Steelhead $\geq$ 120 mm.
[c] Cutthroat $\geq$ 160 mm.
[d] Number captured.

in 1999, allowing for better growth in years when abundance is low. Cutthroat trout average lengths are more variable between years than the other two species and no distinct trends are evident. The seasonal average lengths for the four species are presented in Table 5.

Adult Trapping and Tagging

North Fork Scappoose Creek

After accounting for fallbacks, 33 adult steelhead and one rainbow trout were counted in the trap at Bonnie Falls between 11 January and 9 April 1999. Seventeen were females and 16 were males. Of the females, 13 were of hatchery origin and of the males, 9 were hatchery fish. All fish were passed above the falls.

North Fork Nehalem River

Coho salmon, both wild and hatchery reared were caught throughout October and most of November. Fish were captured at the Waterhouse trap during the first two weeks of sampling in October and during the first two weeks of November (Figure 1). Numbers of salmonids captured at this trap are shown in Table 6.

For the 45 coho salmon adults captured in the upstream trap or found as carcasses on spawning surveys, 12 had been marked with floy tags. An estimate of adult coho salmon spawners was made using an adjusted Petersen Mark-Recapture methodology:

$$N = ((M + 1)(C + 1)) / (R + 1)$$

where:

M = 218, the number of adult coho salmon marked with floy tag(s). Nine fish were passed without tags.

C = 45, the number of adult coho salmon captured in the upstream trap or found as carcasses on spawning surveys.

R = 12, the number of adult coho salmon marked with floy tag(s) captured in the upstream trap or found as carcasses on spawning surveys.

Using this methodology, the spawning escapement of adult coho salmon in the North Fork Nehalem watershed was estimated to be 775 fish. The ratio between wild and hatchery reared fish caught in the Waterhouse trap was used to estimate the number of these that were wild (550) and that were hatchery reared (225). Bootstrap methodology bound the wild fish estimate with a 95% confidence interval that had 994 as the upper limit and 326 as the lower limit. The number of males and females were similarly estimated by their ratio among Waterhouse trap captures. Among the wild fish, 297 were males and 253 were females, and among the hatchery reared fish, 115 were males and 110 were females.

Table 2. The estimated number of downstream migrant salmonid smolts and juveniles at index monitoring sites in the Oregon coast range, spring 1998 and 1999.

Location	Estimated number of downstream migrants			
Year	Coho	Chinook[a]	Steelhead[b]	Cutthroat[c]
Upper Nehalem				
1998	51,900	255,720	3,759	1,295
1999	10,409	--	1,257	120
Little N. Fk. Wilson				
1998	3,345	1,175,423	13,885	524
1999	330	451,236	3,524	422
Little S. Fk. Kilchis				
1998	571	106,896	1,418	143
1999	385	30,948	1,948	475
Bales				
1998	1,624	249,308	--	197
1999	508	50,261	2	5
E. Fk. Lobster				
1998	1,286	--	--	--
1999	909	--	--	--
U. Mainstem Lobster				
1998	2,913	--	--	--
1999	1,481	--	--	--
N. Fk. Coquille				
1998	2,486	38,199	4,438	310
Winchester				
1999	2,208	--	144	351
Fall				
1999	1,610	4,883	326	89
Bottom				
1999	2,574	2,965	160	364

[a] Chinook $\leq$ 60 mm.

[b] Steelhead $\geq$ 120 mm.

[c] Cutthroat ≥ 160 mm.

Table 3. Timing of downstream migration of juvenile salmonids at seven survival monitoring sites during 1998 and 1999.

Location Year	Week of peak migration			
	Coho	Chinook[a]	Steelhead[b]	Cutthroat[c]
N. Scappoose				
1999	May 18-23	--	May 11-17	May 18-23
N. Nehalem				
1998	Apr 27-May 3	Mar 23-29	Apr 27-May 3	Apr 27-May 3
1999	May 3-9	Apr 5-11	Apr 26-May 2	May 31-Jun 6
L. Nestucca				
1998	Apr 27-May 3	Mar 23-29	Apr 20-26	Apr 20-26
Mill Cr. Siletz				
1998	Apr 20-26	--	Apr 20-26	Apr 13-19
1999	May 10-16	Mar 15-21	Mar 29-Apr 4	Apr 12-18
Mill Cr. Yaquina				
1998	Apr 27-May 3	Mar 23-29	Apr 27-May 3	Apr 20-26
1999	May 3-9	May 24-30	Apr 26-May 2	May 17-23
Cascade				
1998	Apr 20-26	May 25-31	Apr 20-26	Mar 9-15
1999	Apr 19-25	--	Apr 5-11	Mar 29-Apr 4
W. Fk. Smith				
1998	Apr 20-26	Mar 2-8	Apr 20-26	--
1999	May 17-22	Mar 15-21	May 3-9	May 3-9

[a] Chinook ≤ 60 mm.
[b] Steelhead ≥ 120 mm.
[c] Cutthroat ≥ 160 mm.

An estimate of adult chinook salmon spawners was made using the same methodology, where:

M = 158, the number of adult chinook salmon marked with floy tag(s).
C = 68, the number of adult chinook salmon captured in the upstream trap or found as carcasses on spawning surveys.
R = 16, the number of adult chinook salmon marked with floy tag(s) captured in the upstream trap or found as carcasses on spawning surveys.

The estimate for the spawning escapement of adult chinook salmon in the North Fork Nehalem watershed was 645 fish. The bootstrap yielded a 95% confidence interval with 1230 as the upper limit and 415 as the lower limit. Using the ratio between males and females caught in the Waterhouse trap, we estimated that there were 291 males and 354 females. The distribution of the returning adults is presented in Figure 2.

