2001 ANNUAL REPORT

Salmonid Screening, Habitat Enhancement and Restoration Section (SSHEAR)

Environmental Restoration Division
Habitat Program

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FISH PASSAGE UNIT

INTRODUCTION

Resident and anadromous salmonids are a vital component of the culture and economy of the Pacific Northwest. Each year, millions of dollars in revenues are generated in Washington, Oregon, and California by sport and commercial fisheries targeting salmon and trout. Beyond this, anadromous fish are the most important natural system for the cycling of nutrients from the sea back to the land and the abundance of salmonids indicates the health of Pacific northwest stream ecosystems. Without question, protection and enhancement of salmonids and the habitat that supports them directly enhances the distribution and abundance of many other wildlife species as well.

Correction of human-made fish passage barriers such as impassable culverts, dams, floodgates, or degraded fishways is one of the most cost effective methods of salmonid enhancement and restoration. In many cases, several miles of quality salmon and trout habitat can be retrieved and brought into production by eliminating a single point source fish barrier. To address these problems, the Fish Passage Unit performs several major functions: fishway inspections, fishway operation and maintenance, culvert inventory work, fishway major project development, database management, and training/consultation on fish passage related issues. The unit is composed of specialized fish biologists, engineers, technicians, and equipment operators. Following is a summary of work completed in the year 2001.

FISHWAYS

The Fish Passage Unit is responsible for the inspection and evaluation of 508 fishways statewide. The goal of this program is to insure that these fishways operate as designed and provide unrestricted access to the 3,100 linear miles of spawning and rearing habitat located upstream. The majority of the fishways are associated with road culverts and small low head dams. Inspections are conducted in the spring, after the threat of major flooding and damage, so that the condition of the fishways can be adequately evaluated. For those fishways requiring maintenance, fishway notification letters are sent out with follow-up calls made to the owners. Where necessary, staff schedule on site consultation with the fishway owner to resolve problems. Compliance inspections are conducted in the late summer/early fall to ensure that the maintenance work has been completed. During 2001, 370 fishways received scheduled inspections. Of this number, 91 (25%) required maintenance or reconstruction. Compliance inspections conducted later in the year indicated that the owners of 34 (37%) fishways had completed the work requested. Most of the fishways not in compliance were those requiring major reconstruction. The unit is continually working with those owners to ensure that a time line for reconstruction is developed and implemented. The compliance rate of 37% for 2001 was almost on par from the last ten-year average of 36%.

FISHWAYS OPERATION AND MAINTENANCE

Currently, the Environmental Restoration Division is responsible for the operations, maintenance and the eventual major repairs and modifications of 76 fishways statewide including 24 formal Mitchell Act fishways.

SSHEAR is responsible for maintaining and operating two of the largest fishways in the state. The Granite Falls fishway on the South Fork Stillaquamish River required about 1.8 staff months per year for weekly maintenance during the salmon run. From July to December the Sunset Falls fishway on the South Fork Skykomish requires maintenance and daily operations in the handling and hauling of fish. Operation of the at Sunset Falls required 15.4 staff months annually.

Built in 1958, the Sunset Falls fishway consists of a series of 33 vertical slots which leads into a trap and haul facility at River Mile 51.5. The facility provides salmon, steelhead, trout and native char access to over 92 miles of spawning and rearing habitat in the upper South Fork Skykomish watershed. Table 1., lists the number of each species which were passed upstream at the Sunset Falls fishway during the 2001 season. During the 2001 season a record number of 50,434 adult coho were trapped and hauled above the falls. This eclipsed the former high count of 32,607 coho set in 1994. The total adult production from the area above the falls has been estimated at 60,000 adults based on available habitat and smolt trapping data .

Table 1. Fish trapped and transported upstream at Sunset Falls during 2001.

Species	Total No. Adults	Total No. Jacks
Coho Salmon	50,434	97
Chum Salmon	345	
Summer Chinook Salmon	333	24
Fall Chinook Salmon	768	18
Pink Salmon	12,475	
Sockeye Salmon	22	
Steelhead Trout	2,072	
Sea Run Cutthroat Trout	1	
Native Char	63	

During the 2001 construction season, maintenance, major repairs, and modifications were performed on the following fishways:

Granite Falls Fishway Modifications

Built in 1956, the Granite Falls fishway consists of a series of 51 vertical slots which lead into a 300 foot long tunnel that exits above the 50 foot falls. The fishway provides pink, coho, chinook, steelhead and native char access to 57 miles of spawning and rearing habitat in the upper South Fork Stillaguamish River. During the summer of 2001 a new entrance gate was installed in the fishway resulting in greater attraction flows to the fishway. Concrete repair work to the fishway floor and sills was also completed this year.

Wind River Fishway At Shipperd Falls Modifications and Repairs
Completed in 1958 under Mitchell Act Funds, the Wind River fishway at Shipperd Falls has been in service for 43 years. The facility provides Spring chinook and Summer steelhead access to 38 miles of spawning and rearing habitat.

A severe flood event caused significant damage to the fishway in 1996. Since then, repair work has been underway. In 2001, fabrication of a new entrance gate and replacement of a maintenance building have been completed. Additional modifications and repairs to the fishway in 2002 will include the clean out of the entrance pool and installation of the new entrance gate. The resulting work is aimed at improving fish attraction to the entrance of the fishway.

Washougal River Fishway At Salmon Falls Modifications
Completed in 1956 under Mitchell Act funding, the Washougal River fishway at Salmon Falls provides Fall chinook, coho and Summer steelhead access to over 6 miles of habitat. In 2001, the fishway was modified to provide improved attraction flows at the entrance. During low Fall flow conditions in the past, adult chinook would be attracted to the adjacent impassable falls and their migration wood be delayed. The modification work was highly successful this year, drawing fish into the fishway and eliminating the delay problem. Work planned for 2002 includes repairs to the fishway sills and concrete floor in an effort to prolong the life of the fishway.

Mitchell Act Stream Clearance and Fishway Operation and Maintenance
This project provides stream clearance and maintenance of fishways in the lower Columbia River drainage that were constructed under the Mitchell Act. Between January 1 and December 31 , 2001, a total of 9.2 staff months were spent for fishway maintenance and inspections, barrier reconnaissance, design work and the development of recommendations for future work. The program is currently seeking federal funding for major maintenance on these fishways that have been in service for close to a half a century.

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 ongoing inventory is to document fish passage problems at State Route stream crossings and to correct passage problems located by order of highest priority.

During the ongoing WSDOT inventory 3,415 culverts in natural drainages have been inspected; 1963 have been identified as fish bearing, including 784 fish barriers. The second phase of the ongoing project involves conducting habitat surveys, both up and downstream of identified barriers, to establish priorities for correction and quantify the habitat gain. Based on results of surveys completed to date, sufficient habitat gains to justify correction have been identified at 520 barrier culverts. A total of 126 additional culverts are scheduled for further evaluation to determine the need for fish passage repair. The culverts designated for further evaluation are classified as such in part because the recently merged agency, Department of Fish and Wildlife, has recognized the need for maintaining diverse and healthy stocks of resident salmonids through the correction of barrier culverts. Some of the resident species occupy steeper gradient stream sections which may be unsuitable for salmon. Hence, further assessment is underway to determine potential additional corrections based on consideration for resident fish. An estimated 456 barriers remain to be corrected to address all salmonids (520 barriers to fix minus 64 already fixed barriers equals 456).

Since the inventory began, fish passage has been provided by WSDOT and WDFW's Environmental Restoration Division, using dedicated funding, at 37 priority sites.
Twenty two fish passage barriers were reported corrected by WSDOT during safety and mobility projects, one barrier was corrected during WSDOT's routine operational maintenance, and three barriers were corrected using other funding sources.

During the year 2000 construction season four fish barriers were corrected on WSDOT highways.

DEPARTMENT OF TRANSPORTATION CULVERT REPAIRS

Birnie Creek 409 - State Route 409

Birnie Creek is a tributary of the Columbia River entering at the city of Cathlamet in Wahkiakum County. Prior to repair, a steeply sloping culvert at the State Rout 409 (mile post 3.83) crossing blocked fish passage to the upper creek. In 2001, WDFW removed the lower twenty feet of the

culvert and constructed an eight step concrete pool and weir fishway and installed a series of 21 expanding ring baffles throughout the remaining length of the culvert. A privately owned building adjacent to the site confined construction to a small area, slowing the rate of work and requiring the use of sheet pile supports.

The construction of the State Route 409 project completed the finale phase of a four year, four project effort to restore salmonid access to the habitat in upper Birnie Creek. During the 2001 spawning season, WDFW staff observed adult coho salmon migrating efficiently through all four of the Birnie Creek fish passage projects and documented 12 live adult coho in the 500 meters immediately upstream of State Route 409.

Harlow Creek Fishway

Harlow Creek, a tributary of the Queets River in Jefferson County, crosses State Route 101 at mile post 146.85. WDFW originally completed the Harlow Creek fishway in 1996. A 100 year flood event damaged the fishway in 1999 by undermining of the upper three log controls. In the summer of 2001 the damage was corrected by de-watering the stream and excavating the pit run material above each of the upper three weirs. Larger rip rap material was placed in the stream to secure the logs and withstand future flood events.

Kenyon Creek Fishway

Kenyon Creek is a small tributary to the North Fork Lewis River in Clark County. The stream cross under State Route 503 via a culvert at mile post 49.03. The culvert blocked fish passage to some excellent habitat located upstream, including two low gradient tributaries and a small lake. SSHEAR staff installed baffles within the concrete box culvert providing the ideal depth for fish passage and constructed a seven step, concrete pool and weir fishway on the culvert apron to provide fish passage. Surveyors documented 28 coho salmon using the newly opened habitat within three months of completion of the fishway.

SAFETY AND MOBILITY WORK

Integration of fish passage repairs and road project construction is a cost-effective way to accelerate barrier correction and reduce equipment mobilization costs. WDFW/ SSHEAR staff typically inventory proposed road projects and identify fish barriers requiring repair at least one year prior to the anticipated construction dates, to accommodate WSDOT transportation project

long range budgeting and planning requirements. This report includes the results of transportation project reviews conducted by WDFW in 1998, 1999 and 2000 and 2001. Every odd year (except in 1998 and 2000), the WDFW inventory team obtains a list of proposed transportation projects from each of the six WSDOT regions. Transportation projects reviewed include: Mobility (I-1 subprogram) and Highway Safety (I-2 subprogram) of the Highway Improvement Program. Other Facilities projects (P-3 subprogram) of the Highway Preservation Program are also reviewed.

The Eastern Region reported no transportation work plans in 1998. The Northwest Region reported their year 2000 transportation work plans at the end of WDFW's transportation project review season. WDFW was unable to review safety and mobility projects within the Northwest Region in 2000, since WDFW field crews were unavailable at the end of the project review season and some safety and mobility projects were already past their proposed engineering and ad dates.

Each proposed road project was carefully driven and existing culvert assessment inventory data was edited and updated to meet current WDFW fish passage inventory protocol. The exact location of each culvert was recorded using GPS (Global Positioning System) coordinates, highway name and road mile location. WDFW crews surveyed 0.16 kilometers (0.10 miles) on either side of the project vicinity, upon advisement from WSDOT, since contractors would be in the area during construction and could easily "reach" a barrier culvert in the proximity of heavy equipment work. During this process, WDFW evaluated culverts that were at least 0.45 meters in diameter and appeared to be a natural watercourse (includes ditches and other stream courses altered by human activity). Culverts located and identified as a fish passage barrier were given a *threshold determination* to establish the presence of a significant reach of useable fish habitat. As stated earlier, a significant reach is defined as a linear reach of useable fish habitat for 200 meters downstream and 200 meters upstream of a human made barrier, or a high quality reach of habitat <200 meters that is critical to a self-sustaining stock. Fish passage was recommended on fish bearing streams in both resident and anadromous waters that met the significant reach criteria.

During the summer and early fall of 1998, 1999, 2000, and 2001, WDFW inventoried a total of 1560 highway kilometers (969.29 miles) within safety and mobility projects statewide and evaluated 438 culverts, including 142 fish passage barriers requiring repair. Table 2 summarizes the 1998, 1999, 2000, and 2001 safety and mobility project reviews. The June, 2002 Progress Performance Report for the WSDOT Fish Passage Inventory, Fish Barrier Corrections and Project Evaluations lists individual fish barriers requiring repair that were identified within Safety and Mobility Projects and barriers that have already been corrected during construction of transportation projects.

Table 2. Summary of Proposed WSDOT Safety and Mobility Projects - Fish Passage Inventory Efforts.

