1997 ANNUAL REPORT

Salmonid Screening, Habitat Enhancement and Restoration Division
(SSHEAR)

Lands and Restoration Services Program

CONTENTS

FISH PASSAGE UNIT

INTRODUCTION

Salmonids are an integral part of the culture and economy of the Pacific Northwest. Each year, millions of dollars in revenues are generated in Washington by sport and commercial fisheries for these species. In addition, the presence and abundance of salmonids is an indicator of environmental quality. Protection and enhancement of salmonids and the habitats that support them are essential. Correction of human-made fish passage barriers such as impassable culverts, dams, floodgates, degraded fishways, or weirs is one of the most cost effective methods of salmonid enhancement and restoration. Large amounts of habitat can be brought into production by correcting these fish passage barriers. To address these problems, the Fish Passage Unit performs several major functions: fishway inspections, fishway operations and maintenance, fish passage inventory work, major project development, database management, and training/consultation on fish passage related issues. The unit is composed of specialized fish biologists and scientific technicians. Following is a summary of work completed in 1997.

FISHWAYS

The Fish Passage Unit is responsible for the inspection of 460 fishways statewide on a rotating inspection schedule. The majority of the fishways are associated with road culverts and small low head dams (with the latter not associated with major project development, i.e., hydroelectric or major water diversion dams). Inspections are conducted in the spring after the threat of major flooding and damage, so that the condition of the fishway can be better evaluated. For those fishways requiring maintenance, fishway notification letters are sent out with follow-up calls made to the owners. Where necessary, on site consultation with the fishway owner is made. Compliance inspections are conducted in the late summer/early fall to ensure that the maintenance work has been completed. During 1997, 440 fishways received scheduled inspections. Of this number, 98 (22%) required maintenance or reconstruction. After compliance inspections were completed by late fall, 56 (57%) of the fishways had compliance work done. The majority of the fishways not in compliance were those requiring reconstruction. The unit is continually working with those owners to ensure that a time line for reconstruction is developed and implemented. The overall compliance rate of 57% for 1997 was up from the last seven-year average of 34%. Last year's compliance rate was 52%. The overall improvement in compliance rate reflected SSHEAR's efforts in working closely with fishway owners to ensure compliance. However, as the number of fishways increase, e.g., 373 fishways in 1990 compared to 460 in 1997, it is expected that maintenance needs and potentially non-compliance will increase. Given current staffing levels, inspections on newly developed fishways will not keep pace and alternative measures will have to be explored to ensure that the fishways of today do not become the passage problems of tomorrow.

FISHWAYS OPERATION AND MAINTENANCE

Mitchell Act Stream Clearance and Fishway Operation and Maintenance

This project provides stream clearance and maintenance of fishways constructed under the Mitchell Act in the lower Columbia River drainage. Between January 1 and December 31 , 1997, a total of 8.5 staff months were spent for fishway maintenance and inspections, barrier reconnaissance, design work and development of recommendations for future work. An additional 9.0 staff months were spent on major repairs to facilities damaged by the late December/early January flood.

State Fishways Operations and Maintenance

SSHEAR is responsible for maintenance at Sunset Falls and Granite Falls fishways and operation of Sunset Falls. During 1997, 1.0 and 1.5 staff months were spent on maintenance on Sunset and Granite Falls, respectively. Operation of the trap and haul facility at Sunset Falls required 8.6 staff months. Table 1 lists the number of each species which were passed upstream at the Sunset Falls fishway.

DEPARTMENT OF TRANSPORTATION CULVERT INVENTORY

In 1991, the Washington State Legislature working with the Washington State Department of Transportation (WSDOT) and the Washington State Department of Fish and Wildlife (WDFW) organized and implemented a fish passage inventory on Washington State highways. The purpose of the inventory is to document fish passage problems located at state highway stream crossings and to correct these passage problems by order of highest priority.

During the inventory phase, 1,683 culverts on fish bearing streams have been inspected. The second phase of the project involved conducting habitat surveys, both upstream and downstream of the identified barriers, to establish priorities for correction. Based on results of surveys completed to date, sufficient habitat gains have been identified at 201 barrier culverts to justify correction. Two hundred and thirty-nine culverts are slated for further evaluation to determine whether or not they are barriers requiring a fix. This is in part because the newly merged agency Department of Fish and Wildlife has recognized the need for maintaining diverse and healthy stocks of resident salmonids, also, through the correction of barrier culverts. Further assessment is underway to determine potential additional corrections based on consideration of game fish, but it is estimated that approximately 402 barriers are remaining to correct in order to address all salmonids.

Since the project began, fish passage has been provided by SSHEAR, using dedicated funding, at 22 of the highest priority sites. Barriers corrected in 1997 include Kinman Creek, unnamed

tributary to Big Creek, unnamed tributary to Fairchild Creek, Fairchild Creek, and Ashley Cr. Project descriptions for this work begins on page 5 .

Given the large number of barriers identified in the Washington Department of Transportation inventory (545), it would take approximately a century to provide fish passage at this many sites at the current rate of correction, using dedicated fish passage funds only. However, it is clear the benefit to salmonid production increases with the number of culvert repairs per year. Because of this, WSDOT and WDFW are also integrating fish passage concerns into ongoing WSDOT road safety and mobility projects. Culvert repairs associated with road projects on state highways can be done more quickly and at lower cost since equipment is on-site or in the vicinity of ongoing road construction. To date, WSDOT has resolved 22 impediments to fish passage through safety and mobility projects. Numerous others are currently being evaluated. This approach has reduced the time spent on barrier resolution to 40-60 years.

Fish passage improvements at road crossings will require long term commitment by the legislature and would be beneficial in correcting problems affecting many depressed salmonid stocks in need of immediate attention. Hence, this strategy could assist in recovery of depressed or critical stocks and help avoid listings under the Endangered Species Act which would affect harvest opportunity in Washington.

THURSTON COUNTY CULVERT INVENTORY

Another step SSHEAR has taken to address the serious problem of fish passage barriers in Washington is to initiate an inventory of county road culverts. As a prototype, WDFW implemented a culvert and habitat inventory for identifying and prioritizing fish passage problems at stream crossings in Thurston County. The project started in January 1996 and was completed in June 1997. An existing Thurston County database indicated there were 4,217 culverts in the county (not including municipal areas). All culverts 24" in diameter and greater were selected from this database (approximately 560) for the initial evaluation effort. Once located, the position of each culvert was recorded using the Global Positioning System (GPS). Positional information along with culvert evaluation data were input into a geographic information system (GIS) and plotted on a map. This map was used to identify those county road-stream crossings which did not meet the initial 24"diameter criteria but did potentially involve fish bearing streams and thus warranted evaluation.

A total of 668 culverts were evaluated throughout Thurston County including the municipal areas. Of these, 346 culverts were considered to be in fish bearing streams. These culverts constituted 277 individual stream crossings. Sixty-one of these crossings were identified as potential barriers to fish passage (49 total barriers and 12 partial barriers). Analysis of downstream check and upstream habitat surveys indicated that no habitat or fish production gains would be realized at 19 of the potential barrier crossings. The remaining 42 barrier crossings required repair.

Thirty-nine physical habitat surveys were completed for crossings requiring repair. The surveys covered approximately 38 linear miles of stream. The total potential spawning and rearing habitat blocked by these barriers are 35,400 m^2 and 541,000 m^2, respectively. Priority index values were generated for barrier culverts with significant upstream habitat gains.

Four culverts identified in the inventory have been repaired: three through co-operative projects, one with Thurston County and two the City of Tumwater, and one completed independently by the county. These include Green Cove Creek in 1996, Percival Creek (Mottman Rd.) in 1996, Percival Creek (Chapparel Rd.) in 1997, and Thompson Creek in 1997. Additionally, Schneider Creek, a cooperative project with Thurston County, was completed (1995) prior to the inventory and is not included in the results presented above. The Percival Creek (Chapparel Rd.) project is described under the major projects sections. The other projects have been described in previous annual reports.

JEFFERSON COUNTY CULVERT INVENTORY

A culvert and habitat inventory to identify and prioritize fish passage problems at stream crossings in Jefferson County began in 1997. Barrier culverts were identified by driving all County roads and physically inspecting culverts encountered. The position of each culvert was recorded using the Global Positioning System (GPS) and the physical properties of the culvert were recorded using a data logger. Positional information along with culvert evaluation data were input into a geographic information system (GIS) and plotted on a map. This map was used to identify those county road-stream crossings missed in the initial inventory but that potentially involve fish bearing streams and thus warrant evaluation.

The culvert evaluation phase has been completed and the habitat evaluation will be completed by June 30, 1999. A total of 1,128 culverts were evaluated, of which 265 were determined to be in fish bearing streams. Of those, 156 are considered either total or partial barriers to fish passage. Some culverts identified as barriers will drop off the list as the physical habitat evaluation is completed. There can be no natural barriers within 200 meters upstream or downstream of the culvert for it to be considered for correction, unless a smaller stream reach is essential to a naturally spawning salmonid stock. Once the physical habitat evaluations are completed, a priority index (PI) will be calculated and a prioritized list of barriers will be generated.

WILDLIFE AREA INVENTORY

The Washington Department of Fish and Wildlife (WDFW) has purchased approximately 840,000 acres of Wildlife Area sites, scattered throughout almost every county in the state, over the past 58 years. Due to previous land utilization practices and the increasing interest of fish passage issues, SSHEAR initiated a statewide inventory of fish passage barriers and hydraulic diversions on all state owned and/or managed lands in October 1997. The purpose of the

inventory is to document all fish passage problems and hydraulic diversions with emphasis on unscreened diversions. Washington State laws (RCW 77.16.220, RCW 75.20.040, RCW 75.20.061) require all diversions from waters of the state to be screened to protect fish. SSHEAR designs and installs approximately 10 gravity diversion screens and 100 pump diversion screens throughout the state annually.

In cooperation with other Lands and Restorations Services Program staff, SSHEAR designed a sampling protocol, database format, and Wildlife Area Priority Index for the study. To create the priority index of Wildlife Areas, a prioritization questionnaire was distributed to Regional Lands Coordinators, Regional Fish Biologists and Wildlife Area Managers. This enabled SSHEAR staff to gain the knowledge and expertise that Wildlife Area Managers have accumulated with many years of experience in their assigned area. The questionnaire was designed to prioritize Wildlife Areas based on four main factors (e.g. number of known fish passage problems, stock status, stock mobility, and high profile fish passage issues of public interest) to allow the inventory to be completed in order of priority. As a prototype, the inventory of Scatter Creek Wildlife Area is scheduled to begin early February 1998 with the overall inventory beginning in late March or April. Once the inventory is finalized, the next phase of habitat surveys will begin. The habitat survey data will be used to correct these fish passage and screening problems in priority order.

FISH PASSAGE / INVENTORY INFORMATION MANAGEMENT

Designated biologists are responsible for the development and maintenance of the statewide Fish Passage, WSDOT Culvert Inventory, and County Culvert Inventory databases. The Fish Passage database is used to track 460 fishways and their condition to ensure protection of fish life. In addition, this database contains a statewide inventory of other unresolved fish passage barriers (710 to date). Maintenance of the fish passage database involves coordinating the collection of fish passage barrier information by agency staff and individuals outside the agency, and responding to intra-agency and interagency requests for database reports. The WSDOT Culvert Inventory database contains 1,719 records of culvert inspections made during the barrier inventory process. This database is used to identify, evaluate, and prioritize the repair of fish passage impediments on state managed highways. The Thurston County Culvert Inventory database contains 668 records of culvert evaluations made during the inventory. The Jefferson County Culvert Inventory database contains 1,228 records of culvert evaluations made during the inventory. The county culvert inventory databases are used in the same fashion as that contained in the WSDOT database.

MAJOR PROJECT DEVELOPMENT

The Fish Passage Unit develops major fish passage improvement projects statewide on federal, state, county/local, and private lands. The unit works within the framework of the "Team Concept" with professional staff from the Environmental Engineering Services (EES) and SSHEAR's biological staff and Construction Unit to develop, design, permit, construct, and evaluate fish passage projects. Described below are the major projects undertaken in 1997.

Fairchild Creek

This project was at Mile Post 105.6 on State Route 101 south of the town of Humptulips. The culvert at this site was 185 feet long and extended under SR 101 and the adjacent abandoned ITT Rayonier railroad grade. Fish passage was blocked to anadromous salmonids by a two-foot outfall drop and high velocities in the upper section of culvert under the railroad grade. The project involved the removal of the upper 60 feet of culvert under the railroad grade and constructing a four-step pool and chute fishway downstream of SR 101.

This project restored fish passage to 2.63 miles of spawning and rearing habitat in Fairchild Creek, a tributary to Big Creek in the Humptulips River watershed. Coho salmon and steelhead and cutthroat trout benefitted from the construction of this project. This project was constructed by the SSHEAR Construction Unit and funded by the WSDOT.

Unnamed Tributary to Fairchild Creek

This project was at Mile Post 104.9 on State Route 101 south of the town of Humptulips. The culvert at this site was 175 feet long and extended under SR 101 and the adjacent abandoned ITT Rayonier railroad grade. Fish passage was blocked to anadromous salmonids by a two-foot outfall drop and high velocities in the upper section of culvert under the railroad grade. The project involved the removal of the upper 52 feet of culvert under the railroad grade and constructing a five-step pool and chute fishway downstream of SR 101.

This project restored fish passage to 3.39 miles of spawning and rearing habitat. The stream is a tributary to Fairchild Creek in the Humptulips River watershed. Coho salmon and steelhead and cutthroat trout benefitted from the construction of this project. This project was constructed by the SSHEAR Construction Unit and funded by the WSDOT.

Unnamed Tributary to Big Creek

This project was at Mile Post 103.6 on State Route 101 south of the town of Humptulips. The culverts at this site were 165 feet long and extended under SR 101 and the adjacent abandoned ITT Rayonier railroad grade. Fish passage was blocked to anadromous salmonids by high velocities in the upper sections of the culverts under the railroad grade. The project involved the

removal of the upper 60 feet of the culverts under the railroad grade and installing a log control downstream of SR 101.

This project restored fish passage to 2.07 miles of spawning and rearing habitat. The stream is a tributary to Big Creek in the Humptulips River watershed. Coho salmon and steelhead and cutthroat trout benefitted from the construction of this project. This project was constructed by the SSHEAR Construction Unit and funded by the WSDOT.

Mill Creek

This project involved constructing a fishway to provide fish passage at a private dam on Mill Creek, a tributary to the Chehalis River, that was blocking adult and juvenile salmonids from reaching 2.4 miles of stream habitat. As presently operated, the dam is used to impound water during the summer. In the fall the pond is drained and the gate is left open. Before our project, the stream then flowed through a four-foot wide box culvert that emptied onto a concrete apron. This resulted in velocities that were too high and/or water depths that were insufficient for fish passage while the pond was drained. The pond could not be left full during the winter because the spillway is too small and the dam would fail, or receive significant damage, if overtopped.

We constructed a three-step pool and chute fishway and attached it to the downstream end of the existing box culvert and removed the concrete apron. Two log controls were installed downstream of the fishway to increase the elevation of the stream channel and control bed erosion. The combination of the log controls and the fishway will allow the upstream migration of fish when the gate is open and the pond is drained. A second four-foot box culvert was placed next to the existing box culvert. The second culvert will improve the conveyance of flood flows through the dam during storm events. As built, the dam was overtopped at flows significantly below the 100-year event. With the additional box culvert, flows exceeding the 100-year flow will pass through the dam. A fry-way extends from the pond to the fishway providing for the upstream passage of juvenile and resident salmonids during the summer when the gate is closed and the pond full. The landowner assumes ownership and maintenance of the fishway in perpetuity.

Kinman Creek

The Kinman Creek fish passage project consisted of “jacking” a four-foot diameter metal culvert through the State Route 3 Highway road fill crossing of Kinman Creek where a total salmon blockage was located. Jacking refers to forcing a smooth metal pipe under an earthen fill without trenching. The new jacked pipe is adjacent to the original concrete box and serves as the primary conduit for flow and fish accessing upper Kinman Creek. This project involved working with a specialized boring contractor. Pipe jacking will likely be utilized more frequently in the future to provide fish passage without stopping or detouring highway traffic. Evaluation indicates fish passage has been verified with coho salmon presence above the newly jacked pipe

Kinman Creek Private Culverts

In addition to the pipe jacking at the Highway 3 crossing, another culvert under a private drive was replaced with a larger pipe and a third barrier culvert upstream on an unused crossing was completely removed. This provided anadromous fish access to most of Kinman Creek, but access to a small amount of habitat in the headwaters is still blocked by a private dam which will be difficult to resolve. Suitable spawning areas were added to the two crossings where construction took place to provide additional gravels to the stream.

Percival Creek - Chapparel Road

This project was located at the Chapparel Road crossing of Percival Creek, a tributary of Capitol Lake, in the City of Tumwater. Fish passage was totally blocked by an outfall drop from a 60' long by 4' diameter culvert. The existing culvert was replaced with a 70' long pipe arch culvert (95"x 67"). The new culvert was countersunk below the existing streambed, placed at a 0% slope, and backfilled with spawning-grade gravel to simulate a natural streambed. Three rock controls were installed upstream at 20' intervals to control regrading (head cutting) of the channel. Spawning habitat was enhanced by placing gravel upstream of each rock control. This project provided access for adult and juvenile salmonids to approximately 3,000 lineal meters of spawning and rearing habitat. The project was constructed by SSHEAR and funded by a 50/50 cost share between WDFW and the City of Tumwater. Additionally, the South Puget Sound Regional Enhancement Group contributed $1,000 toward materials.

Ashley Creek

Ashley Creek, a tributary to Little Bear Creek in Snohomish County, flows under State Highway 9 at milepost 1.2 near Woodinville. Fish passage was partially blocked by an outfall drop and high velocities in the lower half of a two-foot diameter culvert. Fish passage was enhanced by constructing two plank weirs downstream of the culvert to raise the water surface and eliminate the outfall drop. Access was improved to approximately 1800 meters of spawning and rearing habitat utilized primarily by coho salmon and cutthroat trout. This project will provide interim improvements to fish passage conditions until a permanent solution (culvert replacement) is constructed as part of the WSDOT Highway 9 road improvement project. At that time structures built under this project may be removed, replaced, or expanded. This project was constructed by SSHEAR and funded by WSDOT.