Steelhead were first caught at Waterhouse Falls in mid November and last caught in mid May. Hatchery reared fish predominated in the first half of this period, while wild fish made up a majority of the steelhead caught in the latter half (Figure 3). However, high flows often interrupted trapping, and such flows were much more prevalent in the earlier period. Thus, trapping effort and efficiency were considerably higher during the latter period when mostly wild steelhead were migrating. The number of steelhead captured are shown in Table 6. None of the 14 steelhead captured in the upstream trap were tagged, and no steelhead carcasses were found on spawning surveys. However, of 220 steelhead seen on surveys for which the surveyor could visually determine tag presence or absence, only 20 were tagged.

An estimate of adult steelhead spawners was made using the same methodology where:

M = 98, the number of adult steelhead marked with floy tag(s).

C = 234, the number of adult steelhead captured in the upstream trap or seen on spawning surveys for which floy tag(s) presence or absence could be determined.

R = 20, The number of adult steelhead captured in the upstream trap or seen on spawning surveys for which a floy tag(s) was determined to be present.

Table 4. Timing of downstream migration of juvenile salmonids at index monitoring sites in 1998 and 1999.

Location	Week of peak migration			
Year	Coho	Chinook[a]	Steelhead[b]	Cutthroat[c]
Upper Nehalem				
1998	Apr 27-May 3	Mar 23-29	Apr 27-May 3	Apr 27-May 3
1999	May 18-23	--	Apr 13-19	Mar 30-Apr 5
Little N. Fk. Wilson				
1998	May 4-10	Apr 20-26	Apr 27-May 3	May 4-10
1999	May 24-30	Apr 19-25	May 3-9	Jun 7-13
Little S. Fk. Kilchis				
1998	Apr 27-May 3	Apr 13-19	Apr 27-May 3	May 11-17
1999	May 3-9	Apr 12-18	Mar 15-21	May 17-23
Bales				
1998	Apr 20-26	Mar 23-29	--	Apr 27-May 3
1999	May 10-16	Apr 5-11	--	--
E. Fk. Lobster				
1998	Apr 27-May 3	--	--	--
1999	Mar 15-21	May 10-16	--	May 10-16
U. Mainstem Lobster				
1998	Apr 20-26	--	--	--
1999	May 3-9	--	--	--
N. Fk. Coquille				
1998	Apr 20-26	Mar 30-Apr 5	Apr 27-May 3	Apr 20-26
Winchester				
1999	Apr 26-May 2	--	Apr 12-18	Apr 19-25
Fall				
1999	May 10-16	Apr 12-18	May 10-16	May 17-22
Bottom				
1999	May 10-16	Apr 19-25	Apr 12-18	Apr 12-18

[a] Chinook $\leq$ 60 mm.

[b] Steelhead $\geq$ 120 mm.

[c] Cutthroat $\geq$ 160 mm.

Table 5. Seasonal average fork length of juvenile salmonids at seven survival monitoring sites during spring 1998 and 1999.

Location / Year	Seasonal average fork length of migrants (mm)			
	Coho	Chinook[a]	Steelhead[b]	Cutthroat[c]
N. Scappoose				
1999	129	--	169	183
N. Nehalem				
1998	108	51	169	190
1999	112	42	176	189
L. Nestucca				
1998	112	47	159	203
Mill Cr. Siletz				
1998	100	--	145	190
1999	108	58	150	182
Mill Cr. Yaquina				
1998	118	54	157	185
1999	141	58	176	224
Cascade				
1998	100	70	140	195
1999	106	--	145	184
W. Fk. Smith				
1998	104	59	161	--
1999	106	50	157	169[d]

[a] Chinook $\leq$ 60 mm.
[b] Steelhead $\geq$ 120 mm.
[c] Cutthroat $\geq$ 160 mm.
[d] After mid-April.

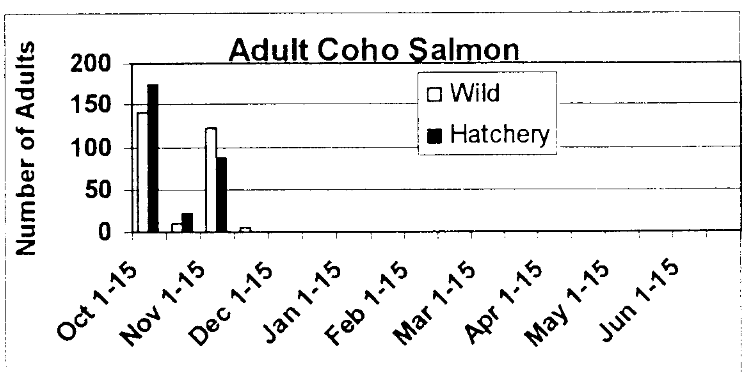


Figure 1. The number of adult coho salmon captured in the North Fork Nehalem River trap between October 1998 and June 1999.

Table 6. Summary of adult salmonids caught in the North Fork Nehalem River trap at Waterhouse Falls, winter 1998-99.

	Coho	Chinook	Steelhea	Cutthroat[a]
Wild Adult Males	123	74	54	-
Wild Adult Females	104	90	45	-
Wild Adult Sex Unknown	0	0	0	-
Wild Jacks	53	3	-	-
Hatchery Adult Males	81	-	31	-
Hatchery Adult Females	77	-	19	-
Hatchery Adult Sex Unknown	0	-	1	-
Hatchery Jacks	125	-	-	-
Total				