WSDOT Region	Total Distance Surveyed[1] in Miles	# of Fish Crossings Identified	# 0f Fish Barriers Requiring Repair2

Nowrthwest	216.52	118	42
North Central	215.33	53	12
Olympic	179.29	129	43
Southwest	124.78	88	31
South Central	180.74	38	8
Eastern	52.63	12	6
Total:	969.29	438	142

[1] On/Off ramps were also evaluated, though they are not included in the total distance surveyed. No fish barriers were reported for On/Off ramps, with the 198, 1999, 2000 and 2001 Safety and Mobility work, except in the Northwest Region.

[2]Represents fish barriers requiring repair that are located within the proposed Safety and Mobility project vicinity.

WILDLIFE AREA INVENTORY

Over the past 62 years, WDFW has purchased approximately 840,000 acres of wildlife area sites, scattered throughout almost every county in the state. Due to previous land utilization practices and the increasing interest in fish passage issues, SSHEAR initiated a statewide inventory of fish passage barriers and water diversions on all state owned or managed lands in October of 1997. The purpose of the inventory is to document and correct all agency owned fish passage problems and water diversions. Washington State laws (RCW 77.16.220, RCW 75.55.040, RCW 75.55.060, and RCW 75.55.070) require all diversions from waters of the state to be screened to protect fish and that all stream human-made obstructions in streams must be provided with a durable and efficient system for fish passage.

In cooperation with the Lands Division, SSHEAR designed a sampling protocol, database format, and Wildlife Area Priority Index for the study. To create the priority index of Wildlife Areas (WLA), a prioritization questionnaire was distributed to Regional Lands Coordinators, Regional Fish Biologists and Wildlife Area Managers. This enabled SSHEAR staff to take advantage of the many years of experience and data accumulated from local Wildlife Area Managers. 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 and water diversion screening issues of public interest). This prioritized list, along with other management considerations, was then used to determine the sequence in which the wildlife areas would be inventoried.

To date, inventories have been completed on the Snoqualmie, Olympic, and Methow Wildlife Areas. In 2000 and early 2001, work was concentrated in the Cowlitz Wildlife Area where 227 culverts, 21 dams, 4 gravity diversions, 6 pump diversions, and 17 “other” features were

evaluated on fish bearing waters. Of these, 173 of the culverts, 19 of the dams, and 6 of the "others" were found to be barriers. Three of the gravity diversions were adequately screened and one was unscreened. The screening status of the pumps include: 2 that are screened but not in compliance with WDFW screen criteria, 3 are unknown at present, and 1 that has been abandoned. The Cowlitz WLA report is near the final draft stage and should be available in the near future.

The Sunnyside WLA was inventoried during the summer of 2001. A total of 39 culverts, 1 dam, and 13 pump diversions) were evaluated. Of these, 8 culverts and 7 pump diversions are in fish bearing waters and, of these, 7 culverts require repair and 5 pump diversions were found to be inadequately screened and non-compliant. The Sunnyside WLA report should be available in the summer 2002.

During the fall of 2001, the Skagit WLA was inventoried. The Skagit System Cooperative conducted a fish passage inventory of the Skagit River basin in 1999, which included a large portion of the Wildlife Area. While conducting the WLA inventory, WDFW revisited those sites and collected additional data, photos, verified global positioning coordinates, and filled in data gaps if needed. There are currently 3 tidally influenced sites left to review in the area before the final report can be completed.

Work on the inventory of the Sinlahekin WLA was began and approximately 65 percent of the fieldwork was completed before inclement weather ended the effort in December. Work on the Sinlahekin WLA will resume in June 2002.

At present, the plan is to dedicate one field crew towards inventorying the Shillapoo WLA starting in late February 2002. The other field crew will concentrate on the completion of the reports.

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 482 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 FISH PASSAGE PROJECT DEVELOPMENT

Unnamed Tributary of Pilchuck Creek - Private Project #4.
Pilchuck Creek is part of the Stillaguamish River system and is located in Snohomish County. Completed as part of a multi-year effort between WDFW, WSDOT, Snohmish County and several private landowners to restore salmonid access throughout this unnamed tributary (WRIA # 05.0065), the 2001 project involved the placement of four log controls downstream of a culvert under a private farm access road. The controls back-watered the culvert and provided fish access.

During the 2001 spawning season, many coho were observed spawning upstream of the log weirs and farm culvert. This stream is also known to support naturally reproducing populations of cutthroat and steelhead trout and chum salmon.

In 2002 SSHEAR will proceed with the next project on this tributary by providing fish passage over a small private dam.

TECHNICAL ASSISTANCE

SSHEAR staff are available to provide training and technical assistance to federal, state, county and local governments, tribal organizations, grant groups and others interested in conducting fish passage and screening inventories and assessments. Table 1 shows the groups that SSHEAR staff have provided training and technical assistance to in the past or will be providing training and technical assistance to in the future. Staff have also been available to give presentations on fish passage at various meetings and workshops around the state.

Table 3. Groups provided training and technical assistance by SSHEAR staff.

Group	Watershed(s)[1]	Status
Clark Conservation District	Lewis River	Completed
Pacific Conservation District	Willapa River (Pacific County owned barriers)	Completed
Pierce Conservation District	Puyallup River, Nisqually River, Key Peninsula Streams	Ongoing
Adopt-A-Stream Foundation	Swamp, Little Bear, Allen, North, and Quilceda Creeks	Ongoing
Grays Harbor Conservation District	Satsop, Wynoochee, and Humptulips Rivers	Ongoing
Cowlitz Conservation District	Elochoman, Cowlitz, and Kalama Rivers	Completed
Lewis County Public Works	Chehalis, Cowlitz, and Nisqually Rivers	Ongoing
Washington Trout	Skykomish, Snohomish, and Snoqualmie Rivers	Completed
Skagit System Cooperative	Skagit River	Completed
Underwood Conservation District	White Salmon River	Ongoing
Yakama Tribe	On-Reservation Streams	Ongoing

Hood Canal Salmon Enhancement Group	Miscellaneous Hood Canal Tributaries	Ongoing
Squaxin Island Tribe	Oakland Bay Tributaries	Completed
Quileute Tribe	Bogachiel River	Completed
Thurston Conservation District	McLane Creek, Spurgeon Creek	Completed
WA State Parks	Statewide	Ongoing
South Puget Sound Salmon Enhancement Group	WRIA 14	Ongoing
Okanogan Conservation District	Methow, Okanogan	Ongoing
WDFW (SSHIAP)	Lower Columbia small dam inventory and assessment	Ongoing
Whatcom Conservation District	Whatcom County	Ongoing
Skagit Conservation District	Skagit County	Ongoing
Hoh Tribe JFE	Goodman Creek	Ongoing
WDFW F&F Biologists/WDNR Roads Staff	Statewide	Ongoing
Lewis Conservation District	Cowlitz (belo w barrier dam)	Ongoing
Governor's Council on Environmental Education	Statewide	Future
WDFW WST Biologists	Statewide	Ongoing
King County Roads Department	County Roads	Ongoing
Fish Passage Grants Program	Statewide	Future

[1]Usually does not include the entire watershed

WILD STOCK RESTORATION / ENHANCEMENT

INTRODUCTION

In the late 1980's, wild coho stocks from the rivers of the North Coast and North Puget Sound rivers were in decline. Very restrictive fishing regulations were put in place to protect these wild stocks from over harvest in the mixed stock ocean fisheries. This resulted in reduced fishing opportunity and economic loss to citizens of Washington State and Northwest Indian Tribes.

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 intent of the program was to increase and stabilize wild coho smolt production by expanding and improving key production habitats. Improved smolt production could, in turn, strengthen wild coho populations in the target rivers and allow harvest restrictions to be eased.

Historical watershed reconstruction clearly shows that many key habitat features for coho such as flowing backwater sloughs, spring channels, and off- channel ponds have been lost overtime

due to human activities. Diking, urban development, agricultural activities, logging, road building, and dams have degraded many of these high quality habitats. The restoration of these areas can improve juvenile coho 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 key 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. In addition to direct economic benefits, stronger wild salmon runs also restore the critical natural flow of marine based nutrient to a verity of wildlife species. Basically, the return of wild salmon enhances the health of Washington ecosystems. Habitat enhancement and restoration can play an important role in the recovery of wild salmonid stocks.

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 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 been found to improve juvenile freshwater survival and accelerate growth rates. The larger size of the smolts produced leads to increased marine survival rates (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 takes place entirely within the Habitat Program's Environmental Restoration Services Division. This work is performed by a project team made up of biologists, engineers, and construction staff with many years of experience. By using a team approach during project development, efficiency is greatly increased and costs are reduced.

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 affect the composition of riparian vegetation and aquatic communities including rearing juvenile salmon. This finding suggests that anadromous (sea run) fish play a key role in nutrient cycling and ecosystem function.

NORTH SOUND

ABSTRACT

Major project work completed during 2001 on the Skagit included the final half of the extension to our 1995 Illabot ground water channel project and spawning gravel supplementation at our 1998 Taylor Channel project. On the Stillaguamish, we completed the first half of a bridge placement and culvert and fill removal at Koonz Creek. All these sites were sponsored and managed by SSHEAR staff.

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 0.35 smolts per square meter at Stillaguamish and 0.36 smolts per square meter at Skagit sites. Although the mean production rates are similar, the variability around the Stillaguamish number is nearly twice the Skagit. The large range in Stillaguamish production is influenced by several large sites that will not likely ever produce fish at the same rate as smaller sites since they are more difficult to fully seed with only low to moderate escapements. 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 22 Skagit projects completed in this program may currently be producing 182,869 smolts annually. This represents about 18% of the estimated wild Skagit coho production averaged over the years 1990-1999 (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data). Similar evaluation at Stillaguamish sites indicates all 25 projects in this basin are capable of producing 134,796 smolts or 49% 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 Stillaguamish, however, includes several large projects (Granite Falls, Marsh Creek, Trout Creek and W.F.Church) that may never reach their potential and subtracting these yields a production potential of 68,249 smolts or 24% of the watershed total.

The total area enhanced in North Sound now totals about 888,776 square meters. This includes high quality habitat to which access has been restored through fish passage work and stable off channel projects where we added enhancements to existing areas and built new ones in the form of ground water channels. These sites will serve to increase and stabilize coho and other salmonid production in these river basins.

Field surveys to record previously undocumented habitat and identify possible enhancement project sites have been 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 the North Coast program will be a thorough inventory of previously undocumented off-channel habitat in these two river basins. 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). SSHEAR Habitat Inventory data base includes this new data. This information is available to all resource managers on request. 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. The inventory information will also help identify potential habitat enhancement projects.

The inventory effort began in 1989 and work has continued through 2001. 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 and updated as

necessary to allow for quick decisions about what habitat is to be included and excluded. Rules direct coverage to those areas not covered by any earlier work. In addition to habitat documentation, the surveys specifically describe fish passage/blockage structures for data entry into the SSHEARBASE program, the agency catalog for this information.

Documented habitat such as those described in 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 descriptive field form is entered into the database (along with any passage/blockage structure(s)). In the future, the other file information will be scanned and stored in a digital format attached to the form.

The Skagit system inventory was completed in 2001. Work immediately began in the Stillaguamish where about 10% of the area has now been covered. We plan to compile the Skagit information into a summary format in 2002 and combined it with the work of Johnson (1986) and the Stream Catalog (1975).

ENHANCEMENT PROJECT IDENTIFICATION

The intensive habitat inventory work identifies a number of future enhancement project sites. Possible projects are also found by reviewing aerial photos and conducting field surveys in likely locations. Aerial flights using both fixed-wing and helicopters have also been helpful in locating opportunities, especially where access may be limited. References from other professional biologists have also been helpful in locating potential opportunities. Fish passage barriers located during habitat surveys are also scheduled for correction.

Listings of habitat enhancement options are annually ranked by potential habitat gain and fish production, level of design difficulty and construction, landowner considerations, expected project life, cost, potential funding opportunities/constraints and other related factors. These istings are dynamic with new possibilities continually being added and others dropped based on additional evaluation.

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. Selected projects tend to be difficult and/or high risk projects that require advanced skills and techniques and are not likely to be completed by other programs, groups or agencies. Most of these projects require considerable planning, survey, flow monitoring, evaluation and design development. It is common for complex projects to require three to five years of design and planning before actual construction.

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.

SSHEAR conducts surveys of adult coho spawners and juvenile coho immigrant and smolt emigrant trapping to evaluate proposed and completed project sites. These efforts measure project use at key life history stages and ultimately document project effectiveness. Spawner surveys are conducted 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 for coho 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 Program, personal communication). Spawner use can also be calculated for other species such as chum salmon. 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 that older projects continue to function as designed and identify needed maintenance.. All spawner survey data are on file with this program as well as included in the WDFW Fish Program database.