Currently the SSHEAR Division is responsible for the maintenance, operations and the eventual major repairs and modifications of 76 fishways statewide including 24 formal Mitchell Act fishways. During the 1997 construction season, major repairs, modifications and maintenance was done on the following fishways:

Sonnybrook Creek Fishway

Built by the former Washington Department of Fisheries (WDF) in 1990, the Sonnybrook Creek Fishway (WRIA # 19.0223 @ River Mile 0.4) was built as part of a mitigation agreement among the Washington Department of Wildlife, Clallam County Public Works and the Makah Indian Tribe. A six step laminated weir/pool fishway was built adjacent to an existing falls that was impassable to steelhead during low to moderate stream flows. The project resulted in providing an improved passage window for steelhead and coho to 0.5 miles of habitat. During the 1997 construction season all of the six weirs were replaced due to damage incurred by debris and high flows over the years. In addition, the flow control point upstream of the fishway exit was lowered by a series of controlled demolition blasts to improve the range of flows to the fishway. Work was completed by the SSHEAR Construction Unit based out of Olympia.

North Fork Newaukum River Fishway

Built in 1970 by WDF, the seven step concrete weir/pool North Fork Newaukum River Fishway (WRIA# 23.0887 @ River Mile 12.5) affords spring chinook, coho and steelhead passage to 14 miles of habitat. Several of the weirs damaged by previous seasonal high flow events required reconstruction to accommodate spring chinook passage within several weeks of completion of the project. Work was performed by the SSHEAR Construction Unit based out of Yakima.

Hutchinson Creek Fishway

Built in the late 1950's by a sportsmen club and rebuilt by WDF in the late 1960's, the three step concrete weir/pool fishway on Hutchinson Creek (WRIA# 01.0264 @ River Mile 1.5) required major modifications to afford continued passage for steelhead to six miles of habitat. The immediate downstream area of the fishway required controlled demolition blasts and the addition of a concrete weir to eliminate a sheet flow-drop passage problem at the entrance to the fishway. Work was completed by the SSHEAR Construction Unit based out of Olympia.

Little Kalama River Fishway

The Little Kalama River Fishway (WRIA# 27.0046 @ River Mile 1.7) is one of 24 formal Mitchell Act fishways under the operation and maintenance responsibilities of the SSHEAR Division. In recent years, flood flow events had damaged the fishway, necessitating the replacement of 30 stop logs throughout the entire 350 foot reach of the fishway. In addition, both small woody debris and bedload were removed from the fishway. The facility affords steelhead passage to 3.7 miles of habitat. Work was completed by the SSHEAR Construction Unit based out of Olympia.

Klickitat River Fishway (Castille Falls # 5)

During the early 1960's, a series of three tunnel weir/pool fishways were constructed throughout the Castille reach of the Klickitat River under the auspices of the Mitchell Act. At that time, like today, the construction and maintenance was a significant challenge due to the inaccessibility created by the 3,000 foot long Castille Canyon. In the winter of 1997, during a high water event, a log jam had amassed at the entrance of the fishway which bridges Falls #4 and #5, creating a total barrier to fish passage. The jam was removed by using a boom truck above the site and lowering an employee in a boson chair onto the jam. Once in place, site specific demolition charges were set throughout the log jam and detonated. Upon the successful removal of the jam both spring chinook and steelhead were able to negotiate the fishway and access up to 80 miles of habitat. Work on Klickitat River (WRIA# 30.0002 @ River Mile 60.0) was completed by the SSHEAR Construction Unit based out of Olympia.

HATCHERY RACK/INTAKE INVENTORY

Phase II of the hatchery rack inventory was completed in 1997. This project was completed with the cooperation with the Hatcheries Program. In 1995, SSHEAR initiated a study to evaluate fish passage conditions at racks and intakes at Washington Department of Fish and Wildlife (WDFW) hatcheries. This study is an attempt to implement a process that will eventually bring all WDFW hatcheries into compliance with RCW's 75.20.060 and 77.16.210.

Hatcheries with fish passage problems were identified by a combination of staff knowledge, information provided on a questionnaire by hatchery managers, and site reviews. During the initial screening, 27 problem sites were identified. As more information became available and additional site evaluations were conducted, 11 additional sites were added, bringing the total to 38.

Once a site was identified as having a fish passage problem, habitat surveys were conducted to quantify the available habitat upstream of the barrier. A priority index (PI) was then calculated for each stream so that a prioritized list of projects could be generated.

Table 2 contains the PI, the spawning and rearing habitat available upstream of each barrier, and the species affected by each barrier. Stock status was taken from SASSI and is indicated for each species by a "d" for depressed and a "c" for critical. May Creek has the highest PI, followed by Issaquah Creek, Voight Creek, Friday Creek, Kendall Creek, Fork Creek, Soos Creek, and so on. A PI was not calculated for the Tucannon River - we assume it would fall in the top five given its large watershed area and that Snake River spring chinook are listed as threatened and bull trout are a candidate for listing under the Endangered Species Act.

Table 1. Fish trapped and transported upstream at Sunset Falls during 1997.

Species	Total No. Adults	Total No. Jacks
Coho Salmon	15,152	101
Chum Salmon	22	
Spring/Summer Chinook Salmon	210	28
Fall Chinook Salmon	489	17
Pink Salmon	1,988	
Sockeye Salmon	14	
Steelhead Trout	883	
Sea Run Cutthroat Trout	3	
Dolly Varden/Bull Trout	42	

Table 2. Prioritized list of fish passage barriers at WDFW hatcheries.[1]

PI[2]	Hatchery	Stream	WRIA	Spawning Area (M^2)	Rearing Area (M^2)	Species Impacted	Pathogen Concerns
66.6	Skykomish	May Creek	07.0943	23,984.4	61,867.6	1,2,3,4,6	A
57.0	Issaquah	Issaquah Creek	08.0178	125,103.4	285,869.7	1,4[d],5[d],6[d]	B
56.7	Voight Creek	Voight Creek	10.0414	30,779.1	70,239.0	1,2,3,4[d],6,*	B
55.8	Samish	Friday Creek	03.0017	102,952.7	1,429,047.7	1,2,4,6[d]	B
52.7	Kendall Creek	Kendall Creek	01.0406	20,199.2	55,113.2	1[c],2,3,4,6	B
45.7	Fork Creek	Fork Creek	24.0356	115,263.2	165,662.5	1,2,4,6	
42.9	Soos Creek	Soos Creek	09.0072	183,893.3	1,182,554.9	1,2,4,6,**	
38.7	Hoodsport	Finch Creek	16.0222	9,775.4	8,253.7	2[c],3,4,6[d]	A,B
38.1	Dungeness	Canyon Creek	18.0038	2,493.1	12,315.9	1,2,3[c],4[d],6[d]	A,B
31.8	Marblemount	Clark Creek	04.1421	1,430.5	17,749.6	2,3,4[d],6	A
30.1	Minter	Minter Creek	15.0048	43,099.5	62,536.4	1,2,4,6	
29.7	Salkum	Cowlitz River	26.0002	527.1	214,026.0	1,4[d],6[d]	
23.8	Tokul Creek	Tokul Creek	07.0440	1,263.6	9,190.0	1[d],3,4,6	B
21.9	Marblemount	Jordan Creek	04.1412	20,532.5	16,018.8	1[d],3,4[d],6	
19.9	George Adams	Purdy Creek	16.0005	2,547.8	4,015.6	1,2,4,6[d]	A
19.5	Washougal	Washougal River	28.0160	142,983.6	201,562.6	1,4[d],6	
19.2	Beaver Creek	Beaver Creek	25.0247	20,764.1	31,002.0	1,4[d],6[d]	B
19.2	Shale Creek Pond	Shale Creek	21.0041	29,012.2	56,060.9	1,4,6	
17.8	Humptulips	Hatchery Creek	22.0065	3,564.6	3,935.5	2,4,6	B
17.5	Blue Creek	Blue Creek	26.0527	9,477.8	81,954.3	4[d],6[d]	
16.9	Skykomish	Wallace River	07.0940	65,704.9	118,685.4	1	
16.1	Lake Whatcom	Brannian Creek	01.0619	11,139.1	9,017.2	***	
15.3	Speelyai	Speelyai Creek	27.0430	9,148.7	57,302.6	***	A,B
12.4	Johns Creek	Johns Creek	14.0049	284,772.6	458,518.0	2	
11.8	Bogachiel	Bogachiel Tributary	20.0162X	1,665.9	23,003.8	4,6	
11.3	Coulter Creek	Unnamed Tributary	15.0002B	341.1	2,401.6	2,4,6	B
10.8	Fallert Creek	Fallert (Hatchery) Creek	27.0017	1,380.2	4,709.4	1,4[d],6[d]	A,B
10.1	Bogachiel	Calawah Tributary	20.0175A	1,009.3	12,674.9	4,6	
9.4	Elochoman	Clear Creek	25.0253	2,070.6	5,090.5	4[d],6[d]	B
9.4	Hupp Springs	Hupp Springs	15.048A	147.0	1167.6	1,2,4,6	

Table 2. (continued) Prioritized list of fish passage barriers at WDFW hatcheries.[1]

PI[2]	Hatchery	Stream	WRIA	Spawning Area (M^2)	Rearing Area (M^2)	Species Impacted	Pathogen Concerns
9.3	Whitehorse Pond	Whitehorse Slough	05.0254A	0	4,047.0	4[d],6	
7.7	Hurd Creek	Hurd Creek	18.0028	400.3	3,422.8	4[d],6[d]	A,B
6.8	Cowlitz Ponds	Jordan Creek	26.0261	963.7	2,601.2	4[d],6	
6.3	Soleduck	Unnamed Tributary	20.0096X	757.5	1,876.9	4,6	
5.4	Naselle	Dog Creek	24.0633	3,472.6	5,572.9	4,6	
3.4	Palmer Ponds	Spring Creek	09.0147	130.7	520.0	4,6	B
1.4	Reiter Ponds	Hogarty Creek	07.0972	582.5	1,104.6	6	B

[1] Excludes the Tucannon River which was not surveyed. It is assumed that it would fall in the top 5 due to the large amount of habitat available upstream of the hatchery and the status of stocks in the watershed.
[2] The PI was calculated using salmon and steelhead only. Potential production was not adjusted to account for interspecific competition.
1 - Chinook
2 - Chum
3 - Pink
4 - Coho
5 - Sockeye
6 - Steelhead
[d] Listed as depressed in SASSI
[c] listed as critical in SASSI
* whitefish are known to have difficulty getting over the rack
** King County has documented the presence of bull trout in Soos Creek
*** Kokanee, sockeye production value used
A - listed in document entitled “Fish Passage at Migration Barriers Caused by Salmon Culture Division Activities” dated May 1, 1992
B - listed in Kevin Amos memo dated March 22, 1995

WILD STOCK RESTORATION / ENHANCEMENT

INTRODUCTION

The 1987 Washington State Legislature directed WDFW to develop a wild coho habitat enhancement program on North Coast and North Puget Sound rivers. Those rivers included the Hoh, Queets, and Quillayute systems on the North Coast, and the Skagit and Stillaguamish Rivers in North Puget Sound. The purpose was to increase and stabilize coho smolt production by expanding and improving key production habitats. Improved production could ease harvest impacts and strengthen wild stocks. Harvest restrictions necessary to protect low numbers of these wild fish resulted in reduced fishing opportunity and economic loss to citizens of Washington State and Indian Tribes.

Historical watershed reconstruction has shown that key habitat features for coho have been lost. These key habitats consisting of flowing backwater sloughs, channels, and ponds have been termed "off-channel" habitat. Many of these high quality habitats have been degraded or permanently lost by diking, urban development, agricultural activities, logging, road building, and dams. Restoration of these areas can improve survival throughout all freshwater life history stages.

Work began immediately to identify project options and implement construction. A comprehensive inventory of previously undocumented off-channel habitats on each of the river systems was also initiated. The purpose of the inventory was to carefully describe habitat areas that were not included in the Washington Department of Fisheries Stream Catalog (Williams et al., 1975) and other major surveys. Once identified and compiled into an easily accessible database, these areas could be better managed for protection by various watershed managers and to complement the WDFW Hydraulic Project Approval permit process.

Since 1987, there has been increased recognition that many wild salmonid species use the "off channel" habitat targeted by this program. This understanding has led SSHEAR to implement a variety of similar habitat enhancement projects throughout Washington, such as spawning channels for depressed chum salmon stocks in the lower Columbia River. However, most habitat enhancement work is still focused on coho and other wild salmonids in the North Coast and North Puget Sound, with smaller efforts in central and south Puget Sound and the lower Columbia River. Benefits from these projects accrue to total ecosystem health. Habitat work is an important component to the recovery of wild salmonid stocks. These efforts supplement the fish passage and screening work of SSHEAR.

Wild salmonid recovery efforts received further attention in 1992 in North Puget Sound watersheds when coho salmon were listed as "depressed" in the 1992 SASSI report (WDF et al., 1993). The listing further supported enhancement of high quality habitats to aid in stock recovery.

The high value of small stream and off-channel areas to coho was recognized as early as 1948 through 1958 in work on the Wilson River in northern Oregon (Skeesick, 1970). Additional work on the north coast of Washington by Cederholm and Scarlett (1981) and Peterson and Reid (1984) further demonstrated the value of off-channel winter refuge habitats in the Clearwater River. They demonstrated that 20% to 35% of the total coho smolt production came from these areas.

Additional investigations in Canada by Tschaplinski and Hartman (1983), Foy (1985), and Brown and McMahon (1987) further confirmed these habitat preferences by juvenile coho and the value of off-channel project types to increasing production. Nickelson et al., (1992) have also concluded that off-channel habitat development has the highest potential for increasing wild coho salmon production in Oregon coastal streams. High quality off-channel habitats have not only been found to improve juvenile freshwater survival but lead to faster growth rates and larger size, increasing marine survival (Bilton et al., 1982).

The performance of projects constructed by SSHEAR has been evaluated at selected sites by monitoring summer juvenile use, smolt production, spawner use, and observation of overall project function. Evaluation results are described below for each respective area. Construction methods are also continuously monitored to learn where techniques can be improved. Identifying, designing and permitting these projects entirely within Lands and Restoration Services using a team approach of biologists, engineers, and construction staff greatly increases efficiency and reduces costs.

Recovery of these depressed stocks and all stocks in general will lead to greater watershed health and productivity. Increased escapements will require modifications of land use activities that improve water quality, runoff rates and preserve habitat. Recent work by Bilby et al., (1996) has further shown the carcasses of returning coho spawners can contribute significantly to the nutrient supply and composition of riparian vegetation and rearing juvenile salmon. This finding demonstrates the role these fish play in nutrient cycling and ecosystem function.

NORTH SOUND

ABSTRACT

Major project work completed during 1997 included a large ground water spawning and rearing channel on the Skagit River near Marblemount and a large spawning gravel enhancement at the outlet of Mud Lake, the headwater of a tributary to the South Fork Stillaguamish River. Other work included expansion of the available spawning area at Gold Basin Mill Pond and Barnaby Slough and creation of a new spawning area in upper Harrison Pond Slough. We also did some repair work at Harrison Pond and weirs on the Spring Creek Project. All these sites are SSHEAR projects.

We continued spawner surveys and smolt trapping to monitor production at projects completed in this program. Mean annual smolt production for all projects in their existing design configuration combined has been 0.39 smolts per square meter at Stillaguamish and 0.28 smolts per square meter at Skagit sites. Although the difference in smolt production between the basins is not statistically significant, Skagit rates may be less because several projects with large pond complexes (i.e., Barnaby/Harrison) have not yet fully cycled up in production. Mean coho spawner densities per square meter of available spawning area has been higher on the Skagit projects but also not at a level that is statistically significant. Higher Skagit spawner densities may reflect the greater area of specifically designed spawning habitat we have built in this watershed.

Mean smolt production from selected sites trapped since 1988 or in their current condition if modifications have been made, when applied to all sites, indicates the 15 Skagit projects completed in this program may currently be producing 135,135 smolts annually. This represents about 16% of the estimated wild Skagit coho production averaged over the years 1990-1996 (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data). Similar evaluation at Stillaguamish sites indicates all 14 projects in this basin are capable of producing 106,370 smolts or 29% of that watershed's estimated production each year based on mean production estimates 1979-1981 (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data).

The total area enhanced in North Sound now totals about 762,548 square meters. These are very stable high quality habitat areas largely exempt from detrimental environmental fluctuations normal to most streams. They will serve to increase and stabilize coho smolt production in these river basins.

Field surveys to record previously undocumented habitat and identify possible enhancement project sites have been about 80% completed in the Skagit River and 10% on the Stillaguamish River. A number of potentially valuable projects have been identified that have been scheduled into a five-year planning cycle.

HABITAT INVENTORY

A major product of our program will be a thorough inventory of the undocumented off-channel habitat in these two river basins as well as specific habitat enhancement projects. Off-channel habitat inventory information has not generally been included in the WDFW Stream Catalog (Williams et al., 1975) or work of other survey studies such as Johnson (1986). The new information collected is being entered into a database developed within the SSHEAR Division to be available for all resource managers on request. This database is constructed to accommodate entry of earlier information collected in this program in a different format with minimum effort. The new storage and retrieval system will allow this habitat information to be easily accessed and incorporated into land use decisions, plans and practices so these areas can receive the highest level of protection possible. Additionally, inventory information will continue to be used to identify potential habitat enhancement projects.

We began the inventory effort in 1989 and have continued work through 1997. Techniques used are similar to those developed by the North Coast program. U.S. Geological Survey topographic maps are used to split each river system into convenient reaches for surveys with break points at principal river meanders and other topographic breaks . Each reach is numbered starting at the mouth and moving upstream. Within each reach, each site inventoried is coded as to river, reach, bank (L or R), and its sequential number examined in that reach. Therefore, a typical code might be "SK-7-LB3" denoting site number 3 (the third site examined) in reach number 7 on the left bank of the Skagit River. Precise rules for coverage have been developed so decisions can be quickly made for what habitat is to be included and excluded. Rules direct coverage to those areas not covered by any earlier work.

Documented habitat such as the Stream Catalog is the basis for identifying associated or nearby undocumented areas. Aerial photos and topographic maps are then used to identify prospective sites not previously described. In the field, the prospective areas are examined for habitat type and value and the immediate area searched for habitat not visible on aerials and maps. All undocumented area providing habitat for coho and other salmonids is then surveyed and mapped. Variables measured are shown on the sample field form in Attachment 1. The completed field form, site specific drawn maps, and associated copies of topographic maps and aerials are then retained in hard copy files. Currently, only the field form is entered into the database. In the future, the other file information may be scanned and stored in a digital format.

We estimate that about 80% of the previously undocumented habitat in the Skagit system has now been covered by the inventory and about 10% of the Stillaguamish.

ENHANCEMENT PROJECT IDENTIFICATION

Our intensive habitat inventory work identifies a number of enhancement project sites. We also find possible projects from general review of aerial photos and foot surveys in likely locations. Aerial flights have also been helpful in locating opportunities, especially where access may be limited. Both fixed-wing and helicopters are used. References from other professional biologists

in the field have been helpful as well in locating potential opportunities. Special experience is often required to identify more elusive project opportunities such as ground water channel sites. Listings of habitat enhancement options are then annually ranked by potential habitat gain and fish production, level of design difficulty and construction, landowner considerations, expected project life, cost and related factors. Listings are dynamic with new possibilities continually being added and others dropped. Many sites require several years of review and field checking to determine feasibility.

