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Select Area Fishery Evaluation Project

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SELECT AREA FISHERY EVALUATION PROJECT

FINAL PROJECT COMPLETION REPORT

October 1993 – October 2005

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
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Fisheries Project

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ACKNOWLEDGMENTS

This project has been recognized by the Ash Institute for Democratic Governance and Innovation, and the Kennedy School of Government, Harvard University as one of the 150 most innovative government sponsored local/regional programs in the United States for 2003. This accomplishment has only been possible through the hard work and dedication of many individuals and agency representatives of local, state and federal governments working together collaboratively.

We wish to acknowledge Clatsop County through its Clatsop Economic Development Council, over two hundred gillnet fishermen, and seven local fish processors, as well as the Astoria High School Aquatic Science Program for their continued support. Other organizations such as Salmon For All, the Columbia River Fishermen's Protective Union, and many local businesses have made contributions of volunteer time and resources to make the program a success.

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This report and the work it reflects would not have been possible without those that have gone before us. It is fitting that we conclude this acknowledgment with a tribute to former state legislator Ted Bugas; Oregon State University Professor Emeritus Duncan Law; Paul Hirose, Oregon Department of Fish and Wildlife, Ret.; and Jim Hill, former CEDC Fisheries Project Director.

The use of trade names throughout this report does not imply endorsement by the SAFE project.

EXECUTIVE SUMMARY

As part of the 1993 Strategy for Salmon, the Northwest Power Planning Council (NPPC, currently Northwest Power and Conservation Council, NPCC) recommended terminal-fishing sites be developed to allow harvest of known hatchery production while minimizing incidental harvest of weak stocks. Beginning in 1991, listing of various Evolutionarily Significant Unit (ESU's) under the federal Endangered Species Act (ESA) complicated harvest management and severely limited execution of mixed-stock fisheries in the mainstem Columbia River. The Select Area Fisheries Evaluation (SAFE) Project was subsequently initiated by Bonneville Power Administration (BPA) in 1993 to mitigate fisheries by providing the opportunity to harvest locally-produced salmon stocks in off-channel areas of the Columbia River. This report summarizes activities and findings of the SAFE project during fall 1993 through fall 2005, except some earlier information is provided for background and to identify trends.

During 1993 -1996, 25 potential sites were evaluated for rearing potential, capacity for fishers, access, water quality, and potential to impact non-local stocks; of which eight were selected for further study. Physicochemical and aquatic bio-monitoring surveys were conducted from 1994-1996 to establish baseline conditions at each site. Extensive test fishing was conducted during this same period to assess the harvest potential in each site by evaluating abundance and timing of non-target fish stocks, suitable gear restrictions, and fishing area boundaries. The Youngs Bay net-pen project that was initiated in 1986 by Clatsop Economic Development Council's Fisheries Project (CEDC), served as the model for development of the SAFE project due to superior growth and survival rates documented for this rearing strategy. Based on this information and available funds, Tongue Point, Blind Slough, Deep River, and Steamboat Slough were selected for development of rearing sites and establishment of SAFE fisheries. Releases in Youngs Bay were increased and used as a standard for comparison with the new sites.

Experimental groups of coho (*Oncorhynchus kisutch*) were reared and released from the Tongue Point, Blind Slough, and Deep River sites in 1995 and Steamboat Slough in 1999 to determine each site's capability to successfully acclimate and imprint smolts based on recovery of coded-wire tags from returning adults. Coho were used during initial production years due to a surplus of juveniles and a shorter maturation cycle. Spring chinook (*O. tshawytscha*) were subsequently reared and released at Tongue Point, Blind Slough, and Deep River. Two stocks of fall chinook including upriver brights (URB) and select area brights (SAB; originally Rogue River stock) were evaluated at all Oregon sites.

Approximately 1.9 million coho, 1.35 million spring chinook, and 1.3 million fall chinook hatchery smolts are currently reared and released from SAFE net pens and associated hatcheries. Commercial and recreational fisheries have expanded substantially due to improved rearing strategies and increased releases as the project has progressed from initial research to fishery implementation.

Experimental fishing seasons were established for each site concurrent with initial adult returns of each species. Extensive sampling of the landed catch for each fishery has been and continues to be conducted to recover coded-wire tags applied previously to a representative component of each SAFE release and from any non-target stocks. Sampling of local hatchery returns, SAFE recreational fisheries, and spawning ground surveys in select area tributaries provides additional tag recovery data that is used to monitor survival, straying, and fishery contributions to determine if project objectives are being met. Fishing periods, gear, and area boundaries have been refined over time to minimize impacts to listed species.

Adult survival of SAFE spring chinook (1994-2000 broods) averaged 0.85 percent, slightly better than releases from Willamette River Basin hatcheries (0.76 percent). SAFE coho smolt-to-adult survival rates (SAR's) ranged from 0.69-3.73 percent annually (1993-2000 broods) compared to lower Columbia River hatcheries, which ranged from 0.47-4.22 percent. Adult survival rates of SAB fall chinook averaged 1.22 percent for broodstock releases at Klaskanine Hatchery (1995-2000 broods) and 1.05 percent for releases from net pens in Youngs Bay (1991-2000 broods). Average survival of upriver bright fall chinook (URB) was 0.11 percent (1994-1997 broods).

Average stray rates for SAFE 1994-2000 brood spring chinook were 3.6 percent for Blind Slough; 4.6 percent for Youngs Bay; 22.1 percent for Tongue Point, and 19.1 percent for Deep River. Escapement of 1993-2000 brood SAFE coho averaged 1.0 percent for Youngs Bay, 1.0 for Blind Slough, 2.5 for Tongue Point, 3.0 for Deep River, and 33.3 for Steamboat Slough (1997-1999 broods). Average stray rates for SAB fall chinook were 0.7 percent for Klaskanine Hatchery (1995-2000 broods), and 1.8 percent for Youngs Bay net pens (1991-2000 broods). The stray rate for URB fall chinook (1994-1997 broods) averaged 8.1 percent.

Based on these results several modifications to the original release programs were required. URB fall chinook releases at Tongue Point were discontinued due to unacceptable stray rates, and releases at Youngs Bay were curtailed because of poor returns. Releases of SAB fall chinook from Tongue Point and Blind Slough were discontinued after 1997 due to poor survival and high stray rates, primarily to lower Columbia River tributaries. SAB fall chinook production was continued in Youngs Bay; however, the broodstock release and collection site was moved from Big Creek Hatchery to Klaskanine Hatchery in 1996 to reduce straying and maximize harvest of surplus adult returns. Production-level releases of spring chinook from Tongue Point were discontinued in 2000; pending results of 2003-2006 release trials from a new rearing site established in this area. Releases of coho from Steamboat Slough were discontinued in 2004 due to lack of participation.

During this reporting period, spring fisheries (mid-April through mid-June) targeting spring chinook were expanded in Youngs Bay based on increased releases, with new seasons established in Tongue Point, Blind Slough, and Deep River select areas beginning in 1998. Winter seasons were established during late-February through mid-March in Youngs Bay (1998), Blind Slough (1999), and Tongue Point (2000) to target early-returning spring chinook. Summer seasons (mid June-July) have been adopted in Youngs Bay since 1999 to harvest SAB fall chinook. Due to these expanded fishing opportunities and additional releases, chinook harvest in winter-summer SAFE fisheries increased steadily from 155 fish harvested in 1995 to 11,699 in 2002. Since then, chinook landings in winter-summer fisheries have ranged between 2,535 and 10,500 fish annually.

Fall commercial fisheries were established from early August through October in Youngs Bay (1993-2005), and September-October in Tongue Point, Blind Slough, Deep River (1996-2005), and Steamboat Slough (2000-2005). The August portion of the Youngs Bay season targets SAB fall chinook and shifts to coho-directed fisheries beginning in September. During 1996-2005, Youngs Bay harvest ranged from 1,225 to 4,285 fall chinook, and 13,649 to 91,435 coho. At the other sites annual coho harvest ranged from 26 to 19,083 fish during this period. In 2003, a record 114,352 coho were harvested in SAFE fisheries. Annual harvest of white sturgeon (*Acipenser transmontanus*) in SAFE fisheries has averaged 568 fish.

Fisheries adopted during this reporting period resulted in a significant increase in interest in SAFE fisheries by both commercial and recreational user groups. During 1996-2005, an average of 122 and 149 commercial vessels participated in winter-summer and fall SAFE fisheries, respectively. Since recreational surveys were initiated in 1998, sport harvest has increased significantly especially for spring chinook and SAB fall chinook. An analysis of the economic value of SAFE fisheries and the cost:benefit of the project is ongoing by an independent contractor and will be presented as a separate report.

One of the primary goals of this project was to maximize harvest of returning adults while minimizing catch of non-SAFE stocks. Coded-wire tag recoveries document extremely high harvest rates for all species: coho (98.0 percent, excluding discontinued Steamboat Slough releases), spring chinook (91.2 percent), SAB fall chinook (97.0 percent), and URB fall chinook (94.4 percent). These high harvest rates for target stocks are achieved through adaptive inseason management and are documented and supported by extensive monitoring of fisheries and stream surveys (Miller et al, 2002; North et al. 2004).

As intended, the majority of the fish harvested in SAFE fisheries were of local origin although the contribution varied by site and year. For winter-summer fisheries, SAFE releases comprised an average of 93.5 percent of the Blind Slough harvest, 92.0 percent in Deep River, 83.2 percent in Youngs Bay, and 70.4 percent in Tongue Point. During 1996-2004, locally-produced coho contributed an average of 87.2 percent of the coho harvest in Youngs Bay, 88.3 percent in Deep River, 79.9 percent in Tongue Point, 80.1 percent in Blind Slough, and 45.5 percent in Steamboat Slough. Fall chinook harvest and stock composition varied considerably depending on the extent of releases at each site. During 1996-2005, Youngs Bay had an average annual harvest of 2,599 fall chinook, with 95.7 percent originating from SAFE sites based on non-expanded CWT recoveries. Tongue Point and Blind Slough averaged 956 and 1,433 fall chinook, respectively, with SAFE stocks comprising 69.1 percent of the Tongue Point catch and 71.2 percent of the Blind Slough landings. In Deep River, 86.5 percent of the average annual harvest of 156 chinook were of SAFE origin.

Another major goal of the SAFE project was to develop fisheries that provided greater protection for depressed and listed stocks. Estimated impact rates to ESA-listed stocks in winter-summer SAFE fisheries have not escalated commensurate with the increase in SAFE landings and have remained relatively low for all listed stocks. From 1993-2005 combined harvest rates on upriver spring chinook in all winter-summer SAFE fisheries have averaged 0.06 percent with a range of 0.00-0.19 percent, which equates to an annual average harvest of 26 wild upriver spring chinook (24 Snake River stock and 2 Columbia River stock). Impacts to Willamette River wild spring chinook during 1996-2005 ranged from 0.24-1.60 percent (15-195 fish), with an annual average impact of 0.68 percent. Impacts to wild Sandy River spring chinook during 1999-2005 have averaged 1.67 percent (98 fish). The harvest rate of upriver summer chinook has been consistently low, ranging from 0.00-0.10 percent (0-65 fish) during 1999-2005. Except for one fish (0.001 percent) landed during 2001 in Youngs Bay, the impact rate on sockeye in SAFE fisheries has been 0.0 percent since 1996.

In conjunction with rearing and releasing smolts into SAFE sites for the purpose of fishery development, many fish propagation studies were also initiated. Studies have included evaluations of avian avoidance and predation, subsurface feeding, oxygen supplementation, winter dormancy, rearing density, size at release, time of release, smolt condition and migration rates, and adult holding. Whenever possible, study results have been incorporated into production strategies to maximize project benefits.

In addition to documenting results of released fish and impacts to non-target stocks, all sites have been monitored for water quality to determine whether any change is occurring in local biochemical composition. Monthly measurements of water chemistry and macro-invertebrate populations have been conducted before, during, and after each rearing period. To date the tendency has been for limited changes at some sites during the rearing period (November-April), with return to previous conditions during the recovery period (May-October).

Future plans of the SAFE project include increasing production through project efficiencies. Specific near-term actions include a net reduction of 2.15 FTE, consolidation of staff duties, simplification of the water quality program, adding oxygen supplementation and shifting SAB broodstock production to allow addition of 0.75 million coho. All these efficiencies will allow for production increases of 1.25 million smolts with limited funding increases.

In summary, the SAFE project has successfully developed net-pen rearing strategies and established new and significant harvest opportunities for both commercial and recreational fishers to harvest strong, locally-produced stocks of hatchery salmon with minimal impacts to non-local stocks including species listed under the ESA. Several key findings and results of the SAFE project include:

1) Since 1993, SAFE fisheries have accounted for an average of 40.0, 53.5, and 15.7 percent of the combined non-Indian Columbia River commercial harvest of coho, spring chinook and fall chinook.
2) Due to geographic separation, SAFE fisheries have far less impact on non-target stocks per harvested fish than do “mixed-stock” commercial and recreational fisheries occurring in the mainstem Columbia River, even when these fisheries utilize selective harvest methods. Since 2002, SAFE commercial fisheries averaged 450 and 280 percent more spring chinook harvested per upriver spring chinook killed than occurred in mainstem commercial and recreational spring chinook fisheries in the mainstem Columbia River.
3) Average harvest rates of 91.2 percent for spring chinook, 98.0 percent for coho (excluding Steamboat Slough), and 97.0 percent for SAB fall chinook produced by the SAFE project far exceed rates for production from other regional hatcheries that typically have high escapement rates due to complexities associated with harvest in mixed-stock fisheries of the mainstem Columbia River.
4) Average survival rates for all salmonid stocks produced by the SAFE project are equal to or greater than comparable regional production.
5) An average of 18.3 percent of spring chinook, 55.3 percent of SAB fall chinook, and 35.6 percent of coho production from the SAFE project is harvested in other regional fisheries.
6) No adverse environmental effects have been identified associated with SAFE project net-pen rearing.

1. INTRODUCTION AND PROJECT HISTORY

BACKGROUND

In its 1993 Strategy for Salmon, the Northwest Power and Conservation Council (NPPC, formerly Northwest Power Planning Council) recommended that terminal-fishing sites be identified and developed to harvest abundant fish stocks while minimizing the incidental harvest of weak stocks. The Council called on the Bonneville Power Administration (BPA) to "Fund a study to evaluate potential terminal fishery sites and opportunities. This study should include: general requirements for developing those sites (e.g., construction of acclimation/release facilities for hatchery smolts so that adult salmon would return to the area for harvest); the potential number of harvesters that might be accommodated; type of gear to be used; and other relevant information needed to determine the feasibility and magnitude of the program."

Beginning in 1993 BPA initiated the Columbia River Terminal Fisheries Project, a comprehensive program to investigate the feasibility of establishing and expanding terminal fisheries in Youngs Bay and other off-channel sites in the lower Columbia River (LCR) (Hirose et al. 1996). This project is an extension of the existing hatchery system that utilizes existing hatchery facilities to spawn, hatch, and conduct initial rearing of juvenile salmonids for subsequent outplanting to net-pen facilities at each of the SAFE sites. This strategy capitalizes on documented improvements to growth and survival provided by net-pen culture pioneered by the Clatsop Economic Development Council Fisheries Project (CEDC) (Hirose et al. 1998).

Referred to as the Select Area Fisheries Evaluation (SAFE) Project (since 1997), the sponsors are the Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), and CEDC Fisheries Project. The goal of the project is to determine the feasibility of creating and expanding known stock sport and commercial fisheries in the Columbia River Basin to allow harvest of strong anadromous salmonid stocks while providing protection to depressed stocks.

The SAFE project was designed with three distinct stages: an initial research phase to investigate potential sites, salmon stocks, and methodologies (Hirose et al. 1998); a second phase of expansion in Youngs Bay and introduction into areas of greatest potential as shown from the initial stage; and a final phase of establishment of terminal fisheries at full capacity at all acceptable sites (Miller et al. 2002). The final phase of the SAFE project is intended to establish SAFE fisheries at full capacity at all acceptable sites through adaptive management strategies. No site is currently rearing all species of fish at full capacity and several potential sites have not been thoroughly evaluated. Although expansion has been constrained somewhat by stock availability, limitations on funding will control progression into this third phase of the program.

Impacts (lethal take of listed stocks) to listed stocks resulting from SAFE fisheries are covered under Biological Opinions (BO's) issued for mainstem Columbia River spring and fall fisheries (NMFS 2003a; NMFS 2003b; NOAA 2005). Hatchery production by the SAFE project is currently covered in a separate BO issued in 1998 (NMFS 1998). Hatchery Genetic Management Plans (HGMP's) have been submitted to the National Oceanic and Atmospheric Administration (NOAA), from which a new BO will be developed. Existing and previous BO's have found the project does not likely jeopardize the continued existence of listed salmonid stocks in the Columbia River Basin.

The project was initially operated under the Final Environmental Assessment (EA) of Youngs Bay Salmon Rearing and Release Program (BPA 1993). In May 1994 BPA prepared a Categorical Exclusion to perform research activities to identify and evaluate potential sites for expansion of this program. In 1995, BPA completed an EA for the SAFE project and issued a Finding of No Significant Impact (FONSI). An additional FONSI issued in 1998 by BPA was found to be adequate in 2002 when BPA reinitiated ESA consultation with NOAA regarding SAFE project activities. This EA and FONSI remain valid as long as project activities remain unchanged.

This report summarizes activities and results of the SAFE project for the period Fall 1993-Fall 2005 (Chapters 1-7). A description of a forthcoming detailed economic analysis report is discussed in Chapter 8, and justification for continuation of the project is presented in Chapter 9. Plans for future direction of the project, including cost-saving measures and actions presented in the 2007-2009 BPA solicitation are outlined in Chapter 10. Responses to the March 2005 review of the project by the ISRP/IEAB are presented in Chapter 11.

SITE SELECTION

When the SAFE project was initiated in 1993, eight potential sites were identified, surveyed, and classified with respect to rearing potential, access, capacity for fishers, and potential for impacts on stocks listed under the Endangered Species Act (ESA). Spring and fall test fishing programs were initiated to determine area, time, and gear parameters that would maximize harvest of targeted stocks. Physicochemical surveys and aquatic bio-monitoring were conducted from November 1994 through October 1996 at five sites in Oregon and three sites in Washington to establish baseline conditions and document differences between sites.

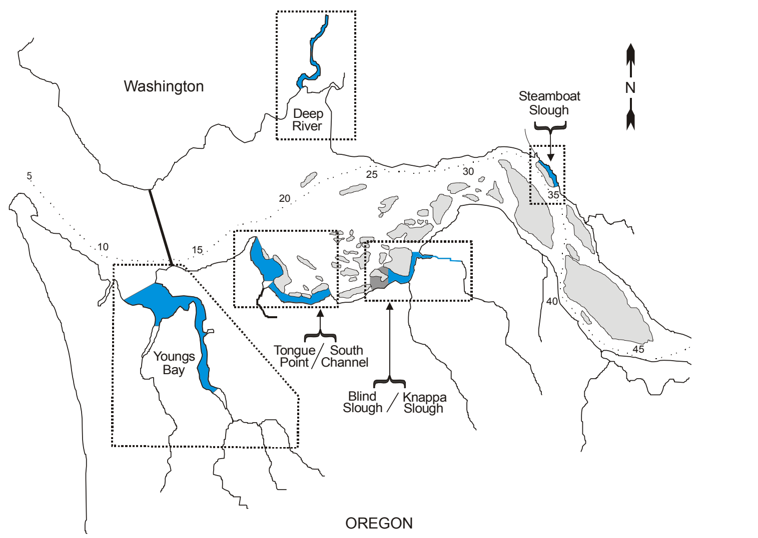


Figure 1.1. Select area fishing locations in the lower Columbia River.

Based on this information four sites were selected in Oregon (Tongue Point, Blind Slough, Clifton Slough, and Wallace Slough), and three in Washington (Deep River, Steamboat Slough, and Cathlamet Channel), for consideration as terminal fishing areas. In addition the established Youngs Bay site was included for further expansion. Based on available funds, Youngs Bay, Tongue Point, Blind Slough, Deep River, and Steamboat Slough were selected for rearing and establishment of SAFE fisheries (Figure 1.1). Experimental releases of 1993 brood coho (*Oncorhynchus kisutch*) were conducted to determine each site's capability to successfully acclimate and imprint smolts based on recovery of coded-wire tags (CWT's) from returning adults.

FISHING SITES AND FACILITIES

The five SAFE net-pen rearing and fishing sites are located in the lower Columbia River (LCR) between river miles 10.0 and 35.0 (Figure 1.1). Each site provides commercial and recreational fishing opportunities, although season structure and target species differ depending on current production goals and management objectives.

Youngs Bay

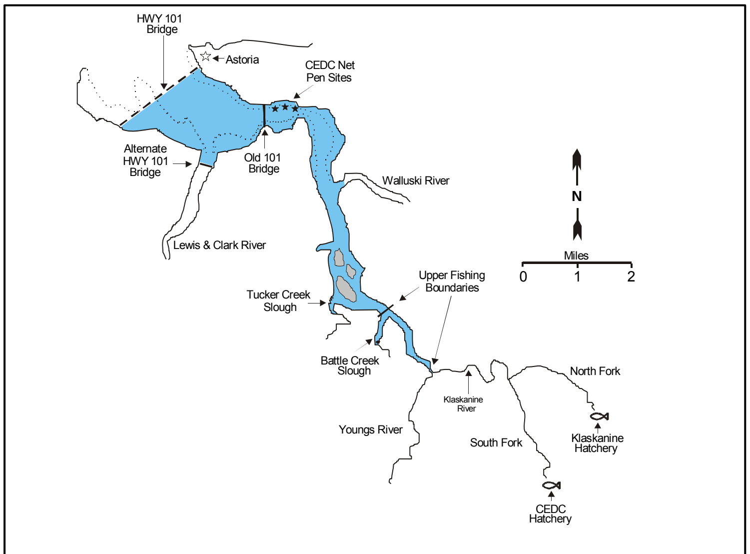


Figure 1.2. Youngs Bay Select Area fishing site.

Youngs Bay is located in Oregon waters adjacent to the city of Astoria and inland of the Highway 101 Bridge (Figure 1.2). The fishing area includes those waters of Youngs Bay from the new Highway 101 Bridge upstream to either the upper boundary markers at the confluence of the Klaskanine and Youngs rivers or Battle Creek Slough (depending on season), except for those waters which are closed southerly of the alternate Highway 101 Bridge (Lewis and Clark River). The upper fishing boundary is the confluence of Youngs and Klaskanine rivers for all fisheries except for the fall commercial fishery when the boundary is moved downstream to Battle Creek Slough to increase SAB fall chinook (*O. tshawytscha*) broodstock escapement. All waters in this site are under Oregon State jurisdiction with an Oregon landing permit required for participation. Currently there are a total of 76 net pens at three different rearing locations within Youngs Bay.

Tongue Point/South Channel

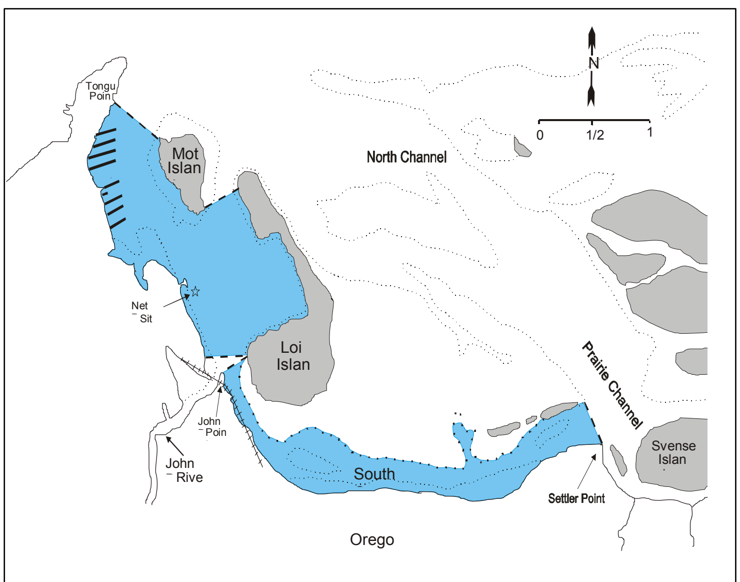


Figure 1.3. Tongue Point/South Channel Select

Tongue Point Basin is located just east of Astoria in concurrent Columbia River waters bounded by the Oregon shore and Mott and Lois islands (Figure 1.3). The South Channel area extends easterly from the Tongue Point Basin along the Oregon shoreline to its confluence with Prairie Channel. The Tongue Point fishing area includes all waters bounded by a line from a yellow marker midway between the red light at the tip of Tongue Point and the downstream (northern most) pier (#8) at the Tongue Point Job Corps facility, to the flashing green USCG navigation light #3 on the rock jetty at the west end of Mott Island, a line from a marker at the southeast end of Mott Island northeasterly to a marker on the northwest tip of Lois Island, and a line from a marker on the southwest end of Lois Island westerly to a marker on the Oregon Shore. All waters are under concurrent jurisdiction and open to fishers from both states. The South Channel area includes all waters bounded by a line from a marker on John Day Point through the green navigation buoy “7” north to a marker on the southwest end of Lois Island, upstream to an upper boundary line from a marker on Settler Point northwesterly to the flashing red marker “10”, then northwest to a marker on Burnside Island defining the terminus of South Channel. All waters in this site are under concurrent state jurisdiction.

In 2002 CEDC began to pursue a new site for the net pens at Tongue Point with less exposure to strong east winds that were causing damage to the pens and creating dangerous conditions. The appropriate permits were secured from Oregon Division of State Lands and the U.S. Army Corps of Engineers to relocate the net pens to a site 1.5 miles upstream at south Tongue Point near the Marine and Environmental Research and Training Station (MERTS; Fig. 1.3). Currently there are 30 net pens at this site and extra piling for potential future expansion. An additional temporary net-pen site is located in the John Day River (river mile 3.0), a tributary that enters the Tongue Point fishing area approximately 0.6 miles east of the MERTS site.

Blind Slough/Knappa Slough

Blind Slough is located near Brownsmead, Oregon and encompasses the lower reaches of Gnat Creek to its confluence with Knappa Slough, which then extends downstream to its confluence with Prairie Channel at the west end of Minaker Island, including Big Creek and Calendar sloughs (Figure 1.4). The Blind Slough fishing area is approximately 2.5 miles long and includes all waters from markers at the mouth of Gnat Creek located approximately 0.5 miles upstream of the county road bridge, downstream to markers at the mouth of Blind Slough. Concurrent waters extend downstream of the railroad bridge. Oregon State waters extend upstream of the railroad bridge. The Knappa Slough fishing area includes all waters bounded by a line from the northern-most marker at the mouth of Blind Slough, westerly to a marker on Karlson Island, downstream to boundary lines defined by markers on the western end of Minaker Island to markers on Karlson Island and the Oregon shore. An area closure of about 100’ radius at the mouth of Big Creek is defined by markers. All waters in this site are under concurrent state jurisdiction. Presently there are 15 net pens at the Blind Slough rearing site.

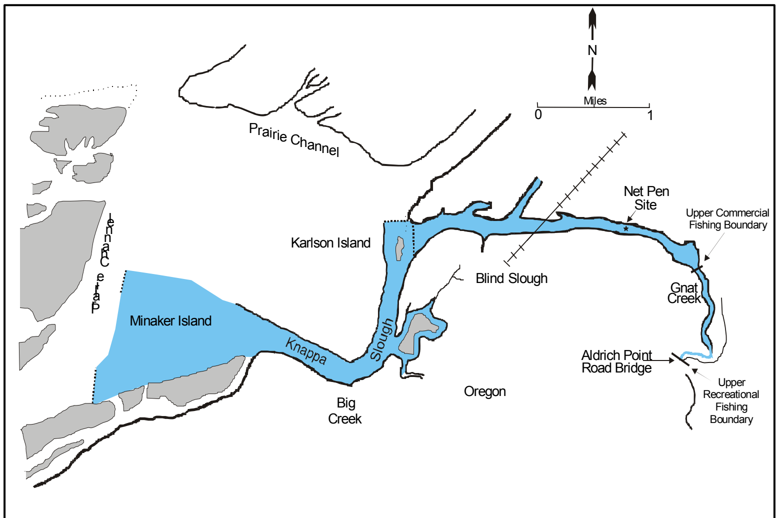


Figure 1.4. Blind Slough/Knappa Slough Select Area fishing sites.

Deep River

The Deep River fishing site is located within the lower reaches of Deep River near the town of Deep River, Washington and extends downstream to its confluence with the Columbia River in Grays Bay (Figure 1.5). The fishing area includes all waters downstream of the town of Deep River to the mouth (a line from navigation marker "16" southwest to a marker on the Washington shore). Washington State waters extend upstream of the Highway 4 bridge and concurrent state waters extend downstream. There are currently two rearing sites in Deep River; one upstream and one downstream of Highway 4 with a total of 52 net pens.

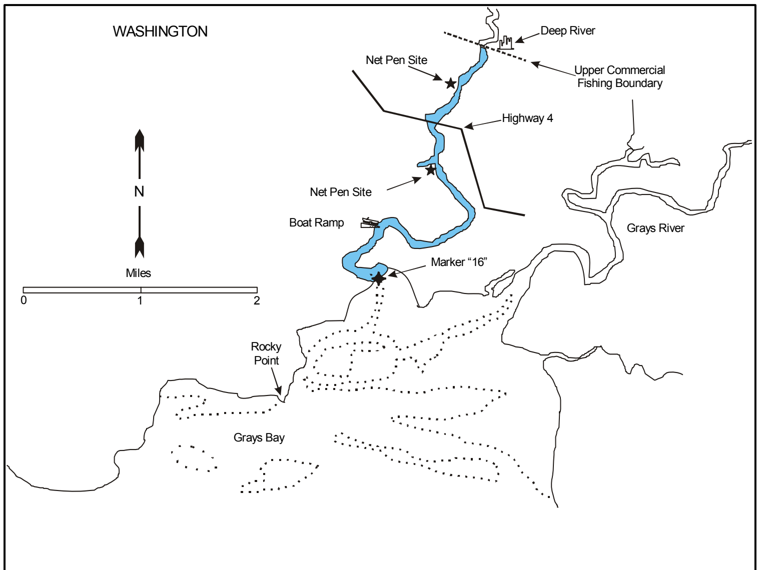


Figure 1.5. Deep River Select Area fishing site.

Steamboat Slough

Steamboat Slough is a side-channel area just east of the town of Skamokawa, Washington and is bounded by the Washington shoreline and Price Island (Figure 1.6). The Steamboat Slough fishing area includes all waters bounded by markers located on Price Island and the Washington shore at both ends of Steamboat Slough. All waters in this site are under concurrent state jurisdiction.

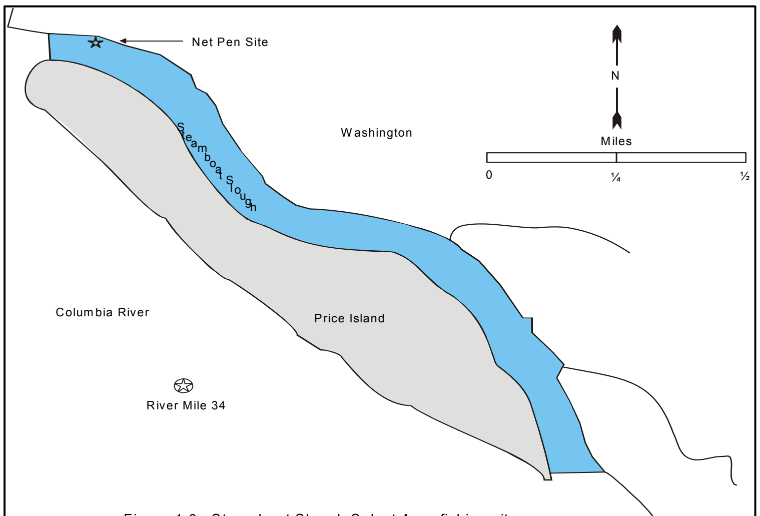


Figure 1.6. Steamboat Slough Select Area fishing site.

Following five years of coho releases from Steamboat Slough during 1999-2004, the decision was made to discontinue rearing at that site. Data showed good survival rates for these fish upon return to Elochoman Hatchery, but they were not holding in Steamboat Slough where they could be harvested. After the last group was released in 2004 the pens were moved to the Deep River site to boost coho rearing to 400,000 smolts (see Chapter 2).

Net Pens

The net-pen rearing complex at each site consists of 2-4 individual 6.1-m^2 inside dimension frames of high-density polyethylene pipe (33 cm o.d.) filled with styrofoam (Figure 1.7). A wooden walkway of 2" x 12" lumber is bolted to the plastic frame for access. A 3.1-m deep net hung within each frame confines the fish during rearing and acclimation. Mesh sizes of 3.2-19.0 mm (0.125-0.750") are utilized and adjusted depending on fish size. Vertical plastic standpipes are submerged around the perimeter of each pen to maintain the shape of the net. Actual rearing area of each net is approximately 91 m^3 (3,200 ft^3). Fish are grown and released from these pens under varying management and grow-out regimes including two-week acclimation, over-winter, and full-term net-pen rearing (see Chapter 2).

Figure 1.7. Net pens at the Youngs Bay Yacht Club site.

Hatcheries

Hatcheries providing production for these sites are South Fork Klaskanine (CEDC); Big Creek, Bonneville, Cascade, Gnat Creek, Klaskanine, Oxbow, Sandy, and Willamette (all ODFW); Cowlitz, Elochoman, Lewis, and Gray's River (all WDFW); and Eagle Creek (U. S. Fish and Wildlife Service; USFWS). The SAFE project fully funds Gnat Creek and Grays River hatcheries and partially funds Klaskanine Hatchery. A summary of each facility's association with the SAFE project is provided in Table 1.1.

LISTED ANADROMOUS SPECIES

A total of 13 salmonid evolutionarily significant units (ESU's) are listed under the federal ESA (Table 1.2). Naturally-produced coho salmon destined for tributaries downstream of Bonneville Dam are also listed as endangered by the State of Oregon (effective 1999). All of these stocks migrate past, and in some cases, through the fishery areas. Incidental take of listed stocks in SAFE fisheries is included in Biological Assessments (BA's) and BO's adopted for mainstem Columbia River fisheries. All winter, spring, and summer SAFE fisheries are established in accordance with the Willamette Fish Management and Evaluation Plan (ODFW 2000). The project has regularly been evaluated for its impact on endangered species resulting from juvenile production and harvest (NMFS 1998; NMFS 2003a; NMFS 2003b, TAC 2005).

In order to facilitate consultations with the NOAA Fisheries for past mainstem treaty Indian and non-Indian fisheries, the *U.S. v Oregon* Technical Advisory Committee (TAC). The TAC has prepared BA's for combined fisheries based on relevant *U.S. v Oregon* management plans and agreements. The TAC has completed BA's of potential impacts to all ESA-listed salmonid stocks (including steelhead) for all mainstem Columbia River fisheries including SAFE fisheries since January 1992 and for Snake River Basin fisheries since January 1993. A BA concerning Columbia River treaty Indian and non-Indian fisheries as described in the recently adopted "2005-2007 Interim Management Agreement for upriver Chinook, sockeye, steelhead, coho, and white sturgeon" was submitted to the NOAA Fisheries during the spring of 2005 (NOAA 2005), and a BO was issued on May 9th, 2005.

As a note of explanation, annual releases from Deep River net pens are generally the latest each year due to the need to minimize interactions of hatchery stocks with ESA-listed chum salmon (*Oncorhynchus keta*) that spawn in this system. Stream surveys are conducted each year to determine when chum juveniles have emigrated from Deep and Grays rivers, at which time fish are released from both the net pens and Grays River Hatchery. Beginning in 2004, this date was set at May 1.

Table 1.1. Summary of salmonid[a] production facilities associated with the select area fisheries project, 1993-2005.

Hatchery	Agency	Early Rearing COH	Early Rearing CHS	Early Rearing SAB	Early Rearing CHF	Early Rearing URB	Direct Release COH	Direct Release CHS	Direct Release SAB
Oregon									
Big Creek	ODFW	X[b]		X[c]	X[b]		X		
Bonneville	ODFW	X				X			
Cascade	ODFW	X							
Eagle Creek	USFWS	X[d]							
Gnat Creek	ODFW		X						
Klaskanine	ODFW			X[e]					X[f]
Oxbow	ODFW	X							
Sandy River	ODFW	X							
S. Fork Klaskanine	CEDC	X[g]	X[h]	X[i]			X[g]	X[h]	
Willamette	ODFW		X						
Washington									
Cowlitz River	WDFW		X						
Lewis River	WDFW		X						
Elochoman River	WDFW	X							
Grays River	WDFW	X					X		

[a] *Coho (COH); spring chinook (CHS); select area bright (SAB) fall chinook (Rogue River stock); tule fall chinook (CHF); upriver bright fall chinook (URB)*

[b] *Production is not funded by SAFE project but significant numbers of returning adults are harvested in SAFE fisheries due to location of the hatchery*

[c] *1993-2005 brood years. Production will be transferred to SF Klaskanine Hatchery beginning with 2005 brood (June 2006)*

[d] *Discontinued after 2002 brood year*

[e] *Onsite rearing of 1995-2004 brood years. Egg collections only in 2005 brood year. Rearing and production will be transferred to SF Klaskanine Hatchery beginning with 2005 brood. Egg collections will continue onsite through at least 2009.*

[f] *Onsite releases ended with 2004 brood year. 2005 brood transferred to SF Klaskanine Hatchery*

[g] *1991-2001 brood years*

[h] *1992-1995 and 2002-2004 brood years*

[i] *1994 and 2003-2005 brood years*

Table 1.2. Federally-listed salmonid evolutionarily significant units (ESU's) in the Columbia River Basin.

ESU	Designation	Effective Date
Sockeye		
Snake River	Endangered	December 20, 1991
Chinook		
Snake River fall	Threatened	May 22, 1992
Snake River spring/summer	Threatened	May 22, 1992
Upper Columbia River spring	Endangered	May 24, 1999
Lower Columbia River spring/fall	Threatened	May 24, 1999
Upper Willamette spring	Threatened	May 24, 1999
Chum		
Lower Columbia River	Threatened	May 24, 1999
Coho		
Lower Columbia River	Threatened[a]	June 28, 2005
Steelhead		
Snake River	Threatened	October 17, 1997
Upper Columbia River	Endangered	October 17, 1997
Middle Columbia River	Threatened	May 24, 1999
Lower Columbia River	Threatened	May 18, 1998
Upper Willamette River	Threatened	May 24, 1999

[a] The *State of Oregon listed wild coho destined for Oregon tributaries of the lower Columbia River as an endangered species in July 1999.*

2. REARING AND RELEASE OF ANADROMOUS FISH STOCKS FROM SELECT AREA FACILITIES

Selection of salmonid stocks used for select area fisheries has been based on flesh quality, availability of eggs, homing ability, and overall value to the economy. To date, stocks evaluated in SAFE rearing programs have included early stock coho; select area bright (SAB) fall chinook; upriver bright (URB) fall chinook, and lower-river spring chinook. Annual releases of SAFE salmonids from 1993-2005 have ranged from 3.5-5.9 million fish, comprised of approximately 2.0-4.2 million coho, 0.1-1.4 million SAB fall chinook, 0.1-0.6 million URB fall chinook, and 0.4-1.8 million spring chinook (Figures 2.1 and 2.3).

Salmonid species currently being reared and released from SAFE sites include spring chinook, SAB fall chinook, and early stock coho. Currently source stocks of spring chinook are obtained from the Willamette River for Oregon select areas and the Cowlitz or Lewis rivers for the Deep River select area. The SAB fall chinook stock originated from Rogue River stock egg transfers but is currently supported by a local broodstock program established at Klaskanine Hatchery in 1996. Early-stock coho released from Oregon select areas originate from Bonneville, Eagle Creek or Sandy hatcheries while Washington coho releases originate from either Grays or Elochoman hatcheries.

Smolts released from SAFE net-pen rearing and acclimation sites may interact with wild juveniles rearing in or migrating through these areas. It is important to note that the SAFE net-pen sites were originally established based in part on a lack of presence of adult wild salmonids. Additionally, fish released from net pens have completed smoltification and therefore move quickly through freshwater areas to reach the Columbia River estuary (see Chapter 6). Based on a review of the SAFE juvenile production BA, the NOAA fisheries issued a BO concluding that current smolt production conducted by the SAFE project has little impact on wild smolts utilizing the Columbia River estuary for short-term rearing and migration purposes (NMFS 1998). The current production BO is scheduled for renewal through the ongoing HGMP process. Three separate HGMP's were completed for the production for the Oregon component of SAFE project describing production of coho, spring chinook and SAB fall chinook. These documents were submitted to NOAA Fisheries in September 2005 for review. Two additional HGMP's were prepared and submitted in 2005 for SAFE production of coho and spring chinook in Washington (ODFW 2005a, ODFW 2005b, ODFW 2005c).

The Production Advisory Committee (PAC) established by the US v. Oregon Columbia River Fish Management Plan is informed of changes in SAFE project production to assure compliance and that allocation obligations are met. All policies and procedures of the Integrated Hatchery Operations Team (IHOT) are applied to SAFE salmonid production (IHOT 1997).

A variety of fish rearing strategies are utilized in the SAFE net pens. Generally, known numbers of fry, fingerlings or smolts are transferred from associated hatcheries by truck and piped directly into the pens. The fish are then dipped into the appropriate number of pens to achieve target densities. Fish are fed recommended levels of pelletized feed throughout the rearing period and released according to developed schedules. During the time the fish are in the pens, growth is monitored bi-weekly and mortalities removed and recorded daily. If significant loss to disease occurs, ODFW or WDFW pathology staff are usually called in to diagnose the cause and recommend treatment; typically medicated feed. In the case of large losses, mortalities are removed, counted and disposed of in a facility dumpster. Other losses during net-pen rearing (i.e. predation or holes in nets) can only be estimated, as fish are not typically inventoried at release. Therefore, actual release numbers may be lower than reported. Detailed descriptions of rearing strategies by species and brood year are provided in the following sections.

SPRING CHINOOK

Willamette River stock spring chinook were first released from Youngs Bay in 1989 (1988 brood). Releases have continued annually at this site with the exception of 1993 when rearing strategies shifted from sub-yearling (0+) to yearling (1+) release patterns. Early experimental releases from CEDC's South Fork (SF) Klaskanine facility ended with the 1995 brood, due to generally poor returns, most likely due to high levels of bacterial kidney disease (BKD). Initiation of the SAFE project provided opportunities to expand the program, and releases from Youngs Bay net pens were increased in 1995. Releases for site comparison at Tongue Point and Blind Slough began in 1996 (1994 brood), and beginning with the 1996 brood WDFW started releasing Cowlitz River stock spring chinook from the Deep River site, adding Lewis River stock beginning with the 2001 brood.

Releases of spring chinook reared on an experimental winter dormancy feeding regime were added in 1997 through collaborative research with NOAA. Since 2002 (2000 brood) NOAA has conducted additional research of release timing/ocean entry at Blind Slough. Releases of spring chinook increased significantly in 2004 and 2005 (2002-03 broods) with production at the SF Klaskanine Hatchery transitioning from coho to spring chinook. Beginning with the 1998 brood, all releases of spring chinook from select areas have been mass marked by removing the adipose fin (AD).

Similar to coho, net-pen rearing of spring chinook is generally limited to over-wintering and two-week acclimation strategies due to elevated summer water temperatures, although some small-scale over-summer experiments have been conducted to determine if this strategy will provide for increased net-pen production. In Oregon, eggs are collected at Willamette Basin hatcheries and transferred to Gnat Creek Hatchery for incubation, early rearing, mass marking, and coded-wire tagging. Eggs for the Deep River site are collected at Cowlitz and Lewis hatcheries and transferred to Grays River Hatchery for incubation, early rearing, mass marking, and coded-wire tagging. Fingerlings are transported from the hatcheries to the net pens in Youngs Bay, Tongue Point, Blind Slough, and Deep River during the fall. The fingerlings are generally fed BioDiet Grower™ three days per week at recommended levels during the rearing period. Target release size is 12 fish/pound, which is typically achieved in March or April, depending on feeding regimes and winter water temperatures. Winter dormancy feeding regimes, with little or no feeding from mid-December through January, have been conducted at Youngs Bay and Deep River (1999-2000 broods). Time of release has also been evaluated, with comparative February, March, and April releases tested (see Chapter 6). Two and four-week acclimation strategies have also been evaluated at both Blind Slough and Youngs Bay.

Due to straying of spring chinook reared at the Tongue Point site, releases were discontinued after 2000 (1998 brood). However, an enhanced homing experiment using the chemical morpholine with small-scale releases has been conducted at that site, beginning with the 2001 brood (see Chapter 6).

The overall quality of the spring chinook released improved dramatically beginning with the 1996 brood, when hatcheries in the Willamette system began culling BKD-positive adults from the broodstock.

The following information details year-specific rearing activities for 1999-2001 brood years. Similar information is available for 1993-1995 broods in Hirose et al. (1998); and for 1996-1998 in Miller et al. (2002).

1999 Brood Spring Chinook

The Oregon portion of the 1999 brood spring chinook was obtained from Willamette Hatchery, with about 850,000 eyed eggs transferred to Gnat Creek Hatchery. Early rearing, mass marking and coded-wire tagging occurred at Gnat Creek. Fingerlings were transferred to SAFE net pens in the fall of 2000. Due to homing concerns, Tongue Point releases were discontinued. However, when Gnat Creek Hatchery began to experience low flow conditions in September, 105,499 fish at 37 fish/pound were transferred to Tongue Point instead of Blind Slough as scheduled, because the Blind Slough water temperatures were high. These fish were later transferred to Blind Slough in November when water temperatures decreased. Also, Youngs Bay received 131,242 fingerlings at 44 fish/pound in September, again to relieve concerns about low water flows at Gnat Creek Hatchery. On October 30, 2000 the balance of the Youngs Bay fish were transferred (409,083 at 25 fish/pound). Blind Slough received 152,655 fish at 31 fish/pound on October 6, and the balance was transferred from Tongue Point, as stated above, in late November.

At Blind Slough there were three tag groups; one released March 1 at 12 fish/pound, one fed normally and released April 1 at 12 fish/pound, and the third put on a modified winter dormancy feeding regime and released April 1 at 12 fish/pound. The modified winter dormancy schedule included no feeding from mid-December until mid-January, then once per week until February 2 when normal (three days per week) feeding resumed. At Youngs Bay there were four tag groups; two groups released March 1 at 12 fish/pound, one group fed on a normal schedule and released April 1 at 12 fish/pound, and one group put on the same modified winter dormancy feeding regime mentioned above and released April 1 at 12 fish/pound. In addition to the over-winter groups, two 2-week acclimation tag groups totaling 52,917 fish were transferred to the Blind Slough net pens on March 11, 2001; one normally fed and the other on winter dormancy feeding while at Gnat Creek Hatchery. Also, two acclimation tag groups totaling 54,772 fish were transferred to Youngs Bay from Gnat Creek Hatchery on March 11; one was a 2-week acclimation group and the other was a 4-week acclimation group.

The Blind Slough over-winter fish that were temporarily reared at Tongue Point were treated for vibriosis with 1.7 percent Romet 30™ for 15 days before transfer to Blind Slough. Losses to disease were minimal at Blind Slough, but some significant losses to otter predation were incurred. In Youngs Bay there was a significant outbreak of vibriosis in the fish that were received early, and they were treated with 1.7 percent Romet 30™ for 15 days. The fish received on October 30 also received the same 15-day treatment for vibriosis. In February, the March 1 release group in Youngs Bay was treated for furunculosis with 1.7 percent Romet 30™ for 10 days. Losses to disease in all groups were kept to a minimum with these treatments and no further outbreaks occurred.

In Washington limited releases of spring chinook were initiated with the 1996 brood. Beginning with the 1999 brood larger releases were initiated, and experiments were conducted with winter dormancy and continued through two broods. Federal regulations restricted release of spring chinook to after May 1, resulting in considerable BKD losses since fish were held for an extended period in warm water. Dates, number, and fish size of each release are provided in Table 2.1.

2000 Brood Spring Chinook

Gnat Creek Hatchery received the Oregon portion of the 2000 brood spring chinook as eyed eggs from Willamette Hatchery (~850,000). Early rearing, mass marking and coded-wire tagging occurred at Gnat Creek Hatchery. Because of the past disease problems, these fish were vaccinated for vibriosis and enteric redmouth while at Gnat Creek Hatchery, and in the fall of 2001 the fingerlings were transferred to the SAFE net pens. Blind Slough received 332,541 fish at 38 fish/pound on September 17; again early because of low water flow concerns at Gnat Creek Hatchery. Youngs Bay received 427,872 fish at 31 fish/pound on October 1; also earlier than planned because of continued low water flows at Gnat Creek Hatchery.

At Blind Slough there were two tag groups; one fed normally, and the other fed with the experimental subsurface feeding technique that had previously been tested on SAB fall chinook. The subsurface feeding began while the fish were at Gnat Creek Hatchery, after coded-wire tagging was completed. In Youngs Bay there were two tag groups; one fed normally and released April 1 at 12 fish/pound, and the other on a modified winter dormancy regime and released April 1 at 12 fish/pound. The modified winter dormancy schedule was one day each week feeding from December 17-February 4, followed by normal three days per week feeding. In addition to the over-winter groups, two acclimation tag groups totaling 53,133 fish were transferred to Youngs Bay from Gnat Creek Hatchery on March 12, 2002; a 2-week and 4-week acclimation.

Blind Slough fish suffered from a significant outbreak of columnaris, most likely a result of being transferred in September when water temperatures were still high (above 60°F). Both tag groups were treated with 2.0 percent TM-100™ for 14 days. Losses were substantial (~20 percent), but diminished after treatment. The subsurface group was fed normally during treatment to make sure all fish received medication. In early March both tag groups were diagnosed with furunculosis and received a 10-day treatment with 1.7 percent Romet 30™. Again, to treat more effectively, the subsurface group was fed normally, and because of observed size disparity in those fish, the decision was made to discontinue the subsurface feeding strategy. Both tag groups also experienced significant river otter (*Lutra canadensis*) predation losses. In Youngs Bay both tag groups were treated for furunculosis with 1.7 percent Romet 30™ for 10 days, after which losses were minimal.

At Deep River 150,000 spring chinook fingerlings were reared for the second year. Fish originated from Cowlitz Hatchery and were held until May 16, 2002 when juvenile chum had exited the system. Again, tests were made with overwinter dormancy on one tag group, and a second tag group fed normal rations. With the warming of water in April came an increase in the incidence of BKD. Dates, numbers, and fish sizes for each release group are provided in Table 2.1.

2001 Brood Spring Chinook

Because of 2001 spring chinook broodstock shortages at Willamette Hatchery, Gnat Creek Hatchery received ~850,000 eyed eggs from South Santiam and Clackamas hatcheries. As a possible method to expand SAFE spring chinook production, the decision was made to experiment with over-summer net-pen rearing of fingerlings. On June 13, 2002 approximately 20,000 spring chinook fingerlings at 129 fish/pound were transferred to two sites; 10,000 to Youngs Bay and 10,000 to the new MERTS site at Tongue Point. These fish were mass marked and vaccinated for vibriosis and enteric redmouth while at Gnat Creek Hatchery. The rest of the spring chinook fingerlings were transferred to SAFE net pens in the fall of 2002. In hopes of re-establishing spring chinook production at Tongue Point, the decision was made to evaluate the use of morpholine as a homing enhancer, and 26,300 fingerlings at 24 fish/pound were transferred to the MERTS site on October 21. Blind Slough received 306,589 fish at 23 fish/pound, and Youngs Bay received 447,091 fish at 27 fish/pound.

At Blind Slough there was one tag group fed normally and released April 1 at 12 fish/pound. At Tongue Point one tag group was added to the over-summer fish at the MERTS site exposed to a morpholine drip for one month prior to release on April 1 at 12 fish/pound (see Chapter 6). In Youngs Bay there were three tag groups; one fed normally and released April 1 at 12 fish/pound, one put on a modified winter dormancy feeding regime (one day per week feeding from mid-December to February 1), and the third group fed subsurface for one month prior to release. In addition to the over-winter groups above one acclimation tag group was transferred to a new net-pen site on the John Day River, a tributary of the Columbia River near the MERTS site. Approximately 27,000 fish at 12 fish/pound were transferred from Gnat Creek Hatchery to the John Day site on March 10, 2003. All other acclimation groups were discontinued to avoid the cost of additional coded-wire tagging.

The over-summer spring chinook reared at the MERTS site had to be treated several times for columnaris, and also suffered severe losses to river otter predation. The over-summer spring chinook at Youngs Bay fared better, but needed to be treated for vibriosis twice despite being vaccinated. Over-winter groups at all sites were treated for furunculosis with 1.7 percent Romet 30™ for 10 days in February. The Blind Slough fish suffered chronic low-level losses to BKD, but overall losses to disease were minimal.

In Washington at Deep River, 141,904 spring chinook were released. Winter dormancy experiments were discontinued and replaced with comparisons of releases from Cowlitz and Lewis River hatcheries. BKD problems continued and experiments were initiated to determine a release strategy that would allow for earlier liberations. A release date of April 30, 2003 and cooler temperatures resulted in healthier releases, but BKD continued to be an issue. Dates, numbers, and fish sizes of each release group are provided in Table 2.1.

2002 Brood Spring Chinook

The Oregon portion of the 2002 brood spring chinook production originated at Willamette Hatchery and was transferred to Gnat Creek Hatchery as eyed eggs (~850,000). To further evaluate over-summer rearing at Tongue Point MERTS and Youngs Bay, approximately 25,000 fry were transferred to each site immediately after mass marking in July 2003. The remainder of the production was transferred to the net pens in the fall of 2003 as over-winter fish, with the exception of the John Day acclimation group. Youngs Bay received 456,688 fingerlings; about half of those in late September (due to low flows at Gnat Creek Hatchery) and the balance in late October. Tongue Point MERTS received 28,875 fingerlings on October 30, and Blind Slough received 301,658 fingerlings on October 31.

The Youngs Bay and Blind Slough production fish were each represented by one tag group of approximately 25,000 CWT fish, with no special studies or treatments. At Tongue Point MERTS one tag group of ~25,000 fish was added to the over-summer fish and exposed to a morpholine drip for one month prior to release. The 27,442 John Day acclimation fish were transferred to that site on March 15, 2004 and were 100 percent coded-wire tagged.

The over-summer spring chinook reared at Tongue Point MERTS again required treatment several times for columnaris, and despite various attempts with electric fence wire and tying bird netting to the rearing net, substantial losses to otters occurred and continued into the over-winter rearing period. The over-summer fish at Youngs Bay may have fared better, but a large hole in the net was discovered on July 23 with almost 20,000 of those fish estimated as lost. The remaining 5,631 were added to the over-winter group when they arrived in September.

Both the Youngs Bay and Blind Slough spring chinook were treated for furunculosis during the winter, but losses prior to release were minimal.

Experiments with chum timing continued to show that juvenile chum would not be out of the system until May 1. The Deep River net-pen spring chinook were released on May 1, with significant BKD. Only 97,318 smolts were released from a goal of 150,000. Dates, numbers and fish sizes of each release group are provided in Table 2.1.

2003 Brood Spring Chinook

Gnat Creek Hatchery received ~850,000 2003 brood eyed eggs of from Willamette Hatchery for the Oregon net-pen sites. To evaluate over-summer rearing further, approximately 50,000 swim-up fry were ponded directly into a net pen in Youngs Bay on January 14, 2004. These fish were vaccinated for vibriosis on April 7 and mass marked on April 15 and 16. The balance of the spring chinook production was marked and vaccinated while at Gnat Creek and transferred to the net pens in the fall of 2004, again with the exception of the John Day acclimation fish. Youngs Bay received 444,262 fingerlings, Tongue Point MERTS received 26,450, and Blind Slough received 289,076. All transfers occurred during the first week of November.

One coded-wire tag group was used at each Oregon net-pen site, with the only special treatment given to the Tongue Point MERTS group exposed to the morpholine drip for one month prior to release. The 27,029 John Day acclimation fish were transferred from Gnat Creek Hatchery on March 14, 2005.

The warm waters of Youngs Bay in 2005 contributed to several outbreaks of vibriosis and furunculosis in the over-summer fish and also caused the fish to grow at a faster rate than previous over-summer groups. Otters again reduced the population significantly by October.

The Youngs Bay over-winter fish were treated once for furunculosis in February of 2005, while the Tongue Point MERTS and Blind Slough fish required no treatments for disease, and losses were minimal.

The production goal at Deep River was increased to 250,000 with a temporary decrease in coho while pen capacity was being increased. Pens were towed into the mainstem Columbia River at smolting several weeks earlier than previous releases. This prevented interaction with juvenile chum, and cooler temperatures decreased the incidence of BKD. A total of 254,471 smolts were towed to Rocky Point and released on March 22-23, 2005. Dates, numbers and fish sizes of each release group are provided in Table 2.1.