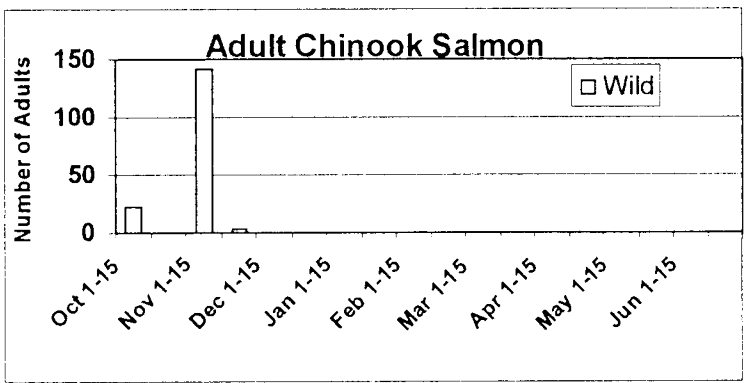
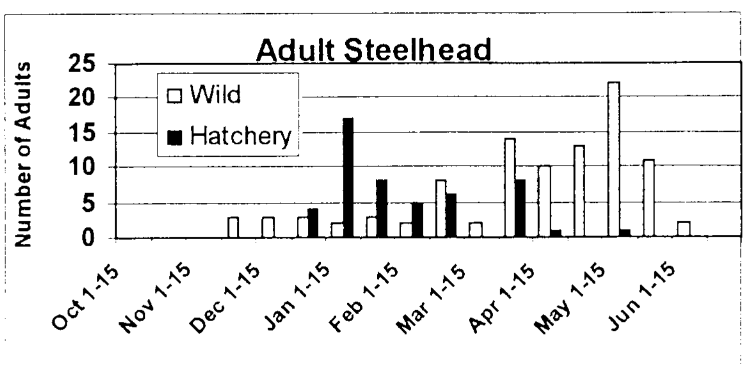


Figure 2. The distribution of adult chinook salmon captured in the North Fork Nehalem River between October 1998 and June 1999.



wooden bulkhead on one side and a concrete bulkhead on the other side that is an extension of the trap box. The concrete trap box is 6.1m long, 1.5 m wide and 1.8 m high (inside dimensions). As fish encounter the floating weir, water flowing through the trap box provides an attractant flow that encourages them to swim under a gap in the concrete bulkhead and through a V-fyke into the trap box. A rolling steel cover over the trap box provides security and access to the trap box. A steel-picket trash rack at the upstream end of the trap box prevents larger debris from impacting the trap box and provides a calm place for fish to recover after processing. A gate is lifted in the trash rack so that processed fish can swim upstream after recovery. Both the weir attachment sill and the head dam have sections that can be removed when the trap is not in operation, providing low-flow passage for small fish and other aquatic organisms. In 1999, a low-head dam was installed at the upstream end of the trap box. This dam provides 30 cm of head (above the level of the floating weir) to force more water through the trap box during low-flow conditions. After failure of the floating weir in 1998, the weir was re-engineered and rebuilt in 1999 and a new system for attaching the weir to the concrete sill was installed.

Fork length, sex, and presence of fin marks was recorded for each fish entering the trap, and two numbered yellow Floy tags were inserted just below the dorsal fin. Tag number was recorded on recaptured fish that had passed downstream of the trap when the weir was submerged or panels intentionally removed. Recaptured fish were then released above the trap. Because the trap is not a 100% barrier, fish were tagged in order to conduct a population estimate using the Peterson technique. Spawning ground surveys were conducted from November 1998 through early May 1999, to measure the ratio of tagged to untagged fish in the spawning tributaries.

Results and Discussion

Juvenile Trapping

The population estimates for juvenile salmonid downstream migrants for the spring of 1998 and 1999 are presented in Tables 1 and 2. Generally, populations of coho and chinook salmon were lower in the spring of 1999 than in 1998. Steelhead populations also tended to be lower in 1999 than in 1998, while cutthroat populations were about the same between years. A total population estimate for cutthroat trout smolts could not be calculated for the W. Fk. Smith River in 1999 because we did not distinguish size classes until after mid-April. The estimate could not be made in 1998 because of handling restrictions imposed under the Endangered Species Act.

Timing of Downstream Migration

The timing of the downstream migration of juvenile coho and chinook salmon was generally later during the spring of 1999 than 1998 (Tables 3 and 4). Cutthroat trout migration was also generally later in 1999 than in 1998 while the steelhead timing varied between years. In four of the eight locations where comparisons are available, steelhead migration was earlier in 1999 than in 1998.

Average Size of Downstream Migrants

Coho salmon smolts were larger in 1999 than in 1998 at each survival-monitoring site where comparisons are available. Steelhead smolts were also larger in 1999 compared to 1998 except in the W. F. Smith River where they were of similar size between years. The larger smolt size in 1999 compared to 1998 may be partially explained by the smaller population sizes

Figure 3. The number of hatchery and wild steelhead captured in the North Fork Nehalem River trap between October 1998 and June 1999.

The spawning escapement of adult steelhead in the North Fork Nehalem watershed was estimated to be 1085 fish. The ratio between wild and hatchery reared fish caught in the Waterhouse trap was used to estimate the number of these that were wild (752) and that were hatchery reared (333). The number of males and females were similarly estimated by their ratio among Waterhouse trap captures. Among the wild steelhead, 410 were males and 342 were females, and among the hatchery reared steelhead, 206 were males and 127 were females.

In considering these estimates for steelhead, one should be mindful that there were considerably greater potential sources of bias than occurred for coho and chinook salmon. High flows were common between late December and mid March, often precluding efficient trapping and enabling most fish to avoid the Waterhouse Falls trap during the time period when a high proportion of hatchery steelhead migrated. Later, when lower flows allowed efficient trapping and made the falls more difficult to bypass, a majority of the fish trapped were wild. Thus, before mid March, there were relatively fewer fish tagged and more that bypassed the ladder and trap. Afterwards, relatively fewer bypassed the ladder and trap but more were tagged and released. Furthermore, high river levels confounded by low water visibility before mid March hampered the effectiveness of spawning survey crews, sometimes precluding their efforts entirely. Afterwards, they were able to conduct surveys more regularly, and could more easily and clearly see the fish. However, a robustness test of the population estimation model made with the trapping and survey data partitioned temporally indicated that these potential violations of the model assumptions did not seriously affect the model results. Nevertheless, visual tag presence or absence verification is always potentially more subject to error than is live trapping or carcass recovery.

Little Nestucca River

It was hoped that this project would yield information on freshwater and marine survival rates of anadromous salmonids. However, difficulties resulting from frequent and high river discharge made it clear that the project would not be feasible using the available facilities.
In October, coho salmon were caught in fairly large numbers only during the second week of sampling. Catch peaked during the first week of November, and then continued intermittently until high flows forced cessation of trapping operations on November 20. Chinook salmon catch was high during the first half of October but zero during the second half, then also peaked in early November and continued in low numbers during the second week. Three chum salmon were also captured during the first week of November. During the low flow period, steelhead were caught in the first two weeks of October, but only one was caught thereafter, in early November.