The highest priority sites are usually studied for at least a year to verify limiting production factors and to gather site specific data required for design and construction considerations. Only projects with high long term production potential are actually built. Each project constructed requires considerable planning time, surveying, flow monitoring, data gathering and evaluation and design development. We have recently moved into a five- year project construction planning cycle to provide needed time for these activities. All project development aspects have evolved to require more lead time.

We continued to work with the U.S. National Park Service (NPS) to develop projects within the Ross Lake National Recreation Area (NRA) at sites identified in a special survey conducted in 1990. Results of that survey and the document we prepared for the NPS were included in the 1990 annual report. The first project developed from that survey was the Park Slough Extension in 1991. Other sites are being evaluated.

METHODOLOGY

Enhancement Project Evaluation

Fish production evaluation efforts are designed to determine pre and post project conditions. Pre project evaluation work is conducted to determine existing conditions and learn if habitat enhancement work can be effective in improving productivity. Post project work is conducted to verify that an enhancement project functions as designed.

We use adult coho spawner surveys in addition to juvenile coho immigrant and smolt emigrant trapping at some proposed and completed project sites to evaluate performance. These efforts measure project use at key life history stages and ultimately record project effectiveness.

Evaluation work has required considerable effort during fall and spring each year since program inception. The accumulated data have become useful in identifying key habitat features and functions which are required to make a project most successful.

We conduct spawner surveys about every 10 days at key project sites to accurately measure total fish days use. Fish days use is the best way to summarize a season of spawning activity. Fish days use can be converted to total spawners by dividing days use by 14, the average life of a coho spawner on spawning areas (Baranski, Washington Department of Fish and Wildlife, Fish

Management Program, personal communication). Less frequent spot surveys at prospective sites are usually made to determine whether there is any spawner use or access. Spot surveys are also used to confirm an older project continues to function as designed. Spawner survey data are on file with this program as well as included in the WDFW Fish Management database. Trapping methods and materials are similar to those used on the North Coast program. Two-way traps are used at some sites with a division board to separately capture and enumerate (including marking by freeze brand at some sites) up and downstream migrants. At other sites, one-way traps are installed with large mesh screens which capture emigrating smolts, but allow immigrant 0 age fish to pass through. Dual trap designs are used when chum are involved to reduce predation by juvenile coho. Trapped fish are anesthetized briefly for handling, measured and/or marked, allowed to fully recover and passed in the direction they intend to migrate. A systematic sampling scheme is used to reduce number of fish handled and speeds the process, avoiding unnecessary handling stress. Adult traps are sometimes installed in conjunction with juvenile traps to accurately determine extent of on-site spawner use (especially where spawner surveys would be time consuming or difficult).

Minnow trapping is another method used to evaluate juvenile coho use at prospective project sites. Minnow trapping provides an easier and more economical method than smolt trapping, especially when only qualitative information is needed. Traps are typically baited with salmon eggs and allowed to fish for a few hours up to several days depending on initial catches and expectations of population size. Fish are unharmed by this sampling method.

We evaluate every project at some level to verify its function and performance. Extensive evaluation, however, must be restricted to a few key sites where funding is available and practical. Some sites, for example, cannot be trapped in spring or fall because the project is frequently back-watered by high river stages in those seasons. Access to other sites is not possible in the spring because roads are blocked by snow. Project evaluation, however, is an essential part of our enhancement effort and will continue throughout the life of this program.

RESULTS

North Sound project sites are shown on the map in Figure 1. A list of North Sound projects completed from 1991 through 1997 is found in Table 3.

Fish Production

Smolt production and spawner use has been summarized in Table 4. Site specific smolt data are listed in Table 5. Site specific spawner use data are too extensive to be included in this report. Smolt production among all projects measured has varied widely from 0.01 to 2.09 fish per square meter of habitat. Spawner use has also varied greatly among sites, ranging from 0.007 to 0.343 spawners per square meter of available spawning area. Several sites have no “inside” spawning capability and have served as rearing areas only.

Trapping results by project site through 1997 are shown in Table 5. Some of the trap information precedes the current program. The temporal pattern of emigration and immigration, growth rates, temperatures and other information have been summarized for each site but is too lengthy to be included in this report. More concise evaluation of the trap data is discussed below. The table does not show modifications made at some sites so production in later years may not reflect conditions in earlier years at these locations.

Mean smolt production for the Stillaguamish projects in their current condition has been 0.39 smolts per square meter, about 36% greater than the Skagit projects at 0.28 smolts per square meter. Although the difference is not statistically significant, higher production rates on the Stillaguamish may reflect the smaller sized projects in that basin. Smaller sites tend to cycle up in production more quickly and they are more likely to be adequately seeded every year. Except for the upper South Fork, the Stillaguamish is also more likely better escaped with spawners than the Skagit, providing more fish to use enhanced habitat areas. Several of the Skagit projects are very large and will require more time to be fully productive.

The high variability in smolt production both within and between project sites (Table 5) over the period of record reflects wide ranges of escapements during this period coupled with many other variables we do not fully understand and are difficult to measure. Severe floods in some years, for instance, have had an effect on spawner and consequently juvenile fish distribution in the watershed. Inter-species behavior between coho and chum spawners may also alter coho distribution patterns in some places at times. Homing is imprecise and juveniles imprinted to a project site may return as adults to adjacent areas rather than the project. Minor homing differences could be exacerbated by small annual variations in flows, temperatures or other water quality factors that may attract or discourage spawners from specific enhancement sites. Projects located high in the watershed may not as reliably recruit juveniles if on-site or upriver spawning is low. Unintentional selective fisheries, especially in depressed stocks, could also impact the return to segments of the river that may include a project site. Considered together, these types of factors could help explain the highly variable use we see both in spawning returns and smolt production.

Several spawning cycles may be needed for these high quality enhancement sites to demonstrate the stability in production levels they can provide. The Hazel site on the Stillaguamish, however, seems to already be demonstrating this value. Figure 2 shows that when there was a significant drop in basin escapement the site was able to keep producing smolts at near its maximum rate. Gold Basin, by contrast, has shown the more typical pattern of tracking escapement closely (Figure 3) in spite of its demonstrated ability to produce fish at a high rate (Table 5).

Figure 4 demonstrates the progressive cycling up of a large project (Newhalem) on the Skagit. It also shows how a single large project can make a significant contribution to basin production. In five years of project life, it has come to capture almost 5% of all Skagit spawners based on WDFW spawning escapement estimates. Spawner use or proportion of the available escapement should level off at a high rate and remain relatively constant as multiple cycles of spawners home

on the project. This type of stability reflects the protection enhanced habitats have from the ravages of winter flooding and summer stranding mortality typical of most streams and unprotected areas.

Mean spawner density per square meter of available spawning area has been higher in the Skagit (0.36 per square meter) than the Stillaguamish (0.08 per square meter). The Skagit mean has probably been strongly influenced by the several projects in that river designed primarily for spawning enhancement, these being ground water channels. Fish have responded quite favorably to those projects with high immediate use. We have no spawning specific projects in the Stillaguamish because we have not found opportunities for this type of enhancement there. Stillaguamish spawning enhancements are part of larger projects aimed more specifically at rearing habitat improvements. Spawners are not necessarily required for a site to produce smolts in large numbers but they help ensure a project is adequately seeded with fry and/or parr if recruitment from upstream areas is low.

Applying the mean Skagit smolt production figure to all Skagit projects indicates a production potential of 135,135 fish annually or 16% of the total basin production based on seven years of scoop trap data from 1990 to 1996 (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data). This proportion will be more fully realized as existing projects come into full production and new ones are built.

A similar smolt production estimate for all our Stillaguamish projects using the mean value indicates our sites are potentially able to contribute 106,370 smolts or about 29% of the total basin production. This is based on three years of scoop trap data from 1979 to 1982 covering a wide range of parent broods from 9,000 to 36,000 spawners (escapement goal of 18,000) (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data).

Where possible, we are making efforts to improve smolt production at sites not meeting their expected rates or even respective basin mean values. Additional excavation work at County Line Ponds in 1996, for example, was designed to improve ground water flow and attractiveness to both juveniles and adult spawners. We are expanding the extent of inside spawning at several sites to help insure full project seeding and conducting needed maintenance promptly to ensure fishways perform as designed. Some sites, however, may only perform well during relatively wet years. Two sites that seem sensitive to average or better precipitation are Marsh Pond and Cascade Mill Pond.

Production at the upper South Fork Stillaguamish projects, upstream of the canyon reach, may always be lower than the rest of that basin. Fishway performance at Granite Falls has never met expectations with poor attraction conditions. Improvements are scheduled before the year 2000. Passage through the canyon above Granite Falls, however, will remain difficult and often flow dependent. Annual variations in rainfall seem to determine the extent migrating adults can

negotiate the numerous steep cascades and waterfalls. Additionally, the loss of several sequential year classes from blockages in the early 1990's will make recovery slow.

Predation is another factor that may limit site production in ways we cannot improve beyond a certain level. The large Carey's Slough complex, for example, is heavily populated with spiny rays known to adversely impact juvenile salmonids. We demonstrated significant smolt loss between two traps at the upper and lower end of the project. Adverse predator impacts justified the culvert replacement on Little Carey's Creek, a small tributary, to provide refuge habitat. Little Carey's is generally too small and shallow to support the spiny ray and large salmonid predators found in the main slough. However, there is little more we can do to enhance survival in this site. Cover placement can also be used to reduce predation and has been added to projects where feasible. The potential adverse impact of bird, fish, and mammal predators is considered in all project planning.

One important production feature we have not evaluated is the contribution some projects are very likely making to pre smolt parr which move out of the site to finish rearing in downstream areas. These are additional parr to the system which help seed existing habitat. An intensive year-around evaluation of a channel project in Canada (Foy, 1985) found this contribution to be significant. Since many sites substantially produce fry in excess of those required to fully seed available rearing area on the project, we believe the excess fry leave and contribute to system-wide production. We have not, however, had sufficient resources to study this behavior intensively. We strongly suspect, however, that this is a major occurrence at our Constant Channel site. This site has been well escaped every year by spawners but smolt production has been much lower than expected. Electrofishing population estimates of early summer and early fall parr made in 1994 and 1995 did show the site to be fully seeded. We assume the parr move out of the project in late fall possibly to avoid the aggressive action of adult spawners. It may also be a residual response from when the site annually dried every summer before the project was constructed. Late summer and/or fall emigration may have been an evolved response to successfully deal with the stranding problem. It will take a number of generations to evolve year-long juvenile residency. The position of the project in a steep gradient reach of the Sauk River without significant spawning upstream may prevent juvenile fall recruitment to replace the fish that leave.

Another enhancement feature our projects provide which has not been measured is the availability of off-channel areas for short term residence of emigrating smolts . We know smolts seek these areas during their spring migration for temporary rearing, moving into them for refuge until they are physiologically ready for seaward migration and then leaving. Greater availability of this temporary refuge habitat provided by our projects likely increases size and survival of pre smolts and smolts.

Evaluation smolt trapping and spawner surveys will continue to be most useful tools in judging site performance and productivity. Generally, however, multiple years of trapping and survey work will be required to average wide ranges of escapements, weather, and project capabilities

where we have made improvement modifications. Smolts, though, should be considered only one measure of project site productivity.

Overwinter Survival

Trapping and marking a sample of fall recruits at the Hazel site, with subsequent enumeration the following spring, has consistently shown overwinter survival to be near 50%. Nearly identical figures have been found at Rowan and Harrison Pond. We believe this survival rate to be indicative of other quality off-channel pond sites and a considerable improvement over the 10-30% estimated survival [Tschaplinski and Hartman (1983), Groot and Margolis (1991)] for fish unable to access this type of off-channel habitat. In addition to increased freshwater survival, accelerated growth of pond reared coho produces a larger smolt and increases the probability of marine survival (Hartman and Scrivner, 1990).

Post-Project Additions/Modifications

Evaluation work has led to a variety of project modifications to help sites perform at their maximum levels. Trapping work at Boundary, for instance, indicated the critical need for inside spawning. Juvenile fish did not apparently colonize the site from downstream spawning areas as expected and smolt production was low. To help seed the project area and encourage use of this valuable site, we built a small inside spawning area two years ago. Spawner use was immediate and smolt production has nearly doubled. Further evaluation in the coming years will determine whether the added spawning area is large enough or if it needs to be expanded further.

A low smolt production and adult escapement at the County Line Pond project indicated the need for higher flow during the fall when spawners are seeking small high quality tributaries and juveniles off-channel areas. Our flow test in 1995 indicted supplying supplemental water would increase the outflow from the site without it being lost to ground water and additional excavation work was done in 1996 to develop more ground water inflow. The increased project flow has succeeded in attracting a much bigger spawner population in 1997. Smolt production in 1999 should reflect this enhancement.

1997 PROJECT CONSTRUCTION

Stillaguamish River Basin

Mud Lake Spawning Gravel

Mud Lake is the headwater of Tiger Creek, tributary to Canyon Creek on the South Fork Stillaguamish River. Tiger Creek has long been a productive stream with good escapement and high quality and abundant rearing area. However, spawning habitat has been quite limited. We had observed coho attempting to spawn at the outlet of Mud Lake but little more than pea gravel and sand was available for substrate. We believed the addition of appropriately sized and graded gravel to this area would significantly improve spawning conditions and production from this

system. Attracting spawners to the headwater lake would also ensure the shallow lake habitat was being more fully used as juvenile rearing area. Downstream migrating fry and parr would also be able to colonize the rearing marsh areas downstream. Similar work in Canada had been very successful both for coho and sockeye salmon.

Our project spread about 450 cubic yards of washed, specially mixed drain rock in the very lower end of the lake where equipment access could easily be developed. We spread the gravel about one foot to eighteen inches deep over an area of about 500 square meters. A special effort was made to extend the gravel from one side of the outlet to the other so the increase in velocity (as a consequence of the raised bed) would make all the gravel placed equally attractive. The goal was to distribute spawners as well as possible to avoid redd superimposition.

We believe we accomplished our objective in construction and spawner use in 1997 has been extensive with nearly all the area used. We plan to monitor the site over the next couple years and may consider expanding the project. Another opportunity for additional gravel may be at the lake inlet where there is now only room for several redds. The small inlet flow, however, will limit the area we can enhance.

Gold Basin Spawning Habitat Expansion

Gold Basin has been a highly productive off-channel pond site on the upper South Fork we made accessible in 1989 with a fish ladder and culvert baffles at the Mountain Loop Highway and fishway at the pond outlet. Spawner use and return have been excellent when fish have been able to migrate upstream of the canyon reach. Excellent fish response led us to believe expanding the limited spawning area could improve site production even further. We had added about 10 cubic yards of gravel to the inlet stream in 1996 that was immediately colonized and so proceeded to add about another 10 cubic yards to reach where truck access was possible. Gravel was again hand placed to minimize disturbance to the stream and the well-developed riparian cover.

Spring Creek Culvert Weir Repairs

Maintenance of this 1994 project was needed to ensure security of the weirs vital to providing reliable passage through the culvert under the Jordan Road. Storm flows in winter of 1996 had eroded some of the protective rock at the end of the second weir. Restoration and improvement in the rock ballast and protection was needed to prevent the creek from eroding the steep adjacent bank that would jeopardize our work. Only hand work was used to keep adverse impacts minimal to the recovering vegetation. We will continue to monitor the work for any future needs.

Skagit River Basin

Taylor Channel

The major North Sound project in 1997 was a 3,000 feet long ground water spawning and rearing channel on the upper Skagit River near Marblemount. We had identified the site in 1990 but

were unable to develop a project because the large second growth forest surrounding the site prevented any equipment access. However, the site was logged in 1991 and later transferred from private to U.S. Forest Service ownership that made project development possible.

Planning began two years ago for the largest project of this type SSHEAR has built to date. Considerable time was invested in planning, design and permitting. Construction began in May with the expectation of being done by early August. However, the large snowpack kept the Skagit very high through early summer eventually back-watering the construction to the point where work was slowed and even discontinued in early July. We returned to complete the project in September when river levels were low, but even working into mid November we did not quite finish all aspects of the project. Fall rains, short daylight hours and cold weather forced us to postpone final work until 1998. All work was completed but placement of wood cover structures in cover "trenches" or specifically designed deeper reaches of the channel.

Designed to benefit both chum and coho, the project attempts to mix as much open spawning area as possible with woody debris and rock cover. Chum prefer the open spawning habitat while coho spawners need spawning area adjacent to cover for security during juvenile rearing. We modeled the design after our Illabot Channel project where we had similar objectives and good use by both species as well as other salmonids.
Spawner use in early 1997 has been low but chum escapements to the Skagit have also been very small and lack of adequate cover has likely discouraged many coho. It is also likely that it will take several years for fish to find the site and begin the cycling up process.

Final work in 1998 is expected to take about two weeks.

Barnaby and Harrison Spawning Enhancements

We have always known spawning habitat was limited in Barnaby relative to the tremendous rearing area available, which was why we included spawning additions with each weir passage project at this site in 1995. Excellent spawner use of the enhanced areas justified additional work where possible. Additional gravel was added to the central weir structure at the outlet of the old rearing pond this year. Access was easy and no special equipment was needed. Only hand labor was used. Expansion of spawning area at the other two sites is being considered but heavy equipment may be required and scheduled with our construction crews.

Smolt production from the large Harrison Pond and slough has not met expectations, probably because it does not get well seeded with juveniles. Recruitment of juveniles from the very upper end of Lucas Slough (outlet of Harrison) may not be very efficient and the small amount of spawning area inside the project limits inside production. Opportunities for spawning enhancement were few but one probable location identified was the inlet channel at the crossing of the Barnaby access road. The deep channel had a firm silt/sand bottom that could accommodate gravel without the need to remove or disturb the stream bed. Furthermore, the gravel would make the channel more shallow, increasing velocities over it and improving its

attractiveness and value. Using this opportunity, we added about 25 cubic yards of clean washed drain rock mixed to our specifications. Coho were observed using the area immediately in 1997.

We also conducted some maintenance at Harrison including cabling of a debris boom log in front of the fishway, fishway clean out, and cleaning of the screen.

SCHEDULED 1998 PROJECTS

Stillaguamish River Basin

Dazzling Howie Culvert Replacement

Dazzling Howie Creek is a small spring fed tributary to the upper South Fork near Silverton. It crosses the Mountain Loop Highway in a 60 year old wooden box culvert before immediately entering the river. Sheet flow in the culvert blocks fish passage at virtually all stream flows and river stages. Furthermore, outfall at the culvert has begun to undermine the structure and maintenance will soon be needed.

