# 2002 ANNUAL REPORT

## Habitat and Passage Projects Section
## And Screening Projects Section

### Technical Applications 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. In addition, the presence and abundance of salmonids indicates the health of Pacific Northwest stream ecosystems. Without question, protection and enhancement of salmonids and the habitats 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 2002.

### FISHWAYS

The Fish Passage Unit is responsible for the inspection and evaluation of 508 fishways statewide. The purpose of this program is to insure that the 3,100 miles of habitat associated with those fishways is available to fish. 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 2002, 403 fishways received scheduled inspections. Of this number, 110 (27%) required maintenance or reconstruction. Compliance inspections conducted later in the year indicated that the owners of 50 (45%) 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 46% for 2002 was almost on par from the last ten-year average of 36%. Continual efforts will be made in working with fishway owners to resolve outstanding fish passage problems associated with fishways.

## FISHWAYS OPERATION AND MAINTENANCE

Currently, the Habitat and Passage Projects Section is responsible for the operations, maintenance and the eventual major repairs and modifications of 76 fishways statewide including 24 formal Mitchell Act fishways.

The Habitat and Passage Projects Section 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 2.1 staff months per year for weekly maintenance during the salmon run. The Sunset Falls fishway on the South Fork Skykomish River also requires maintenance and daily operations in the handling and hauling of fish from July through December. Operation of the trap and haul facility at Sunset Falls required 13.1 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 passed upstream at the Sunset Falls fishway during the 2002 season. This year marked the second largest return of adult coho to the fishway since operations began in 1958. The 44,152 coho that were trapped and hauled above the falls, was only second to last years record return of 50,434 adult coho. The total adult production above the falls (with no fisheries) has been estimated at 60,000 adult coho based on available habitat and smolt trapping at the site.

Table 1. Fish trapped and transported upstream at Sunset Falls during 2002.

| Species | Total No. Adults | Total No. Jacks |
|---|---|---|
| Coho Salmon | 44,152 | 126 |
| Chum Salmon | 387 | |
| Summer Chinook Salmon | 173 | 53 |
| Fall Chinook Salmon | 592 | 124 |
| Pink Salmon | 0 | |
| Sockeye Salmon | 21 | |
| Steelhead Trout | 1,491 | |
| Sea Run Cutthroat Trout | 1 | |
| Native Char | 90 | |

During the 2002 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 exiting above a 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 2002 project season, a new gantry system and gates were installed at the fishway exit. The new modifications will allow the fishway to be shut off for periodic inspections and maintenance. In addition, the stairwell leading down to the fishway exit area was modified to accommodate safety concerns and the new gantry network.

**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 44 years. The facility provides Spring chinook and Summer steelhead access to 38 miles of spawning and rearing habitat.

In 1996, a severe flood event resulted in significant damage to the fishway. Since then, work has continued to repair the damages. In 2002, the final phase of the work started in 1997 was completed. The work included modifications to the fishway entrance and the installation of a new entrance gate. Large rock that had resulted from the 1996 flood was shot and removed from the fishway entrance pool. 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 2002, the fishway underwent concrete repair work throughout the entire floor of the facility along with the installation of new sill blocks to further enhance fish passage. In addition, a new high flow entrance gate was designed, fabricated and installed. The work is aimed in enhancing fish passage and prolonging the life of the fishway.

**Mitchell Act Stream Clearance and Fishway Operation and Maintenance**

This project provides stream clearance and maintenance of fishways constructed under the Mitchell Act in the lower Columbia River drainage. Between January 1 and December 31 , 2002, a total of 5.7 staff months were spent for fishway maintenance and inspections, barrier reconnaissance, design work and development of recommendations for future work. The program is currently seeking federal funding for major maintenance associated with fishways that have been service for close to a half a century.

## WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) FISH PASSAGE INVENTORY

In 1991, the Washington State Legislature, working with the Washington State Department of Transportation (WSDOT) and the Washington State Department of Fisheries (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 highway stream crossings, and to correct inventoried passage problems by order of highest priority.

During the ongoing WSDOT inventory 3,883 state highway crossings have been inspected; 2,256 crossings were identified as fish bearing, including 1,036 fish barriers. The second phase of the ongoing project involves conducting habitat surveys, both downstream and upstream of identified barriers, to establish priorities for correction and quantify the habitat gain.

Three methods of habitat assessment are used; Full Physical Surveys, Threshold Determinations (TD), and Expanded Threshold Determinations (ETD), per the *WDFW Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (August 2000, located on the Internet at: http://www.wa.gov/wdfw/hab/engineer/habeng). The Full Physical Survey and ETD are used to qualify and quantify habitat, while the TD verifies a significant reach of habitat (200 m) exists both downstream and upstream of a barrier culvert crossing. Based on results of surveys completed to date, sufficient habitat gains to justify correction have been identified at 599 barrier features (culverts and/ or non-functional fishways). Another 150 fish barrier crossings are scheduled for further evaluation, to determine status for fish passage repair. An estimated 508 barriers remain to be corrected to address all salmonids (599 barriers to fix minus 91 already fixed barriers equals 508).

Since the inventory began, fish passage has been provided by WSDOT and WDFW's Technical Applications Division at 91 priority sites. During the year 2002 construction season, three WSDOT fish barriers were corrected by WDFW, including Cement Creek, WF Hylebos Creek, and an unnamed tributary to Bulson Creek.

## WSDOT FISH PASSAGE BARRIER CORRECTION EFFORTS BY WDFW IN 2002

### Cement Creek Fishway - SR 401 Milepost 8.80

Cement Creek is a tributary to the Naselle River. Prior to project completion, the culvert crossing was evaluated as a barrier due to its small size, causing high water velocities inside the culvert. In 2002, WDFW constructed an five-step, concrete "pool-chute" fishway. In addition, multiple rock weirs were placed downstream. More than four linear miles of habitat has been re-opened to chum, coho and other salmonids. Fish immediately reclaimed the newly opened habitat; a total of 679 chum salmon were counted on November 15, 2002, upstream of the new fishway, only a few months after its construction.

**WF Hylebos Creek Fishway - SR 99 Milepost 6.86**

WF Hylebos Creek is a tributary to Hylebos Creek, which flows into Commencement Bay. The pre-cast concrete box culvert crossing WF Hylebos Creek at SR 99 was considered a fish passage barrier due to a 3.5% slope, creating high velocities throughout the culvert. A new concrete lift and baffles were installed within the culvert to reduce velocities and maintain a stable gradient within the culvert. Log controls and large woody debris were also placed downstream of the baffled culvert to facilitate fish passage.

**Unnamed (WRIA 03.0199) tributary to Bulson Creek Fishway - SR 534 Milepost 1.20**

The unnamed stream (WRIA 03.0199) is a tributary to Bulson Creek. The original concrete round culvert was assessed as a fish barrier due to a 2.0 meter outfall drop and 4.5% culvert slope creating high velocities within the culvert. WDFW staff installed a new concrete round culvert fitted with steel baffles, and a 4-step concrete “pool-chute” fishway at the downstream end. The original culvert was left in place to accommodate highwater overflow. Nearly five miles of quality habitat has been re-opened to coho and other salmonids.

## WDFW WILDLIFE AREA (WLA) FISH PASSAGE AND SCREENING INVENTORY

During the past 62 years, WDFW has acquired approximately 840,000 acres of land associated with wildlife area sites, scattered throughout nearly every county in the state. Because of poor previous land use practices and the increasing awareness of fish passage and fish health 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 unscreened 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 human-made structures in streams be provided with a durable and efficient system for fish passage.

In cooperation with the Lands Division, the Habitat and Passage Projects Section 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 the Habitat and Passage Projects Section 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, Methow, Skagit, Sunnyside, Shillapoo and LT Murray wildlife areas. In 2002, work was concentrated within the LT Murray Wildlife Area where 63 features were evaluated on fish-bearing streams or streams with unknown fish use. Of these 63 features, 34 were found to be partial or total barriers to fish passage, which require repair. Of the features requiring repair, 31 are culverts, 2 are dams, and 1 is an "other" feature (ford crossing). Outside the WLA, 108 features on fish-bearing streams were evaluated. The LT Murray WLA report was sent to the printer in March 2003 and should be available in the near future.

Work on the inventory of the Sinlahekin WLA began in 2001 and approximately 65 percent of the fieldwork was completed before inclement weather ended the effort in December 2001. Work on the Sinlahekin WLA will resume in 2003.

## WDFW WILDLIFE AREA FISH PASSAGE BARRIER CORRECTION EFFORTS

### Methow Wildlife Area

The Methow Wildlife Area report was completed in 2001. In 2002, a private consulting company was contracted through General Administration to remove fish passage barriers identified in the report. Scoping and preliminary designs have been completed for the highest priority fish passage barriers on the WLA, permitting is underway, and construction is likely in summer 2004. 11 fish passage barriers are scheduled for correction in 2004.

### LT Murray Wildlife Area

In 2002, 13 barrier culverts were scoped and scheduled for removal in summer 2003 on Robinson and Ainsley Creeks, using WDFW construction crews. When completed, this effort will render the Robinson Canyon Creek watershed free of human-made fish passage barriers, on WDFW-owned land. Scoping continued in 2002 on the Taneum and North Fork Manastash Creek watersheds, also on the LT Murray wildlife area. This work requires coordination with wildlife area managers and the RMAP process to ensure road abandonment requirements are met.

## FISH PASSAGE PROJECT DEVELOPMENT

### Valley Creek Fish Passage and Stream Restoration Project

This was a cooperative project between the Washington Department of Fish and Wildlife (WDFW), the City of Port Angeles (City), the Port of Port Angeles, the North Olympic Salmon Coalition, the Port Angeles Rotary Club, and the Lower Elwha S'klallam Tribe to restore fish access and habitat in Valley Creek. This project was the second phase of a multi-phase project to restore the Valley Creek Watershed. Phase I was the correction of the fish passage barrier under SR 101 that was completed in 2000. Phase III will be the removal of the upper 500 feet of a 2000 foot culvert. This culvert extends upstream from the estuary - which was restored several years ago. The upper 500 feet of this culvert is the most problematic for fish passage. Future phases could include removal of most or all of the remaining culvert, acquisition of property in the lower watershed, and creating a green belt and trail between the waterfront and Olympic National Park.

This project is located in the City of Port Angeles, just upstream of the end of Valley Street and extends upstream about 0.1 miles. Before project construction, the stream in this reach was contained in a relatively straight, incised, channel that was confined between the base of the hill to the east and an access road to the west. There was a concrete structure in the middle of the reach that blocked fish passage. This concrete structure encased a City water line. The City removed the concrete structure and lowered the water line so that it would be below the streambed. Downstream, WDFW construction crews returned the stream to what was believed to be it's historic channel where it has a functioning flood plain and more diverse habitat. The new channel contains a riffle - pool complex with debris jams and large woody debris throughout, is 120' longer than the old channel, and provides high quality spawning and rearing habitat that was limited in the old channel. Upstream of the dam, for a distance of approximately 220 feet, we removed the road fill that was adjacent to the stream, creating a terrace about 12 feet wide just above the ordinary high water mark that will allow the stream room to meander and develop a functioning flood plain.