SELECT AREA BRIGHT FALL CHINOOK

The SAB fall chinook stock used in the select areas originated from Rogue River stock egg transfers to Big Creek Hatchery in 1982, and to CEDC's SF Klaskanine Hatchery in 1983. This stock was utilized because of its high quality/red flesh color and south-turning migration pattern, which makes it available for harvest to all Oregon coast commercial and sport fisheries, as well as in LCR and Youngs Bay fisheries. An additional benefit of this stock is the protracted timing of return, which provides harvest opportunity from late spring through summer, when few other fall chinook are present in Youngs Bay tributaries. The broodstock was maintained at Big Creek Hatchery through 1995. Fishery enhancement efforts in Youngs Bay began with releases from the SF Klaskanine Hatchery in 1983 and expanded to include net-pen releases in 1989. Releases from the SF Klaskanine were discontinued in 1988, but due to program changes production will be reinstated at this site beginning with the 2005 brood. Youngs Bay net-pen releases have continued annually.

Beginning with the 1996 brood, the SAB broodstock program (funded by ODFW's Restoration and Enhancement program, R&E) was relocated to ODFW's Klaskanine Hatchery to address the problem of excessive straying (10-33 percent) from Big Creek Hatchery releases. Likewise, straying was documented from experimental releases at Tongue Point, so SAB net-pen releases have been restricted to Youngs Bay since 1998 (1997 brood). With the exception of the 1986-1989 broods, all SAB fall chinook released from select areas have been marked by removal of the left ventral (LV) fin to facilitate external identification. Time of release, rearing density, and sub-surface feeding experiments have been conducted in recent years (see Chapter 6).

A variety of production strategies are currently utilized for SAB fall chinook to achieve a target production goal of 1.5 million smolts. To maintain the broodstock program, approximately 700,000 fish that in the past were reared at Big Creek Hatchery and released at Klaskanine Hatchery, will be incubated, reared and released from CEDC's SF Klaskanine Hatchery site with partial funding provided by ODFW's R&E Program. SAFE-funded production of 750,000 is incubated at the SF Klaskanine Hatchery and transferred to the pens in February or March at about 1,000 fish/pound, vaccinated for vibriosis, mass marked (LV clip) and coded-wire tagged beginning in April, and reared until release in July or August at a target release size of 15 fish/pound. The fish are fed BioDiet Grower™ daily at recommended levels until release.

The following information details year-specific rearing activities for 2000-2002 brood years. Similar information is available for 1994-1995 broods in Hirose et al. (1998); and for 1996-1999 broods in Miller et al. (2002).

2000 Brood SAB Fall Chinook

In 2000, SAB fall chinook broodstock were collected at both Big Creek and Klaskanine hatcheries. Some early returning adults were collected at these facilities and transferred to holding pens in Youngs Bay. Spawning took place in October, and enough eggs (~750,000) for Klaskanine Hatchery broodstock releases were incubated at Big Creek Hatchery (Figure 2.2). Eggs in excess of the broodstock production goal were incubated at the CEDC SF Klaskanine Hatchery. Ponding of fry began February 11, 2001, and by the end of March about 240,000 fry were in the Youngs Bay net pens. Mass marking and coded-wire tagging occurred from May 8 to May 16 at Youngs Bay.

Approximately 100,000 fish were designated for funding by BPA, with the remaining production funded by ODFW's R&E program. Four study groups of about 25,000 fish each were differentially coded-wire tagged to evaluate subsurface feeding at target release densities of 0.25 lbs/ft^3 and 0.50 lbs/ft^3.

Before and during tagging, the fish were treated for vibriosis with 2.0 percent TM 100™ for 12 days. Losses dropped to near zero, and all study groups were vaccinated for vibriosis on May 22. Mortality increased shortly after vaccination, so another course of TM 100™ was administered from May 26 to June 4. From that time until release, losses were minimal. All groups were released on July 4 when water temperatures reached or exceeded 65°F. Dates, numbers, and fish sizes for each study group at release are provided in Table 2.2.

2001 Brood SAB Fall Chinook

Broodstock for the 2001 SAB fall chinook were again collected at Big Creek and Klaskanine hatcheries. Some early returning adults were also held in net pens in Youngs Bay. Eggs were taken at all three sites, with about 750,000 eggs incubated at Big Creek Hatchery for broodstock release needs, and an additional 500,000 incubated at the CEDC SF Klaskanine Hatchery. Ponding of fry into the Youngs Bay net pens occurred between February 12 and March 20. The fry were vaccinated for vibriosis prior to mass marking and coded-wire tagging, which took place from April 23 to May 13.

Approximately 300,000 fish were designated as BPA study fish, again with four CWT groups. The 0.50 lbs/ ft^3 surface-fed group had about 125,000 fish; the 0.50 lbs/ ft^3 subsurface group had about 25,000 fish; the 0.25 lbs/ ft^3 surface-fed group had about 125,000 fish; and the 0.25 lbs/ ft^3 subsurface group had about 25,000 fish. The balance of the net-pen production (~165,000 fish) was funded by ODFW's R&E program.

During tagging, mortality in the pens increased, and the fish were treated for vibriosis with 0.86 percent Romet 30™ for 10 days beginning May 7. After treatment all study groups had minimal losses to disease. All groups were released on July 2 when water temperatures reached or exceeded 65 °F. Dates, numbers, and fish sizes of each study group at release are provided in Table 2.2.

2002 Brood SAB Fall Chinook

Almost all of the broodstock for the 2002 SAB fall chinook production were collected at Klaskanine Hatchery. All eggs were incubated at Big Creek Hatchery, and on February 12, approximately 416,000 fry designated for the BPA study were transferred to the Youngs Bay net pens. An additional 400,000 fry were reared at Big Creek Hatchery and transferred to the Youngs Bay net pens in June. These fish were funded by ODFW's R&E program.

Figure 2.2. Spawning select area bright fall chinook at ODFW's North Fork Klaskanine Hatchery.

On April 14 the fish were vaccinated for vibriosis at a size of about 200 fish/pound. Mass marking and coded-wire tagging began April 22 and concluded May 6. As a result of budget limitations and pending results of the density and subsurface feeding experiments, there was only one BPA-funded tag group. That group was fed normally and reared at a release density of 0.50 lbs/ ft^3.

Again, despite being vaccinated, the fish began to experience an outbreak of vibriosis during tagging and were treated with 0.86 percent Romet 30™ for five days. After treatment losses were low to moderate. With adult return data suggesting higher survival for larger smolts, the decision was made to hold the BPA study fish as long as possible, until Youngs Bay water temperatures reached 70°F. The BPA study group was released on July 24, while the smaller R&E-funded fish were released on August 7. Dates, numbers, and fish sizes of each study group at release are provided on Table 2.2.

2003 Brood SAB Fall Chinook

Broodstock for the 2003 SAB fall chinook production were collected at Klaskanine Hatchery, CEDC's SF facility and at the confluence of Youngs and Klaskanine rivers (see Chapter 6). Big Creek Hatchery again incubated enough eggs (~750,000) for broodstock releases, and the balance of the eggs collected were incubated at CEDC's SF facility (~600,000).

Between February 6 and March 4 of 2004 approximately 570,000 fry were ponded in Youngs Bay net pens from CEDC's SF facility. The fry were vaccinated for vibriosis on April 13, and fin clipping and coded-wire tagging began April 16. Approximately 400,000 fry were designated as BPA-funded production, and the balance (~150,000) were funded by ODFW's R&E program. Additionally, there were also ~50,000 (R&E) fry ponded at CEDC's SF facility in an attempt to develop an alternate broodstock source. Each of the net-pen groups was represented by ~25,000 CWT fish with normal rearing strategies employed.

Again, despite vaccination, the fish began to suffer from vibriosis and required treatment with 0.86 percent Romet 30™ for five days in June. Losses were minimal during the remainder of the rearing period and the fish appeared healthy at release in July. Dates, numbers and fish sizes are provided in Table 2.2.

2004 Brood SAB Fall Chinook

2004 broodstock were again collected at Klaskanine Hatchery, CEDC's SF facility and at the confluence of Youngs and Klaskanine rivers (see Chapter 6). Adult returns were low; only about 220,000 eggs were available for net-pen production after meeting broodstock release needs at Klaskanine Hatchery (~750,000).

Ponding of fry from CEDC's SF facility began February 7 and concluded March 13 with approximately 167,000 fry going into Youngs Bay net pens, and the balance (54,000) fry released at SF Klaskanine Hatchery. Approximately half (25,000) of these fry were ponded at Astoria High School as part of their Aquatic Sciences program, transferred back to the SF facility after marking and released July 14. Use of a Mark IV tagging machine and quality control unit and 30,000 tags were donated by Northwest Marine Technology for this group, and rearing was funded by the R&E program.

Net-pen fry were vaccinated for vibriosis on April 7 and fin clipping and coded-wire tagging began April 20. Approximately 100,000 fry were designated as BPA-funded production, and the balance (~60,000) was funded by ODFW R&E program. Again, despite vaccination, the fish had to be treated for vibriosis, but losses were minimal during the month before release. Dates, numbers and fish sizes are provided in Table 2.2.

UPRIVER BRIGHT CHINOOK

Beginning in 1995 the Pacific States Marine Fisheries Commission (PSMFC) provided funding to examine the suitability of URB fall chinook for use in the SAFE program. In brood years 1994-1997, approximately 200,000 fingerlings were transferred annually to SAFE sites (Youngs Bay and Tongue Point). Additionally, due to a shortfall of SAB fall chinook, about 400,000 (1997 brood) fingerlings were reared at Big Creek Hatchery and later transferred to the Youngs Bay net pens with funding from ODFW's R&E program.

Warm water temperatures and disease problems, primarily bacterial gill disease (BGD) and furunculosis plagued these releases, and overall poor survival rates led to abandoning any further attempts at rearing this stock. Rearing information for 1996-1997 brood years is available in Miller et al. (2002). Annual releases are shown in Table 2.3.

COHO

Releases of coho by CEDC have occurred in Youngs Bay since 1977 and were continued by the SAFE project since its inception in 1993. Releases were initiated in the new SAFE sites at Tongue Point, Blind Slough, and Deep River beginning with the 1993 brood. Steamboat Slough releases were initiated beginning with the 1997 brood. Approximately 1.2 million additional coho were released annually from the Klaskanine Hatchery until 1996 when production at this facility switched to SAB fall chinook.

Similar to spring chinook, coho are best suited for over-wintering or two-week acclimation. Rearing coho full-term in the net pens is challenging because of elevated summer water temperatures in the estuary. Juveniles for over-winter rearing are generally transferred from Oxbow, Cascade, Elochoman, and Grays River hatcheries to the SAFE sites in October or November. Mass marking (AD clip) and coded-wire tagging are completed before transfer. The fish are received at approximately 30 fish/pound, fed recommended levels of BioDry 1000™ three days per week, and released in April-May at about 12 fish/pound. Two-week acclimation fish have been transferred from ODFW's Sandy Hatchery to Blind Slough, and from Eagle Creek National Fish Hatchery to Youngs Bay and Tongue Point. The acclimation coho are usually received in April at approximately 15 fish/pound and held for a minimum of 14 days prior to release to allow for imprinting. Federal funding reductions resulted in discontinuation of the one million acclimation coho from Eagle Creek National Fish Hatchery after the 2002 brood year.

For three years beginning with the 1999 brood, an avian avoidance experiment was conducted with SAFE coho in Youngs Bay. Each year one tag group was towed into the mainstem Columbia River and released in hopes of reducing losses to cormorant (*Phalacrocorax* spp.) and Caspian tern (*Sterna* caspia) predation. Results of this experiment are currently being evaluated and may influence future release strategies (see Chapter 6).

The following information details year-specific rearing activities for 1999-2001 brood years. Similar information is available for 1993-1995 broods in Hirose et al. (1998); and for 1996-1998 in Miller et al. (2002).

1999 Brood Coho

In October of 2000 the Oregon SAFE sites received 1999 brood coho fingerlings from ODFW's Oxbow Hatchery. Tongue Point received 202,869 fish at 27 fish/pound (one CWT group), and Youngs Bay received 473,426 at about 28 fish/pound (two CWT groups). The extra tag code at Youngs Bay was applied to an experimental group of fish that was towed into the mainstem Columbia River at the time of release (see avian predation studies in Chapter 6). Because of increased spring chinook production at Blind Slough, the over-winter group of BPA-funded coho at that site was replaced with acclimation coho from ODFW's Sandy Hatchery.

With all production of Grays River Hatchery dedicated to Washington SAFE sites, coho eggs were readily available. Hatchery goals of 150,000 broodstock and 200,000 coho for each net-pen site were established. With the 1999 brood, increased spring chinook production at Deep River resulted in coho reductions by 150,000 fish. At Steamboat Slough 209,966 coho were released, and at Deep River 395,337 were released.

None of the BPA study groups received any treatment for disease, although some chronic low-level losses to BKD occurred. Dates, numbers, and fish sizes for each group are provided in Table 2.4.

2000 Brood Coho

In November of 2001 the Oregon SAFE sites received 2000 brood coho fingerlings from ODFW's Oxbow Hatchery. Tongue Point received 180,258 fish at 34 fish/pound (one CWT group), and Youngs Bay received 371,878 fish at 38 fish/pound (two tag groups). This was the second year of the avian predation study at Youngs Bay. All groups received were in the middle of a 28-day treatment for BKD with 4.5 percent Aquamycin™, so the fish were given medicated feed daily for 15 days after transfer to the net pens. Losses to disease were minimal while in the net pens and no further treatments were necessary.

In Washington a total of 354,557 coho were released at Deep River, and 158,598 at Steamboat Slough (Table 2.4). Dates, numbers, and fish sizes of each release group are provided in Table 2.4.

2001 Brood Coho

As in previous years, the Oregon SAFE sites received coho fingerlings from ODFW's Oxbow Hatchery in October of 2002. Tongue Point received 198,078 fish at 35 fish/pound (one CWT group) and Youngs Bay received 408,918 fish at 37 fish/pound (two CWT groups). This was the third year of the avian predation study at Youngs Bay (see Chapter 6).

The Youngs Bay study groups were treated for vibriosis with 1.7 percent Romet 30™ for 10 days beginning October 23, after which losses were minimal. The Tongue Point fish received no treatments, and losses to disease were insignificant.

Coho were released at the following levels from Washington net pens: 236,890 at upper Deep River, 129,545 at lower Deep River and 239,635 at Steamboat Slough. Experiments continued relative to the addition of spring chinook at the lower Deep River site, and the possibility of releasing Deep River fish at an earlier time to reduce disease and predation losses. Dates, numbers, and fish sizes of each release group are provided in Table 2.4.

2002 Brood Coho

Beginning with the 2002 brood, ODFW's Cascade Hatchery provided the SAFE project with coho (~600,000) that had formerly been coming from the lower Herman Creek ponds of Oxbow Hatchery. The stocks utilized both originated from Bonneville Hatchery, but now the early rearing, mass marking and coded-wire tagging occurred at Cascade Hatchery.

The fingerlings were transferred to Youngs Bay and Tongue Point MERTS on October 7 and 8 of 2003 with Youngs Bay receiving ~408,000 and Tongue Point MERTS ~207,000. Following three years of avian predation study (Chapter 6), there was only one CWT group at Youngs Bay that was towed into the mainstem Columbia at release. The Tongue Point MERTS group was released normally.

The Youngs Bay fish received a ten-day treatment for vibriosis with 0.86 percent Romet 30™ after which losses to disease were minimal, and the Tongue Point MERTS fish required no treatments for disease. However again, despite efforts with electric fence barriers, fairly significant losses to otter predation were incurred at both sites.

A total of 152,780 coho smolts were released at the lower Deep River site, 204,420 at the upper Deep River site and 204,600 at Steamboat Slough. Results from coded-wire tag experiments showed that Steamboat Slough survival was high though the fishery harvests were low, so this release was determined to be the last from this site. Pens were moved to the lower Deep River site when permits for expansion became available. Dates, numbers and fish sizes are provided in Table 2.4.

2003 Brood Coho

Fingerlings for the 2003 brood SAFE coho production were reared at ODFW's Cascade Hatchery until transfer to the net pens in the fall of 2004. Youngs Bay received ~425,000 fish and Tongue Point MERTS received ~217,000 in mid-October. Again there was only one CWT group at each site, with the Youngs Bay fish towed into the mainstem Columbia at release and the Tongue Point MERTS group released normally on site.

Neither of the groups required treatment for disease while in the pens and losses to otter predation were reduced. However, both groups of fish developed significant numbers of “pinheads” or “dropouts” that became more apparent as release time approached. It is possible that this was a delayed result of a serious outbreak of coldwater disease that occurred during early rearing at Cascade Hatchery, but the definite cause is unknown.

Coho goals were reduced temporarily at Deep River. Steamboat Slough had been eliminated and spring chinook production increased at Deep River. The end result was a release on May 1, 2005 of 144,900 coho smolts. The intent is to enlarge the lower Deep River site during the summer of 2006 and rear 350,000 spring chinook and 400,000 coho. Dates, numbers and fish sizes of each release group are provided in Table 2.4.

Table 2.1. Releases of spring chinook from lower Columbia River select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size #/lb	Funding Agency[c] and Study
1993	2/7/95	SFK	86,978	51,829	07-03-51	14.4	BPA
	2/9/95	YB	79,336	39,519	07-03-45	12.1	BPA / Feb release
	3/7/95	YB	156,519	52,446	07-03-43	8.1	BPA / Mar release
	3/30/95	YB	127,367	52,224	07-03-44	7.4	BPA / Apr release
			450,200	**196,018**			
1994	1/31/96	SFK	76,618	52,205	07-11-19	14.7	BPA
	2/5/96	TG	100,138	52,119	07-12-38	10.1	BPA / Feb release
	2/29/96	TG	142,181	48,281	07-12-36	10.8	BPA / Mar release
	2/29/96	BS	199,389	52,369	07-12-37	9.9	BPA / Mar release
	2/5/96	YB	142,976	53,685	07-11-21	11.9	BPA / Feb release
	2/29/96	YB	133,517	51,909	07-11-22	10.7	BPA / Mar release
	3/21/96	YB	97,945	41,085	07-11-20	10.0	BPA / Apr release
			892,764	**351,653**			
1995	2/1/97	YB	100,680	49,944	09-17-37	18.1	BPA / Feb release
	3/5/97	YB	96,540	49,341	09-17-38	15.2	BPA / Mar release
	4/4/97	YB	95,396	50,208	09-17-39	14.6	BPA / normal
	4/4/97	YB	94,612	50,139	09-17-40	12.7	BPA / dormancy
	3/4/97	SFK	76,821	25,149	07-13-37	15.9	BPA
	3/5/97	BS	171,229	58,002	09-17-16	15.2	BPA / Mar release
	3/5/97	TG	151,905	51,461	09-17-17	16.6	BPA / Mar release
	4/4/97	TG	149,889	50,309	09-17-18	14.6	BPA / Apr release
			937,072	**384,553**			
1996	3/3/98	YB	149,878	50,865	09-22-16	11.6	BPA / Mar release
	4/1/98	YB	153,265	47,147	09-22-14	12.0	BPA / dormancy
	4/1/98	YB	153,139	49,392	09-22-15	9.6	BPA / normal
	3/3/98	TG	128,314	46,710	09-22-18	13.8	BPA / Mar release
	4/1/98	TG	125,456	43,987	09-22-19	13.6	BPA / dormancy
	3/3/98	BS	198,034	44,452	09-22-17	12.6	BPA / Mar release
	4/1/98	BS	25,284	24,203	09-20-35	9.6	BPA /acc/normal
	4/1/98	BS	25,396	23,319	09-20-36	11.6	BPA / acc/dorm.
	4/22/98	DR	56,414	56,414	63-61-15	5.1	BPA
			1,015,180	**386,489**			
1997	3/4/99	YB	165,298	24,415	09-25-34	13.2	BPA / Mar release
	4/1/99	YB	158,574	24,253	09-25-33	11.9	BPA / dormancy
	4/1/99	YB	102,546	23,566	09-25-36	8.2	BPA / normal
	3/3/99	TG	118,291	23,782	09-25-32	10.0	BPA / Mar release
	4/1/99	TG	105,986	21,637	09-25-35	8.9	BPA / dormancy
	3/3/99	BS	148,881	24,644	09-25-30	14.0	BPA / Mar release
	4/1/99	BS	25,553	25,544	09-25-31	11.0	BPA / acc/dorm.

continued

Table 2.1. (continued) Releases of spring chinook from lower Columbia River select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size #/lb	Funding Agency[c] and Study
1997	4/1/99	BS	25,573	25,560	09-25-37	10.0	BPA /acc/normal
	5/13/99	DR	25,205	24,856	63-05-11	6.8	BPA
	5/13/99	DR	14,473	14,106	63-06-52	6.4	BPA
			890,380	**232,363**			
1998	3/1/00	YB	128,656	27,420	09-28-47	15.9	BPA / Mar release
	4/4/00	YB	180,695	24,689	09-28-46	18.7	BPA / dormancy
	4/4/00	YB	155,299	26,694	09-28-48	14.4	BPA / normal
	3/1/00	TG	132,484	29,028	09-28-50	12.6	BPA / Mar release
	4/4/00	TG	117,525	23,515	09-28-49	9.8	BPA / dormancy
	3/1/00	BS	143,507	25,656	09-28-45	17.7	BPA / Mar release
	4/4/00	BS	26,393	25,442	09-28-43	13.8	BPA / acc/dorm.
	4/4/00	BS	26,501	25,397	09-28-44	11.9	BPA /acc/normal
			911,060	**207,841**			
1999	3/2/01	YB	101,516	24,021	09-31-23	15.1	BPA / Mar release
	3/29/01	YB	27,310	25,773	09-31-33	13.8	BPA / 2-wk acc.
	3/29/01	YB	96,839	16,883	09-31-27	14.2	BPA / Mar release
	4/3/01	YB	146,346	25,371	09-31-26	16.2	BPA / dormancy
	4/3/01	YB	138,491	24,160	09-31-24	15.8	BPA / normal
	4/12/01	YB	27,396	23,576	09-31-29	12.3	BPA / 4-wk acc.
	3/2/01	BS	139,319	24,893	09-31-28	16.4	BPA / Mar release
	3/29/01	BS	25,384	23,967	09-31-25	12.8	BPA /acc/normal
	3/29/01	BS	27,467	22,945	09-31-32	14.4	BPA / acc/dorm.
	4/3/01	BS	27,897	13,235	09-31-31	13.4	BPA / normal
	4/3/01	BS	30,329	14,403	09-31-30	16.3	BPA / dormancy
	5/9/01	DR	119,533	25,109	63-13-10	12.0	BPA / normal
	5/9/01	DR	40,032	25,485	63-13-11	11.0	BPA / dormancy
			947,859	**289,821**			
2000	3/29/02	YB	212,214	24,508	09-33-30	10.4	BPA / normal
	3/29/02	YB	213,069	24,924	09-33-31	12.6	BPA / dormancy
	3/29/02	YB	26,973	25,416	09-33-32	13.4	BPA / 2-wk acc.
	4/12/02	YB	25,806	24,362	09-33-29	9.9	BPA / 4-wk acc.
	3/28/02	BS	67,981	20,612	09-33-33	12.3	BPA / subsurface
	3/28/02	BS	177,625	20,054	09-33-34	11.7	BPA / normal fed
	4/10/02	BS	24,887	21,197	09-01-20	14.8	NOAA / acclim.
	4/19/02	BS	23,871	20,074	09-01-19	13.6	NOAA / acclim.
	4/30/02	BS	24,164	20,002	09-01-21	13.7	NOAA / acclim.
	5/10/02	BS	24,441	20,992	09-01-22	13.0	NOAA / acclim.
	5/20/02	BS	23,536	19,646	09-01-23	15.7	NOAA / acclim.
	5/30/02	BS	24,403	20,798	09-01-24	13.0	NOAA / acclim.
	5/16/02	DR	83,563	12,361	63-10-87	9.0	BPA / normal
	5/16/02	DR	12,377	12,377	63-12-88	10.0	BPA / dormancy
			964,910	**287,323**			

continued

Table 2.1. (continued) Releases of spring chinook from lower Columbia River select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size #/lb	Funding Agency[c] and Study
2001	3/27/03	BS	302,934	17,431	09-36-01	11.5	BPA
	3/27/03	TGM	30,385	25,361	09-35-61	11.9	BPA/morpholine
	3/27/03	TGJ	27,412	26,277	09-36-02	11.4	BPA/JD acclim.
	3/28/03	YB	188,956	26,219	09-35-62	9.0	BPA / normal
	3/28/03	YB	187,097	24,733	09-35-63	12.7	BPA / dormancy
	3/28/03	YB	75,570	25,513	09-35-60	11.4	BPA / subsurface
	4/9/03	BS	18,508	17,764	09-36-19	16.6	NOAA / acclim.
	4/18/03	BS	22,353	21,782	09-36-22	15.5	NOAA / acclim.
	4/28/03	BS	21,236	20,982	09-36-20	15.6	NOAA / acclim.
	4/30/03	DR	33,113	20,052	63-15-72	10.0	BPA / Lewis
	4/30/03	DR	108,791	20,455	63-15-73	11.4	BPA / Cowlitz
	5/7/03	BS	20,801	20,273	09-36-23	16.5	NOAA / acclim.
	5/16/03	BS	20,158	19,726	09-36-21	16.6	NOAA / acclim.
	5/27/03	BS	20,319	19,767	09-36-24	14.7	NOAA / acclim.
			1,077,633	**306,335**			
2002	3/31/04	SFK	639,446	21,871	09-37-23	13.7	SFK production
	4/5/04	BS	261,840	26,465	09-39-01	12.1	BPA
	4/6/04	TGM	20,913	20,329	09-36-61	11.1	BPA/morpholine
	4/6/04	TGJ	27,143	26,595	09-36-63	10.4	BPA/JD acclim.
	4/8/04	BS	16,185	15,138	09-39-06	12.8	NOAA / acclim.
	4/8/04	YB	455,825	25,886	09-36-62	12.8	BPA
	4/16/04	BS	27,359	26,346	09-39-03	12.5	NOAA / acclim.
	4/26/04	BS	27,644	26,412	09-39-07	11.7	NOAA / acclim.
	5/6/04	BS	27,471	26,699	09-39-04	13.1	NOAA / acclim.
	5/17/04	BS	24,488	23,849	09-39-08	11.4	NOAA / acclim.
	5/20/04	BS	23,508	22,811	09-39-05	12.5	NOAA / acclim.
	5/1/04	DR	31,095	24,088	63-21-76	12.0	BPA / Cowlitz
	5/1/04	DR	66,223	9,867	63-21-77	11.0	BPA / Lewis
			1,649,140	**296,356**			

continued

Table 2.1. (continued) Releases of spring chinook from lower Columbia River select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size #/lb	Funding Agency[c] and Study
2003	3/22/05	YB	29,495		AD only	5.3	BPA/over-summer
	4/4/05	TGJ	26,955	26,029	09-39-29	12.0	BPA/JD acclim.
	3/22/05	DR	101,344	22,500	63-21-74	10.0	BPA/Cowlitz/tow
	3/23/05	DR	153,127	22,300	63-21-73	10.0	BPA/Lewis/tow
	4/4/05	TGM	26,344	25,440	09-39-30	13.0	BPA/morpholine
	4/4/05	BS	285,959	26,198	09-39-32	13.2	BPA
	4/5/05	YB	428,499	25,922	09-39-31	14.2	BPA
	4/5/05	SFK	458,659	24,217	09-37-36	12.1	SFK production
	4/6/05	BS	25,646	23,807	09-40-55	15.8	NOAA / acclim.
	4/15/05	BS	25,344	23,964	09-40-56	14.2	NOAA / acclim.
	4/25/05	BS	25,182	23,786	09-40-57	16.0	NOAA / acclim.
	5/4/05	BS	24,747	24,259	09-40-58	14.0	NOAA / acclim.
	5/13/05	BS	23,051	22,898	09-40-60	13.6	NOAA / acclim.
	5/23/05	BS	23,115	22,516	09-40-59	13.7	NOAA / acclim.
	9/26/05	SFK	566,030	27,173	09-37-22	24.5	SFK production[d]
			2,223,497	**341,009**			

[a] *BS=Blind Slough, DR=Deep River, SFK=South Fork Klaskanine, SS=Steamboat Slough, TG=Tongue Pt., TGM=Tongue Pt. MERTS, TGJ=Tongue Pt. John Day, YB=Youngs Bay*

[b] *Tag codes funded by BPA representing production releases for each site that were used for year/site survival and straying analyses*

[c] *BPA-Bonneville Power Administration; NOAA-National Oceanic & Atmospheric Administration (10-day acclimation study)*

[d] *Early release due to high incidence of BKD and lack of funds to treat effectively*

Table 2.2. Releases of select area bright fall chinook from lower Columbia River select area facilities, 1994-2004 brood years.[a]

Brood Year	Study Group	Site	Release Date	Number Released	Number of CWT's	Tag Code	Release Size (#/lb)	Funding Agency[b]
1994	July 15 or 65º	YB	6/27/95	107,892	49,826	07-07-42	18.2	BPA
	Aug 1 or 70º	YB	7/17/95	77,100	49,657	07-09-28	13.6	BPA
	0.25 #/ft^3 density	YB	7/17/95	116,030	43,518	07-09-29	10.9	BPA
	0.56 #/ft^3 density	YB	7/17/95	127,936	44,123	07-09-30	11.8	BPA
	0.66 #/ft^3 density	YB	7/17/95	115,702	42,854	07-09-31	13.8	BPA
	R&E	YB	7/17/95	707,127	19,514	07-14-21	36.5	R&E
	SFK Raceways	SF	8/15/95	15,758	LV only		37.0	OR/FPC
				1,267,545	**249,492**			
1995	0.25 #/ft^3 density	YB	7/16/96	64,679	57,523	07-13-42	13.1	BPA
	0.67 #/ft^3 density	YB	7/16/96	154,593	45,148	07-13-41	14.5	BPA
	R&E	TG	7/15/96	26,792	26,354	07-13-50	22.0	R&E
	PSMFC	YB	7/17/96	329,976	26,934	07-13-54	31.8	PSMFC
	R&E	BS	7/15/96	27,380	27,231	07-13-51	19.9	R&E
	R&E	YB	7/16/96	389,320	LV only		16.3	R&E
	PSMFC	YB	7/17/96	428,405	LV only		37.5	PSMFC
				1,421,145	**183,190**			
1996	July 15 or 65º	YB	6/17/97	53,442	52,956	07-13-39	38.0	BPA
	Aug 1 or 70º	YB	7/17/97	50,868	50,371	07-13-38	18.1	BPA
	0.14 #/ft^3 density	YB	7/17/97	116,680	52,468	09-21-36	21.4	BPA
	0.33 #/ft^3 density	YB	7/17/97	188,948	51,270	09-21-35	17.9	BPA
	0.46 #/ft^3 density	YB	7/17/97	53,765	52,618	07-13-40	18.4	BPA
	R&E	TG	7/17/97	27,482	27,427	09-21-46	24.1	R&E
	R&E	BS	7/17/97	27,413	27,413	09-21-45	31.6	R&E
				518,598	**314,523**			
1997	July 15 or 65º	YB	7/1/98	25,201	24,853	09-24-54	19.8	BPA
	Aug 1 or 70º	YB	7/20/98	25,019	24,896	09-24-53	16.0	BPA
	0.27 #/ft^3 density	YB	7/20/98	25,036	24,513	09-24-56	14.5	BPA
	0.34 #/ft^3 density	YB	7/20/98	17,303	16,850	09-24-57	15.8	BPA
	0.47 #/ft^3 density	YB	7/20/98	25,024	24,931	09-24-55	16.5	BPA
				117,583	**116,043**			
1998	July 15 or 65º	YB	7/12/99	25,811	25,369	09-27-54	17.1	BPA
	Aug 1 or 70º	YB	8/2/99	26,000	25,395	09-27-53	12.5	BPA
	0.24 #/ft^3 density	YB	7/12/99	25,992	25,697	09-27-57	16.6	BPA
	0.45 #/ft^3 density	YB	7/12/99	25,921	25,106	09-27-56	18.1	BPA

continued

Table 2.2. (continued) Releases of select area bright fall chinook from lower Columbia River select area facilities, 1994-2004 brood years.[a]

Brood Year	Study Group	Site	Release Date	Number Released	Number of CWT's	Tag Code	Release Size (#/lb)	Funding Agency[b]
1998	0.57 #/ft^3 density	YB	7/12/99	32,410	25,570	09-27-55	17.8	BPA
	R&E	YB	7/12/99	85,838	25,851	09-27-58	30.6	R&E
				221,972	**152,988**			
1999	0.46#/ft^3, surface	YB	7/5/00	24,944	24,075	09-30-39	17.1	BPA
	0.46#/ft^3, subsurf.	YB	7/5/00	25,079	23,586	09-30-40	17.0	BPA
	0.23#/ft^3, subsurf.	YB	7/5/00	24,909	24,167	09-30-41	16.7	BPA
	0.27#/ft^3, surface	YB	7/5/00	24,983	24,344	09-30-42	14.3	BPA
	R&E	YB	7/5/00	24,738	22,269	09-30-43	15.7	R&E
	R&E	YB	7/5/00	29,275	LV only		15.7	R&E
				153,928	**118,441**			
2000	0.50#/ft^3, surface	YB	7/4/01	25,263	24,342	09-32-58	26.9	BPA
	0.50#/ft^3, subsurf.	YB	7/4/01	24,658	22,683	09-32-59	26.5	BPA
	0.25#/ft^3, subsurf.	YB	7/4/01	25,235	23,059	09-32-60	22.2	BPA
	0.25#/ft^3, surface	YB	7/4/01	25,221	23,026	09-32-61	20.2	BPA
	0.50#/ft^3, density	YB	7/4/01	104,768	22,948	09-32-62	24.4	R&E
				205,145	**116,058**			
2001	0.50#/ft^3, surface	YB	7/2/02	125,607	23,970	09-35-09	22.1	BPA
	0.50#/ft^3, subsurf.	YB	7/2/02	25,065	24,329	09-35-10	26.2	BPA
	0.25#/ft^3, subsurf.	YB	7/2/02	24,775	24,086	09-35-11	22.9	BPA
	0.25#/ft^3, surface	YB	7/2/02	126,448	24,853	09-35-12	22.8	BPA
	R&E	YB	7/2/02	165,161	24,551	09-35-13	27.0	R&E
				467,056	**121,789**			
2002	SAFE	YB	7/24/03	370,942	23,529	09-38-09	17.4	BPA
	R&E	YB	8/7/03	409,372	27,679	09-38-19	22.3	R&E
				780,314	**51,208**			

continued

Table 2.2. (continued) Releases of select area bright fall chinook from lower Columbia River select area facilities, 1994-2004 brood years.[a]

Brood Year	Study Group	Site	Release Date	Number Released	Number of CWT's	Tag Code	Release Size (#/lb)	Funding Agency[b]
2003	Broodstock	SF	7/6/04	53,963		LV only	91.3	R&E[c]
	R&E	YB	7/15/04	147,467	25,013	09-39-55	16.5	R&E
	Production	YB	7/15/04	372,209	24,741	09-39-54	15.5	BPA
				573,639	**49,754**			
2004	Broodstock, AHS	SF	7/14/05	45,247	27,530	62-02-27	31.6	R&E
	Production	YB	7/18/05	101,987	24,724	09-39-48	15.4	BPA
	R&E	YB	7/18/05	59,250	24,676	09-39-49	13.4	R&E
				206,484	**76,930**			

[a] *Does not include R&E-ODFW funded broodstock releases from ODFW Big Creek and Klaskanine Hatcheries.*

[b] *BPA-Bonneville Power Administration; OR/FPC-Oregon Department of Fish and Wildlife (ODFW) and Fishermen Poundage Contributions; R&E-ODFW; PSMFC-Pacific States Marine Fisheries Commission; AHS-Astoria High School cooperative marking*

[c] *Early release due to disease*

Table 2.3. Releases of upriver bright fall chinook from lower Columbia River select area facilities, 1994-1997 brood years.

Brood Year	Release Date	Release Site	Number Released	Number of CWT's	Tag Code	Release Size (#/lb)	Funding Agency[a]
1994	7/17/95	Youngs Bay	199,088	50,608	07-12-35	23.3	PSMFC
			199,088	**50,608**			
1995	7/15/96	Tongue Point	97,866	46,186	09-17-11	27.0	PSMFC
			97,866	**46,186**			
1996	7/15/97	Tongue Point	201,849	51,897	09-21-37	42.8	PSFMC
			201,849	**51,897**			
1997	7/1/98	Youngs Bay	205,544	27,305	09-25-15	37.0	PSFMC
	7/6/98	Youngs Bay	424,252	26,744	09-25-16	44.4	R&E
			629,796	**54,049**			

[a] *R&E-ODFW Restoration and Enhancement Program; PSMFC-Pacific States Marine Fisheries Commission*

Table 2.4. Releases of lower Columbia River early stock coho from select area facilities,1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size (#/lb)	Funding Agency[c] and Study
1993	5/11/95	YB	138,371	28,995	07-15-44	7.8	BPA / site comparison
	5/12/95	BS	140,267	26,258	07-15-45	8.9	BPA / site comparison
	5/12/95	TG	130,623	26,426	07-53-29	8.7	BPA / site comparison
	5/12/95	DR	201,200	30,751	63-54-44	8.1	BPA / site comparison
	4/10/95	SFK	433,674	23,160	07-03-56	10.5	OR/FPC
	4/17-18/95	YB	822,185	25,886	07-07-58	9.7	Mitchell
	5/1-8/95	YB	467,531	22,545	07-07-43	12.6	R&E / acclimation
	5/15/95	YB	280,412	22,057	07-07-44	12.6	R&E / acclimation
			2,614,263	**206,078**			
1994	5/7/96	YB	216,187	26,274	07-12-22	9.5	BPA / site comparison
	5/6/96	BS	209,761	24,942	07-59-01	9.0	BPA / site comparison
	5/6/96	TG	190,032	23,942	07-12-41	8.4	BPA / site comparison
	5/7/96	DR	200,100	28,406	63-57-39	9.7	BPA / site comparison
	4/14/96	SFK	443,183	25,979	07-09-25	10.7	OR/FPC
	4/15/96	YB	808,263	28,299	07-12-42	11.7	Mitchell
	4/26/96	YB	829,600	26,548	07-09-61	9.6	Mitchell
	5/20/96	YB	341,339	22,104	07-12-23	11.3	R&E / acclimation
	5/28/96	YB	295,512	26,418	07-11-36	11.2	Mitchell
			3,533,977	**232,912**			
1995	5/5/97	YB	146,818	27,198	07-09-42	13.2	BPA / site comparison
	5/5/97	BS	196,963	25,104	09-18-18	14.4	BPA / site comparison
	5/5/97	TG	430,221	26,174	07-13-36	13.9	BPA / site comparison
	5/12/97	YB	633,310	17,865	07-13-35	14.5	Mitchell
	5/12/97	SFK	621,932	28,284	09-18-24	12.7	OR/FPC
			2,029,244	**124,625**			
1996	5/1/98	YB	133,373	25,672	09-23-02	10.4	BPA / site comparison
	5/1/98	BS	144,958	24,607	09-23-05	11.4	BPA / site comparison
	5/1/98	TG	119,611	18,355	09-23-06	11.2	BPA / site comparison
	4/23/98	DR	208,350	29,717	63-62-47	10.6	BPA / site comparison
	4/29/98	SFK	550,427	26,787	09-23-21	16.8	OR/FPC
	5/1/98	YB	268,870	52,510	05-37-32	12.2	R&E / acclimation
	5/1/98	YB	261,654	50,604	05-37-33	12.2	R&E / acclimation
	5/26/98	YB	425,634	30,159	09-23-36	13.3	Mitchell / acclimation
	5/26/98	YB	30,101	29,990	09-23-38	13.3	Mitchell /acclim/d.index
			2,142,978	**288,401**			

continued

Table 2.4. (continued) Releases of lower Columbia River early stock coho from select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size (#/lb)	Funding Agency[c] and Study
1997	4/28/99	YB	158,203	28,809	09-23-34	11.9	BPA / site comparison
	4/28/99	BS	197,089	26,072	09-25-28	11.3	BPA / site comparison
	4/28/99	TG	204,143	26,269	09-25-29	11.4	BPA / site comparison
	5/13/99	DR	203,284	25,003	63-05-30	11.4	BPA / site comparison
	5/13/99	DR	210,824	24,563	63-05-31	13.0	BPA / site comparison
	5/5/99	SS	210,530	24,248	63-05-32	10.4	BPA / site comparison
	4/21/99	SFK	429,652	19,622	09-24-28	13.3	OR/FPC
	5/5/99	YB	502,146	24,963	05-39-47	12.5	R&E / acclimation
	5/19/99	YB	479,662	24,874	05-39-46	11.8	R&E / acclim/d.index
	6/1/99	YB	272,656	26,215	09-26-43	13.4	Mitchell / acclimation
	6/1/99	YB	26,894	26,841	09-26-56	13.4	Mitchell /acclim/d.index
			2,895,083	**277,479**			
1998	5/4/00	YB	206,377	24,396	09-29-14	11.9	BPA / site comparison
	5/4/00	BS	195,645	24,624	09-29-12	11.5	BPA / site comparison
	5/4/00	TG	228,290	24,634	09-29-13	10.8	BPA / site comparison
	5/3/00	DR	217,732	25,774	63-12-01	11.8	BPA / site comparison
	5/4/00	DR	213,411	29,697	63-12-02	11.3	BPA / site comparison
	4/24/00	SS	191,543	29,937	63-11-17	11.2	BPA / site comparison
	4/12/00	YB	836,845	26,244	09-27-16	15.7	Mitchell
	5/1-8/00	SFK	610,658	25,414	09-27-30	12.8	OR/FPC
	5/11/00	TG	525,833	26,176	09-27-49	13.5	Mitchell
	5/25/00	YB	27,138	27,086	09-25-40	13.6	Mitchell /acclim/d.index
	5/25/00	YB	272,992	26,699	09-27-29	13.6	Mitchell / acclimation
	5/31/00	YB	476,148	21,743	05-39-48	15.9	R&E / acclimation
			4,002,612	**312,424**			
1999	5/14/01	YB	502,077	22,577	05-01-91	14.2	R&E / acclimation
	4/10/01	YB	808,735	26,075	09-30-06	15.6	Mitchell
	4/16/01	YB	234,032	26,011	09-31-61	14.0	BPA / control
	4/17/01	YB	179,187	26,494	09-31-59	14.7	BPA / towed
	5/07/01	SFK	344,738	26,231	09-30-13	12.5	OR/FPC
	5/24/01	BS	274,257	26,969	09-32-20	15.5	Mitchell / acclimation
	5/24/01	BS	25,154	25,104	09-32-22	15.5	Mitchell /acclim/d.index
	5/31/01	TG	482,414	25,055	05-49-08	15.3	R&E / acclimation
	4/16/01	TG	173,199	21,854	09-31-60	13.2	BPA / site comparison
	5/09/01	DR	166,087	22,468	63-03-75	12.0	BPA / site comparison
	5/09/01	DR	229,250	24,062	63-03-76	12.0	BPA / site comparison
	5/01/01	SS	208,966	29,800	63-03-69	12.0	BPA / site comparison
			3,628,096	**302,700**			

continued

Table 2.4. (continued) Releases of lower Columbia River early stock coho from select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size (#/lb)	Funding Agency[c] and Study
2000	5/06/02	YB	482,657	24,632	05-42-50	14.1	R&E / acclimation
	4/12/02	YB	837,201	26,400	09-30-15	13.0	Mitchell
	5/05/02	YB	177,730	24,555	09-33-39	11.9	BPA / towed
	5/03/02	YB	191,108	22,937	09-33-40	12.0	BPA / control
	5/07/02	BS	315,988	26,896	09-33-52	13.8	Mitchell / acclimation
	5/07/02	BS	27,854	27,798	09-33-56	13.8	Mitchell /acclim/d.index
	5/07/02	SFK	583,248	24,144	09-33-57	11.4	OR/FPC
	5/16/02	TG	488,866	28,068	05-42-54	14.4	R&E / acclimation
	4/25/02	TG	178,892	23,639	09-33-41	14.6	BPA / site comparison
	5/16/02	DR	229,501	24,940	63-06-64	12.0	BPA / site comparison
	5/16/02	DR	125,056	25,359	63-10-82	9.4	BPA / site comparison
	5/01/02	SS	158,598	20,585	63-07-64	12.0	BPA / site comparison
			3,796,699	**299,953**			
2001	5/08/03	YB	512,549	23,482	05-47-60	12.6	R&E / acclimation
	4/10/03	YB	844,653	27,009	09-19-32	11.7	Mitchell
	5/09/03	YB	158,476	25,201	09-36-10	10.4	BPA / control
	5/10/03	YB	171,033	27,969	09-36-11	10.3	BPA / towed
	5/07/03	BS	161,222	26,940	09-34-61	13.0	Mitchell / acclimation
	5/07/03	BS	155,582	26,452	09-36-38	13.0	Mitchell /acclim/d.index
	4/28/03	SFK	641,555	24,698	09-34-60	12.0	OR/FPC
	5/22/03	TG	477,918	23,396	05-47-59	12.8	R&E / acclimation
	4/24/03	TG	197,794	25,439	09-36-12	10.0	BPA / site comparison
	4/30/03	DR	129,545	24,506	63-15-19	12.0	BPA / site comparison
	4/30/03	DR	236,890	25,652	63-15-20	12.0	BPA / site comparison
	5/05/03	SS	239,635	29,747	63-11-74	12.0	BPA / site comparison
			3,926,852	**310,491**			

continued

Table 2.4. (continued) Releases of lower Columbia River early stock coho from select area facilities, 1993-2003 brood years.

Brood Year	Release Date	Release Site[a]	Number Released	Number of CWT's	Tag Code[b]	Release Size (#/lb)	Funding Agency[c] and Study
2002	4/6/04	TGM	186,520	24,770	09-38-62	13.0	BPA / site comparison
	4/9/04	YB	758,997	24,155	09-37-27	11.6	Mitchell
	4/28/04	YB	361,078	23,546	09-38-63	11.4	BPA / towed
	4/28/04	BS	298,748	26,760	09-37-32	14.4	Sandy acclimation
	4/28/04	TGM	511,002	24,150	05-37-25	13.7	R&E / acclimation
	4/29/04	YB	350,839	21,825	05-37-24	12.4	R&E / acclimation
	5/1/04	DR	152,780	24,900	63-20-72	14.0	BPA / site comparison
	5/1/04	DR	204,420	25,100	63-20-77	13.0	BPA / site comparison
	4/26/04	SS	204,600	30,000	63-20-67	13.0	BPA / site comparison
			3,028,984	**225,206**			
2003	4/6/05	YB	723,793	27,956	09-39-44	15.4	Mitchell
	5/1/05	DR	144,900	20,200	63-22-94	11.0	BPA / site comparison
	5/2/05	YB	422,275	26,855	09-39-46	15.2	BPA / towed
	5/3/05	BS	309,527	26,342	09-41-14	14.5	Sandy acclimation
	5/4/05	TGM	202,727	25,179	09-39-45	15.9	BPA / site comparison
			1,803,222	**126,532**			

[a] *BS=Blind Slough, DR=Deep River, SFK=South Fork Klaskanine, SS=Steamboat Slough, TG=Tongue Pt., TGM=Tongue Point MERTS, YB=Youngs Bay*

[b] *Tag codes funded by Bonneville Power Administration representing production releases for each site that were used for year/site survival and straying analyses*

[c] *BPA-Bonneville Power Administration; OR/FPC-Oregon Department of Fish and Wildlife (ODFW) and Fishermen Poundage Contributions; R&E-ODFW Restoration and Enhancement Program; Mitchell-Mitchell Act Funds. Double index (d.index)*

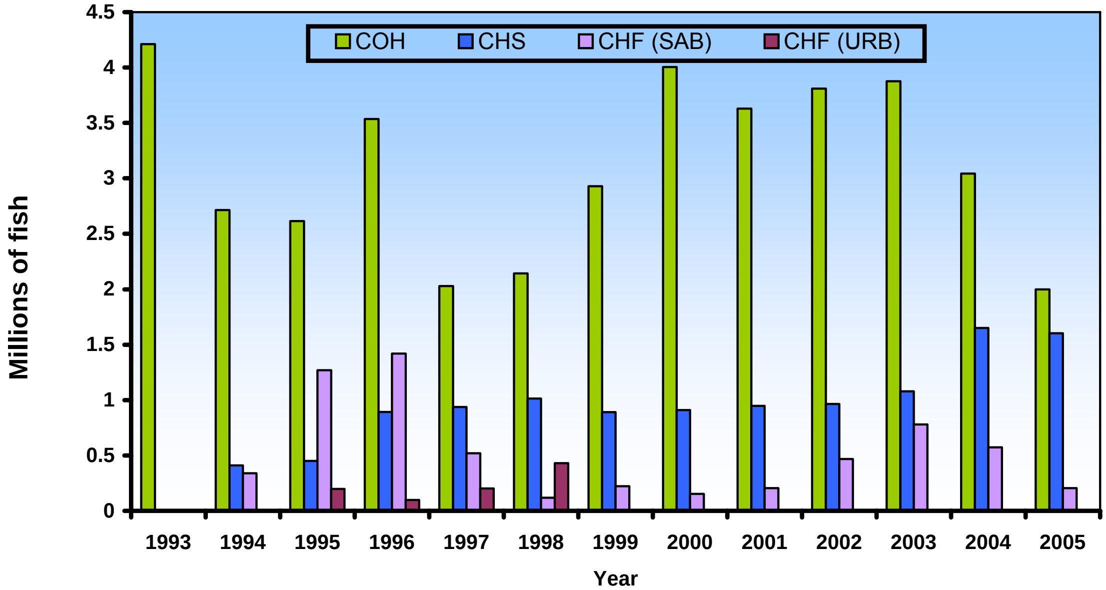


Figure 2.1. Annual smolt releases by the select area fisheries project, 1993-2005.

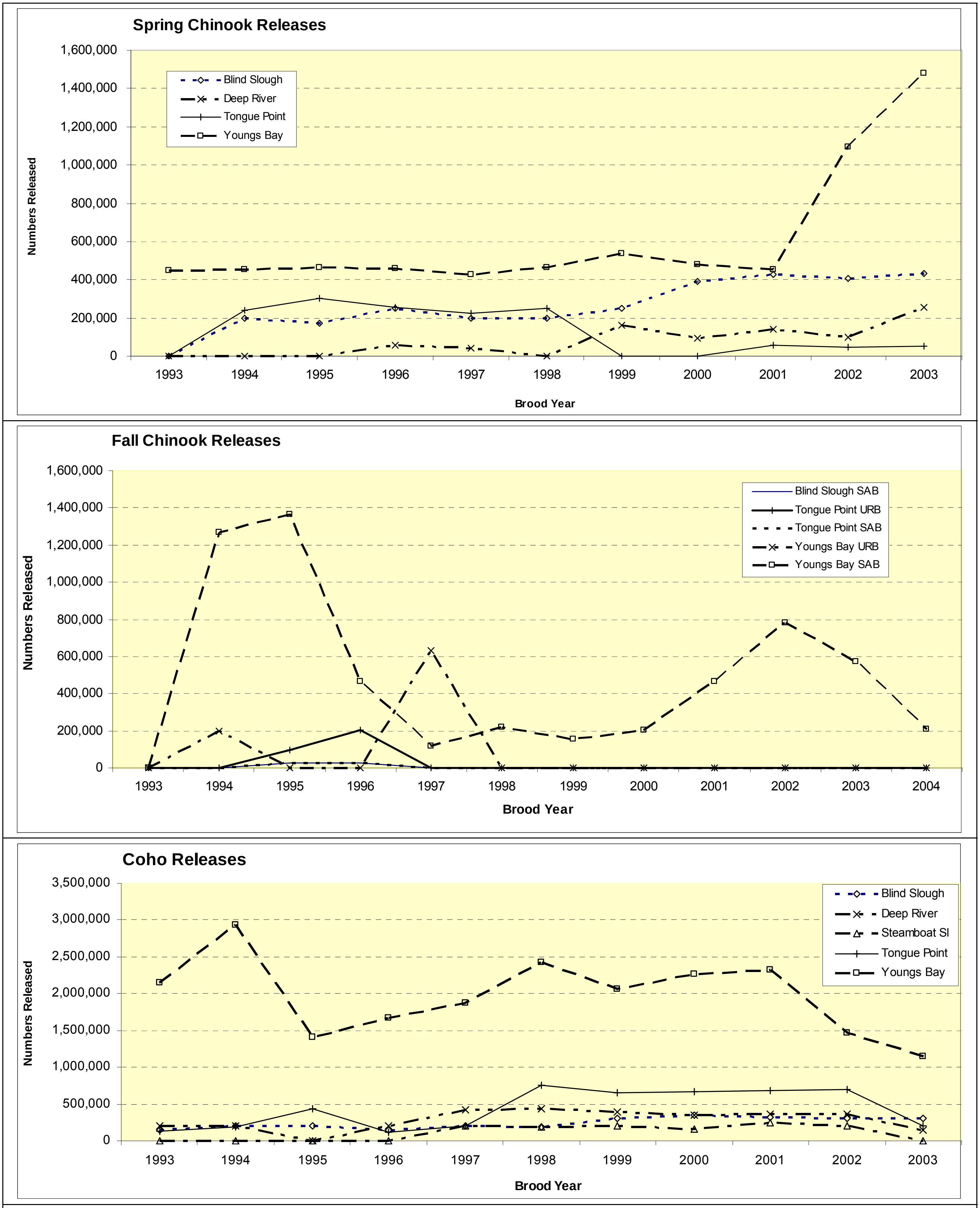


Figure 2.3. Number of salmon smolts released from net-pen sites, by species and brood year, 1993-2003.

3. SUMMARY OF SELECT AREA FISHERIES

Select area fisheries have been developed to minimize impacts to listed and non-target species and stocks while providing expanded harvest opportunities for commercial and recreational fisheries. With the exception of SAB fall chinook, SAFE production does not rely on escapement of fish through the fishery allowing for high harvest rates, maximum economic benefit, and reduced opportunity for straying. Due to geographic separation from the mainstem Columbia River, SAFE fishing sites are used relatively little by upriver stocks, making these areas inherently “cleaner” with less risk of intercepting non-target stocks. Even so, SAFE commercial fishing seasons are designed to maximize effort during times of peak abundance of locally-produced stocks and low abundance of listed stocks whenever possible to further minimize impacts to non-target stocks. This is accomplished by site-specific time, gear, and area regulations for commercial fisheries and retention regulations for sport fisheries.

The four current SAFE fishing sites were selected primarily based on data indicating limited use by listed species; therefore, impacts to listed species are inherently minimized by avoiding interaction with listed species through geographic separation from the mainstem Columbia River. Prior to development of each SAFE fishing site, multi-year test fishing was conducted to identify specific boundaries of potential fishing sites and timeframes when migrating listed species are unlikely to be encountered. Results of subsequent fisheries have substantiated test fishing results since impacts to listed species and handle of non-target stocks has been low for all species and stocks in most years.

Initial commercial fisheries established in 1996 in the new SAFE areas were based on experimental releases in 1995 of 1993 brood coho, due to greater availability and a shorter life span of this species. Development of spring chinook seasons followed at several sites but was constrained initially due to a limited egg supply resulting from reduced run sizes and restricted stock availability, particularly in Washington. Ongoing releases of SAB fall chinook in Young Bay were increased to provide expanded harvest opportunities, including summer target seasons.

Since the majority of listed spring chinook stray into select areas during mid-March through mid-April, commercial fishing has generally been limited to a short, winter season prior to, and a longer, and more liberal spring season, following this timeframe. Winter season spring chinook fisheries typically occur from mid-February through mid-March to target early-returning SAFE stock adult spring chinook. Steelhead abundance is also low during this timeframe since most winter steelhead migrating through select areas are early-returning hatchery stock that primarily return during December through January. A longer and more liberal spring season occurs from mid- to late April through mid-June in Youngs Bay, Blind Slough/Knappa Slough and Deep River to maximize harvest of SAFE-stock spring chinook following departure of listed spring chinook stocks. A summer season consisting of 1-2 days per week occurs in Youngs Bay only. Early fall seasons during August are usually limited to less than two days per week and occur in Youngs Bay to target SAB fall chinook and occasionally in Knappa Slough to target surplus tule fall chinook. Fall fisheries targeting SAFE stock coho salmon are not initiated until late August or early September when net-pen reared coho abundance are nearing their peak, and abundance of fall chinook is declining.

Gear restrictions are adopted for SAFE fisheries to focus harvest on target species. Winter fisheries have a 7-inch minimum mesh size restriction in effect to focus the fishery on chinook and limit handle of steelhead. Spring and summer chinook fisheries have an 8-inch maximum mesh size restriction to target salmon and limit sturgeon (*Acipenser* spp.) harvest. The majority of gear actually used during chinook salmon fisheries is 7½ to 8-inch mesh, which further minimizes handle of steelhead. Fall season regulations include a 6-inch maximum mesh size restriction to target coho. Allowable sales for all select areas are restricted to salmon, sturgeon and shad (*Alosa sappidissima*).