Dazzling Howie was the third in a series of three culverts needing replacement for fish passage we identified on the Mountain Loop Highway in the upper South Fork belonging to Snohomish County. The other two, Marsh and Trout Creeks, were corrected in 1993 and 1996 respectively. These were joint projects with the county. Dazzling Howie will be the last cooperative project with the county in this reach. All three projects will have restored fish access to valuable off-channel habitat critical to salmonid stock recovery in the upper river. Tributary habitat, especially marsh and spring fed streams such as these, provide the most useful habitat in this area where the mainstem has been seriously degraded.

The Dazzling Howie project will be conducted in a manner similar to the other two sites. Traffic will be routed onto a single lane bypass while the old culvert is removed and the new one installed. Efforts will be made to complete the work before opening of Barlow Pass so seasonal tourist traffic will not be affected. It would not be possible to block the highway entirely since there are residences east of the crossing.

The design will differ somewhat from the other two projects. This plan will include a new sloped corrugated metal pipe culvert embedded about 20% into the channel with a stream bed built through the pipe. The stream bed will act as a natural “rough” channel providing durable fish passage without the need to maintain baffles or other structures in the culvert. Two downstream rock controls will provide efficient entry into the pipe and prevent any additional stream bed degradation.

Each of the three projects with Snohomish County in this area will have demonstrated a slightly different method of using culverts to effect fish passage. They will have shown alternative

solutions that the county can adapt in their own program of fish passage improvements that has begun in the last couple years. Cooperation to implement these projects with the county has been excellent and we have developed another partner in the large task of correcting fish barriers at road crossings.

Spawning Gravel Additions

Additional spawning gravel is scheduled for addition to Gold Basin Mill Pond, a 1989 project. Some of the gravel we added last year was contaminated by a 20 year storm event in 1997 and this effort will help restore that effort. Gold Basin is an extremely productive and valuable site we want to maintain in the highest production condition. Gravel can be added as it was in 1996 with hand tools and labor only, making minimal impact on the stream or riparian vegetation.

West Fork Church Creek

Church Creek is a highly productive independent tributary of the lower Stillaguamish that annually receives several hundred coho spawners and an undetermined number of other salmonids. However, the upper reach of the West Fork is inaccessible because the long culvert under Interstate 5 poses a passage barrier. Upstream of the highway there is very good spawning and rearing habitat that could contribute to additional production.

This culvert was identified in the WSDOT Culvert Inventory (discussed elsewhere in this report) as a high priority for repair and is now scheduled for 1998. This is one in a continuing series of cooperative projects between WDFW and WSDOT to correct WSDOT owned fish passage problems.

The design is somewhat complicated by the fact two culvert types were joined in this project. The lower section is a concrete box culvert under the old Pacific Highway. The upper section under the adjacent Interstate highway is a round corrugated metal pipe with a different grade under each freeway section (north and south bound lanes).

Our current plan calls for placement of bent metal plate baffles in the lower concrete section and round hoop-attached baffles in the upper length. The lower portion each hoop contains the plate baffle welded to an adjustable ring. The design allows each of the 26 required installations to be custom fit. The irregular shape of the metal culvert over its length and the asphalt coating requires each baffle placement to be unique. The hoops will all be prefabricated with on-site adjustments made as needed with field welding capability. No additional work will be needed outside of the culvert to provide passage criteria meeting WDFW standards.

Skagit River Basin

Taylor Channel

As was discussed above, final debris placement in 1998 should complete the project. We have found the cover provided by the debris to be a critical component that cannot be neglected. Additional cost share funding by the Non Flow Coordinating Committee of the Skagit FERC Settlement Agreement (Seattle City Light) will help cover the expenses.

Lornezan Creek

Permit difficulties in 1996 and scheduling conflicts in 1998 have now postponed this project to 1999. The cooperative agreement with Skagit County for this culvert replacement has been extended and we hope to complete the work in that year. This will be a major project replacing a long culvert at the mouth of the stream located near Concrete on the central Skagit. It will provide anadromous salmonids access to the entire stream.

O'Brian Spawning Gravel

O'Brian Creek is a tributary to upper Illabot Creek Pond as is our Illabot ground water channel we built in 1995. Except for a short section of headwater, the creek is primarily a large slough on the flood plain that runs in a relic channel of the Skagit River. As such, it provides abundant rearing habitat but very little spawning area. Coho spawn in the small headwater area and a few chum salmon use the very limited patches of gravel in the lower stream reach above the pond.

Based on the immediate colonization of the Illabot channel by both coho and chum salmon spawners, we believe we can provide additional enhancement for them in the lower reach of O'Brian by adding gravel. With just a small amount of excavation, we are planning to build about four "spawning pads" totaling about 350 square meters. Since this stream is very low to dry in late summer at the lower end, work should be relatively easy without large pumping requirements, diversions and related needs.

PROJECTS PROPOSED FOR 1999 AND FUTURE YEARS

Program planning in the SSHEAR Section has required development of three and preferably five year project plans. This planning has been done for the North Sound Program with firm projects defined through 2000 and tentative projects through 2003. The list will, however, be dynamic to allow unique opportunities to work with available funding sources and landowners such as counties and federal agencies. Habitat inventory work is still not complete and more projects will likely be developed from this effort to help shape the project plan in coming years.

INSERT North Sound Map FIGURE 1 HERE

Table 3. Completed North Sound projects through 1997.

Project	River Basin	Year Completed	Habitat Benefit	Cost	Landowner
Skagit River Basin					
Newhalem	Skagit River	1991	81,000 m^2	$283,000[a]	Sea. City Light
County Line	Skagit River	1991	22,000 m^2	$62,000[a]	Sea. City Light
Cascade Park	Cascade River	1991	2,030 m^2	$14,764[a]	Cas. Park Assoc.
Cascade Mill	Cascade River	1989	7,000 m^2	$27,200[b]	Cramer
Barnaby Slough	Skagit River	1995	26,302 m^2	$41,490[a]	WDFW
Harrison Pond	Skagit River	1990	141,600 m^2	$68,120[c]	Sea. City Light
Harrison Pond	Skagit River	1995	141,600 m^2	$100,000[a]	Sea. City Light
Illabot Channel	Skagit River	1995	1,672 m^2	$160,377[a]	Seattle City Light
Constant Channel	Sauk River	1991	2,800 m^2	$130,000[a e]	USFS
Suiattle Slough	Suiattle River	1988	3,120 m^2	$68,270[c]	Wash. DNR
Careys[d]	Skagit River	1986	169,000 m^2	$15,240[b]	City of Hamilton
Little Careys	Skagit River	1991	1,920 m^2	$13,400[a e]	Crown Pacific
Marsh Pond	Suiattle River	1992	3,800 m^2	$32,000[a e]	USFS
Boundary	Suiattle River	1994	830 m^2	$41,092[a e]	USFS
Park Slough Ext.	Skagit River	1992	1,400 m^2	$78,000[a]	NPS
Grouse Marsh	Cascade River	1996	13,150 m^2	$101,214[a]	USFS
Taylor Channel	Skagit River	1997	5,000 m^2	$437,260	USFS
TOTAL SKAGIT BASIN			482,624 m^2		
Stillaguamish River Basin					
Granite Falls	S.F. Stillaguamish R.	1988,93	17,900 m^2	$20,880[b]	McEwen, Ind. Hills Community Park
Rowen Pond	N.F. Stillaguamish R.	1992	4,000 m^2	$38,300[c]	Charley
Hazel Pond	N.F. Stillaguamish R.	1987	9,580 m^2	$17,280[c]	Snoh. County
Forts on Ponds[d]	N.F. Stillaguamish R.	1989,90,92,93	47,180 m^2	$3,585[b]	Grandy Lake F.A.
Gold Basin	S.F. Stillaguamish R.	1989	5,000 m^2	$51,710[b e]	USFS
Stilly Canyon	S.F. Stillaguamish R.	1994	60 miles	$34,523[a]	Hancock
Oso Pond	N.F. Stillaguamish R.	1994	32,368 m^2	$31,382[a]	Snoh. County
Spring Cr. Culvert	S.F. Stillaguamish R.	1994	32,300 m^2	$21,518[a e]	Snoh. County
Spring Cr. Dikes	S.F. Stillaguamish R.	1993	32,300 m^2	$43,500[a]	Folker, Wheatley
Kackman Creek	Stillaguamish R.	1993	1,920 m^2	$15,500[a e]	Klein
Rowen Creek	N.F. Stillaguamish R.	1995	156 m^2	$49,193[a]	Phillips
Forts on Ponds[d]	N.F. Stillaguamish R.	1995	200 m^2	$11,593[a]	Grandy Lake F.A.
Big Four Creek	S.F. Stillaguamish R.	1995	220 m^2	$5,360[a]	USFS
Marsh Creek	S.F. Stillaguamish R.	1993	100,000 m^2	$93,200[a e]	Snoh. County
Trout Creek	S.F. Stillaguamish R.	1996	28,000 m^2	$99,186[a]	Snoh. County
Jordan Creek	S.F. Stillaguamish R.	1996	400 m^2	$7,302[a]	Lundberg
Trout Farm Creek	S.F. Stillaguamish R.	1996	200 m^2	$3,651[a]	Brenner
Mud Lake	S.F. Stillaguamish R.	1997	500 m^2	$22,870	Hancock
TOTAL STILLAGUAMISH BASIN			2799424 m^2		
TOTAL NORTH SOUND			762,548 m^2		

[a]Cost figure includes design, development, construction and post project evaluation as recorded by WDFW accounting system (AFRS) which began in 1991 for individual projects.
[b]Cost figure developed from methodology of Sekulich (1991) which approximates AFRS closely for work completed before 1991.
[c]Cost figure is a combination of AFRS and Sekulich (1991) because portions of the project were completed before and after 1991.
[d]Only that portion of the project completed in this program is included.
[e]Project cost shared with another contributor(s).

Table 4. Summary of project performance where evaluation trapping and spawner surveys have been conducted since 1986.

Project Site	WRIA	Area (m^2)	Current Production		Comments
			Mean Annual Smolts/m^2 [1]	Mean Annual Spawners/m^2 [2]	
SKAGIT RIVER BASIN					
Suiattle Slough	03.0710A	3,116	1.14	0.108	The strong perennial flow, excellent spawning areas, and recent improvements in fishway attraction function to seed a large ponded area with excellent cover for juvenile rearing.
Cascade Millpond	03.1411B	7,050	0.04	0.132	Outflow has dropped significantly since construction (during recent six year drought) decreasing ability of site to attract both spawners and juveniles.
Careys Slough	03.0354	169,000	0.11	0.337	Large fish predator population will not likely allow this site to produce smolts at a higher level. Additionally, incidental catch of coho during in-river steelhead fishery may be reducing numbers of inside spawners.
Barnaby Slough	03.1343	72,800	0.14	No estimate available	Production from site with temporary access. Formal fishway built in 1995 should help improve production by providing efficient assess.
Harrison Pond	03.1340	140,000	0.01	No estimate available	Poor fishway attractiveness and denial of spawner entry have led to low production levels. Changes in management of the site and a new fishway constructed in 1995 now provide free spawner access and improved juvenile attraction.
Constant Channel	03.0111A	2,350	0.18	0.090	Trapping problems have not allowed an accurate smolt production estimate. Additionally, low flows as a consequence of recent drought since construction have likely reduced potential smolt production. Preliminary late summer evaluation suggests pre-smolt parr contribution to downstream areas may be significant (4.1 parr/m^2).
Boundary	03.0710H	830	0.19	2.0	Inside spawning area built in 1995 and 1996.
Marsh Pond	03.0807	3,800	0.05	no inside spawning areas	Recent drought since construction has reduced flows below acceptable levels for significant smolt production. The site will always be naturally flow dependent. Pre-project production from years when fish had temporary access indicated site is capable of smolt production in range of 0.5-0.8/m^2.
Park Slough	03.1859A,B	4,400	0.94	0.015	Perennial ground water channel provides excellent spawning and rearing habitat.
County Line Ponds	03.1853B	22,250	0.07	0.108	Unexpected poor outflow conditions have led to less than expected production. Improvements made in 1996 may improve flow and production.
Newhalem Ponds	03.1864A	81,000	no data	0.059	Site has not yet been trapped for smolt emigration. Adult spawner use is cycling up quickly.
TOTAL and MEANS (w/ 95% C.I.)		506,596 m^2	$\bar{x}$=0.28 ±0.06	$\bar{x}$=0.36 ±0.25	
STILLAGUAMISH RIVER BASIN					
Forts on Ponds	05.0254A	47,180	0.27	0.343	Spawning area additions in 1995 will likely boost pre smolt production seeding downstream areas but smolt production may not change given its stable level over a number of years.
Gold Basin	05.0401A	5,000	0.53	0.007	Project is very productive when upper South Fork has had an escapement.
Granite Falls	05.0358C	17,900	0.10	0.009	Production has varied considerably over 5 years of evaluation possibly being influenced by large fish predator population.
Rowen	05.0220A	4,000	0.59	0.026	Spawning area expansion and stream rehabilitation in 1995 should increase production in 1997 and future years.
Hazel	05.0228	9,584	0.46	0.024	Production has been constant over evaluation period.
TOTAL and MEANS (w/ 95% C.I.)		83664 m^2	$\bar{x}$=0.39 ±0.14	$\bar{x}$=0.08 ±0.13	

[1] Mean values for years of record with project in current design configuration.
[2] Per square meter of available spawning area. Mean value for years of record available for each site with inside spawning capability. Spawner density derived from fish days use assuming a spawner life of 14 days.

Table 5. Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
SKAGIT										
1986-87	Suiattle	2.0[b]	3116 m^2	---[p]	---	3054	95 mm (10.0)[149]	---	0.98	3966
1987-88	Suiattle	"	"	80	---	1396	104 mm (19.6)[508]	---	0.45	1821
1988-89	Suiattle	"	"	116[c]	80 mm (13.1)[72]	2041	100 mm (11.6)[1732]	---[t]	0.65	2630
1989-90	Suiattle	"	"	---	---	2006	96 mm (16.4)[1936]	---	0.64	2589
1992-93	Suiattle	"	"	---	---	3314	89 mm (17.2)[843]	---	1.06	4289
1993-94	Suiattle	"	"	---	---	3656	91 mm (20.2)[1275]	---	1.17	4734
1994-95	Suiattle	"	"	---	---	3742	89 mm (12.9)[555]	---	1.20	4855
1993-94	Boundary Cr.	11.75	830 m^2	---	---	208[au]	101 mm (7.3)[192]	---	0.25	1014
1994-95	Boundary r.	"	3138 m^2	---	---	115	110 mm (12.5)[74]	---	0.04	162
1995-96	Boundary Cr.	"	"	---	---	400	98 mm (10.0)[180]	---	0.13	516
1996-97	Boundary Cr.	"	"	---	---	770	96 mm (12.0)[235]	---	0.25	993
1989-90	Cascade Mill	1.5[w]	7050 m^2	---	---	496	---	---	0.07	283
1990-91	Cascade Mill	"	"	---	---	260	---	---	0.04	162
1991-92	Cascade Mill	"	"	---	---	337	106 mm (no data)[no data]	---	0.05	202
1992-93	Cascade Mill	"	"	---	---	74	? (no data)[no data]	---	0.01	40
1985-86	Careys	39.2	169000 m^2[v]	---	---	3725	---	---	0.02	81
1986-87	Careys	"	"	---	---	5488	---	---	0.03	121

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1987-88	Careys	"	"	1579	---	6432	111 mm (11.0)[506]	---	0.04	162
1988-89	Careys	"	"	3473	80 mm (10.6)[1481]	2636[f]	100 mm (10.4)[1441]	---[t]	0.02	81
1989-90	Careys[n]	"	"	6023[l]	79 mm (8.8)[944]	18730	112 mm (12.8)[3731]	---[t]	0.11	445
1989-90	Upper Careys[s]	"	51708 m^2 [u]	4381[l]	84 mm (8.7)[96]	4165	104 mm (9.3)[2510]	---[t]	0.08	324
1994-95	Barnaby Slough[ay]	68.8	72828 m^2	---	---	12277	107.3 mm (9.4)[1220]	---	0.17	682
1995-96	Barnaby Slough	"	"	---	---	7415		---	0.10	412
1996-97	Barnaby Slough	"	"	---	---	10177	106 mm (13.6)[1597]	---	0.14	565
1990-91	Harrison	68.8	140000 m^2	665[aa ab]	91 mm (12.0)[576]	2023	121 mm (9.9)[1767]	33%	0.01	40
1991-92	Harrison[an]	"	"	---	86 mm (9.4)[1375][ai]	3379	125 mm (15.0)[2406]	40%[aq]	0.02	81
1992-93	Harrison[ao]	"	"	---	78 mm (12.9)[288][ap]	1301	146 mm (30.0)[265]	58%	0.01	40
1993-94	Harrison[at]	"	"	---	7 4 mm (10.1)[142]	1876	134 mm (28.1)[994]	68%	0.01	40
1994-95	Harrison	"	"	---	---	1973	127 mm (15.3)[308]		0.01	40
1995-96	Harrison	"	"	---	---	4777			0.03	138
1996-97	Harrison	"	"	---	---	1286	106 mm (11.3)[504]	---	0.01	37
1990-91	Constant	27.6	1000 m^2 [af]	---	---	48[ac]	87 mm (10.4)[39]	---	0.05	202
1991-92	Constant	"	2350 m^2	---	---	756	88 mm (10.7)[756]	---	0.32	1294

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1992-93	Constant	"	"	---	---	450[ax]	69 mm (12.5)[255]	---	0.19	769
1993-94	Constant	"	"	---	---	483	79 mm (12.8)[352]	---	0.21	850
1994-95	Constant	"	"	---	---	381	84 mm (18.1)[151]	---	0.16	647
1995-96	Constant	"	"	---	---	417	83 mm (16.9)[179]	---	0.12	718
1985-86	Marsh Pond and Creek	16.4[am]	5280 m^2 [ak]	---	---	2778[aj]	---	---	0.53	2144
1986-87	Marsh Pond and Creek	"	"	---	---	1799[aj]	---	---	0.34	1376
1987-88	Marsh Pond and Creek	"	"	---	---	1570[aj]	---	---	0.30	1214
1988-89	Marsh Pond and Creek	"	"	---	---	3075[aj]	---	---	0.58	2347
1989-90	Marsh Pond and Creek	"	"	---	---	786[aj]	---	---	0.15	607
1990-91	Marsh Pond	"	3800 m^2 [ak]	---	---	320[aj]	?	---	0.08	324
	Marsh Pond and Creek	"	5280 m^2 [ak]	---	---	337[aj]	?	---	0.06	243
1991-92	Marsh Pond	"	3800 m^2 [ak]	---	---	76[aj]	?	---	0.02	81
	Marsh Pond and Creek	"	5280 m^2 [ak]	---	---	1900[aj]	?	---	0.36	1456
1992-93	Marsh Pond	"	3800 m^2	---	---	12	?	---	0.01	40
1992-93	Marsh Pond and Creek	"	5280 m^2	---	---	996	?	---	0.19	769
1993-94	Marsh Pond	"	3800 m^2	---	---	29	107 mm (8.8)[22]	---	0.01	40
1994-95	Marsh Pond	"	"	---	---	475	130 mm (10.7)[177]	---	0.13	526