Trapping methods and materials are similar to those used on the North Coast program. Both one and two-way traps are used (enabling enumeration of both up and downstream migrants) depending on the level of desired evaluation. One-way traps are installed with large mesh screens to capture emigrating smolts only. The large screen mesh allows both emigrant and immigrant 0 age fish to pass through reducing the workload of the trap check team and avoiding the high levels of predation that can occur at some trap sites. Two way traps are fitted with a division board to separately capture, count and separate upstream and downstream moving fish.

Trapped fish are anesthetized briefly for handling. The species of each fish was noted and samples were measured and/or marked. After allowing the fish to fully recover, they were passed along in the direction of their migration. Screen mesh size may allow some salmonids other than coho to pass through so counts of these species are incidental and not measures of total production. 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) or to capture broodstock for hatchery management programs.

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 migrant 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 they are frequently back-watered by high river stages in those seasons. Access to other sites for complete spawner surveys and spring trapping can also be limited by snow.

Each year since the program's inception, these evaluation efforts have required considerable staff time during fall and spring. The accumulated data have become useful in identifying the best potential sites and encouraged the development of new and effective techniques. Project evaluation 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 2001 is found in Table 4.

Fish Production

Smolt production and spawner use at sites where both types of information is available has been summarized in Table 4. More extensive smolt and juvenile trap data are shown in Table 5. Some of the trap information precedes the current program. Since Table 5 does not show when and where habitat modifications were made at some sites, production rates in later years may not reflect earlier conditions at these locations. Please contact the Division before using any of this data and for clarification and specific questions, needs and uses. Site specific spawner use data are too extensive to be included in this report. The information is available on request.

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.

Mean smolt production for the projects in both areas has been nearly equal (Table 5) but the variability about the Stillaguamish value is somewhat larger than that of the Skagit. The greater variability can be explained by the fact that the smaller Stillaguamish projects are more fully seeded and productive on an area basis than the large projects that will likely take many years to be fully productive. Full production at the large sites will likely require larger total basin spawner escapements. This is especially true for the upper South Fork Stillaguamish projects at Marsh and Trout Creeks that additionally will rely on improved late summer flows to get passage through the canyon reach upstream of Granite Falls.

The high variability in smolt production both within and between project sites (Table 5) over the period of record reflects wide ranges of adult 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 spawners 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 spawner densities are low. Unintentional selective fisheries, especially in depressed stocks, could also impact the return to segments of the river that may include a project site. Access to project sites can vary annually depending on flows affecting adults and juveniles or both.

Comparing smolt production of sites with large pond areas to those with small or no such area (i.e. groundwater channels) may not be appropriate because we do not believe all of a large pond is used by rearing juveniles. It is unlikely much of the central open water area is contributing to production yet it is entered into the production "per square meter". However, we do not yet have a documented method of knowing the "effective" habitat area to compare sites equally.

Several spawning cycles may be needed for some of 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 and stability 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 eight years of project life, it had come to capture about 1.5% of all Skagit spawners based on WDFW spawning escapement estimates. Spawner use or proportion of the available escapement appears to have leveled off at a high rate and should remain relatively constant as multiple cycles of spawners begin to 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 (Table 4) has been higher in the Skagit (0.39 per square meter) than the Stillaguamish (0.21 per square meter). The Skagit mean has been strongly influenced by the ground water channel projects in that drainage that don't exist in the Stillaguamish. Additionally, the channel projects have received high spawner use immediately after construction. No channel opportunities have been identified in the

Stillaguamish. Spawning habitat constructed in the Stillaguamish has only been as part of off-channel pond development and access.

Applying the mean Skagit smolt production figure to all Skagit projects indicates a production potential of 182,869 fish annually or 18% of the total basin production based on nine years of scoop trap data from 1990 to1998 (D. Seiler, Washington Department of Fish and Wildlife, Fish Management Program, unpublished data). A similar smolt production estimate for all our Stillaguamish projects, using the mean value, indicates our sites are potentially able to contribute 134,796 smolts or about 49% 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). However, the Stillaguamish figure is not likely to be fully realized. Several large Stilly projects such as Granite Falls, W.F. Church, Marsh Creek, and Trout Creek may never produce fish on an area basis equal to the smaller projects. Predation by spiny rays is a significant limiting factor at the Granite Falls site and fish access is a problem at the other three sites. A continuous series of large spawner escapements and favorable streamflows during migration times will help to achieve better adult and juvenile colonization of these areas and should result in an increase in production. Removing these four projects from the estimated contribution potential produces a more reasonable estimate of 68,249 smolts being produced annually or about 24% of the basin total.

Comparing projects on an area basis may not be appropriate. Large open water areas in large off-channel sites probably do not contribute significantly to site production. In these sites, only the perimeter is probably productive. However, we have no reliable method to separate the higher from lower productive areas at individual sites and since this varies with average depth, vegetative cover, general occurrence of avian and mammal predators and other factors, it cannot be accurately predicted.

Efforts are being made at project sites where smolt production is less than the basin average. 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. Flow from the project was improved year around and may, in part, have been responsible for the eight fold increase in smolt production measured in 1998 and 2000. Continued trapping over the next several years will evaluate this higher production rate further. Inside spawning habitat is being expand at several sites to increase fry production which will insure that the projects are fully seeded. This technique has apparently been effective at the Harrison Slough where spawning gravel was add in the late 1990's. By 2001 smolt production at the site increased by threefold.

At some sites critical physical attributes cannot easily be modified and their performance will naturally vary widely over time. Two examples are Cascade Millpond and Marsh Pond projects that are dependent on average or better water years to provide sufficient outflow for fish attraction.

Production at the upper South Fork Stillaguamish projects, upstream of Granite Falls and the canyon reach, may always be lower than the rest of that basin and never achieve the basin mean

value. The Granite Falls Fishway has not performed efficiently and passage through the steep rugged canyon upstream will always remain difficult and flow dependent. Planned structural modifications and improved management of the fishway in the next few years may improve spawner access to the upper South Fork. Loss of several sequential year classes from canyon blockages (rock-fall) in the early 1990's will also slow stock recovery in the upper watershed.

Predation is probably another factor limiting production at some sites. Carey's Slough, for example, is a large slough complex on the lower Skagit heavily populated with spiny ray piscivores. Tracking marked fish from one trap at the upper end of the slough to another at the outlet showed considerable loss presumably due to that predation. In spite of the high habitat diversity of the slough and seemingly adequate escape cover, fry and smolts are being lost to predators at a high rate especially during their outward migration. Replacement of the impassable culvert at the mouth of Little Carey's Creek, a small slough tributary, may help by providing additional spawning and rearing area largely free of these predacious fish . Where avian and mammal predation seemed to be significant, we have attempted to provide adequate escape cover in the form of complex submerged woody debris. Adding debris, however, is usually expensive, difficult and not always accepted by landowners. Because predation can almost totally negate the value of an otherwise good project, we consider its importance in all project planning and implementation but it cannot always be fully anticipated.

One important production feature we have not evaluated is the contribution some projects are very likely making to coho fry and pre smolt parr which move out of upriver sites to finish rearing in downstream areas. These are additional juveniles to the system coming from high quality habitat that help seed existing slough and off-channel areas. Intensive year-around evaluation of a several channel projects in Canada (Sheng, M.D. et. al., 1990) found this contribution to be significant usually exceeding smolt production many fold. This finding is not surprising since the high egg to fry survival in protected and off-channel sites often produce juveniles in excess of carrying capacity causing density dependent emigration. To date sufficient resources have not been available to study this behavior intensively. Evidence strongly suggests that this is a major occurrence at our Constant Channel site. Electrofishing estimates of the early summer coho fry and early fall parr population made in 1994 and 1995 found the site to be fully seeded. However, smolt production the following years was much lower than expected when compared to similar project types. Since predation did not seem to be a problem and water conditions through subsequent winters were excellent, we have assumed the parr moved out of the project in late fall to reduce competition and/or possibly to avoid the aggressive activity of spawning adults, particularly chum salmon. It may also have been a residual response from pre project conditions when flows at the site went intra-gravel late in the summer. Late summer and/or fall emigration may have been a locally evolved response to successfully deal with the stranding problem. This may be especially true because there is an extensive natural high quality rearing slough area a short distance downstream at the mouth of the Suiattle River. Late fall recruitment of downstream migrating juveniles to replace those that leave may not occur here since there is little coho spawning upstream and the steep gradient location of the project in the Sauk River prevents fish from easily finding the small project outlet. For Constant Channel, smolt production may not be a good measure of project performance. Ensuring adequate adult escapement may be our only reasonable production measure. Evaluating juvenile movement late

in the fall has not been possible because of a lack of staff and because out migrant traps would interfere with the recruitment of adult chum.

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 reach the threshold size and physiological readiness for seaward migration and then leaving. The greater availability of this temporary refuge and rearing habitat the greater the size and survival of those pre smolts and smolts fortunate enough to find them.

Although project evaluation through smolt trapping has limitations, it will in combination with spawner surveys continue to be the easiest and most comparative method to judge site performance and productivity. Evaluation efforts at specific projects will need to done over several years, at least, to average different escapement levels, weather patterns and fish behaviors.Unfortunately, year-round trapping and extensive marking and tracking of fry and pre smolts to accurately ascertain exactly how different habitats and project types are used in various areas of the watersheds is beyond the scope of this program.

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).

2001 PROJECT CONSTRUCTION

<u>Stillaguamish River Basin</u>
Koonz Creek

This project restores fish passage to habitat in upper Koonz Creek by replacing a failing culvert and the substantial associated fill with a bridge. Since work on this project was delayed, only the installation of the bridge was completed before permit windows required work to stop at the end of October. The culvert and fill will be removed and some channel restoration work will be completed in 2002. The bridge had to be installed first so traffic access could be maintained. The use of bridges will occur more frequently in the future as they are cost effective and require less maintenance than culverts. By removing culverts and other structures from the stream natural channel forming processes can be restored. Restoration of these processes is especially important in these high gradient reaches where the exact channel orientation and shape can change dramatically from one year to the next.

Skagit River Basin

Illabot Channel Extension

This year work on a 1300 foot extension of the Illabot Channel project which was originally built in1995. The total project length is now about 2300 feet. The extra length should help to relieve the over-spawning and redd superimposition problems that were observed on the original project. Revegetation of the site with native shrubs and trees was complete in fall 2001. This project could not have been done without the excellent cooperation of Seattle City Light.

Bulson Creek Tributary

A long culvert under a very large road fill on State Highway 534 near Conway and I-5 block fish access to 6 plus miles of excellent habitat on Bulson Creek in Skagit County. This is a very complex project requiring a new larger diameter culvert to be bored and jacked through the road. The project was delayed by a ruling by an Attorney General requiring a portion of the project be contracted out to a private vendor. Plan revisions began immediately for contract bidding and award but could not be completed successfully in time for the 2001 construction season. The contract process requires all work on the project access roads will be done in early 2002 with the actual boring work to begin in mid summer. Access and pipe boring work will be followed by fishway construction at the downstream end using our WDFW construction crew. All work should be complete when the 2002 permit window closes October 31. This project has required years of evaluation and design and will restore fish access to miles of high quality habitat for a variety of salmonids that are currently spawning up to the culvert outfall. Fish use of the restored habitat should be immediate and high. Cooperation and funding from Washington Department of Transportation and the affected landowners has been excellent and all parties expect a good project next year.

Taylor Channel Gravel

This year additional gravel was placed in this large ground water channel project which was originally built in 1998. A long reach excavator was able to place the gravel without damage to the new riparian vegetation growing along the bank lines. The original construction road along one side was used for equipment access and gravel delivery by dump truck. Gravel addition was needed to provide full use of the project by salmonid spawners. The original spawning gravel was generally too large and the fish had been avoiding it. Spawner survey evaluation in 2001 indicated an increase in spawner use.

Future spawning gravel mixes will insure more smaller rock is included in the screening. Past spawning gravel placements have been appropriate because we ordered the rock mixed to our specifications. In this case, we had made the spawning rock on site with a portable screen that had size limitations. At the time, we did not appreciate the need for the small rock fraction to our target species.

SCHEDULED 2002 PROJECTS

Stillaguamish River Basin

Fortson Creek

We will need to install another log weir structure in the outlet stream from Fortson Ponds, a 1983 fish passage project built by this program, to maintain fish access into the ponds. The original project needed only two weir structures in the stream to make up the channel gradient into an active side channel of the river. In recent years, however, channel migration of the Stillaguamish towards the project has cut off the side channel and Fortson Creek now enters the river directly. The decrease in stream gradient over a much shorter distance has begun to undermine the lower-most weir causing it to begin failing and blocking upstream migrants. The supplemental weir will allow us to control channel elevation in a way that maintains durable passage and efficiently repair the one weir where we are losing the upstream seal. Fortson Ponds and the outlet stream are extensively used by coho and chum salmon being probably the most important coho spawning and rearing site on the North Fork Stillaguamish River.