## WDFW FISH PASSAGE AND SCREENING INVENTORY DATA MANAGEMENT

SSHEARbase was designed as a repository for data collected during inventory efforts conducted under the auspices of the WDFW Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual (WDFW 2000) protocols. It is intended to provide a common framework for the collection and storage of information pertaining to the location and barrier status of culverts, dams and fishways and the location and screen presence/function status for gravity and pump diversions. It includes data compiled from several WDFW inventory efforts as well as data from a variety of non-WDFW inventory efforts. The data are statewide in scope but do not represent a comprehensive or complete inventory of fish passage and screening features. For example, it is estimated the SSHEARbase currently contains information on 10 – 15% of the potential culvert crossing existent within the state

The data are used to identify, locate, and prioritize correction of human-made fish passage barriers and unscreened diversions. Identifying and correcting fish passage barriers and unscreened diversions is a key component of salmon recovery. SSHEARbase data is available any group interested in salmon and habitat recovery. Data have been provided to SSHIAP, Conservation Commission limiting factors analysis, regional fisheries enhancement groups, counties, cities, tribes, etc. WDFW also uses the data to identify potential projects for WDFW and WSDOT.

SSHEARbase was designed to generate stand-alone geographic data layers for fish passage and screening features. Approximately 92% of the data set is spatially enabled. These layers can be integrated with other layers for display and analytical purposes. The data can be delivered electronically in GIS or tabular formats. The GIS layers are available via the Internet in ArcView shapefile format. Tabular output can be generated for most popular spreadsheet and data base applications. Geographic coordinates can be included in the tabular output so that it can be used with GIS applications.

SSHEARbase contains data from WDFW fish passage barrier inventory initiatives including WSDOT, the WDFW Wildlife Area Fish Retrofit project, and Thurston, Jefferson, Whatcom, and Kitsap counties. Data have also been assimilated from the Unresolved Fish Passage Problem (UFPP) and Fishway databases. Currently, the Habitat and Passage Projects Section is actively working on WSDOT and Wildlife Area inventories and Fishway inspections. Data from these activities are continually being added to the database.

SSHEARbase also receives data from non-WDFW agencies and organizations involved in fish passage barrier and screening inventories. Currently, there are 20 groups that have or will be submitting data for inclusion in SSHEARbase. This number is expected to increase dramatically with SRF Board funding and the participation of volunteer groups.

## NORTH SOUND

### ABSTRACT

Major project work completed during 2002 on the Skagit included the fishway construction on the un-named tributary to Bulson Creek, the beginning of the Powerline Groundwater Channel project and the replacement of a barrier culvert on an unnamed tributary to Walker Creek. On the Stillaguamish, we completed the Koonz Creek fish passage project. All these sites were sponsored and managed by the Habitat and Passage Projects Section 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 24 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 26 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 987,082 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 our program will be a thorough inventory of the undocumented off-channel habitat in these two river basins as well as specific habitat enhancement projects. Off-channel habitat inventory information has not generally been included in the WDFW Stream Catalog (Williams et al., 1975) or work of other survey studies such as Johnson (1986). The new information collected is being entered into a database developed within the Habitat and Passage Projects Section to be available for all resource managers on request. This database is constructed to accommodate entry of earlier information collected in this program in a different format with minimum effort. The new storage and retrieval system will allow this habitat information to be easily accessed and incorporated into land use decisions, plans and practices so these areas can receive the highest level of protection possible. Additionally, inventory information will continue to be used to identify potential habitat enhancement projects.

We began the inventory effort in 1989 and have continued work through 2002. 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 so decisions can be quickly made for what habitat is to be included and excluded. Rules direct coverage to those areas not covered by any earlier work. 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 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 stream area providing habitat for coho and other salmonids is then surveyed and mapped. 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 (and any passage/blockage structure(s) into SSHEARbase). In the future, the other file information will be scanned and stored in a digital format attached to the form.

The inventory in the Skagit system was completed in 2001 and work immediately began in the Stillaguamish where about 10% of the area has now been covered. In 2003, all the Skagit files will be converted to a new format where all data fields can be separated for maximum utility. When the conversion is done, we plan to compile the Skagit off channel information with the work of Johnson (1986) and the Stream Catalog (1975) for a full accounting of the habitat available in this river basin. A similar conversion will be made of the Stillaguamish data when the inventory is complete.

## ENHANCEMENT PROJECT IDENTIFICATION

Our intensive habitat inventory work identifies a number of enhancement project sites. We also find possible projects from general review of aerial photos and foot surveys in likely locations. Aerial flights using both fixed-wing and helicopters have also been helpful in locating opportunities, especially where access may be limited. References from other professional biologists in the field have been helpful as well in locating potential opportunities. We have also begun to implement fish passage work identified by focused surveys in our area aimed at correcting jurisdictional barriers.

Listings of habitat enhancement options are then annually ranked by potential habitat gain and fish production, level of design difficulty and construction, landowner considerations, expected project life, cost, potential funding opportunities/constraints and related factors. Listings 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. Our program tends to focus on those difficult and/or high-risk projects unlikely to be completed by another program or agency. These projects require considerable planning, survey, flow monitoring, data gathering and evaluation and design development. The considerable lead time needed for most projects has moved us into a three to five year planning cycle to get work done.

## METHODOLOGY

### Enhancement Project Evaluation

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

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

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

The 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). Similar use can 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 an older project continues to function without problems and/or to identify improvements. All spawner survey data are on file with this program as well as included in the WDFW Fish Program database.

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 workload of the trap check team and severe predation problems at some sites. Two-way traps are fitted with a division board to separately capture, count and separate differentially moving fish.

Trapped fish are anesthetized briefly for handling, identified to species, samples measured and/or marked, allowed to fully recover and passed 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 coordinate with hatchery management programs where broodstock needs to be captured.

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.

## RESULTS

North Sound project sites are shown on the map in Figure 1. A list of North Sound projects completed from 1991 through 2002 is found in Table 2.

### Fish Production

Smolt production and spawner use at sites where both types of information is available has been summarized in Table 3. More extensive smolt and juvenile trap data are shown in Table 4. Some of the trap information precedes the current program. Since Table 4 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 us before using this data. 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 4) 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 4) over the period of record reflects wide ranges of escapements during this period coupled with many other variables we do not fully understand and are difficult to measure. Severe floods in some years, for instance, have had an effect on spawner and consequently juvenile fish distribution in the watershed. Inter-species behavior between coho and chum spawners may also alter coho distribution patterns in some places at times. Homing is imprecise and juveniles imprinted to a project site may return as adults to adjacent areas rather than the project. Minor homing differences could be exacerbated by small annual variations in flows, temperatures or other water quality factors that may attract or discourage spawners from specific enhancement sites. Projects located high in the watershed may not as reliably recruit juveniles if on-site or upriver 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 4).

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 that 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 3) 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 groundwater 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 to 1998 (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 is a significant limiting factor at Granite Falls (spiny rays) and access a problem at the other three. A continuous series of large spawner escapements and favorable streamflows during migration times will help to achieve better adult and juvenile colonization and subsequent measured production. Removing these four projects from the estimated contribution potential produces a more reasonable estimate of 68,249 smolts being produced or 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.

Where possible, we are making efforts to improve smolt production at sites where yield has been 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. We are also continuing to expand the area for inside spawning at several sites to help insure full project seeding with juveniles by attracting a sufficient number of adults. Adding spawning gravel to Harrison Slough through the late 1990's seemed to achieve this result in that smolt production increased three fold and greater by 2002.

However, critical physical attributes of several projects cannot be easily modified and their performance will naturally vary widely over time. Two examples are Cascade Millpond and Marsh Pond that seem to rely on average or better water years to have sufficient outflow for fish attraction.

Production at the upper South Fork Stillaguamish projects, upstream of 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. Structural modifications and improved management of the fishway in the next few years may soon, however, improve its ability to pass spawners. 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 in ways we cannot control. 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, fish are lost at a high rate from predators that probably seek and become habituated to them in 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 (perhaps in addition to piscivores), 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 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 produces juveniles in excess of carrying capacity causing density dependent emigration. We have not, however, had sufficient resources to study this behavior intensively. We strongly suspect, however, that this is a major occurrence at our Constant Channel site. 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 adult spawners, particularly chum salmon. Evaluating juvenile movement late in the fall has not been possible because we believe it could negatively interfere with adult chum recruitment and would exceed our evaluation resources. 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.

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 results in the greater 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. Smolts, though, should be considered only one measure of project site productivity not the total basis for project comparison. 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).

## 2002 PROJECT CONSTRUCTION

### Stillaguamish River Basin

### Koonz Creek

The major project on the North Fork tributary to replace a failing driveway culvert and associated road fill with a bridge was completed this year. Work had begun in 2001 but there was insufficient time available to finish it before permit windows stopped work. The bridge work, however, was completed in 2001. The old culvert and fill were removed in 2002. Fill removal included stream reconstruction through the footprint of the fill prism. Fill removal was made especially challenging by the very confined work area in a narrow steep canyon. Sequential operations were needed to provide continuous access for landowners including any need for emergency services. The cost competitiveness of the bridge versus a replacement culvert will likely make this option considered more often in the future. Bridges are preferred, especially at high gradient reaches seen at this site, to remove all structures from the stream. Without an in stream structure, natural processes of bedload movement, scour and wood debris migration can occur unimpeded providing the best conditions for fish habitat and passage. Additionally, maintenance of an in stream structure is eliminated. Fin stream structure maintenance can be a major problem and responsibility at any site but is made more difficult in high gradient areas that move considerable bedload and debris. Experience gained in the design and construction of this project is already being used to assist others with similar projects throughout the region and is being used as a model project.

## Skagit River Basin

### Powerline Channel

The Powerline project is a combination off channel site development and slough rejuvenation project on the upper Skagit near Rockport and upstream of the Illabot projects about one quarter mile. The project will reopen a relic river slough and add a pond area at the upper end. Since the existing slough is no longer connected to the river at its upper end and has insufficient groundwater outflow most of the year, it is generally blocked by silt deposition from the river making it inaccessible and generally unattractive to fish. The added pond and some minor dredging of the slough is expected to add the groundwater flow needed to keep the confluence with the river open and provide the ideal conditions for off channel habitat. Colonization by coho and chum among other salmonids is expected to be immediate and use high based on similar responses in the adjacent Illabot 1 and 2 projects. Powerline will be another project is a series of projects we have built in the Skagit Basin since 1985 to recover an extremely valuable habitat type that has largely been lost from river regulation by the Skagit Hydroelectric Project and subsequent development activity, bank hardening and diking. Powerline will be one of the last sites in the basin where we can affect this type of recovery.

Work on the pond excavation began in 2002 but commitments to finish other projects in North Sound and continuous high river levels from the high snowpack stopped work with only about one half of the project completed. The project will be finished in 2003 and should be helped by the low snowpack this year with lower summer groundwater levels greatly reducing the pumping requirement needed to work in a largely dry condition. It should be available for the 2003 spawning return.

**Bulson Creek Tributary**

The challenging fish passage project at this difficult site was completed in 2002 after many years of planning and alternative designs. The large fill prism and high volume traffic use of this SR 534 crossing prevented the option of an open cut for the undersized barrier culvert replacement. Instead, the final design required a new pipe be bored through the fill adjacent to the existing culvert, be fitted with welded baffles, and have a concrete fishway constructed at the downstream end.