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1992-93	Park Sl. Old	91.5	3000 m^2	---	---	3430	89 mm (11.1)[1743]	---	1.14	4612
1992-93	Park Sl. New	"	1400 m^2	---	---	2832	89 mm (13.1)[1476]	---	2.02	8173
1992-93	Park Sl. Combined	"	4400 m^2	---	---	6262	89 mm (12.1)[3219]	---	1.42	5745
1993-94	Park Sl. Old	"	3000 m^2	---	---	3441	75 mm (16.0)[3195]	---	1.15	4653
1993-94	Park Sl. New	"	1400 m^2	---	---	1299	74 mm (23.4)[1218]	---	0.93	3763
1993-94	Park Sl. Combined	"	4400 m^2	---	---	4740	75 mm (18.0)[4413]	---	1.08	4370
1994-95	Park Sl. Old	"	3000 m^2	---	---	1235	84 mm (14.4)[1198]	---	0.41	1659
1994-95	Park Sl. New	"	1400 m^2	---	---	1305	94 mm (15.9)[1199]	---	0.93	3763
1994-95	Park Sl. Combined	"	4400 m^2	---	---	2540	89 mm (15.8)[2397]	---	0.58	2347
1995-96	Park Sl. Old	“	3000 m^2	---	---	1284	67 mm (14.5)[1281]	---	0.43	1732
1995-96	Park Sl. New	“	1400 m^2	---	---	2315	70 mm (16.6)[2314]	---	1.65	6690
1995-96	Park Sl. Combined	“	4400 m^2	---	---	3599	69 mm (16.0)[3595]	---	0.82	3309
1996-97	Park Sl. Old	“	3000 m^2	---	---	1951	83 mm (21.5([1945]	---	0.65	2623
1996-97	Park Sl. New	“	1400 m^2	---	---	752	81 mm (13.6)[747]	---	0.54	2185
1996-97	Park Sl. Combined	“	3400 m^2	---	---	2703	83 mm (19.7)[2692]	---	0.80	3237
1992-93	County Line	89.0	22,250 m^2	---	---	447	116 mm (8.3)[187]	---	0.02	81
1993-94	County Line	"	"	---	---	1925	112 mm (9.9)[1891]	---	0.08	324
1994-95	County Line	"	"	---	---	1259	114 mm (9.3)[974]	---	0.06	243
1995-96	County Line	“	“	---	---	2766	98 mm (9.5)[2760]	---	0.12	503
1996-97	County Line	“	“	---	---	1835	99 mm (7.4)[1829]	---	0.08	334

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1990-91	Newhalem	90.5	1393 m^2 [ag]	---	---	133[ad]	---	---	0.09	364
STILLAGUAMISH										
1984-85	Fortson Ponds	27.8	47180 m^2 [x]	---	---	16000	108 mm (7.2)[240]	---	0.34	1376
1984-85	Fortson-enhanced channel below ponds	"	3325 m^2	---	---	5913	100 mm (10.6)[347]	---	1.78	7202
1985-86	Fortson Ponds	"	47180 m^2	---	---	7200[g]	112 mm (8.8)[100]	---	0.15	607
1985-86	Fortson-enhanced channel below ponds	"	3325 m^2	---	---	3756	no data	---	1.13	4572
1986-87	Fortson Ponds	"	47180 m^2	---	---	13400	111 mm (21.0)[382]	---	0.28	1133
1986-87	Fortson-enhanced channel below ponds	"	3325 m^2	---	---	6938	96 mm (14.6)[288]	---	2.09	8456
1987-88	Fortson Ponds	"	47180 m^2	---	---	7633[m]	---	---	0.16	647
1988-89	Fortson Ponds	"	47180 m^2	---	---	12992	112 mm (11.6)[4258]	---	0.27	1092
1988-89	Upr Fortson	"	41270 m^2	---	---	11552[h]	113 mm (11.7)[3134]	---	0.28	1133
1988-89	Lwr Fortson	"	5910 m^2	---	---	1440	109 mm (10.7)[1124]	---	0.24	971
1989-90	Gold Basin	49.0	5000 m^2	---	---	---[q]	---	---	---	---
1990-91	Gold Basin	"	"	---	---	1218	107 mm (5.8)[1215]	---	0.24	971
1991-92	Gold Basin	"	"	---	---	2657	103 mm (7.8)[1865]		0.53	2144
1992-93	Gold Basin	"	"	---	---	152[al]	127 mm (7.9)[150]	---	0.03	121
1993-94	Gold Basin	"	"	---	---	767[av]	108 mm (7.9)[763]	---	0.15	607
1994-95	Gold Basin	"	"	---	---	2848	99 mm (7.0)[609]	---	0.57	2306

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1988-89	Hazel[i]	22.3	9584 m^2	1054	78 mm (11.9)[511]	3804	108 mm (7.0)[201][r]	38%	0.40	1618
							112 mm (7.5)[633][j]	---		
1989-90	Hazel[o]	"	"	4124	80 mm (13.4)[1282]	4469	111 mm (6.71)[840]	39%	0.48	1942
							110 mm (8.3)[3584][j]	---		
1990-91	Hazel[y]	"	"	2365	84 mm (12.0)[729]	3872[z]	106 mm (7.5)[3155][ah]	---	0.40	1618
1991-92	Hazel	"	"	---	---	4386	106 mm (9.3)[2904]		0.46	1861
1995-96	Oso Pond	13.3	28300 m^2	---	---	3188	99.6 mm (8.6)[454]	---	0.11	456
1996-97	Oso Pond	"	"	---	---	1753	106 mm (9.5)[331]	---	0.06	251
1990-91	Gnite Falls	32.2	17900 m^2	---	---	283[ae]	119 mm (13.3)[283]	---	---	---
1991-92	Gnite Falls	"	"	---	---	1896	109 mm (9.1)[1896]	---	0.10	405
1994-95	Gnite Falls	"	"	---	---	1513	127 mm (9.6)[324]	---	0.08	324
1987-88	Rowen	20.6	4000 m^2	---	---	1160	90 mm (7.6)[466]	---	0.29	1173
1988-89	Rowen	"	"	967	77 (11.6)[690]	941	101 mm (9.9)[825]	31%[as]	0.23	931
1992-93	Rowen[ar]	"	"	---	82 (9.1)[256][ap]	2376	91 mm (9.7)[802]	11%[as]	0.59	2387
1993-94	Rowen[at]	"	"	---	81 (9.2)[497][ap]	1570[aw]	95 mm (8.6)[914]	17%[as]	0.39	1578
1994-95	Rowen[az]	"	"	---	85 (7.3)[490]	3224	99 mm (8.5)[502]	16%[as]	0.81	3277

Table 5. (continued) Summary of juvenile coho migrant trapping at 17 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 1997.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs [a]	Mean Length Downs (SD) [N]	%Change Length[k]	Out migrant/ m^2	Out migrant / acre
1995-96	Rowen[ba]	"	"	---	74 (7.0)[222][ap]	3856	92 mm (9.4)[553]	24%	0.96	3910
1996-97	Rowen[ba]	"	"	492	86 mm (6.2)[167]	6032	98 mm (11.7)[1165]	14%	1.51	6101

[a]Total downs represent juveniles recruited previous fall plus progeny of spawners within the site (which occurred at all projects).
[b]82 miles from mouth of Skagit River
[c]488 downstream migrants were enumerated from 10/19 - 2/13 for a net loss of 372 fish but late trap installation missed undetermined number of early upstream migrants.
[f]Inadequate seal allowed undetermined number of fish to pass uncounted most of spring season.
[g]Trap flooded or leaking significantly only 2 days of season.
[h]Trap flooded with undetermined number of fish passing uncounted 7 days of season.
[i]Pelvic clips (1054) not entirely enumerated in spring to enable survival calculation (clip difficult to see, considerable fin regrowth). 63 downstream migrants yielded (1054-63)=991 net ups.
[j]Diseased fish only, presumably progeny of inside spawning (none of the marked fall inmigrants showed the disease the following spring); fluke (neascus) not seen at other sites.
[k]Represents growth of marked fall inmigrants only.
[l]Represents only partial count since trap was inoperable after mid November from frequent flooding and significant inmigration likely occurred after this date.
[m]Derived by assuming 68% of total Forts on out migrants (ponds and stream) were attributable to ponds alone. Traps operated simultaneously immediately downstream of the ponds and at lower end of the stream in 1985, '86 and '87 showed pond contribution was 73%, 66% and 66% respectively (mean=68%). Only trap data from lower end of the stream was available (Tulalip Tribe) for 1988.
[n]Overwinter survival was 25% based on marked group (approximately one half of enumerated immigrants). Low survival attributed to large predator population including spiny rays.
[o]Overwinter survival was 44% based on marked group (approximately one half immigrants)
[p]Dashes indicate no trapping was done or data taken was incomplete or unreliable.
[q]Effort to out migrant trap in 1990 failed from freshets overtopping trap. New trap installation design planned for out migrant trapping 1991.
[r]Represents size of out migrants marked as immigrants fall 1988.
[s]This was the first season the upper portion of Careys was separated from the total enumerated. All fish trapped at Upper Careys were released and again enumerated at the lower trap. However, based on several marked groups through the season, only about 43% of the fish released at the upper trap ever appeared at the lower trap suggesting significant mortality presumably from high predation rates.
[t]Percent change cannot be calculated because immigrants were not marked and out migrants measured were a combination of immigrants plus progeny of inside spawning.
[u]This area included within the 169000 m^2.
[v]Wetted area during winter, summer area approximately 125000 m^2.
[w]80 miles from mouth of Skagit River.
[x]Wetted area during summer, the effective or limiting habitat (production at this site is assumed to be reliant on inside spawning only; very little juvenile recruitment is thought to occur during fall through the fishway below the lower pond). Winter area of the large pond is 1.7 times larger; the smaller pond has about the same area year-round.
[y]Overwinter survival was 46% based on marked group which was about one third of fall recruits.
[z]310 1+ coho were upstream trapped from 3/18 to 5/18.
[aa]Dike breached at fishway site by flood waters which could have allowed an undetermined number of juveniles to enter the pond.
[ab]Overwinter survival was 22% based on marked group which was 88% of recruits trapped. 665 recruits trapped does not represent total inmigration since some fish entered during fall flooding when trap was submerged and additional fish entered during construction via raceways.
[ac]27567 0+ coho were trapped and electroshocked from this enhancement site in addition to smolts shown in table.
[ad]745 0+ coho were trapped and electroshocked from this 1991 enhancement site in addition to smolts shown in table.

[ae]Represents partial count only since trap not installed until 5/7.
[af]Area before project, area after project is 2350 m^2.
[ag]Area accessible before project, area after project is 81000 m^2.
[ah]Both diseased (Neascus) and non-diseased fish combined.
[ai]The 1375 fish trapped were only a portion of immigrants. Trapping was done only to assess fishway performance. Of the 1375, 818 were marked to evaluate overwinter survival.
[aj]Data from trapping by Skagit System Cooperative.
[ak]Available pond area estimated only, exact area used cannot be determined.
[al]Two year old residuals only, there was virtually no spawner escapement to upper South Fork in 1991 or 1992.
[am]95 miles from mouth of Skagit River.
[an]Overwinter survival was 47% based on marked group.
[ao]Overwinter survival was 50% based on marked group.
[ap]Only a sample of emigrants was trapped and marked for overwinter survival estimate.
[aq]Length change calculation derived by excluding all marks greater than 136 mm which are assumed to be 2+ out migrants based on scale sampling conducted at this site in '93.
[ar]Overwinter survival was 41% based on marked group which may have been low because a large number of juveniles were already in the site as progeny of inside spawning leading to intense competition.
[as]Mean length of marked out migrants was not significantly different than all out migrants enabling accurate calculation based on sample group.
[at]Overwinter survival was 20% based on marked group.
[au]Preproject production before culvert replacement and creation of impoundment.
[av]Production from 1-2 redds located inside the project site which were virtually the only redds located in the upper South Fork in 1992.
[aw]Production was reduced by heron predation on emigrant smolts immediately above the trap.
[ax]Fish leaked from trap and it was sufficiently backwatered to be non functional much of the season.
[ay]Preproject enumeration when only juvenile fish were able to access slough area.
[az]Overwinter survival was 48% based on marked group.
[ba]Overwinter survival could not be calculated because the site was backwatered during fall floods of 1995 and many of the marked fish are assumed to have left.
[Ba]Overwinter survival could not be calculated because the site was backwatered during floods of 1995 and 1996 and many of the marked fish are assumed to have left.

NOTE: Mean smolt production for all Skagit project sites in their existing condition is 1134 smolts per acre. Mean smolt production from all Stillaguamish project sites in their existing condition is 1552 smolts per acre. Difference between rivers is not statistically significant.

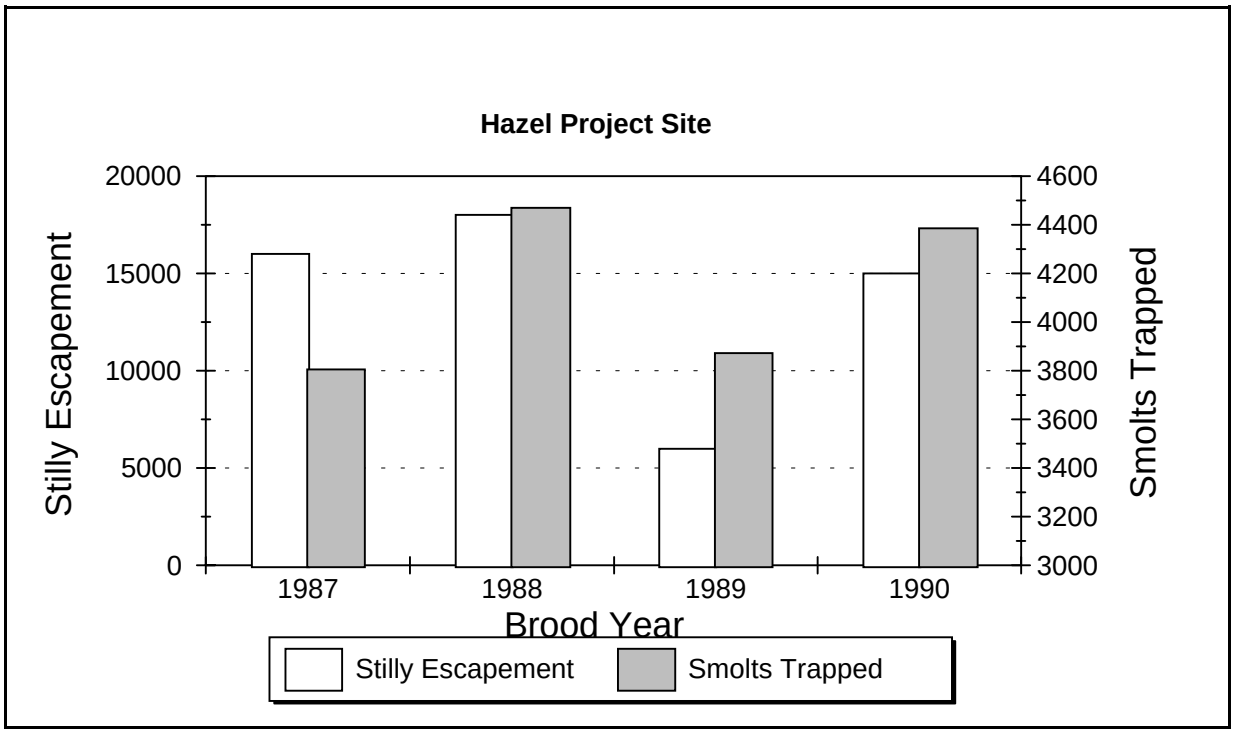

Figure 2. Coho smolt production from four brood years showing the stability off-channel projects can provide even when basin escapement is low.

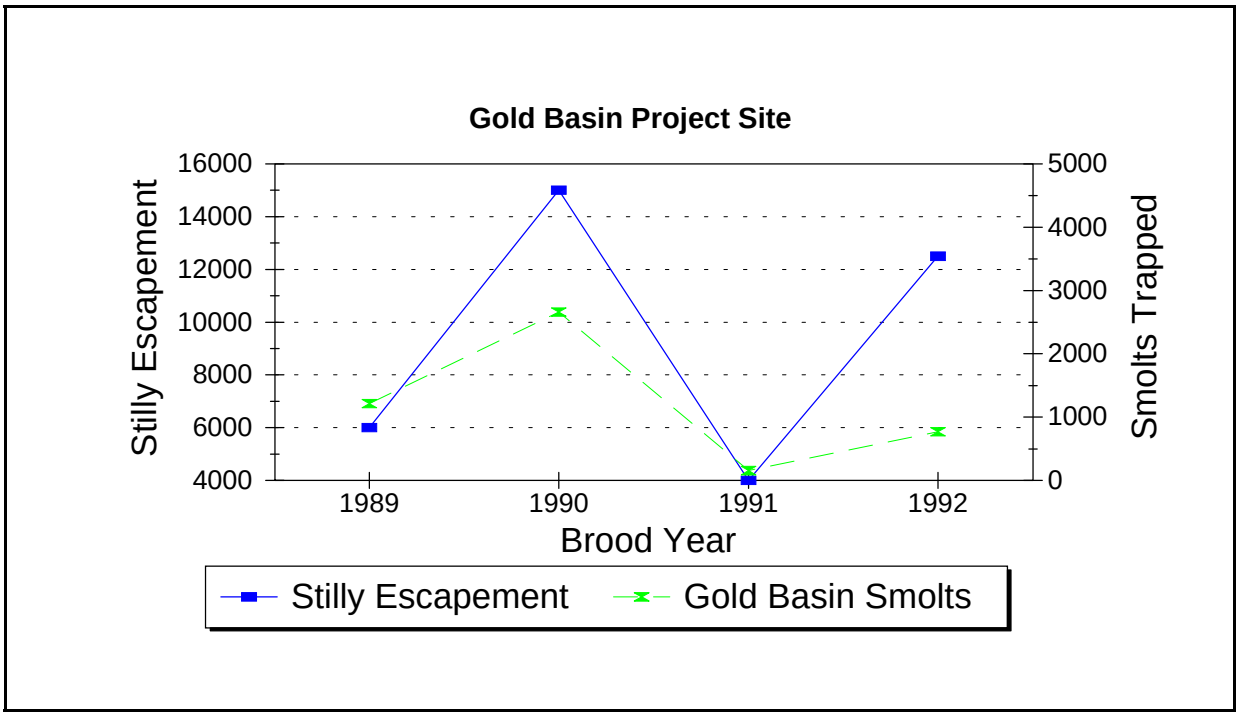

Figure 3. Smolt production from off-channel projects without significant inside spawning to track brood year escapement trends.