Koonz Creek

As mentioned above, the second phase of this project to remove the culvert and associated fill will be completed next year. Work also will include final grading and shaping of the bridge approaches and minor utility work to trench and hang them from the bridge.

Skagit River Basin

Powerline Channel

Upstream from the Illabot Channel project about one third mile is a another relic slough of the Skagit River offering opportunity for ground water development as off-channel habitat. The current concept is to excavate a large circular pond area at the head of the old slough under the power lines to capture the gradient of the ground water through the site and minor re-excavation of the slough itself so that it can once again actively flow to the river. Most of the spawning area will be in the shallow pond where suitable gravel will be placed for maximum utility. Our test excavations in this area indicate the native rock will be too large for ideal fish use. Anchored cover structures will be placed in the pond for cover and rip-rap will be set around the perimeter as in our more conventional channel projects for maximum juvenile fish use and retention. The

old slough will primarily be off-channel rearing habitat. Being near the Illabot project and entering the river directly where there already is considerable chum and coho spawning, immediate colonization and use by these species should be guaranteed. The entire project will be on property owned by Seattle City Light right of way insuring project longevity.

PROJECTS PROPOSED FOR 2003 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 2003 and tentative projects through 2005. 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 4. Completed North Sound projects through 2001.

Project	River Basin	Year Completed	Habitat Benefit	Cost	Landowner
		Skagit River Basin			
Newhalem	*Skagit River*	*1991*	*81,000 m²*	*$283,000a*	*Seattle City Light*
County Line Ponds	*Skagit River*	*1991, 1996*	*22,000 m2*	*$114,000a*	*Seattle City Light*
Cascade Park	*Cascade River*	*1991*	*2,030 m2*	*$14,764a*	*Cas. Park Assoc.*
Cascade Mill	*Cascade River*	*1989*	*7,000 m2*	*$27,200b*	*Keller*
Barnaby Slough	*Skagit River*	*1995*	*26,302 m2*	*$41,490a*	*WDFW*
Harrison Pond	*Skagit River*	*1990*	*141,600 m2*	*$68,120c*	*Seattle City Light*
Harrison Pond	*Skagit River*	*1995*	*(incl. W/Har. '90)*	*$100,000a*	*Seattle City Light*
Illabot Channel	*Skagit River*	*1995*	*1,672 m2*	*$160,377a*	*Seattle City Light*
Constant Channel	*Sauk River*	*1991*	*2,800 m2*	*$130,000a e*	*USFS*
Suiattle Slough	*Suiattle River*	*1988*	*3,120 m2*	*$68,270c*	*Wash. DNR*
Careysd	*Skagit River*	*1986*	*169,000 m2*	*$15,240b*	*City of Hamilton*
Little Careys	*Skagit River*	*1991*	*1,920 m2*	*$13,400a e*	*Crown Pacific*
Marsh Pond	*Suiattle River*	*1992*	*3,800 m2*	*$32,000a e*	*USFS*
Boundary	*Suiattle River*	*1994*	*830 m2*	*$41,092a e*	*USFS*
Park Slough Ext.	*Skagit River*	*1992*	*1,400 m2*	*$78,000a*	*NPS*
Grouse Marsh	*Cascade River*	*1996*	*13,150 m2*	*$101,214a*	*USFS*
O'Brian Slough	*Illabot Creek*	*1998*	*300 m2*	*$30,575*	*Seattle City Light*
Barnaby 2 Slough	*Skagit River*	*1998*	*2,868 m2*	*$10,612*	*WDFW*
Harrison Slough	*Skagit River*	*1998*	*200 m2*	*$11,907*	*Seattle City Light*
Taylor Channel	*Skagit River*	*1998*	*5,694 m2*	*$437,260*	*USFS*
Lornezan	*Skagit River*	*1999*	*18,000m2*	*$118,139*	*Skagit County*
Barnaby 2+ Slough	*Skagit River*	*2000*	*(incl. W/ B2)*		*WDFW*
Illabot Channel Ext.	*Skagit River*	*2001*	*2,430m2*	*$530,864*	*Seattle City Light*
TOTAL SKAGIT BASIN			*507,166 m2*		
		Stillaguamish River Basin			
Granite Falls	*S.F. Stillaguamish R.*	*1988,93*	*17,900 m2*	*$20,880b*	*McEwen, Indian Hills Community Park*
Rowen Pond	*N.F. Stillaguamish R.*	*1992*	*4,000 m2*	*$38,300c*	*Charley*
Hazel Pond	*N.F. Stillaguamish R.*	*1987*	*9,580 m2*	*$17,280c*	*Snoh. County*
Forts on Pondsd	*N.F. Stillaguamish R.*	*1989,90,92,93*	*47,180 m2*	*$3,585b*	*WDFW*
Gold Basin	*S.F. Stillaguamish R.*	*1989*	*5,000 m2*	*$51,710b e*	*USFS*
Stilly Canyon	*S.F. Stillaguamish R.*	*1994*	*60 miles*	*$34,523a*	*Hancock*
Oso Pond	*N.F. Stillaguamish R.*	*1994*	*32,368 m2*	*$31,382a*	*Snoh. County*
Spring Cr. Culvert	*S.F. Stillaguamish R.*	*1994*	*32,300 m2*	*$21,518a e*	*Snoh. County*
Spring Cr. Dikes	*S.F. Stillaguamish R.*	*1993*	*32,300 m2*	*$43,500a*	*Folker, Wheatley*
Kackman Creek	*Stillaguamish R.*	*1993*	*1,920 m2*	*$15,500a e*	*Klein*
Rowen Creek	*N.F. Stillaguamish R.*	*1995*	*156 m2*	*$49,193a*	*Phillips*
Fortson Pondsd	*N.F. Stillaguamish R.*	*1995*	*200 m2*	*$11,593a*	*WDFW*
Big Four Creek	*S.F. Stillaguamish R.*	*1995*	*220 m2*	*$5,360a*	*USFS*
Marsh Creek	*S.F. Stillaguamish R.*	*1993*	*100,000 m2*	*$93,200a e*	*Snoh. County*
Trout Creek	*S.F. Stillaguamish R.*	*1996*	*28,000 m2*	*$99,186a*	*Snoh. County*
Jordan Creek	*S.F. Stillaguamish R.*	*1996*	*400 m2*	*$7,302a*	*Lundberg*
Trout Farm Creek	*S.F. Stillaguamish R.*	*1996*	*200 m2*	*$3,651a*	*Brenner*
Mud Lake	*S.F. Stillaguamish R.*	*1997*	*500 m2*	*$22,870*	*Hancock*
Dazzling Howie	*S.F. Stillaguamish R.*	*1998*	*1,247 m2*	*$126,374*	*Snoh. County*
WF Church Creek	*Stillaguamish R.*	*1998*	*42,514*	*$17,101*	*Wash. DOT*
Schoolyard DOT	*N.F. Stillaguamish R.*	*1999*	*2,377*	*$360,289*	*Wash. DOT*
Schoolyard Timm	*N.F. Stillaguamish R.*	*1999*	*Incl. w/ Sch. DOT*	*$59,883*	*Timm*

Schoolyard Bergstrom	*N.F. Stillaguamish R.*	*1999*	*Incl. w/ Sch. DOT*	*$54,897*	*Bergstrom*
Lake Bosworth	*S.F. Stillaguamish R.*	*1999*	*25,000m2*	*$144,020*	*WDFW*
Pilchuck #1	*N.F. Stillaguamish R.*	*2000*	*8,118m2*		*Secret Ck. Estates*
Pilchuck #2	*N.F. Stillaguamish R.*	*2000*	*22,480m2*		*Secret Ck. Estates*
TOTAL STILLAGUAMISH BASIN			*381,660m2*		
TOTAL NORTH SOUND			*888,776 m2*		

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

Project Site	WRIA	Area (m2)	Current Production		Comments
			Mean Annual Smolts/m2 [1]	Mean Annual Spawners/m2 [2]	
SKAGIT RIVER BASIN					
Suiattle Slough	03.0710A	3,116	1.14	0.11	The strong perennial flow, excellent spawning areas, and recent improvements in fishway attraction function seed a large pond area with abundant complex cover for juvenile rearing.
Cascade Millpond	03.1411B	7,050	0.06	0.23	Outflow very dependent on prevailing weather pattern leading to wide variability in attractiveness to spawners.
Careys Slough	03.0354	169,000	0.11	0.34	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	0.05	No estimate available	Formal fishway built in 1995 will continue improve production by providing efficient assess.
Harrison Pond	03.1340	140,000	0.05	No estimate available	Production since 1995 when formal fishway was constructed at the outlet providing free access to adults and juveniles. Subsequent inside spawning gravel enhancements have continued to lead to improved smolt production.
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/m2).
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	Drought through much of the 1990's evaluation period reduced flows below acceptable levels for significant smolt production. Pre-project production from years when fish had temporary access indicated site is capable of smolt production in range of 0.5-0.8/m2. Production will likely always be flow dependent.
Park Slough	03.1859A,B	4,400	0.91	0.02	Perennial ground water channel provides excellent spawning and rearing habitat.
County Line Ponds	03.1853B	22,250	0.36	0.29	Production since 1996 when upper pond enlarged by excavation and outflow improved.
Newhalem Ponds	03.1864A	81,000	0.19	0.08	Not all of the large pond area is likely contributing to site production.
TOTAL and MEANS (w/ 95% C.I.)		506,596 m2	=0.31 ±0.25	=0.39 ±0.47	
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 with juveniles but smolt production may not change given its stable level over a number of years.
Gold Basin	05.0401A	5,000	0.30	0.153	Project is very productive when upper South Fork has had an escapement.
Granite Falls	05.0358C	17,900	0.10	0.094	Production has varied considerably over 5 years of evaluation possibly being influenced by large fish predator population.
Rowen	05.0220A	4,000	0.83	0.203	Spawning area expansion and stream rehabilitation in 1995 should increase production in 1997 and future years.
Hazel	05.0228	9,584	0.43	0.270	Production has been constant over evaluation period.
TOTAL and MEANS (w/ 95% C.I.)		83664 m2	=0.39 ±0.34	=0.21 ±0.12	

[1] *Mean values for years of record with project in current design configuration. NOTE: A more accurate estimate of smolt production for each river basin that includes more sites is found in Table 5.*
[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 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs a	Mean Length Downs (SD) [N]	%Change Lengthk	Out migrant/ m2	Out migrant / acre
SKAGIT										
1986-87	Suiattle	2.0b	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

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

Season	Trap Site	RM	Area	Total Ups	Mean Length UPS (SD) [N]	Total Downs a	Mean Length Downs (SD) [N]	%Change Lengthk	Out migrant/ m2	Out migrant / acre
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
1997-98	Boundary Cr.	"	"	—	—	967	94 mm (9.2([315]	—	0.31	1246
1998-99	Boundary Cr.	"	"	—	—	427	108mm(12.0)[290]	—	0.14	551
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
1998-99	Cascade Mill	"	"	—	—	638	119mm(8.9)[297]	—	0.09	366
1999-00	Cascade Mill	"	"	—	—	651	101mm(11.8)[222]	—	0.09	374
00-01	Cascade Mill	"	"	"	—	379	104mm(14.6)[135]	—	0.05	217
1985-86	Careys	39.2	169000 m^{2v}	---	---	3725	---	---	0.02	81
1986-87	Careys	"	"	---	---	5488	---	---	0.03	121
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[p]	"	"	6023[l]	79 mm (8.8)[944]	18730	112 mm (12.8)[3731]	---[t]	0.11	445
1989-90	Upper Careys[s]	"	51708 m^{2u}	4381[l]	84 mm (8.7)[96]	4165	104 mm (9.3)[2510]	---[t]	0.08	324
00-01	Careys	"	169000m^2	—	—	7429	101mm(11.0)[605]	—	0.04	178

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

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
1997-98	Barnaby Slough	"	"	—	—	3881	109 mm (9.8)[707]	—	0.05	216
1998-99	Barnaby Slough	"	"	—	—	1748	117mm(11.0)[448]	—	0.02	97
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
1997-98	Harrison	"	"	—	—	3806	109 mm (9.9)[820]	—	0.03	110
1998-99	Harrison	"	"	—	—	5796	107mm(9.1)[776]	—	0.04	168
1999-00	Harrison	"	"	—	—	14,886	94mm(11.2)[1704]	—	0.10	430
00-01	Harrison	"	"	—	—	9662	106mm(9.0)[820]	—	0.07	279
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
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