Catch of white sturgeon in select areas is included in the annual non-Indian commercial harvest allocation. Past management practices regarding white sturgeon catch in select areas have varied and were developed in consultation with participants of the SAFE commercial fisheries. Prior to 1997 no catch restrictions were in place. Beginning in 1997, white sturgeon catch in select areas was limited to 5 percent of the commercial white sturgeon allocation and this limit was subsequently increased to 10 percent for 1998 and 1999. Sales of sturgeon were allowed in the Youngs Bay fisheries only prior to 1998 and in all SAFE fisheries thereafter. In 2000, commercial fishing industry leaders met to discuss the harvest of white sturgeon in select areas, as it relates to the commercial allocation, and arrived at the following consensus points:

1) SAFE fisheries should be managed as salmon-directed fisheries.
2) Use of gear (mesh size) restrictions should be adopted to target salmon, not sturgeon. New gear restrictions should be phased in to limit economic impact on participating fishers.
3) Enforcement presence is encouraged to ensure compliance with gear restrictions.

The adoption of the sturgeon retention management protocol for 2003-2005 superceded previous agreements regarding SAFE fisheries and beginning in 2003, SAFE sturgeon retention was managed consistent with the adopted protocol for white sturgeon in mainstem Columbia River commercial fisheries. Since 2003, sturgeon harvest in SAFE fisheries has been managed to not exceed 400 fish annually, with no more than 300 fish allowed during winter-summer fisheries. Weekly vessel landing limits are normally used to ensure sturgeon harvest does not exceed management guidelines.

RUN-SIZE FORECASTS

The ODFW, WDFW, and the TAC produce formal forecasts for the expected return of salmonid stocks to the mainstem Columbia River and select areas annually during December through February. These run size estimates are incorporated into preseason fishery planning and used to estimate impacts to ESA-listed stocks based on catch estimates for each stock.

Prior to 2003, predicted returns of spring chinook returning to Oregon select areas were forecast based on average predicted Willamette River Basin spring chinook survival rates (ratio of predicted adult return/smolt releases) applied to site-specific SAFE smolt releases to determine run size forecasts. A similar procedure was used for Deep River in Washington based on survival of Cowlitz and/or Lewis River stock spring chinook. Since 2003, return predictions have been calculated based on annual smolt releases and previous year's site-specific survival rates by age class.

Stock-specific run predictions for Columbia River fall chinook stocks have been based on cohort relationships since about 1980. Age composition is derived from scale reading and CWT analysis from fisheries, hatcheries, and natural spawning areas. The preseason forecasts to the Columbia River mouth are adjusted for expected ocean impacts. SAB fall chinook return to the Youngs Bay site only. Data is inadequate to develop an accurate cohort relationship so predictions are based on annual smolt releases and expected survival rates by age class.

Predicted coho returns for areas above Bonneville Dam, lower Columbia River hatcheries, and select areas are based on smolt release numbers, historic smolt-to-jack return estimations and annual smolt-to-adult survival rates (). Returns to each specific SAFE fishery sites are apportioned based on smolt releases.

SEASON SETTING PROCESS

All fisheries in the Columbia River are established within the guidelines and constraints of the Columbia River Fisheries Management Plan (CRFMP), the ESA, and management agreements negotiated between the parties to *U.S. v. Oregon*. Initial season design and management guidelines for Columbia River non-Indian fisheries, including select areas, are established through the Biological Assessment/Opinion and Compact/Joint State hearing processes in accordance with the aforementioned agreements and ESA requirements. Biological Assessments are prepared by the TAC in advance of intended fisheries and submitted to NOAA Fisheries for review. These documents outline predicted harvest impacts on federally-listed species and measures that will be taken to minimize these impacts. A BO is then issued by NOAA with a determination regarding the likelihood that the proposed fisheries will jeopardize recovery of listed stocks. The BO outlines management guidelines for the proposed fisheries including “take” limitations and other management concerns the states should address while executing the fisheries.

The Columbia River Compact is an agreement ratified by Congress in 1918 covering concurrent jurisdiction of Columbia River fisheries. The Compact is comprised of the Washington Department of Fish and Wildlife Commission (WFWC) of WDFW and the Oregon Fish and Wildlife Commission (OFWC) of ODFW. In recent years, the two commissions have delegated Compact decision-making authority to the agency’s director or the director’s designee. Seasons for concurrent state waters, of which some SAFE fisheries are included, are established by the Compact. Select area commercial seasons occurring in state waters, and all recreational seasons and regulations are established by the regulating state.

Each year, pertinent management constraints and information on historic and predicted run sizes, and past and projected fisheries are summarized by agency staff and distributed to management agencies including the TAC, tribes, and the public. These “Joint Staff Reports” are distributed approximately three times each year in advance of anticipated seasons. One report is generally dedicated to sturgeon and smelt, one to spring and summer runs and fisheries, and one for fall runs and fisheries. For SAFE fisheries, annual pubic meetings to solicit community input regarding commercial and sport season recommendations are generally held in Astoria, Oregon around January of each year for spring fisheries, and June or July for fall fisheries. Subsequent "fact sheets" are then prepared and distributed by staff in advance of the main Compact/Joint State Hearings where mainstem Columbia River and SAFE fisheries are set.

In recent years, these major Compact hearings have occurred in December, January/February and July. The fact sheets detail specific season recommendations and regulations based on fishery objectives, management guidelines and agreements, and public and industry input. Agency staff present the information from the fact sheets at the Compact/Joint State hearings. Public testimony from non-Indian recreational and commercial fishers regarding the recommended seasons is taken along with input from treaty and non-treaty tribes, NOAA, USFWS, Idaho Fish and Game (IFG), and the TAC. The Compact representatives use this testimony and information from the fact sheets to weigh the risks and benefits of the proposed seasons and make final rulings based on their joint decision. Adopted seasons and regulations are presented in a Compact, Joint State, or State Action notice following each hearing.

DATA COLLECTION

Select area commercial and recreational fisheries are monitored extensively throughout the year to ensure adequate representation of the catch and to determine impacts to non-local stocks based on in-season updates of mainstem salmon and steelhead returns. The ODFW and the WDFW are responsible for sampling their respective SAFE fisheries to collect biological data and for summarizing data to estimate landed catch. The landed catch from all SAFE fisheries is sampled for biological information, including scale samples and the recovery of CWT's. Each SAFE site is monitored separately to account for variability in total landings, and species, stock, and age composition within each fishery. Funding for fishery sampling is provided by the BPA through the SAFE project (BPA #1993-06000) in Oregon and Washington, and also by the coded-wire tag recovery project (BPA Project #1982-01301) in Oregon.

Commercial Fisheries

Sampling of SAFE commercial fisheries includes collecting representative weight and length data by species, examining the catch for any external tags or marks and collecting visual stock identification (VSI; spring chinook only) information. Scales and CWT's are collected for age and stock composition analyses and to determine straying and survival rates. All snouts are delivered to tag recovery labs in Clackamas, Oregon or Olympia, Washington where the CWT is extracted and decoded. The resulting tag code is entered and verified on a mainframe computer. The CWT recovery data are summarized to estimate the number of CWT's recovered for each tag code for each sampling program. Associated fishery/recovery and biological data collected when snouts are recovered, are entered into electronic databases, uploaded to the mainframe computer, and merged with corresponding CWT recovery data. Data is then transferred to the Pacific States Marine Fisheries Council (PSMFC), where individual tag recoveries are expanded based on program-specific weekly and site-specific sampling rates to estimate the total number of a particular tag code present in a given fishery. The data is then posted on the Regional Mark Information System (RMIS) website for use by fishery managers in making fishery management decisions and conducting run reconstructions. Preliminary data are summarized immediately after each fishing period and used for in-season management.

Minimum target sampling rates are 20 percent of the landed catch by area and season; however, sampling rates are usually significantly higher. During 2001-2005, over 118,000 (28 percent) of all salmon harvested in SAFE fisheries were examined for fin marks with season-specific sampling rates of 52, 47, 43, and 26 percent in winter, spring, summer, and fall seasons, respectively (Table 3.1). As a rule, more intensive sampling is conducted whenever a new site or season is established. For instance, the sampling rate for 2003-2005 spring seasons in Deep River was 100 percent of the landed catch, since fish could not lawfully be removed from the area prior to inspection by WDFW staff. Similar rules were in effect for other SAFE sites when fisheries were first implemented. Preliminary landings are summarized by statistical week based on phone surveys of buyers and processors. These landings are later confirmed with actual point-of-sale fish tickets. Average fish weight data from the sampled catch collected at buying stations is applied to species-specific landings (in pounds) by week to determine the number of fish landed by species for each select area. Coded-wire tag and VSI (spring chinook) data is summarized to determine stock compositions of fish landed in each SAFE fishery. Stock compositions are then applied to total landing estimates to produce stock-specific catch estimates. Stock-specific catch estimates for fisheries are monitored in conjunction with in-season run size updates to maintain fisheries within ESA guidelines.

Table 3.1. Number and percent of total salmonid catch mark-sampled in Oregon select area fisheries, 2001-2005.

	2001		2002		2003		2004		2005[a]		2001-2005 Totals	
Season	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Winter	341	50%	117	54%	57	66%	619	47%	169	88%	1,303	52%
Spring	2,897	36%	5,468	51%	3,668	49%	3,914	44%	1,520	68%	17,467	47%
Summer	316	54%	366	53%	49	18%	60	23%	38	35%	829	43%
Fall	11,644	32%	29,885	38%	20,314	16%	17,020	26%	19,765	27%	98,628	26%
Total:	15,198	33%	35,836	40%	24,088	18%	21,613	29%	21,492	28%	118,227	28%

[a] 2005 fall landings are through week 44.

Recreational Fisheries

Prior to 2002, a modified and limited creel census program was used to estimate sport catch in select areas. Since then, a more extensive program has been implemented in response to increased sport fishing effort. Recreational angler surveys are currently conducted in Youngs Bay, Knappa Slough, Blind Slough, Big Creek, and Gnat Creek during the spring, and in the Klaskanine River and tidewater sections of Youngs River during the fall. Depending on the specific site and fishery, fishing effort is estimated by counting one of the following: 1) trailers at the primary launch sites, 2) vehicles parked at access points, 3) boats from observation points, or 4) anglers exiting the fishery. In some fisheries with boat and bank access, several methods are used to accurately reflect effort. Aerial flight data obtained from mainstem Columbia River surveys are used to corroborate effort counts or to supplement counts on days when ground surveys are not conducted. Effort data is stratified by day-type (weekday or weekend/holiday) and month and expanded for non-survey days to estimate total effort for each fishing site. Catch rates are determined primarily from angler interviews and verified in some cases with voluntary harvest log books. Catch-per-angler-day is estimated by expanding survey data for non-surveyed hours. Total catch by species is estimated by applying expanded catch rate data to estimates of effort by fishing area.

The landed catch is sampled to collect biological information, recover CWT's, and determine stock composition. Scales are collected to determine age structure of the landed catch. Coded-wire tag (or VSI) data are applied to the estimated landings for each site to estimate impacts to listed species.

IN-SEASON MANAGEMENT

To ensure impacts resulting from SAFE fisheries remain within management guidelines, fish run sizes and harvest of individual stocks are tracked in-season with regulations and fishing periods adjusted accordingly, if needed. Run-size estimates for mainstem Columbia River stocks are updated by the TAC regularly throughout the adult run based on passage updates at Bonneville Dam and other data. Real-time landings for SAFE fisheries are obtained immediately following each fishing period through phone surveys. Impact rates are tracked continuously by staff as new information becomes available. Whenever additional fishing opportunity is considered or in-season management action is required to reduce impacts to listed stocks, a Compact or Joint State hearing is scheduled and an associated fact sheet is prepared summarizing any new information and suggested management actions. The entire process is extremely intensive and responsive with over 50 Compact hearings occurring annually in recent years, with multiple Compacts weekly not uncommon during winter and spring seasons. This level of management is not necessarily needed for SAFE fisheries due to relatively minor impacts. However, since

SAFE fisheries are managed in concert with mainstem fisheries and utilize some of the non-Indian allowable impacts, they have been subject to frequent review and management action as needed to account for results of mainstem fisheries.

As mentioned, winter and spring SAFE fisheries are managed intensely to ensure the impact rate (0.1-0.2 percent of the upriver run) is not exceeded. For these fisheries, VSI of the sampled catch is used to estimate stock composition of the total catch each week. Total upriver spring chinook harvest is used as a surrogate to track impacts to listed upriver spring chinook since few of these fish are coded-wire tagged. These VSI stock calls are made by experienced samplers who can accurately classify upriver and lower-river stocks of spring chinook. Coded-wire tags recovered from sampling of the landed catch are decoded periodically in-season and used to verify, and if needed, correct VSI calls to calculate the frequency of upriver spring chinook in the sample by week. In most cases, the correction factor is minor since the samplers are very experienced at classifying stock based on visual cues. This adjusted rate is then applied to the total weekly landed catch to calculate weekly stock-specific impacts. Weekly and season-total impacts are divided by the current estimated run size to determine the impact rate. If the data suggests that impacts will exceed management guidelines, adopted seasons are modified through the Compact hearing process.

WINTER, SPRING, AND SUMMER COMMERCIAL FISHERIES

Season Structure

Select area fishing seasons are established based on time of year (calendar week) to facilitate fishery management, with each season providing different harvest opportunities for different stocks. Fishing periods include winter (early-February through mid-March), spring (mid-April through mid-June), summer (mid-June through July), and fall (August through October) seasons. Not all species are reared at all sites, so the number of fishing sites open during each season is variable (Table 3.2).

Participation in each SAFE site is a combined reflection of availability, price and relative size of the site. Deep River, for example, has experienced a reduced effort in recent years due to smaller releases, and therefore anticipated lower harvests. Tables 2.1 and 2.4 show increased total numbers of coho and spring chinook from all sites but Deep River. To maintain the goals of the project release numbers in Deep River are being increased.

Table 3.2. Summary of current select area fishing seasons by site, 2005.

Season[a]	Youngs Bay	Tongue Point/ South Channel	Blind Slough/ Knappa Slough	Deep River	Steamboat Slough
Winter	X	[b]	X	X	
Spring	X	X[c]	X	X	
Summer	X				
Fall	X	X	X	X	X[d]

[a] *Winter=weeks 7-12; spring=weeks 16-24; summer=weeks 25-31; fall=weeks 32-44*

[b] *Winter season closed since 2002 since area is open concurrent with mainstem Columbia River*

[c] *2003 marked the last year of significant adult returns from production-level releases that were discontinued in 2000 due to excessive straying. Did not reopen in 2004-05.*

[d] *Coho production terminated following release of 2002 brood. 2005 marked last year of fisheries at this site.*

Winter Seasons

As production of SAFE spring chinook increased, winter seasons were adopted, beginning with Youngs Bay, followed by Blind Slough and Tongue Point, in an attempt to meet the project goal of 100 percent harvest of returning adults. The timeframes for winter seasons in each of the areas were established based on test fishing results and adjusted based on 1) onboard monitoring during the initial years of full-fleet implementation fisheries in each of the areas, and 2) week-specific coded-wire tag data collected from the landed catch during all years. Based on this data, the winter season has typically occurred during the mid-February through mid-March timeframe (statistical weeks 7-12) to target early-returning age-5 net-pen reared spring chinook prior to the time of any significant presence of non-local stocks. Although winter season landings are lower than during the spring fishery, this season is popular as it provides an opportunity to harvest some of the first spring chinook of the year, which command a high market value.

Youngs Bay

Winter seasons have been adopted in Youngs Bay since 1998. A season format consisting of several short fishing periods weekly is intended to provide sufficient opportunity to harvest early returns of SAFE spring chinook that may build up in the area while minimizing the risk of impacting winter steelhead and upriver spring chinook. Initially, fishing periods were scheduled during daylight hours to facilitate monitoring. From 2000-2002, fishing time consisted of 1-2 weekly fishing periods of 12-54 hours each for three weeks (Table 3.3). This season structure was effective in allowing some harvest (≤544 fish annually) of early local adult returns while minimizing impacts on listed stocks through 2002. In 2003, unanticipated high abundances of upriver stocks during the first three fishing periods prompted an emergency closure of the remaining three periods. In 2004 several brief additional fishing periods were adopted in upper Youngs Bay (above the old Youngs Bay Bridge) to harvest significant early returns of local stock. Volunteer test fishing was utilized prior to adopting each season to verify stock composition. Winter season landings in 2004 were the highest on record with 1,029 spring chinook landed. This option was implemented again in 2005 for two additional periods but included the entire Youngs Bay fishing area due to extremely low impacts to upriver spring chinook.

During 1998-2002, an 8-inch minimum mesh size restriction was required to target the larger 5-year old chinook, and ensure minimal handle of steelhead. In 2003, an industry request for a minimum mesh size of 7¼-inches was adopted which was subsequently reduced to 7-inches in 2005. Previous monitoring data has shown that steelhead handle during the winter season is negligible regardless of mesh size. The maximum net length for all seasons in Youngs Bay is 250 fathoms (1,500 feet), and leadline weight may not exceed two pounds per fathom of length.

Blind Slough/Knappa Slough

The first winter season in Blind Slough was adopted in 2000, and seasons have continued annually. Knappa Slough is not open during the winter season to minimize interceptions of upriver spring chinook. Fishing periods have consisted of one or two nighttime openers each week although total opportunity has increased from three to nine fishing days in recent years. Fishing periods occur at night to maximize catch and minimize interactions with recreational fishermen and boaters using this area. Catches have ranged between 8 and 290 spring chinook (Table 3.3).

Net length is restricted to 100 fathoms (600 feet) due to the smaller size of this fishing site. No leadline weight restriction is in effect since this area cannot be effectively drift-fished due to weak tidal currents (Blind Slough) and an abundance of snags. Since September 2004, use of additional weights or anchors on the leadline has been allowed at this site. Allowable sales include salmon, sturgeon, and shad.

Tongue Point/South Channel

Winter seasons occurred at the Tongue Point fishing site in 2000 and 2001 with modest catches (≤124 fish annually) but were discontinued in 2002 because this area was open concurrent with the mainstem winter commercial fishery. In addition, 2003 marked the final year of significant adult returns from production-level releases of spring chinook that were discontinued at this site in 2000 due to excessive straying of returning adults from 1996-1998 releases. To resolve this issue, a new rearing site was established at the MERTS dock located further inside the fishing area and experimental releases were implemented in 2003 (see Chapter 6). The South Channel area has not been open during any past winter seasons.

Deep River

An experimental winter season was implemented in Deep River in 2006, with future seasons anticipated when increased releases and survival will provide improved harvest opportunities.

<u>Spring Seasons</u>

SAFE spring seasons have generally occurred between mid-April and mid-June (statistical weeks 16-24) and account for the majority of the spring chinook harvest since the abundance of non-local stock decreases rapidly during this timeframe, allowing fishing time to be liberalized. The goal of this fishery is to harvest 100 percent of the returning adults since SAFE spring chinook originate from transferred hatchery stock and local collection of eggs is not needed to perpetuate the program. The peak of the fishery traditionally occurs during mid-April through early-May but does extend into late-May in some years. Spring seasons have been established at Youngs Bay, Blind Slough, Tongue Point, and Deep River fishing sites concurrent with initial adult returns at each site (Table 3.3). As with all SAFE seasons, timeframes for spring seasons at each site were established based on test fishing results and fine-tuned with either onboard monitoring or commercial sampling data.

Youngs Bay

Spring seasons in Youngs Bay have been established every year since originally adopted in 1992. Net weight and length regulations are the same as the winter fishery. An 8-inch maximum mesh size restriction is in place during spring seasons to target chinook, while minimizing sturgeon harvest. A season format consisting of weekly fishing periods of progressively increasing length is intended to maximize harvest of local stocks while minimizing impacts to non-local stocks whose presence decreases to near zero by early May. Fishing opportunity was expanded gradually from 1992-2002 based on positive stock composition results in order to harvest increasing adult returns while maintaining low impacts to non-local stocks (Table 3.3). During 2000-2002, fishing time consisted of one weekly fishing period of 30-102 hours.

As was the case in the 2003 winter seasons, unusually high mixing of non-local stocks in many of the select areas during the early part of the spring season, and inclusion of select area impacts within the mainstem non-Indian spring chinook impact limits prompted fishery managers to rescind several of the adopted seasons to remain within the upriver spring chinook impact guideline for non-Indian commercial fisheries. For this reason, spring seasons adopted for 2004 were modified to begin later in April with shortened, staggered openings to allow managers time to update landings, summarize sampling data, and assess impacts to non-local stocks. This approach was warranted, as the upriver spring chinook run did not meet preseason expectations, forcing managers to rescind several openings scheduled for SAFE areas in early-mid May due to combined commercial and recreational fishery impacts from mainstem Columbia River fisheries increasing beyond management guidelines. Fortunately, a similar cautious season structure was used in 2005 when the upriver run again came in below expectations resulting in most fishing periods planned for mid-April through early May being rescinded or substantially reduced.

Increased production of spring chinook from the SF Klaskanine Hatchery since 2004 should contribute to larger adult returns in Youngs Bay beginning in 2006. More creative and adaptive management of the Youngs Bay winter and spring seasons may be required to maximize harvest while maintaining low impacts to non-target stocks. Short, staggered openings upstream of the old Youngs Bay Bridge may be used to maintain harvest opportunity during periods that have historically been closed since these fish, unlike those released from the net pens, will be inclined to migrate through the lower Bay area. Longer fishing periods may be considered for the area upstream of the Walluski River (upper Youngs Bay) to maximize harvest opportunity.

Tongue Point/South Channel

Spring seasons were initiated at the Tongue Point site beginning in 1998. Season dates were established based on experience gained in Youngs Bay and from test fishing conducted during 1994-1996. Nighttime, weekday fishing periods (7pm-5am) were adopted consistently to minimize interactions with recreational boaters. Based on test fishing results, the Tongue Point site was expanded in 1999 to include the South Channel; a 4.0-mile slough extending east along the Oregon shoreline to Settler Point (river mile 23.0). The number of fishing periods allowed each year was expanded from 9 in 1998 to 15 in 2002 (Table 3.3)

The 2003 spring season was discontinued after one fishing period due to higher than anticipated abundances of upriver spring chinook in the fishing area. Since 2003 marked the last year of adult returns to this site, no additional fishing periods were adopted for the remainder of the 2003 spring season. Since this area is open concurrent with mainstem fisheries, no SAFE spring seasons were established for this site in either 2004 or 2005. Future spring fisheries in this area will depend on positive homing results of 2003-2005 experimental releases (see Chapter 6); therefore, full-fleet winter or spring commercial fisheries are not anticipated at this site until 2007 or beyond. A limited fishery may occur at this site beginning in May 2006 to recover adult returns from experimental release from the MERTS site and the nearby John Day River if sufficient upriver spring chinook impacts remain available.

Blind Slough/Knappa Slough

Spring seasons have been established in Blind Slough since 1998. The fishing area was expanded in 1999 to include Knappa Slough; a 3.4-mile channel extending downstream from the mouth of Blind Slough to a north-south line through the eastern tip of Minaker Island. Similar to Tongue Point, the season format has consisted of two, weekday 12-hour nighttime fishing periods (7pm-7am) each week to minimize interactions with recreational boaters. Since 1998 the number of fishing periods allowed each year has remained fairly constant at 13-18 nights (Table 3.3). As in Youngs Bay, an 8-inch maximum mesh size restriction is in effect to target chinook and reduce sturgeon harvest. Other restrictions are the same as required in the winter season.

Deep River

The first experimental spring season in Deep River was adopted in 2003, and has continued since then. Season structure is similar to that used in Tongue Point and Blind Slough consisting of two, 12-hour nighttime fishing periods (7pm-7am) per week. Nets are restricted to a maximum length of 100-fathoms (600’) with an 8-inch maximum mesh size. Weight of nets is not regulated. In order to obtain accurate biological data, fishers have been required to have all harvested fish be sampled by WDFW staff prior to transportation from the fishing area. Spring season landings at this site have been low, ranging from 50-117 spring chinook annually during 2003-2005 (Table 3.3). Delayed release of spring chinook in Deep River due to the threat to outmigrating chum salmon has resulted in reduced survival. Beginning in 2005 the net pens have been towed to the main Columbia River channel two months earlier with anticipated improved survival.

Summer Seasons

SAFE summer seasons occur from mid-June through July (statistical weeks 25-31) with a goal of harvesting early returning SAB fall chinook and late returning spring chinook. Summer seasons have been established annually in Youngs Bay since 1999, based on favorable results of test fishing conducted in 1997 and 1998. A 1999 experimental summer season in Blind Slough landed only eight fish; therefore, additional summer season fisheries have not been adopted at this site. Gear regulations are the same as those in effect during spring seasons. The season typically consists of one, 30-48 hour fishing period each week. Summer-season landings in Youngs Bay have ranged from 110-695 chinook annually, with SAB fall chinook being somewhat more predominant in the catch than spring chinook (Table 3.3)

Results of Winter, Spring, and Summer Fisheries

The combined annual harvest of chinook in SAFE winter-summer fisheries during 1994-2005 ranged between 155 and 11,699 fish landed (Figure 3.1). Landings increased substantially from 1994 to 2002 but have fluctuated between 2,535 and 10,500 since then. Catches increased significantly beginning in 1997 with initial returns from increased SAFE project releases since 1995 (Figure 3.2; Table 3.3). Landings during the spring season, especially during late April through mid-May, have accounted for the majority of the landings during the winter-summer period. Since 1998, spring season annual chinook landings have ranged from 1,585 to 10,786 fish. Annual harvest during winter seasons has ranged from a low of 4 fish in 1999 to 1,319 fish landed in 2004. Catches during 1999-2005 summer fisheries have ranged between 110 and 695 fish annually. For 1998-2005 winter-summer SAFE fisheries, landings of chinook salmon have been distributed 5.0 percent during the winter season, 90.2 percent during the spring season, and 4.8 percent for the summer season. During 1993-2004, incidental harvest of white sturgeon in SAFE winter-summer fisheries ranged between 31 and 644 fish annually, with an average annual harvest of 336 fish. Since 2003

Figure 3.2. Spring chinook salmon produced by the select area fisheries project.

when a 300 white sturgeon harvest guideline was adopted for SAFE winter-summer fisheries, harvest has averaged 238 sturgeon annually. Incidental harvest of green sturgeon in SAFE winter-summer commercial fisheries is very low, with only 17 fish landed during 1993-2005 (~1.3 fish/year). Only one sockeye has been landed in 1996-2005 SAFE fisheries.

Figure 3.4. Commercial fishermen and a fish buyer in Youngs Bay.

In Youngs Bay, harvest of chinook increased significantly since the first spring chinook fishery in 1992. Annual landings in winter-summer fisheries ranged from 155 fish landed in 1994 to 6,840 fish in 2004. Only 1,092 spring chinook were landed in 2005 winter-summer fisheries (Table 3.3). Commercial landings in Blind Slough increased from 60 fish harvested in 1998 to 3,545 for 2004. Landings at this site averaged slightly over 2,000 fish annually during 2001-2003, increased to 3,545 in 2004, but fell to 1,393 fish landed in 2005. During 1998-2002 annual landings in Tongue Point winter-spring fisheries increased from 31 to 3,003 fish. In 2003 high abundances of upriver spring chinook in this area resulted in the harvest of 348 fish during the first fishing period, prior to the remainder of the season being rescinded. In Deep River, annual commercial harvest of spring chinook during 2003-2005 has been 117, 115, and 50 fish, respectively (Table 3.3).

During 1993-2005, harvest of spring chinook in SAFE fisheries represented the majority (53.5 percent) of the combined annual LCR (Zones 1-5) harvest of this stock due to significant restrictions on mainstem harvest through 2001 (ODFW and WDFW 2000). Even though adoption of selective harvest methods has allowed for increased harvest of spring chinook in the mainstem Columbia River non-Indian commercial fishery since 2002, SAFE winter-summer fisheries have contributed 47.5 percent of the total spring chinook landings during 2002-2005 (Table 3.4; Figure 3.3).

The minimum number of fishermen participating in SAFE winter-summer fisheries increased over 400 percent to 218 fishers during 1996-2001, but has decreased to 100 -166 fishers since then (Table 3.5; Figure 3.4). Youngs Bay has consistently supported the most participants due to area and larger adult returns. The number of fishers utilizing the Tongue Point and Blind Slough sites increased annually from 1998-2001 in response to implementation of spring fisheries in these new sites. Effort in Deep River will remain low until net-pen releases are more in line with other sites.

Stock Composition

The stock composition of chinook salmon harvested in all winter-summer SAFE fisheries has consisted predominantly of local stocks, based on recovery of 8,365 CWT's from 1993-2005 (Table 3.6). For this period 85.9 percent of all CWT recoveries were from SAFE releases; 11.0 percent were from LCR stocks; 3.0 percent originating from areas above Bonneville Dam; and 0.1 percent from fish originating from Oregon Coast tributaries. During this period 4,829 CWT recoveries from Youngs Bay winter-summer fisheries were comprised of 83.2 percent SAFE stocks, 13.0 percent LCR stocks, 3.7 percent upriver stocks, and 0.1 percent Oregon Coast stocks.

The composition of 2,901 CWT's recovered during 1998-2005 winter-spring fisheries in Blind Slough was weighted even more toward locally-produced fish with 93.5 percent from SAFE releases, 5.5 percent from LCR stocks, and 1.0 percent from upriver stocks (Table 3.6). Based on recovery of 585 CWT's from 1998-2003 Tongue Point winter-spring fisheries, 70.4 percent were from locally-produced fish; 20.9 percent were from LCR stocks; 8.2 percent from releases above Bonneville Dam; and 0.5 percent from Oregon coastal stocks. In Deep River, 50 CWT's were recovered from 2003-2004 spring fisheries with 92.0 percent originating from local releases, 8.0 percent from LCR stocks, with no tags from fish released from the Oregon Coast or from above Bonneville Dam.

Expansion of coded-wire tag recoveries by sampling rate and total landings indicates the chinook harvest in 1993-2005 SAFE winter-summer commercial fisheries consisted of 83.0 percent SAFE stocks, 13.3 percent LCR stocks, 3.0 percent upriver stocks, 0.3 percent Oregon coastal chinook stocks, and 0.4 percent summer chinook stocks (Table 3.7). On average, composition of SAFE stocks was highest for Blind Slough (91.6 percent), followed by Youngs Bay (81.6 percent), Tongue Point (73.9 percent), and Deep River (69.2 percent); however, only 2003 data is currently available for the Deep River fishery.

<u>Winter, Spring and Summer Fishery Impacts</u>

In recent years, impacts to listed stocks from SAFE commercial fisheries have been managed as part of the overall impact allocation for mainstem non-Indian fisheries. Impact rates in select areas are minor and generally of little consequence to the overall management of mainstem fisheries; however, in some cases impacts from mainstem fisheries can seriously affect the management of SAFE fisheries. In 2003 for example, a slight overage in the mainstem impact rate to upriver spring chinook forced the states to close 36 fishing days in select areas, which ultimately reduced the SAFE spring chinook harvest, increased escapement to local hatcheries and raised the potential for straying.

Estimated impact rates to ESA-listed stocks in winter-summer SAFE fisheries have not escalated commensurate with the increase in SAFE landings and have remained relatively low for all listed stocks (Figure 3.5). From 1993-2005 combined harvest rates on upriver spring chinook in all winter-summer SAFE fisheries have averaged 0.06 percent with a range of 0.00-0.19 percent (Table 3.8). The average impact rate for 2001-2004 increased to 0.14 percent, most likely due to significant increases in the upriver spring chinook run and subsequent increased abundance in SAFE fishing sites. The upriver impact rate decreased to 0.01 percent (14 fish) in 2005 due to a much reduced upriver spring chinook run, low abundance of upriver fish in SAFE fishing sites, and delay of the spring season until May.

During 1993-2005, an average of 26 wild upriver spring chinook (24 Snake River stock and 2 Columbia River stock) have been harvested annually in SAFE winter-summer fisheries. Impacts to Willamette River wild spring chinook during 1996-2005 ranged from 0.24-1.60 percent (15-195 fish), with an annual average impact of 0.68 percent. Impacts to wild Sandy River spring chinook during 1999-2005 have averaged 1.67 percent (98 fish). The harvest rate of upriver summer chinook has been consistently low, ranging from 0.00-0.10 percent (0-65 fish) during 1999-2005 (Table 3.8). Except for one fish (0.001 percent) landed during 2001 in Youngs Bay, the impact rate on sockeye in SAFE fisheries has been 0.0 percent since 1996 (Table 3.9).

Fisheries in Youngs Bay have typically accounted for the majority of upriver spring chinook impacts resulting from SAFE fisheries due to more fishing periods and higher effort at this site.

From 1992-2005 combined harvest rates on upriver spring chinook in Youngs Bay winter-summer fisheries have averaged 0.04 percent, with a 2001-2005 average of 0.08 percent (Table 3.8). Impacts during winter seasons have typically been minor with the majority of upriver harvest occurring in April concurrent with increased fishing opportunities. Harvest of Snake River and Columbia River wild spring chinook in Youngs Bay winter-summer fisheries has ranged between 0-76 and 0-7 fish, respectively. Impacts to Willamette River wild spring chinook during 1996-2005 Youngs Bay winter-summer fisheries have ranged form 0.21-1.14 percent (13-139 fish) and averaged 0.54 percent (46 fish). Harvest of upriver summer chinook in SAFE fisheries mainly occurs during the late-spring and summer fisheries in Youngs Bay, with impacts ranging from 0.00-0.09 percent (0-21 fish) during 1999-2005 (Table 3.8).

Impacts to listed stocks resulting from winter and spring fisheries in Blind Slough have been extremely low (Table 3.8), likely due to the isolated location of this site relative to the main Columbia River channel. From 1998-2005 the annual harvest of upriver spring chinook has ranged between 0-38 fish, with an annual harvest of 0-7 wild Snake River and ≤1 upper Columbia River wild spring chinook (Table 3.8). During these eight years the annual impact rate for upriver spring chinook stocks averaged <0.007 percent.

Since 1998, winter and spring fisheries in Tongue Point have accounted for 11.1-48.7 percent of the annual impacts to upriver spring chinook resulting from SAFE winter-summer fisheries. Actual annual harvest of upriver spring chinook has ranged from 3-199 fish, with an average upriver impact rate of 0.03 percent (Table 3.8). Harvest of Snake River and Columbia River wild spring chinook has ranged between 0-29 and 0-5 fish, respectively. Annual harvest of summer chinook has been low (≤7 fish or 0.010 percent) since summer fisheries have not been adopted at this site (Table 3.8). Harvest of Willamette River wild spring chinook has ranged from 0-38 fish annually (0.00-0.31 percent impact rate).

Harvest of non-target stocks has been low in Deep River spring fisheries since first established in 2003; however, sampling data for 2005 fisheries has not been finalized (VSI calls corrected with CWT data). No CWT's from upriver spring chinook were recovered from 2003-2004 fisheries. Based on recoveries of coded-wire tagged Willamette Basin spring chinook, only one wild Willamette River spring chinook was estimated to have been harvested annually during 2003 and 2004.

Due to geographic separation, SAFE fisheries have less impact on non-target stocks per harvested fish than do "mixed-stock" commercial and recreational fisheries occurring in the mainstem Columbia River, even when these fisheries utilize selective harvest methods. For instance, during 2002-2005, SAFE commercial fisheries harvested an average of 450 percent more spring chinook per upriver spring chinook killed than occurred in mainstem commercial spring chinook fisheries and 280 percent more than in mainstem recreational spring chinook fisheries. The difference was even more pronounced in 2005, when SAFE commercial fisheries harvested very few upriver spring chinook (14 estimated) resulting in 14.1 and 24.0 times as many spring chinook harvested per upriver spring chinook impact compared to mainstem recreational and commercial selective spring chinook fisheries.

FALL COMMERCIAL FISHERIES

Season Structure

SAFE fall fisheries occur between August 1 and October 31 (statistical weeks 32-44), and are managed to primarily harvest hatchery or net-pen reared coho and fall chinook salmon produced by the SAFE project. The management goal for this fishery is to maximize harvest of SAFE stock coho and SAB fall chinook, while providing for sufficient escapement to maintain the SAB broodstock program and minimizing impacts to non-local stocks. Occasionally, a target chinook fishery is adopted in Knappa Slough (terminus of Big Creek) whenever surplus tule fall chinook are expected to return to Big Creek Hatchery. These fishing periods typically occur during late August and early September, with length and number of fishing periods varying in response to expected surplus. Landings from these seasons are grouped with SAFE harvest due to location but Big Creek Hatchery does not produce coho or tule fall chinook for the SAFE project.

Fall seasons have been adopted in Youngs Bay since 1962; in Tongue Point Basin, Blind Slough and Deep River since 1996; and in Steamboat Slough since 2000. Since 1996, the fall season format has consisted of weekly fishing periods in Youngs Bay during August and early September to target SAB fall chinook, followed by liberal fishing opportunities in all sites from Labor Day (early September) through the end of October to maximize harvest of net-pen reared coho. The majority of the coho harvest occurs during the first three weeks of September, while SAB harvest is usually distributed throughout August and early September.

Youngs Bay

Fall seasons in Youngs Bay have typically consisted of one 30-36 hour fishing period weekly during most of August. This season framework has been used since 1996 to maximize commercial harvest, while maintaining an opportunity for recreational harvest and providing escapement of broodstock to Klaskanine Hatchery. Recently, due to Labor Day occurring later in September, a transitional three-day fishing period during the last week of August and the first week of September has been adopted to provide access to early-arriving coho. Following Labor Day weekend, a very liberal season running continuously (no closed periods) through the end of October is typically adopted to target net-pen coho, whose abundance peaks in mid-September, and late returning SAB fall chinook. This season structure has been effective at harvesting approximately 98 percent of the returning SAFE coho production annually (1993-2000 broods) based on recovery of CWT's from all sources. Annual participation in this fishery has averaged 78 fishers from 1996-2005 (Table 3.5).

Net weight and length regulations are the same as all other commercial fisheries in Youngs Bay with a maximum net length of 250 fathoms and maximum weight of two pounds per fathom of net. An 8-inch maximum mesh size restriction is in place during most of the August component of the fall season to target chinook salmon. A 6-inch maximum mesh is required during September and October to target coho. During August the upper fishing deadline is generally moved downstream from the confluence of the Klaskanine and Youngs rivers to Battle Creek Slough to allow increased SAB fall chinook escapement to Klaskanine Hatchery. Allowable sales include salmon and sturgeon; however, weekly vessel sturgeon limits or sturgeon retention prohibitions have been imposed in recent years to maintain sturgeon harvest at historic levels and for consistency with mainstem regulations.

Tongue Point/South Channel, Blind Slough/Knappa Slough, Deep River and Steamboat Slough

The structure of fall seasons in Tongue Point/South Channel, Blind Slough/Knappa Slough, Deep River, and Steamboat Slough are similar and generally consist of three or four nighttime fishing periods each week beginning immediately after Labor Day and continuing through October. During 1996-2003, fishing periods in all sites were generally 12-hours long (7 PM-7 AM) during most of September and lengthened to 14 hours in late September through October as available daylight and recreational fishing activity decrease. Since 2004, fishing periods after mid-September were lengthened to 16 hours each (4 PM-8 AM) in Tongue Point/South Channel, Deep River, and Steamboat Slough to provide additional fishing opportunity. Late-fall hours were not extended in the Blind Slough/Knappa Slough site based on a request by commercial fishers to not impede recreational access to and from a launching ramp located within the fishing site. In general, this season format has provided enough commercial harvest opportunity to harvest the vast majority of returning adults with little interaction with, or negative effect on, local recreational fisheries. Minimum annual participation in these fisheries since 1996 has averaged 39 fishers in Tongue Point/South Channel, 23 in Blind Slough/Knappa Slough, 11 in Deep River, and 3 in Steamboat Slough (Table 3.5).

Regulations governing length and weight of nets and fishing boundaries for these select areas are generally the same as in their corresponding spring fisheries with a few exceptions. During the fall season, the Knappa Slough fishing area is expanded to include waters downstream to the western end of Minaker Island to reduce congestion. Except for the intermittent August Knappa Slough fishery targeting tule fall chinook, the maximum allowable mesh size is 6-inches during fall seasons in these select areas. Beginning in September 2004, the use of additional weights or anchors attached to the leadline was allowed for fisheries in Blind/Knappa sloughs, South Channel, Deep River, and Steamboat Slough. Allowable sales include all salmon species and sturgeon, although specific sturgeon harvest rules may be adopted annually to maintain harvest within the 400 fish harvest guideline.

Results of Fall Fisheries

Since 1996, salmon harvest in SAFE fall fisheries has increased steadily, most likely a factor of improved ocean conditions and better rearing and release strategies. During this period, combined chinook harvest has ranged between 1,606-12,642 fish annually; however, landings during 2002-2004 were artificially inflated by inclusion of harvest occurring in August Knappa Slough fisheries targeting Big Creek Hatchery tule fall chinook. Chinook harvest in Youngs Bay, which is primarily comprised of SAB fall chinook, has increased from 1,439 in 1996 to 4,289 in 2005 (Table 3.10). Chinook landings have remained stable and averaged 173 fish per year in Deep River. Increased fall chinook landings in the Tongue Point fall fishery are likely an artifact of larger mainstem Columbia River returns since 2001. Annual landings at this site have increased from an annual average of 226 fish from 1996-2001 to 2,051 since 2002. Including August Knappa Slough fisheries, SAFE harvest of fall chinook has accounted for 22.2 percent of the total non-Indian Columbia River commercial fall chinook harvest during 1993-2005 (Figure 3.6).

The combined SAFE harvest of coho since 1996 has ranged from a low of 16,936 fish landed in 1997 to 114,352 in 2003 (Table 3.10). During this timeframe, coho harvest in Youngs Bay has ranged from 13,649 fish in 1997 to 91,435 in 2003. In the other sites, annual coho harvest has ranged from 861-19,083 in Tongue Point/South Channel, 615-3,879 in Blind/Knappa Sloughs, 303-14,039 in Deep River, and 0-362 in Steamboat Slough. Average annual coho landings for all sites combined since 2000 (66,149 fish) have been 300 percent higher than average landings during 1996-1999. Since 1996, Youngs Bay landings have accounted for 71.3 percent of SAFE coho landings, followed by Tongue Point/South Channel (17.2 percent), Deep River (6.8 percent), Blind/Knappa Slough (4.6 percent), and Steamboat Slough (0.1 percent).

No more than three chum have been caught annually at any site, and no more than five chum landed each year in all sites combined since 1996. Incidental harvest of white sturgeon in SAFE fall fisheries since 1996 has not exceeded 334 fish annually (144 annual average), with most harvest occurring in Youngs Bay and Tongue Point.

For the period 1993-1998, coho returns to the Columbia River were among the lowest in the past 30 years (ODFW and WDFW 2001). During those years, the only unrestricted freshwater commercial harvest occurred in SAFE fisheries that accounted for 79.8-98.9 percent of the annual Columbia River coho harvest. Since then run sizes have increased, allowing for larger mainstem commercial fisheries but SAFE fisheries have still accounted for 13.3-67.0 percent of the non-Indian Columbia River commercial coho harvest (Table 3.4; Figure 3.7). During 1993-

2005, coho harvest in select areas accounted for 40.0 percent of the total lower Columbia River commercial harvest.

Participation in fall SAFE fisheries is influenced by strength of adult returns and market price. From 1996-2005 an average of 149 fishermen participated in fall SAFE fisheries, with a range of only 96 active fishers in 2001 up to 192 fishers in 2000 (Table 3.5). The low effort in 2001 was primarily a result of poor coho prices which lead to an industry strike. Youngs Bay consistently draws the most participants (average of 78 fishers) due to its size and significantly higher fall returns, followed by Tongue Point (39 fishers), Blind Slough (21 fishers), Deep River (11), and Steamboat Slough (3 fishers). Effort estimates for all sites may be artificially low since some fishers may sell their catch in the other state and not be accurately recorded in the effort estimate. Some SAFE landings (and associated participants) in Tongue Point/South Channel, Steamboat Slough, Knappa Slough, and portions of Blind Slough and Deep River are recorded on mainstem fish tickets since these waters are considered joint state waters and are open concurrent with mainstem fishing periods. This situation usually occurs late in the season when landings and participation in SAFE fisheries is declining.

Stock Composition

In 1996, fishery monitoring was initiated at all of the new SAFE fishery sites. About 20 percent of the Youngs Bay harvest was sampled, but at Tongue Point, Blind Slough, and Deep River regulations were initiated that required harvested fish be examined by an agency sampler prior to being transported out of the fishing area. For the first three seasons this helped prevent mixing of SAFE catches with fish harvested in the mainstem Columbia River and facilitated a near 100 percent sampling rate. Since 1999, the sampling goal has been to inspect at least 20 percent of the harvest in each select area for external marks and recovery of CWTs. Since 2001, the sampling rate in fall fisheries has averaged 28 percent of the landed catch with a range of 16-38 percent. Only in 2003, when over 114,000 fish were landed and over 20,000 were sampled in fall SAFE fisheries, did the sampling rate fall below the 20 percent goal (Table 3.1).

Coho

The results of the 1996-2004 CWT sampling of harvested coho are presented in Table 3.11. For the four SAFE sites releasing fish since 1995, fisheries were dominated by fish of net-pen origin; averaging 88.3 percent at Deep River, 80.1 percent at Blind Slough, 87.2 percent at Youngs Bay, and 79.9 percent at Tongue Point (Figure 3.8). Youngs Bay, Blind Slough and Deep River averaged less that one (1.0) percent contribution from above Bonneville Dam. The first years of the Steamboat Slough fishery were the exception, with 45.4 percent of SAFE origin (34.0 percent local), 51.7 percent below Bonneville, and 2.9 percent above Bonneville Dam. The reason for low harvest and few local origin contributors is presented in Chapter 5.

Fall Chinook

The stock composition of fall chinook harvested in SAFE sites from 1996 through 2005 varied considerably; depending on if and when SAB and URB fall chinook had been released at the site. As described previously, SAB fall chinook have been released at Youngs Bay since the beginning of the project, while releases from Blind Slough and Tongue Point were limited (1995-1996 brood years). Experimental releases of URB fall chinook at Youngs Bay and Tongue Point also contributed to harvest in these sites during 1997-2002. No fall chinook have been released at Deep River or Steamboat Slough.

At Youngs Bay, with annual releases of up to 1.48 million SAB smolts (including production at Klaskanine Hatchery) since 1994, the average contribution of local fall chinook to the harvest was 95.7 percent during 1996-2005 (Table 3.12). At Blind Slough and Tongue Point, the SAFE segment of the catch was reduced (69.1 and 71.2 percent, respectively), however the proportion generally increased over time as the 1995-1996 brood SAB fall chinook appeared in those fisheries. Fall chinook landings in Deep River and Steamboat Slough were expectedly low since no fall chinook releases have occurred at these two sites. The average harvest contribution of stocks originating above Bonneville Dam to each SAFE fishing site was 1.5 percent at Deep River, 13.3 percent (1 fish) at Steamboat Slough, 2.9 percent at Youngs Bay, 3.5 percent at Blind Slough, and 20.8 percent at Tongue Point. Harvest of non-target fall chinook in select areas is anticipated and included in mainstem harvest modeling.

Fall Fishery Impacts

For all SAFE fall fisheries combined during 1993-2003, the impact rate to Snake River wild fall chinook ranged from 0.00-0.35 percent, and averaged 0.11 percent (7 fish). At the time this document was completed run size estimates were not available for 2004-2005; therefore, specific impacts cannot be estimated for these two years. However, the harvest rate on upriver bright fall chinook which is a surrogate stock for Snake River wild fall chinook, was 0.26 percent in 2004 and an estimated 0.18 percent in 2005 (Table 3.13). The impact rates on LRH fall chinook during 1993-2004 ranged from 0.00-7.0 percent, and averaged 1.9 percent (Table 3.13). As mentioned previously, most LRH fall chinook are landed in the August chinook fisheries occurring in Knappa Slough which are included in SAFE landings due to the location of the fishery even though this stock isn't part of the SAFE project. Except for 2003 when 85 (0.33 percent) LRW stock fall chinook were harvested in SAFE fisheries, impact rates on this stock have been 0.0 percent during 1996-2004. Since 1996, approximately two chum salmon have been landed annually in SAFE fall fisheries, with impact rates averaging 0.08 percent and not exceeding 0.24 percent annually (Table 3.9).

RECREATIONAL FISHERIES

The SAFE project benefits many different recreational fisheries in the region. Contributions of SAFE fish to Columbia River mainstem and ocean recreational fisheries have been significant (see Chapters 5 and 8) since these fisheries were already established. Recreational fisheries within SAFE fishing sites have evolved slowly due to these other angling opportunities in the lower Columbia River area and relatively low adult returns early in the program's history. Recently, both effort and harvest in SAFE sport fisheries has increased significantly, likely due to increasing adult returns and quality fishing opportunities. Presently all species produced by the SAFE project are targeted by recreational fisheries; however, the magnitude of the effort and catch differs greatly between sites and years. The most popular and productive fisheries occur in Blind Slough/Knappa Slough and Youngs Bay during March-May for spring chinook and in the Klaskanine River/Youngs Bay from July-October for SAB fall chinook. Angling for coho salmon occurs during August-October in Knappa Slough, Big Creek, Klaskanine River, Deep River, and directly from the Youngs Bay net pens during some years. Very little recreational effort occurs in the Tongue Point and Steamboat Slough areas.

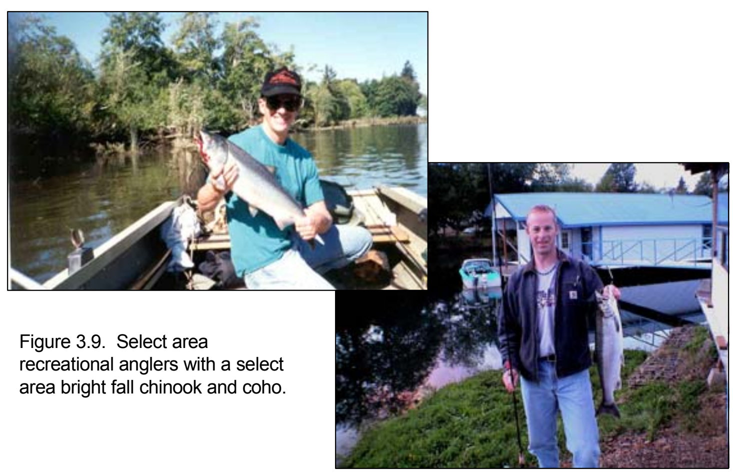


Figure 3.9. Select area recreational anglers with a select area bright fall chinook and coho.

Since 1998, year-round recreational seasons have been in effect for chinook and adipose fin-clipped coho in Youngs Bay, Tongue Point and Blind Slough. Similar regulations were adopted for South Channel and Knappa Slough in 1999 and for Deep River in 2000. In 2003 regulations to allow year-round angling for adipose fin-clipped steelhead were adopted in all select areas. To meet guidelines of the Willamette Fish Management Plan, SAFE recreational spring chinook fisheries have been managed for selective spring chinook harvest since January 1, 2004, with retention restricted to adipose-fin clipped spring chinook only during January 1-July 31 in all Oregon SAFE sites. A similar regulation requiring release of unmarked chinook from January 1-July 31 is in effect for Deep River in Washington. These regulations further minimize impacts to listed stocks of spring chinook due to sport harvest in select areas. Angling for fall chinook is open in all areas from July-December. Effective January 1, 2004 salmon angling regulations were liberalized for most tributaries entering Oregon SAFE fishing areas to allow nearly year-round recreational harvest opportunities. These changes were adopted to maximize angling opportunity and minimize effects of SAFE fish straying to these streams. To protect SAB broodstock destined for Klaskanine Hatchery, a regulation prohibiting angling in the Klaskanine River upstream of the Olney Lane Bridge was enacted in 2005.

Recreational harvest in SAFE areas has increased significantly since creel surveys were initiated in 1998 (Figure 3.9). Harvest of spring chinook increased from only 25 fish caught in 1999 to an estimated 1,081 in 2004 (Table 3.14). Most of this increase was due to growing effort in Knappa Slough, although an estimated 450 fish were landed in Gnat and Big creeks in 2003 due to restrictions imposed on the commercial fishery that resulted in increased escapement to these streams. Recreational harvest of spring chinook dropped markedly in 2005, most likely an artifact of the poor returns. From 1998-2005, landings of SAB fall chinook fluctuated between 50 and 601 fish annually. Sport effort for this stock has shifted from Knappa Slough to the tidewater sections of Youngs and Klaskanine rivers commensurate with transfer of the broodstock program to Klaskanine Hatchery. This fishery has grown rapidly in recent years and may require further restrictions to ensure adequate broodstock escapement.

Recreational harvest of coho within SAFE areas increased steadily from 118 fish landed in 1998 to 772 fish in 2003; however, landings decreased to an estimated 76-117 fish in 2004-2005. The most significant landings of coho in recent years have occurred in Youngs and Klaskanine rivers.

Although recreational harvest in select areas has increased since 1998, future seasons will likely remain unchanged to maximize fishing opportunities unless impacts to listed stocks increase substantially. During 2001-2005, annual impact rates have been extremely low, ranging from 0.00-0.01 percent for upper Columbia River (0 fish) and Snake River wild spring chinook (0-6 fish), and 0.003-0.052 percent (0-6 fish) for Willamette River wild spring chinook (Table 3.15).

Table 3.3. Select area winter, spring, and summer commercial seasons and harvest, 1992-2005.

Year	Fishery	Season	Days	Chinook	Coho	Chum	White Sturgeon
1992	Youngs Bay	Apr. 27 - May 26	9	296	0	0	10
		Total	9	296	0	0	10
1993	Youngs Bay	Apr. 26 – May 26	9	851	0	0	32
		Total	9	851	0	0	32
1994	Youngs Bay	Apr. 25 - May 25	9	155	0	0	31
		Total	9	155	0	0	31
1995	Youngs Bay	May 1 – Jun. 7	11	201	0	0	108
		Total	11	201	0	0	108
1996	Youngs Bay	Apr. 29 – Jun. 14	15	789	0	0	581
		Total	15	789	0	0	581
1997	Youngs Bay	Apr. 28 – Jun. 13	22	1,821	0	0	351
		Total	22	1,821	0	0	351
1998	Youngs Bay	Feb. 25 – Mar. 4	2	74	0	0	6
	Youngs Bay	Apr. 23 – Jun. 12	23	2,093	0	0	251
	Tongue Point	Apr. 29 – May 27	9	31	0	0	79
	Blind Slough	Apr. 29 – Jun. 12	13	60	0	0	19
		Total	47	2,258	0	0	355
1999	Youngs Bay	Feb. 24 – Mar. 11	3	4	0	0	1
	Youngs Bay	Apr. 22 – Jun. 11	26	936[a]	0	0	84
	Youngs Bay	Jun. 14 – Jul. 28	10	358[a]	0	0	85
	Tongue Point	Apr. 28 – Jun. 9	13	199	0	0	260
	Blind Slough	Apr. 28 – Jun. 11	13	450	0	0	94
	Blind Slough	Jun. 24 – Jul. 2	3	8	0	0	0
		Total	68	1,955	0	0	524
2000	Youngs Bay	Feb. 23 – Mar. 8	3	33	0	0	6
	Youngs Bay	Apr. 19 – Jun. 5	23	4,494[b]	0	0	182
	Youngs Bay	Jun. 12 – Jul. 26	11	204[b]	0	0	78
	Tongue Point	Feb. 29 – Mar. 14	3	10	0	0	5
	Tongue Point	Apr. 24 – Jun. 14	15	937	0	0	220
	Blind Slough	Feb. 27 – Mar. 13	3	8	0	0	0
	Blind Slough	Apr. 23 – Jun. 13	15	810	0	0	44
		Total	73	6,496	0	0	535
2001	Youngs Bay	Feb. 21 – Mar. 9	3	544	0	0	14
	Youngs Bay	Apr. 18 – Jun. 4	30	4,462[c]	0	0	122
	Youngs Bay	Jun. 18 – Jul. 31	9	587[c]	0	0	181
	Tongue Point	Feb. 20 – Mar. 7	3	124	0	0	2
	Tongue Point	Apr. 17 – Jun. 13	15	1,507	0	0	145
	Blind Slough	Feb. 19 – Mar. 6	3	14	0	0	0
	Blind Slough	Apr. 2 – Jun. 14	18	2,031	0	0	27
		Total	81	9,269	0	0	491

continued

Table 3.3. (continued) Select area winter, spring, and summer commercial seasons and harvest, 1992-2005.