In mid December, when water levels had receded sufficiently to again allow consistent trap operation, one coho and one chinook salmon, as well as a steelhead were found in the trap. Considering this as well as the migration timing of adult salmon and steelhead, it seems likely that some fish bypassed the trap between November 20 and December 14, during which period the trap was operational for just one day. During this second sustained period of trapping, lasting until December 26, no other fish were caught. Afterwards, during the third period of consistent trap operation from January 5 –14, only steelhead were caught. However, these were caught in relatively large numbers as soon as trapping was resumed, again suggesting that relatively large numbers of steelhead passed during the periods before and afterwards when the trap was flooded.

Owing to the long periods during which the trap was not operational, as well as the lack of tagged fish recovery data it was not possible to estimate the total numbers of returning adults of any of the species sampled. Spawning surveys revealed only three tagged chinook and five untagged coho salmon and one untagged steelhead. Overall, for coho salmon, the total catch of wild fish was 20 males, 26 females and 14 jacks, and of hatchery fish there were 4 males, 8 females and 1 jack. There was little difference in migration timing of wild and hatchery fish. Coded-wire tag revealed that all of the hatchery fish were reared at Salmon River, which enters the ocean approximately 8 miles to the south.

Chinook salmon numbered 28 males, 15 females and 17 jacks. All three chum salmon were males. Hatchery steelhead predominated, with 5 males and 13 females. It is likely that these came from Cedar Creek hatchery, located on a tributary to the Nestucca River. There were also 2 male wild steelhead and 5 female wild steelhead, as well as 3 steelhead of undetermined origin. The bimodal nature of their periods of capture suggests that those fish caught in the first half of October were probably summer steelhead while those caught in early to mid January were probably winter steelhead. Furthermore, in the Nestucca watershed, summer steelhead are almost exclusively of hatchery origin while winter fish are of both wild and hatchery origin, and only one naturally reared fish was captured in October.

Siletz Mill Creek

Table 7 summarizes the salmonids captured between October 1998 and June 1999. Fifty-four wild adult coho and 4 wild jack coho entered the trap during the winter of 1998-99. Eleven hatchery adult coho and 2 hatchery jack coho were collected in the Mill Creek trap during the winter. Fifty-four adult coho (29 males and 25 females) and 3 jacks were released above the trap. All of these fish were double floy tagged.

Eleven wild steelhead adults (5 males and 6 females) and 1 steelhead jack were double-floy tagged and released above the trap. Ninety-six hatchery adult steelhead and one hatchery jack steelhead also entered the trap during the winter of 1998-99. Hatchery fish accounted for 89% of the steelhead entering the watershed. Most of the hatchery fish entered the trap in November and December. These were adipose-clipped fish and were generally dark, indicating they had been in the river for some time. Presumably, these were mostly Siletz summer steelhead. The hatchery fish entering the trap in the late winter and spring were almost all adipose-left maxillary marked. These were Siletz winter steelhead originally released from the Palmer Creek acclimation ponds near Moonshine Park.

Sixteen live coho salmon were observed on spawning surveys and one coho salmon carcass was found. All adult coho salmon observed were floy tagged, indicating they had been counted at the trap. Forty-two live steelhead and 1 dead steelhead were observed on the spawning surveys. Five of the live steelhead were floy tagged, the dead steelhead was not tagged.

An estimate of the adult coho spawners was made using the adjusted Petersen Mark-Recapture methodology where:

- M = 54, the number of adult coho marked with floy tags
- C = 17, the number of adult coho observed for presence of floy tags on spawning surveys. This includes live and dead fish. Live fish that could not be observed well enough to determine if a floy tag was attached were excluded from this analysis.
- R = 17, the number of marked live or dead fish observed during the spawning surveys.

The spawning escapement of adult coho in Siletz Mill Creek was estimated to be 55 fish (30 males and 25 females). The distribution of adult coho salmon is shown in Figure 4.

Adult steelhead spawners were estimated using the same methodology where:

M = 11, the number of adult steelhead marked with floy tags

C = 43, the number of adult steelhead observed for presence of floy tags or opercal punches on spawning surveys. This includes live and dead fish. Live fish that could not be observed well enough to determine if a floy tag was attached were excluded from this analysis.

R = 5, the number of marked fish observed during the spawning surveys.

The estimated spawning escapement of adult steelhead in the Siletz Mill Creek watershed was 88 fish (40 males and 48 females). The distribution of returning adult steelhead is presented in Figure 5.

Yaquina Mill Creek

A total of 138 wild coho adults and 46 hatchery coho adults were captured in the Yaquina Mill Creek trap. Nineteen wild coho jacks and one hatchery coho jack were also captured. A total of 134 wild coho adults (77 females and 57 males) and 16 coho jacks were placed above the trap and into the reservoir. Because the ladder is the only possible route into reservoir, this represents the total number of spawners. Table 8 summarizes the salmonids captured in the trap and Figure 6 shows the distribution of the returning coho salmon.

Table 7. Summary of adult salmonids caught in the Siletz Mill Creek trap, winter 1998-99.

	Coho	Chinook	Steelhead	Cutthroat[a]
Wild Adult Males	29	2	5	0
Wild Adult Females	25	1	6	0
Wild Adult Sex Unknown	0	0	0	4
Wild Jacks	4	0	1	0
Hatchery Adult Males	8	0	40	0
Hatchery Adult Females	3	0	56	0
Hatchery Adult Sex Unknown	0	0	0	0
Hatchery Jacks	2	0	1	0
Total	71	3	109	4

[a] The cutthroat trout count is incomplete because bar spacing in the trap will allow them to pass through.