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

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*
1996-97	*Marsh Pond*	*“*	*“*	*—*	*—*	*81*	*116mm(6.0)[54]*	*—*	*0.02*	*86*
1998-99	*Marsh Pond*	*“*	*“*	*—*	*—*	*98*	*107mm(16.2)[91]*	*—*	*0.03*	*104*
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*
1997-98	*Park Sl. Old*	*“*	*3000 m^{2}*	*—*	*—*	*2168*	*76 mm (13.2)[2162]*	*—*	*0.72*	*2924*
1997-98	*Park Sl. New*	*“*	*1400 m^{2}*	*—*	*—*	*1066*	*78 mm (12.6)[1057]*	*—*	*0.76*	*3081*
1997-98	*Park Sl. Combined*	*“*	*4400 m^{2}*	*—*	*—*	*3234*	*77 mm (13.0)[3219]*	*—*	*0.73*	*2974*
1998-99	*Park Sl. Old*	*“*	*3000m^{2}*	*—*	*—*	*2853*	*84mm(13.6)[2214]*	*—*	*0.95*	*3848*

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

1998-99	*Park Sl. New*	*“*	*1400m^2*	*—*	*—*	*1587*	*80mm(12.7)[1433]*	*—*	*1.13*	*4586*
1998-99	*Park Sl. Combined*	*“*	*4400m^2*	*—*	*—*	*4440*	*83mm(13.3)[3647]*	*—*	*1.01*	*4083*
1999-00	*Park Sl. Old*	*“*	*3000m^2*	*—*	*—*	*2542*	*75mm(13.0)[2389]*	*—*	*0.85*	*3428*
1999-00	*Park Sl. New*	*“*	*1400m^2*	*—*	*—*	*1223*	*76mm(15.5)[1202]*	*—*	*0.87*	*3534*
1999-00	*Park Sl. Combined*	*“*	*4400m^2*	*—*	*—*	*3765*	*75mm(13.9)[3591]*	*—*	*0.86*	*3462*
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*
1997-98	*County Line*	*“*	*“*	*—*	*—*	*16,141*	*93 mm (6.2)[13,677]*	*—*	*0.73*	*2935*
1998-99	*County Line*	*“*	*“*	*—*	*—*	*3821*	*89mm(10.7)[1399]*	*—*	*0.17*	*695*
1999-00	*County Line*	*“*	*“*	*—*	*—*	*10,733*	*87mm(10.1)[3707]*	*—*	*0.48*	*1952*
00-01	*County Line*	*“*	*“*	*—*	*—*	*6301*	*93mm(8.3)[423]*	*—*	*0.28*	*1146*
1990-91	*Newhalem*	*90.5*	*1393 m$^{2\,ag}$*	*---*	*---*	*133^{ad}*	*---*	*---*	*0.09*	*364*
1997-98	*Newhalem^{bb}*	*“*	*81,000 m^2*	*—*	*—*	*16,453*	*105 mm (8.9)[1585]*	*—*	*0.20*	*823*
1998-99	*Newhalem*	*“*	*“*	*—*	*—*	*13,616*	*105mm(11.3)[1138]*	*—*	*0.17*	*680*
1999-00	*Newhalem*	*“*	*“*	*—*	*—*	*15,715*	*105mm(10.4)[1071]*	*—*	*0.19*	*785*
1998-99	*Cascade Park*	*3.7*	*2023m^2*	*—*	*—*	*178*	*101mm(9.2)[159]*	*—*	*0.09*	*356*
1999-00	*Cascade Park*	*“*	*“*	*—*	*—*	*783*	*92mm(9.9)[269]*	*—*	*0.39*	*1566*
00-01	*Cascade Park*	*“*	*“*	*—*	*—*	*1231*	*82mm(10.9)[316]*	*—*	*0.61*	*2474*
1999-00	*Taylor*	*79.4*	*5694m^2*	*—*	*—*	*6102*	*86mm(8.2)[645]*	*—*	*1.07*	*4336*
00-01	*Taylor*	*“*	*“*	*—*	*—*	*5649*	*90mm(9.3)[726]*	*—*	*0.96*	*3904*
					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*

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

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[e,l]*	*127 mm (7.9)[150]*	*---*	*0.03*	*121*
1993-94	*Gold Basin*	*"*	*"*	*---*	*---*	*767[e,v]*	*108 mm (7.9)[763]*	*---*	*0.15*	*607*
1994-95	*Gold Basin*	*"*	*"*	*---*	*---*	*2848*	*99 mm (7.0)[609]*	*---*	*0.57*	*2306*
1998-99	*Gold Basin*	*"*	*"*	*—*	*—*	*536*	*104mm(11.3)[289]*	*—*	*0.11*	*434*
1999-00	*Gold Basin*	*"*	*"*	*—*	*—*	*666*	*101mm(10.2)[208]*	*—*	*0.13*	*539*
00-01	*Gold Basin*	*"*	*"*	*—*	*—*	*1971*	*82mm(6.0)[447]*	*—*	*0.39*	*1602*
1988-89	*Hazel[f]*	*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[f]*	*"*	*"*	*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[f]*	*"*	*"*	*2365*	*84 mm (12.0)[729]*	*3872[z]*	*106 mm (7.5)[3155][a,h]*	*---*	*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*

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

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
1998-99	Big Four	64.0	3278 m^2	—	—	576	90 mm (11.9)[315]	—	0.18	711
1999-00	Big Four	"	"	—	—	1131	84mm(13.8)[346]	—	0.34	1396
00-01	Big Four	"	"	—	—	610	86mm(11.8)[285]	—	0.19	756
1998-99	Marsh Creek	44.2	100,000 m^2	—	—	244	115 mm (7.5)[231]	—	0.01	40
1999-00	Marsh Creek	"	"	—	—	362	117mm(6.0)[175]	—	0.01	40
00-01	Marsh Creek	"	"	—	—	2465	107mm(7.3)[603]	—	0.02	80
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][pp]	2376	91 mm (9.7)[802]	11%[as]	0.59	2387
1993-94	Rowen[ar]	"	"	---	81 (9.2)[497][pp]	1570[aw]	95 mm (8.6)[914]	17%[as]	0.39	1578
1994-95	Rowen[ar]	"	"	---	85 (7.3)[490]	3224	99 mm (8.5)[502]	16%[as]	0.81	3277
1995-96	Rowen[ba]	"	"	---	74 (7.0)[222][pp]	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
1997-98	Rowen	"	"	—	—	2927	89 mm (9.7)[747]	—	0.73	2961

[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.

Table 5. (continued) Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 to 2001.

[i] *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 floods of 1995 and 1996 and many of the marked fish are assumed to have left.*
[bb] *First smolt evaluation since the project was completed in 1991.*

NOTE: *Mean smolt production for all Skagit project sites in their existing condition is 1466 smolts per acre (95% CI of ± 194). Mean smolt production from all Stillaguamish project sites in their existing condition is 1429 (95% CI of ± 496) smolts per acre. Difference between rivers is not statistically significant.*

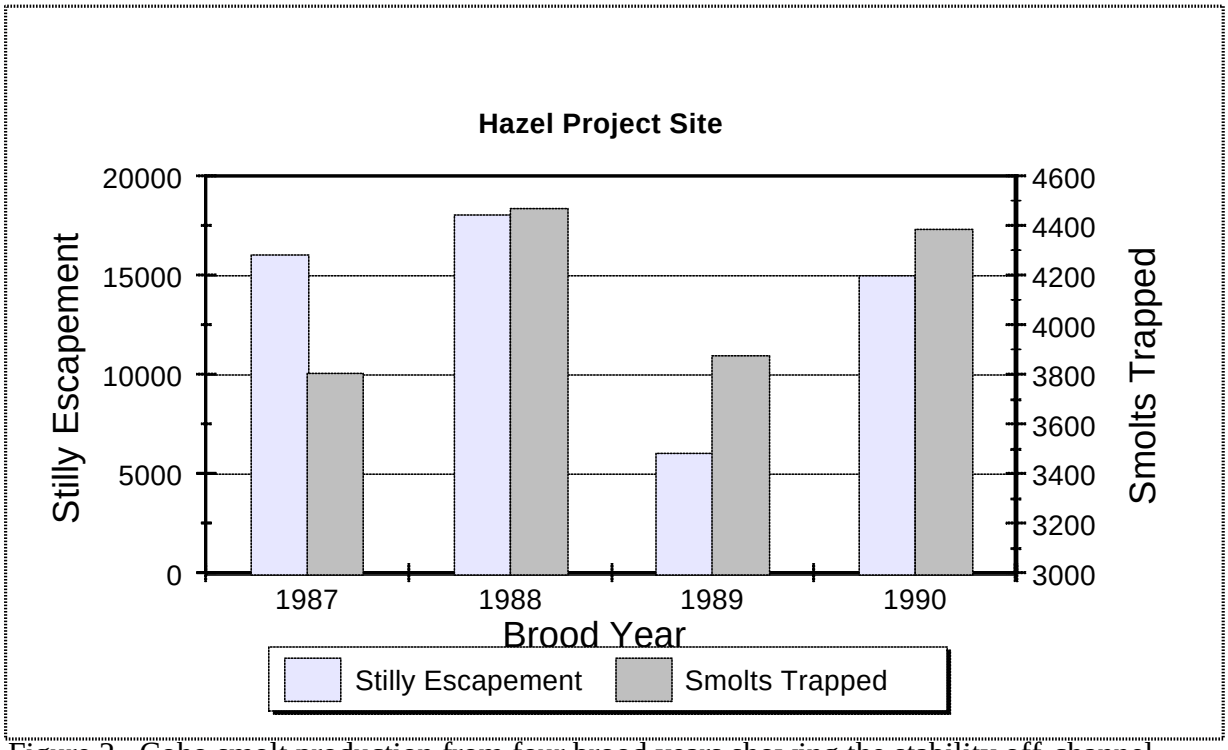
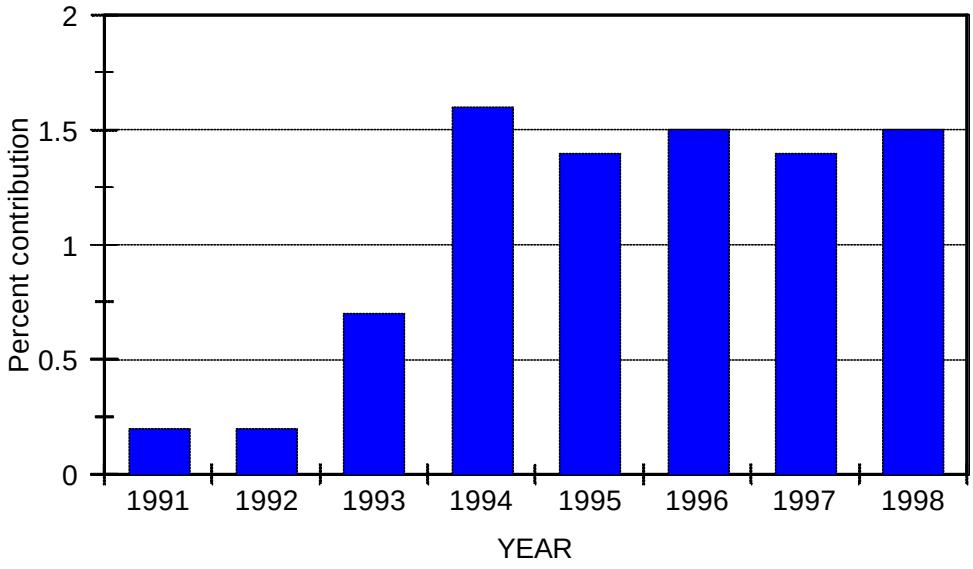


Figure 2. Coho smolt production from four brood years showing the stability off-channel projects can provide even when basin escapement is low.

Figure 3. Smolt production follows escapements at some sites such as Gold Basin.

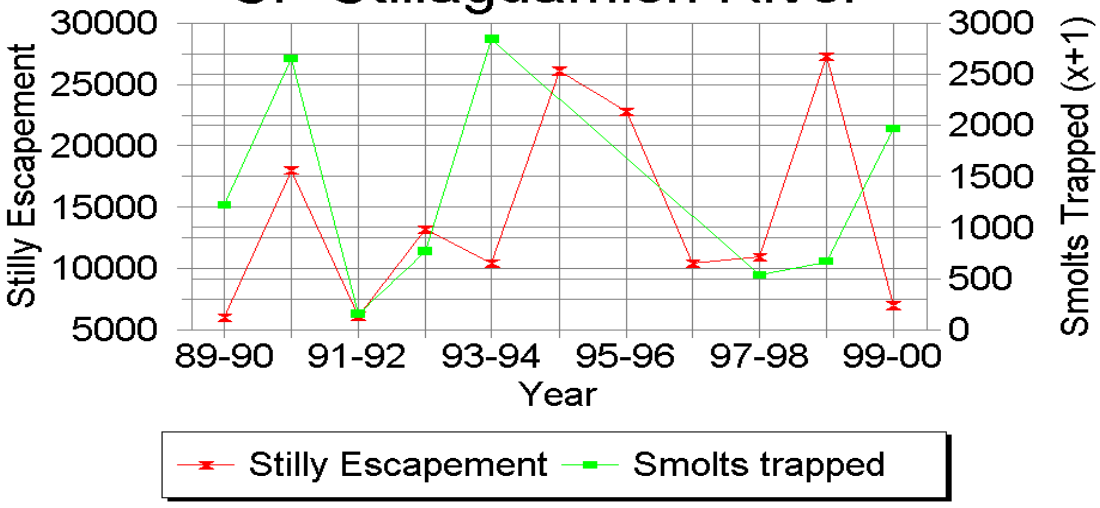
NEWHALEM PONDS

% Coho Spawner Contribution to Skagit



Gold Basin Project Site

SF Stillaguamish River



NORTH COAST

ABSTRACT

During 2001, we continued to inventory off-channel spawning and rearing habitat in the Sol Duc River with emphasis on tributary streams. The North Coast inventory project is about 85% complete for the main stems of the Queets/Clearwater, Hoh, Bogachiel, Calawah, Sol Duc, and Dickey Rivers and about 50% complete for their major tributaries. In 2001, two major fish habitat enhancement projects were completed on the South Fork of the Hoh River including the extension of an existing project and the enhancement of a spring-fed channel.