Year	Fishery	Season	Days	Chinook	Coho	Chum	White Sturgeon
2002	Youngs Bay	Feb. 20 – Mar. 8	6	199	0	0	3
	Youngs Bay	Apr. 17 – Jun. 13	30	5,749[d]	0	0	135
	Youngs Bay	Jun. 19 – Aug. 1	9	695[d]	0	0	103
	Tongue Point	Apr. 18 – Jun. 12	15	3,003	0	0	354
	Blind Slough	Feb. 18 – Mar. 5	3	19	0	0	1
	Blind Slough	Apr. 18 – Jun. 12	15	2,034	0	0	48
		Total	78	11,699	0	0	644
2003[h]	Youngs Bay	Feb. 18 – Feb. 25	3	74	0	0	1
	Youngs Bay	Apr. 16 – Jun. 12	21	4,963[e]	0	0	81
	Youngs Bay	Jun. 18 – Jul. 31	9	279[e]	0	0	102
	Tongue Point	Apr. 17 - Apr. 18	1	348	0	0	11
	Blind Slough	Feb. 18 – Mar. 2	3	12	0	0	0
	Blind Slough	Apr. 17 – Jun. 13	13	2,027	0	0	32
	Deep River	Apr. 17 – Jun. 13	20	117	0	0	24
		Total	70	7,820	0	0	251
2004[h]	Youngs Bay	Feb. 14 – Mar. 21	9	1,029	0	0	8
	Youngs Bay	Apr. 12 – Jun. 18	22	5,555[f]	0	0	92
	Youngs Bay	Jun. 23 – Jul. 29	8	256[f]	0	0	19
	Blind Slough	Feb. 14 – Mar. 21	6	290	0	0	1
	Blind Slough	Apr. 12 – Jun. 18	13	3,255	0	0	59
	Deep River	Apr. 23 – Jun. 18	12	115	0	0	5
		Total	70	10,500	0	0	184
2005[h]	Youngs Bay	Feb. 16 – Mar. 17	9	143	0	0	6
	Youngs Bay	May 5 – Jun. 17	21	839[g]	0	0	137
	Youngs Bay	Jun. 22 – July 28	9	110[g]	0	0	67
	Blind Slough	Feb. 16 – Mar. 17	9	50	0	0	3
	Blind Slough	May 5 – Jun. 17	13	1,343	0	0	57
	Deep River	May 5 – Jun. 17	13	50	0	0	8
		Total	74	2,535	0	0	278

[a] *Includes 207 select area bright (SAB) fall chinook*
[b] *Includes 151 SAB fall chinook*
[c] *Includes 464 SAB fall chinook*
[d] *Includes 509 SAB fall chinook*
[e] *Includes 108 SAB fall chinook*
[f] *Includes 255 SAB fall chinook*
[g] *Includes 59 SAB fall chinook*
[h] *Anticipated seasons in 2003-2005 were reduced significantly due to high abundance of non-local stocks (2003) and lower-than-anticipated upriver returns that increased mainstem commercial impacts (2004-2005)*

Table 3.4. Harvest (thousands) of salmon in lower Columbia River mainstem and select area commercial fisheries, 1993-2005.

Species/Year	Minimum Adult Run	Mainstem Harvest	SAFE Harvest	SAFE %[a]
Spring chinook				
1993	203.0	1.5	0.9	36.2
1994	81.4	1.9	0.2	7.5
1995	61.9	0.0	0.2	100.0
1996	95.1	0.1	0.8	87.7
1997	160.2	0.1	1.8	95.2
1998	92.1	0.01	2.3	99.5
1999	103.4	0.02	2.0	99.2
2000	251.7	0.5	6.5	92.9
2001	517.6	6.7	9.3	58.2
2002	444.6	14.4	11.7	44.9
2003	373.5	3.0	7.8	72.0
2004	392.1	13.2	10.5	44.4
2005	195.1	5.4	2.5	31.8
Fall chinook				
1993	214.9	17.0	0.4	2.1
1994	254.0	1.7	0.1	6.7
1995	242.8	0.1	0.8	93.8
1996	330.8	12.0	1.6	11.8
1997	321.5	4.6	2.1	31.2
1998	255.4	2.4	1.7	42.2
1999	313.2	5.9	2.1	26.6
2000	255.0	10.9	2.3	17.5
2001	548.9	21.5	3.1	12.6
2002	733.3	35.0	8.6	19.7
2003	893.1	58.4	8.8	13.1
2004	799.0	41.1	12.6	23.5
2005	560.0[a]	27.5	8.7	24.0
Coho				
1993	113.9	20.7	15.5	42.8
1994	168.9	6.0	57.8	90.5
1995	74.0	0.2	22.3	98.9
1996	113.7	5.6	22.3	79.8
1997	146.8	2.8	16.9	86.0
1998	164.8	0.3	24.1	98.8
1999	271.7	57.6	23.0	28.5
2000	553.5	112.4	61.7	35.5
2001	1,112.9	219.7	33.8	13.3
2002	514.8	94.9	69.3	42.2
2003	683.7	149.8	114.4	43.3
2004	446.2	66.5	51.9	43.8
2005	280.0[b]	32.4	65.8	67.0

[a] *Calculated based on actual landings*
[b] *Preliminary*

Table 3.5. Minimum numbers of commercial fishers participating in select area fisheries, 1996-2005.

Year	Season	Youngs Bay[a]	Tongue Point[a]	Blind Slough[a]	Deep River	Steamboat Slough	All Areas
1996	Spring-Summer	53	[b]	[b]	[b]	[b]	53
	Fall	87	31	24	17	[b]	159
1997	Spring-Summer	49	[b]	[b]	[b]	[b]	49
	Fall	78	22	24	18	[b]	142
1998	Spring-Summer	69	14	11	[b]	[b]	94
	Fall	68	28	19	[b]	[b]	115
1999	Spring-Summer	57	21	21	[b]	[b]	99
	Fall	81	41	21	7	[b]	150
2000	Spring-Summer	74	43	40	[b]	[b]	157
	Fall	83	54	21	26	13	192
2001	Spring-Summer	94	71	53	[b]	[b]	218
	Fall	70	8[c]	12[c]	6	0	96
2002	Spring-Summer	79	51	27	[b]	[b]	157
	Fall	73	34[c]	16[c]	4	2	129
2003	Spring-Summer	92	32	37	5	[b]	166
	Fall	80	48[c]	16[c]	6	4	154
2004	Spring-Summer	85	[b]	41	5[d]	[b]	131
	Fall	87	55[c]	36[c]	8[d]	0	186
2005	Spring-Summer	53	[b]	42	5[d]	[b]	100
	Fall	77	68[c]	19[c]	8[d]	0	172

[a] *Represents number of fishers landing to Oregon buyers only*
[b] *No season*
[c] *Mainstem Columbia River season open concurrently*
[d] *Estimated*

Table 3.6. Stock composition of coded-wire tagged chinook salmon harvested in select area winter, spring and summer commercial fisheries [a], 1993-2005.

						Below Bonneville			
							SAFE		
Fishery	Year	Harvest	Total Recoveries	Oregon Coast	Above Bonneville	Non-SAFE	Local[b]	Non-Local	Origins of above Bonneville Dam recoveries
Youngs Bay	1993	851	230		3	41	186		2 - Deschutes R., 1 - Dworshak NFH
	1994	155	29		0	2	27		None
	1995	201	107		0	2	105		None
	1996	789	95		2	15	78		2 - Umatilla H.
	1997	1,821	479		8	21	450		2 - Dworshak NFH, 2 - Imnaha R., 2 - Similkameen R,, 2 - S. Fk. Salmon R.
	1998	2,167	581	1	5	16	559		1 - S. Fk. Clearwater, 1 - Dworshak NFH, 2 - W. Fk. Hood R., 1 - Rapid R. H
	1999	1,298	338	1	14	36	287		2 - Col R. general, 3 - Col. R. @ Turtle Rock, 2 - Dworshak NFH, 1 - Methow R., 1 - Wind R., 1- Similkameen H, 3 - Wenatchee R., 1– Warm Springs NFH
	2000	4,731	752		15	87	592	58	2 - Turtle Rock Hatchery, 5 - Warm Springs NFH, 1 - Lookingglass H, 1 – Round Butte H,, 1 – Clearwater H., 1 – Similkameen H, 4 – McCall H
	2001	5,593	424	1	18	55	320	30	4- Warm Springs NFH, 3– McCall H, 3– Wells H, 1-Clark Pnd, 2 – Round Butte H, 1 – Lookingglass H, 1 – Winthrop NFH, 1 – Clearwater NFH, 1 – Turtle Rock H, 1 Chiwawa H
	2002	6,643	470	1	59	172	181	57	13 – Warm Springs NFH, 16 –Round Butte, 1 – Carson NFH, 4 – LW Salmon NFH 4 – Dryden Pond, 3 – Wells H., 1 – Winthrop NFH, 1 – Leavenworth NFH, 2 – Klickitat H., 3 – Lookingglass H, 2-Irrigon, 1-Umatila H, 2-Similkameen H 2-McCall H, 2-Turtle R. H, 1-Rapid R. H, 1-Chiwawa H
	2003	5,316	470	1	34	80	325	30	8 – Warm Springs NFH, 7 – Round Butte H., 3 – McCall H., 4 – Lookingglass H, 3 – Leavenworth NFH, 1 –Winthrop NFH, 1 – Entiat NFH, 2 – Umatilla H, 1 – Wells H, 2 – Methow H., 1 – Dryden Pond, 1 – Little White Salmon NFH
	2004	6,840	747	0	18	82	627	20	1-Catherine Cr., 1-Clear Cr., 1-CR near Wells H., 1-Deschutes R., 2-Imnaha R., 1-LW Salmon NFH, 1-Methow R., 1-Rapid River H., 1-SFK Clearwater, 3-SFK Salmon, 3-Warm Springs R., 2-Wind R.
	2005	1,092	107	0	1	22	81	3	1-Wenatchee R.
	Total	37,296	4,829	5	177	631	3,818	198	
				0.1%	3.7%	13.0%	79.1%	4.1%	
								83.2%	

[a] *Recoveries from February-July commercial fisheries*
[b] *Includes SAB fall chinook*

continued

Table 3.6. (continued) Stock composition of coded-wire tagged chinook salmon harvested in select area winter, spring and summer commercial fisheries [a], 1993-2005.

Fishery	Year	Harvest	Total Recoveries	Oregon Coast	Above Bonneville	Below Bonneville: Non-SAFE	Below Bonneville: SAFE Local[b]	Below Bonneville: SAFE Non-Local	Origins of above Bonneville Dam recoveries
Tongue	1998	31	5				5		
Point	1999	199	27	1	1	3	22		1 – Warm Springs NFH
	2000	937	195		4	15	121	55	2-Warm Springs NFH, 1-McCall H, 1-Wells H
	2001	1,507	158	1	17	46	37	57	4-Chiwawa H, 3-Lookingglass H, 3-Round B. H, 2-Warm S. H, 1-Leavenworth, 1-Clearwater, 1-Wells H, 1-Clark P., 1-Carson
	2002	3,003	182	1	20	51	46	64	5-Round B. H, 2-Umatilla, 2-Warm S., 2-Dworshak NFH, 2-Clearwater, 2-Similkameen, 1-McCall, 1-Lookingglass, 1-Winthrop, 1-Chiwawa, 1-Dryden Pond
	2003	348	18		6	7		5	3-Round B. H, 1-Carson H, 1-Warm S. NFH, 1-Lookingglass H
	Total	6,025	585	3	48	122	231	181	
				0.5%	8.2%	20.9%	39.5%	30.9%	
								70.4%	
Blind	1998	60	15			1	14		
Slough	1999	458	92			8	84		
	2000	818	226			14	169	43	
	2001	2,045	329		16	44	143	126	3-Round B., 2-Winthrop, 2-Warm S., 2-Methow, 1-Little White S, 1-Dworshak, 1-Lookingglass, 1-Sawtooth, 1-Clearwater, 1-Tucannon, 1-Clark Flat Pond
	2002	2,053	490		5	49	403	33	1-Carson, 1-Leavenworth, 1-Warm S., 1-Umatilla, 1-Round B.
	2003	2,039	457		5	9	368	75	2–Carson NFH, 1–Lookingglass H, 1-Methow H, 1-Round Butte
	2004	3,545	678		1	33	606	38	1-Lochsa R
	2005	1,393	614		2	3	591	18	1-CR near Wells, 1-Imnaha R
	Total	12,411	2,901		29	161	2,378	333	
				0.0%	1.0%	5.5%	82.0%	11.5%	
								93.5%	
Deep	2003	117	21			3	16	2	
River	2004	115	29			1	28	0	
	2005	50			*(data not available)*				
	Total	282	50			4	44	2	
				0.0%	0.0%	8.0%	88.0%	4.0%	
								92.0%	

[a] *Recoveries from February-July commercial fisheries*
[b] *Includes SAB fall chinook*

Table 3.7. Estimated stock composition of chinook salmon harvested in select area winter, spring and summer commercial fisheries based on expanded coded-wire tag recoveries, 1992-2005.

		Stock Component (%)					
Year	Fishery	Local[a]	Lower River	Upriver	Coastal	Summer	Total
1992	Youngs Bay	245 (83%)	44 (15%)	7 (2%)			296
1993	Youngs Bay	496 (58%)	343 (40%)	12 (<2%)			851
1994	Youngs Bay	127 (82%)	26 (17%)	2 (1%)			155
1995	Youngs Bay	187 (93%)	14 (7%)	0 (0%)			201
1996	Youngs Bay	705 (89%)	71 (9%)	13 (<2%)			789
1997	Youngs Bay	1,613 (89%)	189 (10%)	19 (1%)			1,821
1998	Youngs Bay	1,955 (90%)	171 (8%)	24 (1%)	17 (<1%)	0	2,167
	Tongue Point	25 (80%)	3 (10%)	3 (10%)	0	0	31
	Blind Slough	57 (95%)	3 (5%)	0 (0%)	0	0	60
		2,037 (90%)	177 (8%)	27 (1%)	17 (<1%)	0 (0%)	2,258
1999	Youngs Bay	1,012 (78%)	265 (20%)	16 (1%)	5 (<1%)	0	1,298
	Tongue Point	168 (84%)	13 (7%)	7 (4%)	11 (5%)	0	199
	Blind Slough	351 (77%)	105 (23%)	2 (<1%)	0	0	458
		1,531 (78%)	383 (20%)	25 (1%)	16 (<1%)	0 (0%)	1,955
2000	Youngs Bay	3,984 (84%)	706 (15%)	20 (<1%)	0	21 (<1%)	4,731
	Tongue Point	803 (85%)	138 (15%)	3 (<1%)	0	3 (<1%)	947
	Blind Slough	726 (89%)	92 (11%)	0 (0%)	0	0	818
		5,513 (85%)	936 (14%)	23 (<1%)	0 (0%)	24 (<1%)	6,496
2001	Youngs Bay	5,128 (92%)	261 (5%)	172 (3%)	13 (<1%)	19 (<1%)	5,593
	Tongue Point	1,245 (76%)	152 (9%)	199 (12%)	31 (2%)	4 (<1%)	1,631
	Blind Slough	1,747 (85%)	259 (13%)	38 (2%)	0	1 (<1%)	2,045
		8,120 (88%)	672 (7%)	409 (4%)	44 (<1%)	24 (<1%)	9,269
2002	Youngs Bay	4,558 (69%)	1,651 (25%)	356 (5%)	30 (<1%)	48 (<1%)	6,643
	Tongue Point	2,262 (75%)	552 (18%)	173 (6%)	9 (<1%)	7 (<1%)	3,003
	Blind Slough	1,813 (88%)	207 (10%)	33 (2%)	0	0	2,053
		8,633 (74%)	2,410 (21%)	562 (5%)	39 (<1%)	55 (<1%)	11,699
2003	Youngs Bay	3,931 (74%)	971 (18%)	300 (6%)	49 (<1%)	65 (1%)	5,316
	Tongue Point	94 (27%)	188 (54%)	66 (19%)	0	0	348
	Blind Slough	1,948 (96%)	64 (3%)	27 (1%)	0	0	2,039
	Deep River	100 (85%)	17 (15%)	0 (0%)	0	0	117
		6,073 (78%)	1,240 (16%)	393 (5%)	49 (<1%)	65 (<1%)	7,820
2004	Youngs Bay	6,001 (88%)	643 (9%)	158 (2%)	0	38 (<1%)	6,840
	Blind Slough	3,350 (95%)	160 (4%)	35 (1%)	0	0	3,545
	Deep River	[b]	[b]	[b]	[b]	[b]	115
		9,351 (90%)	803 (8%)	193 (2%)	0 (0%)	38 (<1%)	10,500
2005	Youngs Bay	907 (83%)	170 (16%)	13 (1%)	0	2 (<1%)	1,092
	Blind Slough	1,374 (99%)	17 (1%)	1 (<1%)	0	1 (<1%)	1,393
	Deep River	[b]	[b]	[b]	[b]	[b]	50
		2,281 (92%)	187 (8%)	14 (<1%)	0 (0%)	3 (<1%)	2,535

[a] *Includes SAB fall chinook*
[b] *Data not yet available*

Table 3.8. Summary of harvest impacts during winter-summer select area commercial fisheries, 1992-2005.

			Upper Columbia River Spring Chinook (CHS)										Willamette River Spring Chinook					Sandy R. Wild CHS			Columbia River Summer Chinook		
Year	Site	Total Adult Harvest	% Upriver Stock	Upriver Run Size	SAFE Upriver Harvest	Upriver Impact Rate %	Snake River Wild Run Size	SAFE Snake River Wild Harvest	Snake River Wild Impact %	Upper CR Wild Run Size	SAFE CR Wild harvest	CR Wild Impact %	% Willamette River Stock	SAFE Willamette River Harvest	Willamette River Run Size	Willamette River Harvest Rate	Number Willamette River Wild	Sandy River Run Size	SAFE Sandy River Harvest	Sandy River Harvest Rate	Columbia River Run Size	SAFE Summer Chinook Harvest[a]	Columbia River ChR Harvest Rate
1992	Youngs Bay	296	0.024	68,800	7	0.010%	19,283	2	0.010%	5,007	1	0.010%		0	75,000	0.000%	0	9,234	-	-	9,796	0	0.000%
1993	Youngs Bay	851	0.014	111,000	12	0.011%	15,435	2	0.011%	5,268	1	0.011%		0	65,900	0.000%	0	6,369	-	-	14,781	0	0.000%
1994	Youngs Bay	156	1.282%	20,800	2	0.010%	3,401	0	0.010%	1,804	0	0.010%		0	49,600	0.000%	0	3,498	-	-	14,977	0	0.000%
1995	Youngs Bay	201	0.000%	9,800	0	0.000%	3,017	0	0.000%	290	0	0.000%		0	42,600	0.000%	0	2,686	-	-	12,615	0	0.000%
1996	Youngs Bay	789	1.648%	51,500	13	0.025%	8,896	2	0.025%	308	0	0.025%	0.217	171	34,800	0.491%	17	3,997	-	-	12,333	0	0.000%
1997	Youngs Bay	1,806	1.052%	114,000	19	0.017%	8,126	1	0.017%	1,071	0	0.017%	0.105	189	35,300	0.535%	19	4,625	-	-	18,277	0	0.000%
1998	Youngs Bay	2,167	1.108%	38,300	24	0.063%	13,062	8	0.063%	401	0	0.063%	0.055	119	45,100	0.264%	12	3,768	-	-	16,332	0	0.000%
	Tongue Point	31	9.677%	38,300	3	0.008%	13,062	1	0.008%	401	0	0.008%	0.097	3	45,100	0.007%	0	3,768	-	-	16,332	0	0.000%
	Blind Slough	60	0.000%	38,300	0	0.000%	13,062	0	0.000%	401	0	0.000%	0.050	3	45,100	0.007%	0	3,768	-	-	16,332	0	0.000%
	All SAFE	2,258	3.595%		27	0.070%		9	0.070%		0	0.070%	0.067	125		0.277%	13					0	0.000%
1999	Youngs Bay	1,298	1.233%	38,700	16	0.041%	5,579	2	0.041%	642	0	0.041%	0.133	172	54,200	0.317%	17	3,985	64	1.606%	22,347	0	0.000%
	Tongue Point	199	3.518%	38,700	7	0.018%	5,579	1	0.018%	642	0	0.018%	0.050	10	54,200	0.018%	1	3,985	0	0.000%	22,347	0	0.000%
	Blind Slough	453	0.442%	38,700	2	0.005%	5,579	0	0.005%	642	0	0.005%	0.146	66	54,200	0.122%	7	3,985	33	0.828%	22,347	0	0.000%
	All SAFE	1,950	1.731%		25	0.065%		4	0.065%		0	0.065%	0.109	248		0.458%	25		97	2.434%		0	0.000%
2000	Youngs Bay	4,731	0.423%	178,600	20	0.011%	13,201	1	0.011%	3,007	0	0.011%	0.113	535	57,500	0.930%	54	3,778	114	3.017%	23,169	21	0.091%
	Tongue Point	947	0.317%	178,600	3	0.002%	13,201	0	0.002%	3,007	0	0.002%	0.137	130	57,500	0.226%	13	3,778	0	0.000%	23,169	3	0.013%
	Blind Slough	818	0.000%	178,600	0	0.000%	13,201	0	0.000%	3,007	0	0.000%	0.105	86	57,500	0.150%	9	3,778	0	0.000%	23,169	0	0.000%
	All SAFE	6,496	0.247%		23	0.013%		2	0.013%		0	0.013%	0.118	751		1.306%	75		114	3.017%		24	0.104%
2001	Youngs Bay	5,593	3.075%	416,500	172	0.041%	60,977	25	0.041%	10,026	4	0.041%	0.044	246	80,300	0.306%	25	5,742	6	0.104%	54,935	19	0.035%
	Tongue Point	1,631	12.201%	416,500	199	0.048%	60,977	29	0.048%	10,026	5	0.048%	0.076	124	80,300	0.154%	12	5,742	8	0.139%	54,935	4	0.007%
	Blind Slough	2,045	1.858%	416,500	38	0.009%	60,977	6	0.009%	10,026	1	0.009%	0.082	167	80,300	0.208%	17	5,742	56	0.975%	54,935	1	0.002%
	All SAFE	9,269	5.712%		409	0.098%		60	0.098%		10	0.098%	0.067	537		0.669%	54		70	1.219%		24	0.044%
2002	Youngs Bay	6,643	5.359%	295,100	356	0.121%	49,004	59	0.121%	5,975	7	0.121%	0.209	1386	121,700	1.139%	139	6,366	137	2.152%	92,820	48	0.052%
	Tongue Point	3,003	5.761%	295,100	173	0.059%	49,004	29	0.059%	5,975	4	0.059%	0.127	381	121,700	0.313%	38	6,366	150	2.356%	92,820	7	0.008%
	Blind Slough	2,053	1.607%	295,100	33	0.011%	49,004	5	0.011%	5,975	1	0.011%	0.087	178	121,700	0.146%	18	6,366	5	0.079%	92,820	0	0.000%
	All SAFE	11,699	4.242%		562	0.190%		93	0.190%		11	0.190%	0.141	1,945		1.598%	195		292	4.587%		55	0.059%
2003	Youngs Bay	5,316	5.643%	208,900	300	0.144%	52,994	76	0.144%	2,602	4	0.144%	0.146	776	126,600	0.613%	93	5,848	56	0.958%	83,120	65	0.078%
	Tongue Point	348	18.966%	208,900	66	0.032%	52,994	17	0.032%	2,602	1	0.032%	0.523	182	126,600	0.144%	22	5,848	0	0.000%	83,120	0	0.000%
	Blind Slough	2,039	1.324%	208,900	27	0.013%	52,994	7	0.013%	2,602	0	0.013%	0.026	54	126,600	0.043%	6	5,848	0	0.000%	83,120	0	0.000%
	Deep River	117	0.000%	208,900	0	0.000%	52,994	0	0.000%	2,602	0	0.000%	0.043	5	126,600	0.004%	1	5,848	0	0.000%	83,120	0	0.000%
	All SAFE	7,820	6.483%		393	0.188%		100	0.188%		5	0.188%	0.185	1,017		0.803%	122		56	0.000%		65	0.078%
2004	Youngs Bay	6,840	2.310%	193,400	158	0.082%	33,008	27	0.082%	3,213	3	0.082%	0.070	477	143,700	0.332%	48	13,320	38	0.285%	65,446	38	0.058%
	Blind Slough	3,545	0.987%	193,400	35	0.018%	33,008	6	0.018%	3,213	1	0.018%	0.033	118	143,700	0.082%	12	13,320	21	0.158%	65,446	0	0.000%
	Deep River	115	0.000%	193,400	0	0.000%	33,008	0	0.000%	3,213	0	0.000%	0.043	5	143,700	0.003%	1	13,320	0	0.000%	65,446	0	0.000%
	All SAFE	10,500	1.099%		193	0.100%		33	0.100%		3	0.100%	0.049	600		0.418%	60		59	0.443%		38	0.058%
2005	Youngs Bay	1,092	1.190%	106,900	13	0.012%	13,064	2	0.012%	2,474	0	0.012%	0.117	128	61,000	0.210%	13	9,327	0	0.000%	60,038	2	0.003%
	Blind Slough	1,393	0.072%	106,900	1	0.001%	13,064	0	0.001%	2,474	0	0.001%	0.011	15	61,000	0.025%	2	9,327	0	0.000%	60,038	1	0.002%
	Deep River	50	0.000%	106,900	0	0.000%	13,064	0	0.000%	2,474	0	0.000%	0.040	2	61,000	0.003%	0	9,327	0	0.000%	60,038	0	0.000%
	All SAFE	2,535	0.421%		14	0.013%		2	0.013%		0	0.013%	0.056	145		0.238%	15		0	0.000%		3	0.005%

[a] *Data not available prior to 2000*

Preliminary

Table 3.9. Summary of lower Columbia River chum and sockeye harvest impacts during select area commercial fisheries, 1996-2005.

		Lower Columbia River Chum			Sockeye		
Year	Site	SAFE Chum Harvest	Chum Run Size[a]	Chum Impact %	SAFE Sockeye Harvest	Sockeye Run Size	Sockeye Impact %
1996							
	Youngs Bay	3	3,300	0.091%	0	30,280	0.000%
	Tongue Point	0	3,300	0.000%	0	30,280	0.000%
	Blind Slough	2	3,300	0.061%	0	30,280	0.000%
	Deep River	0	3,300	0.000%	0	30,280	0.000%
	Steamboat Slough		3,300	0.000%		30,280	0.000%
	All SAFE Areas	**5**		**0.152%**	**0**		**0.000%**
1997							
	Youngs Bay	2	1,700	0.118%	0	46,939	0.000%
	Tongue Point	1	1,700	0.059%	0	46,939	0.000%
	Blind Slough	0	1,700	0.000%	0	46,939	0.000%
	Deep River	1	1,700	0.059%	0	46,939	0.000%
	Steamboat Slough		1,700	0.000%		46,939	0.000%
	All SAFE Areas	**4**		**0.235%**	**0**		**0.000%**
1998							
	Youngs Bay	2	1,900	0.105%	0	13,220	0.000%
	Tongue Point	2	1,900	0.105%	0	13,220	0.000%
	Blind Slough	0	1,900	0.000%	0	13,220	0.000%
	Deep River		1,900	0.000%	0	13,220	0.000%
	Steamboat Slough		1,900	0.000%		13,220	0.000%
	All SAFE Areas	**4**		**0.211%**	**0**		**0.000%**
1999							
	Youngs Bay	1	2,400	0.042%	0	17,878	0.000%
	Tongue Point	0	2,400	0.000%	0	17,878	0.000%
	Blind Slough	0	2,400	0.000%	0	17,878	0.000%
	Deep River	2	2,400	0.083%	0	17,878	0.000%
	Steamboat Slough		2,400	0.000%		17,878	0.000%
	All SAFE Areas	**3**		**0.125%**	**0**		**0.000%**
2000							
	Youngs Bay	1	2,500	0.040%	0	93,757	0.000%
	Tongue Point	0	2,500	0.000%	0	93,757	0.000%
	Blind Slough	0	2,500	0.000%	0	93,757	0.000%
	Deep River	1	2,500	0.040%	0	93,757	0.000%
	Steamboat Slough	0	2,500	0.000%	0	93,757	0.000%
	All SAFE Areas	**2**		**0.080%**	**0**		**0.000%**
2001							
	Youngs Bay	1	5,500	0.018%	1	116,623	0.001%
	Tongue Point	0	5,500	0.000%	0	116,623	0.000%
	Blind Slough	0	5,500	0.000%	0	116,623	0.000%
	Deep River	0	5,500	0.000%	0	116,623	0.000%
	Steamboat Slough	0	5,500	0.000%	0	116,623	0.000%
	All SAFE Areas	**1**		**0.018%**	**1**		**0.001%**
2002							
	Youngs Bay	0	11,900	0.000%	0	49,629	0.000%
	Tongue Point	0	11,900	0.000%	0	49,629	0.000%
	Blind Slough	0	11,900	0.000%	0	49,629	0.000%
	Deep River	1	11,900	0.008%	0	49,629	0.000%
	Steamboat Slough	0	11,900	0.000%	0	49,629	0.000%
	All SAFE Areas	**1**		**0.008%**	**0**		**0.000%**
2003							
	Youngs Bay	0	11,000	0.000%	0	39,375	0.000%
	Tongue Point	0	11,000	0.000%	0	39,375	0.000%
	Blind Slough	0	11,000	0.000%	0	39,375	0.000%
	Deep River	0	11,000	0.000%	0	39,375	0.000%
	Steamboat Slough	0	11,000	0.000%	0	39,375	0.000%
	All SAFE Areas	**0**		**0.000%**	**0**		**0.000%**
2004							
	Youngs Bay	1	14,000	0.007%	0	123,992	0.000%
	Tongue Point	0	14,000	0.000%	0	123,992	0.000%
	Blind Slough	0	14,000	0.000%	0	123,992	0.000%
	Deep River	0	14,000	0.000%	0	123,992	0.000%
	Steamboat Slough	0	14,000	0.000%	0	123,992	0.000%
	All SAFE Areas	**1**		**0.007%**	**0**		**0.000%**
2005[b]							
	Youngs Bay	1	12,000	0.008%	0	72,452	0.000%
	Tongue Point	0	12,000	0.000%	0	72,452	0.000%
	Blind Slough	0	12,000	0.000%	0	72,452	0.000%
	Deep River	0	12,000	0.000%	0	72,452	0.000%
	Steamboat Slough	0	12,000	0.000%	0	72,452	0.000%
	All SAFE Areas	**1**		**0.008%**	**0**		**0.000%**

[a] *Estimated run size rounded to nearest hundred fish. 2004 and 2005 run sizes estimated based on Washington tributary stream survey data applied to 2003 estimated return.*

[b] *Chum run size based on preseaon expectation*

Table 3.10. Select area fall commercial seasons and harvest, 1996-2005.

Year	Fishery	Season	Days	Chinook	Coho	Chum	White Sturgeon
1996	Youngs Bay	Aug. 12 - Sept. 6 Sept. 9 - Oct. 31	10 52	1,439	15,783	3	85
	Tongue Point	Sept 17 - Oct. 31	14	50	1,955	0	[a]
	Blind Slough	Sept. 16 - Oct. 29	13	82	2,301	2	[a]
	Deep River	Sept. 16 - Oct. 29	13	35	2,240	0	[a]
		Total	102	1,606	22,279	5	85
1997	Youngs Bay	Aug. 11 – Aug. 28 Sept. 3 - Oct. 31	7 59	1,726	13,649	2	76
	Tongue Point	Sept. 3 - Oct. 24	16	180	861	1	[a]
	Blind Slough	Sept. 8 - Oct. 22	18	32	1,605	0	[a]
	Deep River	Sept. 8 - Oct. 22	18	149	821	1	[a]
		Total	118	2,087	16,936	4	76
1998	Youngs Bay	Aug. 10 – Sept. 4 Sept. 8 – Oct. 31	11 53	1,225	20,121	2	105
	Tongue Point	Sept. 10 - Oct. 23	13	421	3,398	1	67
	Blind Slough	Sept. 8 - Oct. 21	17	103	615	0	2
		Total	94	1,749	24,134	3	174
1999	Youngs Bay	Aug. 3 – Sept. 1 Sept. 7 – Oct. 31	5 54	1,589	15,911	2	99
	Tongue Point	Sept. 7 - Oct. 28	19	339	3,659	0	122
	Blind Slough	Sept. 9 - Oct. 28	19	167	1,958	0	4
	Deep River	Sept. 9 - Oct. 28	19	48	1,426	2	0
		Total	116	2,143	22,954	4	225
2000	Youngs Bay	Aug. 1 – Aug. 30 Sept. 5 – Oct. 31	5 56	1,744	33,214	1	88
	Tongue Point	Sept. 5 - Oct. 31	32	252	10,731	0	59
	Blind Slough	Sept. 7 - Oct. 31	31	132	3,398	0	9
	Deep River	Sept. 5 - Oct. 31	32	109	14,039	1	0
	Steamboat Slough	Sept. 7 - Oct. 28	30	78	363	0	1
		Total	186	2,315	61,745	2	157
2001	Youngs Bay	Aug. 6 – Aug. 28 Sept. 4 – Oct. 31	4 57	2,040	25,469	1	21
	Tongue Point	Sept. 4 – Oct. 31	33	116	2,021	0	0
	Blind Slough	Sept. 4 – Oct. 31	33	793	3,764	0	0
	Deep River	Sept. 4 – Oct. 31	33	149	2,491	0	0
	Steamboat Slough	Sept. 4 – Oct. 31	33	0	26	0	0
		Total	193	3,098	33,771	1	21

continued

Table 3.10. (continued) Select area fall commercial seasons and harvest, 1996-2005.

Year	Fishery	Season	Days	Chinook	Coho	Chum	White Sturgeon[a]
2002	Youngs Bay	Aug. 7 – Aug. 29 Sept. 3 – Oct. 31	4 58	3,774	51,859	0	96
	Tongue Point	Sept. 3 – Oct. 31	34	1,708	15,560	0	202
	Blind/Knappa Sloughs	Aug. 26 – Aug. 29 Sept 3 – Oct. 31	3 34	2,760	1,449	0	33
	Deep River	Sept. 3 – Oct. 31	34	145	303	1	3
	Steamboat Slough	Sept. 3 – Oct. 31	34	183	105	0	0
		Total	201	8,570	69,276	1	334
2003	Youngs Bay	Aug. 6 – Aug. 30 Sept. 2 – Oct. 31	4 59	4,271	91,435	0	45
	Tongue Point	Sept. 2 – Oct. 31	35	2,451	15,598	0	97
	Blind/Knappa Sloughs	Aug. 25 – Aug. 28 Sept. 2 – Oct. 31	3 35	1,903	3,879	0	28
	Deep River	Sept. 2 – Oct. 31	35	168	3,333	0	3
	Steamboat Slough	Sept. 2 – Oct. 31	35	44	107	0	0
		Total	206	8,837	114,352	0	173
2004	Youngs Bay	Aug. 4 – Aug. 26 Aug. 31 – Sept. 3 Sept. 7 - Oct. 31	4 3 55	3,890	34,613	1	23
	Tongue Point	Aug. 31 – Oct. 29	34	2,124	10,196	0	33
	Blind Slough	Aug. 24 – Aug. 27 Aug. 31 – Oct. 29	3 34	6,235	1,355	0	59
	Deep River	Aug. 23 – Oct. 29	40	393	5,780	0	2
	Steamboat Slough	Aug. 31 – Oct. 29	34	0	0	0	0
		Total	207	12,642	51,944	1	117
2005	Youngs Bay	Aug. 3 – Aug. 25 Aug. 30 – Sept. 2 Sept. 6 - Oct. 31	4 3 56	4,289	42,361	1	37
	Tongue Point	Aug. 30 – Oct. 28	34	1,919	19,083	0	29
	Blind Slough	Aug. 30 – Oct. 28	34	2,124	1,777	0	0
	Deep River	Aug. 30 – Oct. 28	34	364	2,586	0	8
	Steamboat Slough	Aug. 30 – Oct. 28	34	0	0	0	0
		Total	199	8,696	65,807	1	74

[a] *Retention of sturgeon not allowed*

Table 3.11. Stock composition of coho salmon harvested in select area fall[a] commercial fisheries based on coded-wire tag recoveries, 1996-2004.

Fishery	Year	Coho Harvest	Total Recoveries	Below Bonneville: Above Bonneville	Below Bonneville: Non-SAFE	SAFE: Local	SAFE: Non-Local	Origins of above Bonneville Dam recoveries.
Youngs Bay	1996	15,783	1,594	0	220	1207	167	
	1997	13,649	891	0	52	760	79	
	1998	20,121	1,197	34	210	878	75	23-L. White Salmon Hat, 2- Ringold Pond, 4-Rosa Accl. Pond, 5-Umatilla R.
	1999	15,911	1,614	4	51	1467	92	2-L. Yakima R., 1-Umatilla R., 1-Wenatchee R.
	2000	33,214	2,857	3	348	2309	197	3-Cascade Hatchery (Yakima R)
	2001	25,469	1,307	6	182	1043	76	5-Umatilla R., 1-Little White Salmon
	2002	51,859	3,198	22	654	2215	307	19-Willard HFH, 3-Umatilla R.
	2003	91,435	5,500	106	612	4281	501	41-Willard NFH, 65-Cascade Hat.
	2004	34,613	2,058	21	200	1501	336	4-Cascade Hat., 14-Winthrop NFH, 3-Willard NFH
				0.81%	11.97%	78.43%	8.78%	
Tongue Point	1996	1,955	350	0	15	260	75	
	1997	861	62	0	3	37	22	
	1998	3,398	204	3	35	46	120	2-L. White Salmon, 1-Umatilla R.
	1999	3,659	459	1	33	255	170	1-Umatilla R.
	2000	10,731	589	0	155	199	235	
	2001	2,021	181	0	48	61	72	
	2002	15,560	1,079	9	579	306	185	6-Willard NFH, 3-Cascade Hat.
	2003	15,598	903	39	224	335	305	23-Willard NFH, 16-Cascade Hat.
	2004	10,196	396	7	30	244	115	3-Cascade NFH, 3-Willard NFH, 1-L. White Salmon NFH
				0.96%	19.15%	45.18%	34.71%	
Deep River	1996	2,240	393	0	6	374	13	
	1997	821	139	0	5	133	1	
	1998	0						
	1999	1,426	268	0	7	257	4	
	2000	14,039	2,120	0	83	2027	10	
	2001	2,491	202	0	23	124	55	
	2002	303	72	3	41	23	5	3-Keta Creek Hatchery
	2003	3,333	805	0	44	722	39	
	2004	5,780	789	0	31	747	11	
				0.52%	11.17%	82.51%	5.80%	

continued

Table 3.11. (continued) Stock composition of coho salmon harvested in select area fall[a] commercial fisheries based on coded-wire tag recoveries, 1996-2004.

					Below Bonneville			
						S A F E		
Fishery	Year	Coho Harvest	Total Recoveries	Above Bonneville	Non-SAFE	Local	Non-Local	Origins of above Bonneville Dam recoveries.
Blind Slough	1996	2,301	470	0	24	431	15	
	1997	1,605	215	0	3	209	3	
	1998	615	52	0	6	22	24	
	1999	1,958	390	0	17	344	29	
	2000	3,398	436	0	47	381	8	
	2001	3,764	653	0	89	400	164	
	2002	1,449	195	2	158	2	33	2-Cascade Hatchery
	2003	3,879	873	0	76	749	48	
	2004	1,355	81	0	34	10	37	
				0.11%	19.83%	63.03%	17.03%	
Steamboat Slough	2000	363	32	1	8	19	4	1-Dworshak NFH
	2001	26	9	0	1	5	3	
	2002	105	16	0	14	2	0	
	2003	107	94	8	78	8	0	8-Cascade Hatchery
	2004	0	0					
				2.91%	51.65%	33.99%	11.46%	

[a] *Recoveries from August-October fisheries*

Table 3.12. Stock composition of chinook salmon harvested in select area fall [a] commercial fisheries based on coded-wire tag recoveries, 1996-2005.

					Below Bonneville			
						SAFE		
Fishery	Year	Harvest	Total Recoveries	Above Bonneville	Non-SAFE	Local	Non-Local	Origins of above Bonneville Dam recoveries
Youngs Bay	1996	1,439	113		1	112		
	1997	1,726	317	1	1	315		1- Col. R. @ Turtle Rock
	1998	1,225	323	5	4	312	2	2- Clearwater R., 1- Col. R. general, 2-Snake R.
	1999	1,589	240	1	5	234		1-Lower Snake R.
	2000	1,744	431	14	6	407	4	2-Umatilla R., 6-Snake R., 3-Priest Rapids, 3-Columbia R. general
	2001	2,040	587	27	3	557		14-Lyons Ferry Hat., 6-Ringold Pond, 4-Spring Cr, NFH, 2-Turtle Rock Hat., 1-Umatilla R.
	2002	3,774	1,068	24	22	1,022		20-Lyons Ferry Hat., 2-Hanford Reach, 2-Spring Cr. NFH
	2003	4,271	195	10	3	181	1	2-Klickitat, 2-Snake, 4-SR lower, 2-Spring Cr. NFH
	2004	3,890	176	12	3	159	2	4-SR lower, 1-Klickitat R., 1-Similkameen R., 1-Spring Cr. NFH, 1-Big Canyon Pond, 1-Capt. Johns pond, 3-CR @ Priest R
	2005	4,289	98	7	3	86	2	1-CR @ Priest R., 6-SR lower
			3,548	101	51	3,385	11	
				(2.9%)	(1.4%)	(95.4%)	(0.3%)	
Tongue Point	1996	50	4	1	3			1-Col. R. @ McNary
	1997	180	10	3	3		4	1-Clearwater R., 1-Col. R. near Wells, 1-Snake R.
	1998	421	47	14	6	4	23	2-Spring Cr. NFH, 8-L. Snake R., 2-Iron Gate Hatchery, 1-McNary, 1-Clearwater R.
	1999	339	62	12	2	40	8	3-Clearwater R., 1-Col. R. @ McNary, 1-Little White Salmon Hatchery, 6-Snake R., 1-Yakima R. @ Prosser
	2000	252	43	9	2	12	20	1-Col. R. general, 7-Snake R., 1-Spring Cr. NFH
	2001	116	52	2	2		48	2-Lyons Ferry Hatchery
	2002	1,708	139	30	23		86	15-Lyons Ferry Hat., 5-Sping Cr. NFH, 3-Hanford Reach, 3-Priest Rapids Hat., 3-Umatilla R @ Bonneville, 1-Umatilla Hat.
	2003	2,451	27	7	4		16	2-Klickitat, 2-Little White Salmon, 2-Spring Cr. NFH
	2004	2,124	29	9			20	1-Klickitat R., 3-Spring Cr. NFH, 3-SR lower
	2005	1,919	33	6			27	2-CR @ Priest R., 1-Methow R., 2-SR lower, 1-Spring Cr. NFH
			446	93	45	56	252	
				(20.8%)	(10.1%)	(12.6%)	(56.5%)	

continued

Table 3.12 (continued) Stock composition of chinook salmon harvested in select area fall[a] commercial fisheries based on coded-wire tag recoveries, 1996-2005.

				Below Bonneville				
					SAFE			
Fishery	Year	Harvest	Total Recoveries	Above Bonneville	Non-SAFE	Local	Non-Local	Origins of above Bonneville Dam recoveries
Deep River	1996	35	6		5		1	
	1997	149	15		12		3	
	1998	0						
	1999	48	9				9	
	2000	109	18		5		13	
	2001	149	27		2		25	
	2002	145	53	3			50	3-Lyons Ferry Hatchery
	2003	168	24				24	
	2004	393	48				48	
	2005	364	*(data not available)*					
			200	3	24		173	
				(1.5%)	(12.0%)		(86.5%)	
Blind Slough[b]	1996	82	6		6			
	1997	32	5		3	2		
	1998	103	30		4	24	2	
	1999	167	131	1	1	92	37	1-Lower Snake R.
	2000	132	13		2	3	8	
	2001	793	18	2			16	2-Priest Rapids Hatchery
	2002	2,760	92	5	80		7	2-Hanford Reach, 1-Lyons Ferry Hat., 2-Spring Cr. Hat.
	2003	1,903	2	1		1		Trinity R. H.
	2004	6,235	80	4	3	70	3	1-CR @ Priest R., 1-SR lower, 1-Spring Cr. NFH, 1-Umatilla R.
	2005	2,124	19		3	15	1	
			396	14	100	207	75	
				(3.5%)	(25.3%)	(52.3%)	(18.9%)	
Steamboat Slough[c]	2000	78	4	1	3			1-Lower Snake R.
	2001	0						
	2002	183	11	1	5		5	1-Spring Cr. NFH
	2003	44	*(data not available)*					
			15	2	8	0	5	
				(13.3%)	(53.3%)	(0.0%)	(33.4%)	

[a] *Recoveries from August-October fisheries*
[b] *Includes landings from Knappa Slough "tule" target fisheries*
[c] *No landing since 2004 and 2005*

Table 3.13. Summary of fall chinook harvest impacts during select area commercial fisheries, 1993-2005.

Year	Site	Upriver Bright (URB) Harvest	URB Run Size	URB Harvest Rate	Snake River Wild (SRW) Run Size	SAFE SRW Harvest	SRW Impact %	Lower River Hatchery (LRH) Run Size	SAFE LRH Harvest	LRH Impact %	Lower River Wild (LRW) Run Size	SAFE LRW Harvest	LRW Impact %
1993													
	Youngs Bay	46	102,908	0.045%	1,518	1	0.045%	-	-	-	-	-	-
	Tongue Point	0	102,908	0.000%	1,518	0	0.000%	-	-	-	-	-	-
	Blind Slough	0	102,908	0.000%	1,518	0	0.000%	-	-	-	-	-	-
	All SAFE	**46**		**0.045%**		**1**	**0.045%**	**52,300**	**0**	**0.000%**	**13,300**	**0**	**0.000%**
1994													
	Youngs Bay	0	132,839	0.000%	1,000	0	0.000%	-	-	-	-	-	-
	Tongue Point	0	132,839	0.000%	1,000	0	0.000%	-	-	-	-	-	-
	Blind Slough	0	132,839	0.000%	1,000	0	0.000%	-	-	-	-	-	-
	All SAFE	**0**		**0.000%**		**0**	**0.000%**	**53,600**	**0**	**0.000%**	**12,200**	**0**	**0.000%**
1995													
	Youngs Bay	44	106,459	0.041%	1,328	1	0.041%	-	-	-	-	-	-
	Tongue Point	0	106,459	0.000%	1,328	0	0.000%	-	-	-	-	-	-
	Blind Slough	0	106,459	0.000%	1,328	0	0.000%	-	-	-	-	-	-
	All SAFE	**44**		**0.041%**		**1**	**0.041%**	**46,400**	**0**	**0.000%**	**16,000**	**0**	**0.000%**
1996													
	Youngs Bay	0	143,193	0.000%	1,795	0	0.000%	-	-	-	-	-	-
	Tongue Point	16	143,193	0.011%	1,795	0	0.011%	-	-	-	-	-	-
	Blind Slough	0	143,193	0.000%	1,795	0	0.000%	-	-	-	-	-	-
	Deep River	0	143,193	0.000%	1,795	0	0.000%	-	-	-	-	-	-
	All SAFE	**16**		**0.011%**		**0**	**0.011%**	**75,500**	**2,938**	**3.891%**	**14,600**	**0**	**0.000%**
1997													
	Youngs Bay	4	161,727	0.002%	1,863	0	0.002%		-		-	-	-
	Tongue Point	0	161,727	0.000%	1,863	0	0.000%		-		-	-	-
	Blind Slough	0	161,727	0.000%	1,863	0	0.000%		-		-	-	-
	Deep River	0	161,727	0.000%	1,863	0	0.000%		-		-	-	-
	All SAFE	**4**		**0.002%**		**0**	**0.002%**	**57,400**	**2,220**	**3.868%**	**12,300**	**0**	**0.000%**
1998													
	Youngs Bay	22	141,600	0.016%	779	0	0.016%	-	-	-	-	-	-
	Tongue Point	42	141,600	0.030%	779	0	0.030%	-	-	-	-	-	-
	Blind Slough	0	141,600	0.000%	779	0	0.000%	-	-	-	-	-	-
	Deep River	0	141,600	0.000%	779	0	0.000%	-	-	-	-	-	-
	All SAFE	**64**		**0.045%**		**0**	**0.045%**	**45,300**	**498**	**1.099%**	**7,300**	**0**	**0.000%**
1999													
	Youngs Bay	17	165,900	0.010%	2,495	0	0.010%	-	-	-	-	-	-
	Tongue Point	80	165,900	0.048%	2,495	1	0.048%	-	-	-	-	-	-
	Blind Slough	12	165,900	0.007%	2,495	0	0.007%	-	-	-	-	-	-
	Deep River	0	165,900	0.000%	2,495	0	0.000%	-	-	-	-	-	-
	All SAFE	**109**		**0.066%**		**2**	**0.066%**	**40,000**	**380**	**0.950%**	**3,300**	**0**	**0.000%**
2000													
	Youngs Bay	86	156,600	0.055%	2,756	2	0.055%	-	-	-	-	-	-
	Tongue Point	140	156,600	0.089%	2,756	2	0.089%	-	-	-	-	-	-
	Blind Slough	0	156,600	0.000%	2,756	0	0.000%	-	-	-	-	-	-
	Deep River[a]	1	156,600	0.001%	2,756	0	0.001%	-	-	-	-	-	-
	All SAFE	**227**		**0.145%**		**4**	**0.145%**	**27,000**	**135**	**0.500%**	**10,200**	**0**	**0.000%**
2001													
	Youngs Bay	22	232,500	0.009%	14,469	1	0.009%	-	-	-	-	-	-
	Tongue Point	414	232,500	0.178%	14,469	26	0.178%	-	-	-	-	-	-
	Blind Slough	387	232,500	0.166%	14,469	24	0.166%	-	-	-	-	-	-
	Deep River[a]	0	232,500	0.000%	14,469	0	0.000%	-	-	-	-	-	-
	All SAFE	**823**		**0.354%**		**51**	**0.354%**	**94,300**	**1,193**	**1.265%**	**15,700**	**0**	**0.000%**
2002													
	Youngs Bay	381	277,300	0.137%	3,551	5	0.137%	-	-	-	-	-	-
	Tongue Point	350	277,300	0.126%	3,551	4	0.126%	-	-	-	-	-	-
	Blind Slough	51	277,300	0.018%	3,551	1	0.018%	-	-	-	-	-	-
	Deep River[a]	2	277,300	0.001%	3,551	0	0.001%	-	-	-	-	-	-
	All SAFE	**784**		**0.283%**		**10**	**0.283%**	**156,500**	**3,887**	**2.484%**	**25,200**	**0**	**0.000%**
2003													
	Youngs Bay							-	-	-	-	-	-
	Tongue Point	36	373,200	0.010%	6,892	4	0.010%	-	-	-	-	-	-
	Blind Slough							-	-	-	-	-	-
	Deep River[a]							-	-	-	-	-	-
	All SAFE	**36**		**0.010%**		**4**	**0.010%**	**155,000**	**3,330**	**2.148%**	**26,000**	**85**	**0.327%**
2004													
	Youngs Bay							-	-	-	-	-	-
	Tongue Point	960	363,500	0.264%	na	na	0.264%	-	-	-	-	-	-
	Blind Slough							-	-	-	-	-	-
	Deep River[a]							-	-	-	-	-	-
	All SAFE	**960**		**0.264%**		**na**	**0.264%**	**108,900**	**7,657**	**7.031%**	**22,300**	**0**	**0.000%**
2005[bc]													
	Youngs Bay							-	-	-	-	-	-
	Tongue Point	520	293,400	0.177%	na	na	0.177%	-	-	-	-	-	-
	Blind Slough							-	-	-	-	-	-
	Deep River[a]							-	-	-	-	-	-
	All SAFE	**520**		**0.177%**		**na**	**0.177%**	**78,400**	**na**	**na**	**21,400**	**na**	**na**

[a] *Includes landings for Steamboat Slough*
[b] *Upriver run size and impacts are preliminary*
[c] *Lower river hatchery (LRH) and wild (LRW) run sizes are based on preseason forecasts*

Table 3.14. Minimum estimated harvest of adult salmonids in select area recreational fisheries, 1998-2005.

Year	Species[a]	Youngs Bay	Tongue Point	Blind/Knappa Sloughs	Deep River	Steamboat Slough	SAFE Tributaries[b]	Total
1998	CHS	55						55
	CHF			300			100	400
	COH			18			100	118
	Total	55		318			200	573
1999	CHS	25						25
	CHF			300				300
	COH	59					100	159
	Total	84		300			100	484
2000	CHS	14		121			120	255
	CHF						50	50
	COH			102			100	202
	Total	14		223			270	507
2001	CHS	50		400			50	500
	CHF						150	150
	COH	50		111			100	261
	Total	100		511			300	911
2002	CHS	121	1	430				552
	CHF						500	500
	COH	200		44			100	344
	Total	321	1	474			600	1,396
2003	CHS	51		493			450	994
	CHF						601	601
	COH	300		114	8		350	772
	Total	351		607	8		1,401	2,367
2004	CHS	96		285			700	1,081
	CHF						356	356
	COH		30[c]	50[c]			37	117
	Total	96	30[c]	335			1,093	1,554
2005	CHS	9		81			67	157
	CHF						122	122
	COH			30[c]			46	76
	Total	9		111			235	355

[a] *Species are: spring chinook (CHS); select area bright fall chinook (CHF); coho (COH)*

[b] *SAFE tributaries include Big Creek, Gnat Creek, Youngs River, and Klaskanine River (North and South Forks)*

[c] *Estimated*

Table 3.15. Summary of spring chinook harvest impacts during select area recreational fisheries, 2001-2005.

			Upper Columbia River Spring Chinook										Willamette River Spring Chinook				
Year	Site	Total Harvest[a]	% Upriver Stock	Upriver Run Size	Number Upriver	Upriver Impact %	Snake River Wild Run Size	Number Snake River Wild	Snake River Wild Impact %	Upper CR Wild Run Size	SAFE CR Wild harvest	CR Wild Impact %	% Willamette River Stock[c]	SAFE Willamette River Harvest	Willamette River Run Size[c]	Willamette River Harvest Rate	Number Willamette River Wild
2001[b]																	
	Youngs Bay	50	2.20%	416,500	1	0.000%	60,977	0	0.000%	10,026	0	0.000%	4.54%	2	80,300	0.003%	0
	Tongue Point	0	0.00%	416,500	0	0.000%	60,977	0	0.000%	10,026	0	0.000%	7.71%	0	80,300	0.000%	0
	Blind Slough	400	1.71%	416,500	7	0.002%	60,977	1	0.002%	10,026	0	0.002%	8.18%	33	80,300	0.041%	3
	All SAFE	**450**	**1.304%**		**8**	**0.002%**		**1**	**0.002%**		**0**	**0.002%**	**6.810%**	**35**		**0.044%**	**3**
2002[b]																	
	Youngs Bay	121	5.40%	295,100	7	0.002%	49,004	1	0.002%	5,975	0	0.002%	21.24%	26	121,700	0.021%	3
	Tongue Point	1	1.20%	295,100	0	0.000%	49,004	0	0.000%	5,975	0	0.000%	12.70%	0	121,700	0.000%	0
	Blind Slough	430	3.90%	295,100	17	0.006%	49,004	3	0.006%	5,975	0	0.006%	8.68%	37	121,700	0.031%	4
	All SAFE	**552**	**3.500%**		**23**	**0.008%**		**4**	**0.008%**		**0**	**0.008%**	**14.206%**	**63**		**0.052%**	**6**
2003[b]																	
	Youngs Bay	51	8.20%	208,900	4	0.002%	52,994	0	0.002%	2,602	0	0.002%	12.19%	6	126,600	0.005%	1
	Tongue Point	0	0.00%	208,900	0	0.000%	52,994	0	0.000%	2,602	0	0.000%	11.34%	0	126,600	0.000%	0
	Blind Slough	493	4.83%	208,900	24	0.011%	52,994	6	0.011%	2,602	0	0.011%	2.70%	13	126,600	0.011%	1
	All SAFE	**544**	**4.343%**		**28**	**0.013%**		**6**	**0.013%**		**0**	**0.013%**	**8.743%**	**20**		**0.015%**	**2**
2004																	
	Youngs Bay	96	0.00%	193,400	0	0.000%	33,008	0	0.000%	3,213	0	0.000%	7.00%	7	143,700	0.005%	1
	Tongue Point	0	0.00%	193,400	0	0.000%	33,008	0	0.000%	3,213	0	0.000%	0.00%	0	143,700	0.000%	0
	Blind Slough	285	2.80%	193,400	8	0.004%	33,008	1	0.004%	3,213	0	0.004%	3.30%	9	143,700	0.007%	1
	All SAFE	**381**	**0.933%**		**8**	**0.004%**		**1**	**0.004%**		**0**	**0.004%**	**3.433%**	**16**		**0.011%**	**2**
2005																	
	Youngs Bay	9	0.00%	106,900	0	0.000%	13,064	0	0.000%	2,474	0	0.000%	11.70%	1	61,000	0.002%	0
	Tongue Point	0	0.00%	106,900	0	0.000%	13,064	0	0.000%	2,474	0	0.000%	0.00%	0	61,000	0.000%	0
	Blind Slough	81	0.00%	106,900	0	0.000%	13,064	0	0.000%	2,474	0	0.000%	1.10%	1	61,000	0.001%	0
	All SAFE	**90**	**0.000%**		**0**	**0.000%**		**0**	**0.000%**		**0**	**0.000%**	**4.267%**	**2**		**0.003%**	**0**

[a] *Harvest does not inlcude fish caught in SAFE tributaries*
[b] *Percent upriver stock based on commercial VSI data*
[c] *Percent Willamette stock based on commercial CWT data.*

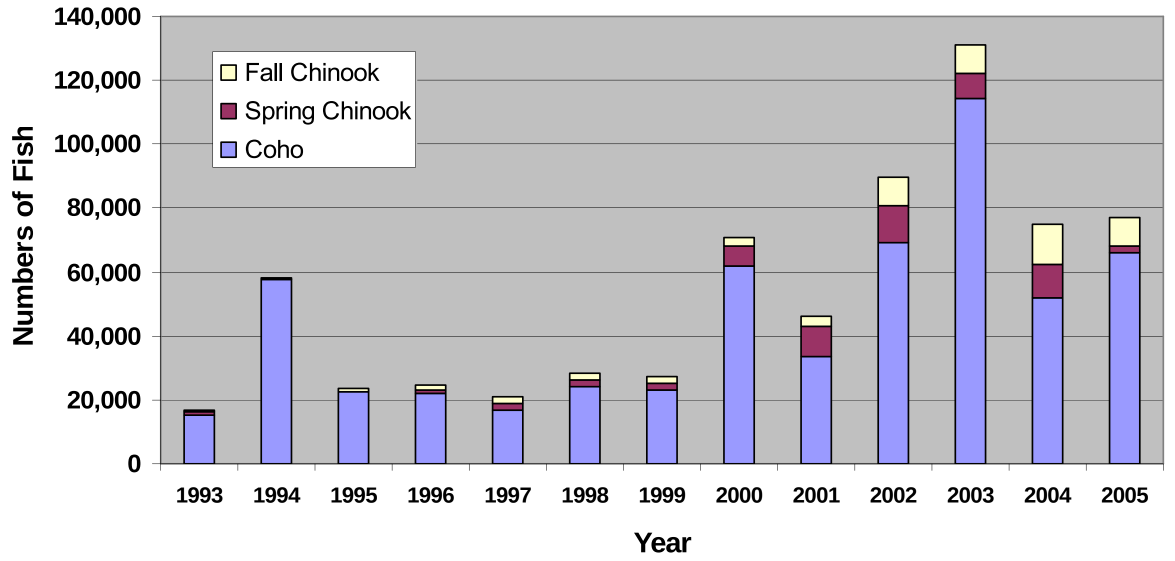


Figure 3.1. Combined annual salmonid harvest in Select Area commercial fisheries, 1993-2005.