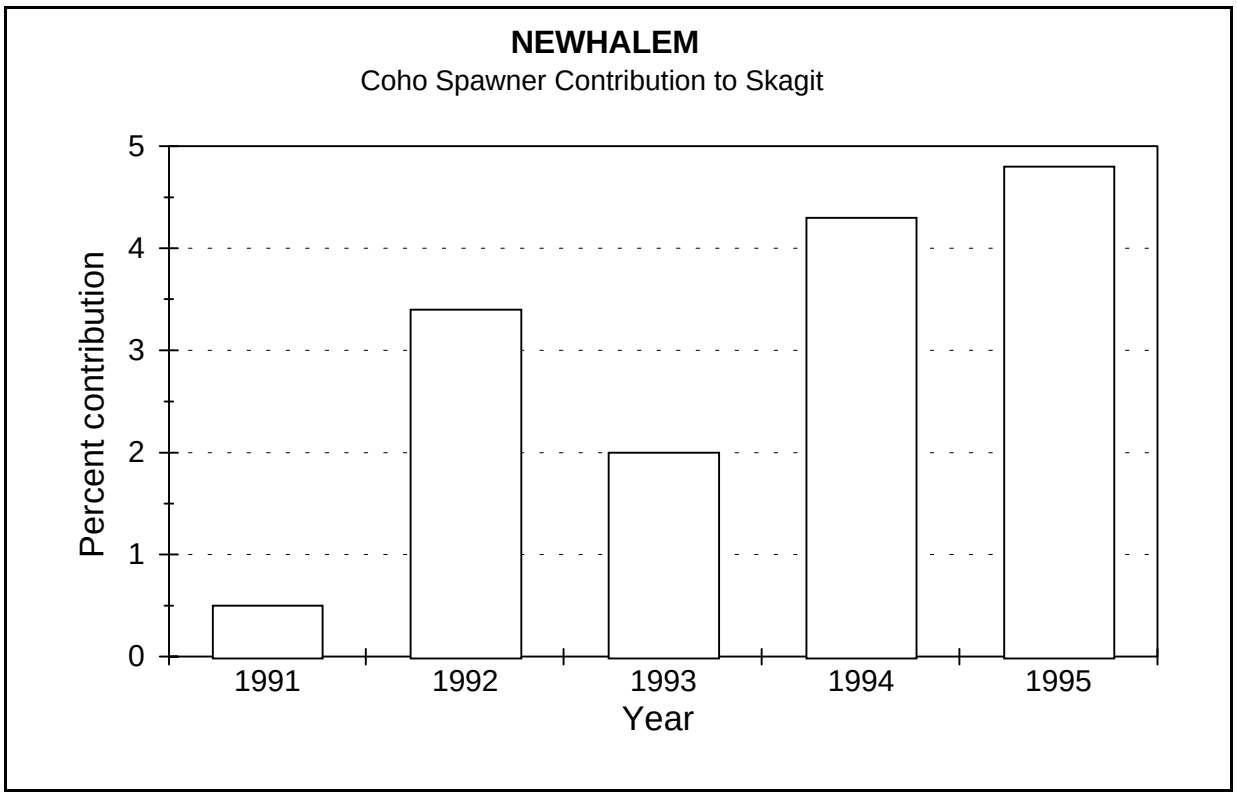

Figure 4. The large Newhalem off-channel project has cycled up to a high level of production in five years and is now responsible for a significant proportion of the total Skagit River escapement.

Insert Attachment 1, page 1 here

Insert Attachment 1, page 2 here

NORTH COAST

ABSTRACT

During 1997, we continued to inventory off-channel spawning and rearing habitat in the Sol Duc river system. The inventory is about 80% complete for the Queets/Clearwater, Hoh, Bogachiel, Calawah, Sol Duc, and Dickey main stems and 20% for the major tributaries of the main stems. A cooperative culvert removal/replacement project with the Rayonier timber company and the Quileute Indian tribe was completed on a tributary of the Sol Duc river. A fish rearing habitat enhancement project was done on a tributary of the Calawah river. Maintenance and repair work was completed on several existing projects using contract labor from the Clearwater Corrections Center. Habitat enhancement work was identified in the Sol Duc and Bogachiel river systems and is scheduled to be completed during the summer of 1998. We evaluated existing and potential habitat enhancement projects by monitoring fish use and overall function. In 1996, adult coho salmon escapement to the Hoh river system was nearly 5000 fish which is the best it has been since 1984 and the second best in the last 24 years. Within the Hoh river system we have 13 projects which are capable of producing about 15 percent of the estimated total coho smolt production from the entire watershed. The Quillayute system has 17 projects that are estimated to be capable of producing about 13 percent of the total smolt output. In the Bogachiel alone, six of our projects have the capability of producing about 23 percent of the total smolt output from the Bogachiel river. Spawning activity also is monitored on our project sites each year.

METHODOLOGY

Site Inventory

Aerial photos and U.S.G.S. maps are used to identify potential off-channel spawning and rearing habitat. Field surveys are then conducted on foot to locate and confirm the existence of specific habitat. The land adjacent to each bank of the river is divided into a series of manageable areas. Each area is separated from the next by a distinct geographic landmark (e.g., high cut bank, tributary, bend in the river, bridge, etc.). Within each area are a number of specific habitat sites (channels, ponds, etc.). The areas within a river system and the sites within each area are identified, using an alphanumeric system, beginning at the mouth of each river. For example, H-L1-1 describes a site along the (H) Hoh River which is on the (L) left bank (facing downstream). The first (1) identifies the first group of habitat sites moving upstream from the mouth and the second (1) identifies the first site within that area. In most cases, local names are also used to help identify the sites.

Each site which has existing and/or potentially usable fish habitat is surveyed, and data on the following characteristics are recorded: flood susceptibility, water source and amount, water

quality, juvenile fish access and current use, channel entrance conditions, machinery accessibility, substrate type, and location within the watershed. The evaluations for potential enhancement projects are based, in part, on this information.
After the onset of autumn rains, follow-up surveys of inventoried sites are conducted to provide additional information on overwinter water volumes since many sites are dewatered, or nearly so, during the summer.

Project Evaluation

Upstream / downstream migrant trapping is the primary means we use to evaluate production from our projects. The traps, made of ½-inch plywood, are 4 feet long by 3 feet wide by 4 feet high with 4-inch diameter circular openings on the upstream and downstream ends. A removable 1/4-inch mesh screen separates the interior in half. One half is open to upstream migrating fish and the other half to downstream migrating fish. Each half is lined with a nylon 1/8-inch mesh net to facilitate fish removal and lessen the chance of handling injury. Cones are formed from 1/4-inch mesh plastic screening and placed over the entrances to both halves to keep fish from finding their way back out of the trap. These cones taper from 4 inches to 1.5 inches. The fish are funneled into the trap openings by placing wing panels in a "V" formation both upstream and downstream from the trap. These panels vary in size, but have a standard 1/4-inch mesh screening that is made from galvanized, stainless steel, or plastic coated hardware cloth. We found that the galvanized wire tends to corrode in one or two years in the spring water of these channels and, as a result, we are using the more expensive coated and stainless wire which is showing no signs of deterioration after five years of use.

A sample of fish is randomly selected at each trap and anesthetized with tricaine methane sulfonate (MS-222). The fork length of each fish in the sample is then recorded. All fish found in each trap are checked visually for freeze brands or paint marks since some of the coho may be holdovers from the previous year.

At selected trapping sites, a sample of the upstream migrants is marked with a freeze brand or a fluorescent dye to help determine overwinter survival. The freeze branding tool, made of brass and silver, is inserted into a mixture of dry ice and acetone and then placed on the left side of the fish below the dorsal fin for two to four seconds. This leaves an identifiable mark that can be visually detected in the spring, yet disappears soon after the smolts begin to grow in the ocean environment. The dye mark is injected into the base of the anal fin using a “Syrijet” brand pneumatic medication inoculator which forces the dye into the tissue without breaking the surface of the tissue.

At other inventoried sites, fish use information is collected by using an electroshocker and/or by setting wire mesh minnow traps baited with salmon roe.

Project Design

Each proposed project is subjected to a rigorous review by the project review team which consists of the lead Environmental Engineering Services (EES) engineer, the SSHEAR construction superintendent, and the lead SSHEAR Division biologist. Once the projects are approved for further development, an engineering survey of each project site is conducted and a preliminary design is produced for review by the project development team. Review and approval by the project review team are then completed, permits are applied for, and materials and equipment are identified prior to final construction scheduling.

Construction

The SSHEAR Construction Unit prepares for the construction of each project by ordering necessary materials and renting the appropriate equipment. The primary pieces of equipment used to complete construction work on the projects include hydraulic excavators, front-end loaders, dozers, and dump trucks.

RESULTS

Habitat Inventory

During 1997, off-channel rearing habitat inventory work was done on the Sol Duc river. In addition to providing information for identifying potential enhancement projects, inventory data are being loaded into a database so that it will be available to various resource managers, including our Habitat Managers to help them when reviewing environmental permit applications. Our inventory information has improved our ability to protect key coho producing habitat. We have completed about 85% of the inventory on the North Coast river systems which includes main stems and tributaries.

In addition, our habitat inventory has become a key component of the Watershed Analysis process being conducted on these river systems. All new habitat sites are being identified and cataloged with the WDFW water resource inventory area (WRIA) numbering system which is the standard identifier for all waters of the State.

The North Coast Project study area is shown on the map in figure 5.

Project Evaluations

The goal of our evaluation efforts is to gain knowledge that will help us determine the most effective enhancement techniques. So far our results indicate a survival advantage at projects with large amounts of complex submerged woody debris and certain species of submergent and emergent aquatic vegetation. In recent studies in Oregon (Rodgers et al., 1993), the addition of woody debris to constructed overwintering habitat greatly improved the overwinter survival and

size of fish. Coho parr use the wood and vegetation as cover to avoid avian and mammalian predation. This complex cover also encourages aquatic insect production which supplies necessary forage for the juvenile fish. We have found that fast-growing shrubs and trees planted along the pond perimeters soon after construction quickly supply shade, soil stability, and an insect food source.

We plan to continue evaluation work at the current level to add to what we have already learned and to increase the effectiveness of our enhancement techniques.

Hoh River Overview

The adult coho return to the Hoh river in the Fall of 1996 was nearly 5,000 fish which is the best since 1984 and second best in the past 24 years (Figure 6) September of 1997 was an unusually wet month and undoubtedly many fish migrated into the project sites prior to trap installation. We operated traps at five different project sites on the Hoh during the winter of 1996/97. Using a measured mean production of 0.23 smolts per square meter, the 13 projects on the Hoh are producing about 15 percent of the total smolt output of the entire watershed.

Dismal Pond (Hoh River)

In the summer of 1989, we deepened and expanded an existing gravel removal site to create one acre of shallow pond habitat. The pond was then connected to a nearby wall-base channel which flows into the Hoh River. Water flow was supplemented by diverting nearby spring flow into the pond. Rayonier Timberlands (RTOC) granted land use rights to WDF, at no cost, for construction and maintenance of this site.

At Dismal Pond this autumn, the average fork lengths of the juvenile immigrant coho are following the trend from the past eight years and we are seeing a close inverse relationship (r^2 = 0.93) between Hoh river coho escapement brood year size and mean fork length of their progeny measured in the autumn when they are migrating into overwinter rearing habitat (Figure 8). This information tends to point more towards a density dependent factor on summer growth than variation in summer rearing conditions from year to year.

In the spring of 1997, based on our mark-recapture work, we captured only 7% of the marked coho in our out-migrant trap (Table 6). Due to flooding conditions in the spring we feel that a portion of the juvenile emigrants left the site during the time that the trap was inoperable. The previous five years of evaluation have shown an average of 45% overwinter survival. This compares favorably with a study done at Paradise Pond on the Clearwater River on the Olympic Peninsula of Washington (Cederholm, et al., 1988), where backwatering of a wall-base channel improved the overwinter survival rate from a mean of 11% for two years pre-project to a mean of 56% for two years post-project. During the evaluation period at Dismal Pond, we have found a close relationship between the number of coho spawners in the Hoh River and the number of

juvenile recruits the following fall (figure 7). This is similar to what Jeff Cederholm found on the Clearwater River, (Cederholm, personal communication).

This autumn we have enumerated over 1,400 juvenile coho moving into the pond (Table 7). Evaluation of the past eight years shows an average of 1,975 fall immigrants at this site.

Hoh Springs (Hoh River)

This is a springwater-fed tributary of Dismal Creek and was identified as a site with excellent potential for habitat enhancement. A pre-project evaluation was set up in the fall of 1992 and consisted of trapping and enumerating all upstream and downstream migrating fish. From our mark-recapture work, we estimated the pre-project overwinter survival at 15%. In the summer of 1993, we constructed a habitat enhancement project that included the creation of close to ten times the amount of pre-project rearing and spawning habitat. From our mark-recapture information during the winter of 1993/94 we estimated 30% overwinter survival which doubled the pre-project survival. Since the project was built, the average overwinter survival has been 35%. This autumn, we have enumerated only about 700 juvenile coho moving upstream into this project (Table 7). Once again, the early rains would have drawn fish in prior to trap installation. This site has averaged over 2,000 juvenile coho immigrants over the past four years.

Young Slough (Hoh River)

This 2,500' long ground water-fed spawning and rearing channel was constructed in 1994 by excavating below the ground water table in a relic side channel of the Hoh River. During the winter of 1995, heavy river flows at the upper end of the project caused a breach in the dike and washed sand and silt into the upper project. In the summer of 1996, the upper 200 feet of channel was covered and the dike moved downstream to prevent future problems with erosion. During the fall of 1996, DNR monitored the overwinter survival of juvenile fish in the channel. High water problems over the winter caused the trap to be backwatered several times by the Hoh river and only 11% of the marked group was recovered in the spring out-migration. As a result of the continual back watering problems, this site will no longer be evaluated with an in-stream trap. The repair work to the upper end of the project held up well and we don't foresee any more problems.

Lewis Channel (Hoh River)

This 1,650' long ground water-fed spawning and rearing channel was constructed in 1994 in a similar manner to Young Slough. During the first two years of trapping, we observed low numbers of marked fish leaving the channel each spring. The trap was opened periodically during the autumn upstream migration to allow adults to pass. With this unusually low showing of the marked fish, we theorized that a considerable number of fish left the channel in response to the large number (60+) of adult spawners that came into the channel. We have seen this phenomenon occur at other channels of this type (C. Detrick and D. King, Washington

Department of Fish and Wildlife, Lands and Restoration Services Program, personal communication). The other possibilities were heavy predation by birds and/or cutthroat or unusually high natural mortality. Very few birds were observed feeding in the channel and no significant numbers of cutthroat were captured or observed. Also, no sick or dying fish were observed.

During the autumn of 1996, we tried to determine if the juvenile coho were exhibiting a mid-winter downstream migration during the adult spawning run. Our plan included keeping a two-way trap in place from September to the end of June to monitor all upstream and downstream movement by juvenile fish. This trap setup also has an adult spawner trap attached to allow us to count and assess the condition of the spawners moving into the channel. Over 90 spawners moved into the channel, however most of the females had already spawned before entering the trap. As a result, only 8 redds were visible in the
channel above the trap. There was a juvenile coho immigration into the channel of over 2,200 fish (Table 7). Approximately 86% of the fish were marked. About 300 juvenile coho moved back out of the channel prior to the arrival of spawners. Some of them were summer resident fish based on their larger average size compared to the smaller autumn immigrants.

Additionally, we collected a small number of dead or dying juvenile coho with circular lesions on their sides where the freeze brand had been applied. A sample was preserved for analysis by a pathologist and it was determined that they had low temperature disease (B. Rogers, Washington Department of Fish and Wildlife, Lands and Restoration Services Program, personal communication). This led us to believe that other infected fish died before floating into the trap area and were eaten by birds or other predators. The fact that the only infected fish were the marked fish indicates that unmarked fish were not affected.

We did not observe a downstream movement in response to the spawners as suspected. Observation of the marked group showed a recovery of 20 percent, which would be a minimal number due to the mortality from the low temperature disease.

This autumn, we are repeating our evaluation plan from last year. So far we have trapped close to 600 juvenile immigrants and at the same time over 700 juvenile coho have moved downstream. The majority (99%) of these downstream fish are from the summer holdovers which was determined by the lack of marked fish in the group. No spawners have appeared at the trap at this time.

Mosley Springs (South Fork Hoh River)

This spring-fed pond and channel enhancement project was evaluated for out-migrant fish only since there had been a large number of spawners in 1995. We wanted to find out how many smolts could be produced from a project that had been seeded to capacity with spawners. We captured over 1,600 coho and 126 trout leaving the project. The 0.71 coho per square meter is similar to what Peterson found at Coppermine Bottom pond after seeding it to estimated capacity

with hatchery fish (Peterson and Reid, 1984). The average size of the coho was relatively small (83 mm) and very few were showing signs of smoltification. However, the majority of the fish left the site earlier in the spring than normal and would explain part of the reason for the smaller size. Typically, early out migration and smaller size are functions of exceeding carrying capacity. Nonetheless, this is one of the few projects that has functioned at full seeding.

Quillayute System Overview

The Quillayute watershed consists of the Quillayute mainstem, Dickey, Sol Duc, Calawah, and Bogachiel rivers. Coho escapement estimates for 1996 were good and should result in good recruitment of juveniles to off-channel habitat this autumn. Spawner returns are predicted to be low coming off a poor brood year in 1994. The mean smolts per square meter measured at selected project sites is about 0.35. Using the 17 project sites within the entire watershed we calculate that they are producing about 13 percent of the total Quillayute smolt output. The six projects on the Bogachiel are producing close to 23 percent of its entire smolt yield.

Laforrest Pond (Bogachiel River)

This project was completed in 1996 and consists of a ground water-fed pond and outlet channel. Due to frequent back watering from nearby Bear creek we feel that many fish migrated both up and downstream undetected. Almost 400 coho smolts were trapped during the Spring emigration in 1997. We are no longer trapping this site due to the backwater problem.

Calawah Springs (Calawah River)

In the summer of 1992, WDF constructed a fish habitat enhancement project which included spawning and rearing habitat improvements. We added a number of woody debris bundles during the summer in an attempt to lessen the suspected heavy trout predation. Our mark-recapture work in the winter of 1996/97 indicated about 32 percent of the juvenile coho survived to the smolt stage (Table 6). This is the second year in a row that we have seen over 30 percent mark recoveries. In the fall of 1997, we have counted over 1,100 juvenile coho immigrants (Table 7). With the early rains, prior to trap installation, there was undoubtedly an early immigration into this project.