Boring of the new steel pipe was a specialized operation that required a contractor and considerable site preparation working in a very confined steep area. Baffles were welded in the new pipe after boring and work on the fishway began immediately to complete work by the end of the permit window in late October. In addition to the fishway downstream, the streambed had to be rebuilt on the upstream end to avoid problems associated with the needed regrade.

All work was completed as designed with excellent cooperation from Washington Department of Transportation, the adjacent landowner and the contractor. The new facility meets all the statute requirements for fish passage including juveniles for all salmonids. About four and one half miles of high quality habitat were reopened to anadromous fish after about 80 years of blockage. Fish use was immediate with coho spawners found immediately upstream after the first freshet. This was the last barrier to be corrected of this magnitude in the Skagit Basin.

**Walker Creek Tributary**

A barrier culvert was replaced at the confluence of this un-named small stream with Walker Creek, a very productive tributary of Nookachamps Creek. This was a farm field crossing 30 feet in length that did not require specialized equipment or techniques and work was completed quickly. The new six feet diameter pipe will not only be large enough to easily accommodate all expected flows but also be easy to enter and clean of occasional debris. Cooperation of the private landowner was excellent and funding from the Skagit System Cooperative most helpful. The low gradient off channel nature of the habitat recovered will be especially valuable to coho salmon and native trout.

## SCHEDULED 2003 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 has come to now enter 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.

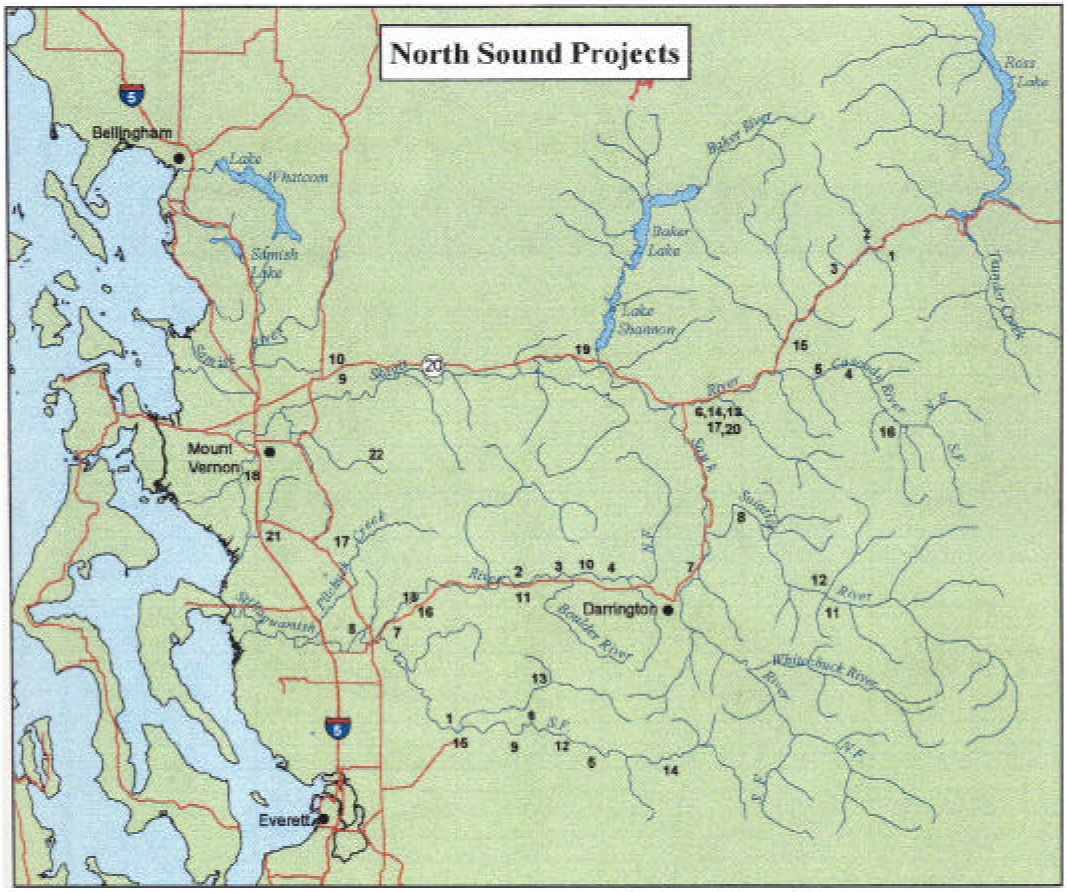
### Skagit River Basin

#### Powerline Channel

Final work on the pond excavation and minor dredging of the slough to install several log weirs will be completed and the project turned over to Seattle City Light, owner of the property and the final project.

## 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 2004 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.




## Project Locations

Projects Completed Through 2002

**SKAGIT BASIN SITES**

1. Park Slough Extension
2. Newhalem Ponds
3. County Line Ponds
4. Cascade Park
5. Cascade Mill Pond
6. Harrison Pond
7. Constant Channel
8. Suiattle Slough
9. Carey's Slough
10. Little Carey's Creek
11. Marsh Pond
12. Boundary Creek
13. Illabot Channel
14. Barnaby Slough
15. Taylor Channel
16. Grouse Marsh
17. O'Brian Slough
18. WF Church Creek
19. Lornezan Creek
20. Illabot-2
21. Bulson x-trib
22. Walker Creek

**STILLAGUAMISH BASIN SITES**

1. Granite Falls
2. Rowan Pond
3. Hazel Pond
4. Fortson Ponds
5. Gold Basin
6. Marsh Creek
7. Spring Creek (2 proj.)
8. Kackman
9. Canyon Passage
10. Oso Pond
11. Rowan Creek Restoration
12. Trout Creek
13. Mud Lake
14. Dazzling Howie
15. Lake Bosworth
16. Schoolyard Creek (3 proj.)
17. Pilchuck Tribs. (2 proj.)
18. Koonz

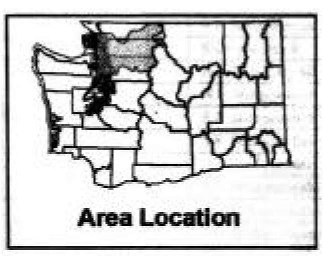



Figure 1.

Table 4. Completed North Sound projects through 2002.

| Project | River Basin | Year Completed | Habitat Benefit | Cost | Landowner |
|---|---|---|---|---|---|
| ***Skagit River Basin*** | | | | | |
| Newhalem | Skagit River | 1991 | 81,000 $m^2$ | $283,000[a] | Seattle City Light |
| County Line Ponds | Skagit River | 1991, 1996 | 22,000 $m^2$ | $114,000[a] | Seattle City Light |
| Cascade Park | Cascade River | 1991 | 2,030 $m^2$ | $14,764[a] | Cas. Park Assoc. |
| Cascade Mill | Cascade River | 1989 | 7,000 $m^2$ | $27,200[b] | Keller |
| Barnaby Slough | Skagit River | 1995 | 26,302 $m^2$ | $41,490[a] | WDFW |
| Harrison Pond | Skagit River | 1990 | 141,600 $m^2$ | $68,120[c] | Seattle City Light |
| Harrison Pond | Skagit River | 1995 | (incl. w/ Har. '90) | $100,000[a] | Seattle City Light |
| Illabot Channel | Skagit River | 1995 | 1,672 $m^2$ | $160,377[a] | Seattle City Light |
| Constant Channel | Sauk River | 1991 | 2,800 $m^2$ | $130,000[a e] | USFS |
| Suiattle Slough | Suiattle River | 1988 | 3,120 $m^2$ | $68,270[c] | Wash. DNR |
| Careys[d] | Skagit River | 1986 | 169,000 $m^2$ | $15,240[b] | City of Hamilton |
| Little Careys | Skagit River | 1991 | 1,920 $m^2$ | $13,400[a e] | Crown Pacific |
| Marsh Pond | Suiattle River | 1992 | 3,800 $m^2$ | $32,000[a e] | USFS |
| Boundary | Suiattle River | 1994 | 830 $m^2$ | $41,092[a e] | USFS |
| Park Slough Ext. | Skagit River | 1992 | 1,400 $m^2$ | $78,000[a] | NPS |
| Grouse Marsh | Cascade River | 1996 | 13,150 $m^2$ | $101,214[a] | USFS |
| O? Brian Slough | Illabot Creek | 1998 | 300 $m^2$ | $30,575 | Seattle City Light |
| Barnaby 2 Slough | Skagit River | 1998 | 2,868 $m^2$ | $10,612 | WDFW |
| Harrison Slough | Skagit River | 1998 | 200 $m^2$ | $11,907 | Seattle City Light |
| Taylor Channel | Skagit River | 1998 | 5,694 $m^2$ | $437,260 | USFS |
| Lornezan | Skagit River | 1999 | 18,000$m^2$ | $118,139 | Skagit County |
| Barnaby 2+ Slough | Skagit River | 2000 | (incl. W/ B2) | | WDFW |
| Illabot Channel Ext. | Skagit River | 2001 | 2,430$m^2$ | $530,864 | Seattle City Light |
| Bulson X-Trib | Skagit River | 2002 | 45,616$m^2$ | $750,000 | WSDOT |
| Walker X-Trib | Skagit River | 2002 | 30,951$m^2$ | $15,209 | Schacht-VanHine |
| TOTAL SKAGIT BASIN | | | 583,733 $m^2$ | | |
| ***Stillaguamish River Basin*** | | | | | |
| Granite Falls | S.F. Stillaguamish R. | 1988,93 | 17,900 $m^2$ | $20,880[b] | McEwen, Indian Hills Community Park |
| Rowen Pond | N.F. Stillaguamish R. | 1992 | 4,000 $m^2$ | $38,300[c] | Charley |
| Hazel Pond | N.F. Stillaguamish R. | 1987 | 9,580 $m^2$ | $17,280[c] | Snoh. County |
| Forts on Ponds[d] | N.F. Stillaguamish R. | 1989,90,92,93 | 47,180 $m^2$ | $3,585[b] | WDFW |
| Gold Basin | S.F. Stillaguamish R. | 1989 | 5,000 $m^2$ | $51,710[b e] | USFS |
| Stilly Canyon | S.F. Stillaguamish R. | 1994 | 60 miles | $34,523[a] | Hancock |
| Oso Pond | N.F. Stillaguamish R. | 1994 | 32,368 $m^2$ | $31,382[a] | Snoh. County |
| Spring Cr. Culvert | S.F. Stillaguamish R. | 1994 | 32,300 $m^2$ | $21,518[a e] | Snoh. County |
| Spring Cr. Dikes | S.F. Stillaguamish R. | 1993 | 32,300 $m^2$ | $43,500[a] | Folker, Wheatley |
| Kackman Creek | Stillaguamish R. | 1993 | 1,920 $m^2$ | $15,500[a e] | Klein |
| Rowen Creek | N.F. Stillaguamish R. | 1995 | 156 $m^2$ | $49,193[a] | Phillips |
| Fortson Ponds[d] | N.F. Stillaguamish R. | 1995 | 200 $m^2$ | $11,593[a] | WDFW |
| Big Four Creek | S.F. Stillaguamish R. | 1995 | 220 $m^2$ | $5,360[a] | USFS |
| Marsh Creek | S.F. Stillaguamish R. | 1993 | 100,000 $m^2$ | $93,200[a e] | Snoh. County |
| Trout Creek | S.F. Stillaguamish R. | 1996 | 28,000 $m^2$ | $99,186[a] | Snoh. County |
| Jordan Creek | S.F. Stillaguamish R. | 1996 | 400 $m^2$ | $7,302[a] | Lundberg |

| Project | River Basin | Year Completed | Habitat Benefit | Cost | Landowner |
|---|---|---|---|---|---|
| Trout Farm Creek | S.F. Stillaguamish R. | 1996 | 200 $m^2$ | $3,651[a] | Brenner |
| Mud Lake | S.F. Stillaguamish R. | 1997 | 500 $m^2$ | $22,870 | Hancock |
| Dazzling Howie | S.F. Stillaguamish R. | 1998 | 1,247 $m^2$ | $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 | $54,897 | Bergstrom |
| Lake Bosworth | S.F. Stillaguamish R. | 1999 | 25,000$m^2$ | $144,020 | WDFW |
| Pilchuck #1 | N.F. Stillaguamish R. | 2000 | 8,118$m^2$ | $70,992 | Secret Ck. Estates |
| Pilchuck #2 | N.F. Stillaguamish R. | 2000 | 22,480$m^2$ | $52,805 | Secret Ck. Estates |
| Koonz | N.F. Stillaguamish R. | 2002 | 21,689$m^2$ | $323,680 | Towne |
| TOTAL STILLAGUAMISH BASIN | | | 403,349$m^2$ | | |
| TOTAL NORTH SOUND | | | 987,082 $m^2$ | | |