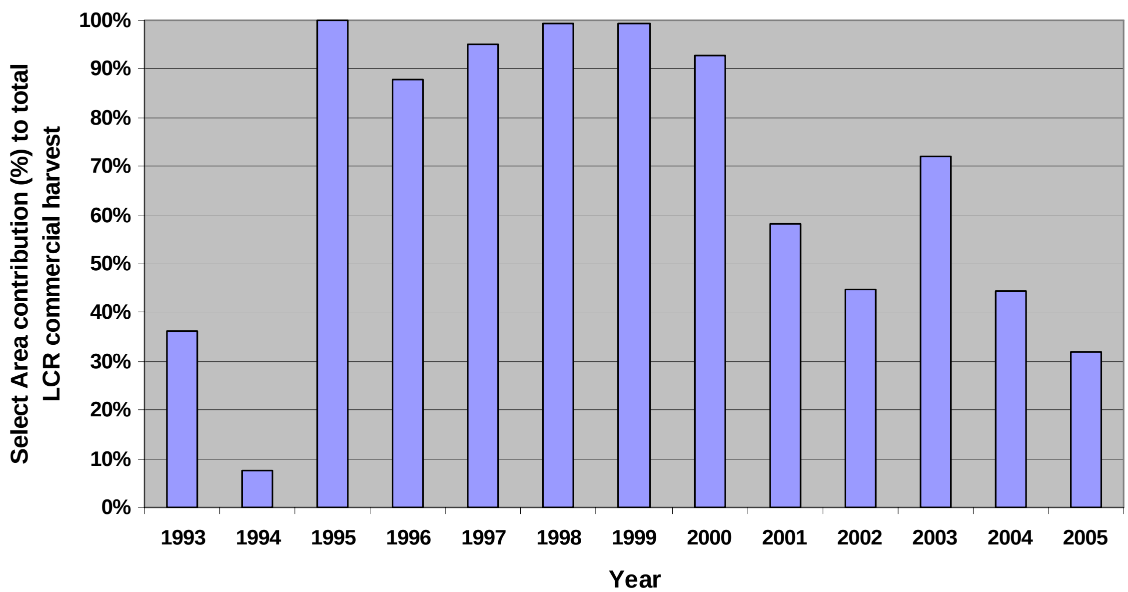


Figure 3.3. Contribution of chinook harvest in Select Area winter-summer commercial fisheries to the total lower Columbia River (LCR) non-Indian spring chinook commercial harvest, 1993-2005.

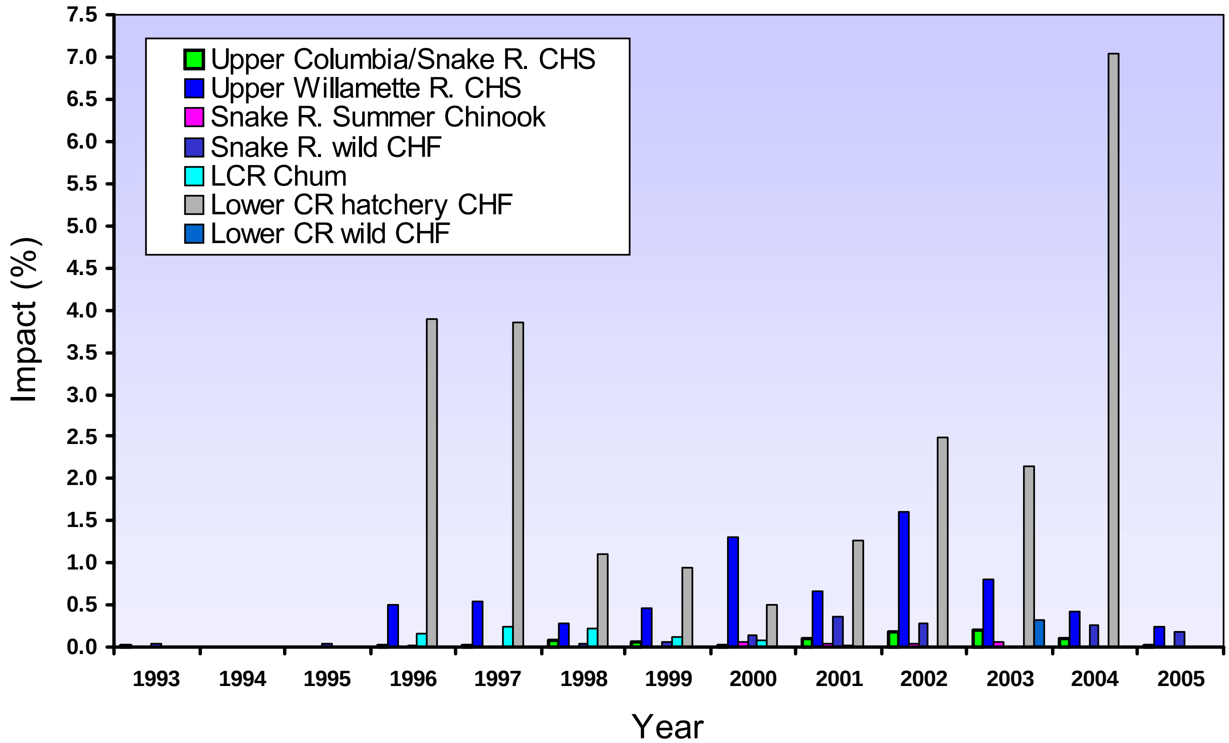


Figure 3.5. Impact rates on ESA-listed stocks in Select Area commercial fisheries, 1993-2005. 2004-2005 data is preliminary.

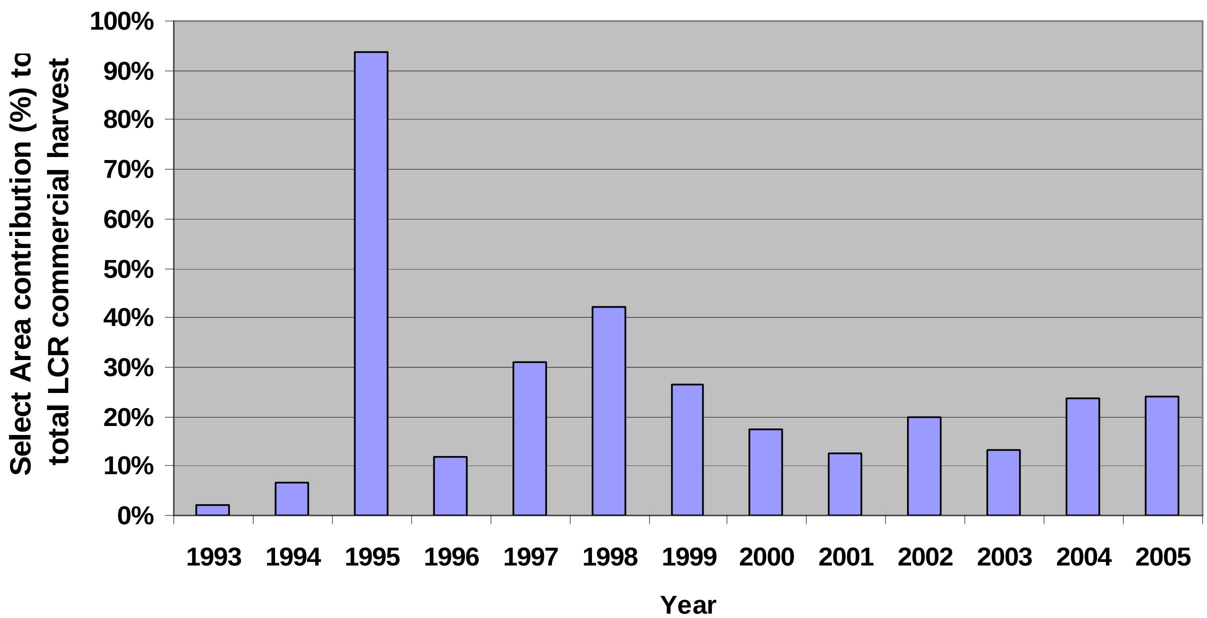


Figure 3.6. Contribution of fall chinook harvest in Select Area commercial fisheries to the total lower Columbia River (LCR) non-Indian commercial fall chinook harvest, 1993-2005.

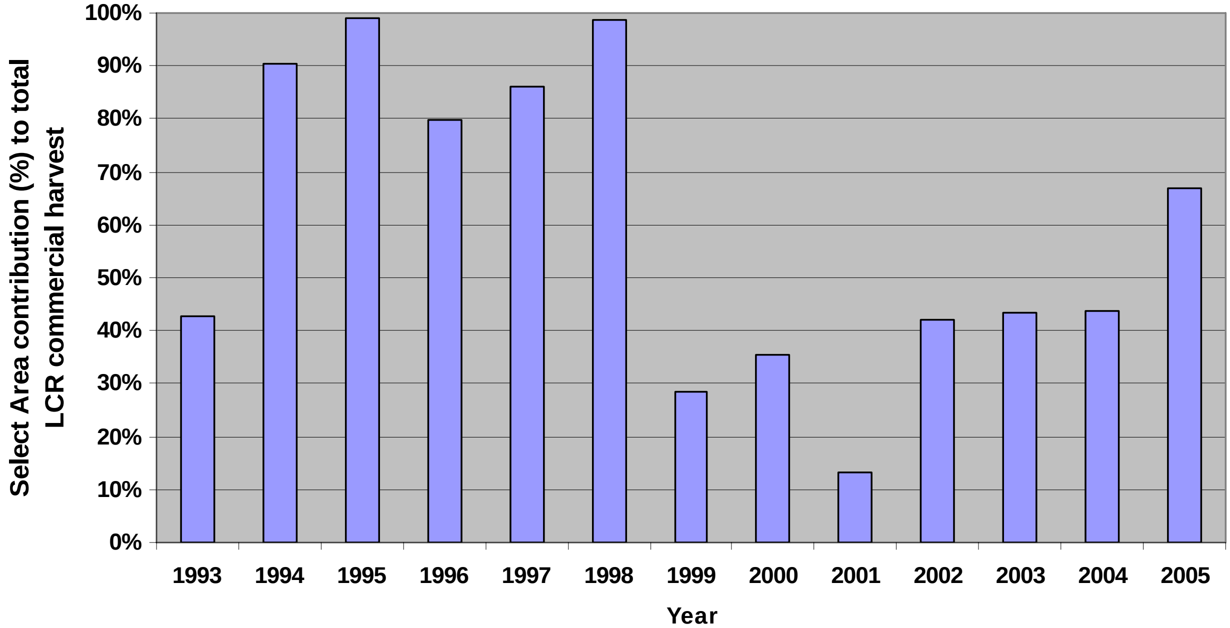


Figure 3.7. Contribution of coho harvest in Select Area commercial fisheries to the total lower Columbia River (LCR) non-Indian commercial coho harvest, 1993-2005.

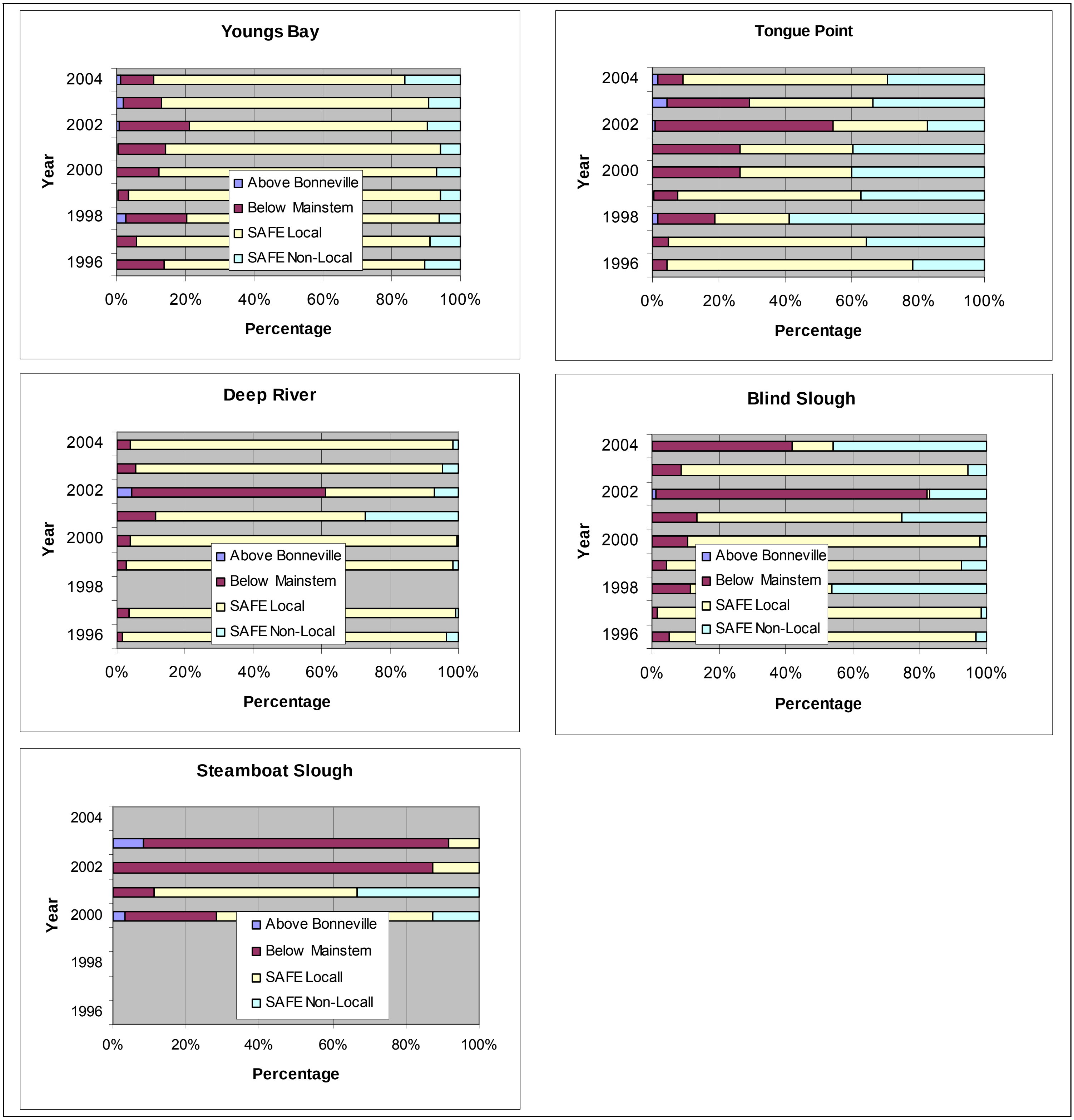


Figure 3.8. Stock composition of select area commercial coho harvest by site, 1996-2004.

4. TEST FISHING

Test fishing has played an important role in development of SAFE fisheries and continues to be used for in-season management and research as needed. Development of fisheries and seasons in all select areas was based on extensive test fishing prior to, and sometimes concurrent with, adoption of all new sites and seasons to determine if, when, and at what level, non-target stocks were present in each potential fishing area (Table 4.1). Test fishing was conducted throughout the timeframe that non-target stocks could potentially be present to establish baseline stock compositions in each site. Sampling was conducted at different locations within each fishing area to determine the best potential fishing boundaries for each site and season to minimize handle of non-target stocks. The initial season at each new site was based on test fishing results but 100 percent sampling of the catch continued for several years through mandatory catch inspection requirements to ensure the fisheries performed as predicted. Based on both pieces of information, the duration and boundaries for each site and season were adjusted in subsequent years to maximize fishing opportunity while minimizing non-target handle.

Test fishing has been conducted by both contracted and volunteer local fishermen, who are accompanied by experienced agency staff as observers. Data collected includes net type and configuration, set location, sampling effort, biological data of the catch (length, condition, marine mammal damage, mark type, VSI, scale samples, and CWT recoveries), and water condition (temperature and clarity). Catch rates are converted to a standardized unit (catch per hour of 100 fathoms of net) for intra- and inter-site comparisons. During winter and spring test fishing, visual stock identification is used to classify “lower-river” and “upriver” spring chinook. This provides for larger sample sizes since not all fish are coded-wire tagged and also allows for live release.

Recently, test fishing has been used periodically as a tool to determine time-specific stock compositions in SAFE sites to ensure proposed seasons will not impart excessive impacts to listed species. Additionally, test fishing has been used as a means to increase recovery of CWT’s from release groups for evaluation of rearing strategies. All test fishing is conducted following ESA-mandated guidelines of allowable impacts to listed stocks. Recent test fishing has incorporated live-capture gear (tangle nets and recovery boxes) to minimize impacts.

Table 4.1. Summary of select area test fishing activities, 1994-2005.

Year	Season	Date	Area[a]	Effort (drifts)	Purpose
1994	Spring	4/20/-6/2 4/25-5/31	TP, BS, CC, WS, DR/GB, SS, CCh	128	Assess harvest potential in selected sites; catch and timing of non-target stocks, variation in gear type, establish fishing area boundaries
1994	Fall	9/21-10/31	TP, BS, CC, WS, DR/GB, SS, CCh	124	Same as above
1995	Spring	4/25-5/1	TP, BS, CC, WS, DR/GB, SS, CCh	129	Same as above
1995	Fall	9/20-10/26	TP, BS, CC, WS, DR/GB, SS, CCh	126	Same as above
1996	Spring	4/24-5/31	TP, BS, SC, PC, CC, WS, DR/GB, SS, CCh	155	Same as above
1996	Fall	9/23-10/31	YB, TP, SC, PC, BS, CC, DR/GB. SS, WS	77	Same as above plus added smaller meshes to collect coho jacks from 1993 brood SAFE releases. Also used large-mesh nets to evaluate bycatch rate of sturgeon
1997	Summer	7/8-7/24	YB	19	-Determine SAB and non-local stock abundances -Evaluate ability to hold adults in net pens
1997	Fall	9/3-10/2	SC, PC	?	-Determine coho jack abundances -Adult coho fishing assessment
1997	Fall	9/23-11/1	YB, TP, BS, CC, WS, DR, SS	many	-Determine stock abundances and type by time and area
1998	Summer	6/17-7/8	YB	19	-Determine SAB and non-local stock abundances
1998	Fall	9/17-10/9	YB, TP, BS, DR	28	-Determine stock abundances and type by time and area
1999	Spring	3/18-4/23	YB (below 101 bridge), PC	59	-Determine the potential for development of spring chinook fisheries

continued

Table 4.1. (continued) Summary of select area test fishing activities, 1994-2004.

Year	Season	Date	Area[a]	Effort (drifts)	Purpose
1999	Fall	11/2-11/30	YB	30	-Determine the feasibility of establishing a late-run fall chinook fishery
1999	Fall	9/17-10/1	TP, BS	14	-Determine coho jack abundances -Adult coho fishing assessment
2000	Spring	3/20-5/30	YB, PC, DR	51	-Determine the potential for development of spring chinook fisheries
2003	Summer	9/6-18	YB (Youngs, Klaskanine river confluence)	37	-Determine the potential for collecting SAB broodstock to maximize egg production
2004	Spring	4/6-7	YB (above old Hwy 101, BS	21	-Determine stock composition prior to adopting additional early-spring season fishing periods
2005	Spring	4/26-5/25	TP	30	-Recover age-3 and age-4 adult returns of experimental releases of spring chinook from the John Day and MERTS sites.

[a] *Areas include: Youngs Bay (YB), Blind Slough (BS), Tongue Point (TP), South Channel (SC), Prairie Channel (PC), Clifton Channel (CC), Cathlamet Channel (CCh), Wallace Slough (WS), Deep River (DR), Grays Bay (GB), and Steamboat Slough (SS).*

5. RUN RECONSTRUCTION

Survival and homing/straying rates based on run reconstructions were calculated using the RMIS coded-wire tag database (www.rmis.org) managed by the PSMFC (www.psmfc.org). For each tag group, all regional CWT recoveries including hatchery and spawning ground escapement and harvest in fisheries were combined to determine total SAR's. Adult returns were categorized by area of recovery to determine contribution to the various regional fisheries and to separate detrimental straying from returns to natal streams. Survival rates of chinook salmon were calculated separately for sub-adults (jacks) and adults based on age-specific CWT recoveries. Unless otherwise noted, survival rates represent smolt-to-adult rates and do not include jack survival.

The following is from the draft Regional Overview of Coded-Wire Tagging of Anadromous Salmonid and Steelhead in Northwest America (Johnson, update from 1989 to 2004) provides additional detail regarding methods used for expansion of CWT recoveries:

Recovery Estimation Equations

The total number of fish from a particular release group that are caught in a particular area (or landed at a particular port) during a particular time period can be estimated in a two-step, process. The first step is to estimate the number of tagged fish in the fishery sample for that area (or port) and time:

$$R_T = aR_O;$$

R_T = the estimated total recoveries of tags bearing the release group's code;
R_O = the observed number of tags of the appropriate code;
a = a sampling expansion factor: (total catch)/(sampled catch).

The second step is to account for the fraction of the release group that was tagged:

$$C = bR_T;$$

C = the total estimated contribution of the release group to the fishery in that area at that time;
b = a marking expansion factor: (total fish released)/(total fish marked).

These are the simplest forms of the recovery expansion equations. Typically, the sampling expansion factor is adjusted to account for biases introduced by snouts with no tags, snouts sampled but not taken, lost snouts, and lost tags. Similar expansions are conducted for CWT's recovered during carcass surveys in tributaries and from hatchery sampling.

Upon completion of this process, the recovery agency forwards the observed and estimated tag recovery data and associated catch and sample data on magnetic tape to the Mark Center. The Mark Center checks the data for errors and works with the recovery agency to resolve discrepancies. Once validated, the CWT data (preliminary or final) are combined with those of other recovery agencies in the online CWT database.

All sampling and recovery data from commercial and recreational fisheries, stream surveys and hatcheries are collected and analyzed on the basis of statistical weeks, beginning on Monday and ending on Sunday. The first statistical week of the year ends on the first Sunday of the calendar year, and the weeks are numbered sequentially thereafter. This system is identical to that used by WDFW.

It is important to note that determining survival and straying is a lengthy process. The life history pattern of salmon (up to six years for chinook) inherently delays this process. In addition, reporting agencies require a substantial amount of time to collect, process, and report CWT recovery data to RMIS. Therefore the RMIS database is continually updated as new information becomes available from the individual reporting agencies. For these reasons, final recoveries of all age classes of a study group may not be accessible for up to six years post-release.

SPRING CHINOOK

Results for spring chinook included in this report are based on recoveries of 9,296 coded-wire tags recovered from 77 CWT study groups released between 1990 and 2002 (1988-2000 brood years) from SAFE production facilities; including 31 tag groups released from net pens in Youngs Bay, 24 tag groups from Blind Slough, 10 tag groups from Tongue Point, 7 groups from Deep River, and 5 CWT groups released from CEDC's SF Klaskanine facility. Of these, 69 CWT groups were released between 1996 and 2002 (1994-2000 brood years) resulting in recovery of 8,141 individual coded-wire tags from returning adults. These data are used for comparison with tag recoveries of up to 65 spring chinook CWT groups (1994-2000 brood years) released from five ODFW Willamette Basin hatcheries (Clackamas, Marion Forks, McKenzie, Santiam and Willamette). These same data are used for survival comparisons between SAFE sites; however, analysis is confounded somewhat since fish were not released from all sites in all years.

Average annual survival rates of SAFE spring chinook (1988-2000 brood years) based on CWT recoveries of 77 tag groups fluctuated widely within and between release locations (Table 5.1). During this period, survival rates for individual CWT groups ranged between 0.004-2.83 percent and averaged 0.82 percent. Average annual site-specific survival rates ranged between 0.02-1.84 percent. Survival of spring chinook released from SAFE net pens averaged 0.86 percent (1990-2000 broods) based on recoveries of 72 CWT groups and 0.26 percent for 5 CWT groups (1988-1995 brood years) released from the SF Klaskanine Hatchery (Table 5.1; Figure 5.1).

For 1994-2000 brood years when spring chinook were released from most SAFE facilities, releases from Blind Slough (24 CWT groups) and Youngs Bay (26 CWT groups) had the highest average adult survival (1.00 and 0.88 percent) and returns from South Fork Klaskanine River (2 CWT groups) releases were the poorest (0.03 percent; Table 5.2). However, SF Klaskanine Hatchery releases were discontinued after 1997, so the poor survival rates for this site are likely an artifact of poor ocean conditions in the mid 1990's. The average adult survival for Deep River releases during this timeframe (1996-2000 broods) was 0.73 percent based on recovery of 7 CWT groups. The average survival for 10 CWT groups released from Tongue Point (1994-1998 brood years) was 0.64 percent. Average survival for 67 spring chinook CWT groups released from net pens during this period averaged 0.86 percent. This compares favorably with the average survival rate of 0.76 percent for 65 tag groups released during the same time period from the aforementioned Willamette Basin hatcheries. During this timeframe, only releases from Clackamas Hatchery exhibited an average survival rate higher than SAFE net-pen releases (Figure 5.2).

Oceanic conditions appear to strongly influence survival of yearling spring chinook with good survival more likely during years of a low 12-month post-release average Pacific Decadal Oscillation (PDO) index (Mantau 1997). Discrepancies to this trend were only apparent for fish released in 1992, 1994, and 2002 (Figure 5.3).

As intended, the majority (72.9 percent) of SAFE spring chinook were harvested in SAFE commercial fisheries based on recoveries of 69, 1994-2000 brood tag groups (Table 5.2; Figure 5.4). Of these recoveries, 87.7 percent were harvested in commercial fisheries; 3.5 percent were harvested in sport fisheries, with the balance (8.8 percent) escaping harvest. In comparison, spring chinook released from Willamette River Basin hatcheries were most likely to escape harvest (61.5 percent) with similar contributions to commercial (16.9 percent) and recreational fisheries (21.6 percent), based on CWT recoveries of 55 CWT groups released from 1996-2002 (Table 5.2). Adult returns from Youngs Bay releases had the highest contribution to commercial fisheries (93.6 percent) followed by Blind Slough (86.4 percent), Tongue Point (72.5 percent), and Deep River (69.1 percent). Production from SAFE facilities contributed far less (3.5 percent average) to inland recreational fisheries than did Willamette Basin hatchery releases (20.8 percent), most likely a result of SAFE adult returns leaving the mainstem Columbia River prior to being exposed to significant sport fisheries. The average escapement rate of adult spring chinook returning to the Willamette Basin (61.5 percent) was 700 percent higher than for comparable SAFE production (8.8 percent; Figure 5.5). Youngs Bay releases exhibited the lowest escapement rates (5.2 percent) followed by Blind Slough (6.2 percent), Tongue Point (22.1 percent), and Deep River (25.9 percent). The low escapement rates observed for Youngs Bay and Blind Slough are desirable since a primary goal of the SAFE project is to maximize harvest of local stocks in order to achieve the greatest economic value of the project while minimizing impacts of the program.

Homing of SAFE spring chinook was generally good based on adult recoveries from the 69, 1994-2000 brood CWT groups, but varied considerably between the four sites releasing this stock. The average stray rate for all sites combined averaged 7.8 percent with only 0.18 percent straying to areas above Bonneville Dam (Table 5.2). Adults returning to Blind Slough exhibited the lowest straying rate (3.6 percent) followed by releases from Youngs Bay (4.6 percent), Deep River (19.1 percent), and Tongue Point (22.1 percent). Fortunately, most (72.1 percent) of all SAFE spring chinook strays and the vast majority (84.3 percent) from Oregon sites were recovered at Big Creek Hatchery rather than in systems with endemic spring chinook stocks. The proportion of strays from each site that were recovered at Big Creek Hatchery was highest for releases from Tongue Point (87.5 percent) followed by Youngs Bay releases (79.4 percent) and Deep River releases (8.2 percent). Adults returning to Big Creek Hatchery from Blind Slough releases were not considered strays since the mouth of Big Creek is very close to Blind Slough. Straying of SAFE spring chinook to Big Creek Hatchery does not present a conservation risk since all spring chinook returning to this facility are trapped and either released in the Blind Slough site for potential harvest or sacrificed. Discounting adult returns to Big Creek Hatchery, only 2.2 percent of all adult spring chinook returning from 1996-2002 SAFE releases strayed to areas or basins not associated with the release site, which is similar to the average stray rate (1.6 percent) of Willamette Basin releases during the same period (Table 5.2).

The age structure of SAFE spring chinook was comprised of nearly all (99.1 percent) age 4-5 fish based on aging of scales collected during sampling of adults recovered from regional fisheries, stream surveys, and hatchery returns during 1994-2003 and subsequently corrected when needed with CWT data (Table 5.3). Most fish returned at age-4 (55.4 percent), with 43.7

percent returning as 5-year olds, and a few age-3 (0.5 percent) and age-6 (0.4 percent) fish. The correlation of paired jack and adult survival rates of 77 CWT groups was poor (R^2=0.129) (Figure 5.6).

COHO

Each year throughout the study period a representative CWT group (usually 25,000-30,000) was included at each net-pen site, as was the practice at all hatcheries in the Columbia River Basin. Additional tag groups may have been applied to study groups at various times, but the fish reared utilizing a standard set of practices agreed to by all parties, were monitored through the representative CWT groups (Table 2.4). For 1993-2000 brood year coho, 54 tag groups were monitored; from single or double annual releases at Tongue Point, Blind Slough, Deep River and Steamboat Slough; to multiple releases at Youngs Bay where more fish were reared and experimentation was concentrated.

Percent survival (total expanded recoveries / total CWT releases) of the representative study groups provides a reference for relative success of each annual release. In general, the 1993-2000 mean survival ranged from a low of 1.5 percent at Blind Slough to a high of 3.8 percent at Steamboat Slough, where brood years 1997-2000 were observed. Total CWT accountability for all representative tag groups is shown in Tables 5.4 and 5.6. Survival varied substantially among 1993-2000 brood releases with reduced returns occurring at all sites in 1994, 1995 and 1999 (Figure 5.7); however, survival generally improved over time.

Relative success of SAFE releases compared to hatchery production groups is shown in Figure 5.8. For all Columbia River hatcheries releasing early-run coho salmon, survival rates were calculated for the same years as with SAFE sites (Table 5.5). Overall, SAFE sites averaged 2.4 percent survival while Columbia River hatcheries averaged 1.9 percent (Figure 5.8). Of the ten hatcheries examined, average survival ranged from 1.0 percent at Elochoman River Hatchery to 2.5 percent at North Toutle Hatchery.

The contribution of 1993-2000 brood SAFE and representative hatchery coho to regional fisheries and escapement is compared in Figures 5.9, 5.10, 5.11 and 5.12. Releases from Youngs Bay, Blind Slough and Deep River performed similarly. For these sites the vast majority of CWT's were accounted for in a SAFE fishery (74.5-79.4 percent), about 22.2 percent caught in other fisheries, and an average of 1.4 percent in escapement. At Tongue Point 41.2 percent were harvested in SAFE fisheries, 56.3 percent in non-SAFE fisheries, and 2.5 percent escaped harvest. This decrease in SAFE harvest is mostly a reflection of overlapping harvests between mainstem Columbia gillnet fisheries and that SAFE site. For Steamboat Slough, an average of 12.1 percent were harvested in SAFE fisheries, 54.6 percent in non-SAFE fisheries, and 33.3 percent escaped. This slough is open-ended and its water was apparently not unique enough to attract returning adults to the local fishery, but instead fish returned to the Elochoman Hatchery where they had originated. Though the releases survived at rates higher than any other site (Figure 5.8), the site has been discontinued due to the poor performance of its fishery. Excluding Steamboat Slough and SF Klaskanine Hatchery, and average of 98 percent of adult SAFE coho were harvested in regional fisheries. A much larger percentage of Columbia River hatchery fish contributed to escapement (67 percent) than to harvest (33 percent).

As mentioned earlier, insufficient harvest of SAFE coho releases over a four brood period at Steamboat Slough resulted in the closure of that site. However, by comparing survival and fishery contributions of coho released from Steamboat Slough and Elochoman Hatchery, the benefit of net-pen production is apparent. The fish reared at each site originated at Elochoman

Hatchery and were subjected to identical rearing practices prior to release. They were separated for the 4-6 months prior to smoltification. Figure 5.13 shows 1997-2000 brood survivals at each site. Net-pen survivals averaged 3.8 percent, while hatchery survivals averaged 1.6 percent. In all major categories of survival (ocean harvest, Columbia River harvest, and escapement) the pens at least doubled those of the hatchery. Based on this comparison, net pens have the potential for increasing production at more than SAFE fishery sites.

FALL CHINOOK (SAB)

Results for SAB fall chinook included in this report are based on recoveries for 46 CWT study groups released between 1990 and 2001 (1989-2000 brood years) from SAFE net pens; 12 CWT groups released from 1992-1996 at Big Creek Hatchery, 11 CWT groups released from Klaskanine Hatchery between 1996 and 2001, and 4 CWT groups released from the SF Klaskanine Hatchery between 1986 and 1988. Recovery data for the 2000 brood year is incomplete but is included herein and will be updated in future reports.

Survival rates of 1985-2000 brood year SAB fall chinook varied substantially between release sites and year (Table 5.7; Figure 5.14). Many factors probably affect these results including different production years, completeness of CWT recoveries, river and ocean conditions, size at release, release timing and location, and health of released smolts. Due to programmatic changes, little opportunity exists to compare sites within years. Of the land-based facilities that have reared SAB fall chinook, releases from the South Fork and Klaskanine hatcheries had the highest average survival rates (1.18 and 1.22 percent, respectively). The average survival of smolts released from Big Creek Hatchery was 0.58 percent but releases from this site occurred during years of poor ocean conditions. During 1996-2001 when SAB releases occurred annually from both Klaskanine Hatchery and from Youngs Bay net pens, average annual survival rates were similar (1.22 and 1.29 percent, respectively) for both release locations with significant increases in survival observed for both sites beginning with the 1998 brood class (Figure 5.15). It is unclear what variable mostly influences survival rates of SAB fall chinook, although it appears oceanic conditions may have a significant influence. Based on CWT recoveries for 1986-2001 (1985-2000 broods) SAB releases, survival rates were inversely related to the 12-month post-release PDO index with the highest survival rates nearly always occurring during periods of a low PDO and poorer survival generally occurring during years with a high PDO index value (Figure 5.16).

SAB fall chinook contribute substantially to a variety of regional fisheries (Figure 5.17; Table 5.8). Based on run reconstructions of 37 CWT groups released from SAFE Youngs Bay net pens, an average of 85.6 percent of the returning SAB adults are harvested in commercial fisheries and 11.4 percent are harvested in recreational fisheries, with only 3.0 percent escaping harvest. An average of 41.7 percent of adult SAB returns from Youngs Bay net pens are harvested in SAFE commercial fisheries. When SAB production from Youngs Bay net pens and Klaskanine Hatchery are considered, the average percentage of returning adults harvested in commercial fisheries decreases to 74.7 percent, with recreational harvest and escapement percentages increasing to 17.0 and 8.3 percent, respectively (Figure 5.18). In either case, a surprisingly high percentage (22.3-24.9 percent) of the total adult SAB returns for this period were harvested in ocean troll fisheries; however, many user groups and fisheries benefit from select-area releases of this stock. For example, of the total SAB return in 2003, an estimated 3,045 fish were harvested in SAFE fisheries; 3,001 were landed in ocean troll fisheries; 2,338 in the Columbia River gillnet fishery, 1,838 in Columbia River sport fisheries, 933 in ocean recreational fisheries, and 637 in SAFE recreational fisheries.

Straying of SAB fall chinook has been an issue in the past, even jeopardizing compliance with ODFW's wild fish policy (Chilcote et al. 1992) and federal ESA recovery plans. Significant escapement of Big Creek Hatchery releases to natural fall chinook spawning areas in LCR Washington tributaries prompted relocation of the broodstock program to Klaskanine Hatchery. Stray rates of 33.0 percent and 25.9 percent; with 10.9 percent and 9.2 percent occurring in natural spawning areas, were documented in 1994 and 1995, respectively, when the broodstock program operated out of Big Creek Hatchery.

Based on adult tag recoveries from 60 CWT study groups, relocating Big Creek SAB releases and broodstock production to Youngs Bay net pens and the Klaskanine Hatchery, respectively, has been an overwhelming success (Table 5.8). The transfer resulted in a significant reduction in straying with only 0.7 percent of the adult returns from 1995-2000 brood releases released from Klaskanine Hatchery straying, compared to 13.8 percent for 1992-1996 Big Creek releases. Straying of adult returns from 1991-2000 brood releases from Youngs Bay net pens was also very low at 1.8 percent. In addition, the economic value of these fish was greatly increased by shifting SAB production to Youngs Bay where higher harvest rates can be achieved. Based on coded-wire tag recoveries, 88.6 and 96.9 percent of adult returns to Klaskanine Hatchery and Youngs Bay net pens were harvested compared to only 45.9 percent harvest rates for Big Creek SAB releases. Interestingly, local escapement (defined as unharvested returns to natal tributaries and hatcheries) for Youngs Bay net pen releases was considerably lower (1.3 percent) than for Klaskanine Hatchery releases (10.7 percent), even though returning adults for both cohorts migrated through the Youngs Bay commercial fishery. This difference indicates net-pen fish hold within the fishing area longer than fish released farther upstream, thereby increasing their vulnerability to capture.

Straying above Bonneville Dam was the same for production from Big Creek Hatchery and Youngs Bay net pens (0.4 percent, but dropped to 0.0 percent for releases from Klaskanine Hatchery. Straying within the LCR was also reduced significantly from an average rate of 13.4 percent for 1991-1995 brood Big Creek Hatchery releases to ≤1.4 percent for releases from both Youngs River Basin sites (Table 5.8).

The age structure of SAB fall chinook, based on scales collected from adults returning during 1994-2003, indicates age-3 (39.1 percent) and age-4 fish (47.0 percent) are the most abundant age classes (Table 5.3). Age-2 jacks comprised 9.8 percent of returning fish with smaller numbers of age-5 (3.9 percent) and age-6 (0.2 percent) also present. The correlation between survival of jack and adult SAB's was positive but weak (R^2=0.457; Figure 5.19).

FALL CHINOOK (URB)

A total of five CWT study groups of URB fall chinook were released from 1995-1998 at the Youngs Bay and Tongue Point net-pen sites. Adult survival rates were generally poor, ranging from 0.01 percent to 0.37 percent, and averaging 0.11 percent.

The vast majority (90.5 percent) of adult returns from SAFE URB fall chinook releases were harvested in commercial fisheries, primarily in the mainstem Columbia River gillnet fishery (53.7 percent). An additional 13.6 percent were harvested in ocean commercial fisheries with only 25.4 percent harvested in SAFE fall gillnet fisheries. The remaining 7.3 percent of returning adults were either harvested by sport fisheries (1.4 percent) or escaped harvest and were recovered at hatcheries (3.1 percent) and in tributaries (2.5 percent).

This stock did not appear to acclimate very well to the SAFE release sites, resulting in excessive straying. This may have been exacerbated since the only two tag groups that survived very well were both released at Tongue Point where homing for chinook stocks has been less than ideal. Approximately 2.8 percent of the combined adult returns for these tag groups were recovered above Bonneville Dam, a rate significantly higher than observed for other SAFE chinook releases. The SAFE project does not intend to use this stock in the future.

The age structure of URB fall chinook, based on freshwater recoveries of three CWT groups, consisted primarily (74.3 percent) of age-4 adults, followed by age-3 (22.2 percent), age-5 (2.5 percent), and age-2 (1.0 percent) fish (Table 5.3).

Table 5.1. Smolt-to-adult[a] survival rates (%) of 77 spring chinook coded-wire tag (CWT) groups[b] released from select area production facilities, 1988-2000 brood years.

	Production Site				
Brood Year	S. Fork Klaskanine	Youngs Bay Net Pens	Tongue Point Net Pens	Blind Slough Net Pens	Deep River Net Pens
1988	1.14				
1989					
1990		0.81			
1991					
1992	0.02	0.36			
1993	0.06	0.68			
1994	0.02	0.16	0.07	0.11	
1995	0.04	0.10	0.22	0.26	
1996		1.49	0.75	0.40	0.02
1997		1.21	0.94	0.77	1.17
1998		0.92	1.22	1.84	
1999		1.53		1.01	0.36
2000[c]		0.52		1.19	1.01
1988-00 average[d]	0.26	0.85	0.64	1.00	0.73
1994-00 average[d]	0.03	0.88	0.64	1.00	0.73

[a] *Does not include smolt-to-jack survival.*
[b] *Excludes eight sub-yearling releases from the South Fork Klaskanine facility and Youngs Bay net pens during 1989-1992*
[c] *Incomplete CWT recovery data*
[d] *Weighted for all CWT release groups within years*

Table 5.2. Summary of smolt-to-adult survival, contribution to fisheries, and straying rates of coded-wire tagged (CWT) spring chinook from select area and Willamette River Basin release sites, 1994-2000 brood years.

	Release Site					
	Youngs Bay	Blind Slough	Tongue Point	Deep River[a]	All SAFE Facilities[b]	Willamette Basin Hatcheries[c]
Brood Years	1994-00	1994-00	1994-98	1996-00	1994-00	1994-00
Number of CWT groups	26	24	10	7	69	65
Average survival rate (%)						
Smolt-jack	0.01	0.02	0.01	0.12	0.03	0.03
Smolt-adult	0.88	1.00	0.64	0.73	0.85	0.76
Total	0.89	1.02	0.65	0.85	0.88	0.79
Fishery contributions (% of total adult return)						
Commercial						
SAFE	81.7%	71.2%	52.5%	22.0%	72.9%	1.8%
Ocean	6.3%	7.9%	6.1%	44.0%	7.4%	12.5%
Columbia River	5.6%	7.3%	13.9%	3.1%	7.4%	2.6%
Total	93.6%	86.4%	72.5%	69.1%	87.7%	16.9%
Recreational						
Ocean	0.1%	0.3%	0.0%	3.8%	0.2%	0.8%
Freshwater	1.1%	7.1%	5.4%	1.2%	3.3%	20.8%
Total	1.2%	7.4%	5.4%	5.0%	3.5%	21.6%
Escapement[d] (straying)	5.2% (4.65%)	6.2% (3.56%)	22.1% (22.07%)	25.9% (19.08%)	8.8% (7.79%)	61.5% (1.60%)
Straying						
Above Bonneville Dam[e]	0.26%	0.33%	0.02%	0.00%	0.18%	0.01%
Below Bonneville Dam[f]	4.39%	3.23%	22.05%	19.08%	7.61%	1.59%
Percent of below Bonneville Dam escapement returning to Big Creek Hatchery (94-00 brood data)	79.4%	na[g]	87.5%	8.2%	72.1%	~0.0%
Straying corrected for returns to Big Creek Hatchery (94-00 brood data)	0.96%	3.56%	2.76%	17.5%	2.17%	1.60%

[a] *Recovery data based on three commercial seasons (2003-2005) in Deep River*.
[b] *Includes two coded-wire tag releases (1994-95 broods) from the SF Klaskanine Hatchery.*
[c] *Survival data based on recoveries of 65 coded-wire tag groups. Fishery contribution based on 55 coded-wire tag groups.*
[d] *Escapement includes recoveries from streams and hatcheries (natal & out-of-system).*
[e] *Includes escapement to hatcheries, streams, and fisheries above Bonneville Dam.*
[f] *Includes non-natal straying to streams and hatcheries not associated with the release site.*
[g] *Blind Slough-origin fish returning to Big Creek Hatchery are considered as natal returns due to proximity of Big Creek to the release site.*

Table 5.3. Average annual age composition of select area chinook stocks sampled from regional fisheries, hatcheries, and stream surveys, 1994-2003.

Select area stock	Expanded fish numbers	Age at return (% of total)				
		2	3	4	5	6
Spring chinook						
(scales)	31,875	0.0	0.5	55.4	43.7	0.4
Rogue River fall chinook (SAB)						
(scales)	52,609	9.8	39.1	47.0	3.9	0.2
Upriver bright fall chinook (URB)						
(coded-wire tag recoveries)	203	1.0	22.2	74.3	2.5	0.0

Table 5.4. Accountability of coho from SAFE project releases at all net-pen sites, 1993-2000 brood years.

				Expanded CWT Recoveries							
					Columbia River						
SAFE Site	BY	CWT Releases	CWT Groups	Ocean	Fisheries	(SAFE)	Hatcheries	Streams	Total	Percent Survival	Hatchery/Stream Location
Youngs Bay	93	28,995	1	59	1,020	-955	0	0	1,079	3.72%	
	94	26,274	1	3	293	-259	3	0	299	1.14%	Big Cr. H. (1), Klaskanine H. (2)
	95	27,198	1	20	374	-349	3	0	397	1.46%	Big Cr. H. (3)
	96	25,672	1	36	640	-546	3	0	679	2.64%	Big Cr. H. (2), Elochoman H. (1)
	97	28,809	1	31	643	-589	3	0	677	2.35%	Big Cr. H. (3), Klaskanine H. (2)
	98	126,357	5	408	2,361	-1,347	27	4	2,800	2.22%	Big Cr. H. (16), Elochoman H. (1) Klaskanine H. (8), Salmon R H. (1) Sandy H. (1), Crooked Cr. (1) Jim Crow Cr. (1), Joe Cr. (1) Paradise Cr. (1),
	99	101,662	4	125	1,931	-1,708	18	0	2,074	2.04%	Big Cr. H. (7), Elochoman H. (1), Klaskanine H. (10), Youngs R. (2)
	00	98,669	4	908	4,974	-3,714	25	3	5,910	5.99%	Big Cr. H. (8), Klaskanine H. (13) Kalama F. H. (3), Elochoman H. (1) Jim Crow Cr. (2), L & C R. (1)
		463,636		1,590	12,236	-9,467	82	7	13,915	2.69%	
Tongue Point	93	26,426	1	57	747	-432	14	0	818	3.10%	Big Cr. H. (13), Elochoman H. (1)
	94	23,942	1	5	202	-116	9	0	216	0.90%	Big Cr. H. (9)
	95	26,174	1	4	124	-117	11	1	140	0.53%	Big Cr. H. (7), Cowlitz H. (1), Elochoman H. (3)
	96	18,355	1	39	694	-310	3	0	736	4.01%	Big Cr. H. (3)
	97	26,269	1	34	376	-245	8	0	418	1.59%	Big Cr. H. (8)
	98	50,950	2	247	1,408	-221	104	12	1,771	3.48%	Big Cr. H. (52), Cowlitz H. (1) Elochoman H. (50), Fallert Cr. H (1) Siletz R. (1), Beaver Cr. (2) Big Cr. (1), Coon Cny. Cr. (1) Duck Cr. (1), Green Cr. (1) Jim Crow Cr. (3), Plympton Cr. (1) Skamokawa Cr. (1)
	99	46,909	2	68	719	-466	15	5	807	1.72%	Big Cr. H. (12), Indian Cr Pd (1) Bear Cr. H. (2), Klaskanine H. (2) Umpqua R. (1), Skamokawa Cr (1) Elochoman R. (1), Bear Cr. (2)
	00	51,794	2	513	1,559	-708	18	1	2,091	4.04%	Big Cr. H. (15), Bonneville H. (1) Elochoman H. (1), Klaskanine H. (1) Big Cr. (1)
		270,819		967	5,829	-2,615	192	19	6,997	2.42%	

continued

Table 5.4. (continued) Accountability of coho from SAFE project releases at all net-pen sites, 1993-2000 brood years.

				Expanded CWT Recoveries							
					Columbia River						
SAFE Site	BY	CWT Releases	CWT Groups	Ocean	Fisheries	(SAFE)	Hatcheries	Streams	Total	Percent Survival	Hatchery/Stream Location
Blind Slough	93	26,258	1	41	468	-445	3	0	512	1.95%	Big Cr. H. (3)
	94	24,942	1	7	314	-246	3	1	325	1.30%	Big Cr. H. (3), Duck Cr. (1)
	95	25,104	1	0	18	-16	0	0	18	0.07%	
	96	24,607	1	10	396	-359	3	0	409	1.66%	Big Cr. H. (3)
	97	26,072	1	28	488	-456	8	0	524	2.01%	Big Cr. H. (8)
	98	24,624	1	49	520	-423	2	1	572	2.32%	Big Cr. H. (2), Mill Cr. (1)
	99	52,073	2	0	2	-2	0	0	2	0.00%	
	00	54,694	2	98	1,177	-869	8	0	1,283	2.35%	Big Cr. H. (8)
		258,374		233	3,383	-2,816	27	2	3,645	1.46%	
Deep River	93	30,535	1	52	426	-399	13	2	493	1.61%	Grays R. H. (13), Deeo R. (1) Grays R. (1)
	94	28,320	1	7	176	-147	8	4	195	0.69%	Grays R. H. (7), Lewis R. H (1), Grays R. (2), Deep R. (1), Duck Cr. (1)
	95	0	0						0		
	96	29,474	1	46	365	-304	7	8	426	1.45%	Big Cr. H. (2), Grays R. H. (5), Gorley Cr. (1), Grays R. (7)
	97	49,566	2	284	2,345	-2,118	63	0	2,692	5.43%	Big Cr. H. (2), Grays R. H. (61)
	98	55,422	2	67	278	-158	17	3	365	0.66%	Grays R. H. (16), Elk R. H. (1) Person Cr. (2), Sisson Cr. (1)
	99	46,530	2	0	37	-25	0	0	37	0.08%	
	00	50,299	2	167	842	723	15	0	1,024	2.04%	Grays R. H. (12), Big Cr. H. (2) Elochoman H. (1)
		290,146		623	4,469	-3,875	123	17	5,232	1.71%	
Steamboat Slough	97	24,248	1	92	268	-72	215	0	575	2.37%	Elochoman H. (209), Grays R. H. (5), Fallert Cr. H. (1)
	98	29,937	1	191	847	-48	525	37	1,600	5.34%	Elochoman H. (521), Big Cr. H. (4) Abernathy Cr (4), Beaver Cr. (7) Duck Cr. (11), Elochoman R. (12) Germany Cr. (1), Jim Crow Cr. (1) Skamokawa Cr. (1)
	99	29,800	1	132	479	-201	255	77	943	3.16%	Elochoman H. (248), Kalama F. H. (6), Big Cr. H. (1), Elochoman R. (71) Abernathy Cr. (3), Duck Cr. (1), Kalama R. (2)
	00	21,225	1	387	268	-148	237	8	900	4.24%	Elochoman H. (235), Big Cr. (2) Elochoman R. (6), Wolson Cr (1) Skamokawa Cr. (1)
		105,210		802	1,862	-469	1,309	45	4,018	3.78%	

Table 5.5. Accountability of early run coho from representative Columbia River hatchery releases, 1993-2000 broods.

				Expanded CWT Recoveries					
					Columbia River				
Hatchery	BY	CWT Releases	CWT Groups	Ocean	Fisheries	Hatcheries	Streams	Total	Percent Survival
Elochoman R.	93	31,149	1	3	5	12	1	21	0.1%
	94	30,568	1	3	1	0	0	4	0.0%
	95	0	0					0	
	96	30,215	1	36	26	172	0	234	0.8%
	97	29,723	1	22	61	89	0	172	0.6%
	98	28,876	1	134	237	449	13	833	2.9%
	99	30,150	1	55	144	188	29	416	1.4%
	00	53,619	2	295	262	212	0	769	1.4%
		234,300	8	548	736	1,122	43	2,449	1.0%
Fallert Cr.	93	31,060	1	14	3	79	0	96	0.3%
	94	30,760	2	4	37	92	0	133	0.4%
	95	27,551	1	5	62	209	9	285	1.0%
	96	28,176	1	48	46	255	3	352	1.2%
	97	29,080	1	27	39	164	0	230	0.8%
	98	30,255	2	172	208	653	13	1,046	3.5%
	99	30,863	1	60	106	354	18	538	1.7%
	00	30,228	1	59	35	308	0	402	1.3%
		237,973	10	389	536	2,114	43	3,082	1.3%
Grays R.	93	29,547	1	17	45	107	2	171	0.6%
	94	28,236	1	0	50	92	3	145	0.5%
	95	0	0					0	
	96	29,907	1	25	37	79	7	148	0.5%
	97	29,339	1	181	352	1,148	0	1,681	5.7%
	98	28,774	1	266	473	615	50	1,404	4.9%
	99	28,835	1	35	90	56	1	182	0.6%
	00	29,971	1	53	65	47	0	165	0.6%
		204,609	7	577	1,112	2,144	63	3,896	1.9%
North Toutle	93	27,967	1	7	4	50	0	61	0.2%
	94	29,734	1	46	35	81	2	164	0.6%
	95	31,056	1	39	118	1,339	6	1,502	4.8%
	96	30,221	1	66	83	276	1	426	1.4%
	97	31,625	1	91	133	689	0	913	2.9%
	98	29,649	2	178	544	438	7	1,167	3.9%
	99	109,613	2	198	392	1,553	10	2,153	2.0%
	00	31,033	2	206	252	846	1	1,305	4.2%
		320,898	11	831	1,561	5,272	27	7,691	2.5%
Lewis R.	93	70,487	1	39	33	528	3	603	0.9%
	94	73,767	1	27	65	281	1	374	0.5%
	95	139,456	2	84	79	913	6	1,082	0.8%
	96	146,588	2	166	151	2,772	13	3,102	2.1%
	97	147,303	2	301	207	3,403	0	3,911	2.7%
	98	148,360	2	741	1,023	7,511	358	9,633	6.5%
	99	148,174	2	95	311	2,639	51	3,096	2.1%
	00	147,686	2	1,027	523	4,629	4	6,183	4.2%
		1,021,821	14	2,480	2,392	22,676	436	27,984	2.5%

continued

Table 5.5. (continued) Accountability of early run coho from representative Columbia River hatchery releases, 1993-2000 broods.