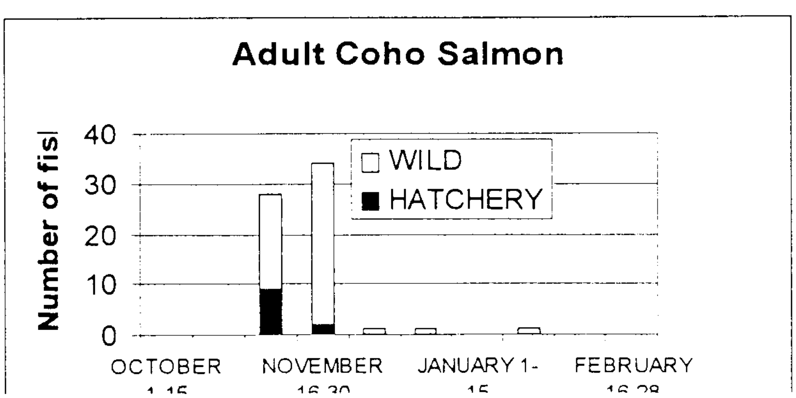


Figure 4. The distribution of adult coho salmon captured in the Siletz Mill Creek trap between October 1998 and February 1999.

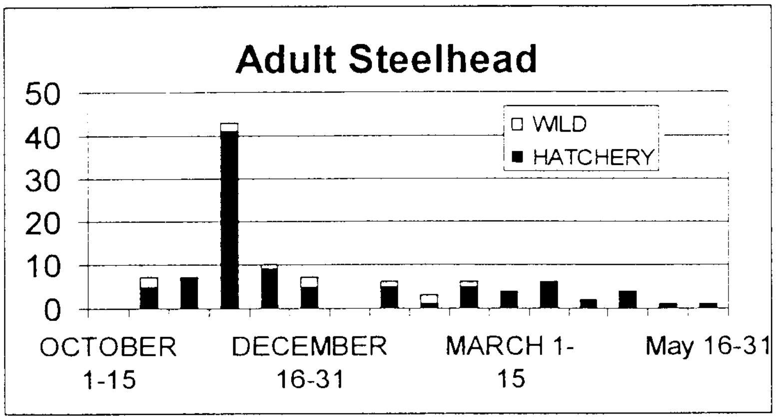


Figure 5. The distribution of adult steelhead returning to the Siletz Mill Creek trap between October 1998 and June 1999.

Table 8. Summary of adult salmonids caught in the Yaquina Mill Creek trap, winter 1998-99.

	Coho	Chinook	Steelhea	Cutthroat[a]
Wild Adult Males	58	14	24	0
Wild Adult Females	80	10	28	0
Wild Adult Sex Unknown	0	0	0	0
Wild Jacks	19	1	2	0
Hatchery Adult Males	37	0	3	0
Hatchery Adult Females	9	0	3	0
Hatchery Adult Sex Unknown	0	0	0	0
Hatchery Jacks	1	0	0	0
Total	204	25	60	0

[a] The cutthroat trout count is incomplete because bar spacing in the trap will allow them to pass through.

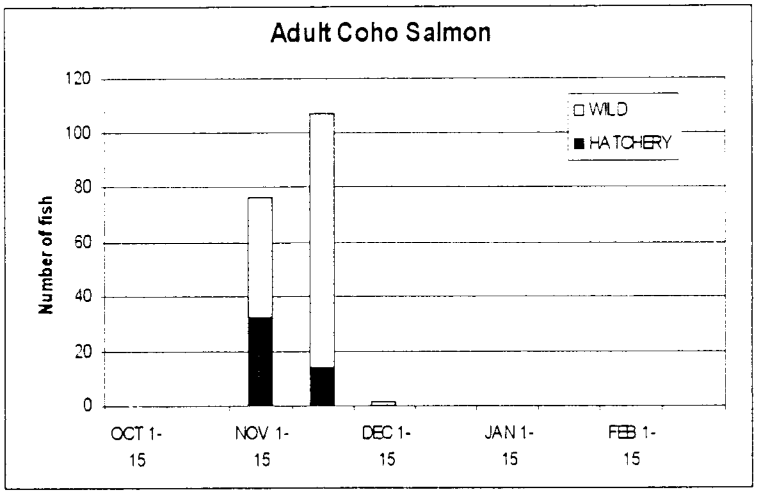


Figure 6. The distribution of the returning adult coho salmon captured in the Yaquina Mill Creek trap between October 1998 and June 1999.

Cascade Creek

Adult salmonids were trapped as they moved through a fish ladder near the mouth of Cascade Creek. The fish ladder provides passage for adult salmon and steelhead around a waterfall at River Kilometer 0.15. The falls are believed to be a complete barrier to upstream migration, so the trap catch should represents the total spawners in the basin. Because there was some possibility that fish might jump the falls at the extremely high flows experienced in the winter of 1998-99, we elected to floy tag the adult salmon and steelhead released above the falls. We then conducted spawning surveys to determine the proportion of tagged and untagged fish present on the spawning grounds.

A total of 6 wild coho adults and 16 hatchery coho adults were captured in the Cascade Creek trap (Table 9). Eight wild jack coho and 3 hatchery jack coho were also captured. Six wild adult coho (5 females and 1 male) and 7 wild jack coho were placed above the trap.

Spawning surveys conducted in Cascade Creek during December 1998 yielded no observations of live or dead coho. We assume that the 6 wild coho placed above the trap make up the entire spawning population for Cascade Creek in 1998-99. Figure 7 shows the distribution of returning adult coho salmon.

West Fork Smith River

The performance of the floating weir was noted at varying streamflows. The weir functioned as a barrier in flows up to approximately 80 cm depth over the attachment sill when the water was free of debris. During rising streamflows water velocity increased with depth at the trap site. At stream-heights above 80 cm, downward force against the surface of the weir exceeded the buoyancy and lift of the resistance boards and the weir submerged and failed as a fish barrier. During the period from mid-October through November, heavy loads of suspended alder and maple leaves impinged on the weir, adding resistance and diminishing the flow through the pickets that hits the resistance boards. During this period, frequent maintenance was required to clean the weir and the increased debris load from rising streamflows submerged

Table 9. Summary of adult salmonids caught in the Cascade Creek trap, winter 1998-99.