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

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

| Project Site | WRIA | Area ($m^2$) | Current Production | | Comments |
|---|---|---|---|---|---|
| | | | Mean Annual Smolts/$m^2$ [1] | Mean Annual Spawners/$m^2$ [2] | |
| ***SKAGIT RIVER BASIN*** | | | | | |
| Suiattle Slough | 03.0710A | 3,116 | 1.14 | 0.11 | 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/$m^2$). |
| Boundary | 03.0710H | 830 | 0.19 | 2.0 | Inside spawning area built in 1995 and 1996. |
| Marsh Pond | 03.0807 | 3,800 | 0.05 | no inside spawning areas | 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 |

| Project Site | WRIA | Area ($m^2$) | Current Production | | Comments |
|---|---|---|---|---|---|
| | | | Mean Annual Smolts/$m^2$ [1] | Mean Annual Spawners/$m^2$ [2] | |
| | | | | | of smolt production in range of 0.5-0.8/$m^2$. 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 $m^2$ | $\bar{x}=0.31 \pm 0.25$ | $\bar{x}=0.39 \pm 0.47$ | |
| ***STILLAGUAMISH RIVER BASIN*** | | | | | |
| Forts on Ponds | 05.0254 A | 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 | 05.0401 A | 5,000 | 0.30 | 0.153 | Project is very productive when upper South Fork has had an escapement. |
| Granite Falls | 05.0358 C | 17,900 | 0.10 | 0.094 | Production has varied considerably over 5 years of evaluation possibly being influenced by large fish predator population. |
| Rowen | 05.0220 A | 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 $m^2$ | $\bar{x}=0.39 \pm 0.34$ | $\bar{x}=0.21 \pm 0.12$ | |

[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 6. Summary of juvenile coho migrant trapping at 21 off-channel habitat enhancement project sites on the Skagit and Stillaguamish River basins from 1985 – 2002.

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **SKAGIT** | | | | | |
| 1986-87 | Suiattle | 2.0[b] | 3116 $m^2$ | --- | --- | 3054 | 95 mm (10.0)[149] | --- | 0.98 | 3966 |
| 1987-88 | Suiattle | " | " | 80 | --- | 1396 | 104 mm (19.6)[508] | --- | 0.45 | 1821 |
| 1988-89 | Suiattle | " | " | 116[c] | 80 mm (13.1)[72] | 2041 | 100 mm (11.6)[1732] | --- | 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 |
| | | | | | | | | | | |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 01-02 | Cascade Mill | " | " | --- | --- | 445 | 115mm(10.8)[198] | --- | 0.06 | 255 |
| | | | | | | | | | | |
| 1985-86 | Careys | 39.2 | 169000 $m^2$ | --- | --- | 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] | --- | 0.02 | 81 |
| 1989-90 | Careys[n] | " | " | 6023[l] | 79 mm (8.8)[944] | 18730 | 112 mm (12.8)[3731] | --- | 0.11 | 445 |
| 1989-90 | Upper Careys[s] | " | 51708 $m^2$ [u] | 4381[l] | 84 mm (8.7)[96] | 4165 | 104 mm (9.3)[2510] | --- | 0.08 | 324 |
| 00-01 | Careys | " | 169000$m^2$ | | | 7429 | 101mm(11.0)[605] | --- | 0.04 | 178 |
| 01-02 | Careys | " | | | | 7361 | 98mm(12.4)[626] | --- | 0.04 | 176 |
| | | | | | | | | | | |
| 1994-95 | Barnaby Slough[ay] | 68.8 | 72828 $m^2$ | --- | --- | 12277 | 107.3 mm (9.4)[1220] | --- | 0.17 | 682 |
| 1995-96 | Barnaby | " | " | --- | --- | 7415 | | --- | 0.10 | 412 |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | Slough | | | | | | | | | |
| 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 |
| 01-02 | Harrison | " | " | --- | --- | 11,438 | 103mm(9.2)[882] | --- | 0.08 | 330 |
| | | | | | | | | | | |
| 1990-91 | Constant | 27.6 | 1000 $m^2$ [af] | --- | --- | 48[ac] | 87 mm (10.4)[39] | --- | 0.05 | 202 |
| | | | | | | | | | | |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 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 |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| | | | | | | | | | | |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 1997-98 | Park Sl. Combined | " | 4400 $m^2$ | --- | --- | 3234 | 77 mm (13.0)[3219] | --- | 0.73 | 2974 |
| 1998-99 | Park Sl. Old | " | 3000$m^2$ | --- | --- | 2853 | 84mm(13.6)[2214] | --- | 0.95 | 3848 |
| 1998-99 | Park Sl. New | " | 1400$m^2$ | --- | --- | 1587 | 80mm(12.7)[1433] | --- | 1.13 | 4586 |
| 1998-99 | Park Sl. Combined | " | 4400$m^2$ | --- | --- | 4440 | 83mm(13.3)[3647] | --- | 1.01 | 4083 |
| 1999-00 | Park Sl. Old | " | 3000$m^2$ | --- | --- | 2542 | 75mm(13.0)[2389] | --- | 0.85 | 3428 |
| 1999-00 | Park Sl. New | " | 1400$m^2$ | --- | --- | 1223 | 76mm(15.5)[1202] | --- | 0.87 | 3534 |
| 1999-00 | Park Sl. Combined | " | 4400$m^2$ | --- | --- | 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 |
| 01-02 | County Line | " | " | --- | --- | 3950 | 96mm(10.9)[582] | --- | 0.18 | 718 |
| | | | | | | | | | | |
| 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 |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 1999-00 | Newhalem | " | " | --- | --- | 15,715 | 105mm(10.4)[1071] | --- | 0.19 | 785 |
| | | | | | | | | | | |
| 1998-99 | Cascade Park | " | $2023m^2$ | --- | --- | 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 |
| 01-02 | Cascade Park | " | " | --- | --- | 445 | 102mm(7.6)[186] | --- | 0.22 | 890 |
| | | | | | | | | | | |
| 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 |
| 01-02 | Taylor | " | " | --- | --- | 7573 | 86mm(10.4)[810] | --- | 1.33 | 5381 |
| | | | | | | | | | | |
| 1984-85 | Fortson Ponds | 27.8 | 47180 $m^2$ [x] | --- | --- | 16000 | 108 mm (7.2)[240] | --- | 0.34 | 1376 |
| 1984-85 | Fortson-enhanced channel below ponds | " | 3325 $m^2$ | --- | --- | 5913 | 100 mm (10.6)[347] | --- | 1.78 | 7202 |
| 1985-86 | Fortson Ponds | " | 47180 $m^2$ | --- | --- | 7200[g] | 112 mm (8.8)[100] | --- | 0.15 | 607 |
| 1985-86 | Fortson-enhanced channel below ponds | " | 3325 $m^2$ | --- | --- | 3756 | no data | --- | 1.13 | 4572 |
| 1986-87 | Fortson Ponds | " | 47180 $m^2$ | --- | --- | 13400 | 111 mm (21.0)[382] | --- | 0.28 | 1133 |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 1986-87 | Fortson-enhanced channel below ponds | " | 3325 $m^2$ | --- | --- | 6938 | 96 mm (14.6)[288] | --- | 2.09 | 8456 |
| 1987-88 | Fortson Ponds | " | 47180 $m^2$ | --- | --- | 7633[m] | --- | --- | 0.16 | 647 |
| 1988-89 | Fortson Ponds | " | 47180 $m^2$ | --- | --- | 12992 | 112 mm (11.6)[4258] | --- | 0.27 | 1092 |
| 1988-89 | Upr Fortson | " | 41270 $m^2$ | --- | --- | 11552[h] | 113 mm (11.7)[3134] | --- | 0.28 | 1133 |
| 1988-89 | Lwr Fortson | " | 5910 $m^2$ | --- | --- | 1440 | 109 mm (10.7)[1124] | --- | 0.24 | 971 |
| | | | | | | | | | | |
| 1989-90 | Gold Basin | 49.0 | 5000 $m^2$ | --- | --- | ---[q] | --- | --- | --- | --- |
| 1990-91 | Gold Basin | " | " | --- | --- | 1218 | 107 mm (5.8)[1215] | --- | 0.24 | 971 |
| 1991-92 | Gold Basin | " | " | --- | --- | 2657 | 103 mm (7.8)[1865] | | 0.53 | 2144 |
| 1992-93 | Gold Basin | " | " | --- | --- | 152[al] | 127 mm (7.9)[150] | --- | 0.03 | 121 |
| 1993-94 | Gold Basin | " | " | --- | --- | 767[av] | 108 mm (7.9)[763] | --- | 0.15 | 607 |
| 1994-95 | Gold Basin | " | " | --- | --- | 2848 | 99 mm (7.0)[609] | --- | 0.57 | 2306 |
| 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 |
| 01-02 | Gold Basin | " | " | --- | --- | 443 | 79mm(9.3)[177] | --- | 0.09 | 358 |
| | | | | | | | | | | |
| 1988-89 | Hazel[i] | 22.3 | 9584 $m^2$ | 1054 | 78 mm (11.9)[511] | 3804 | 108 mm (7.0)[201][r] | 38% | 0.40 | 1618 |
| | | | | | | | | | | |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 112 mm (7.5)[633][j] | --- | | |
| 1989-90 | Hazel[o] | " | " | 4124 | 80 mm (13.4)[1282] | 4469 | 111 mm (6.71)[840] | 39% | 0.48 | 1942 |
| | | | | | | | 110 mm (8.3)[3584][j] | --- | | |
| 1990-91 | Hazel[y] | " | " | 2365 | 84 mm (12.0)[729] | 3872[z] | 106 mm (7.5)[3155][ah] | --- | 0.40 | 1618 |
| 1991-92 | Hazel | " | " | --- | --- | 4386 | 106 mm (9.3)[2904] | | 0.46 | 1861 |
| | | | | | | | | | | |
| 1995-96 | Oso Pond | 13.3 | 28300 $m^2$ | --- | --- | 3188 | 99.6 mm (8.6)[454] | --- | 0.11 | 456 |
| 1996-97 | Oso Pond | " | " | --- | --- | 1753 | 106 mm (9.5)[331] | --- | 0.06 | 251 |
| | | | | | | | | | | |
| 1990-91 | Gnite Falls | 32.2 | 17900 $m^2$ | --- | --- | 283[ae] | 119 mm (13.3)[283] | --- | --- | --- |
| 1991-92 | Gnite Falls | " | " | --- | --- | 1896 | 109 mm (9.1)[1896] | --- | 0.10 | 405 |
| 1994-95 | Gnite Falls | " | " | --- | --- | 1513 | 127 mm (9.6)[324] | --- | 0.08 | 324 |
| | | | | | | | | | | |
| 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 |
| 01-02 | Big Four | " | " | --- | --- | 783 | 90mm(9.5)[236] | --- | 0.24 | 966 |
| | | | | | | | | | | |
| 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 |
| | | | | | | | | | | |