1997 CONSTRUCTION PROJECTS

Project costs and habitat benefitted for 1997 projects is summarized in table 8. An entire list of projects that have been constructed since 1988 are shown in Figure 5 with details on each project shown in Table 9.

Powell Springs (Sol Duc River)

This was a cooperative project with the Rayonier timber company and the Quileute tribe. It consisted of removing two undersized culverts and replacing them with appropriately sized culverts. In addition, a culvert under an old abandoned grade was removed and the resulting opening was sloped back and re-vegetated to allow the stream to flow freely. Wooden plank controls were installed in the stream bed to adjust the gradient drop left by the removal of this culvert.

Rootstock Springs (Calawah River)

We created pool habitat in this spring-fed tributary using heavy equipment to excavate holes in the substrate. Additional work in 1998 will consist of the installation of wooden stream bed controls to backwater the holes.

Other maintenance and repair work was done during the summer at various existing project sites using a contract labor crew from the Clearwater Corrections Center.

SCHEDULED PROJECTS FOR 1998

Rayonier Channel - (Bogachiel River)

This project will consist of the excavation of a ground water-fed spawning and rearing channel parallel to the Bogachiel river. The project is located on Rayonier timber company property.

Tyee Channel - (Sol Duc River)

This project includes the extension an existing spring-fed pond into a clear-cut and the placement of spawning gravel at the outlet. It is also located on Rayonier timber company property.

Rootstock Springs Phase II - (Calawah River)

Wooden plank stream bed controls will be installed to complete the work started in 1997. In addition, minor maintenance and repair of existing projects will be done.

SUMMARY

During 1997, the North Coast area experienced well above normal precipitation and probably resulted in very little stranding of coho smolts in off-channel habitat which would allow a good smolt recruitment to the ocean. Contrary to previous years, the major juvenile salmonid upstream migration occurred during September and October rather than November and December due to the heavy precipitation in September.
The high-quality rearing and spawning areas which were either created or enhanced should provide excellent overwintering habitat for wild juvenile coho and other salmonids. Evaluation results of our existing projects are providing us with more effective enhancement techniques which are helping to improve the overall quantity and quality of coho production. Waterfowl, otters, and trout appear to be the major predators of juvenile coho in our enhancement projects. As a result, we incorporate the addition of heavy amounts of complex woody debris to all projects. Our intent is not to exclude predation, but to lessen it.

With the increased number of coho spawners on the Hoh river in 1996 we expected to see a corresponding increase in juvenile immigrants into the project areas during the autumn of 1997. Thus far, the number trapped is falling below the expected level although we feel that with the early heavy rains prior to trap installation, there was early fish movement. At Dismal Pond over the past nine years we have seen a close inverse relationship ($r^2 = 0.93$) between the Hoh river coho brood year escapement size and the brood year's progeny mean fork length measured the next Fall (Figure 8). The average size of this year's juvenile coho immigrants into Dismal Pond is about 78 mm, which would fit with the larger escapement of brood year 1996.

Preliminary estimates show the 1997 coho run to the Hoh river to be extremely poor. With the number of spawners being closely related to the number of following year fall juvenile coho recruits to the Dismal Pond site, it indicates that a higher spawner escapement is needed to fully seed project areas. Until this happens, the sites may never cycle up to production capacity.

Off-channel rearing habitat inventory work was conducted on the Sol Duc river in 1997. Habitat enhancement project work, consisting of new construction and maintenance, was completed in the summer on the Hoh, Bogachiel, Dickey, Clearwater and Sol Duc rivers.

The Clearwater Corrections Center labor crews, which are supervised by the DNR, were contracted by WDFW this year for various parts of the hand labor construction work including much of the re-vegetation. The Rayonier Timber Company, DNR, and the Campbell Group Timber Company have been very willing to help cost share fish enhancement projects on their properties. We will continue to develop cooperative projects with timber companies and any other landowners so that our costs can be held down.

Project evaluation work continues at selected sites and is providing us with valuable information on fish numbers, fish quality, overwinter survival, and overall project function. The information we are gathering is indicating a need for more complex submerged woody debris and specific

types of aquatic vegetation to provide better protection from predatory birds and mammals. This type of improvement is being incorporated into existing and future projects.

FUTURE WORK NEEDS

The habitat inventory work is back into full swing. Additional survey work must be continued throughout the year to monitor all potential project sites. Evaluation work has also required more time than anticipated. We estimate that 85 percent of the inventory work is complete.

The Queets River, which lies primarily within the Olympic National Park (ONP), has not been surveyed but is scheduled to be done now that ONP and the Quinalt Tribe have agreed to allow us to survey. This will include most of the Queets system as well as those portions of the Hoh and Bogachiel rivers contained within the ONP boundary. In addition, the major tributaries of these rivers will have the same type of habitat inventory completed to provide information valuable to ecosystem management efforts.

We continue to identify potential habitat enhancement projects and complete several each year. Construction work is limited by the time frame we have to work within the streams' ordinary high water mark and the increasing lead time required for environmental permits, pre-project evaluation, planning and engineering.

Table 6. North Coast upstream/downstream migrant trapping summary for Fall 1996 and Spring 1997.

Site	River Basin	Coho In	Coho Out	Marked Group Recovery	Trout In	Trout Out
Dismal Pond	Hoh	2,315	279	6.9%	86	19
Hoh Springs	Hoh	4,203	1,642	32.7%	258	132
Lewis Channel	Hoh	2,328	1,392	20.2%	316	214
Young Slough**	Hoh	1,709	1,195	11.3%	237	176
Mosely Springs**	S.Fk.Hoh	N.A.	1,611	N.A.	N.A.	126
Calawah Springs	Calawah	3,615	2,948	31.8%	263	142

Note: All sites have 0+ coho fry moving into them over the summer when the traps aren't operating and, as a result, the number out does not reflect the Fall immigrant population marking study done at each trap.
** Site trapped by DNR.

Table 7. North Coast upstream migrant trapping summary for Fall 1997.

Site	River Basin	Location (RM)	Coho In	Trout In
Dismal Pond	Hoh	26.0	1,449	15
Hoh Springs	Hoh	25.8	679	43
Lewis Channel	Hoh	28.3	596	21
Calawah Springs	Calawah	3.0	1,129	223

Table 8. North Coast habitat enhancement projects completed in 1997.

Project	River Basin	Project Type	Habitat Benefitted	Project Cost	Landowner
Powell Springs	Sol Duc	Fish Passage Improvement	2,000 m^2	$37,000 Quileutes $33,000 WDFW $6,000 Rayonier	Rayonier Timber
Rootstock Springs	Calawah	Rearing Habitat Enhancement	200 m^2	$12,000 WDFW	Rayonier Timber
		TOTALS	2,200 m^2	$45,000 WDFW $37,000 Quileutes $6,000 Rayonier	

Table 9. Project sites listed on study area map.

PROJECT SITE	RIVER BASIN	YEAR COMPLETED	HABITAT BENEFITTED	COST	PROPERTY OWNER
Airport Pond	Clearwater	1988/89	30,000 m²	$16,900	Rayonier
Rayonier Pond	Hoh	1988	4,048 m²	$19,000	Rayonier
Barlow Pond	Hoh	1988/89	8,100 m²	$26,600	Private
Anderson Ponds	Hoh	1988/89	10,150 m²	$45,900	Private
Pole Creek	Hoh	1988/90	6,100 m²	$45,300	Forest Service
Peterson Pond	Hoh	1989	2,000 m²	$22,500	Private
Dismal Pond	Hoh	1989	4,048 m²	$25,700	Rayonier
Anderson Cr. Channel	Hoh	1990	3,000 m²	$16,500	Rayonier
Nolan Pond	Hoh	1990	8,000 m²	$ 3,200	State
Wilson Springs	Bogachiel	1990	3,200 m²	$41,600	Private
Tall Timber	Bogachiel	1990	800 m²	$10,000	Rayonier
Smith Road Pond	Bogachiel	1990	2,000 m²	$15,600	Rayonier
Dahlgren Springs	Bogachiel	1990	600 m²	$ 7,300	Private
* Morganroth Springs	Bogachiel	1991	14,100 m²	$13,400	Forest Service
* W.F. Dickey	Dickey	1991	23,000 m²	$28,000	Rayonier
* Mosely Springs	S.F.Hoh	1991	4,048 m²	$21,000	State
* Lear Springs	S.F.Hoh	1991	800 m²	$18,100	State
* Upper Mosely	S.F.Hoh	1992	690 m²	$23,000	State
Bogey Pond	Bogachiel	1992	13,640 m²	$24,700	Rayonier
Falcon Walrus	Bogachiel	1992,1995	740 m²	$20,600	Rayonier
Calawah Springs	Calawah	1992	900 m²	$50,300	John Hancock Ins.
Colby Springs	Dickey	1992	9,200 m²	$13,500	Rayonier
Elkhorn Pond	Dickey	1992	5,400 m²	$ 9,100	State
W.F.Marsh Ck.	Dickey	1992	3,000 m²	$ 6,200	Rayonier
* Hoh Springs	Hoh	1993,1995	3,450 m²	$86,000	Rayonier
Soot Cr. Springs	E.Fk.Dickey	1993	2,100 m²	$64,000	Rayonier
T-Bone Springs	Dickey	1993	745 m²	$33,000	Rayonier
* Young Slough	Hoh	1994	3,000 m²	$158,000	John Hancock Ins.
* Lewis Channel	Hoh	1994	2,000 m²	$135,000	State
Tassel Springs	Soleduck	1994	600 m²	$16,000	Private
Laforrest Pond	Bogachiel	1995/96	2,520 m²	$133,000	Private
*Nolan Channel	Hoh	1996	1,800 m²	$151,000	Rayonier
*Huelsdonk Creek	Hoh	1996	12,000 m²	$18,000	DOT
Manor Springs	Clearwater	1996	960 m²	$21,550	DNR
*Cascade Springs	W.Fk.Dickey	1996	3,000 m²	$42,000	Rayonier
*Powell Springs	Sol Duc	1997	2,000 m²	$76,000	Rayonier
Rootstock Springs (I)	Calawah	1997	200 m²	$12,000	Rayonier
* Cost share projects with timber companies, DNR, DOT, and/or Tribes.					

INSERT NORTH COAST Map FIGURE 5. HERE.

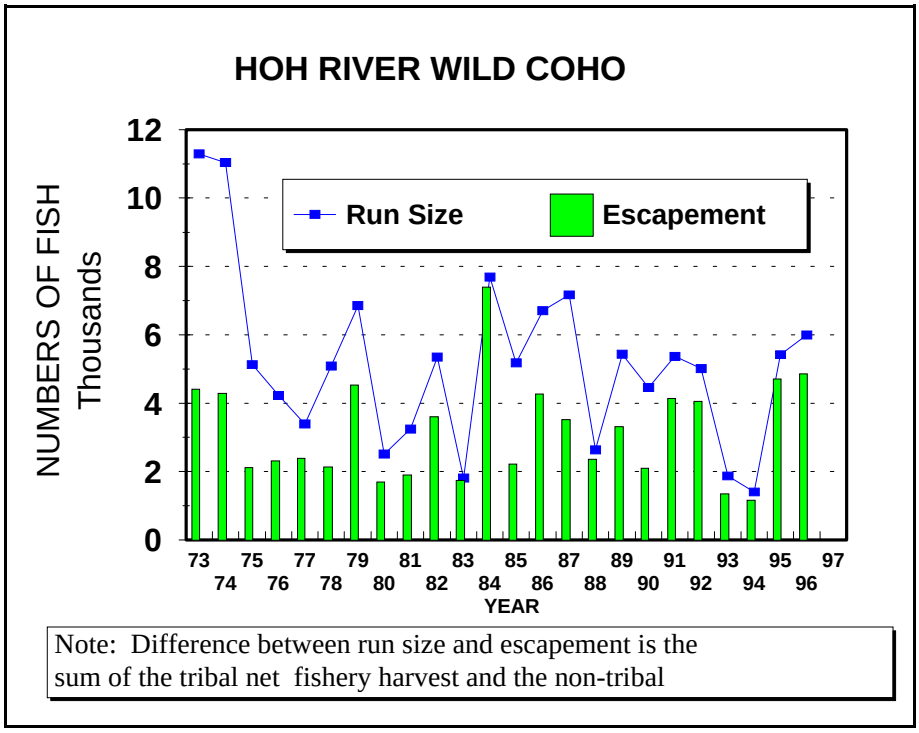

Figure 6. Hoh River wild coho run size and escapement for the years 1973 through 1996.

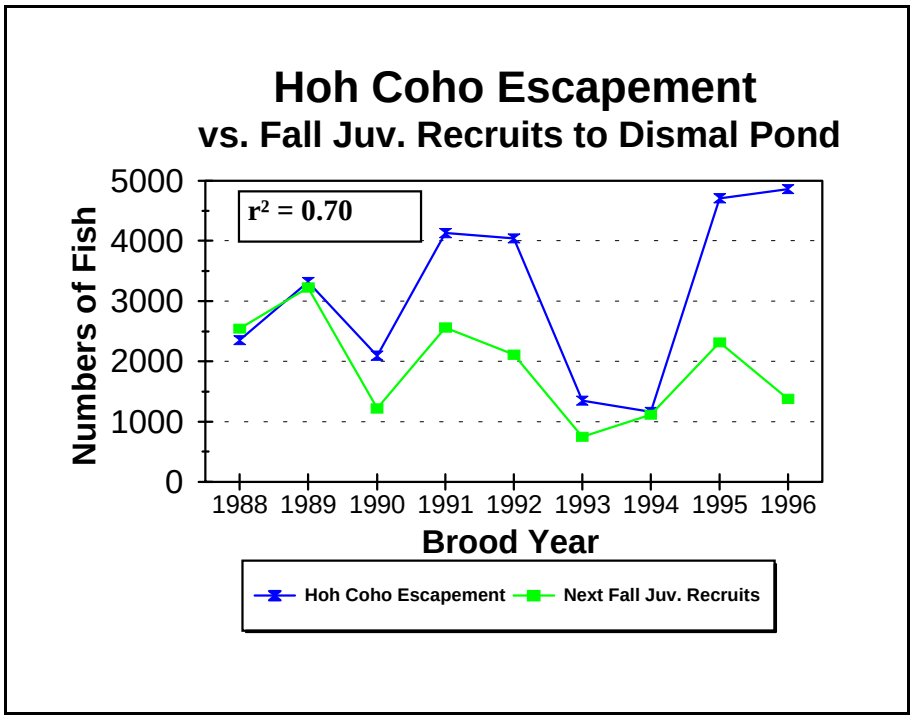

Figure 7. Correlation between Hoh River wild coho escapement and juvenile coho recruitment to Dismal Pond.

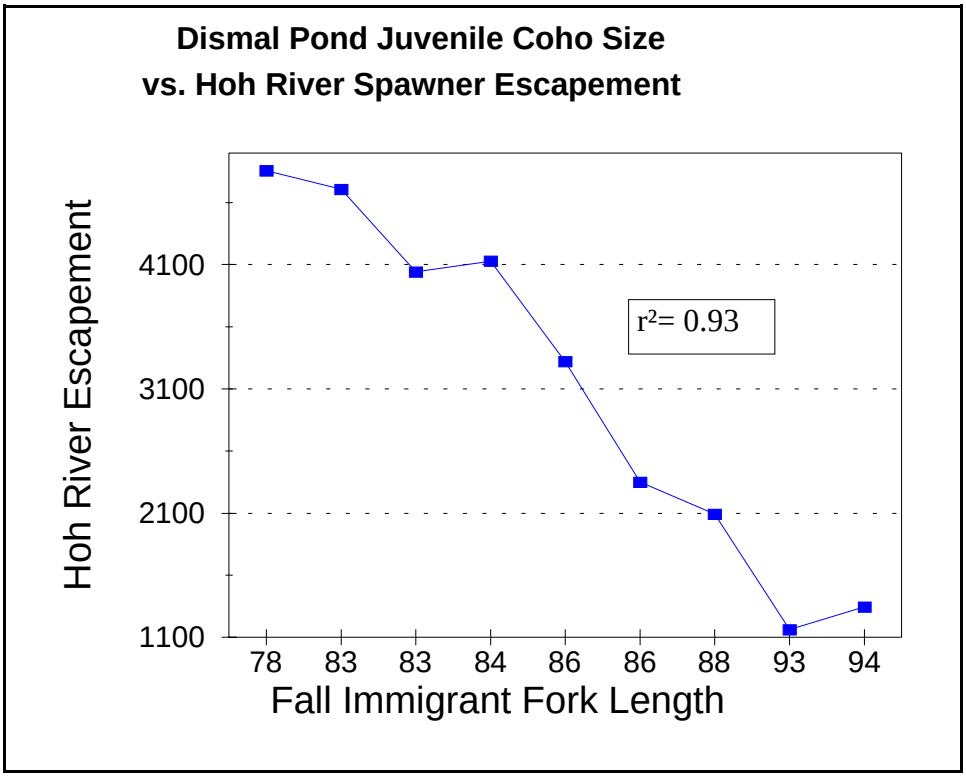

Figure 8. Correlation between Dismal Pond juvenile coho size and Hoh river escapement 1989 to 1997.

COLUMBIA RIVER

Gorley Springs Spawning Channel Rehabilitation

The Gorley Springs spawning channel extension, a branch of the Gorley Springs chum salmon spawning area was built in the autumn of 1995 in an area more protected from flooding than the existing channel. However, heavy rains occurred during construction. This made work on the channel difficult and caused an excessive amount of fine material to be deposited in the channel spawning substrate. To remedy this problem the WDFW custom built gravel cleaning machine (gravel gurdy) was brought on line to remove fines from the channel. However, mechanical failure forced termination of the use of gravel gurdy. As an alternative, the entire channel was re-excavated and washed round rock was placed to act as a high quality spawning habitat. The newly placed spawning gravel was also bermed along the banks of the channel extension to act as impoundment for further siltation due to ground water saturation of the channel banks. In addition, six log structures were placed along the banks of the new channel to serve as holding and hiding areas for adult salmon. The new channel percolates substantial amounts of ground water flow. During autumn (1997) the new spawning channel was well used by chum salmon. The work was cooperatively funded by WDFW, FEMA, and Willamette Industries Inc.