	Coho	Chinook	Steelhea	Cutthroat[a]
Wild Adult Males	1	0	2	0
Wild Adult Females	5	0	3	0
Wild Adult Sex Unknown	0	0	0	50
Wild Jacks	8	0	0	0
Hatchery Adult Males	13	1	0	0
Hatchery Adult Females	3	0	1	0
Hatchery Adult Sex Unknown	0	0	0	0
Hatchery Jacks	3	0	1	0
Total	33	1	7	50

[a] The cutthroat trout count is incomplete because bar spacing in the trap will allow them to pass through.

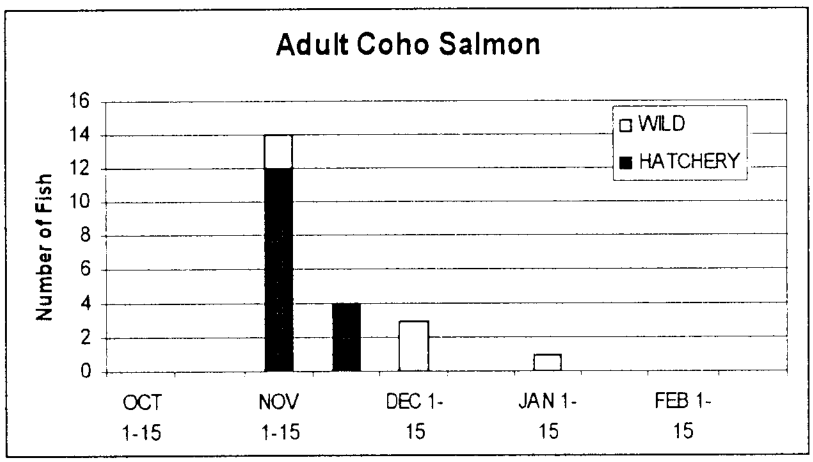


Figure 7. The distribution of returning adult coho salmon to the Cascade Creek trap between October 1998 and February 1999.

the weir at stream-heights of 50 cm or less above the attachment sill.

The adult trap was functional beginning mid-September in 1998. Fish first entered the trap on November 7 and the trap was operated until December 5. Several problems were encountered during the first month of operation. Heavy loads of suspended leaves and high stream flows submerged the weir on several occasions, allowing fish to bypass the weir. The design for attaching the weir to the concrete sill in 1998 caused a low spot to form in the mid-section of the weir at low flows. Some chinook salmon that were passed above the weir or that bypassed the weir at high flows returned downstream. These fish became stranded on the weir and died when unable to swim back upstream and off the weir. To avoid further mortalities, several panels of the weir were removed during low-flow conditions to allow passage of chinook that were headed downstream. These gaps also precluded use of the weir as an upstream barrier. The design for attachment of the resistance boards also failed over most of the weir panels, resulting in breakage of many PVC pickets, loss of buoyancy, and failure of the weir as a barrier. The weir was removed for repair on December 5, 1998, reinstalled on January 12, 1999, and removed from the river on May 5, 1999. High flows combined with periodic failures on some weir components caused the weir to submerge, allowing fish passage, for seven days in January, eight days in February, and nine days in March. Portions of the weir were also intentionally submerged in March and April to permit downstream passage of steelhead kelts.

A total of 13 chinook, 13 coho and 108 steelhead were trapped in 1998-1999 (Table 10). Twelve chinook that by-passed the weir when it was submerged and one of the tagged chinook passed above the trap returned downstream and became stranded on the weir. One Ad-clipped coho (7.1% of total) and five Ad-clipped steelhead (4.6% of total) were trapped and passed.

Table 10. Summary of chinook and coho salmon and steelhead trout captured in the West Fork Smith Adult Trap in 1998 and 1999. The trap was operated Nov. 7 to Dec. 5, 1998, and Jan. 12 to May 5, 1999.

	Chinook			Coho			Steelhead		
Month	Male[a]	Female	Mort.	Male[a]	Female	Mort.	Male	Female	Mort.
Nov-98	13	0	13[b]	8	4	0	0	0	0
Dec-98	0	0	0	0	1	0	0	0	0
Jan-99	0	0	0	0	0	0	12	13	1
Feb-99	0	0	0	0	0	0	24	18	0
Mar-99	0	0	0	0	0	0	13	16	1
Apr-99	0	0	0	0	0	0	4	8	0
Total	13	0	13	8	5	0	53	55	2[c]

a – All males were adult fish; no jacks were caught captured.

b – All chinook mortalities were fish that became stranded on floating weir.

c – All steelhead mortalities were due to injuries sustained inside trap box

PART II. DETERMINE FRESHWATER AND MARINE SURVIVAL RATES FOR COHO SALMON

Introduction

The purpose of estimating the freshwater and marine survival rates for coho salmon in Oregon coastal streams is to develop a database of survival information that can be used to monitor the status and trends in population abundance. In addition, this type of information will be useful to determine if any future changes in the status of coho salmon populations are being effected by freshwater or marine environmental conditions.

Methods

To calculate the freshwater survival rate for coho salmon, we estimated the number of eggs placed in redds by the females that spawned in 1998-99. We estimated the fecundity of each female above the Siletz Mill Creek, Yaquina Mill Creek, and Cascade Creek traps using the following equation where:

Number of eggs = 7.9556 (fork length in mm) - 2854.07.

This relationship between length of female coho salmon and fecundity was developed from hatchery fish returning to Fall Creek Hatchery in the Alsea basin (Johnson 1983). Freshwater survival rate for the 1997 brood was calculated by dividing the estimated number of smolts produced by the number of eggs that were estimated to be deposited by their parents.

To calculate the marine survival rate for coho salmon, the estimated number of adults returning in year t is divided by the estimated smolt abundance in year t-2. To date, the only sites with both sets of needed data are Siletz Mill Creek and Yaquina Mill Creek, because they were the only Life-Cycle Sites monitored during spring 1997.