				Expanded CWT Recoveries					
					Columbia River				
Hatchery	BY	CWT Releases	CWT Groups	Ocean	Fisheries	Hatcheries	Streams	Total	Percent Survival
Big Cr.	93	53,842	2	24	64	317	0	405	0.8%
	94	56,067	2	9	69	329	0	407	0.7%
	95	55,351	2	18	100	245	0	363	0.7%
	96	51,133	2	11	90	219	0	320	0.6%
	97	62,827	2	81	320	430	0	831	1.3%
	98	52,280	2	135	697	1,089	7	1,928	3.7%
	99	54,093	2	141	989	787	22	1,939	3.6%
	00	53,974	2	546	799	777	12	2,134	4.0%
		439,567	16	965	3,128	4,193	41	8,327	1.9%
Bonneville	93	51,936	2	30	19	426	0	475	0.9%
	94	48,695	2	8	101	385	2	496	1.0%
	95	56,689	2	24	44	341	0	409	0.7%
	96	44,037	2	30	49	267	0	346	0.8%
	97	51,549	2	58	80	756	1	895	1.7%
	98	53,361	2	376	660	1,800	14	2,850	5.3%
	99	51,359	2	164	215	1,032	42	1,453	2.8%
	00	52,648	2	730	591	1,680	8	3,009	5.7%
		410,274	16	1,420	1,759	6,687	67	9,933	2.4%
SF Klaskanine	93	23,160	1	13	153	58	0	224	1.0%
	94	25,979	1	0	87	43	0	130	0.5%
	95	28,284	1	15	404	69	0	488	1.7%
	96	27,321	1	18	212	34	0	264	1.0%
	97	19,730	1	10	79	11	0	100	0.5%
	98	25,514	1	139	817	204	0	1,160	4.5%
	99	26,176	1	71	642	74	1	788	3.0%
	00	24,285	1	418	1,315	139	16	1,888	7.8%
		200,549	8	684	3,709	632	17	5,042	2.5%
Eagle Cr. NFH	93	58,383	4	15	11	104	0	130	0.2%
	94	45,517	1	4	11	65	0	80	0.2%
	95	72,101	2	42	104	1,383	0	1,529	2.1%
	96	98,259	2	118	98	1,310	0	1,526	1.6%
	97	98,147	2	173	115	3,411	0	3,699	3.8%
	98	46,175	2	95	483	1,097	7	1,682	3.6%
	99	49,043	2	32	101	884	2	1,019	2.1%
	00	50,948	2	309	260	577	1	1,147	2.3%
		518,573	17	788	1,183	8,831	10	10,812	2.0%
Sandy R.	93	107,472	2	30	20	300	0	350	0.3%
	94	222,754	8	22	106	495	1	624	0.3%
	95	159,152	6	52	68	973	1	1,094	0.7%
	96	87,781	3	37	67	172	0	276	0.3%
	97	144,456	4	213	175	1,502	0	1,890	1.3%
	98	126,546	3	754	1,414	2,103	9	4,280	3.4%
	99	150,729	4	517	701	1,000	4	2,222	1.5%
	00	82,566	3	608	511	705	1	1,825	2.2%
		1,081,456	33	2,233	3,062	7,250	16	12,561	1.2%

Table 5.6. Escapement number by recovery location of SAFE coho based on expanded coded-wire tag recoveries, 1993-2000 brood years.

	SAFE Net-Pen Release Site				
Recovery Site	Youngs Bay	Tongue Point	Blind Slough	Deep River	Steamboat Slough
Elochoman Hat.	4	55		1	1,213
Big Cr. Hat.	40	119	27	6	5
Grays R Hat.				114	5
Elochoman R.		1			89
Klaskanine Hat.	35	3			
Duck Cr.		1	1	1	12
Beaver Cr.		2			7
Grays R.				9	
Kalama Falls Hat.	3				6
Abernathy Cr.					7
Jim Crow Cr.	3	3			1
Big Cr.		2			2
Skamokawa Cr.		2			2
Bear Cr.		2			
Bear Cr. Hat.		2			
Cowlitz Hat.		2			
Deep R.				2	
Fallert Cr. Hat.		1			1
Kalama R.					2
Person Cr.				2	
Youngs R.	2				
Bonneville Hat.		1			
Coon Canyon Cr.		1			
Crooked Cr.	1				
Elk R. Hat.				1	
Germany Cr.					1
Gorley Cr.				1	
Green Cr.		1			
Indian Cr. Pd.		1			
Joe Cr.	1				
Lewis & Clark R.	1				
Lewis R Hat.				1	
Mill Cr.			1		
Paradise Cr.	1				
Plympton Cr.		1			
Salmon R. Hat.	1				
Sandy Hat..	1				
Siletz R.		1			
Sisson Cr.				1	
Skamokawa Cr.		1			
Umpqua R.		1			
Wolson Cr.					1

Table 5.7. Smolt-to-adult[a] survival rates (%) of select area bright fall chinook coded-wire tag (CWT) groups released in select area production facilities, 1985-2000 brood years.

	Hatcheries			Net Pens		
Brood Year	South Fork Klaskanine	Klaskanine	Big Creek	Youngs Bay	Tongue Point	Blind Slough
1985	0.74					
1986	0.36					
1987	2.89					
1988						
1989				1.24		
1990						
1991			0.48	0.11		
1992			1.47			
1993			0.54	1.03		
1994			0.32	0.29		
1995		0.20	0.17	0.35	0.25	0.77
1996		0.32		0.09	0.13	0.07
1997		0.58		0.28		
1998		1.15		2.31		
1999		3.14		2.13		
2000		1.42		1.74		
Average[b]	1.18	1.22	0.58	1.08	0.19	0.42

[a] *Does not include smolt-to-jack survival.*

[b] *Weighted for all CWT release groups within years*

Table 5.8. Summary of smolt-to-adult survival, contribution to fisheries, and straying rates of coded-wire tagged (CWT) select area bright fall chinook from select area release sites, 1991-2000 brood years.

	Release Site			
	Big Creek Hatchery	Klaskanine Hatchery	Youngs Bay Net Pens	Select area Net Pens[a]
Brood Years	1991-1995	1995-2000	1991-2000	1991-2000
Number of CWT groups	12	11	37	41
Average survival rate (%)				
Smolt-jack	0.04	0.05	0.07	0.08
Smolt-adult	0.58	1.22	1.05	0.89
Total	0.62	1.27	1.12	0.97
Fishery Contributions (% of total adult return)				
Commercial				
SAFE	0.7%	30.3%	41.7%	41.6%
Ocean	30.9%	28.3%	22.3%	22.2%
Columbia River	4.2%	15.2%	21.6%	21.8%
Total	35.8%	73.8%	85.6%	85.6%
Recreational				
Ocean	2.3%	6.5%	3.6%	3.6%
Freshwater	7.8%	8.3%	7.8%	7.9%
Total	10.1%	14.8%	11.4%	11.5%
Escapement[b]	54.1%	11.4%	3.0%	2.9%
(Straying)	(13.80%)	(0.70%)	(1.78%)	(1.58%)
Straying				
Above Bonneville Dam (Includes recoveries from hatcheries, fisheries, and streams)	0.40%	0.00%	0.37%	0.39%
Escapement to streams and hatcheries other than location of release	13.40%	0.70%	1.41%	1.19%

[a] *Includes two releases each from Blind Slough and Tongue Point net pens in addition to Youngs Bay net pen production.*

[b] *Escapement includes unharvested fish recovered in streams and hatcheries (natal and out-of-system).*

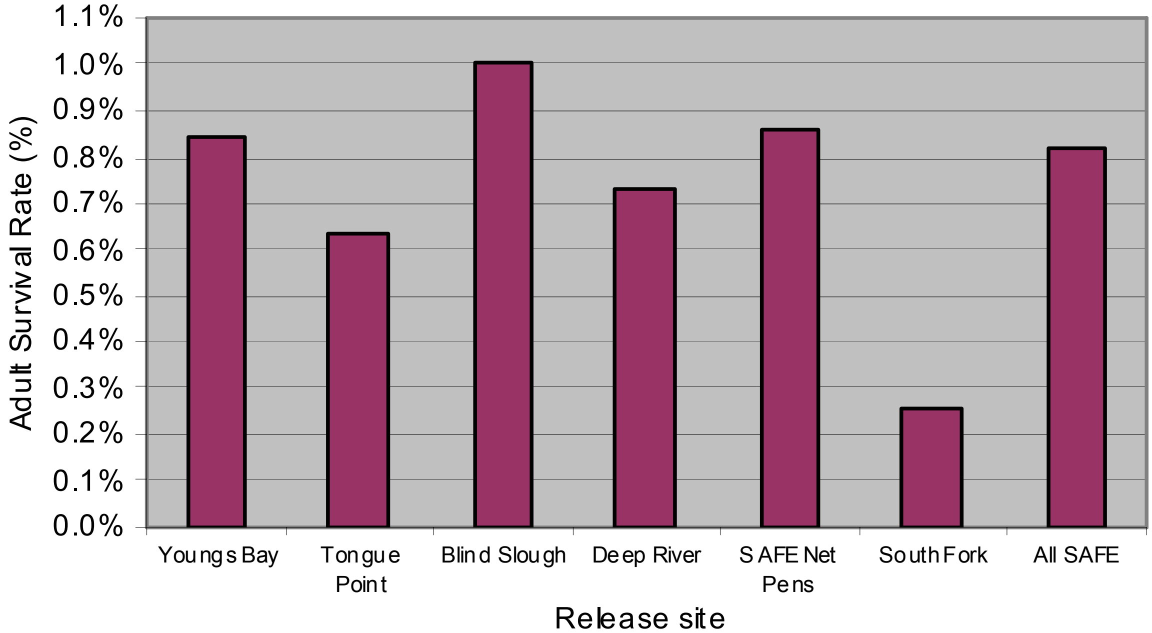


Figure 5.1. Average adult survival rates of SAFE spring chinook based on recoveries of 77 coded-wire tag groups, 1988-2000 brood years.

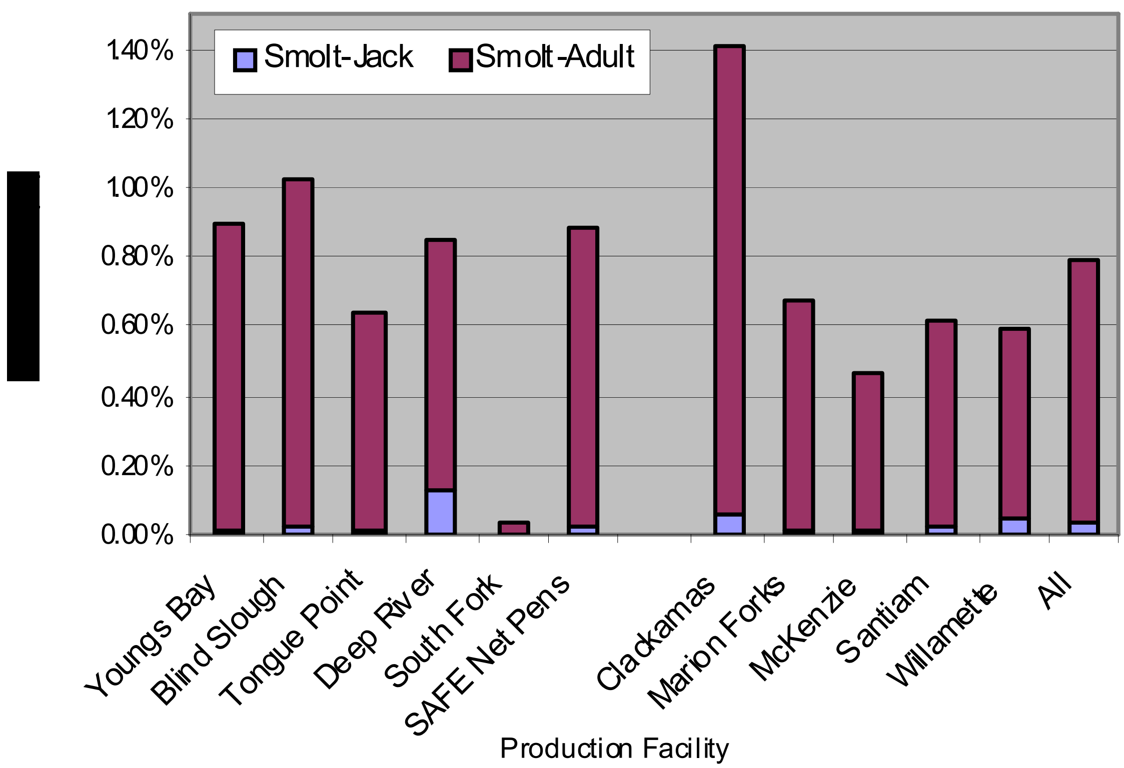


Figure 5.2. Smolt-to-adult survival rates of spring chinook based on recoveries of 134 coded-wire tag groups released from SAFE production facilities (69) and Willamette River Basin hatcheries (65), 1994-2000 brood years.

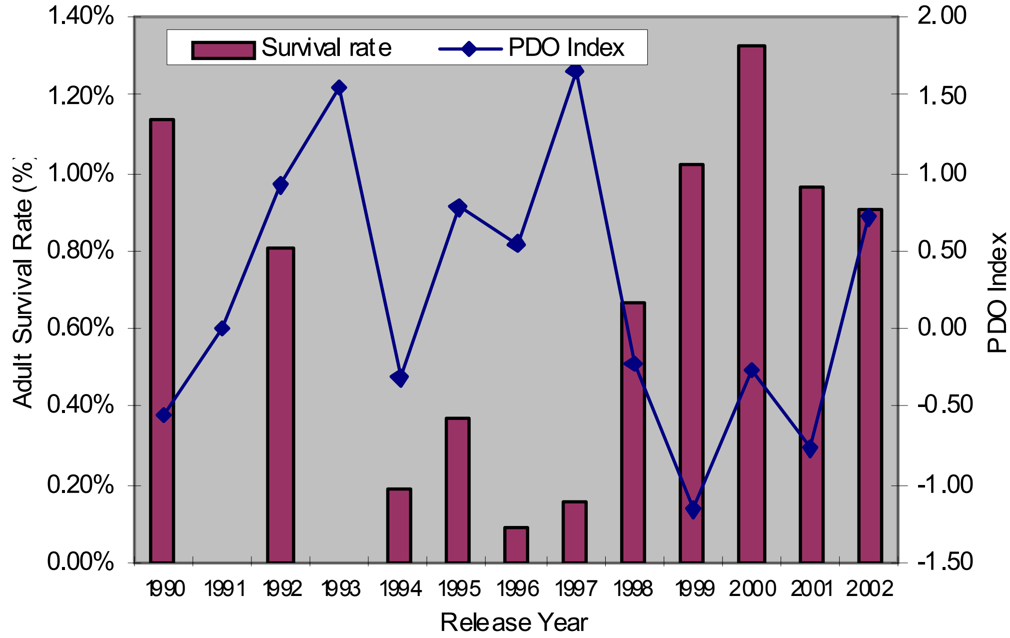


Figure 5.3. Relationship between smolt-to-adult survival rate and 12-month post-release Pacific Decadal Oscillation (PDO) Index (Mantua 1997) for 77 yearling spring chinook coded-wire tag groups released from SAFE facilities, 1988-2000 brood years.

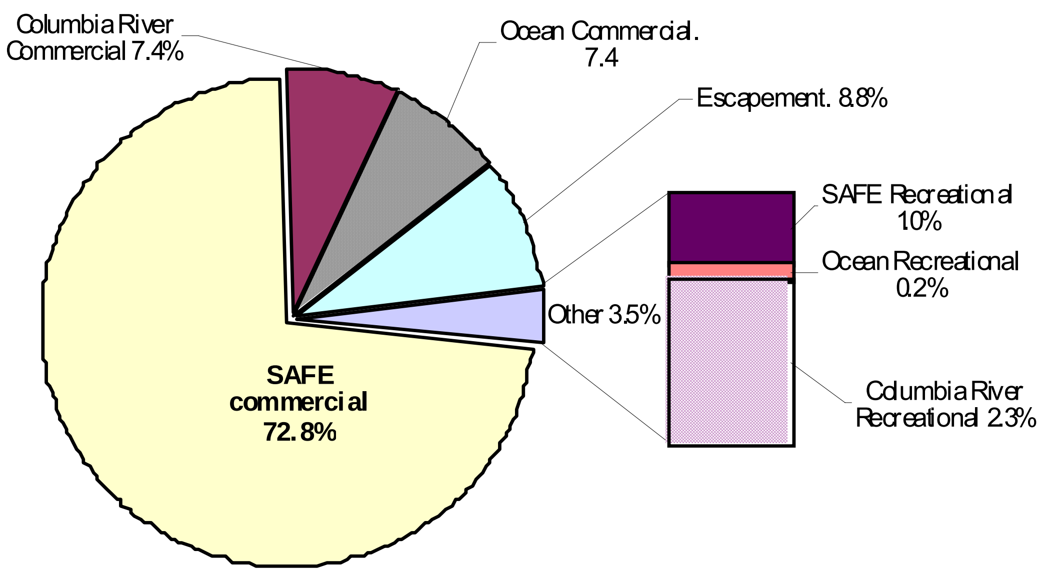


Figure 5.4. Contribution (% of total adult return) of SAFE spring chinook to regional fisheries based on recoveries of 69 coded-wire tag groups,1994-2000 brood years.

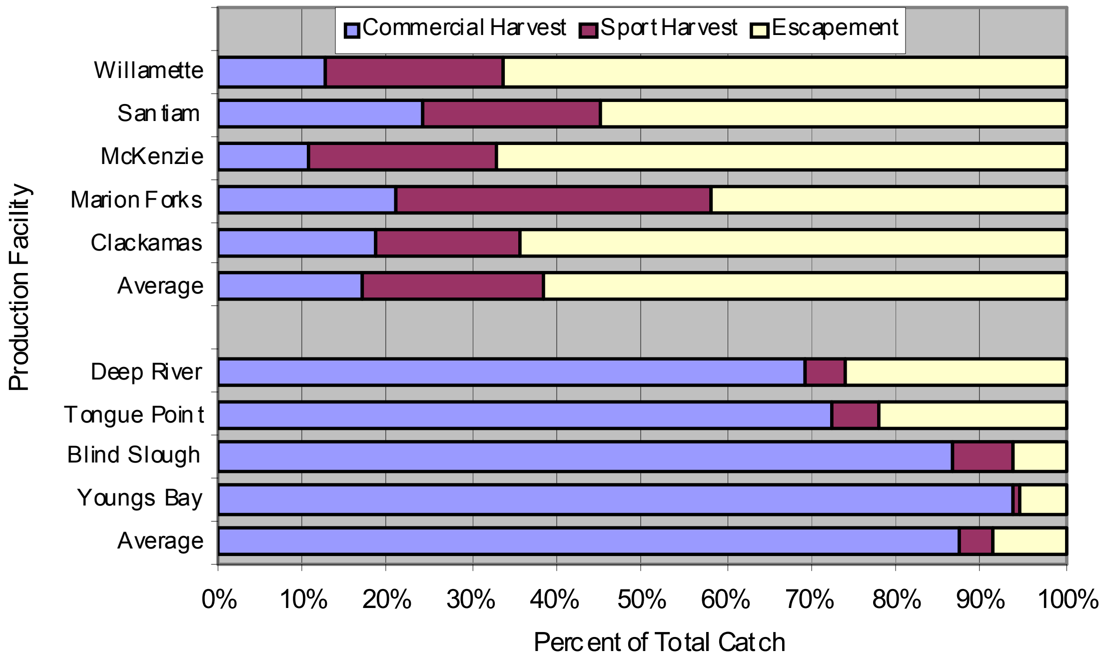


Figure 5.5. Accountability of spring chinook based on coded-wire tag groups released from SAFE facilities (69), and Willamette River Basin hatcheries (55), 1994-2000 broods.

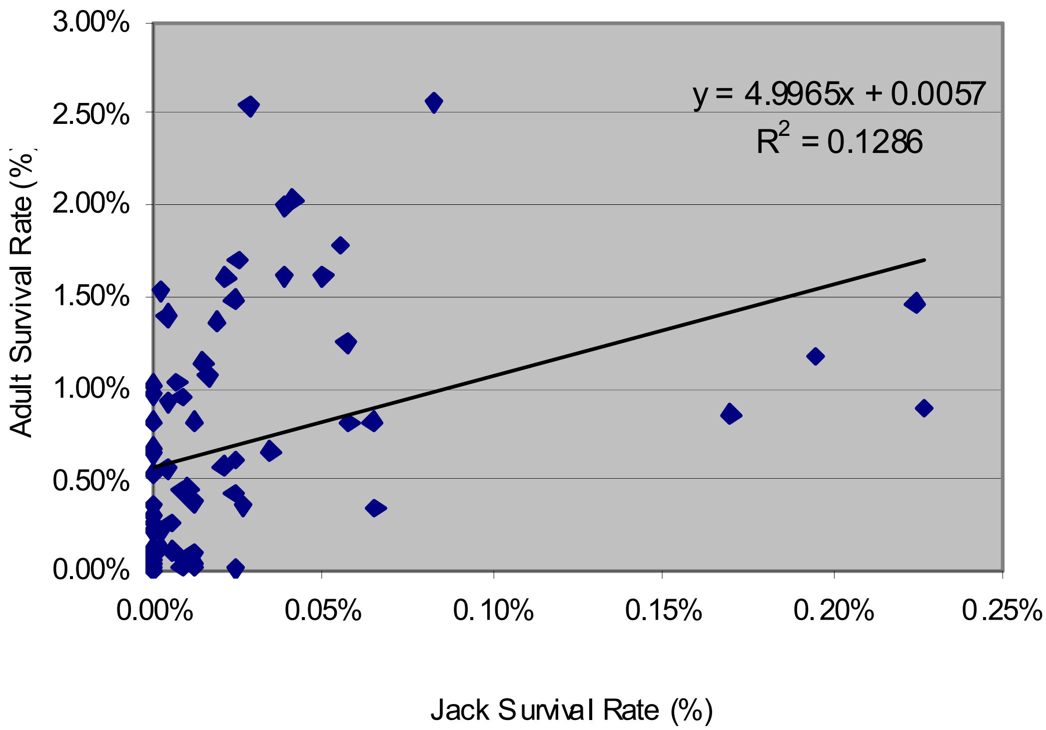
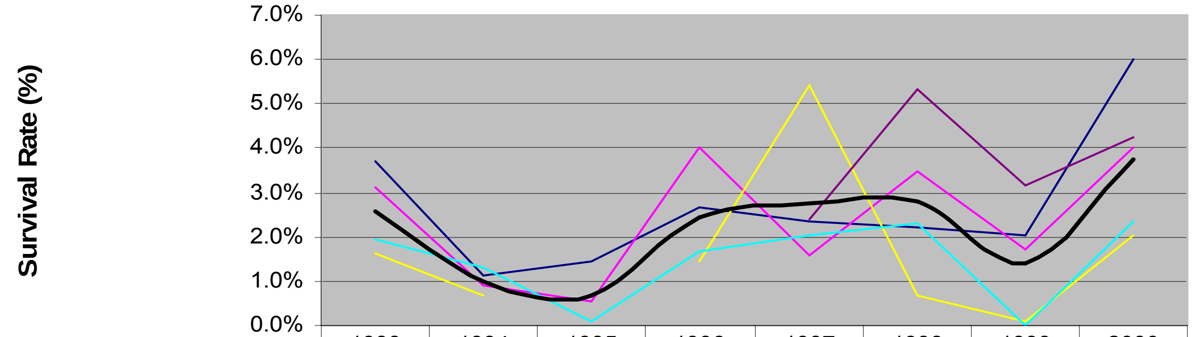


Figure 5.6. Relationship between jack and adult survival rates of SAFE spring chinook based on recoveries of 77 coded-wire tag groups, 1988-2000 brood years.



	1993	1994	1995	1996	1997	1998	1999	2000
Youngs Bay	3.7%	1.1%	1.5%	2.6%	2.3%	2.2%	2.0%	6.0%
Tongue Point	3.1%	0.9%	0.5%	4.0%	1.6%	3.5%	1.7%	4.0%
Deep River	1.6%	0.7%		1.4%	5.4%	0.7%	0.1%	2.0%
Blind Slough	1.9%	1.3%	0.1%	1.7%	2.0%	2.3%	0.0%	2.3%
Steamboat Slough					2.4%	5.3%	3.2%	4.2%
Total	2.6%	1.0%	0.7%	2.4%	2.8%	2.8%	1.4%	3.7%

Brood Year

Figure 5.7. Survival rates (%) of coho released from SAFE net pens, 1993-2000 brood years.

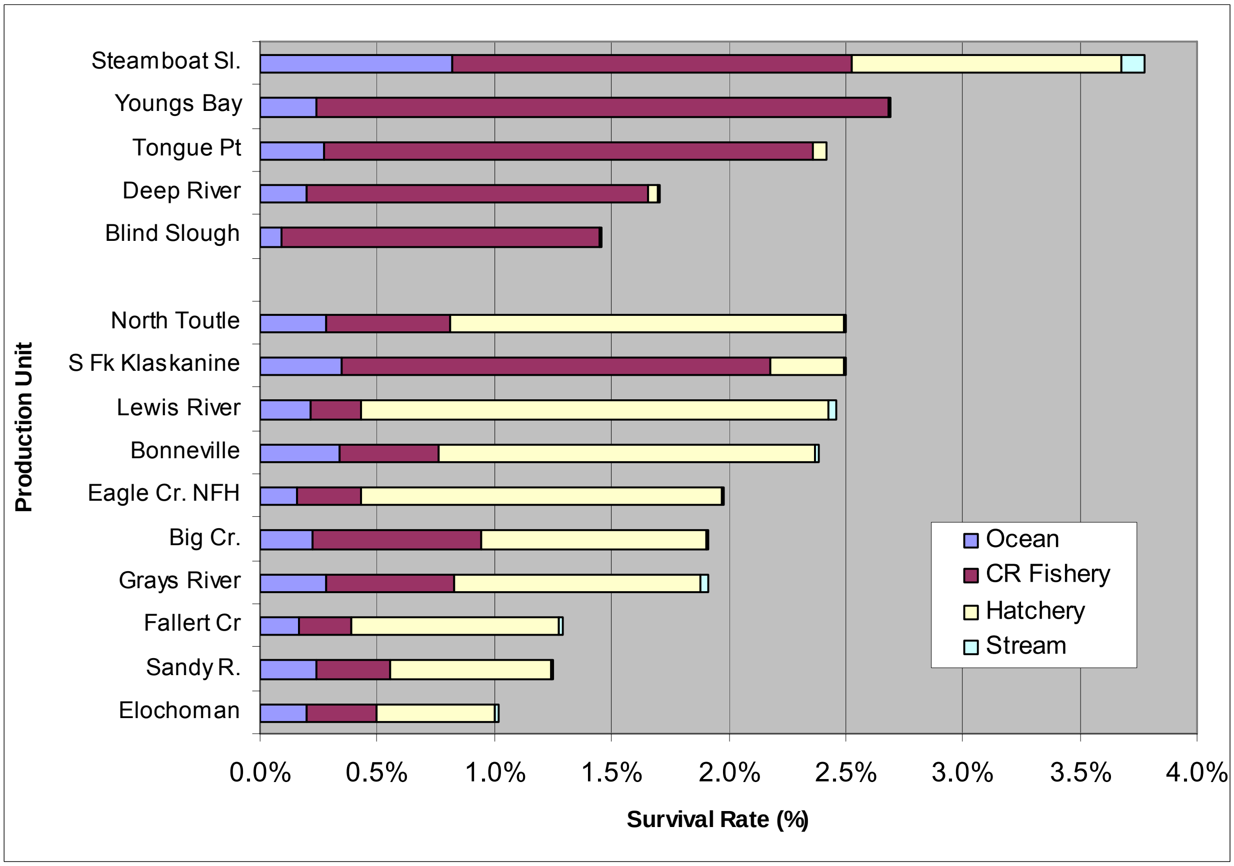


Figure 5.8. Comparison of mean survival rates and fishery contributions of early-run coho released from SAFE net pens and representative Columbia River hatcheries, 1993-2000 brood years.

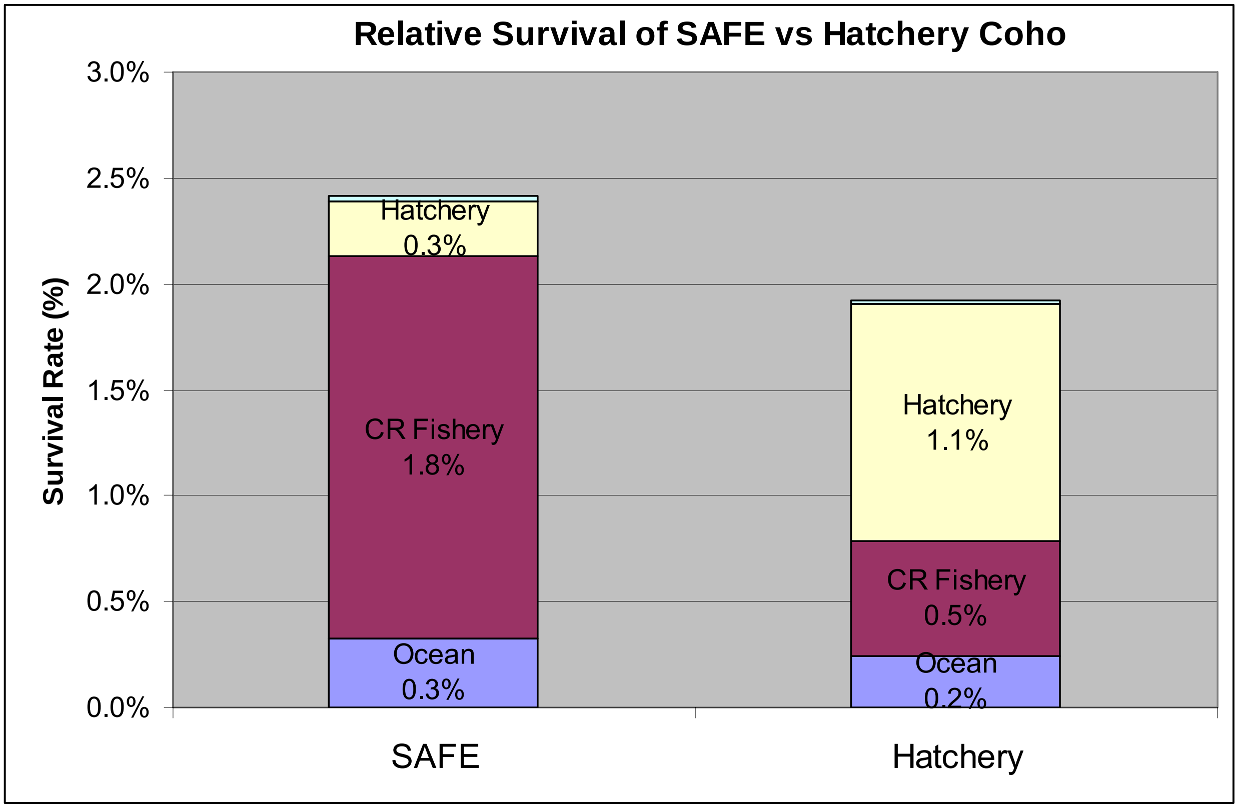


Figure 5.9. Comparative survival rates and contribution to fisheries of 1993-2000 brood early run coho releases from Columbia River hatchery and SAFE net-pen sites.

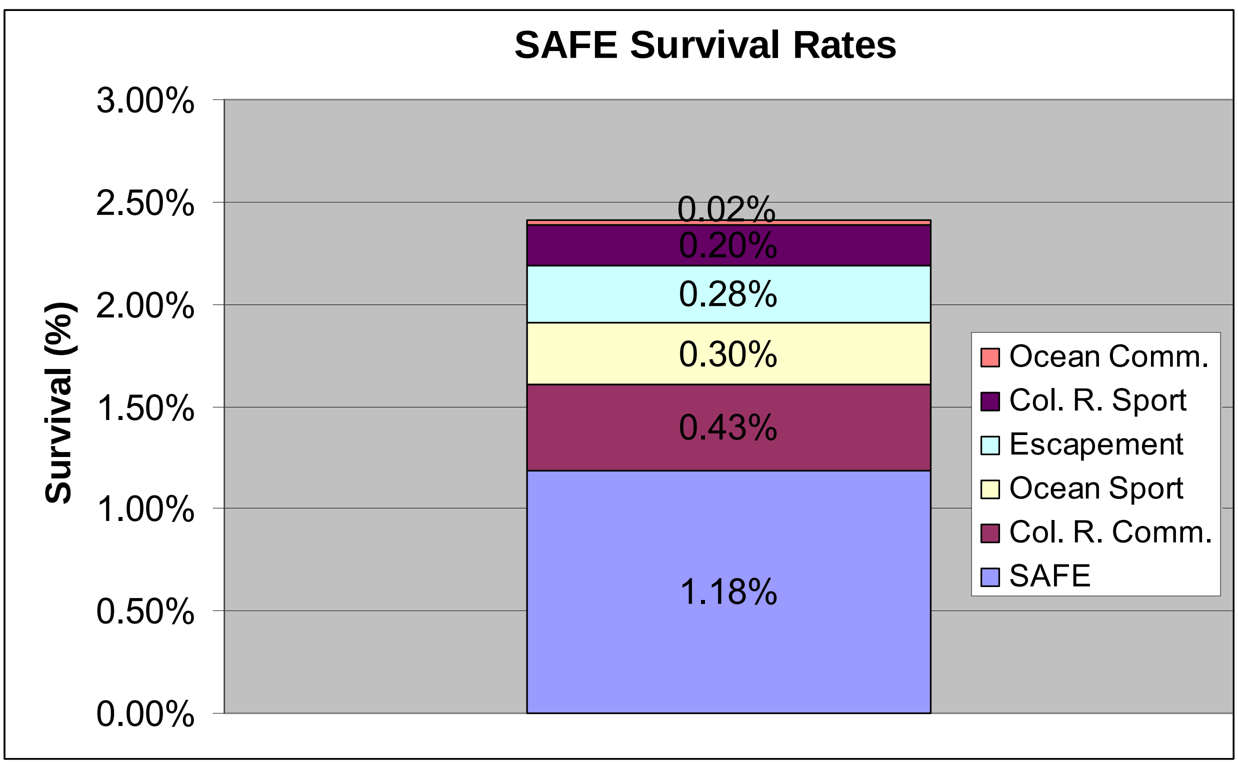
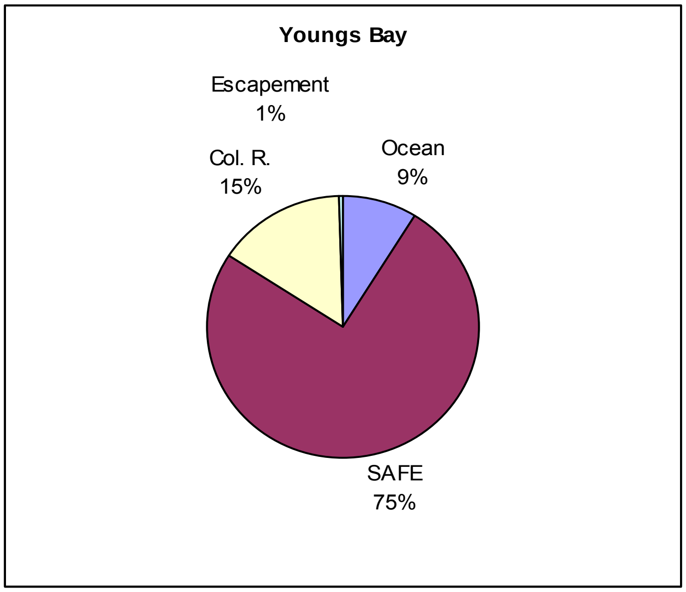
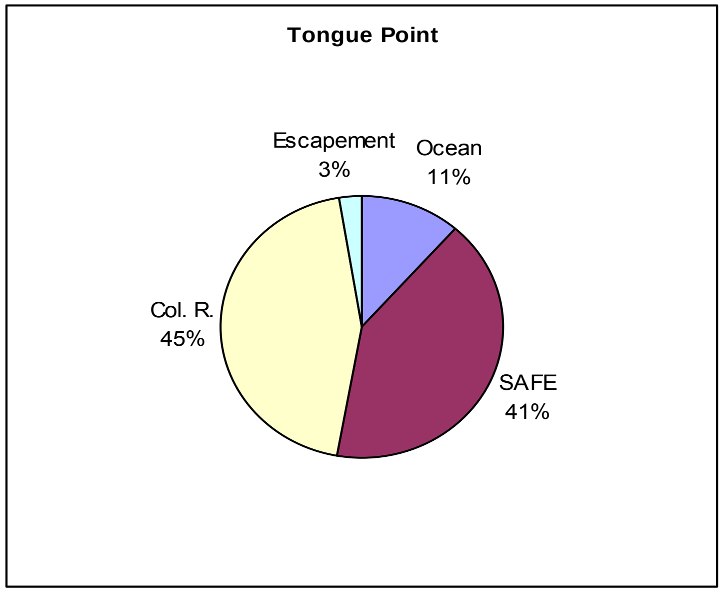
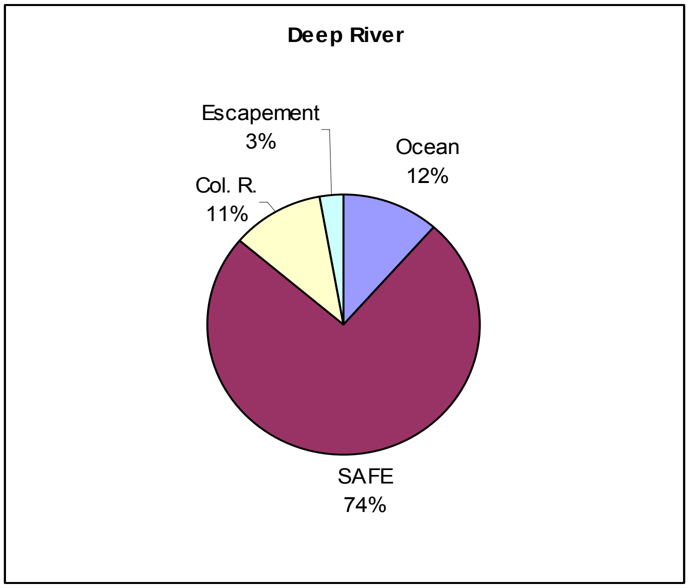
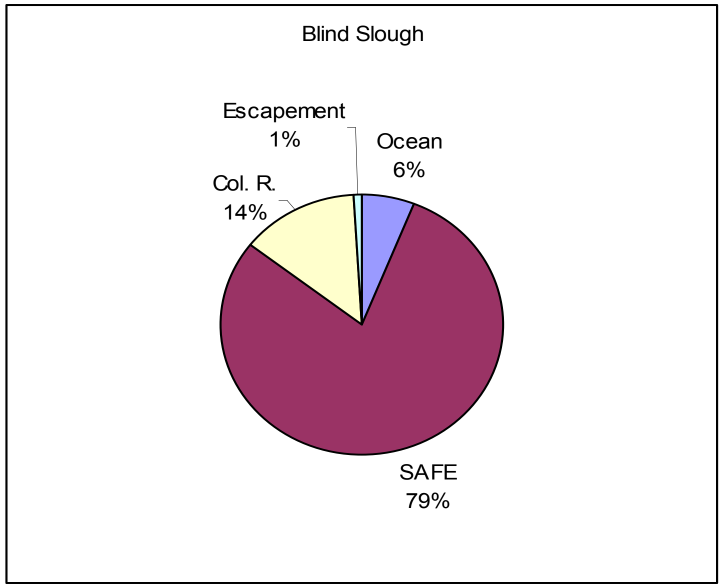


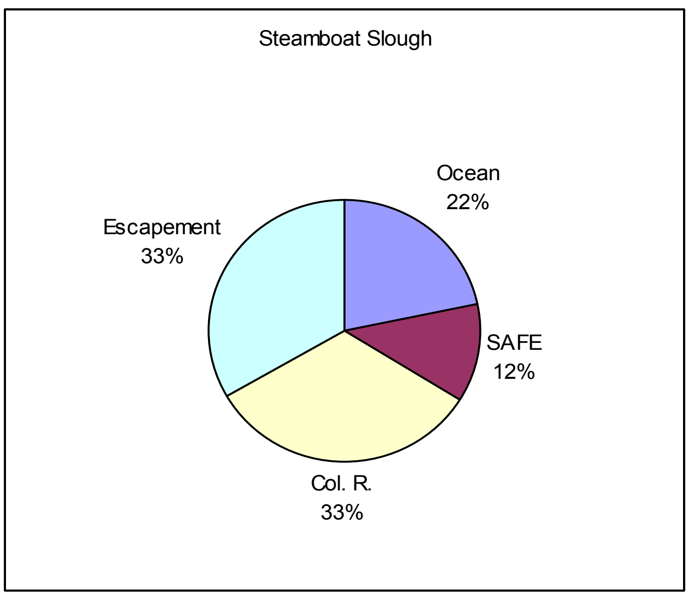
Figure 5.10. Contribution to fisheries based on mean survival rates of SAFE coho coded-wire tag release groups, 1993-2000 brood years.











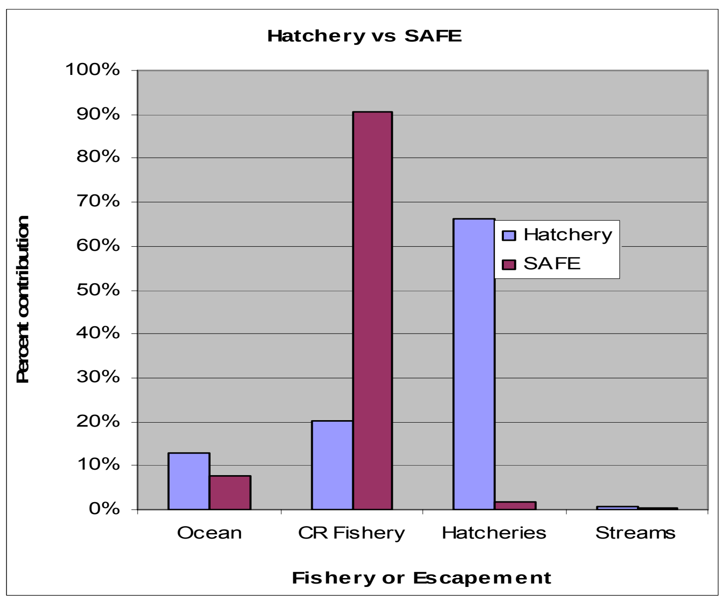
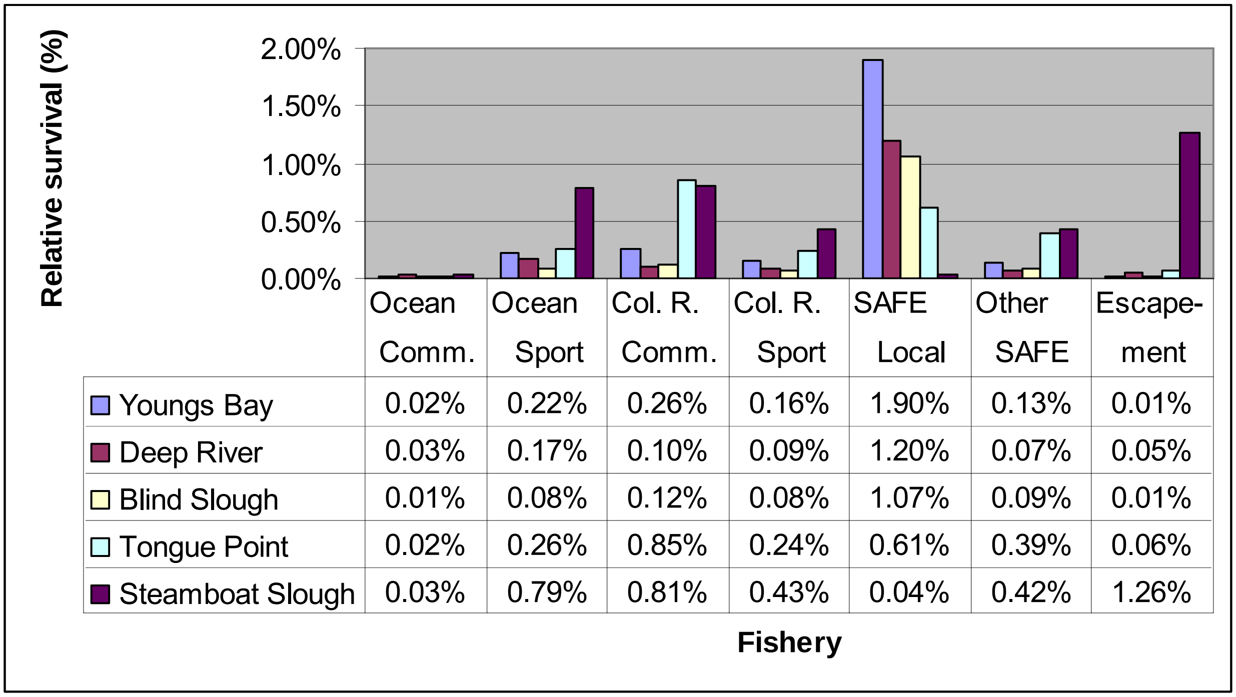


Figure 5.11. Contribution to fisheries and escapement of coho released from SAFE net-pen sites, 1993-2000 brood years.



	Ocean Comm.	Ocean Sport	Col. R. Comm.	Col. R. Sport	SAFE Local	Other SAFE	Escape-ment
Youngs Bay	0.02%	0.22%	0.26%	0.16%	1.90%	0.13%	0.01%
Deep River	0.03%	0.17%	0.10%	0.09%	1.20%	0.07%	0.05%
Blind Slough	0.01%	0.08%	0.12%	0.08%	1.07%	0.09%	0.01%
Tongue Point	0.02%	0.26%	0.85%	0.24%	0.61%	0.39%	0.06%
Steamboat Slough	0.03%	0.79%	0.81%	0.43%	0.04%	0.42%	1.26%

Figure 5.12. Relative contributions to coho fisheries and escapement of representative SAFE coded-wire tag groups by site, 1993-2000 brood years.

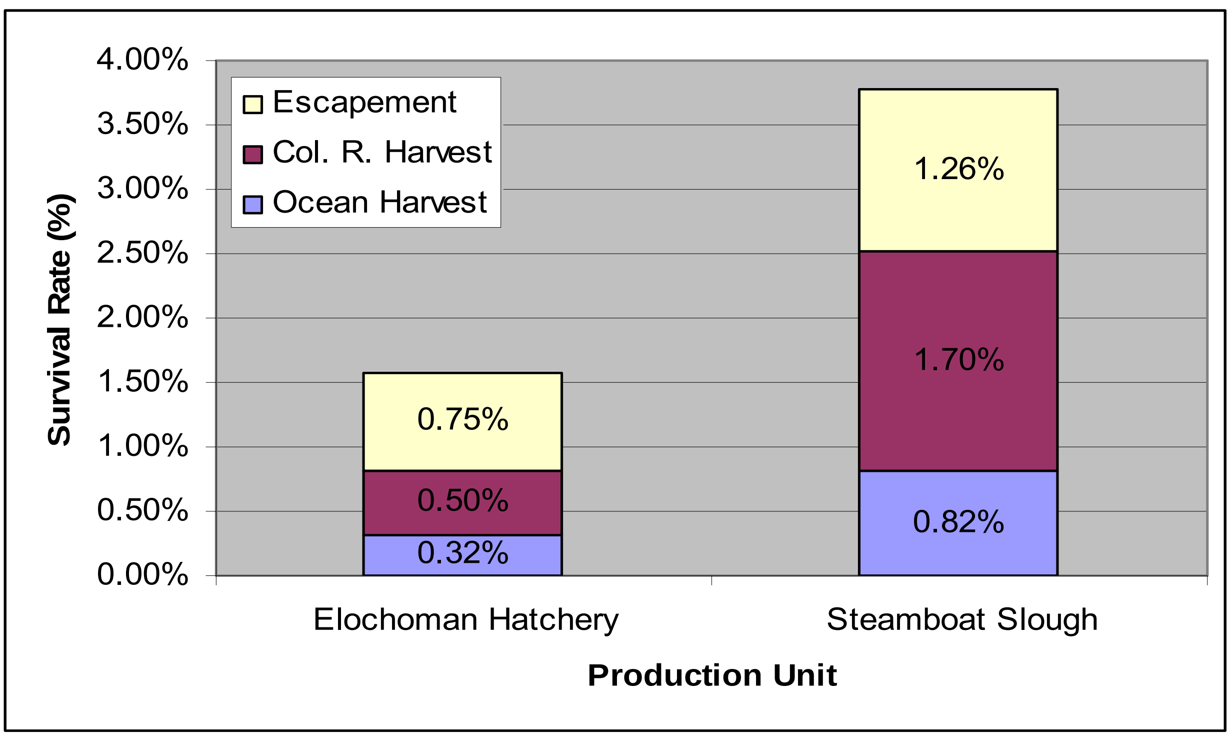


Figure 5.13. Comparative survival rates and contribution to fisheries of 1997-2000 brood coho releases from Elochoman Hatchery and Steamboat Slough net-pen site.

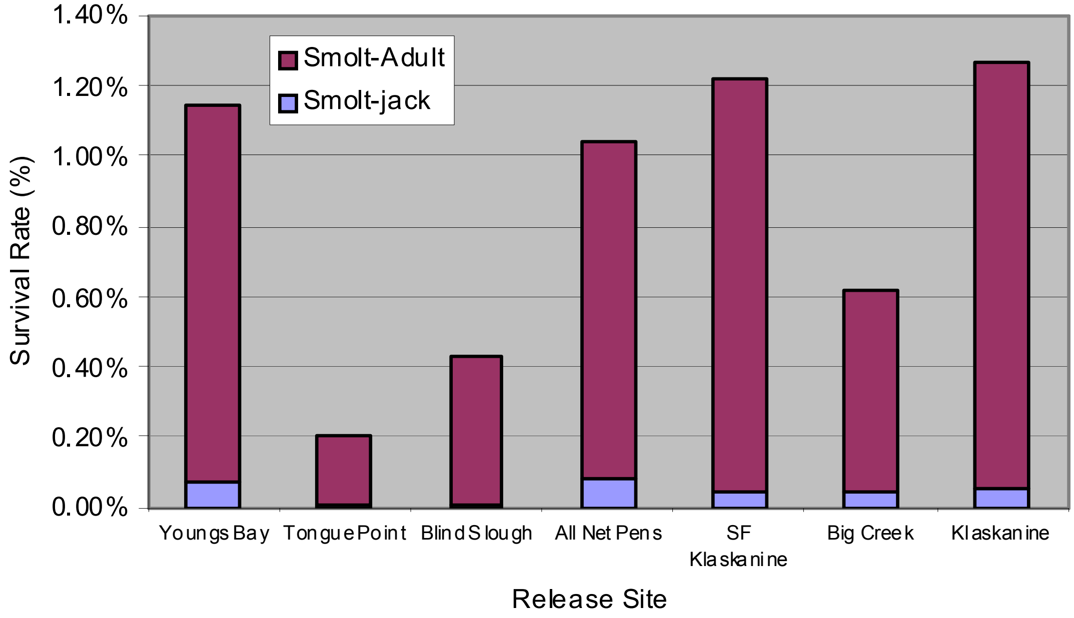


Figure 5.14. Average survival rates of select area bright fall chinook by release site, 1985-2000 brood years. (Production years not consistent among sites).

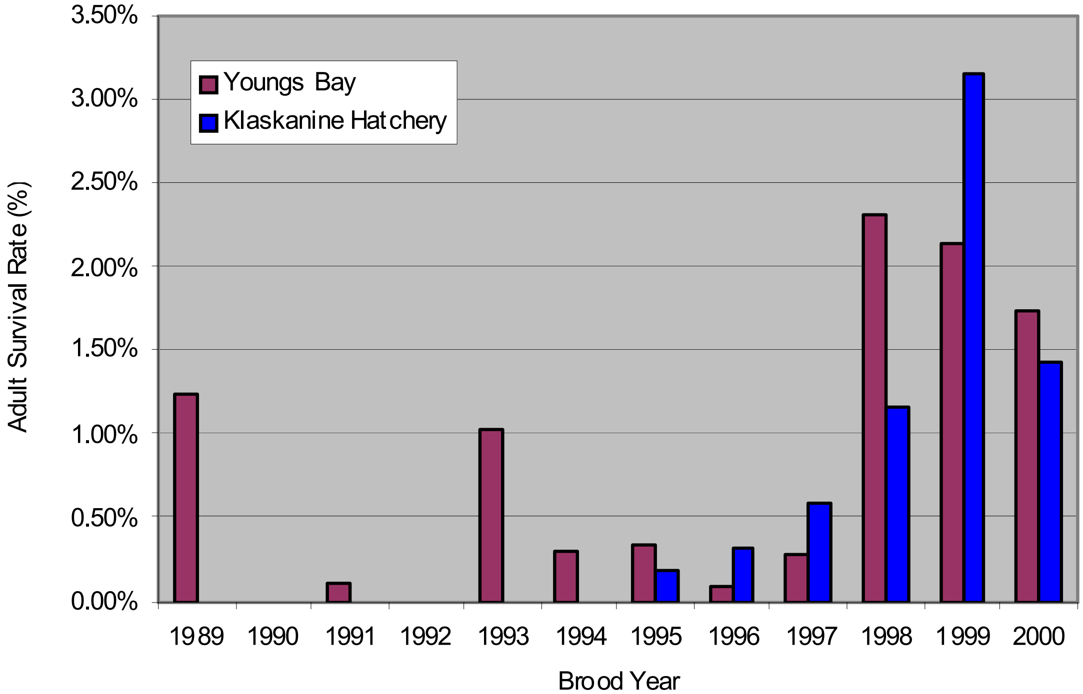


Figure 5.15. Average survival rates of select area bright fall chinook released from Youngs Bay net pens and the Klaskanine Hatchery, 1989-2000 brood years. (No releases in 1990 and 1992).

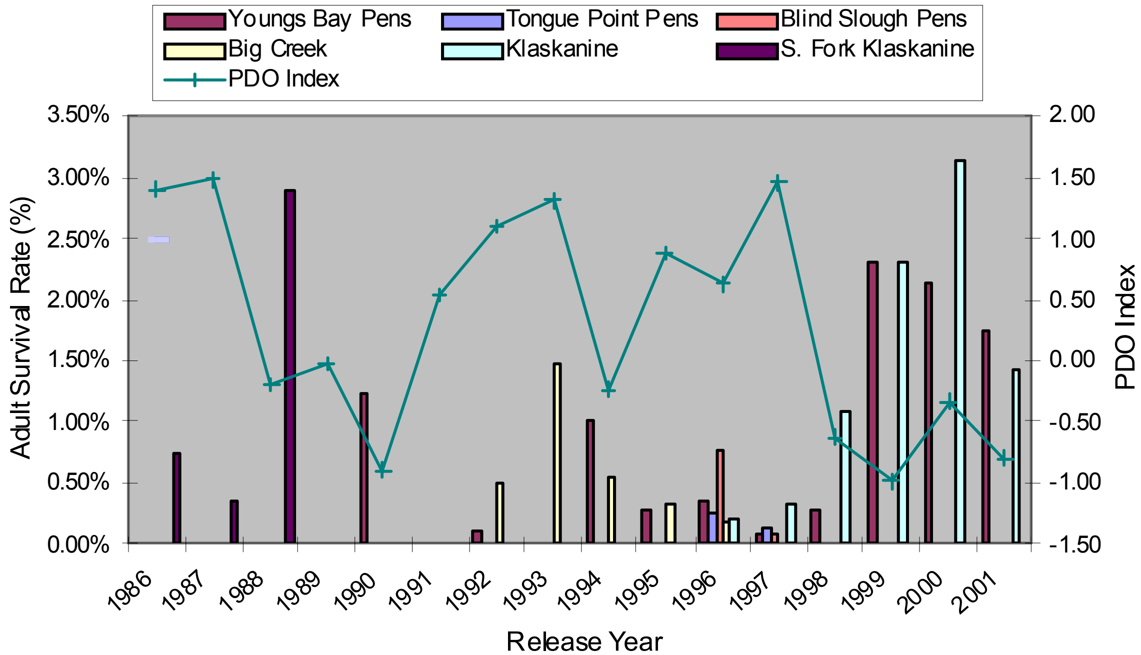


Figure 5.16. Relation between smolt-to-adult survival rate and the 12-month post-release Pacific Decadal Oscillation (PDO) Index (Mantua 1997) for lower Columbia River select area bright production facilities, 1985-2000 brood years.

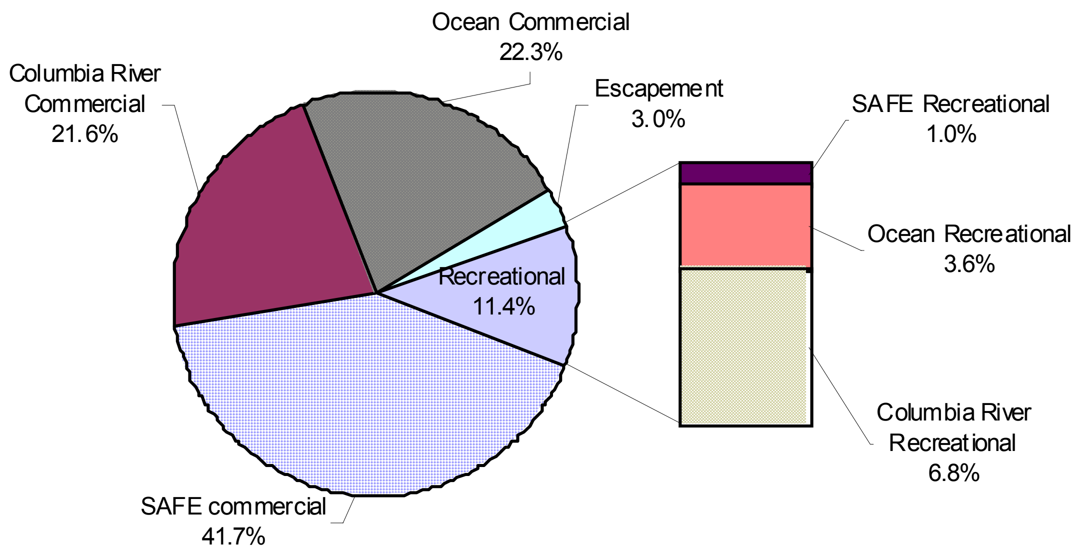


Figure 5.17. Contribution (% of total adult return) of select area bright fall chinook to regional fisheries based on recoveries of 37 coded-wire tag groups released from SAFE Youngs Bay net pens, 1991-2000 brood years.