Maintenance and repair work was performed on several existing projects using contract labor from the Clearwater Corrections Center.

The habitat inventory team also identified potential habitat enhancement opportunities in the Hoh, Sol Duc, and Middle Fork Dickey river systems. These projects are scheduled for completion during the summer of 2002.

Existing and potential habitat enhancement projects were evaluated by monitoring fish use (including spawning activity) and overall function. In 2000, adult coho salmon escapement to the Hoh River system was estimated to be 6,798 fish. This represents the second highest return in 27 years. Preliminary estimates for the 2001 escapement indicate over 7,000 fish. Currently the escapement goal for the Hoh is between 2,000 and 5,000 fish. Coho escapements have exceeded 4,000 fish for seven out of the past ten years.

The Environmental Restoration Division has developed 15 projects in the Hoh River system to date. These projects have the potential to produce about 20 percent of the estimated total coho smolt production in the Hoh watershed. In the Quillayute system we have built 27 projects that have the potential to produce over 10 percent of the total smolt output. In the Bogachiel River alone, nine projects have the potential to produce about 20 percent of the total coho smolt output.

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 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 as you face 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. Any sites found on tributaries to the mainstems have existing WRIA numbers included in the site identification name. If the waters are unnumbered they are given a tentative WRIA number.

Each site which has existing and/or potentially fish habitat is surveyed, and data on the following characteristics such as flood susceptibility, water source and quantity, water quality, juvenile fish access and current use, channel entrance conditions, machinery accessibility, substrate type are recorded. The evaluations for potential enhancement projects are based, in part, on this information. Since many sites are de-watered, or nearly so, during the summer, follow-up surveys sites are conducted after the onset of the autumn rains to provide additional information on water levels and flow.

Project Evaluation

Coho production from these enhancement projects is evaluated primarily by monitoring juvenile fish movement into and out of project areas using two way migrant traps. Traps are made of ½-inch plywood and 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 of the trap. One half of the box is open to upstream migrating fish and the other half to downstream migrating fish. Each half is lined with a 1/8-inch nylon mesh net to facilitate fish removal and lessen the chance of handling injury. Cones formed from 1/4-inch mesh plastic screening are placed over the entrances to both halves of the trap to keep fish from finding their way back out. These cones taper from 4 inches to 1.5 inches. The fish are funneled into the trap openings by placing 1/4-inch mesh screen wing panels in a "V" formation upstream and downstream from the trap. The screens are made of galvanized, stainless steel, or plastic coated hardware cloth. The galvanized wire tends to corrode in one or two years and have been replaced with more expensive coated and stainless wire which lasts five years or more.

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 recorded. Every fish is 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 are 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 electro-shocker and/or by setting wire mesh minnow traps baited with salmon roe.

Project Design

Each proposed project is rigorously reviewed by a team consisting of the lead Environmental Engineering Services (EES) engineer, the SSHEAR construction superintendent, and the lead SSHEAR Division Environmental Specialist. Once the projects are approved for development, an engineering survey of the site is conducted and a preliminary design is produced. After final review and approval of the design by the project team, landuse agreements are negotiated and applications are submitted for the necessary environmental permits. A project time line is developed that identifies the date for materials purchasing and construction.

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 2001, off-channel rearing habitat inventory work continued on the Sol Duc and West Fork Dickey river tributaries. These data are loaded into a database and are available to various resource managers, including local Habitat Management biologists, to help them when reviewing environmental permit applications. This database has improved WDFW's ability to protect key coho producing habitat. To date, habitat inventory work has been completed on about 80% of the North Coast river systems.

This habitat inventory information 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 inventory has located many miles of previously undocumented waterways. These streams have been assessed for fish use and then recommended for water type classification and inclusion into the state Department of Natural Resources water type maps. In some cases, fish use can be documented in streams that have been previously classified as non-fish bearing. This information assists Regional Habitat Biologists in their efforts to protect critical fish habitat.

Providing fish passage at human-made barriers such as poorly designed culverts has become a high priority. Any human-made fish barriers encountered during our surveys are documented and included in the SSHEAR fish passage database.

Project Evaluations

The goal of our project evaluations is to collect information that will assist in the refinement of current habitat enhancement techniques. So far the data indicates that coho over-winter survival is higher at projects with large amounts of complex submerged woody debris and certain species of submergent and emergent aquatic vegetation. From studies in Oregon, the addition of woody debris to constructed overwintering habitat greatly improved the over-winter survival and size of fish. (Rodgers et al., 1993). Coho and trout juveniles use the wood and vegetation as cover to avoid avian and mammalian predators. 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.

Evaluation work at selected sites will continue into the year 2002.

Hoh River Overview

The adult coho escapement to the Hoh river in the Fall of 2000 was 6,798 fish and estimates for 2001 indicate over 7,000 fish. (Mike Gross, Roger Mosley, WDFW personal communication). This is the seventh time in the past ten years that the escapement has been over 4,000 fish, (Figure 6). The year 2000 escapement was the second highest in 27 years. The escapement goal is between 2,000 and 5,000 fish. The Summer of 2001 was below average for precipitation which would have decreased the amount of rearing area for juvenile fish. We operated a two way juv enile fish trap at one existing project site on the Hoh river during the winter of 2000/2001. Using a measured mean production of 0.22 smolts per square meter, the 15 projects on the Hoh are producing about 20 percent of the total smolt output of the entire watershed..

Dismal Pond (Hoh River)

In the summer of 1989, the former Washington Department of Fisheries (WDF) 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 for construction and maintenance to WDF, at no cost. Additional woody debris has been added to the pond several times during the life of the project to keep the cover complexity at a high level.

Over the past eleven years we have observed a very strong, inverse relationship ($r^2 = 0.87$) between the size of the Hoh river coho escapement for the brood year and mean fork length of their progeny measured in the autumn as they enter over-wintering habitat, (Figure 7). In other words, as adult coho escapement increases, the size of their progeny appears to decrease. This information suggests that the summer growth rate of coho young of the year is density dependent. During the fall of 2001, the average fork length of the juvenile immigrant coho entering Dismal Pond continued to follow this trend.

In the spring of 2001, 20 percent of the coho that were previously marked as they entered Dismal Pond in the fall of 2000 were recovered in the out-migrant trap, (Table 6). There were no periods during the trapping season when the trap was backwatered from the Hoh River because of flooding. As a result, the marked recovery rate of 20 percent is considered to be accurate.

In the previous twelve years of evaluation at this site, mark-recapture rates have averaged 30 percent. This is lower than the post enhancement, over-wintering survival rate of 56% reported by Cederholm, et al., (1988) on their study of Paradise Pond, a Clearwater River tributary located on Washington's Olympic Peninsula. At Dismal Pond, in two of the 12 years we saw over 50 percent survival. Visual observations at Dismal Pond suggest that predation by otters and birds may be reducing the coho survival rate. During 1999, we added more woody debris cover to the pond to reduce predation. We are currently looking at different nutrient supplementation methods for this site to bolster the growth rates.

In the fall of 2001, over 3,600 juvenile coho migrated into Dismal Pond from the Hoh River (Table 7). This is well above the twelve year average immigration of 2,475 coho.

Quillayute System Overview

The Quillayute watershed consists of the Quillayute mainstem, Dickey, Sol Duc, Calawah, and Bogachiel rivers. Coho escapement for 2000 was good and resulted in good recruitment of juveniles to off-channel habitat in the autumn of 2001. Spawner returns in 2001 were strong. A two-way juvenile fish trap was operated at one site on the Bogachiel river. The mean smolts per square meter measured at selected project sites is about 0.35. Using the 27 project sites within the entire watershed we calculate that they are producing about 10 percent of the total Quillayute smolt output. The nine projects on the Bogachiel are estimated to be producing close to 20 percent of its entire smolt yield.

Rayonier Channel (Bogachiel River)

This project site was identified during habitat inventory work in the Bogachiel river floodplain. In 1998, a 1,200 foot long groundwater-fed channel was excavated to create overwinter rearing habitat for juvenile salmonids. Since its construction, we have observed juvenile salmonids using it for summer rearing also. A two-way migrant trap was installed in the fall of 2000 to capture upstream migrating juvenile fish. A sample was marked and, in the spring of 2001, only 6 percent of the marked fish were recovered as they migrated out as smolts, (Table 6). The low apparent survival is a mystery although minnow traps set later in the summer after the migrant trap was removed revealed smolt sized coho residing in the channel. Each winter during the trapping season we have observed a small number of dead or

dying juvenile coho on the trap screens or in the channel. . This area had been a dump site for a number of years before the project was built. It is not known what was dumped here, but a couple of old automobiles were uncovered during the channel excavation. We are planning to evaluate water quality at the site and possibly conduct sediment sampling to determine what is causing the mortality
Spawning occurred here for the first time during the fall of 2001. In addition, spawned out hatchery salmon carcasses were placed here in the winter of 2000/2001 to supplement the nutrient load in the channel. Growth rate overwinter was 31 millimeters which was similar to the previous year's rate of 32 millimeters. This method of nutrient supplementation was also done during the winter of 2001/02 and preliminary indications show a similar good growth rate. During the fall of 2001, this site had over 2,900 juvenile coho move in to overwinter, (Table 7).

Calawah Springs (Bogachiel River)

This project was originally completed in 1992 and included backwatering a spring-fed channel using log controls and the creation of a small side channel for spawning. Woody debris was added to provide cover from predators. In the years since the construction, additional woody debris has been added.

This site was monitored with a two-way juvenile fish trap for several years after project construction. Juvenile coho densities were high the last two years of trapping from 1996 to 1998 and the fish showed very little growth over the winter months. From five years of trapping, the fish averaged only 10 millimeters of fork length growth from November through April. With the recent information on nutrient enrichment from salmonid carcasses, we added a large number of dead hatchery fish to the system to see if there was a detectable response and the fish responded, averaging 18 millimeters of growth despite a density of over one fish per square meter. Overwinter survival exceeded 40 percent for this site during the winter of 2000/01, (Table 6).
Over 2,900 juvenile coho were counted moving into the project during the fall of 2001, (Table 7).

2001 CONSTRUCTION PROJECTS

Project costs and habitat benefitted for the 2001 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.

Mosley Springs Extension
The original Mosley Springs project was built on South Fork of the Hoh River in 1991 and 1992. The spawning and rearing habitat had, in some years, been used almost to capacity. During the summer of 2001 the SSHEAR construction crew an additional 900 square meters of habitat to the upper end of the project.

Lear Creek Springs II
Using a crew of Honor Camp inmates from the Clearwater Corrections Center, additional rearing and spawning habitat was created at the Lear Creek Springs site by using cedar plank weirs to backwater the existing shallow water areas in this high quality spring-fed channel.

The Honor Camp inmates also performed maintenance and repair work at various other enhancement sites this summer.

SCHEDULED PROJECTS FOR 2002

Lake Creek Springs
This project is similar to Lear Creek Springs, but is located on the Sol Duc River. It will result in the creation of additional rearing habitat in a high quality spring-fed channel by using cedar plank weirs to backwater the existing shallow water habitat.

Nolan Springs
In this tributary of the Hoh River, an undersized plugged culvert will be replaced with a sloping roughened channel to maintain a large wetland that has been created as a result of the plugged culvert. This will be a cooperative project with WSDOT and the Rayonier Timber Company. It will improve fish access to over 7,000 square meters of rearing habitat.

Pseudo Springs
This project, which is located on the Middle Fork Dickey River, is very similar to Nolan Springs. An undersized plugged culvert will be replaced with a sloping roughened channel to maintain a large wetland that has been created as a result of the plugged culvert. It will improve fish access to over 1,000 square meters of rearing habitat.