| Season | Trap Site | RM | Area | Total Ups | Mean Length UPS (SD) [N] | Total Downs [a] | Mean Length Downs (SD) [N] | %Change Length[k] | Out migrant/ $m^2$ | Out migrant / acre |
|---|---|---|---|---|---|---|---|---|---|---|
| 1987-88 | Rowen | 20.6 | 4000 $m^2$ | --- | --- | 1160 | 90 mm (7.6)[466] | --- | 0.29 | 1173 |
| 1988-89 | Rowen | " | " | 967 | 77 (11.6)[690] | 941 | 101 mm (9.9)[825] | 31%[as] | 0.23 | 931 |
| 1992-93 | Rowen[ar] | " | " | --- | 82 (9.1)[256][ap] | 2376 | 91 mm (9.7)[802] | 11%[as] | 0.59 | 2387 |
| 1993-94 | Rowen[at] | " | " | --- | 81 (9.2)[497][ap] | 1570[aw] | 95 mm (8.6)[914] | 17%[as] | 0.39 | 1578 |
| 1994-95 | Rowen[az] | " | " | --- | 85 (7.3)[490] | 3224 | 99 mm (8.5)[502] | 16%[as] | 0.81 | 3277 |
| 1995-96 | Rowen[ba] | " | " | --- | 74 (7.0)[222][ap] | 3856 | 92 mm (9.4)[553] | 24% | 0.96 | 3910 |
| 1996-97 | Rowen[ba] | " | " | 492 | 86 mm (6.2)[167] | 6032 | 98 mm (11.7)[1165] | 14% | 1.51 | 6101 |
| 1997-98 | Rowen | " | " | --- | --- | 2927 | 89 mm (9.7)[747] | --- | 0.73 | 2961 |

aTotal 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 ps.
[j]Diseased fish only, presumably progeny of inside spawning (none of the marked fall inmigrants showed the disease the following spring); fluke (neascus) not seen at other sites.
[k]Represents growth of marked fall inmigrants only.
[l]Represents only partial count since trap was inoperable after mid November from frequent flooding and significant inmigration likely occurred after this date.[m]Derived by assuming 68% of total Forts on out migrants (ponds and stream) were attributable to ponds alone. Traps operated simultaneously immediately downstream of the ponds and at lower end of the stream in 1985, '86 and '87 showed pond contribution was 73%, 66% and 66% respectively (mean=68%). Only trap data from lower end of the stream was available (Tulalip Tribe) for 1988.
[n]Overwinter survival was 25% based on marked group (approximately one half of enumerated immigrants). Low survival attributed to large predator population including spiny rays.
[o]Overwinter survival was 44% based on marked group (approximately one half immigrants)
[p]Dashes indicate no trapping was done or data taken was incomplete or unreliable.
[q]Effort to out migrant trap in 1990 failed from freshets overtopping trap. New trap installation design planned for out migrant trapping 1991.
[r]Represents size of out migrants marked as immigrants fall 1988.

[s]This was the first season the upper portion of Careys was separated from the total enumerated. All fish trapped at Upper Careys were released and again enumerated at the lower trap. However, based on several marked groups through the season, only about 43% of the fish released at the upper trap ever appeared at the lower trap suggesting significant mortality presumably from high predation rates.
[t]Percent change cannot be calculated because immigrants were not marked and out migrants measured were a combination of immigrants plus progeny of inside spawning.
[u]This area included within the 169000 $m^2$.
[v]Wetted area during winter, summer area approximately 125000 $m^2$.
[w]80 miles from mouth of Skagit River.
[x]Wetted area during summer, the effective or limiting habitat (production at this site is assumed to be reliant on inside spawning only; very little juvenile recruitment is thought to occur during fall through the fishway below the lower pond). Winter area of the large pond is 1.7 times larger; the smaller pond has about the same area year-round.
[y]Overwinter survival was 46% based on marked group which was about one third of fall recruits.
[z]310 1+ coho were upstream trapped from 3/18 to 5/18.
[aa]Dike breached at fishway site by flood waters which could have allowed an undetermined number of juveniles to enter the pond.
[ab]Overwinter survival was 22% based on marked group which was 88% of recruits trapped. 665 recruits trapped does not represent total inmigration since some fish entered during fall flooding when trap was submerged and additional fish entered during construction via raceways.
[ac]27567 0+ coho were trapped and electroshocked from this enhancement site in addition to smolts shown in table.
[ad]745 0+ coho were trapped and electroshocked from this 1991 enhancement site in addition to smolts shown in table.
[ae]Represents partial count only since trap not installed until 5/7.
[af]Area before project, area after project is 2350 $m^2$.
[ag]Area accessible before project, area after project is 81000 $m^2$.
[ah]Both diseased (Neascus) and non-diseased fish combined.
[ai]The 1375 fish trapped were only a portion of immigrants. Trapping was done only to assess fishway performance. Of the 1375, 818 were marked to evaluate overwinter survival.
[aj]Data from trapping by Skagit System Cooperative.
[ak]Available pond area estimated only, exact area used cannot be determined.
[al]Two year old residuals only, there was virtually no spawner escapement to upper South Fork in 1991 or 1992.
[am]95 miles from mouth of Skagit River.
[an]Overwinter survival was 47% based on marked group.
[ao]Overwinter survival was 50% based on marked group.
[ap]Only a sample of emigrants was trapped and marked for overwinter survival estimate.
[aq]Length change calculation derived by excluding all marks greater than 136 mm which are assumed to be 2+ out migrants based on scale sampling conducted at this site in '93.
[ar]Overwinter survival was 41% based on marked group which may have been low because a large number of juveniles were already in the site as progeny of inside spawning leading to intense competition.
[as]Mean length of marked out migrants was not significantly different than all out migrants enabling accurate calculation based on sample group.
[at]Overwinter survival was 20% based on marked group.
[au]Preproject production before culvert replacement and creation of impoundment.
[av]Production from 1-2 redds located inside the project site which were virtually the only redds located in the upper South Fork in 1992.
[aw]Production was reduced by heron predation on emigrant smolts immediately above the trap.
[ax]Fish leaked from trap and it was sufficiently backwatered to be non functional much of the season.
[ay]Preproject enumeration when only juvenile fish were able to access slough area.
[az]Overwinter survival was 48% based on marked group.
[ba]Overwinter survival could not be calculated because the site was backwatered during 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 $\pm$ 194). Mean smolt production from all Stillaguamish project sites in their existing condition is 1429 (95% CI of $\pm$ 496) smolts per acre. Difference between rivers is not statistically significant.

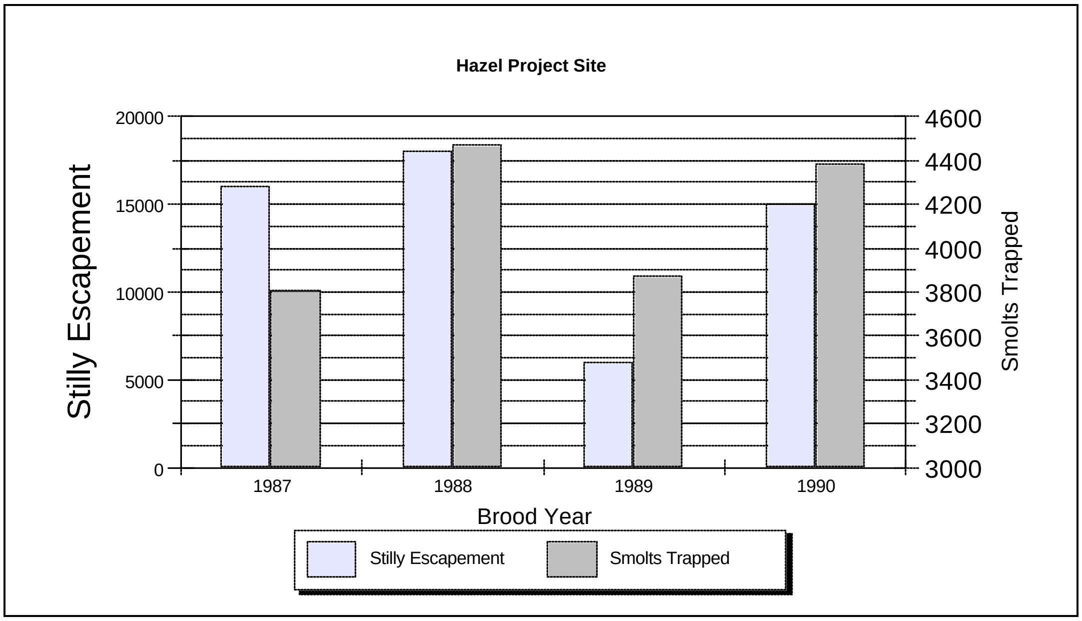



Figure 2. Coho smolt production from four brood years showing the stability off-channel projects can provide even when basin escapement is low.

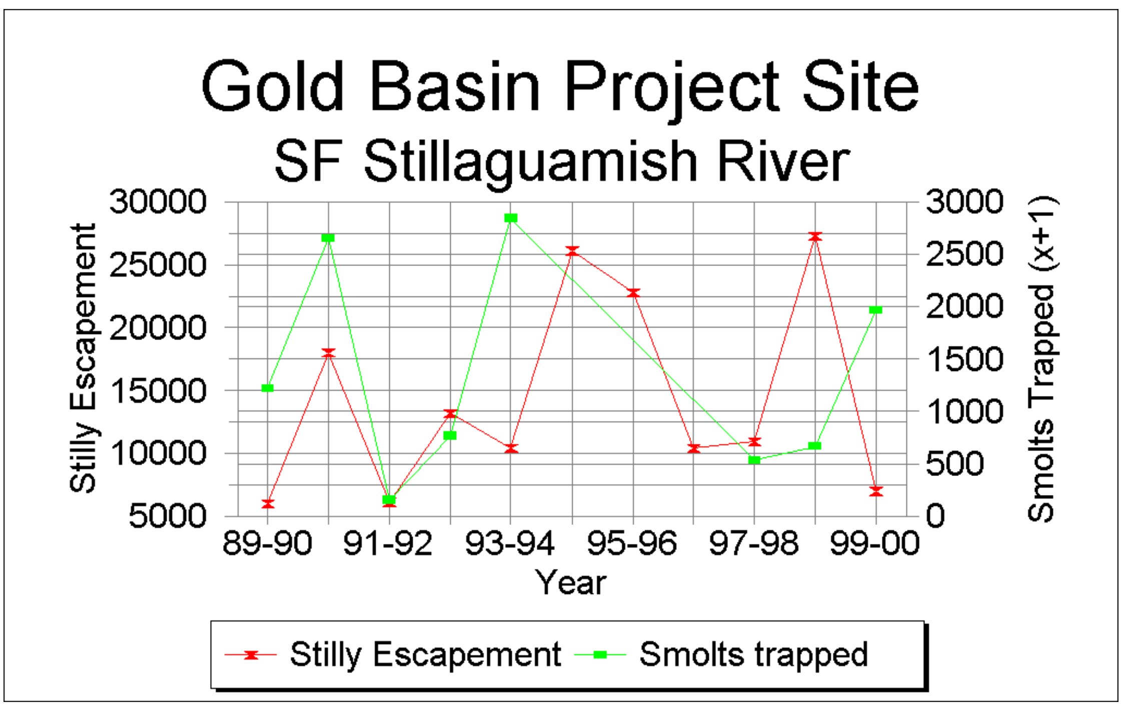



Figure 3. Smolt projection follows escapements of some sites such as Gold Basin.