Results

For the 1997 brood year of coho salmon we are able to estimate the freshwater survival rate, eggs to smolts, in three streams using methods similar to those described above. Freshwater survival ranged from 8.1% in Siletz Mill Creek to 1.5% in Cascade Cr. with Yaquina Mill Cr. at 2.2%. The marine survival rate, smolt to returning adult, will be estimated for these fish when the smolts that migrated during the spring of 1998 return as adults in the fall of 2000. The estimates of the number of female spawners and eggs deposited during the winter of 1998-99 for four streams are shown in Table 11.

Estimated marine survival rates were quite different for the two Mill Creeks for smolts entering the ocean in 1997. Marine survival was estimated to be 0.7% for adults returning to Siletz Mill Creek and 9.7% for adults returning to Yaquina Mill Creek. The difference in survival between the two streams may have been influenced by the size of the smolts. The smolts coming out of Yaquina Mill Creek (where there is a reservoir available for rearing) averaged 123mm in 1997 compared to and average of 98mm for Siletz Mill Creek.

Table 11. The number of wild and hatchery reared female coho spawners and estimated number of eggs deposited above trap sites in four study streams during the winter of 1998-99.

Stream	Number of wild females	Number of hatchery females	Number of eggs
N. Fk. Nehalem R.	253	110	981,640
Mill Cr. (Siletz)	25	0	52,716
Mill Cr. (Yaquina)	77	0	206,935
Cascade Cr.	5	0	10,104

PART III. TENMILE CREEK WATERSHED RESTORATION STUDY

Introduction

This objective initially involved two separate studies. Both studies combined a treatment and reference stream approach with a pre- and post-project evaluation. The first study (Alsea/Nestucca Winter Habitat Study) involved two treatment streams and two reference streams and was designed to examine the effects of increasing winter habitat on the production of downstream migrant salmonids, particularly coho salmon. This study involved two streams in the Alsea basin, East Fork Lobster Creek and Upper Mainstem Lobster Creek, and two streams in the Nestucca basin, East Creek and Moon Creek, as paired study sites. This study began in 1988 and continued for 8 years. Results from this study were summarized in (Solazzi et al 1998). Results of this study have also been accepted for publication in the Canadian Journal of Fisheries and Aquatic Sciences (Solazzi et al. In press).

A second study (Tenmile Watershed Restoration Study) was initiated in 1991 on Tenmile Creek and Cummins Creek, both ocean tributary streams on the central Oregon coast. This study was designed to examine the effects of watershed restoration activities (including the addition of large wood into the stream channel) on the production of downstream migrant salmonids, particularly steelhead and cutthroat trout. Most of the restoration activities in the Tenmile Creek study took place in 1996, and the post-restoration sampling is ongoing. An update of data collected in 1998-99 is presented here.

Study Area Description

Tenmile Creek was chosen as the treatment stream in the Tenmile Creek Watershed Restoration Study with Cummins Creek as its reference. While these streams have populations of coho salmon, they also produce significant numbers of steelhead and cutthroat trout. Tenmile Creek also has a viable population of chinook salmon. Physical characteristics of the study streams are given in Table 12.

Table 12. Physical characteristics of the two study streams.

Stream	Basin area (km^2)	Stream length (km)	Mean summer wetted width (m)	Average gradient (%)
Tenmile Cr.	60.7	24.0	8.5	1.7
Cummins Cr.	24.6	10.0	6.6	2.9

Description of Habitat Modification

Watershed restoration work in the Tenmile basin began in the summer of 1996 as a cooperative project with the US Forest Service (Siuslaw Forest) and local landowners. The U.S. Forest Service decommissioned approximately 12 miles of roads in the watershed, removing culverts and fill to decrease future landslides. Riparian areas were planted with approximately two thousand young conifer trees along approximately 1.6 km of stream. Other streamside riparian areas dominated by hardwood were thinned to increase the growth of existing conifers in the understory. In October of 1996, 240 large conifer trees were transported to the stream channel by helicopter. About 200 of the trees (length of 30 – 35 m, 75 cm butt diameter) were felled on adjacent ridges and placed within the stream channel with limbs attached. The remaining trees were removed from two debris torrent deposits on the road running adjacent to Tenmile Creek. These trees often had rootwads attached, but were generally shorter in length (15 – 20 m) than the felled trees. The trees were placed at 35 different sites throughout reach 3 (133 trees) and the upper portion of reach 2 in the mainstem of Tenmile Creek. Most sites consisted of 3 to 8 large trees placed together to produce accumulations of large wood. Most sites were located in areas near the upper or lower entrances of old side channels, or in natural bends in the stream where large debris would logically accumulate. Trees were not cabled or attached, and no attempt was made to create specific types of habitat (i.e. dam pools) as in the Alsea/Nestucca Winter Habitat Study.

Methods

Summer and Winter Habitat Surveys

In both study streams during August and September of each year, we complete physical habitat surveys. We use the methods described by Hankin and Reeves (1988) to estimate the amount of available habitat, as described by Nickelson et al. (1992). Surface area for each habitat unit in each stream is visually estimated, and every tenth unit is measured to calibrate the visual estimates. In addition, we classify the substrate in each habitat unit by visually estimating the percentage of each category of substrate present. Substrate composition is separated into the following categories: clay (extremely fine sediment that is tightly packed), silt (fine sediment often containing a large proportion of organic material that when disturbed will become suspended in the water column); sand (<0.2 cm); gravel (particles between 0.2 and 6 cm. in diameter); cobble (6 to 25 cm.); small boulders (26 to 100 cm.); large boulders (>100 cm); and bedrock. We also measure the maximum depth of each pool, and estimate the surface area of undercut bank, the percent canopy, and the wood complexity for each habitat unit.