Maintenance
Existing project sites will be inspected for maintenance needs and work will be performed as necessary. Stumps and other woody debris will be added to projects that appear to have inadequate cover.

SUMMARY

During 2001, the North Coast area experienced less than normal precipitation during the summer which probably resulted in a reduction in available rearing habitat as stream flows receded. This year the peak of the juvenile salmonid upstream migration occurred during October and November. As in the past the migration coincided with the onset of autumn rains. Fortunately, this has been a wetter than normal fall and winter which helped compensate for the unusually dry spring and summer months. The high-quality rearing and spawning areas which were either created or enhanced in 2001 should provide excellent overwintering habitat for wild juvenile coho and other salmonids.

The evaluation of past projects is providing valuable information on how to improve the design of off-channel, over-wintering habitat enhancement projects so they are more effective. One example would be our observation that predation by waterfowl, otters, and trout may significantly reduce the survival of over wintering coho at our enhancement sites. To remedy this problem, large amounts of complex woody debris are now being incorporated into all projects to provide cover and reduce predation.

Because of the good number of coho spawners on the Hoh river in 2000 and the higher water conditions of fall and winter 2001, we saw a corresponding increase in juvenile immigrants into the project areas during the autumn of 2001.

At Dismal Pond over the past eleven years we have seen a close inverse relationship ($r^2 = 0.87$) between the Hoh river coho brood year escapement size and the brood year's progeny mean fork length measured the next Fall, (Figure 7). The average size of this year's juvenile coho immigrants into Dismal Pond is about 80 mm. Based on the above relationship, we would have expected an average around 85 mm.

Preliminary estimates show the 2001 coho run to the Hoh river to be the second and possibly the largest in the past 27 years. With the number of Hoh river spawners being fairly 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, (Figure 8). Until this happens, the sites may never cycle up to full production capacity.

Off-channel rearing habitat inventory work continued on the Sol Duc river and it's tributaries in 2001. 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.

During 2001, the Clearwater Corrections Center labor crews, which are supervised by the Department of Natural Resources (DNR), were contracted to perform various parts of the hand labor construction including much of the re-vegetation.

Local timber companies and the DNR have been very cooperative in allowing us to conduct inventories and habitat enhancement/restoration work on their properties. In some cases the timber companies have provided funding and/or in kind services. WDFW will continue to develop cooperative projects with timber companies and any other landowners who are willing to work with us.

Project evaluation work continues at selected sites. The data collected is providing valuable information on the numbers and the quality of fish being produced, over-winter survival rates, and overall project function. The data indicates 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

The habitat inventory work will continue on the North Coast streams. Supplemental survey work must be continued throughout the year to monitor potential project sites under a wide range of environmental conditions.

Evaluation work has also required more time than anticipated. The additional effort required to identify and type new streams and wetlands, participate in Watershed Analysis and other technical advisory groups, and implement the new culvert inventory process has slowed the pace of the habitat inventory but we feel it is necessary to make sure this valuable information is not bypassed.

Because of concerns for fish life, construction work within the streams' ordinary high water mark is limited to a brief period between June 15 and October 15. This combined with the increasingly lengthy and complex process needed to secure the required environmental permits, pre-project evaluation, planning and engineering effectively limits the number of projects that can be completed. However, potential habitat enhancement projects are continually being identified.

Table 6. North Coast upstr eam/downstream migrant trapping summary for Fall 2000 and Spring 2001.

Site	River Basin	Coho In	Coho Out	Marked Group Recovery	Trout In	Trout Out
Dismal Pond	Hoh	3,587	1,214	20.2%	173	44
Rayonier Channel	Bogachiel	1,480	133	5.8%	6	8
Calawah Springs	Calawah	1,659	1,227	40.5%	357	158

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.

Table 7. North Coast upstream migrant trapping summary for Fall 2001.

Site	River Basin	Location (RM)	Coho In	Trout In
Dismal Pond	Hoh	26.0	3,628	151
Rayonier Channel	Bogachiel	18.3	2,948	9
Calawah Springs	Calawah	3.0	2,906	762

Table 8. North Coast habitat enhancement projects completed in 2001

Project	River Basin	Project Type	Habitat Benefitted	Project Cost	Landowner
Mosley Springs Extension	South Fork Hoh	Spring Channel Enhancement	900 m²	$61,000	DNR
Lear Creek Springs	South Fork Hoh	Spring Channel Enhancement	700 m²	$35,169	DNR
		TOTALS	1,600 m²	$96,169	

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
* Mosley Springs	S.F.Hoh	1991	4,048 m²	$21,000	State
* Lear Springs	S.F.Hoh	1991	800 m²	$18,100	State
* Upper Mosley	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

PROJECT SITE	RIVER BASIN	YEAR COMPLETED	HABITAT BENEFITTED	COST	PROPERTY OWNER
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	*Sol Duc*	*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*
Rayonier Channel	*Bogachiel*	*1998*	*1,700m²*	*$135,000*	*Rayonier*
Tyee Pond	*Sol Duc*	*1998*	*2,800m²*	*$80,000*	*Rayonier*
Rootstock Springs (II)	*Calawah*	*1998*	*600m²*	*$22,000*	*Rayonier*
**Eagle Creek Springs*	*Sol Duc*	*1999*	*2,200m²*	*$84,000*	*Private*
Thomas Springs	*Sol Duc*	*1999*	*2,800m²*	*$20,000*	*Private*
Big Beaver Springs	*E.Fk. Dickey*	*1999*	*7,400m²*	*$35,000*	*Rayonier*
**Prairie Fall Creek*	*Sol Duc*	*2000*	*4,700m²*	*$148,400*	*Clallam County*
**Labrador Creek*	*W.Fk.Dickey*	*2000*	*2,000m²*	*$37,800*	*Green Crow Timber*
**M & R Springs*	*Sol Duc*	*2000*	*700m²*	*$59,900*	*Merril & Ring Timber*
Mosley Springs Ext.	*S.Fk.Hoh*	*2001*	*900m²*	*$68,000*	*DNR*
Lear Ck. Springs II	*S.Fk.Hoh*	*2001*	*700m²*	*$35,000*	*DNR*

** Cost share projects with timber companies, DNR, DOT, Salmon Coalition, Counties and/or Tribes.*

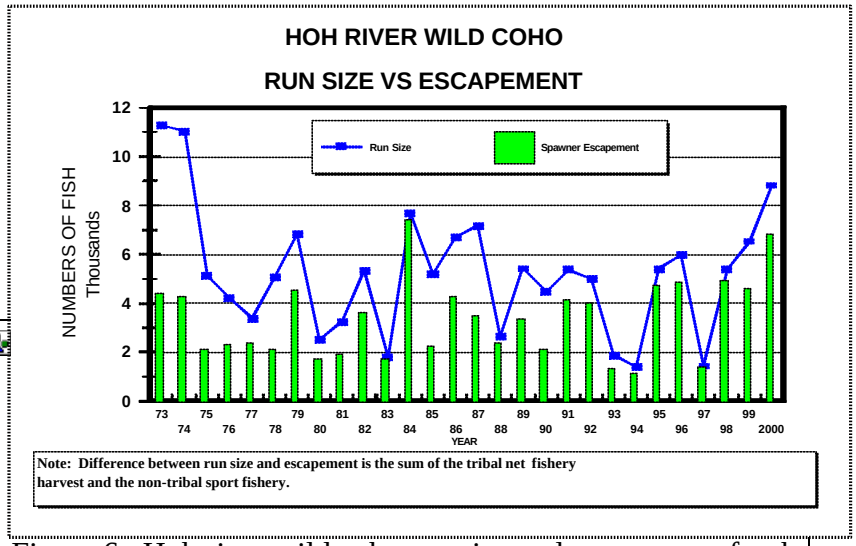


Figure 6. Hoh river wild coho run size and escapement for the years 1973 through 2000.

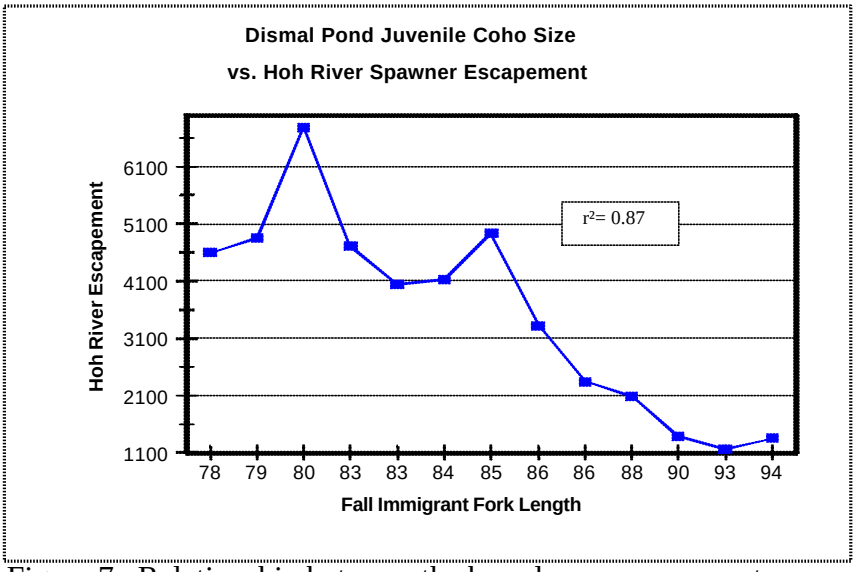


Figure 7. Relationship between the brood year escapement andthe size of their progeny measured in the Autumn for 13

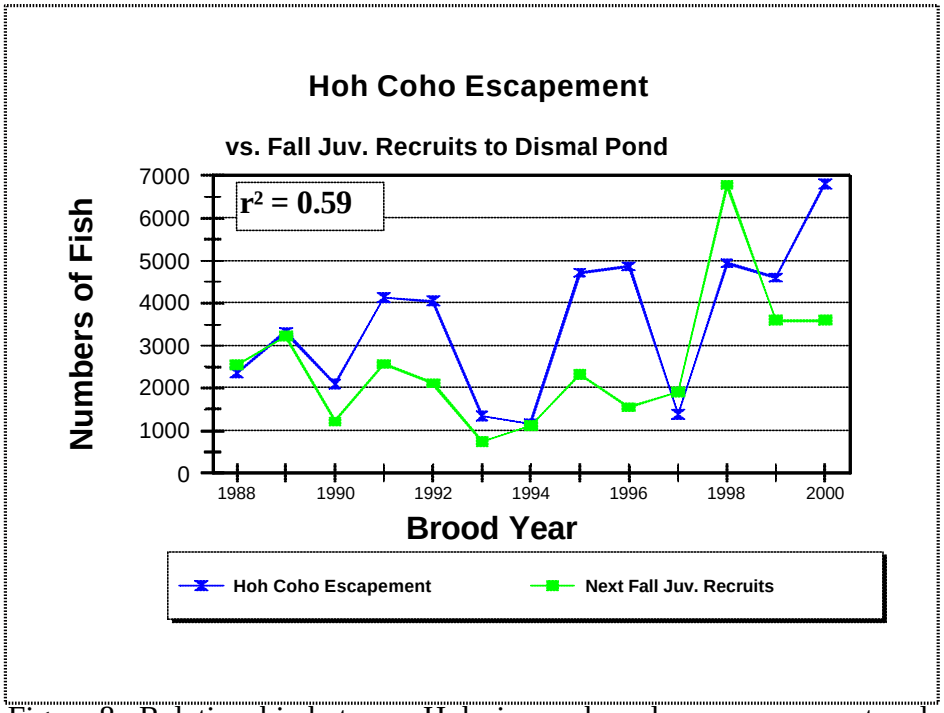


Figure 8. Relationship between Hoh river coho salmon escapement and numbers of brood year offspring immigrating into Dismal Pond the next

FISH SCREENING

INTRODUCTION

The Yakima Screen Shop (YSS) is the eastern Washington component of SSHEAR in the Habitat Program's Environmental Restoration Division. The YSS is organized into the following work units: Screen Fabrication, Fish Screen/Fishway Inspection, Operation & Maintenance (O&M), Fish Screen Facility Capital Construction, and Fish Screen Technical Assistance.
Program management is provided by an Environmental Specialist 5 with local responsibility for all YSS functions, and support staff (a Supply Control Technician and Senior Office Assistant). Funding for the YSS Screening Program administration totals approximately $125,000 annually split between state O&M and state capital budgets. Two Construction & Maintenance Superintendent 2's (CMS 2) support the management of the YSS; one CMS 2 oversees the Fish Screen/Fishway Inspection O&M and Fish Screen Technical Assistance programs, and one CMS 2 oversees the Screen Fabrication program. Two Construction Maintenance Supervisors (CMS), and one Construction Fabrication Supervisor (CFS) provide day-to-day supervision of the Screen Fabrication, O&M, and Fish Facility Capital Construction crews. This report summarizes the calendar year 2001 program accomplishments in each of the four work units.