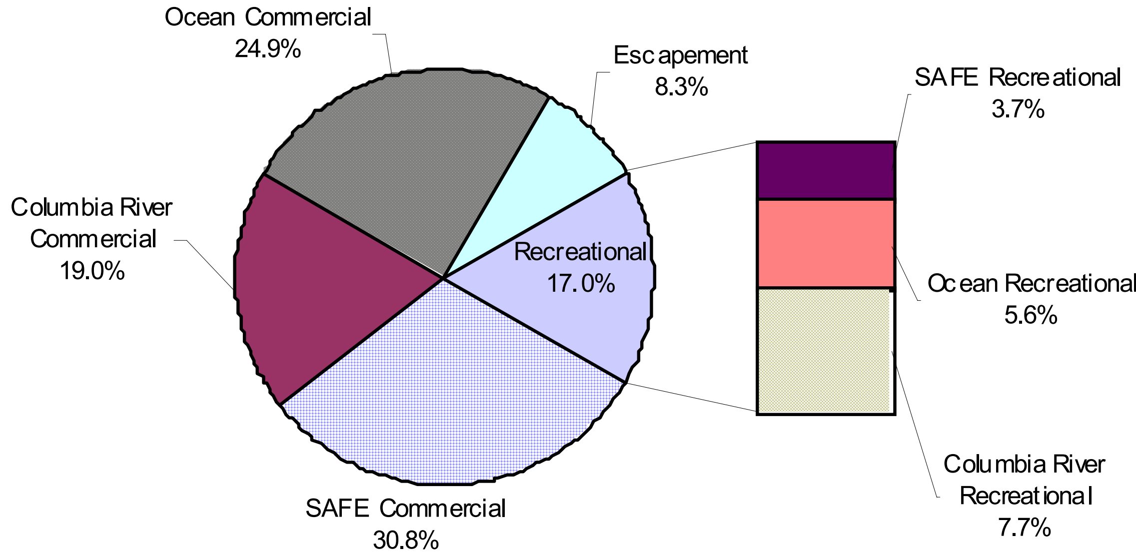


Figure 5.18. Contribution (% of total adult return) of select area bright fall chinook to regional fisheries based on recoveries of 64 coded-wire tag groups released from SAFE Youngs Bay net pens and Klaskanine Hatchery, 1991-2000 broods.

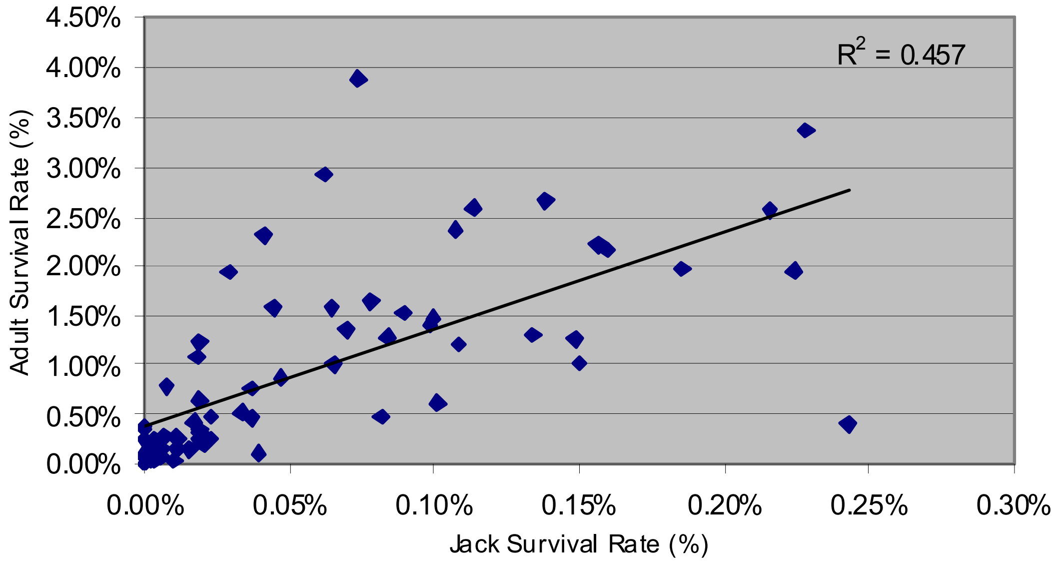


Figure 5.19. Relation between jack and adult survival rates for 69 coded-wire tag groups of select area bright fall chinook, 1989-2000 brood years.

6. RESEARCH AND MONITORING

In addition to developing new fishing sites and establishing high value species, the SAFE project has conducted or been involved in many studies throughout its history with a goal of maximizing smolt-to-adult survival, improving smolt quality, and minimizing impacts of the project on endangered salmonids and their habitat. Studies have included evaluations of avian predation avoidance, determining advantages of winter-fasting to simulate natural behavior of fish, evaluating escapement and natural production of SAFE stocks, documenting outmigration timing of smolts, and determining optimal rearing strategies including rearing density, release timing ,and smolt size. Several of these studies were initiated or completed during the reporting period and are summarized herein.

AVIAN AVOIDANCE AND PREDATION STUDIES

Avian predation of juvenile salmonids in the LCR estuary by piscivorous birds has been well documented by the scientific community (Emmett et al. 1997; Maynard et al. 2001). Artificial nesting areas created by channel dredging have dramatically increased the numbers of these predators. Their close proximity to the SAFE rearing sites creates opportunity for heavy losses of released smolts. Each year increasing numbers of cormorants, Caspian terns, great blue herons (*Ardea herodias*), and gulls (*Larus* spp.) are documented in Youngs Bay at times of chinook and coho releases. Predator control becomes ineffective when the numbers become overwhelming. To address this problem, the SAFE project conducted release trials during 2001-2003 (1999-2001 broods) to evaluate differences in adult survival rates of coho smolts released from net pens within Youngs Bay (control) with experimental releases in the mainstem Columbia River (treatment). Each test group consisted of 200,000 smolts, of which approximately 25,000 were coded-wire tagged. Each year, experimental treatment groups were drifted out of Youngs Bay during an ebb tide with navigation provided by 3-4 contracted commercial fishing vessels (Figure 6.1). Treatment fish were released near Hammond, Oregon at river mile 8.0, approximately ten miles downriver from the rearing site in Youngs Bay. Control fish were released directly from the rearing site about 18 hours before the treatment group during a nighttime ebb tide.

Based on recovery of 3,758 coded-wire tags from 1999-2001 brood coho adults (2001-2003 release groups), the average survival of fish towed out of Youngs Bay prior to release (3.7 percent) was higher than for the control group (3.2 percent), although other release groups exhibited average survival rates higher than either release strategy (Table 6.1). Contributions to regional fisheries and escapement were nearly identical for the towed and control groups. Towing coho out of Youngs Bay prior to release does not appear to reduce homing ability since average stray rates for this release strategy were extremely low (0.10 percent). Although towing results compare favorably with control releases, it is unclear if the difference is due to benefits of towing or because the control fish faired poorer than other rearing and release strategies. Because towed fish survived well and did not stray excessively, this release option warrants further evaluation with spring chinook. It may serve as a useful tool to circumvent avian predation in certain years or as a means of minimizing interaction and competition with wild salmonids in the Columbia River Estuary based on rapid outmigration rates observed for sonic-tagged spring chinook towed and released (see results for telemetry study below).

The unique approach of towing SAFE net pens (and entrained fish) to the mainstem Columbia River prior to release to avoid avian predation has also been applied to spring chinook releases at Deep River to avoid competitive interaction with native juvenile chum salmon. This potential conflict has caused problems with spring chinook releases in the past when holding net-pen fish until all chum have vacated the area delayed release timing to June rather than the preferred April timing. This approach is supported by NOAA Fisheries staff as a way to limit the effect of SAFE hatchery production on listed chum salmon and could possibly be applied in other systems as needed. Release trials similar to those in Youngs Bay and Deep River could be conducted with other species at all sites to see if increased can be achieved.

In addition to efforts to understand the extent of avian predation on smolts released from the SAFE project, attention to limiting or eliminating losses in the net pens from avian and mammalian predation is an ongoing concern. The net pens at all sites are visited by several species of piscivorous birds and families of river otters. A variety of approaches, from legal trapping to sewing bird covers to the nets, have been tried with some success. Incidences of otter predation continue to plague the project and new treatments are underway to address the problem. A solar-powered electric deterrent device similar to the kind used in agriculture to contain bovines has been evaluated at some sites. The Deep River pen complex has been successful in reducing otter predation using this technique, yet it was only marginally successful when tested at Youngs Bay net pens. Net-pen covers have been replaced with finer-mesh netting to prevent chronic predation by blue herons.

SUBSURFACE FEEDING

Frequent criticism of hatchery methodologies includes that of “training” raceway-reared fingerlings to feed on the surface and to respond to human presence associated with surface feeding. It is speculated that this conditioning may result in higher than normal avian predation once fish are liberated. Other trials have concluded that salmon fed in captivity will become accustomed to human hand feeding and respond to human presence yet still maintain avoidance responses to avian shapes (Maynard et al. 1996; Olla et al. 1998; Maynard et al. 2001).

To determine if subsurface feeding would improve survival of juveniles released by the SAFE project, a multi-year release trial was conducted using 1999-2001 brood SAB fall chinook ponded into net pens in Youngs Bay. Each year, two groups of approximately 25,000 fish each were fed using six-inch diameter polyvinyl chloride (PVC) pipes, three per net pen extending 1.0 meters below the surface as a delivery system for feeding (Figure 6.2). Target release densities for the two groups were 0.25 and 0.50 lbs/ft^3. As a control, two additional groups of fall chinook were reared at similar densities in nearby pens and surface fed on an identical schedule. All fish received an LV fin clip for stock identification, and each study group was uniquely coded-wire tagged prior to release. Based on CWT recoveries for 1999-2000 brood year release groups, adult survival does not appear to be greatly influenced by feed delivery practices employed for SAFE juveniles (Figure 6.3). Survival was higher for surface-fed fish reared at low densities, but lower than fish fed subsurface at medium densities. Average survival for the two feeding regimes was nearly identical when data for two rearing densities were combined.

Brood year 1999 spring chinook reared at Gnat Creek Hatchery were also subjected to subsurface feeding in one of fifteen raceways. An engineered subsurface complex of PVC tubes linked to a water-driven system distributed feed into the raceway at six locations one meter below the surface. After just a few days of feeding, the subsurface fed fish showed decreased surface activity, and eventually it became more difficult to capture weight samples because the fish would not come to the surface when "chummed" with feed. The subsurface groups showed comparable growth rates to the traditional surface-fed groups. However, fish reared under these conditions exhibited significant size divergence; half the fish grew rapidly while the remaining fish were less than 50 percent the size of their cohorts. After transferring these fish to net pens the size divergence continued to the extent that many of the "runts" never grew. While this may not be inherent to underwater feeding systems, review of the program resulted in the conclusion that subsurface feeding would be best applied once the fish were transferred to net pens. Based on these results, subsurface feeding strategies are not likely to be adopted for SAFE production.

WINTER DORMANCY

Metabolism of feed and the subsequent feeding response of hatchery fish is directly related to the rearing water temperature. Hatchery operators frequently report that fish naturally reduce their feed intake during cold-water periods but feed heavily as water temperatures increase in the spring resulting in rapid growth prior to smolting; a pattern typical of wild pre-smolts (Beckman et al. 1999). To evaluate how a winter-dormancy feeding regime would affect fish health and resulting survival of net-pen reared fish, release trials were initiated with SAFE Willamette stock spring chinook (1995-2001 broods). Dormancy (treatment) and winter-feeding (control) groups were reared and released from net pens in Youngs Bay during 1997-2003, Blind Slough during 1998-2001, and Tongue Point from 1998-2000. Each year a sub-sample of approximately 25,000 fish of each group was tagged with unique CWT's. During the first year of the study, the dormancy group was not fed for up to 60 days during the coldest water months; however, this resulted in fish that developed near lethal low-lipid levels after three weeks. The trial design was modified to incorporate low-level feeding once per week in subsequent years rather than total fasting, and the dormancy period was reduced to six weeks from mid-December through January.

Fingerlings subjected to reduced winter feeding regimes followed by a satiation diet in early spring can still reach targeted release weights of 12 fish/pound (Figure 6.4); however, anticipated savings in winter feed costs were offset by the increased rations required in the spring to achieve target release sizes.

No clear trend was apparent in adult survival of these two feeding regimes based on recoveries of 20 CWT release groups (1995-2000 brood years) from Youngs Bay and Blind Slough (Figure 6.5). Data for Tongue Point test groups was not evaluated since dormancy groups at this site were consistently released one month prior to the winter-feeding group, thereby imparting bias. For the other two sites, each group's survival fluctuated annually with for the dormancy groups ranging from 0.03-1.99 percent, and winter-feeding groups fluctuating from 0.11-2.56 percent. Average adult survival rates for combined releases from Youngs Bay and Blind Slough were higher for fish fed throughout the winter (0.95 percent) than for "dormant" fish (0.81 percent; Figure 6.6). Based on these results, winter-dormancy rearing strategies do not appear to benefit survival of SAFE spring chinook production; therefore, normal winter-feeding strategies will likely be employed in future years.

REARING DENSITY

Artificial rearing of salmonids is constrained by various factors including rearing density and water flows sufficient to provide adequate oxygen for respiration and flushing of metabolites. Research has shown that there is a direct correlation between the total biomass in rearing situations and eventual survival of liberated smolts to adults (Banks 1989; Ewing and Ewing 1995). Each species and stock of fish may have unique tolerances to the known environmental constraints.

To determine the optimal net-pen rearing density for SAB fall chinook, juveniles of the 1994-2000 broods were reared in net pens in Youngs Bay using three loading levels that would yield target biomass densities of approximately 0.25 lbs/ft^3, 0.50 lbs/ft^3, and 0.75 lbs/ft^3 at a release size of 15 fish/pound (Hirose et al. 1998). Approximately 25,000 fish from each study group were uniquely coded-wire tagged each year prior to release. Due to differential growth rates, annual variance in actual rearing densities occurred between years.

Fish grown at lower densities grew rapidly and generally exceeded the target release weight. Fish grown at medium densities grew at a rate sufficient to meet the target release weight. Fish grown at higher densities grew slower and did not always meet the growth target. Adult survivals based on expanded CWT recoveries were almost always poorer for fish reared at high densities than for fish reared at medium and low densities (Figures 6.7 and 6.8). Given the trade-off of vastly increasing the number of pens and nets to achieve low density rearing and the relatively small advantage over medium density rearing, the program has adopted medium density (0.50 lbs/ft^3) as the standard for rearing SAB fall chinook. This study was not able to differentiate if density of rearing, size at release, or state of smoltification was the actual causative factor in total survival. Trials that use strategies to differentiate these parameters and use different stocks may be evaluated in the future.

RELEASE TIMING AND SMOLT SIZE

Fish propagation programs in the Columbia River Basin are generally driven by an underlying goal to grow fish to a predetermined target release size during a specific timeframe to mimic natural fish behavior. A wealth of propagation information is available from years of species-specific research conducted relative to the extensive land-based hatchery system that has evolved in the system (Senn et al. 1984). In comparison, net-pen culture in the Columbia River system is a more recent development, often requiring verification or fine-tuning of long-standing hatchery practices.

To evaluate the effects of release timing on adult survival, two paired CWT groups of SAB fall chinook smolts were released from Youngs Bay net pens annually during 1995 and 1997-1999 (four paired releases). One test group represented fish released on or near July 15 of each year or when water temperatures reached 65° F. The second CWT group represented fish released on or near August 1 of each year or when water temperatures reached 70° F. Release timing was generally driven by water temperature criteria rather than target release date. During all four years the average size of fish in the early release group (17.1-31.0 fish/pound) was smaller than the later release (12.5-18.1 fish/pound); however, adult survival rates were very similar (Figure 6.9). Given these results, and data from other SAB release trials, the SAFE project has adopted 65° as the target SAB release temperature whenever possible.

Annual variations in timing of egg collection, incubation, and rearing water temperature often influence the subsequent size and timing of smolt releases. Adult survival rates of 1988-1991 brood spring chinook released from SAFE net-pen facilities were consistently poor for eight CWT test groups released late in the year (calendar days 151-206); however, these fish were all sub-yearlings (0^+ life stage). For yearling fish (1988-2000 broods) released during the normal spring period, a weak positive trend (R^2=0.109) indicates liberating fish in or after March may benefit survival, but this may be an artifact of larger smolt size rather than timing (Figure 6.10). Interestingly, the trend of improved survival with a later release date occurred regardless of release location (Figure 6.11). Based on preliminary results, the SAFE project adopted a target release period of late-March to early-April for spring chinook beginning with the 2000 brood year. However, postponing releases until later in the year is being considered given superior survival rates observed for 2001 brood spring chinook released during April-May from the Blind Slough site as part of a study initiated by NOAA Fisheries to evaluate the effect of timing of ocean entry and other parameters. The study design involves acclimating and releasing six CWT-groups annually from the Blind Slough rearing site at 10-day intervals. High harvest rates in the Blind Slough fishery provide for more complete recovery of returning adults which benefits study analyses while contributing to harvest. Recovery data is collected by SAFE project staff and provided to NOAA project sponsors. First year returns indicate smolt-to-adult survival rates from these releases averaged 300 percent higher than the over-winter group, however, those returns were compared to a group of fish that had significant disease problems. Additional data from future returns will be used to modify spring chinook release timing to maximize survival of SAFE production.

Based on CWT recoveries of 75 CWT groups of 1992-2000 brood spring chinook released from SAFE net pens, survival was positively correlated with release size for all release years except the 1996 brood (Figure 6.12). Recoveries of 51 SAB fall chinook (1993-2000 broods) CWT groups released from Klaskanine Hatchery and Youngs Bay net pens showed a little correlation between adult survival and size at release (R^2=0.034), indicating it may not be critical to achieve a specific release size for these fish (Figure 6.13). However, survival of 1995-2000 brood SAB smolts released from Youngs Bay net pens was generally higher for larger smolts during each year of release (Figure 6.14). Based on these results, the SAFE project will maintain a target release size of 12.0 fish/pound for spring chinook and an April 1 release date or later. The release target for SAB fall chinook will be 15-20 fish/pound and 65° F water temperature when possible.

SELECT AREA BRIGHT BROODSTOCK COLLECTION AND ADULT HOLDING

A common problem throughout the evolution of the SAFE SAB fall chinook program has been how to hold early-returning adults in the hatchery facilities. These fish enter freshwater over a protracted period from June through September with returns to hatcheries occurring from July through October. Most of these early returning fish are not ripe when they reach the hatcheries. Even if they could be spawned, protracted egg collections complicate subsequent rearing. Utilizing all returning broodstock has been an important goal of the SAB program since full capacity (2.4 million eggs) has only been accomplished in one year since 1994 (Figure 6.15). Unfortunately these fish do not hold well due to a preponderance to jump, resulting in injury. Early returns are especially vulnerable due to warmer water temperatures.

In 1999 and 2000, SAB fall chinook that returned early to Big Creek, Klaskanine and CEDC's SF Klaskanine hatcheries were transferred to net pens in Youngs Bay to evaluate the potential for holding adults to maturity. In 1999, 107 adults (62 females, 45 males) were held from 93 to 121 days, with 64 percent of the females surviving to be spawned. In 2000, 75 adult SAB's were held up to 42 days with 84 percent of the females spawned successfully. Overall, ripening adult SAB adults in the net pens was successful. The nets cause little abrasion and the brackish water seemed to deter fungus growth. Interestingly, it appears one side effect of net-pen holding is that maturation may be delayed one or two weeks.

During August and September, 2003-2005, additional broodstock collection activities were conducted using tangle nets and a Merwin fish trap (2003 only) in the tidewater sections of the Klaskanine and Youngs Rivers to determine whether offsite broodstock collection is a feasible alternative for obtaining additional SAB eggs. Tangle nets (4½" stretched mesh) were deployed across the confluence hole and weighted heavily to avoid drifting. Fish were removed from the net as quickly as possible, revived in a live box, and held in either a 67-gallon insulated tote or one of three 7.9 ft^3 live boxes prior to being transported to net pens (6) stationed onsite. Both the live box and holding tote were plumbed to continuously deliver raw river water. The Merwin trap was fished across the mouth (~85 percent coverage) of the Klaskanine River overnight for ~26.5 hours.

Overall, the tangle-net component of the experiment was successful, with 517 SAB fall chinook captured yielding 692,639 eggs over the three-year period. The immediate mortality rate averaged 6.6 percent for all three years combined. Catch rate and capture/holding survival (84.5 percent) rates were sufficiently high to warrant future work. Only limited fungus was observed on some fish late in the holding period. Several coho were captured in the Merwin trap but no SAB fall chinook were collected. Based on results of this study, off-site broodstock capture will likely be conducted during late-August through early-September with tangle nets in future years to maximize SAB egg collections.

SPAWNING GROUND, JUVENILE SURVEYS, AND HATCHERY SAMPLING

In addition to systematic stream surveys conducted each fall in LCR tributaries by various state agencies, SAFE project staff also conduct local stream surveys for a variety of reasons. Spawning ground surveys are conducted each fall in the Lewis and Clark, North and South Fork Klaskanine, and the Youngs rivers (all Youngs Bay tributaries) to estimate straying and escapement of adult SAB fall chinook. Each river is surveyed up to five times annually from late-September through October. Data collected includes redd counts and estimates of live and dead fish numbers. Carcasses are examined for sex, spawning success, fin marks, and also measured for length. Scales are collected to determine age composition. Snouts and fin-mark data are collected from carcasses with data incorporated into the RMIS system for estimating survival and stray rates. These surveys have documented the majority (76.3 percent) of fall chinook present in SAFE tributary streams in recent years were SAB stock, which occur at fairly high levels and exhibit spawning activity in area streams (Table 6.2). Project staff will continue to conduct these surveys in future years to ensure that stray rates for SAFE releases remain at the low levels observed to date.

Additional spawning ground surveys were conducted each winter in the South Fork Klaskanine River during 1997-2003 to determine the stock origin of a small run of late fall chinook known to exist in the Klaskanine River drainage. Data collected during these surveys included redd and live fish counts, scale and tissue samples and sex of adult mortalities. Considered to be possible remnants of Chetco and/or Trask stock released from Klaskanine Hatchery in 1975, DNA analysis of tissue samples has recently identified these fish as northern Oregon coastal stock fall chinook, i.e. Trask River.

To determine if either the SAB or Trask stock fall chinook were successfully spawning, juvenile abundance surveys were conducted during July of 1998-2002 and the fall of 1999 in Youngs Bay tributaries. Sampling was conducted within several pools in each of three sections of the Lewis and Clark and Klaskanine rivers (North Fork, South Fork, and mainstem) using multiple passes with a stick seine. Fish were identified to species, counted, examined for fin marks, and measured. Results indicate that abundances of juvenile chinook and cutthroat trout in survey sections of these streams are low, while juvenile coho and steelhead are more common, especially in the Lewis and Clark River (Figure 6.16). Given the low juvenile chinook abundances, it appears the adult chinook spawning activity observed during fall surveys may not be very successful.

Sampling of returning adults is conducted annually at several local hatcheries to collect biological data and recover coded-wire tags to determine adult escapement levels. Sampling of spring chinook occurs annually during April-June at Big Creek Hatchery concurrent with recycling of stray spring chinook back to the Blind Slough fishing site for additional harvest opportunities. Select area bright fall chinook are sampled at Klaskanine Hatchery during October and November of each year concurrent with spawning activities. Coho, spring chinook, and any SAB fall chinook returning to the SF Klaskanine Hatchery are sampled annually. Data collected includes sex, length, examination for external marks, and recovery of snouts containing coded-wire tags. All data is incorporated into the RMIS system for estimation of survival and stray rates.

CONDITION AND OUTMIGRATION OF SAFE SMOLTS

The issue of whether hatchery-reared salmon have a negative effect on wild stocks through competition, predation, disease transmission, and other mechanisms is a topic of continual debate (Myers and Horton 1982; Levings et al. 1986; Williams et al. 1998). Since SAFE project releases are significant, the project has received some criticism for not evaluating potential project effects. Wild juvenile salmonids using Youngs Bay, Tongue Point, Blind Slough, or the Columbia River estuary may be affected by releases of SAFE spring chinook even though only full-term smolts are released. We hypothesize these fish migrate rapidly through SAFE fishing sites and the lower Columbia River estuary with a minimum of ecological interaction with other species. Ledgerwood (1997) found radio-tagged spring chinook smolts released from Youngs Bay net pens out-migrated from Youngs Bay within one full tidal series and moved through the Columbia River estuary rapidly. Although it would be very difficult to quantify any adverse effects of SAFE production on wild salmonids, several actions have been undertaken to evaluate the potential for impacts and minimize the effects of SAFE project releases on wild juvenile salmon.

In 2003, the SAFE project partnered with Sea Resources, Salmon for All, ODFW, Oregon State University, and USFWS on an ODFW R&E funded project to determine the migration rate and residency time of SAFE net-pen spring chinook and the correlation with gill Na^+,K^+-ATPase. Fieldwork was initiated in April 2004 using 38 SAFE spring chinook smolts surgically-implanted with Vemco acoustic transmitters. An additional 141 fish were fitted with BPA-Batelle proprietary acoustic tags in April 2005. All fish were sampled for ATPase levels at time of tagging one day prior to release for subsequent correlation with outmigration rate. In 2004, approximately half the fish were released from the Yacht Club rearing site in Youngs Bay. The other half were transported to the mainstem Columbia River onboard a boat fitted with a flow-through live well and released. In 2005, approximately 75 smolts were released from the SF Klaskanine Hatchery, 31 from the Yacht Club net-pen site, and 35 were towed to the mainstem Columbia River near Hammond prior to release. Both fixed and mobile antennas were used to track tagged fish. Fixed site arrays were established at various points including the confluence of Youngs and Klaskanine rivers (2005), Youngs Bay mouth (2004-05), the mainstem Columbia (2005), and the Columbia River mouth (2004). Data was downloaded weekly.

Preliminary results corroborate the rapid emigration rates documented by Ledgerwood (1997), with average travel time of 11.5 and 48.7 hours from Youngs Bay net pens to the mouth of the Columbia River in 2004 and 2005, respectively (personal communication; Robert Warren; Sea Resources and Columbia River Estuary Study Taskforce (CREST)). Results of this work will be presented in a project summary report to the R&E Board and in the 2006 SAFE Final Report following completion of data analysis. Future studies could be conducted at the other SAFE sites with SAB fall chinook and coho to ensure results observed for Youngs Bay spring chinook apply to all SAFE production.

Understanding residency time of SAFE smolts in the lower Columbia River estuary will help determine the potential for impacts of SAFE releases on listed salmonids. If residency times of SAFE smolts are minimal, the potential for significant negative impacts on other salmonids is reduced. Correlation of outmigration rates with ATPase levels will hopefully provide a tool that can be used to time releases when smolts are most likely to migrate directly to the ocean environment; thus minimizing potential impacts on native stocks during their early life history stages.

Beginning in 2002, project staff began a longer-term project of collecting representative tissue samples for gill Na^+,K^+-ATPase analysis from one annual release of coho and spring chinook (SAB fall chinook added in 2005) to determine levels of smoltification and the effect on adult survival based on subsequent CWT recoveries from returning adult fish. This data, combined with the telemetry results mentioned above, will help refine release guidelines that optimize survival of SAFE production and minimize impacts with other salmonids.

HOMING

Throughout the research phase, the SAFE project has monitored recoveries of coded-wire tagged returning adults to evaluate homing for each stock and release site. This effort has lead to discontinuation of several release programs to minimize affects of the project on other systems in the Columbia River Basin. Spring chinook production at the original Tongue Point rearing site was discontinued in 2001 due to excessive straying of the 1996-1998 releases. Because this site has excellent production and fishing potential, several actions were undertaken in hopes of re-establishing a spring chinook fishery at this location. The current rearing site has been relocated approximately 1.2 miles upstream (east) to the MERTS dock to distance the production area from the mainstem Columbia River. In addition, experimental releases were conducted in 2003-2005 consisting of ~20,900-30,400 spring chinook smolts artificially imprinted with a low concentration (~$5.0x10^{-5}$ mg/L) drip of the synthetic chemo-attractant morpholine and released onsite. As a control, ~27,000 additional smolts were acclimated for two weeks and released each year from a temporary net-pen site in the John Day River (river mile 3.0), a tributary that enters Cathlamet Bay (Tongue Point fishing site) approximately 0.6 miles east of the MERTS site. All release groups have been uniquely marked with coded-wire tags (>83 percent tag rate) to evaluate homing of returning adults. Test fishing was initiated in April 2005 but few fish were captured, likely a result of poor survival rates. A fishery limited in scope by area or participation is being considered for May 2006 to aid in recovering CWT's from returning adults to determine if homing is sufficient to reinstate production-level releases at this site.

OXYGEN SUPPLEMENTATION

Oxygen supplementation has been used in fish propagation programs throughout the world to increase rearing capacity through higher pond loading densities and to reduce disease outbreaks. Higher loading densities allow for increased production through more efficient use of existing facilities without requiring significant construction costs. Fewer disease outbreaks reduce rearing mortalities resulting in increased juvenile production, while decreasing project costs associated with disease prevention or treatment. Since this rearing strategy has proven effective at other hatcheries it was evaluated at Gnat Creek Hatchery with 2003 brood spring chinook to determine potential benefits for SAFE production. In this study, growth rates and dissolved oxygen levels were compared between two identical three-pond raceway series with the same water flows and loading densities. The treatment raceway series received supplemental oxygen via bottled oxygen and a diffuser at the head of the second pond, while the control raceway series received normal surface water with ~125 gallons per minute (gpm) added at the head of both the second and third ponds. Both groups of fish were reared from ponding to 25 fish/pound (approximately January-October). The net benefit of the added oxygen was achieving nearly identical dissolved oxygen levels at discharge of the third pond as the control series, while conserving ~250 gpm of surface water, with similar growth rates for each group of fish. Based on results of this experiment, use of supplemental oxygen may have application in some SAFE hatcheries to either increase production through higher loading densities or by increasing survival by reducing disease outbreaks that can occur when fish are transferred from land-based hatcheries to the net pens too early in the fall when water conditions are less than ideal.

Table 6.1. Summary of average smolt-to-adult survival, contribution to fisheries, and straying rates of avian-predation and comparative coded-wire tag groups reared in, or released from Youngs Bay by the select area fisheries project, 1999-2001 brood years.

	Release Strategy				
	Towed	Control	South Fork	Over-winter	2-week acclimation
Number of CWT groups	3	3	3	3	3
Recovered CWT's	911	551	1,064	336	896
Expanded adult returns	2,929	2,237	2,995	1,281	3,487
Average survival rate (%)					
Smolt-jack	0.04	0.02	0.10	0.06	0.05
Smolt-adult	3.72	3.17	3.93	1.54	4.81
Total	3.76	3.19	4.02	1.60	4.86
Fishery Contributions (% of total adult return)					
Commercial					
SAFE	65.3	65.3	53.7	64.1	75.1
Ocean	0.2	0.6	0.2	0.2	0.4
Columbia River	12.6	12.1	10.8	11.1	8.3
Total	78.1	78.0	64.7	75.4	83.8
Recreational					
Ocean	15.7	15.0	20.0	16.8	10.6
Freshwater	5.8	6.7	7.1	7.5	5.0
Total	21.5	21.7	27.1	24.3	15.6
Escapement[a]	0.4	0.3	8.2	0.3	0.6
(Straying)	(0.10)	(0.16)	(0.55)	(0.00)	(0.32)
Straying					
Above Bonneville Dam (Includes recoveries from hatcheries, fisheries, and streams)	0.00%	0.00%	0.00%	0.00%	0.00%
Escapement to streams and hatcheries other than location of release	0.10%	0.16%	0.55%	0.00%	0.32%

[a] *Escapement includes unharvested fish recovered in streams and hatcheries (natal and out-of-system)*

Table 6.2. Summary of Youngs Bay tributary fall chinook spawning ground surveys, 1997-2005.

Year	Stream	Observed adults	Estimated escapement[a]	Mark sample	Marks observed	Redds[b]
1997	SFK Klaskanine	na	54	13	2 AdLV; 7 LV; 4 no mark	na
	NFK Klaskanine	na	53	10	4 AdLV; 6 LV	na
	Youngs River	na	25	1	1 no mark	na
	Lewis & Clark[c]	----	----	----	----	----
1998	SFK Klaskanine	na	7	0	----	9
	NFK Klaskanine	na	7	1	1 Ad	8
	Youngs River	na	9	3	3 no-mark	6
	Lewis and Clark	na	10	0	----	4
1999	SFK Klaskanine	na	7	0	----	3
	NFK Klaskanine	na	80	14	1 Ad; 1 AdLV; 12 no-mark	16
	Youngs River	na	15	1	1 no-mark	10
	Lewis and Clark	na	7	0	----	na
2000	SFK Klaskanine	na	2	1	1 no-mark	6
	NFK Klaskanine	na	347	57	2 AdLV; 53 LV; 2 no-mark	62
	Youngs River	na	71	4	3 LV; 1 no-mark	25
	Lewis and Clark	na	0	0	0	0
2001	SFK Klaskanine	8	14	3	1 AdLV; 1LV; 1 no-mark	57
	NFK Klaskanine	102	173	37	3 AdLV; 34LV	32
	Youngs River	53	90	15	1 AdLV; 14 LV	35
	Lewis and Clark	3	5	1	1 no-mark	16
2002	SFK Klaskanine	0	0	0	0	0
	NFK Klaskanine	403	685	14	1 AdLV, 8 LV; 5 no-mark	2
	Youngs River[c]	----	----	----	----	----
	Lewis and Clark	8	14	0	0	2
2003	SFK Klaskanine	132	224	44	6 AdLV; 35 LV; 1 Ad; 2 no-mark	105
	NFK Klaskanine	297	505	177	17 AdLV; 94 LV; 4 no-mark	0
	Youngs River	33	56	0	0	36
	Lewis and Clark	121	206	18	4 LV; 14 no-mark	48
2004	SFK Klaskanine	20	34	3	3 LV; 1 ADLV	6
	NFK Klaskanine	592	1,006	40	1 Ad; 32 LV; 1 AdLV; 5 no-mark	7
	Youngs River	16	27	0	0	13
	Lewis and Clark	22	37	0	0	5
2005	SFK Klaskanine	20	34	0	0	3
	NFK Klaskanine	247	420	49	1 Ad; 40 LV; 7 AdLV; 1 no-mark	50
	Youngs River	2	3	0	0	1
	Lewis and Clark	53	90	9	8 LV; 1 AdLV	19

[a] *Escapement expanded from single-pass peak fish counts*
[b] *Peak survey count*
[c] *No survey conducted*
na = data not available

Figure 6.1. Local gillnetters towing net pens containing coho smolts during an avian-predation avoidance experiment, 2001.

Figure 6.2. Subsurface feed delivery system at Youngs Bay Yacht Club net pens.

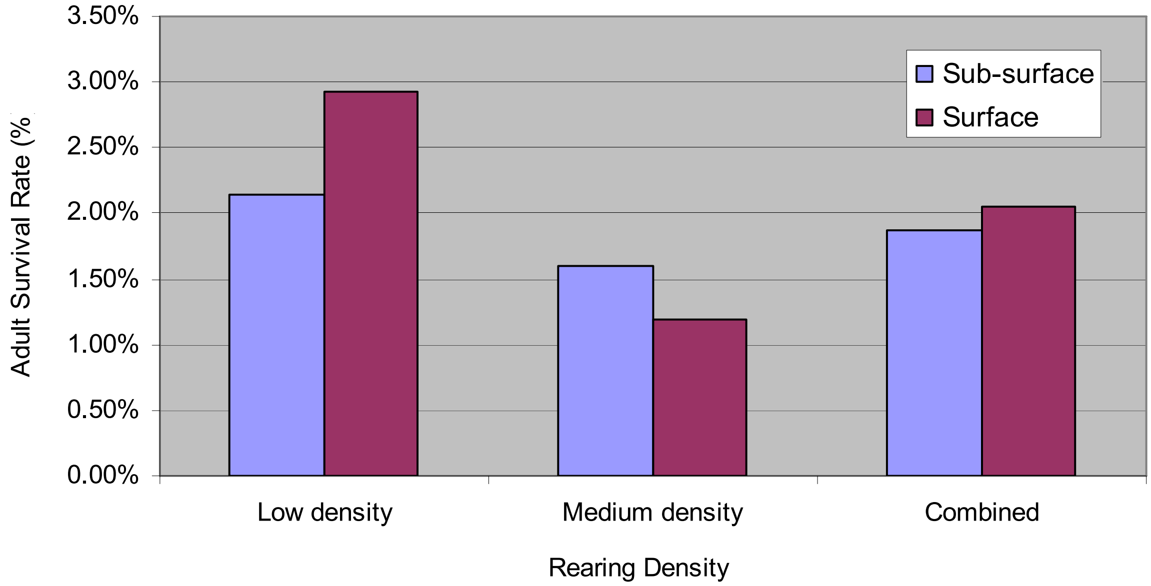


Figure 6.3. Survival of Select Area bright fall chinook reared under normal and sub-surface feeding strategies, 1999-2000 brood years

Figure 6.4. Feeding winter dormancy spring chinook smolts at Blind Slough net pens.

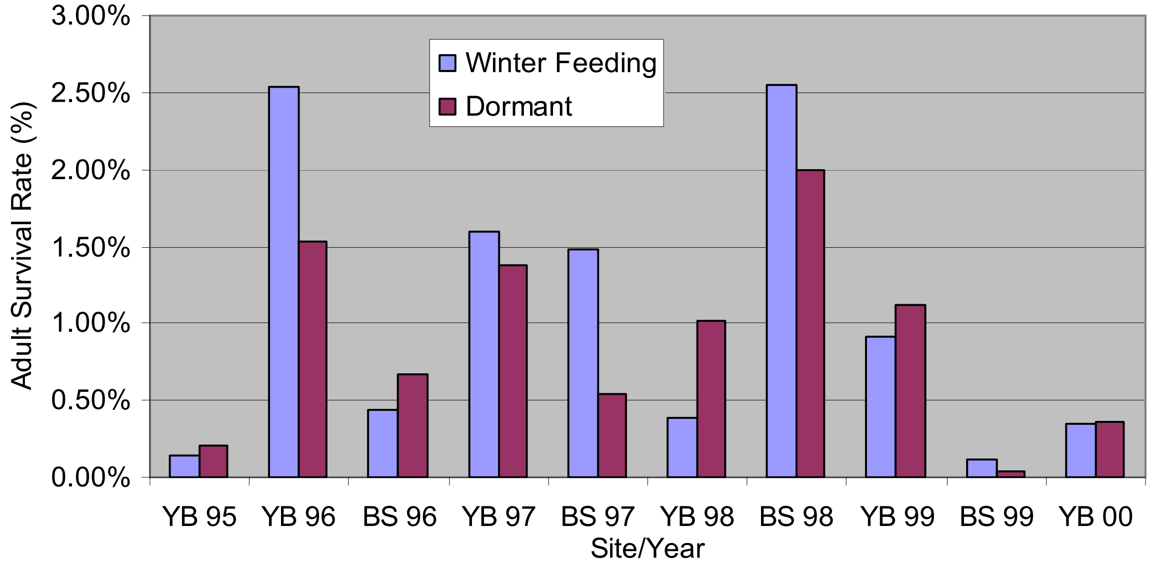


Figure 6.5. Comparison of adult survival rates for Select Area spring chinook winter feeding and dormancy test groups by site and year, 1995-2000 brood years.

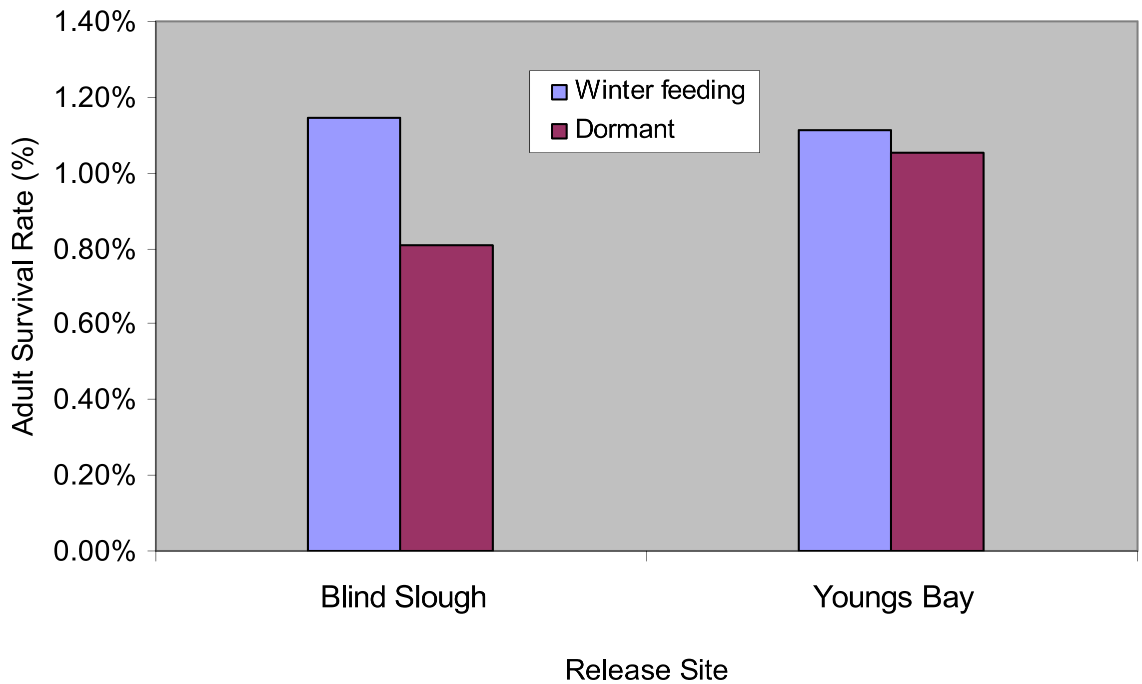


Figure 6.6. Comparison of adult survival rates for Select Area spring chinook winter-feeding and dormancy test groups based on recovery of 20 coded-wire tag groups, 1995-2000 brood years. (Data for Youngs Bay 1995-2000 and Blind Slough 1996-1999).

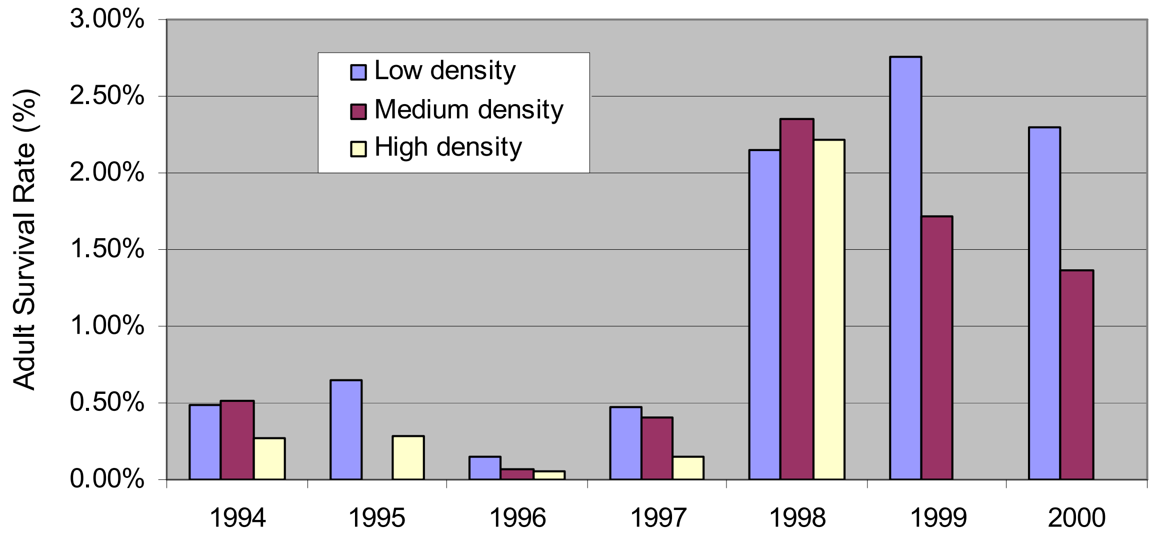


Figure 6.7. Survival rates of Select Area bright fall chinook by rearing density, 1994-2000 brood years.

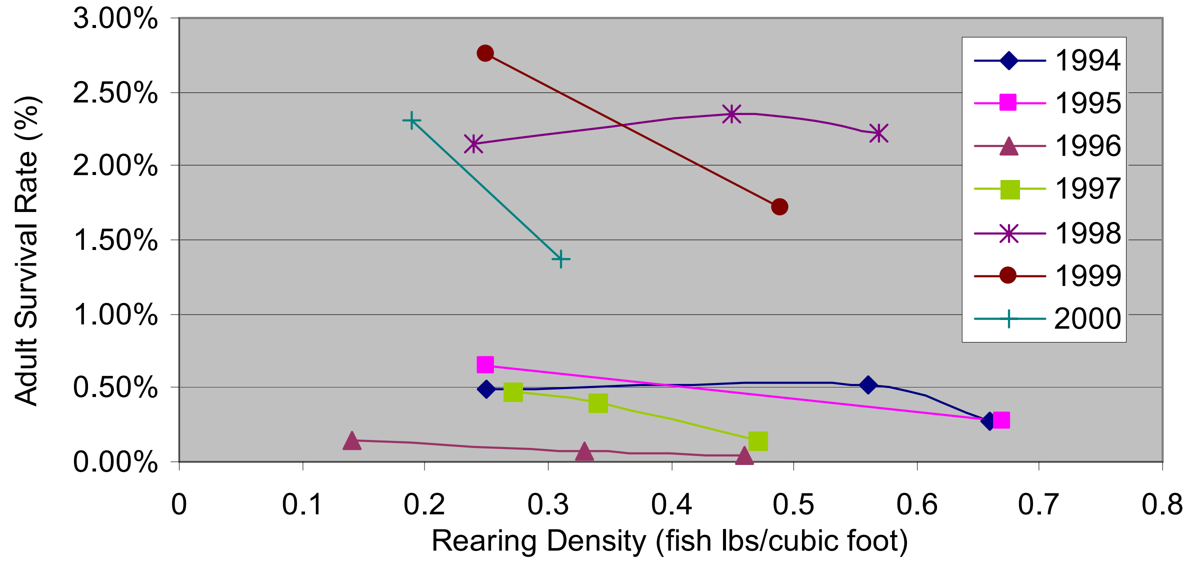


Figure 6.8. Comparison of Select Area bright fall chinook adult survival by actual rearing density, 1994-2000 brood years.

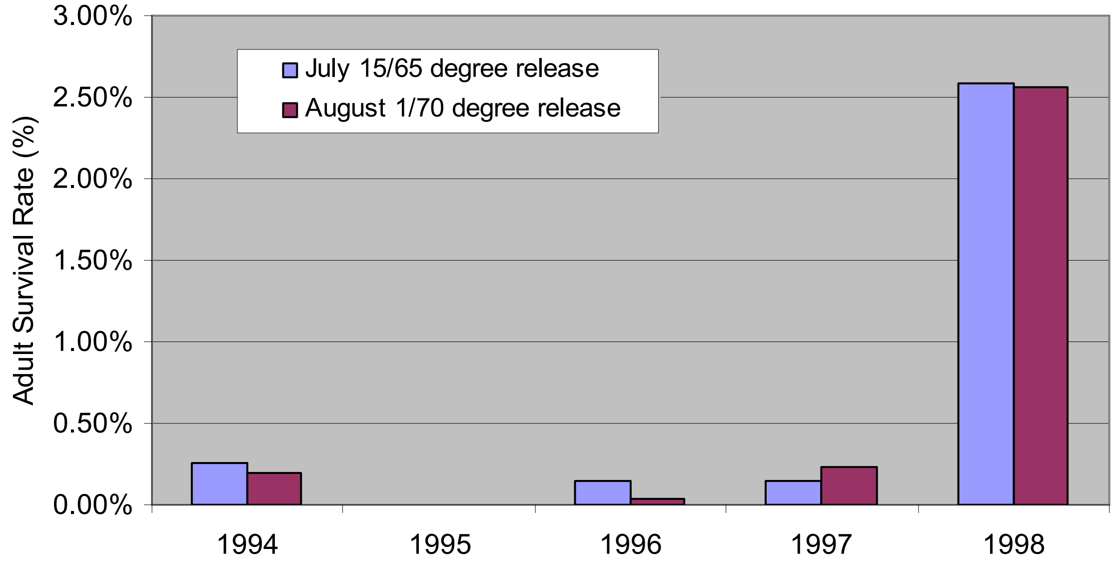


Figure 6.9. Survival rate of Select Area bright fall chinook by release date/temperature test group, 1994-1998 brood years.

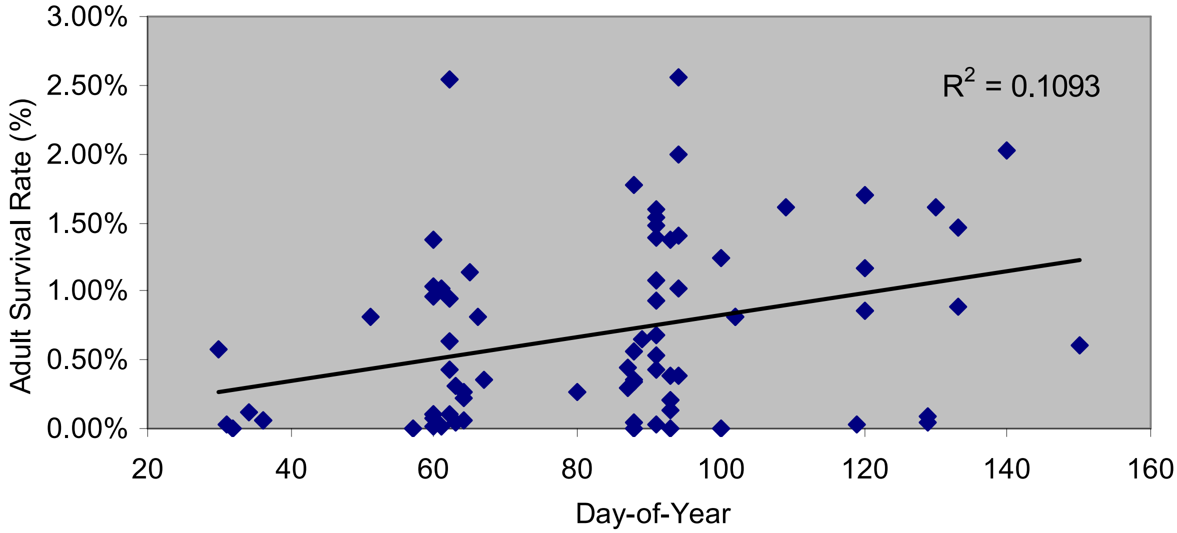


Figure 6.10. Relationship between release timing and adult survival of Select Area spring chinook based on recoveries of 77 coded-wire tag groups, 1988-2000 brood years.

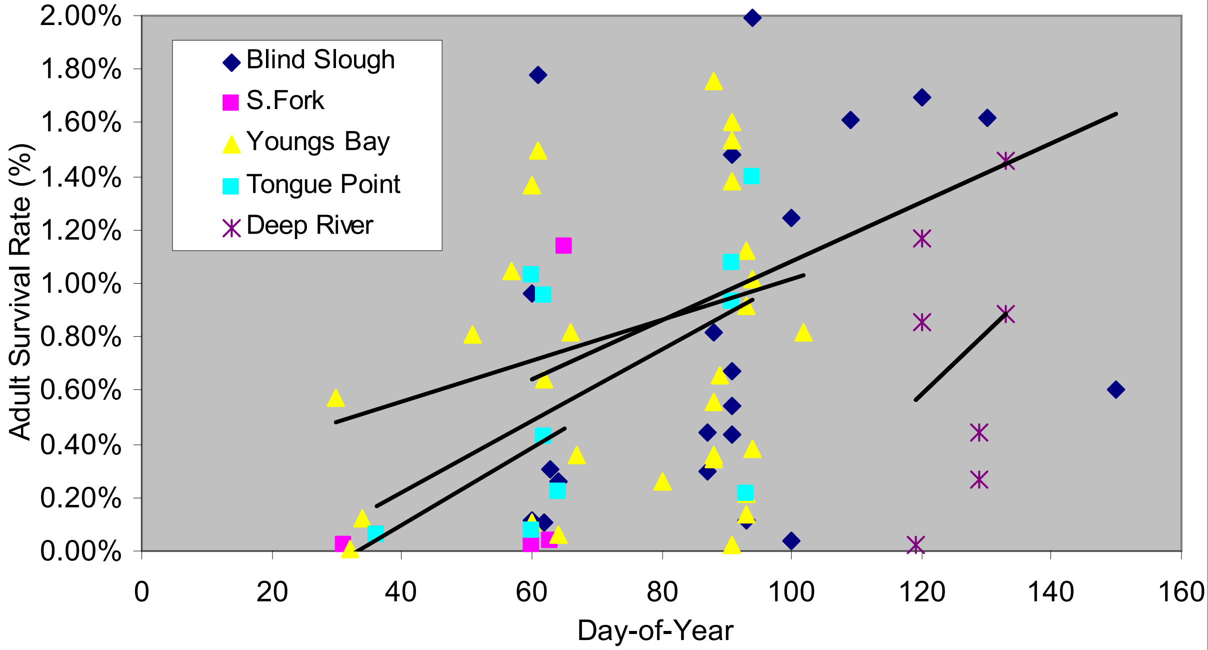


Figure 6.11. Relationship between release timing and adult survival rate of SAFE spring chinook by release site based on recovery of 77 coded wire tag groups, 1988-2000 brood years.

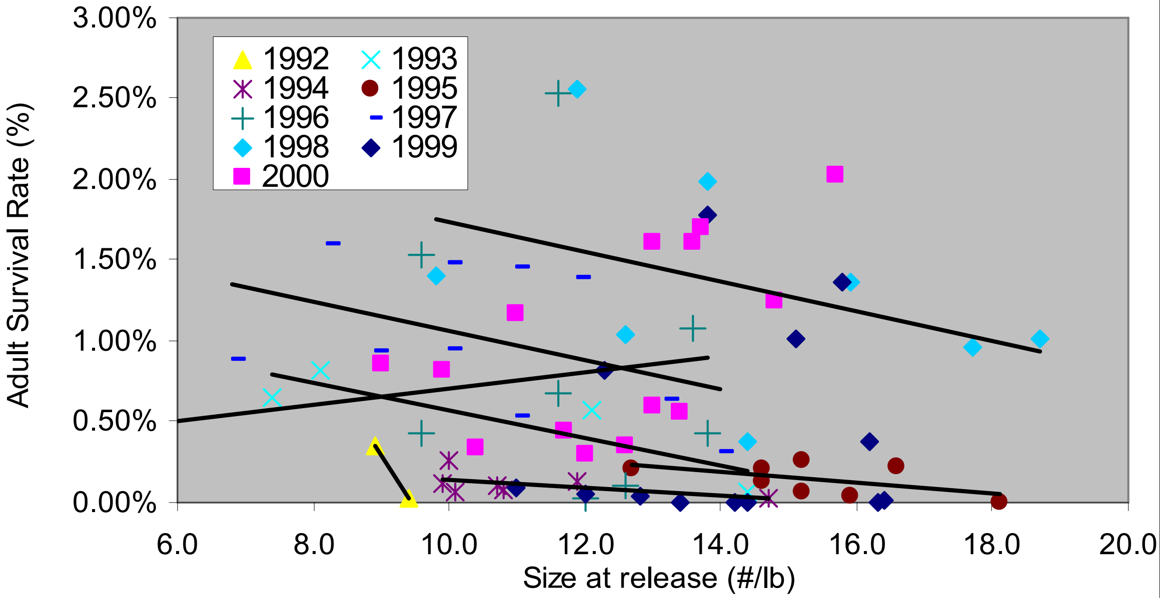


Figure 6.12. Relationship between size at release and adult survival of Select Area spring chinook based on recoveries of 75 coded-wire tag groups, 1992-2000 brood years.