Twice during the pre-restoration period (1991-92, and 1993-94) and once during the post- restoration period (1996-97), we completed winter habitat surveys to determine the amount of winter habitat available for rearing in each stream. These surveys were completed in December and January during moderate winter flow conditions. Another winter habitat survey is planned for the winter of 2000-01.

Estimating Population Size

Estimates are made of the number of young-of-the-year coho salmon, young-of-the-year trout (steelhead and cutthroat combined), age 1+ steelhead trout, and age 1+ cutthroat trout rearing in each stream above the trap sites each year. To estimate the number of fish rearing in the pools, we (1) estimate the mean number of fish per pool by snorkeling every third pool, (2) adjust the mean fish per pool estimate by a calibration factor derived from electrofishing population estimates in a subset of the snorkeled pools, and then (3) multiply this adjusted mean by the total number of pools in the stream (Hankin and Reeves 1988). Snorkel estimates are impractical in habitat with shallow depths. Therefore, we estimate the mean density of fish for a subset of glide, riffle, and rapid habitats by electrofishing. For each habitat type, we then multiplied this mean density by the surface area of this habitat type in the entire stream reach above the trap (Hankin 1984).

We estimate the population size for each species and size group of juvenile salmonid in each sample unit by using either a mark-recapture estimate (Chapman 1951) or a removal estimate with two or more passes (Seber and LeCren 1967). Mark-recapture estimates are generally used in pool habitat that was characterized by high levels of wood complexity or presented special sampling problems where removal estimation methods have been shown to be less accurate (Rodgers et al. 1992). Every habitat unit is blocked by seines on both ends and sampled for juvenile salmonids using 1000-volt D.C. backpack electrofishers. Specific criteria for sampling intensity were established to control the size of the confidence interval derived from the population estimate and to prevent exposing the fish to unnecessary repeated electrofishing. When using the removal method, we continue to sample until we achieved a 50% reduction in the number of fish captured on the previous pass, if the catch on the first pass was fewer than 10 fish. If the catch on the first pass was greater than or equal to 10 fish, then a 66% reduction is required before discontinuing the sampling effort. For the mark-recapture estimates, we attempt to retrieve 50% of the marked fish released.

We divided the Tenmile Creek basin into 6 stream reaches, and the Cummins Creek basin into 3 stream reaches. We make separate estimates of the number of juvenile salmonids rearing in each reach during the summer. We generally sample 5 pools, 10 glides, and 10 riffles in each stream reach.

Estimating the Number of Downstream Migrants

We estimate the number of downstream-migrating juvenile coho salmon, steelhead, cutthroat trout, and chinook salmon in Tenmile and Cummins Creeks each spring using the methods described in the "**Methods for Estimating Abundance of Migrating Juvenile Salmonids**" section of this report.

Results and Discussion

Habitat Modification

In the Tenmile Creek Watershed Restoration Study, the number of key pieces of large wood increased from 21 pieces in reach 3 in pre-restoration surveys to over 150 in the initial post-restoration survey. As a result, the percent of summer pool surface area in reach 3 with high wood complexity increased from an average of 6% in pre-restoration surveys to 12%, 18%, and 15% in post-restoration surveys completed during the summers of 1997 and 1998, and 1999. To date, the total number of pools, the surface area of pools, and the substrate composition have not changed significantly in Reach 3 as a whole.

Observations of habitat immediately in the vicinity of selected sites does suggest substrate changes are occurring near the wood accumulations. More detailed analysis of the physical habitat changes that resulted from the restoration work will be completed as more years of post restoration data are collected.

Estimating Fish Populations

Estimates of fish populations in the post- restoration phase of this project are not complete. Results of summer population estimates and spring migrant estimates observed to date are given for both Tenmile and Cummins creeks in Tables 13 and 14.

Table 13. Summer population estimates of juvenile salmonids in Tenmile and Cummins Creeks during the Tenmile Creek Restoration Study, 1991-99.

Stream	Year of summer sampling	Coho salmon	Cutthroat trout ≥90mm	Steelhead ≥90mm	0+ trout
Cummins Cr.	1991	1,292	1,177	2,306	6,467
	1992	1,316	1,591	3,010	8,104
	1993	1,079	1,274	2,946	4,646
	1994	1,015	1,281	2,255	7,998
	1995	913	1,502	3,689	9,383
	1996	1,074	1,545	5,002	8,625
	1997	1,646	2,417	4,798	17,927
	1998	863	2,524	7,171	11,132
	1999	0	2,702	5,472	16,717
Tenmile Cr.	1991	8,003	4,023	16,613	79,958
	1992	7,799	3,503	16,324	66,226
	1993	30,663	3,231	18,417	70,664
	1994	3,294	2,540	12,180	54,865
	1995	4,369	2,822	12,818	69,391
	1996	3,783	4,256	19,784	63,193
	1997	4,410	2,412	13,491	59,710
	1998	2,105	2,957	12,204	60,903
	1999	1,198	4,203	11,258	74,337

Table 14. Estimates of salmonid smolt production in Tenmile and Cummins Creeks during the Tenmile Creek Restoration Study, 1992-99. Post-restoration sampling will continue in future years.

Stream	Year of spring sampling	Coho salmon smolts	Cutthroat trout smolts ≥160mm	Steelhead smolts ≥120mm	Chinook
Cummins Cr.	1992	1,023	50	786	--
	1993	738	56	1,424	--
	1994	1,435	106	1,623	--
	1995	1,076	40	1,167	--
	1996	475	142	2,303	--
	1997	674	223	2,790	--
	1998	2,215	110	1,816	--
	1999	584	244	2,311	--
Tenmile Cr.	1992	5,442	429	6,312	557[a]
	1993	5,260	350	7,817	381[a]
	1994	9,234	259	5,420	527[a]
	1995	1,729	324	2,342	700[a]
	1996	2,230	215	4,652	2,773[b]
	1997	2,952	632	7,334	4,046[b]
	1998	5,462	813	11,869	4,841[b]
	1999	1,739	687	7,315	5,563[b]

[a] Trapping period March 1 - June 30
[b] Trapping period March 1 - August 15

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