Screen Fabrication
The YSS 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 O&M 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. The gradual expansion of the Screen Fabrication unit, beginning in 1987, provided capability for "production-level" fabrication of new rotating drum, traveling belt, vertical flat plate fish screens, and miscellaneous metalwork (lifting gantries, walkways, handrail, 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 & 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 Walla Walla Basin fish screen projects. The recent ESA listings of bull trout, spring chinook and steelhead in the upper Columbia River basin have greatly expanded the YSS mission, both in scope and geographic area. YSS builds fish screens for other governmental entities such as the Idaho Fish & Game Department, Oregon Department of Fish & Wildlife, U.S. Fish & Wildlife Service, U.S. Bureau of Reclamation, U.S. Forest Service, U.S. Park Service, Bureau of Indian Affairs, and various Irrigation Districts. YSS also provides fabrication services to other WDFW programs. YSS periodically fabricates or rebuilds fish hatchery intake and rearing pond outlet screens for the Hatchery Program. The YSS has also designed and fabricated cougar and black bear live traps used by WDFW wildlife enforcement agents to capture and relocate dangerous wildlife.

Permanent, full-time staff include a CMS 2, a CMS, and four Welder-Fabricators (WF). As annual workload expands or contracts, temporary WF's 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 FFY01 totaled $72,000. BPA Phase 2 fish screen fabrication projects completed in CY01 are summarized in Table 10. Other fabrication projects completed in CY01 are summarized in Table 11.

Fish Screen / Fishway Inspection and O&M
The fish screen/fishway inspection and O&M section is primarily a field-oriented work unit responsible for monitoring the operation of 140+ 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 consist of a CMS 2, one CMS, and two Plant Mechanics (PM) stationed at the YSS who divide the upper Columbia Basin into "north" and "south" areas of responsibility. The north area includes the upper Yakima River Basin (upstream of Roza Dam), Wenatchee River, Entiat River, Methow River, and Okanogan River Basins with a total of approximately 90 active gravity diversion screens and four fishways. The south area includes the lower Yakima Basin (downstream of Roza Dam), Naches River, Tieton River, Walla Walla River, Touchet River, Tucannon River, Asotin Creek, and Grande Ronde River Basins, with about 50 active gravity screens and three fishways. Six screens and one fishway located in the Dungeness River Basin

(Olympic Peninsula) are the responsibility of one half-time General Repairer (GR) 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. However, three "resident fish only" screens located in the Methow (2) and Okanogan (1) River Basins are inspected and/or maintained by YSS O&M personnel.

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 ($185,000 in CY01). Water users may contract with the YSS to perform all or a portion of their statutory O&M obligation utilizing a standardized YSS fish screen service contract. In CY01, 23 diversion owners signed contracts with an estimated value of approximately $36,300.

In 1993, the O&M work unit began performing O&M on BPA-funded Yakima Basin Phase 2 fish screen facilities. In CY01, YSS provided preventive maintenance services on 21 Phase II sites with $141,000 in BPA funding. These facilities range in size from a 2' X 4' long paddlewheel-driven, modular screen (2.2 cfs) up to a 150 cfs canal with 8 - 6½' X 10' electric-drive drum screens.

The O&M work unit also maintained 15 screens and five fishways in the mid and upper Columbia Basin for the National Marine Fisheries Service (NMFS) with $55,000 of FFY01 Mitchell Act funding.

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 sub-basins. During the field season, a two-man crew installed screens on the unscreened pump intakes. However, in CY01 no pump screen fabrication and installation were performed because of the emphasis on funding only high priority gravity screen and fishway construction. These pump screens are now available from a variety of private vendors, eliminating the need for continued fabrication by YSS.

This work unit typically performs screening facility field construction for rotating drum, traveling belt, or fixed plate screens for gravity diversions. This crew has also constructed two 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 up to 6 cubic feet per second (CFS). Field installation typically takes from one to five days, with total costs (including fabrication and installation) ranging from $15,000 to $25,000. Twenty five modular drum screens have been installed in Washington through CY01. In addition, the capital crew fabricates and installs flat plate screens with rotary wiper or gang brush cleaners. 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 2½ cfs. Several of the flat plate screens have been installed in Washington through CY01.

The Capital Crew is allotted 4 FTE's, with permanent staff consisting of a CFS, one WF, one PM, and one career seasonal GR. Temporary staff are added during the summer field season to assist in major gravity screen or fishway construction, and/or portable modular or flat plate screen installations. All of the construction projects for FY01 were funded via the Salmon Recovery Funding Board (SRFB), cost share (diversion owner, NMFS via Mitchell Act funds, BPA, state capital funds) and/or directly reimbursable by the proponent (U.S. Fish and Wildlife Service). Capital projects completed in CY01 are summarized in Table 11.

Fish Screen Technical Assistance

Permanent staff consist of one CMS 2 who provides ongoing technical assistance to irrigation diversion owners, irrigation equipment vendors, and agency personnel (both in-house and out of house). In CY01, numerous contacts were made regarding fish screening technical assistance. The CMS 2 participated in several workshops sponsored by various organizations, and provided practical information relative to fish screening needs.

Table 10. 2001 BPA Phase 2 Screen Fabrication		
Project Name	*Description*	*Time Period*
Wilson Creek	*Fabricated and installed three rotary drum screens (3 ½ ft. dia. x 14 ft. long), trash rack, handrail, walkways, overshot/undershot fish bypass gate/ramp assembly and gantry system.*	*1/01 to 4/01*
Powell LaFortune	*Fabricated and installed three rotary drum screens (3 ½ ft. dia. x 12 ft. long), trash rack, handrail, walkways, overshot/undershot fish bypass gate/ramp assembly and gantry system.*	*1/01 to 4/01*
Scott	*Fabricated two rotary drum screens (3 ½ ft. dia. x 12 ft. long), trash rack, handrail, walkways, overshot/undershot fish bypass gate/ramp assembly.*	*4/01 to 7/01*
Selah Moxee	*Fabricated structural steel support, twelve fixed plate screen panels (each 5 ft. tall x 6 ft. wide), brush wiper system, handrail, walkways, overshot/undershot fish bypass gate/ramp assembly.*	*9/01 to 12/01*
Chapman Nelson	*Installed one 3 ft. dia. x 6 ft. long portable modular screen installation.*	*11/01 to 12/01*
Lewis	*Fabricated and installed 2 ½ ft. dia. x 4 ft. long portable modular screen.*	*11/01 to 12/01*

Table 11. 2001 Other Screen and Miscellaneous Fabrication		
Project Name	*Description*	*Time Period*
Early Winters	*Fabricated two rotary drum screens (3 ½ ft. dia. x 10 ft. long), trash rack, handrail, walkways, over shot/undershot fish bypass gate/ramp assembly.*	*1/01 to 5/01*

Foghorn	*Fabricated two rotary drum screens (3 ½ ft. dia. x 10 ft. long), trash rack, handrail, walkways, over shot/undershot fish bypass gate/ramp assembly.*	*4/01 to 7/01*
Rockview	*Fabricated plate screen panels with paddle wheel driven wiper system (hydraulic driven ball reverser system).*	*5/01 to 8/01*
Granite Falls, Shipperd Falls, Salmon Falls	*Fabricated fixed sill gates.*	*5/01 to 12/01*
Soos Creek #2	*Refurbished one 6 ft. dia. x 8 ft. long rotary end delivery screen.*	*6/01 to 9/01*
Kenyon Creek Fishway	*Fabrication of culvert baffles and stop log guide embeds.*	*7/01*
Muckleshoot Tribe	*Fabricated YSS design cougar trap.*	*7/01 to 8/01*
Lewis Creek (Dewitt)	*Fabricated one 2 ft. dia. x 4 ft. long paddle wheel driven rotary wiper plate screen.*	*7/01 to 8/01*
Kalama Falls	*Refurbished two 4 ft. dia. x 3 ft. long hatchery sand screens.*	*7/01 to 8/01*
Cle Elum Hatchery	*Fabricated hatchery picket barriers (2 ea.) and wall brackets (10 ea.) for net placement.*	*8/01 to 9/01*
City of Kent	*Fabrication of fish screen lift and transport gantry system.*	*8/01 to 10/01*
Maxwell Screens Rebuild - Oregon	*Refurbished three 4 ft. dia. x 12 ft. long rotary drum screens for Westland Irrigation District.*	*10/01 to 12/01*
Snake River Lab	*Screw trap modifications.*	*11/01*

Table 12. 2001 YSS Capital Construction Projects

Project Name	*Funding Sources*	*Time Period*
Early Winters	*SRFB, state proviso and NMFS cost share*	*3/01 to 5/01*
Maltais	*State capital*	*8/01*
Foghorn	*State capital, BPA, and USFWS*	*9/01 to 11/01*

REFERENCES

Bilby, R.E., Fransen, B.R. and Bisson, P.A. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Can. J. Fish. Aquat. Sci. 53: 164-173.

Bilton, H.T., Alderdice, D.F. and Schnute, J.T. 1982. Influence of time and size at release of juvenile coho salmon (Oncorhynchus kisutch) on returns at maturity. Can. J. Fish. Aquat. Sci. 39: 426-447.

Brown, Tom G. and Tom McMahon. 1987. Winter ecology of juvenile coho salmon in Carnation Creek: summary of findings and management implications. in Proceedings of the workshop: applying 15 years of Carnation Creek results. T.W. Chamberlin ed. 239 pp.

Cederholm, C.J., W.J. Scarlett, and N.P. Peterson. 1988. Low-cost enhancement technique for winter habitat of juvenile coho salmon. North American Journal of Fisheries Management 8(4):438-441.

Cederholm, C.J. and W.J. Scarlett. 1981. Seasonal immigrations of juvenile salmonids into four small tributaries of the Clearwater River, Washington, 1977-1981. Pages 98-110 in E. L. Brannon and E. O. Salo, editors. Salmon and trout migratory behavior symposium. University of Washington, Seattle.

Foy, Matthew. 1985. Coho production from upper Paradise Channel. Memorandum, Canada Department of Fisheries and Oceans. 26 pp.

Groot, C. and L. Margolis. 1991. Pacific Salmon Life Histories. Department of Fisheries and Oceans. UBC Press, Vancouver. 564 pp.

Hartman, G.F. and Scrivener, J.C. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Can. Bull. Fish Aquat. Sci. No. 223.

Johnson, Richard. 1986. An assessment of the Skagit River system's coho rearing potential. Washington Department of Fisheries Technical Report No. 95. 22 pp.

Nickelson, T.E., M.F. Solazzi, S.L. Johnson, and J.D. Rodgers. 1992. Effectiveness of selected stream improvement techniques to create suitable summer and winter rearing habitat for juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Can. J. Fish. Aquat. Sci. 49: 790-794.

Peterson, N.P. and L.M. Reid. 1984. Wall-base channels: their evolution, distribution and use by juvenile coho salmon in the Clearwater River, Washington. in Proceedings of the Olympic Wild Fish Conference. Olympic National Park and Peninsula College Publication, Port Angeles, Washington. J.M. Walton and D.B. Houston eds. 308 pp.

Reeves, G.H., F.H. Everest, and T.E. Nickelson. 1989. Identification of physical habitats limiting the productions of coho salmon in western Oregon and Washington. Gen. Tech. Rep. PNW-GTR-245. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. p.18

Rodgers, J.D., S.L. Johnson, T.E. Nickelson, and M.F. Solazzi. 1993. The seasonal use of natural and constructed habitat by juvenile coho salmon (*Oncorhynchus kisutch)* and Preliminary results from two habitat improvement projects on smolt production in Oregon coastal streams. Pages 344-348 *in* L. Berg and P.W. Delaney, editors. Proceedings of the Coho Workshop, Nanaimo, B.C., May 26-28, 1992.

Sekulich, Paul. 1991. Washington Department of Fish and Wildlife, Habitat Management Program, SSHEAR Section, Pre and Post Project Cost Accounting Format as amended on February 26, 1992. WDFW File Memo November 1, 1991. 7 pp.

Skeesick, D.G. 1970. The fall immigration of juvenile coho salmon into a small tributary. Oregon Fish Commission Research Report. 2 (1):90-95.

Tschaplinski, P.J. and G.F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Can. J. Fish. Aquat. Sci. 40:452-461.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State Salmon and Steelhead Stock Inventory. Olympia. 212 pp.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization. Vol. 1 - Puget Sound. Washington Department of Fish and Wildlife. Olympia.

Williams, R.W., L.A. Phinney, and P.B. Bucknell. 1975. A catalog of Washington streams and salmon utilization. Vol. 2 - Coastal Region. Washington Department of Fish and Wildlife. Olympia.