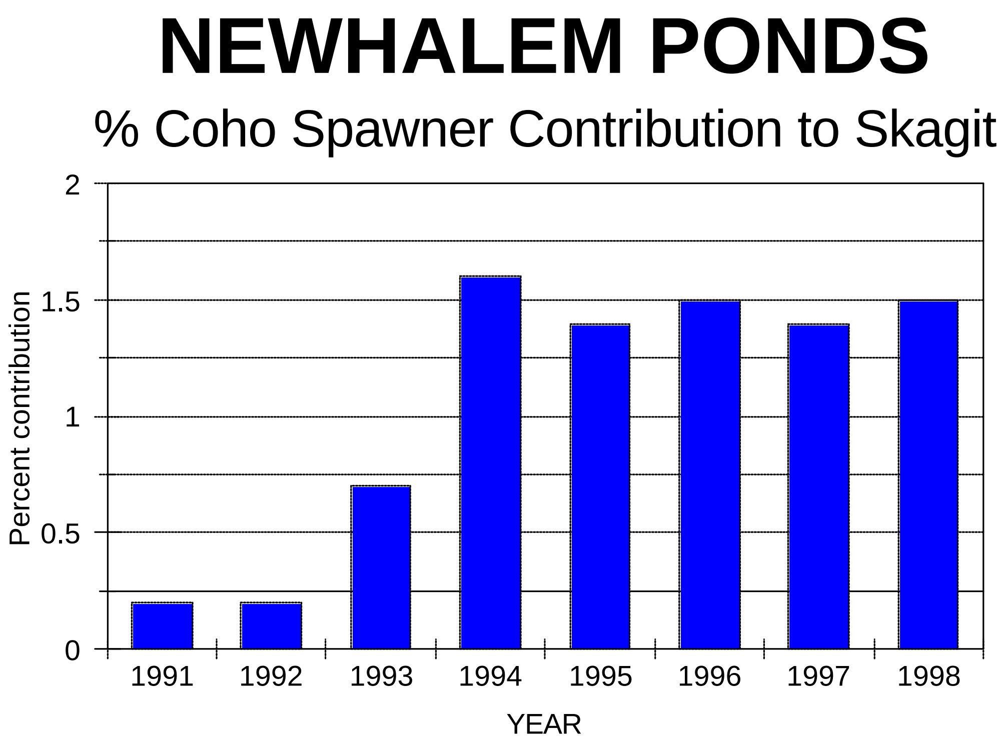



Figure 4. The large Newhalem off-channel project has cycled up to a high level of stable production and is now responsible for a significant proportion of total Skagit River escapement.

## NORTH COAST


**ABSTRACT**
During 2002, we continued to inventory off-channel spawning and rearing habitat in the West Fork Dickey 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 2002, three fish habitat enhancement projects were completed on the Middle Fork of the Dickey River, the Hoh River, and on a tributary to the Sol Duc River. These included two culvert replacement/wetland preservation projects 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.

Potential habitat enhancement opportunities were identified in the Clearwater, West Fork Dickey, and Bogachiel river systems. These projects are scheduled for completion during 2003 through 2004.

Existing and potential habitat enhancement projects were evaluated by monitoring fish use (including spawning activity) and overall function. In 2001, adult coho salmon escapement to the Hoh River system was estimated to be 10,773 fish. This represents the highest return in 29 years. Preliminary estimates for the 2002 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 eight years.

The Habitat and Passage Projects Section has developed 16 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 28 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 2-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, samples of the upstream migrants are marked with a freeze brand or a fluorescent dye to help determine over-winter 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 an 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. Funding for evaluation work was terminated in July of 2002. As a result, we were only able to do a minimal amount of evaluation at existing project sites. Future evaluation work will be very limited due to budget restraints.

**Project Design**

Each proposed project is rigorously reviewed by a team consisting of an environmental engineer, the Habitat and Passage Projects Section construction superintendent, and the lead Habitat and Passage Projects Section 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, land use 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.

## RESULTS

**Habitat Inventory**

During 2002, off-channel rearing habitat inventory work was conducted on the 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 salmonid producing habitat. To date, habitat inventory work has been completed on about 82% 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 fish passage database (SSHEARbase).

**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 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 for 2003 will be very limited due to budget constraints.

**Hoh River Overview**

The adult coho escapement to the Hoh River in the Fall of 2001 was 10,773 fish and estimates for 2002 indicate over 7,000 fish. (Mike Gross, Roger Mosley, WDFW personal communication). This is the seventh time in the past eight years that the escapement has been greater than 4,000 fish, (Figure 6). The year 2001 escapement was the highest in 28 years. The escapement goal is between 2,000 and 5,000 fish. We operated a two-way juvenile fish trap at one existing project site on the Hoh River during the fall of 2002 to collect fork length measurements of immigrant juvenile coho. Using a measured mean production of 0.22 smolts per square meter, the 16 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 12 years we have observed a very strong, inverse relationship (r2 = 0.83) 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 constrained by the amount of summer rearing habitat. During the fall of 2002, the average fork length of the juvenile immigrant coho entering Dismal Pond continued to follow this trend.
In the spring of 2002, seven percent of the coho that were previously marked as they entered Dismal Pond in the fall of 2001 were recovered in the out-migrant trap, (Table 5). There was only a short period during the trapping season when the trap was backwatered from the Hoh River because of flooding. As a result, the marked recovery rate is considered to be a good estimate of the overwinter survival.

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.

**Quillayute System Overview**
The Quillayute watershed consists of the Quillayute mainstem, Dickey, Sol Duc, Calawah, and Bogachiel rivers. Coho escapement for 2001 was good and probably resulted in good recruitment of juveniles to off-channel habitat in the autumn of 2002. Spawner returns in 2002 were strong. No juvenile fish traps were operated in this river system due to budget constraints. The mean smolts per square meter measured at selected project sites is about 0.35. Using the 29 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 2001 to capture upstream migrating juvenile fish. A sample was marked and, in the spring of 2002, only about 5 percent of the marked fish were recovered as they migrated out as smolts, (Table 5). 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. Spawned out hatchery salmon carcasses were placed here in the winter of 2001/2002 to supplement the nutrient load in the channel. We suspected that the channel had been overloaded with decaying carcasses and this, combined with a low water exchange rate, may have had a negative impact on the water quality. A Pathologist examined some of the dead and dying fish, but results were inconclusive. It is possible that a bacterial disease (cold water disease) was introduced via the carcasses.

**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. 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. There is no indication that the fish are growing larger due to this nutrient supplementation. In the two years of treatment, the fish grew only an average of 4 millimeters. Overwinter survival was estimated at 46 percent for this site during the winter of 2001/02 (Table 5). This site will no longer be evaluated due to budget constraints.

## 2002 CONSTRUCTION PROJECTS

Project costs and habitat benefited for the 2002 projects are summarized in Table 6. An entire list of projects that have been constructed since 1988 is shown in Figure 5 with details on each project shown in Table 7.

**Lake Creek Springs**
This project, on a tributary of the Sol Duc River, resulted 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 was replaced with a sloping roughened channel to maintain a large wetland that has been created as a result of the plugged

culvert. This was a cooperative project with WSDOT and the Rayonier Timber Company that improved fish access to over 11,000 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 was 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 3,000 square meters of rearing habitat.

**Maintenance**
Existing project sites were inspected for maintenance needs and work was performed as needed using a crew of laborers from the Clearwater Corrections Center near Forks. Stumps and other woody debris were added to projects that appeared to have inadequate cover.

## SCHEDULED PROJECTS FOR 2003

**Darrow Marsh**
This project, located on the West Fork Dickey River, will replace an undersized plugged culvert 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 4,600 square meters of rearing habitat.

**Fletcher Creek**
This project is located at milepost 167.42 on State Route 101. A series of metal baffles will be installed in a concrete box culvert to increase water depth and break up the sheet flow that currently exists which hinders fish passage at certain flow levels. The Department of Transportation (DOT) will fund this project and WDFW will be contracted to perform the work. We will use a crew of inmates from the Clearwater Corrections Center (CCC) to do the work.

**Bogachiel Pond Retrofit**
This project was originally done in the early 1990s by WDFW and consisted of the installation of log controls in the outlet of a large pond which served to maintain the water level of the pond and also allow fish passage into the pond. A logging road crosses the pond outlet and the original culvert is showing wear as well as being undersized. In addition, one of the log controls is starting to fail due to the culvert misalignment in the channel. The culvert will be replaced with a larger pipe and realigned and the log control will be repaired.

## SUMMARY

During 2002, the North Coast area experienced less than normal precipitation during the summer and fall that probably resulted in a reduction in available rearing habitat as stream flows receded. Significant rain did not occur until November, which is much later than normal for this area. As in the past, the upstream migration of juvenile salmonids into the project sites coincided with the onset of fall storms. Fortunately, December and January were wet enough to charge up the aquifers to adequate levels and keep these important off-channel habitats well watered. The high quality rearing and spawning areas, which were either created or enhanced in 2002, 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 overwintering 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. In addition, nutrient enhancement is being used to bolster food production within some of the newer project sites. We are also learning that the use of hatchery fish carcasses needs to be regulated so we don't overload some of these low waterflow systems.

At Dismal Pond over the past twelve years we have seen a close inverse relationship ($r2 = 0.83$) 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 77 mm. Based on the above relationship, we would have expected an average around 75 mm.

Preliminary estimates show the 2002 coho run to the Hoh River to be over 7,000 fish. With last year's record coho escapement into the Hoh, we did not see a corresponding large number of juvenile coho immigrants into the Dismal pond site. This may indicate that this project has reached its carrying capacity and with higher escapements will not realize any higher numbers of fall immigrants.

Off-channel rearing habitat inventory work continued on the West Fork Dickey River tributaries in 2002. 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 2002, the Clearwater Corrections Center labor crews, which are supervised by the Department of Natural Resources (DNR) and WDFW, 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 service. WDFW will continue to develop cooperative projects with timber companies and any other landowners that 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 as long as funding allows. Supplemental survey work must be continued throughout the year to monitor potential project sites under a wide range of environmental conditions.