FISH SCREENING

INTRODUCTION

The Yakima Screen Shop (YSS) is the eastern Washington component of SSHEAR in WDFW's Lands and Restoration Services Program. The YSS is organized into three functional work units: 1) Screen Fabrication; 2) Fish Screen/Fishway Inspection, Operation and Maintenance (O&M); and, 3) Fish Facility Capital Construction. Program management is provided by a Fish and Wildlife Biologist 4 with local responsibility for all YSS functions, a Construction and Maintenance Superintendent 1 (CMS 1), and support staff (a Supply Control Technician and a part-time Senior Office Assistant). Funding for YSS Screening Program administration totals about $160,000 annually split between state O&M and state capital budgets. The CMS1 supervises the Inspection and O&M unit. Two Plant Mechanic Supervisors (PMS) provide day-to-day supervision of the Fabrication and Capital Construction crews. This report summarizes calendar year 1997 program accomplishments in each of the three work units.

SCREEN FABRICATION

The Yakima Screen Shop is a fully-equipped, metal fabrication shop with the capability to build nearly anything out of mild steel, stainless steel or aluminum. Prior to 1985, a small crew performed operation and maintenance on existing fish screens, but new construction was very limited. The acquisition of high production fabrication equipment and the recruitment of highly skilled metal fabricators has allowed the YSS mission to expand. Formation of the Screen Fabrication unit provided capability for "production-level" fabrication of new rotating drum, traveling belt, vertical flat plate fish screens and miscellaneous metalwork (lifting gantries, walkways, handrails, fish bypass control gates, etc.).

The expanded mission and the accompanying shop enhancement has been driven by the Northwest Power Planning Council's (NWPPC) Fish and Wildlife Program. Since 1985, the YSS has been the Bonneville Power Administration's (BPA) primary supplier of fish screens and miscellaneous metalwork for Yakima Basin and Umatilla Basin fish screen projects. YSS also builds fish screens, as the need arises, for other government entities such as the Idaho Fish and Game Department, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, City of Kent and Okanogan Irrigation District. In addition, YSS provides fabrication services for other WDFW programs. YSS fabricates or rebuilds hatchery intake and rearing pond outlet fish screens for the Hatchery Program on a regular basis. Recently, the YSS has worked with the Enforcement Program to design and fabricate cougar and black bear live traps used by WDFW wildlife control agents to capture and relocate dangerous wildlife in urban areas.

Core (permanent, full-time) staff consists of a PMS, two Welder-Fabricators and a General Repairer. As annual workload expands or contracts, temporary welder-fabricators and/or laborers are hired or laid-off. Roughly 90% of the workload is shop fabrication with field delivery and installation of screens and gantries accounting for the rest. BPA funding for screen fabrication in FFY97 was $214,000.

BPA Phase 2 fish screen fabrication projects completed in 1997 are summarized in Table 10. Miscellaneous fabrication projects are presented in Table 11.

FISH SCREEN / FISHWAY INSPECTION, O&M

The fish screen/fishway inspection and O&M section is primarily a field-oriented work unit responsible for monitoring the operation of 113 active gravity diversion fish screen facilities and eight small fishways. These facilities are located at irrigation diversions in central and southeast Washington on tributaries to the Columbia and Snake Rivers. Permanent staff consists of two PMs stationed at the YSS who divide the upper Columbia Basin into "north" and "south" areas of responsibility. The "north" area includes the upper Yakima Basin (upstream of Roza Dam), Wenatchee, Entiat, Methow and Okanogan Basins with a total of 58 active gravity diversion screens and 4 fishways. The "south" area includes the lower Yakima Basin including the Naches R., Touchet River, Tucannon River, Asotin Creek and Grande Ronde River with 49 active gravity screens and three fishways. Six screens and one fishway located in the Dungeness River basin (Olympic Peninsula) are the responsibility of a half-time General Repairer stationed in Sequim. Nearly all of these facilities were constructed to protect anadromous salmonids, although resident fish also are afforded protection. Very few fish screens are located in "resident fish only" areas of the state. Three “resident fish only” screens located in the Methow (2) and Okanogan (1) basins are inspected and/ or maintained by YSS.

Monitoring facility performance and maintaining a good working relationship with the water users is the state's obligation and is funded through the O&M budget ($140,000 in 1997). Water users may contract with the YSS to perform all or portion of their statutory O&M obligation utilizing a standardized YSS fish screen service contract. In CY97, 38 diversion owners signed contracts generating $8,500 of revenue.

In 1993, the O&M work unit began performing O&M on BPA-funded Yakima Basin Phase 2 fish screen facilities. In 1997, YSS provided preventive maintenance services on 18 Phase 2 sites (Table 12) with $85,000 in BPA funding. These facilities range in size from a 2' diameter by 4' long paddlewheel-driven, modular screen (2.2 cfs) up to a 150 cfs canal with 8 - 6.5' diameter by 10' electric-drive drum screens.

The O&M work unit also maintained 13 screens and 5 fishways in the upper Columbia Basin for the National Marine Fisheries Service (NMFS) with $41,486 of Mitchell Act funding (Table 12). In addition, NMFS provided $67,000 in 1997 for pump screen compliance surveys conducted by

our diving subcontractor (mainstem Columbia R.) and YSS O&M staff (tributaries). During the summer and autumn, O&M staff completed pump screen inspections in the Grande Ronde, Asotin and Entiat basins and partial surveys in the Tucannon (90% complete) and Wenatchee (10% complete) basins. CRIS, Inc., the diving subcontractor, completed dive inspections on 21 large pump stations in the lower Columbia R. downstream of Bonneville Dam. Results of the compliance inspections for completed basins are reflected in the fish screening program overview (Table 13). In 1998, the partially completed surveys will be finished and O&M section staff will inspect pump screens in the Walla Walla, Yakima and Klickitat basins.

FISH FACILITY CAPITAL CONSTRUCTION

The Capital Construction work unit is responsible for constructing new fish screens on unscreened or inadequately screened water diversions identified by program management. This work unit has existed since the 1987-89 biennium and initially conducted an inventory of pump diversions in Columbia River tributary subbasins. Staff then developed low cost pump intake screen designs for small irrigation intakes. During the winter, the crew normally fabricates pump intake screens and components for field installation the following year. During the field season, a two-man crew installs the screens on pump intakes. However, in 1997 very little pump screen fabrication and installation was performed because of the emphasis placed by YSS management on funding high priority gravity screen and fishway construction.

This work unit constructs rotating drum, traveling belt or fixed plate screens, including the concrete structure, for gravity diversions. This crew has also constructed two formed concrete fishways. In 1991, the capital crew developed a portable, modular paddlewheel-driven drum screen that is completely fabricated in the shop using steel, thereby eliminating concrete forming in the field for diversions less than 4.6 cfs. Field installation takes one or two days. Total costs range from $13,000-17,000. Thirteen modular drum screens have been installed in Washington through 1997. In 1997, two modular flat plate screens with rotary wiper cleaners were fabricated and installed in the Beaver Creek drainage (Methow Basin) on agency-owned, “resident fish only” irrigation diversions (Methow Wildlife Area). The modular flat plate screen is a low cost ($3,000-5,000), all metal structure developed by YSS in 1994 for gravity diversions less than 1.5 cfs.

The Capital Crew is allotted 3 FTE's with permanent staff consisting of a PMS and two PMs. Temporary staff are added during the summer field season to assist in pump screen installations or major gravity screen or fishway construction. Capital budget fish screen construction expenditures in FY97 totaled $335,000. Capital projects completed in 1997 are summarized in Table 14.

Table 10. 1997 BPA Phase 2 Screen Fabrication.

Project Name	Description	Time Period
Union Gap	Structural metalwork, bypass control gate, trash rack, stainless profile bar passive screen panels, and wiper screen cleaning system for the 76 cfs Union Gap I.D. Canal (Yakima R.)	8/96 - 4/97
Ellensburg Mill	Structural metalwork, bypass control gate, trash rack, perforated plate passive screen panels, and wiper screen cleaning system for the 40 cfs Ellensburg Mill Canal (Yakima R.)	8/96 - 4/97
Bull	Structural metalwork, trash rack, perforated plate passive screen panels, and wiper screen cleaning system for the 30 cfs Bull Ditch (Yakima R.)	8/96 - 4/97
Lindsey	Fabricate and install 1- 3' dia. x 12' long electric drum screen, fish bypass ramp and control gate, ditch headgate and miscellaneous steel for the 10.7 cfs Lindsey Ditch (Naches R.)	8/96 - 4/97
Clark	Fabricate and install 1- 3' dia. x 8' long paddlewheel-hydraulic drive drum screen, fish bypass ramp and control gate, galvanized steel headgate structure and miscellaneous steel for the 6.5 cfs Clark Ditch (Naches R.)	8/96 - 4/97
Upper WIP	Fabricate screen gantry and access platform; install 4 - 4' dia. x 12' long electric drum screens, bypass control gate and ramp, and miscellaneous metalwork fabricated in 1994 for the 55 cfs Upper Wapato Irrigation Project (WIP) Canal (Ahtanum Cr.)	8/96 - 4/97
Old Union	Concrete structure modification; fabrication and installation of trash rack, structural steel, perforated plate passive screens, wiper cleaning system, fish bypass control gate, adult fish passage facility and miscellaneous steelwork for the 18.5 cfs Old Union Canal (Naches R.)	10/97 - 12/97
Naches-Selah	Fabricate and install canal check structure control gates	2/97 - 4/97

Table 11. 1997 YSS Miscellaneous Fabrication.

Project Name	Description	Time Period
Yakima-Tieton	Fabricate two brush cleaners for the BOR Phase 2 screen facility on the 325 cfs YTID Canal (Tieton R.)	5/97
Ells Hatchery	Refurbish fish hatchery rearing pond outlet screen	6/97
Region 3 spray tank	Fabricate herbicide spray tank for R3 Lands Program	6/97
Wells Dam Hatchery	Refurbish four fish hatchery rearing pond outlet screens	7/97 - 8/97
Lyons Ferry Hatchery	Refurbish three fish hatchery rearing pond outlet screens	7/97 - 8/97
Safety Cages	Fabricate and install safety cages for Chiwawa and Pioneer screen paddlewheels (capital budget)	7/97
Safety Signs	Fabricate metal signs ("Hazardous Area, No Trespassing") for Granite Falls fish facility and Elk Cr. facility (7 total)	7/97 and 12/97
Ringold Hatchery	Fabricate 14 flat plate screen panels	9/97
Cougar Traps	Fabricate two new traps; recondition one used trap	9/97 - 10/97
Okanogan I.D.	Refurbish two - 6' dia. x 12' ED drums for O.I.D. on service contract	12/97

Table 12. 1997 YSS Federally-funded Fish Facility O&M.

Project Name	Type	Description	Funding Source
Naches-Cowiche	Screen	2 - 5' dia. x 12' electric drums (ED); 29 cfs	BPA Yakima Phase 2
Gleed	"	4 - 6.5' wide x 10' traveling belt; 56 cfs	"
New Cascade	"	8 - 6.5' dia. x 10' ED; 147 cfs	"
Holmes	"	2' dia. x 4' paddlewheel modular; 2.2 cfs	"
Snipes and Allen	"	2 - 4' dia. x 12' ED; 24 cfs	"
Taylor	"	2 - 2.5' dia. x 8' ED; 11.5cfs	"
Congdon	"	3 - 4' dia. x 12' ED; 68 cfs	"
Kelly-Lowry	"	2 - 4' dia. x 12' ED; 31 cfs	"
Naches-Selah	"	flat plate w/ motorized cleaner; 136 cfs	"
Fruitvale	"	flat plate w/ motorized cleaner; 32 cfs	"
Emerick	"	2' dia. x 4' paddlewheel modular; 2.2 cfs	"
Stevens	"	2' dia. x 4' paddlewheel (PW); 2.35cfs	"
Anderson	"	2.5' dia. x 4' PW modular drum; 2.75 cfs	"
Bull	"	flat plate w/ motorized cleaner; 30 cfs	"
Ellensburg Mill	"	flat plate w/ motorized cleaner; 40 cfs	"
Clark	"	1 - 3' dia. x 8' PW; 6.5 cfs	"
Lindsey	"	1 - 3' dia. x 12' ED; 10.7 cfs	"
Union Gap	"	flat plate w/ motorized cleaner; 76 cfs	"
Rockview (Methow R.)	"	1 - 3' dia. x 8' PW	NMFS Mitchell Act
Libby (Twisp R.)	"	1 - 1.5' dia. x 4' PW	"
Willis (Early Winters Cr.)	"	1 - 2' dia. x 6' PW	"
McDaniels (Rattlesnake Cr.)	"	1 - 3' dia. x 12' PW	"
East End (Touchet R.)	"	1 - 1.5' dia. x 3' PW	"
Hern (Touchet R.)	"	1 - 1.5' dia. x 3' PW	"
West End (Touchet R.)	"	1 - 2' dia. x 4' PW	"
Huntsville Mill (Touchet R.)	"	1 - 5' dia. x 10' PW	"
Starbuck (Tucannon R.)	"	1 - 2.5' dia. x 6' ED modular	"
Joseph Cr.	"	1 - 2' dia. x 6' PW modular	"
Upper Koch (Asotin Cr.)	"	1 - 2.5' dia. x 6' PW modular	"
Upper Charley Cr.	"	1 - 2' dia. x 4' PW modular	"
Lower Charley Cr.	"	1 - 2' dia. x 4' PW modular	"
Starbuck (Tucannon R.)	Fishway	pool and weir	"
Pioneer (Wenatchee R.)	"	Alaska steep-pass	"
Methow-Valley (Methow R.)	"	"	"
Fulton (Chewuch R.)	"	"	"
Chewuch (Chewuch R.)	"	"	"

Table 1 3. WDFW (Yakima Screen Shop) Fish Screening Program Overview.

Subbasin or Area	Diversion Type	Inventory % Complete*	# of Diversions**	Diversions Screened	# Screened to WDFW Criteria***	Replace / Upgrades Needed	YSS O&M (gravity only) funded by:		
							BPA	NMFS (MA)	Owner
Grande Ronde R.	Gravity Pump	100 100	1 1	1 1	1 1	0 0	0	1	0
Asotin Cr.	Gravity Pump	100 100	3 20	3 20	3 19	0 1	0	3	0
Tucannon R.	Gravity Pump	100 100	8 54	8 54	8 54	0 0	0	1	0
Lower Columbia R. and Snake R.	Pump	100	95	95	82	13			
Snake ESA Subtotals	**Gravity Pump**	**100 100**	**12 170**	**12 170**	**12 156**	**0 14**	**0**	**5**	**0**
Klickitat R.	Gravity Pump	100 100	0 37	37	37	0			
Walla Walla R.	Gravity Pump	80* 0	15 ?	11 ?	0 ?	15 ?	0	4	0
Yakima R.	Gravity Pump	100 100	68 152	64 152	46 134	22 18	18	1	12
Wenatchee R.	Gravity Pump	100 100	8 59	8 59	6 59	2 0	0	0	6
Entiat R.	Gravity Pump	100 100	6 45	6 45	3 37	3 8	0	0	2
Methow R.	Gravity Pump	100 100	24 78	23 78	10 78	14 0	0	3	12
Okanogan R.	Gravity Pump	100 100	0 222	222	28	?			
Mid-Columbia R.	Pump	100*	271	265	151	120			
WDFW Resident Fish	Gravity Pump	0 0	? ?	3 ?	3 ?	? ?			
Dungeness R.	Gravity Pump	100 0	6 ?	6 ?	5 ?	1 ?	0	0	6

Table 1 3. (continued) WDFW (Yakima Screen Shop) Fish Screening Program Overview.

Subbasin or Area	Diversion Type	Inventory % Complete*	# of Diversions**	Diversions Screened	# Screened to WDFW Criteria***	Replace / Upgrades Needed	YSS O&M (gravity only) funded by:		
							BPA	NMFS (MA)	Owner
Western Washington	Gravity	0	?	?	?	?			
	Pump	0	?	?	?	?			
	Gravity Totals	=	139	133	85	57	18	13	38
	Pump Totals	=	1034	1028	680	160	NA	NA	NA

* 100% inventory is for ANADROMOUS ZONE ONLY; "resident fish only" area of each subbasin has NOT been inventoried

Walla Walla R. : 15 known gravity diversions, but only 12 (80%) have had screen condition assessed recently

Okanogan R. : 222 pump stations located--175 in river, 47 in Lake Osoyoos (U.S. side); inventory field work complete, data analysis pending to determine # in compliance

Lower Columbia R. and Snake R.: Snake R. inventory complete to WA-OR border; Lower Columbia R. complete from estuary to Snake R.

Mid-Columbia R. : inventory and data analysis complete Snake R. - Chief Joseph Dam

Western Washington : no YSS effort downstream of Klickitat R. on Columbia or in WW with exception of Dungeness Basin

Totals reflect pump screen compliance re-inspections completed on Grande Ronde R./Joseph Cr., Asotin Cr., and Entiat R. in 1997

** Active diversions when last inspected

** Includes screens meeting “recent”, but not necessarily current (1995) WDFW criteria. Considered “in compliance” if approach velocity 0.5 feet/sec or less and mesh opening 1/8 inch or less (constructed after Jan. 1, 1985 -- e.g. Yakima "Phase 1" screens).

This table does not included WDFW fish culture facility intake screens or FERC hydroelectric project screens which are not under state authority.

Table 14. 1997 YSS Capital Construction.

Project Name	Description	Time Period
Peshastin Screen (40 cfs)	Complete fabrication of paddlewheel and hydraulic drive system; modify pre-cast concrete utility vault for use in fish bypass system as adult fishway and water surface control structure; backfill concrete structure; install: screens, pw drive assembly, porosity boards, gantry, security fencing and miscellaneous. metalwork; construct fish bypass channel with fishway/control structure; site grading and clean up.	1/97 - 5/97
Starbuck Electric Screen (4.3 cfs)	Fabricate ditch headgate structure; fabricate and install modular screen structure, fencing, gantry, power supply; reinstall 2.5' dia. x 6' ED drum screen (Tucannon R.)	2/97 - 7/97
Mill Creek Fishway	Adult and juvenile fishway construction	6/97 - 8/97
Newaukum R. Fishway	Fishway repair	8/97
Starbuck Fishway	Modify and reduce height of fishway walls to minimize flood debris accumulation (Tucannon R.)	9/97
Frazer Cr. Screen and Fish Passage (1 cfs)	Fabrication/installation of ditch headgate and rotary wiper flat plate fish screen; replacement of 450' pipeline; removal of diversion fish barrier	10/97
Bear Cr. Screen (1 cfs)	Fabrication/installation of rotary wiper flat plate fish screen	10/97
McKenzie Screen (6 cfs)	Modify concrete structure; modify and install solar-powered 2.5' dia. x 8' drum screen on this Entiat R. gravity diversion	10/97 - 11/97
Hanan-Detwiler Screen (6 cfs)	Construct new concrete screen structure and fish bypass system for this Entiat R. gravity diversion (will use 2.5' x 8' solar-powered drum screen)	11/97 - 12/97

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APPENDIX A. 1997 SSHEAR Project Summary will be inserted here.