Evaluation work for the future is in doubt due to budget cut backs. 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 5. North Coast upstream/downstream migrant trapping summary for Fall 2001 and Spring 2002.

| Site | River Basin | Coho In | Coho Out | Marked Group Recovery | Trout In | Trout Out |
|---|---|---|---|---|---|---|
| Dismal Pond | Hoh | 3,649 | 441 | 6.9% | 199 | 12 |
| Rayonier Channel | Bogachiel | 2,958 | 417 | 4.7% | 14 | 12 |
| Calawah Springs | Calawah | 2,963 | 2,333 | 46.3% | 882 | 336 |
| 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 6. North Coast habitat enhancement projects completed in 2002

| Project | River Basin | Project Type | Habitat Benefitted | Project Cost | Landowner |
|---|---|---|---|---|---|
| Lake Creek Springs | Sol Duc | Spring Channel Enhancement | 500 m5 | $23,900 | Rayonier |
| Pseudo Springs | Middle Fork Dickey | Spring Channel Enhancement | 3,300m5 | $43,100 | Rayonier |
| Nolan Springs | Hoh | Spring Channel Enhancement | 11,750m5 | $38,400 | Rayonier |
| | | **TOTALS** | 15,550m5 | $105,400 | |

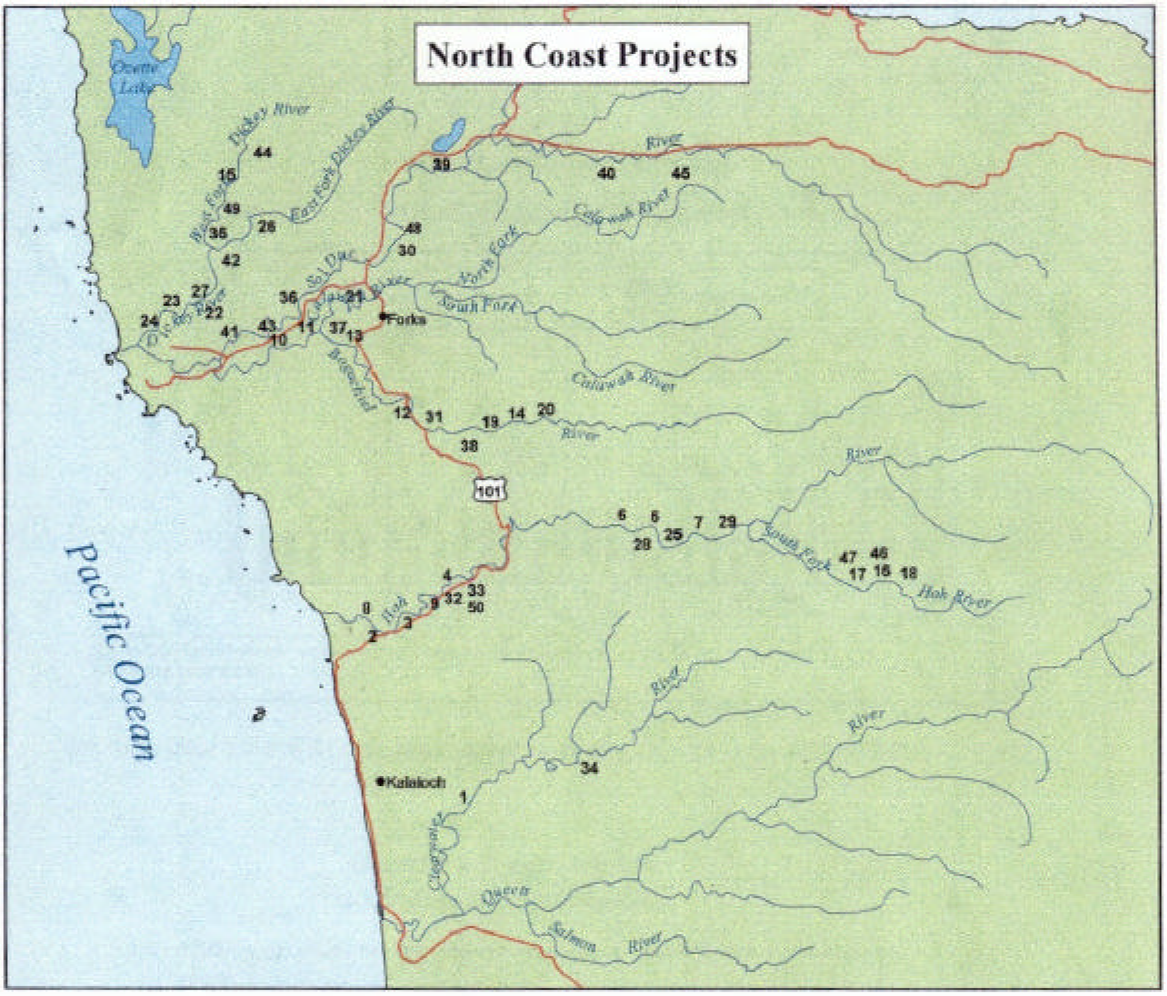
Table 7. Projects completed from 1988 through 2002.

| Project Site | River Basin | Year Completed | Habitat Benefited | Cost | Property Owner |
|---|---|---|---|---|---|
| Airport Pond | Clearwater | 1988/89 | 30,000 m5 | $16,900 | Rayonier |
| Rayonier Pond | Hoh | 1988 | 4,048 m5 | $19,000 | Rayonier |
| Barlow Pond | Hoh | 1988/89 | 8,100 m5 | $26,600 | Private |
| Anderson Ponds | Hoh | 1988/89 | 10,150 m5 | $45,900 | Private |
| Pole Creek | Hoh | 1988/90 | 6,100 m5 | $45,300 | Forest Service |
| Peterson Pond | Hoh | 1989 | 2,000 m5 | $22,500 | Private |
| Dismal Pond | Hoh | 1989 | 4,048 m5 | $25,700 | Rayonier |
| Anderson Cr. Channel | Hoh | 1990 | 3,000 m5 | $16,500 | Rayonier |
| Nolan Pond | Hoh | 1990 | 8,000 m5 | $ 3,200 | State |
| Wilson Springs | Bogachiel | 1990 | 3,200 m5 | $41,600 | Private |
| Tall Timber | Bogachiel | 1990 | 800 m5 | $10,000 | Rayonier |
| Smith Road Pond | Bogachiel | 1990 | 2,000 m5 | $15,600 | Rayonier |
| Dahlgren Springs | Bogachiel | 1990 | 600 m5 | $ 7,300 | Private |
| * Morganroth Springs | Bogachiel | 1991 | 14,100 m5 | $13,400 | Forest Service |
| * W.F. Dickey | Dickey | 1991 | 23,000 m5 | $28,000 | Rayonier |
| * Mosley Springs | S.F.Hoh | 1991 | 4,048 m5 | $21,000 | State |
| * Lear Springs | S.F.Hoh | 1991 | 800 m5 | $18,100 | State |
| * Upper Mosley | S.F.Hoh | 1992 | 690 m5 | $23,000 | State |
| Bogey Pond | Bogachiel | 1992 | 13,640 m5 | $24,700 | Rayonier |
| Falcon Walrus | Bogachiel | 1992,1995 | 740 m5 | $20,600 | Rayonier |
| Calawah Springs | Calawah | 1992 | 900 m5 | $50,300 | John Hancock Ins. |
| Colby Springs | Dickey | 1992 | 9,200 m5 | $13,500 | Rayonier |
| Elkhorn Pond | Dickey | 1992 | 5,400 m5 | $ 9,100 | State |

Table 7. Projects completed from 1988 through 2002.

| Project Site | River Basin | Year Completed | Habitat Benefited | Cost | Property Owner |
|---|---|---|---|---|---|
| W.F.Marsh Ck. | Dickey | 1992 | 3,000 m5 | $ 6,200 | Rayonier |
| * Hoh Springs | Hoh | 1993,1995 | 3,450 m5 | $86,000 | Rayonier |
| Soot Cr. Springs | E.Fk.Dickey | 1993 | 2,100 m5 | $64,000 | Rayonier |
| T-Bone Springs | Dickey | 1993 | 745 m5 | $33,000 | Rayonier |
| * Young Slough | Hoh | 1994 | 3,000 m5 | $158,000 | John Hancock Ins. |
| * Lewis Channel | Hoh | 1994 | 2,000 m5 | $135,000 | State |
| Tassel Springs | Sol Duc | 1994 | 600 m5 | $16,000 | Private |
| Laforrest Pond | Bogachiel | 1995/96 | 2,520 m5 | $133,000 | Private |
| *Nolan Channel | Hoh | 1996 | 1,800 m5 | $151,000 | Rayonier |
| *Huelsdonk Creek | Hoh | 1996 | 12,000 m5 | $18,000 | DOT |
| Manor Springs | Clearwater | 1996 | 960 m5 | $21,550 | DNR |
| *Cascade Springs | W.Fk.Dickey | 1996 | 3,000 m5 | $42,000 | Rayonier |
| *Powell Springs | Sol Duc | 1997 | 2,000 m5 | $76,000 | Rayonier |
| Rootstock Springs (I) | Calawah | 1997 | 200 m5 | $12,000 | Rayonier |
| Rayonier Channel | Bogachiel | 1998 | 1,700m5 | $135,000 | Rayonier |
| Tyee Pond | Sol Duc | 1998 | 2,800m5 | $80,000 | Rayonier |
| Rootstock Springs (II) | Calawah | 1998 | 600m5 | $22,000 | Rayonier |
| *Eagle Creek Springs | Sol Duc | 1999 | 2,200m5 | $84,000 | Private |
| Thomas Springs | Sol Duc | 1999 | 2,800m5 | $20,000 | Private |
| Big Beaver Springs | E.Fk. Dickey | 1999 | 7,400m5 | $35,000 | Rayonier |
| *Prairie Fall Creek | Sol Duc | 2000 | 4,700m5 | $148,400 | Clallam County |
| *Labrador Creek | W.Fk.Dickey | 2000 | 2,000m5 | $37,800 | Green Crow Timber |
| *M & R Springs | Sol Duc | 2000 | 700m5 | $59,900 | Merril & Ring Timber |
| Mosley Springs Ext. | S.Fk.Hoh | 2001 | 900m5 | $68,000 | DNR |
| Lear Ck. Springs II | S.Fk.Hoh | 2001 | 700m5 | $35,000 | DNR |
| Lake Ck. Springs | Sol Duc | 2002 | 500m5 | $23,900 | Rayonier |
| *Pseudo Springs | M.Fk.Dickey | 2002 | 3,300m5 | $43,100 | Rayonier |
| *Nolan Springs | Hoh | 2002 | 11,750m5 | $38,400 | Rayonier |

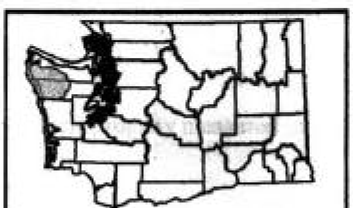
* Cost share projects with timber companies, DNR, DOT, Salmon Coalition, Counties and/or Tribes.




## Project Locations

Projects Completed Through 2002

1. Airport Pond
2. Rayonier Pond
3. Barlow Pond
4. Anderson Ponds
5. Pole Creek
6. Peterson Pond
7. Dismal Creek Pond
8. Anderson Creek Channel
9. Nolan Pond
10. Wilson Springs
11. Tall Timber
12. Smith Road Pond
13. Dahlgren Springs
14. Morganroth Springs
15. West Fk. Dickey Culvert
16. Mosley Springs
17. Lear Creek Springs
18. Upper Mosley Springs
19. Bogachiel Pond
20. Falcon Walrus
21. Calawah Springs
22. Colby Springs
23. Elkhorn Pond
24. West Fk. Marsh Creek
25. Hoh Springs
26. Soot Creek Springs
27. T-Bone Springs
28. Young Slough
29. Lewis Channel
30. Tassel Springs
31. Laforrest Pond
32. Nolan Channel
33. Huelsdonk Creek
34. Manor Springs
35. Cascade Springs
36. Powell Springs
37. Rootstock Springs
38. Rayonier Channel
39. Tyee Channel
40. Eagle Creek Springs
41. Thomas Springs
42. Big Beaver Springs
43. Prairie Fall Creek
44. Labrador Creek
45. M&R Springs
46. Moseley Springs Extension
47. Lear Creek Springs
48. Lake Creek Springs
49. Pseudo Springs
50. Nolan Springs



**Area Location**

Figure 5.

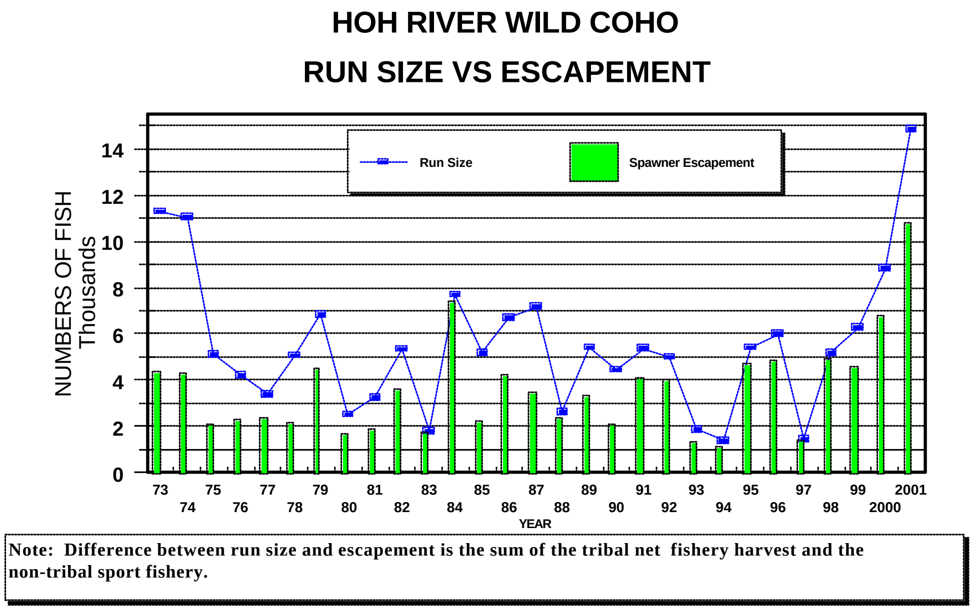



Figure 6. Hoh River wild coho run size and escapement for the years 1973 to 2001.

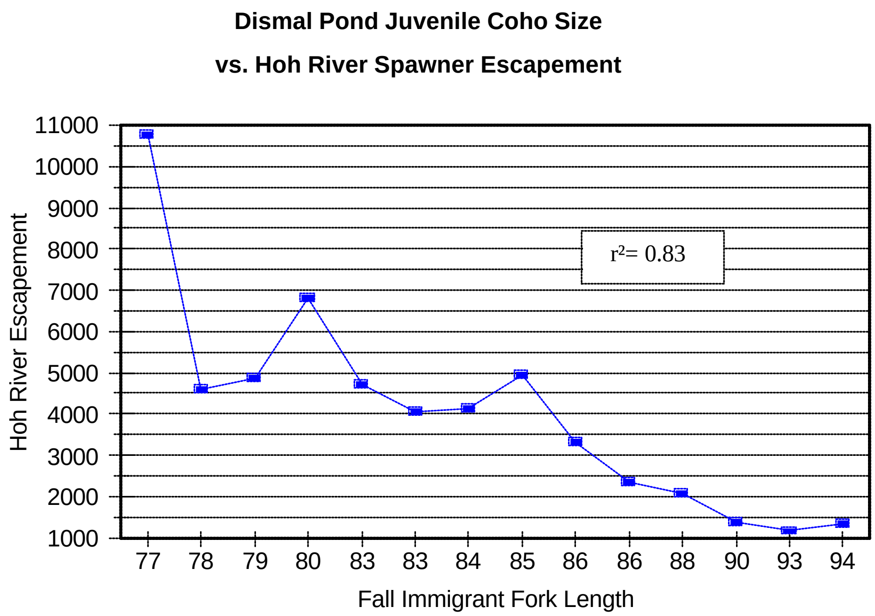



Figure 7. Relationship between the brood year escapement and the size of their progeny measured in the autumn for 14 brood years 1988 to 2001.

## 2002 FISH SCREENING

## INTRODUCTION

The Yakima Construction Shop (YCS), formally known as the Yakima Screen Shop, is the WDFW eastern Washington shop responsible for, among other things, the fabrication, installation, and inspection of fish screens within the state of Washington. Under the WDFW Business Services Program Engineering Division, one Construction & Maintenance Superintendent 2 (CMS 2) supervises the management of the YCS; one Construction Fabrication Supervisor (CFS) and one Construction Maintenance Supervisor (CMS) provide day-to-day supervision of the screen fabrication and construction, and O&M crews, respectively. The YCS is organized into the following work units:

- ?? Fish Screen Fabrication and Construction; and
- ?? Fish Screen/Fishway Inspection, Operation & Maintenance (O&M).

Overall responsibility for the fish-screening program is retained within the WDFW Habitat Program Technical Applications (TAPPS) Division. An Environmental Specialist 5 (ES5) provides program management, and is supported by one CMS2 (screening technical assistance) and one Senior Office Assistant (administrative support).

This report summarizes the calendar year (CY) 2002 accomplishments for the YCS and TAPPS Yakima section.

### Screen Fabrication and Construction

The YCS 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 YCS 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 have been driven by the Northwest Power Planning Council's (NWPPC) Fish & Wildlife Program. Since 1985, the YCS 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 YCS mission, both in scope and geographic area. YCS 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. YCS also provides fabrication services to other WDFW programs. YCS periodically fabricates or rebuilds fish hatchery intake and rearing pond outlet screens for the Fish Program. The YCS has also designed and fabricated cougar and black bear live traps used by WDFW wildlife enforcement agents to capture and relocate dangerous wildlife.

This unit is also 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 CY02 no pump screen fabrication and installation was 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 YCS.

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 fish-ways. In 1991, the 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 cfs. Field installation typically takes from one to five days, with total costs (including fabrication and installation) ranging from $20,000 to $30,000. Twenty-seven modular drum screens have been installed in Washington through CY02. In addition, the crew fabricates and installs flat plate screens with rotary wiper or gang brush cleaners. The modular flat plate screen is a low cost ($5,000 - $10,000), 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 CY02.

Permanent, full-time staff includes one CFS, four Welder-Fabricators (WF), one Plant Mechanic (PM), and one career seasonal General Repairer (GR). As annual workload expands or contracts, temporary WF's and/or laborers are hired or laid-off. Roughly 75% 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 CY02 totaled $79,000. All of the construction projects for CY02 were funded via the Salmon Recovery Funding Board (SRFB), cost share (diversion owner, NMFS via Mitchell Act funds, BPA, state capital) and/or directly reimbursable by the proponent (City of Yakima, Town of Cusick). BPA Phase 2 fish screen fabrication projects completed in CY02 are summarized in Table 8. Other fabrication and construction projects completed in CY02 are summarized in Table 9.

**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 150+ active gravity diversion fish screen facilities, and eight small fish-ways. These facilities are located at irrigation diversions in central and southeast Washington on tributaries to the Columbia and Snake Rivers, and the Olympic Peninsula on the Dungeness River. Permanent staff consists of one CMS, one WF, and one PM stationed at the YCS 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 95 active gravity diversion screens and five fish-ways. 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 fish-ways. Six screens and one fishway located in the Dungeness River Basin (Olympic Peninsula) are the responsibility of one half-time 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 YCS 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 CY02). Water users may contract with the YCS to perform all or a portion of their statutory O&M obligation utilizing a standardized YCS fish screen service contract. In CY02, 31 diversion owners signed contracts with an estimated value of approximately $34,000.

In 1993, the O&M work unit began performing O&M on BPA-funded Yakima Basin Phase 2 fish screen facilities. In CY02, YCS provided preventive maintenance services on 21 Phase 2 sites with $141,000 in BPA funding. The O&M work unit also maintained 15 screens and five fish-ways in the mid and upper Columbia Basin for the National Marine Fisheries Service (NMFS) with $55,000 of FFY02 Mitchell Act funding.

**Fish Screen Technical Assistance**

Fish screen technical assistance is offered and performed by personnel within the WDFW Habitat Program Technical Applications (TAPPS) Division located at the YCS. An ES5 and CMS2 provide ongoing technical assistance to irrigation diversion owners, irrigation equipment vendors, and agency personnel (both in-house and out of house), as well as consultants, contractors, and general public. In CY02, more than 50 contacts were made regarding fish screening technical assistance. The ES5 and CMS 2 participated in several workshops and festivals sponsored by various organizations, and provided practical information relative to fish screening needs.

**Table 8. 2002 BPA Phase 2 Screen Fabrication**

| Project Name | Description | Time Period |
|---|---|---|
| Selah Moxee | Handrail, bypass entry, sluice gate, lift gantry fabrication and install | 1/02 to 3/02 |

Table 9. 2002 Other Screen and Miscellaneous Fabrication and Construction

| Project Name | Description | Time Period |
|---|---|---|
| Town of Cusick | Flat plate screen fabrication | 11/02 to 12/02 |
| Twisp Acclimation Ponds | Flat plate screen and stop log guides fabrication | 11/02 to 12/02 |
| City of Yakima | Intake flat plate screens and barrier rack fabrication and install | 9/02 to 12/02 |
| Goat Creek | Head gate fabrication and install | 11/02 |
| Blue Lake | Trash rack/adult barrier fabrication | 10/02 |
| Oak Creek | Hay forks fabrication | 10/02 |
| Deer Point | Cattle guard fabrication | 10/02 |
| Oak Creek | Hay feeders fabrication and install | 8/02 |
| Ringer | Flat plate screen solar air burst fabrication | 7/02 to 8/02 |
| Kartevold | End of pipe fish screen install | 5/02 |
| Snake River Lab | Screw trap screen modifications | 5/02 |
| Black Canyon | Flat plate screen rotary wiper fabrication and install | 4/02 |
| Lucy Mason | Head gate fabrication and install | 4/02 |
| Willis | Screen removal | 4/02 |
| Zintel Canyon | Flat plate screen fabrication and install | 4/02 |
| Fiorito Lake | Bank stabilization | 3/02 |
| Maxwell (Oregon) | Rotary drum screen rebuilds | 1/02 to 3/02 |

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