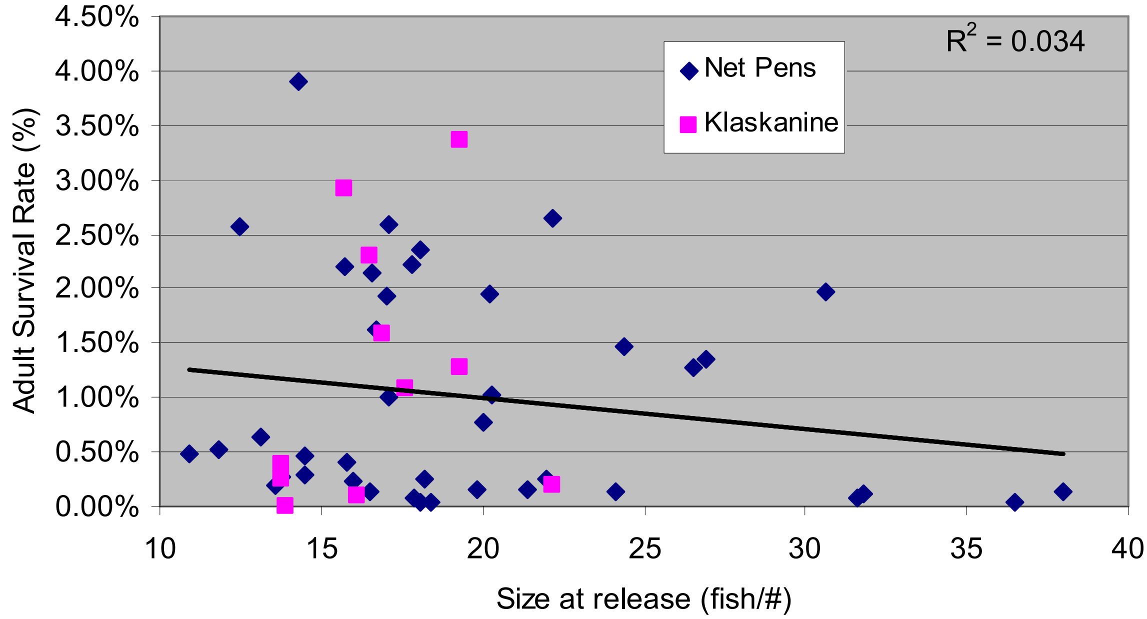


Figure 6.13. Relationship between size at release and adult survival rate for 51 coded-wire tag groups of select area bright fall chinook released from SAFE net pens and the Klaskanine Hatchery, 1993-2000 brood years.

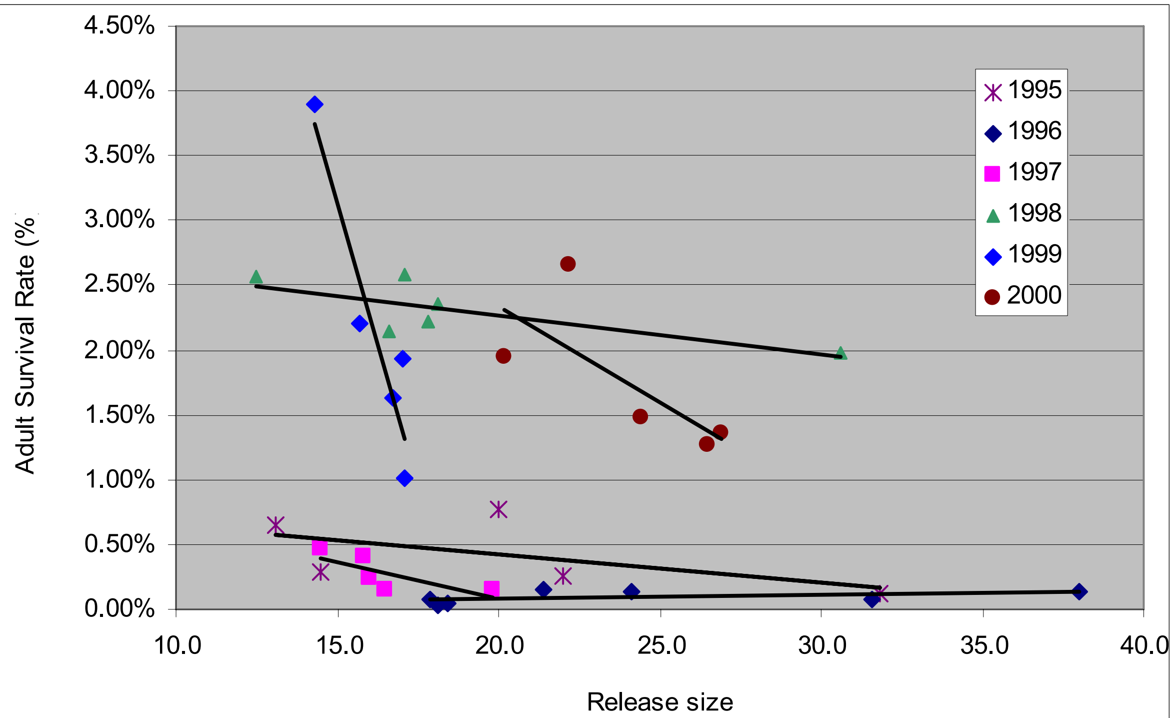


Figure 6.14. Relationship between release size and adult survival rate by brood year for 33 coded-wire tag groups of select area bright fall chinook released from Select Area net pens, 1995-2000 broods.

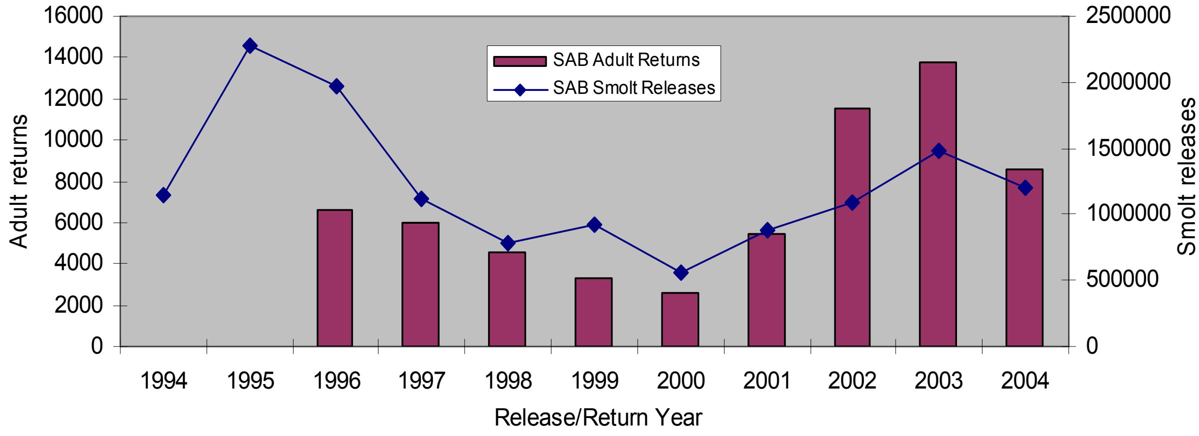


Figure 6.15. Select Area bright fall chinook smolt releases (1993-2003 brood years) and adult returns (1996-2004). Releases include production from ODFW's North Fork Klaskanie Hatchery funded by ODFW's Restoration and Enhancement Program.

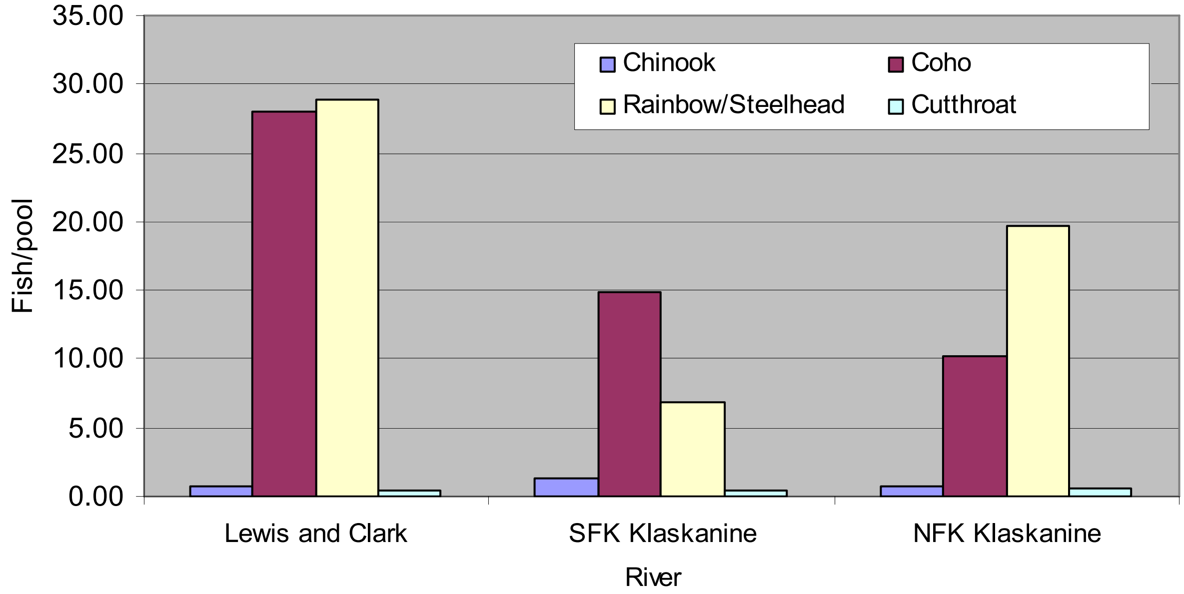


Figure 6.16. Relative abundance of juvenile salmonids in Youngs Bay tributaries during July, 1999-2002.

Figure 6.17. Implanting sonic transmitters in SAFE spring chinook to evaluate outmigration rate, May 2004. Funding provided by ODFW's Restoration and Enhancement Program.

7. ENVIRONMENTAL MONITORING

The objective of the SAFE environmental monitoring program for the last two years has been to monitor the effects of the fish rearing activities on the environmental health of the water bodies where the net-pen operations are located and to monitor the water quality at the facilities to insure its suitability for fish rearing. A comprehensive summary of all study years (1994-2005) is provided in Appendices A and B. Reference is made to (Hirose et al, 1998) where alternative rearing options are outlined to control net-pen environmental impacts.

In addition, the process of acquiring a National Pollutant Discharge Elimination System (NPDES) permit from the Washington Department of Ecology (WDOE) has begun. This permit will allow the expansion of the Deep River facilities.

The SAFE facility at Tongue Point, Oregon has been abandoned and the net pens have been moved to piling near the MERTS pier. The Steamboat Slough, Washington location has also been abandoned and those net pens will be moved to Deep River to accommodate the expansion there. The abandoned facilities were monitored a year after activities ceased. No further monitoring is planned for these locations.

QUALITY ASSURANCE

All work is done following Good Laboratory Procedures and in accordance with the Quality Assurance Project Plan associated with this project (DEQ, Quality Assurance Project Plan) (EPA Guidance for Quality Assurance Project Plans) (Water Quality Monitoring Technical Guide Book July 1999) (PSEP, Environmental Protocols).

Water Quality Parameters

Monitoring of the ongoing suitability of the water quality at the various SAFE facilities has been conducted for many years. All of the physicochemical parameters measured have been within the healthy tolerance range of the salmon being reared in the net pens by this project. Only the summer temperatures sometimes reach levels that may be stressful to salmon, but these occur during months when fish are usually not being held.

A Hydrolab™ water quality probe has been deployed at each site every month for a 24-hour period. This instrument records temperature, dissolved oxygen, pH, turbidity and specific conductance. This instrument and its deployment is expensive and labor intensive and is nearing the end of its life expectancy. Since the water quality parameters measured by this instrument have never been outside acceptable limits, a less stringent and more cost effective monitoring method has been adopted.

The Hydrolab™ water quality probe will continue to be deployed at the Deep River facility until another water quality monitoring method is developed in cooperation with WDOE to meet the requirements of the NPDES permit. At the other facilities temperature, dissolved oxygen (DO) and pH will be measured with hand-held meters several times each month. In addition, temperature will be recorded on disc charts. Data collected shows that the parameters are all within the range expected for the lower Columbia River tributaries and the range suitable for salmonids.

ASSESSING THE ENVIRONMENTAL IMPACT OF THE FISH REARING ACTIVITIES

The environmental impact of the salmon net-pen activities has been well studied over the years, especially those operating in salt water (NOAA Technical Memorandum NMFS-NWFSC-49). Facilities operating in fresh water are less studied. The environmental impact of the SAFE project net pens is monitored by collecting macro invertebrate samples under the net pens and from reference sites at the end of each growing season. These are compared with macro invertebrate population parameters of the impact and reference sites. In addition, samples are collected again in the fall, just before the beginning of the next growing season at any station where an impact was observed in the summer samples to measure recovery. The primary impact from net-pen fish rearing activities is organic enrichment of the area under the net pens. The impact on the macro invertebrate population varies from site to site, depending on the nature of the environment at a particular site. For example, a site with a saltwater influence will have a different macro invertebrate population structure than a fresh water environment, and the influence of an input of organic material on the population structures will be different.

Samples are also collected for sediment chemistry analysis. These samples are analyzed for total organic carbon (TOC) as a measure of organic enrichment and grain size as a reference of the sediment structure.

Some of the net-pen facilities operated by the SAFE project have production levels that require NPDES permits issued by the Oregon Department of Environmental Quality (ODEQ) and by WDOE. Under these permits the net pens at Youngs Bay in Oregon, and eventually the facility at MERTS in Oregon are allowed a 15-meter mixing zone extending in all directions from the net-pen structure. No mixing zone has been determined for facilities in Washington at this time. No environmental impact is permitted outside of the mixing zone as compared with reference conditions, and no impact that adversely affects aquatic life or any beneficial use is permitted within the mixing zone. Samples are collected at the perimeter of the mixing zone at these facilities to ensure that any environmental impact is confined to the mixing zone.

Steamboat Slough and Tongue Point (Pier 8) Facilities

The net-pen facilities at Steamboat Slough in Washington and Tongue Point in Oregon were abandoned at the end of the growing season in 2003. These sites were sampled in the summer of 2004 to determine if they had recovered from any impact of the fish rearing activities. The macro invertebrate population structure at the impact site at both of these facilities does not differ significantly in the major population parameters of density and richness from the reference sites. The only difference at the Tongue Point facility is a reduction in the density of *Ostrocoda* at the impact site, a minor species. The only difference at the Steamboat Slough facility is a reduction in the density of *Americorophium salmonis*; also a minor difference from the reference site. For practical purposes these sites have recovered from any previous impact.

Blind Slough Facility

The Blind Slough facility in Oregon is located over organically rich bottom sediments off the mainstem of the Columbia River, and the benthic macro invertebrate population is dominated by *Oligochaeta* worms. The *Oligochaeta* population is consistently more dense at the impact station than at the reference station at the end of the growing season, but it usually returns to the density levels of the reference station by the beginning of the next growing season in the fall after laying dormant for a few months. This is a minor impact and is considered acceptable by the regulatory agency, ODEQ. The production level at this facility was relatively low compared to some of the other facilities and therefore was below the level that required a discharge permit. There is no indication that an unacceptable environmental condition will develop at this facility at the current production levels.

Tongue Point MERTS Facility

Net pens previously located at the Tongue Point facility have been relocated to the new facility near the MERTS pier. Production at this facility is still low, therefore it does not require an ODEQ permit, but it has the capacity to be greatly increased so sampling here is conducted in the same way as at the higher production facilities. Samples are collected from the impact station located beneath the net pens, from three stations at the perimeter of the mixing zone, and from reference stations outside any possible influence of the fish rearing activities. In addition, a visual inspection is done on core samples taken beneath each net pen.

At the current production level the impact is light. The most common indication of organic enrichment at this facility is an increase in the density of *Oligochaeta* worms. The MERTS facility has not operated long enough to see any long-term trends, but there is some evidence that the organic enrichment persists through the summer period of non-use until the beginning of the next growing season. This could produce a long-term build up of organic matter and the undesirable effect that results from it. There is also indication that there is an impact of organic enrichment outside of the perimeter of the mixing zone at both ends of the facility. This will continue to be monitored and addressed as necessary.

Tide Point/Bornstein Facility at Youngs Bay

These two sets of net pens are located close enough together that they are treated as a single facility for the purpose of environmental monitoring and reporting. Production levels here require an NPDES discharge permit. The Bornstein net pens are the newer of the two and they have not been operating long enough to measure any long-term trends. The Tide Point net pens have been in operation long enough, and since the physical environment around these facilities is very similar it is reasonable to expect Bornstein net pens to show the same long-term conditions as the Tide Point net pens. These pens are very well flushed by the tidal currents and very little build up of organic matter is expected. Indications of organic enrichment exist in samples taken from the impact station below the net pens at the end of each growing season. However, these conditions have always dissipated by the beginning of the following growing season. An impact was detected at perimeter station 18 on the eastern end of the facility at the end of the last growing season in June 2005. No data is available yet to determine if this impact has persisted until the beginning of the following growing season. If this situation persists it would be a violation of the NPDES discharge permit under which this facility operates. However, at this time there are no environmental problems at this facility.

Yacht Club Facility at Youngs Bay

The facility at the Yacht Club in Youngs Bay in Oregon has the highest production level of the SAFE net-pen facilities, and some fish are held in pens here into the summer months. Organic enrichment of the sediments under the net pens is evident. The population density is consistently greater with more species present at the impact station under the net pens than at the reference station. This situation persists through to the start of the next growing season in the fall. The benthic community structure at this site is more complex than at the facilities previously discussed. Taxa that benefit from organic enrichment and are found in dense numbers are *Oligochaeta* worms and amphipods of the genus *Americorophium*. In addition these waters have been invaded by a non-indigenous species, the New Zealand Mud Snail (*Potamopyrgus antipodarum*). Densities of this species have been measured at over 100,000 animals per square meter, but more recent samples may indicate a decline in the population density of this species. Benthic community analysis and visual inspection of sediment cores show indication of heavy organic enrichment. So far the environment under the net pens has been able to absorb the enrichment without the development of anaerobic conditions on the sediment surface. An oxidized layer of one to three centimeters exists. However, deeper sediment is black and anaerobic. The heavy input of organic matter appears to be producing persistent conditions that could become unacceptable.

Samples have been collected at the perimeter of this mixing zone for the last four years. One perimeter station is located east of the net pens in a direction such that currents do not carry organic material to it from the net pens. No indication of an impact has been seen at this station, and none would be expected, so sampling at this station has been eliminated. The other two perimeter stations are in the direction of tidal currents. These two stations could receive organic enrichment from the net pens.

The station at the west end of the net pens was located under a bridge, which makes it difficult to distinguish the impact of the bridge and bridge-related activity from an impact of the net pens. This station was replaced by one located 15 meters from the bridge. No impact from the net pens has been found at this station.

The other perimeter station in the direction of tidal current has shown indications of organic enrichment. This station is located east of the net pens in the direction of the boat ramp. The macro invertebrate population at this station shows the influence of the net-pen activities and the deeper sediments have indications of heavy organic input. More extensive environmental monitoring is recommended at this facility.

Kato's Facility at Upper Deep River

This facility has been operating since 1995. During this time it has operated below the production limit that would require an NPDES discharge permit. However, the process of acquiring a discharge permit is in progress and production levels at this facility could be increased in the future. At the low production levels very little impact has been measured. From the summer of 2002 to the present, the benthic population at the impact site has been consistently more dense than at the reference site. While the Wilcoxon Rank Sum statistical analysis (Lyman, O, 1984) does not always allow for the detection of significance, the trend is apparent. For example, no significant differences from the reference conditions were seen in the samples collected from the impact station at the end of the growing season in June 2004, although the average population density was much greater at the impact site. However, samples collected at the end of the growing season in June 2005 showed a significant increase in population density at the impact site over that of the reference site.

The most common impact is an increase in the density of the population of *Oligochaeta* worms, which benefit from the organic enrichment, as was the case in 2005. The population of *Chironomidae* larvae also increased over the reference population. This produced an increase in the overall population density. However, data from samples collected at the beginning of the growing season in the fall of 2004 show no significant differences at the impact site from the reference condition. Significant differences seldom persist through the summer to the beginning of the following growing season. The most common difference between the impact site and the reference site at the beginning of the growing season is in the number of species. However, it is as likely that there will be more species present at the reference site as at the impact site in any given year. This is not a result of net-pen activity. At the present production level there are no environmental problems anticipated at this facility.

Fauver's Facility at Lower Deep River

This facility has also operated below the production limit that would require an NPDES discharge permit, as with the upriver facility (Kato's). The process of acquiring a discharge permit is in progress for this facility also and the plan is to increase production levels in the future. Environmental impacts have been very similar to those observed at Kato's facility. The low production levels have produced very little measurable impact, and the observed impact does not persist through to the next growing season. However, beginning in the summer of 2002 and persisting to the present, the population density at the impact site has been consistently greater than at the reference site. With the level of production at this site expected to increase it will be important to continue to monitor the environmental impact at this facility.

8. ECONOMIC BENEFIT

In their March 2005 review of the 1993-2004 Final Project Completion Report, the ISRP and IEAB requested a thorough economic analysis of the SAFE project, including value of the fisheries and costs associated with production and harvest (ISRP/IEAB March 2005). Past efforts to address the economic benefit of the SAFE project were limited to estimates of ex-vessel and personal income impact values and did not include project and harvest costs (North et. al. 2004). A formal response to the ISRP/IEAB review was planned for the summer of 2005, but Council staff felt that the SAFE ISRP response and the economic analysis should be submitted together. To address this request the SAFE project contracted The Research Group to complete a detailed analysis of existing economic value of the program and projections for future impacts. Contracting issues delayed the start of the analysis, which therefore delayed formation of the response since many of the issues are intertwined. An agreement was reached with BPA and Council staff to include the ISRP/IEAB responses from the SAFE project in the 2005 Final Completion Report (this report). To address the ISRP concerns, new updated information has been included throughout this document, which is a revision of the draft SAFE Project Final Completion Report (North et. al. 2004). Chapter 11 provides a summary of the ISRP comments and references where each issue is addressed in the report.

The economic analysis was intended to be an addendum to this report, however, it is not yet complete and rather than delay submission of both documents that analysis will be submitted separately.

9. Rationale

The SAFE Project provides the opportunity for both commercial and recreational fishers to harvest strong, locally-produced stocks of hatchery salmon in off-channel areas of the Columbia River with minimal impacts to non-local stocks including species listed under the ESA. Due to the geographic separation of the sites and relatively low abundance of listed stocks, select areas provide meaningful commercial and recreational harvest opportunities that are not always possible in the mainstem Columbia River where various stocks commingle. While mitigation for development of the Columbia hydrosystem is focused on the preservation and recovery of depressed salmonids, the preservation of the fishery infrastructure is equally important if recovery is indeed defined by harvestable, naturally spawning populations.

The SAFE project was recommended in the recent Federal Columbia River Power System (FCRPS) BO as a bridge to a time when naturally spawning populations of salmon and steelhead again support commercial harvest. Fishing communities and their economies have been devastated by the collapse of Columbia River fish runs and curtailment of fisheries. The economic and social benefits of the SAFE project remain significant to affected non-Indian fishers and the sport and commercial fishing industries. Further reduction of non-Indian fisheries would only heighten the imbalance of conservation among industries that impact salmon throughout the basin.

Biological objectives of the SAFE project are consistent with the recently completed Subbasin plans. The Bi-state Mainstem Lower Columbia River and Columbia River Estuary Subbasin plans identify the management of "Columbia River fisheries at sustainable levels, maintaining a viable population through adequate spawner abundance, and directing harvest away from depressed stocks" as Strategy 15 in the biological objectives of the recovery plan (p. 9 of the Executive Summary and p. 4-63 of the Management Plan) (Zenn et al. 2004). In keeping with the vision statement of this plan, this project utilizes "supportive hatchery and harvest practices…" while avoiding issues related to mixed-stock fisheries. Continuation of the SAFE project is specifically called for in Measure 37 (p. 4-63) of the Management Plan.

While harvest reduction has the potential to benefit some species (e.g. fall chinook) more than others (e.g. chum), the Management Plan Supplement to the Bi-state Mainstem Lower Columbia River and Columbia River Estuary Subbasin plans recommends continuation of the SAFE project because it has a "High" probability to contribute to the biological objectives in the recovery of chum (p. 5-36), fall chinook (pp. 5-54 and 5-74), coho (pp. 5-92 and 5-111), winter steelhead (pp. 5-128 and 5-146), spring chinook (pp. 5-162 and 5-179), and summer steelhead (pp. 5-198 and 5-217) (Zenn et al. 2004).

The Washington Lower Columbia River and Estuary Subbasin Plan recommends a strategy "preserving fishery opportunities focused on hatchery fish in a manner that does not adversely affect recovery efforts"; Section 6.6, pp. 6-32 and 6-35). The plan recommends "utilization of the select area off-channel sites" as action to minimize impacts to naturally spawning steelhead, coho, and spring chinook (Section 6.6, pp. 6-41, 6-42, and 6-43). For future monitoring and research the Washington Estuary Subbasin Plan lists "evaluate innovative techniques (e.g. terminal fisheries and tangle nets) to improve access to harvestable stocks and reduce undesirable direct and indirect impacts to wild populations" (Section 7.8.5 p. 7-30). While these strategy recommendations are listed in the estuary and lower Columbia subbasin plans, conservation benefits from the SAFE project apply to anadromous stocks in every subbasin of the Columbia River.

The SAFE project is also consistent with the objectives outlined in the Northwest Power Planning Council's Final 2000 Columbia River Basin Fish and Wildlife Program (NWPP 2000). In the Council's 2000 Multi-Species Approach for Decision Making, two of the overarching objectives are to provide "mitigation across the basin for the adverse effects to fish and wildlife caused by development and operation of the hydrosystem" and "sufficient populations of fish and wildlife for abundant opportunities for tribal trust and treaty right harvest and non-tribal harvest". In its recommendation for artificial production review, the Council further states the harvest "hatcheries intended solely to produce fish for harvest to create a replacement for the lost or diminished harvest opportunities", but cautions "the hatchery must be located and operated in a suitable manner that does not lead to adverse effects on other stocks through excessive straying or the excessive take of weak stocks in mixed stock fisheries". The Council also warns that a harvest hatchery is of "little benefit if the majority of hatchery fish go uncaught because the potential harvest is restricted by another, much weaker stock". Because SAFE fisheries occur in off-channel areas of the lower Columbia, the catch of non-local stocks including listed species is minimized. The acclimation of hatchery fish in net pens and subsequent liberal harvest of local hatchery stocks in SAFE fisheries further minimizes straying and the potential for the interaction with naturally spawning populations. The Council also recommends the identification of potential opportunity for a terminal fishery in every subbasin plan. The SAFE project is one of, if not the only, Bonneville Power Administration's fish and wildlife programs designed specifically to mitigate for lost harvest opportunity on the lower Columbia River.

The Independent Economic Analysis Board (IEAB 2002) reviewed eight Columbia River Hatchery programs and reported their findings in the summer of 2002. One of those programs reviewed was the CEDC Fisheries Project. Although the data used to evaluate the cost-per-adult and cost-per-harvested-adult have since improved, fish produced by this project had better and much higher harvest rates than any of the other projects studied. (IEAB Hatchery Report-Part 2).

The SAFE spring chinook program operates in accordance with the ODFW Fish Hatchery Management Policy (ODFW 2003), the Northwest Power and Conservation Council Annual Production Review Report (NPPC document 99-15), the Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan (LCFRB 2004), and the Lower Columbia River and Estuary Bi-State Subbasin Plan (LCREP 2004). The program is also consistent with the ODFW Native Fish Conservation Policy (ODFW 2003).

10. FUTURE PLANS

Since inception in 1993, the SAFE project has grown steadily and now contributes significant numbers of fish for harvest in select areas, as well as commercial and recreational fisheries occurring in the mainstem Columbia River and the Pacific Ocean. Select area fisheries now provide stable and predictable harvest opportunities for commercial and recreational fishers. Adaptive in-season management has allowed for high harvest rates of returning adults with minimal impacts to listed species. An extensive monitoring program has documented high harvest rates, moderate straying levels, and low impacts to non-target species and listed salmonid stocks. Progress of the project, including site selection and development, juvenile production, and subsequent increased adult returns, was intentionally protracted to ensure that the goal of protecting depressed and listed stocks while expanding harvest opportunities was accomplished.

Because of this extended project development, the long-term goal of the SAFE project to achieve full production of all species at all locations has not yet been achieved (Table 10.1 and Figure 2.2). Until full production has been realized, the true potential and cost:benefit ratio of select area fisheries cannot truly be evaluated. Continuation of this project will maintain the significant fisheries established in select areas and allow for transition from the implementation to expansion phase. Presently, funding is the main obstacle constraining expansion of the SAFE project; however, significant potential exists to increase the economic value and improve the cost:benefit ratio of the project given the current infrastructure through efficiencies and moderate increases in expenses.

This chapter describes the planned short-term and potential long-term actions the SAFE project can implement to meet these objectives and maximize cost effectiveness. The project efficiencies and production changes described in "Short-Term Plans" are known actions that will allow the SAFE project to approach the short-term production goals detailed in Table 10.1. Other actions that could possibly allow for expansion to full production (defined in Table 10.1) are outlined in the "Long-Term Plans" section.

SHORT-TERM PLANS

Improving the value of SAFE fisheries can be accomplished by 1) maximizing the value of the fish harvested, and 2) increasing production. Maximizing value of harvested adults includes releasing fish with a high market value, maximizing harvest opportunities, and improving quality and marketing of the landed product. Increasing production can be accomplished by either increasing smolt releases or by improving SAR's. In the short-term the SAFE project intends to increase production by focusing primarily on increasing SAR's, combined with modest increases in juvenile production whenever possible through cost efficiencies. With regard to maximizing value of adult returns, SAFE project staff plan to shift some production to high value stocks and stabilize and maximize harvest opportunities. Other methods of increasing the value of fish caught in SAFE commercial fisheries are generally outside the scope of this project and therefore require that the commercial fishing industry implement those changes.

Increase Smolt-to-Adult Survival Rates

Increasing SAR's is the most efficient method of increasing adult returns. Although SAR,s are greatly affected by factors outside the scope of this project, there are several project modifications that may improve survival rates including, 1) net-pen towing, 2) release time modifications, 3) discontinuation of the SAB fall chinook LV clip, and 4) reducing predation in net pens. These modifications are generally cost neutral, with some options actually reducing operating expenses of the project. These modifications are expected to increase adult returns, which will improve the cost:benefit ratio of this project.

Net-Pen Towing

Towing net pens outside the rearing area for smolt releases is a liberation strategy currently being evaluated by this project (see Chapter 6). The hypothesis is that towing fish to the mainstem Columbia River for release will increase SAR's because current releases likely suffer significant bird predation during their migration through the tidewater bays and sloughs where net-pen rearing sites are located. By towing the pens through areas of highest avian predation this source of mortality would be reduced and adult returns would increase correspondingly. Results of release trials conducted to date using coho from Youngs Bay have shown potential benefits. Survival rates for towed releases were higher than rates for non-towed releases held over-winter, with no negative effect on straying. This release technique shows promise and project staff are beginning to evaluate this release strategy at other sites and with different stocks. If results are positive this technique could be applied to all species in all locations.

In addition to potential survival rates, this release technique will likely reduce the potential for interaction between smolts released by the SAFE project and local wild juvenile salmonids because the estuarine residency time of towed SAFE smolts is less than rates for smolts released directly from the select area rearing locations (see Chapter 6). Costs associated with this release strategy include contracting vessels to tow the pens, which can be provided by commercial fishers. The cost of net-pen towing is relatively low and could be reduced to minimum levels depending upon voluntary participation levels.

Release Time Modifications

Conducting smolt releases at the proper time can have a significant effect on both SAR's and outmigration rates. Typically, spring chinook smolts are released in the late-February through early-April timeframe, depending on the program. In Oregon SAFE sites, February releases of spring chinook have been discontinued in favor of early-April releases due to poor SAR's, as documented by CWT release trials. Before net-pen towing became an option in Deep River, release of spring chinook was not allowed prior to May 1 to avoid interactions with listed chum salmon. Staff hypothesized that delaying the release of Deep River spring chinook resulted in lower condition factors because they were held past the optimum release time, causing reduced SAR's. Additionally, the late release time may delay outmigration time and increase residualism. Beginning in 2005 the Deep River net pens were towed to the mainstem Columbia River channel two months earlier with anticipated improved survival.

One method of determining appropriate release time is to monitor ATPase levels in smolts prior to release. ATPase can be used as an indicator of smoltification, which can aid in determining the proper timing for release. Currently CEDC is collecting ATPase samples from one CWT group of spring chinook, coho and SAB fall chinook each year prior to release to determine if this indicator is useful for determining optimum release timing for smolts released by the SAFE project. ATPase samples have been collected weekly for Deep River spring chinook beginning six weeks prior to towing in March.

Releasing smolts at the proper time will reduce seaward migration time and residualism, both of which will minimize interactions with local wild salmonids. Costs associated with this evaluation are limited to ATPase sample analysis, since project staff can collect the samples concurrent with production activities. Implementation of towing for Deep River spring chinook may actually reduce project costs by conserving feed if the release date can be moved forward by several months as proposed by staff.

Reduced Fin-Clipping Requirements

Currently SAB fall chinook releases are mass marked with an LV fin clip to facilitate positive identification of broodstock and to document strays upon their return as adults to the lower Columbia River basin (see Chapter 1). This marking program helped document high stray rates of this stock when releases occurred at Big Creek Hatchery. In 1996 the broodstock program was moved from Big Creek Hatchery to Klaskanine Hatchery in an effort to reduce straying. The move has proven to be successful since current stray rates for SAB fall chinook are minor (see Chapter 5). Project staff are interested in discontinuing the left ventral fin clip and increasing CWT rates for SAB stock fall chinook if there is regional support for this action. Past studies indicate that a ventral fin clip causes a 43 percent average decrease in SAR's (Wahle and Vreeland 1978; Blankenship 1998); therefore, elimination of this fin clip would nearly double adult returns.

Eliminating the LV clip would also reduce costs of the project associated with contracting fin-clipping operations. Cost savings produced by this change in marking could be re-invested into increased CWT marking and continued hatchery and spawning ground monitoring to ensure that stray rates remain low for this stock. This project modification would be neutral with respect to interactions between SAFE project smolt releases and wild juvenile salmonids since no additional smolts would be produced. Since the occurrence of other non-SAB adult fall chinook in Youngs Bay tributaries is low and SAB straying is minor, the consequence of eliminating the LV clip on SAB fall chinook broodstock should be minimal.

Predation in Net Pens

Rearing juvenile salmonids in net pens concentrates the fish and makes them an attractive target for predation by birds and otters. Project staff believe small daily losses may currently be resulting in significant annual losses that cannot be accounted for since fish are not generally inventoried (counted) prior to release. This unknown loss results in a negative bias in SAR's since fewer fish (and coded-wire tags) are actually released than the number used in calculations of survival and economic benefit. Staff are investigating if investment in a mechanical fish counter would be feasible so that release numbers could be verified. In the meantime, netting used to cover the pens to prevent avian predation has been replaced with a smaller mesh size to eliminate all bird predation. The mesh size of most of the older covers prevented predation by terns and gulls but did not eliminate predation by blue herons, which can extend their long neck through the netting to prey on the fish. Predation by river otters that inhabit select area rearing sites has been especially difficult to prevent because these animals are very adept at circumventing barriers. Staff have tested various netting configurations and electrified wire in an attempt to control this source of fish loss. While these steps have reduced the level of otter predation somewhat they have not eliminated the problem. Staff will continue to investigate methods of reducing otter predation. If these onsite predation losses can be addressed, more fish will be released yielding a greater economic return for the same investment. Whether or not predation can be eliminated, an accurate inventory of releases will at least provide a more accurate assessment of actual project benefits.

Increased Juvenile Production

Adult production could be significantly increased by combining the aforementioned methods for increasing SAR's with increased numbers of smolts released. Increasing smolt production could be accomplished by either increasing efficiency of current rearing facilities or by increasing capacity of the facilities. Improved adult returns associated with increased juvenile production would likely improve the cost:benefit ratio of this project, depending on implementation costs. Except for additional feed and marking costs, efficiency improvements would generally be cost neutral, with some methods requiring small additional monetary investments. Increasing the capacity of current rearing and/or net-pen acclimation facilities would require significant capital expenditures and additional operating costs. Costs of expanding current facilities and associated smolt releases may or may not result in an improved cost:benefit ratio depending on the cost of the expansion, adult returns, and fishery performance. Methods of increasing juvenile production currently being considered include; 1) oxygen supplementation, 2) improved brood stock collection, 3) re-establishing lost production, and 4) improved project efficiencies.

Oxygen Supplementation

Based on results of our research with dissolved oxygen, this rearing strategy could be used to increase SAFE spring chinook smolt production and fully utilize the existing 1.12 million egg incubation capacity at Gnat Creek Hatchery. The additional 250,000 fry would be reared through the winter to 15 fish/pound at Gnat Creek Hatchery, and then moved to Blind Slough for acclimation until April. The original 850,000 would be split between Youngs Bay (600,000) and Tongue Point MERTS (250,000) for over-winter feeding. Higher smolt production would therefore result in some increase in interaction between SAFE project smolt releases and wild salmonid smolts. Potential interactions could be minimized through net-pen towing and monitoring of gill ATPase. The primary outcome of this rearing strategy will be to increase production modestly, while producing a healthier smolt that will survive at a higher rate. The costs associated with this modification would include installation of an oxygen distribution system, compressed oxygen, and additional feed costs. The cost of disease treatments should be reduced. Additional staffing will not be required because staff can accomplish tasks associated with this modification concurrent with other production activities. This modification would involve modest additional cost to the project but increased production would improve the project's cost:benefit ratio.

Improved Broodstock Collection

Early rearing of SAB fall chinook has primarily been conducted at Big Creek Hatchery, with releases occurring from Klaskanine Hatchery for perpetuation of the broodstock program and from Youngs Bay net pens to maximize harvest opportunity. To date this stock has yet to achieve full production due to insufficient adult returns to the Klaskanine Hatchery located on the North Fork Klaskanine River. This stream is prone to low flows during August-October, which makes it difficult for fish to migrate upstream. Achieving full production for SAB fall chinook will likely require a multi-faceted strategy.

One alternative is to actively collect and hold adult SAB fall chinook in upper Youngs Bay prior to their entry into the Klaskanine River system. Project staff successfully initiated this alternative in 2003 (see Chapter 6). This strategy will likely be continued until it is no longer needed to meet broodstock collection goals.

Some SAB fall chinook also return to the SF Klaskanine Hatchery. This tributary of the Klaskanine River maintains higher flow levels than the North Fork during August-September, which allows for increased conversion of broodstock SAB fall chinook from Youngs Bay to the SF Klaskanine Hatchery. In 2004 and 2005, 45,000-54,000 smolts were released annually from the SF Klaskanine facility to increase broodstock returns for SAB fall chinook. Beginning with the 2005 brood, all releases of this stock are scheduled to be from the SF Klaskanine Hatchery as part of the transition to coho production at the Klaskanine Hatchery (discussed below). Installation of an improved adult weir at the SF Klaskanine Hatchery will be needed to facilitate adult collections and prevent undesirable straying in this system.

These actions should yield increased production of SAB fall chinook that will increase the potential for interaction between wild juvenile salmonids and SAB fall chinook smolts. However; the release time for SAB fall chinook smolts is July, when few wild salmonids are present in the lower Klaskanine River basin (downstream of the two hatcheries) due to low flows and high water temperatures; therefore, tributary interaction between project and wild production is negligible for this stock. Costs associated with these project modifications are minimal since existing staff and equipment are sufficient to implement this work. These modifications would improve the cost:benefit ratio of the project by producing more smolts with little to no increase in costs.

Re-establish Lost Production

For many years, the SAFE project has received up to 1,000,000 full-term coho salmon smolts for acclimation from Eagle Creek National Fish Hatchery through the Mitchell Act; however, this program was discontinued in 2004 (2002 brood) due to federal budget shortfalls. This production loss will represent approximately a 70 percent reduction in coho releases at Tongue Point and a 22 percent reduction at Youngs Bay. Based on results for the 1993-1999 brood years, these lost releases would produce a combined catch of 22,000 adult coho in regional fisheries, of which 16,000 would be harvested in SAFE commercial fisheries. Due to the importance of select area coho production to regional fisheries, SAFE project staff are in the process of re-establishing recent coho production levels through production at ODFW's Salmon River and Klaskanine hatcheries. The Salmon River Hatchery has the capacity to rear 200,000 coho juveniles through October that could then be transferred to the SF Klaskanine Hatchery for final rearing and release. This action is supported by ODFW and is currently in the public review process. Costs associated with this production would be limited to feed and supplies associated with rearing while at the SF Klaskanine Hatchery. Secondly, production of an additional 750,000 coho smolts at Klaskanine Hatchery was incorporated in the SAFE project 2007-2009 BPA funding proposal request. This production opportunity is made possible by the previously described transfer of the SAB fall chinook broodstock program to the SF Klaskanine Hatchery. Annual costs associated with this production are included in the 2007-2009 SAFE project proposal budget at $218,000-230,000. Costs were minimized by 1) only hiring one permanent FTE staff for Klaskanine Hatchery, 2) realigning duties of the existing ODFW staff technician to provide three months hatchery assistance, and 3) re-aligning CEDC staff duties to achieve six months of FTE time for assistance at Klaskanine Hatchery.

Another production program that could yield significant economic value if reinstated is releases of spring chinook from the SAFE Tongue Point MERTS site. Previous production level releases from the original Tongue Point site were voluntarily discontinued in 2001 due to excessive straying of previous broods (see Chapter 1). A new rearing site and use of artificial imprinting are currently being evaluated in an attempt to re-establish significant releases at this site (see

Chapter 6). If results of this study are positive, project staff propose that spring chinook releases at Tongue Point MERTS be restored to their previous level (250,000 smolts annually).

Coho production at the two Deep River sites is presently being increased to levels that were temporarily reduced when spring chinook were prioritized in 2001. In 2006, Steamboat Slough net pens will be relocated to Deep River, providing the total rearing capacity of 350,000 spring chinook and 400,000 coho, and will make the site more competitive with other SAFE sites. This becomes an important management issue when attempting to distribute fishing effort.

The impact of these production changes would not cause a net increase in impacts on wild juvenile salmonids because they would replace production programs that were previously in effect for many years. If relocation to the new Tongue Point MERTS rearing site reduces straying of returning adults, re-establishment of larger spring chinook releases at this site would represent a net reduction in interactions between SAFE and wild stocks. Costs of re-establishing these programs would be moderate because, 1) Klaskanine Hatchery is currently capable of rearing the 750,000 coho and personnel costs are minimized through staffing efficiencies, 2) coho production at Salmon Hatchery would be an in-kind contribution, and 3) spring chinook production for the Tongue Point MERTS site would occur through the proposed oxygen supplementation increases at Gnat Creek Hatchery, which has a relatively low implementation cost. The infrastructure for acclimation of these smolts is already in place and would not require additional investment; therefore, these re-establishments would increase the cost:benefit ratio of this project.

Project Efficiencies

Several steps have already been taken and others planned to achieve modest production increases (Table 10.1), while incurring little additional cost as outlined in the SAFE project 07-09 BPA funding proposal:

- Effective FY 2007, the full-time WDFW environmental specialist position was eliminated with responsibilities shifting to existing SAFE staff.
- Effective FY 2007, duties for the existing ODFW staff technician were adjusted to provide three months of hatchery assistance at Klaskanine Hatchery.
- Effective FY 2007, ODFW's Gnat Creek Hatchery staff will assume feeding duties at CEDC's Blind Slough net-pen site, making it possible for CEDC staff to assist at Klaskanine Hatchery.
- Beginning in 2005, and continuing though 2007, WDFW field duties are being combined into fewer positions, resulting in the elimination of four part-time positions into one position located at Grays River Hatchery, with duties divided between rearing and local SAFE fishery sampling.
- Install an oxygen supplementation system at Gnat Creek Hatchery to fully utilize incubation capacity (1.12 million eggs)
- Improved supplemental broodstock collection methods for SAB fall chinook and relocated brookstock program to SF Klaskanine Hatchery
- Discontinued Steamboat Slough releases and moved net pens to Deep River site to increase coho and spring chinook production
- Effective FY 2008, two full-time project manager positions will be reduced to half-time (CEDC and WDFW).

These steps will enable the following production increases:

- 250,000 spring chinook at Gnat Creek Hatchery (150,000 to Tongue Point MERTS and 100,000 to Youngs Bay)
- 100,000 spring chinook at Deep River
- 750,000 coho at Klaskanine Hatchery
- 200,000 coho at SF Klaskanine Hatchery from Salmon River Hatchery
- 50,000 coho at Deep River
- Potential for attaining production goals for SAB fall chinook (1.5 million)

Increase Value of Fish Harvested

The ultimate goal of fish produced by the SAFE project is for harvest; therefore, maximizing the value of the harvest is a logical objective of this project. Methods of increasing the value of fish harvested in SAFE fisheries include, 1) shifting production to species that have a high commercial value, and 2) developing stable predictable fisheries. These actions are generally cost neutral and would increase the cost:benefit ratio for the project due to the increase value of the catch.

<u>Shifting Production</u>

Shifting production to species or stocks of salmon with the highest commercial value can increase income to the commercial fishing industry for similar production levels. Shifting some production from coho to spring chinook would accomplish that goal if the disparity in market value remains, survival of spring chinook is sufficient to maintain decent adult returns, and SAFE winter-spring fisheries are not constrained due to upriver spring chinook impact limits. Substantial differences in price per pound between these two stocks during 2000-2001 prompted local fishers to request production changes in favor of spring chinook beginning with the 2002 brood. Based on this request, annual production during 2002-2005 at the SF Klaskanine Hatchery was shifted from a release of approximately 600,000 coho smolts to 625,000 spring chinook smolts. Unfortunately, spring chinook reared at the SF Hatchery experienced health issues and production was discontinued after release of the 2003 brood due to loss of August-September water rights at this facility. Additionally, in 2003 coho production for Deep River was reduced from 350,000 to 150,000 smolts, and spring chinook production was increased from 150,000 to 250,000 smolts (see Chapter 1, Figure 2.2).

Similar production shifts may be considered in the future, but the impacts to the project as a whole will be evaluated. It is important to note that a goal of the commercial fishery is to maintain product on the market during as much of the year as possible, and this cannot be accomplished if SAFE production is limited to a single stock; however, the law of diminishing returns must be considered. For instance, if the SAFE project produced only spring chinook then the total value of the commercial fishery may actually decrease if supply exceeded demand. Even though price per pound is consistently higher for spring chinook than coho, this is offset by the increased number of coho landed. In fact, in most years coho yield a greater economic value for SAFE commercial fisheries than do spring chinook. Finally, the effect on sport fisheries should also be considered. Production of coho from the SAFE project contributes significantly to Columbia River, select area, and ocean sport fisheries. Elimination of coho salmon from the SAFE project would have a negative impact on both Columbia River and ocean fisheries targeting hatchery coho salmon. Ultimately the critical issue is to maintain the proper balance between all species being produced by the SAFE project to ensure that a variety of stable and profitable fishing opportunities are available to commercial and sport fisheries in the region.

Shifting production between species should have limited effect on interactions between SAFE and wild production. In general, species and areas were chosen due to their lack of interaction with wild stock adults; therefore, effects of shifting production will be minor. Shifts between coho and spring chinook are cost neutral because both species smolt as yearlings and therefore incur similar rearing costs.

Maintain Stable Predictable Fisheries

Commercial fisheries are strongly impacted by the stability of fishing opportunities over time. Stable predictable fisheries allow the commercial fishing industry to effectively develop and maintain markets for harvested fish. Success of SAFE fisheries depends on providing sufficient releases to support the various SAFE fisheries and providing enough fishing opportunity to maximize harvest. Conversely, unexpected closures or wide variations in fishing seasons from year to year can eliminate market opportunities and reduce the value of the fishery as a whole. Except for 2003 winter and spring, and 2004 and 2005 spring seasons, the SAFE project has effectively managed fisheries to ensure stability and predictability. Fishery actions taken in SAFE areas in 2003-2005 were the result of shared impacts between mainstem and SAFE commercial fisheries. In both years, impacts in mainstem commercial fisheries exceeded expectations due to lower than anticipated returns, resulting in unexpected closures of SAFE commercial fisheries to remain within ESA-related impact guidelines. These closures resulted in lost commercial catch and reduced economic value of the fishery. Project staff recognized the shortcomings of this situation and in 2003 completed a BA for SAFE commercial and sport fisheries. This document clearly describes past fishery impacts to listed species and planned fisheries for future years in addition to proposing revised impact rates for SAFE fisheries that are consistent with the Columbia River Fish Management Plan. The purpose of this document was to establish impact rates for SAFE fisheries that would allow stable predictable commercial fishing opportunities in SAFE sites independent of other fisheries. Although the BA was submitted to NOAA Fisheries in December 2003, a BO was never pursued when it became clear any increase in SAFE impact rates would require compensatory reductions in other non-Indian fisheries.

LONG-TERM PLANS

Full Production for Select Area Fisheries

The primary goal of Phase III of the SAFE project is the maximization of production at each site. Although some of the current sites are nearing full production for some species, no site is at full production for all species. Given all the possible scenarios, it is difficult to identify specific release numbers and costs associated with full-scale SAFE production. Full production essentially is defined by what constraining factor is triggered first. As each factor is addressed satisfactorily, production is then constrained by the next limitation. For example, if funding were available to maximize production at a given site, constraints on waste discharge could limit production capacity. The limiting factors are a combination of technical/physical constraints with local economic elements, depending on the site and species. These factors could include:

- Availability of funding
- Physical and logistical limitations (number of net pens and site permits)

- Availability of gametes and/or fingerlings
- Facilities for early rearing (hatcheries)
- Market conditions
- Biological constraints such as harvest impacts, perceived juvenile interaction, DEQ limitations and straying of adult returns
- Local meetings between SAFE representatives, fishermen and commercial buyers
- State and local agency meetings with stakeholders
- Individual contact by one or more stakeholders

For this document we have assumed that full SAFE production represents reasonable expectations for smolt releases based on current market conditions and existing infrastructure (Table 10.1). Two potential actions that could be utilized to achieve the long-term production goals include 1) expansion and full utilization of existing rearing sites, and 2) development of new select area sites.

Expand Facilities and Associated Smolt Production

Given the existing facilities, most sites are at or near production capacities. Expansion to full production would require significant capital construction costs for additional net pens, and/or major modifications of existing hatchery facilities. In some cases only construction of additional net pens is required, whereas in other situations both investments are required. Costs could be significantly reduced if some of the current regional hatchery production was redirected through SAFE facilities in the form of pre-smolts for acclimation and release.

Additionally, over-summer rearing could potentially be used to increase production. By receiving fish as fry in the spring and rearing fish in net pens over the summer, the SAFE project could significantly increase the number of smolts produced. This rearing strategy has been tested at the Tongue Point and Youngs Bay sites with moderate success documented in Youngs Bay, but poor results due to disease in Tongue Point. Additional studies concerning the locations and species that would benefit from this rearing strategy are being considered. Results of future studies will determine how and if over-summer rearing can be implemented to increase SAFE production.

Implementation of over-summer rearing would allow for production increases at all three Oregon sites by shifting more over-winter fish to Blind Slough and Tongue Point from Youngs Bay and replacing the Youngs Bay production with over-summer fish from other facilities. Additional net pens would be required at all sites to facilitate this strategy. Annual costs of the modification would be moderate and would consist of fish food and medication necessary to rear fish from fry to smolt. Additionally, one mechanical net-pen washer would need to be purchased for each site because net fouling by algal growth increases with warm, summertime water temperatures. Increased production would occur at a moderate cost; therefore it is likely that this project modification would have a positive effect on the cost:benefit ratio.

Develop Additional Sites

During the initial research phase of this project, 20 different sites were evaluated, with the five sites (four current plus Steamboat Slough) being selected because they were best suited for net-pen rearing, harvest of returning adults, and minimizing interactions with wild salmonids. The potential to expand to the remaining sites, and others more recently identified, has been limited by available funding and/or a source of low-cost fish for acclimation. If either of these two obstacles were lifted expansion of SAFE production and fishing opportunities could be implemented, although each site would have a unique schedule depending on current infrastructure and data. For some sites, adequate data and resources exist to allow for a fairly rapid implementation schedule. Other sites would require robust test fishing to ensure harvest could occur with limited impacts to listed stocks and research on access and rearing potential, water quality, and effect on local fishers and landowners.

At its ultimate conclusion, this process would increase the potential for interaction between SAFE and wild production; however, interactions with wild salmonids will be minimized through the site selection process. Costs of expansion in the short-term would depend on the site(s) selected and the scale of the expansion. Short-term costs could include construction of net pens and acclimation of small test groups for species being considered. Over the long-term, costs would include full-term rearing (fry to smolt) costs or could be limited to acclimation costs only. Establishment of new sites will be evaluated in part based on the impact on the project's cost:benefit ratio.

Table 10.1. Summary of current planned short-term and potential long-term SAFE project smolt production.

Species	Site	Current	Short-term (1-9 years)	Long-term (≥10 years)
Spring Chinook	Youngs Bay	450,000	550,000	950,000
	Blind Slough	450,000 [a]	450,000	450,000
	Tongue Point	100,000[b]	250,000	1,500,000
	Deep River	250,000	350,000	450,000
		1,250,000	1,600,000	3,350,000
Coho	Youngs Bay	1,250,000	1,775,000	2,500,000
	Blind Slough	300,000	300,000	300,000
	Tongue Point	200,000	600,000	1,500,000
	Deep River	350,000	400,000	400,000
		2,100,000	3,075,000	4,700,000
Fall Chinook	Youngs Bay	~1,500,000	1,500,000	3,250,000
	Blind Slough	0	0	0
	Tongue Point	0	0	0
	Deep River	0	0	0
		~1,500,000	1,500,000	3,250,000
All Species	**All Sites**	**4,850,000**	**6,175,000**	**11,300,000**

[a] *Includes 150,000 smolt production funded by NOAA Fisheries*
[b] *Experimental releases to evaluate homing of imprinted smolts at new MERTS site*

11. REPONSES TO ISRP/IEAB ISSUES

This chapter is the response to the review of the 1993-2004 SAFE Final Project Completion Report Draft (North et al. 2004) by the Independent Scientific Review Panel and Independent Economic Analysis Board (ISRP/IEAB) dated March 16, 2005. The combined review identified a number of biological and economic issues and concerns that have been addressed in this report, which is an update of the 1993-2004 draft report, as well as in the SAFE project proposal request for FY 2007–2009 funding from the Bonneville Power Administration. The issues, as listed in the review, and the references to their corresponding responses in this report follow:

The report does not adequately describe or reference either the biological or economic methodology used in the project. This is a major concern. Without methods of sampling and analysis described and documented, it is not possible to verify reported results and ensure that repeatable procedures can be applied in the future.

Throughout this report additional detail and explanation of the various biological methodologies previously described in the 1993-2004 report have been provided in the appropriate sections. Methodologies pertaining to economic analyses will be presented in the forthcoming economic report (Davis and Radtke In Preparation).

Biological methods are discussed in the following sections of this report:

- Chapter 2. REARING AND RELEASE OF ANADROMOUS FISH STOCKS FROM SELECT AREA FACILITIES
- Chapter 3. SUMMARY OF SELECT AREA FISHERIES, Data Collection and Table 3.1
- Chapter 5. RUN RECONSTRUCTION
- Chapter 6. RESEARCH AND MONITORING, Spawning Ground, Juvenile Surveys and Hatchery Sampling, and Table 6.2

The summary of the status of the economic analysis is discussed in Chapter 8.

Fishery impacts on listed, as well as non-listed stocks should be better evaluated and described.

The ODFW and the WDFW are responsible for sampling their respective SAFE fisheries to collect biological data, including CWT recoveries, and for summarizing data to estimate landed catch. The ODFW is responsible for fisheries in Youngs Bay, Tongue Point/South Channel and Blind Slough/Knappa Slough, and WDFW is responsible for fisheries in Deep River and Steamboat Slough.

The joint WDFW/ODFW staff will continue to use VSI and CWT data to estimate impacts to listed species in SAFE fisheries. Total catch estimates will be produced using standard creel census and commercial fishery catch estimation techniques described earlier in this document. Visual stock identification and CWT data will be applied to catch estimates to develop individual stock composition estimates for sport and commercial fisheries in each select area. Stock compositions will be provided to the TAC for use in run reconstruction analyses to estimate contribution of listed stocks in fisheries. Each year, the TAC reviews both data and methodologies to improve the database. Data corrections are incorporated on a continuous basis.

Fish run sizes and catches are carefully monitored in-season to ensure that catch does not exceed allowed guidelines. In-season catch estimates will be produced on a daily basis. Based on preseason forecasts or in-season updates produced by the TAC, impacts to listed species will be determined as needed (daily or weekly) to monitor impacts of ongoing fisheries. If the data suggests that impacts will exceed the impact guidelines, seasons will be modified as needed.

A complete detailed description of the methodologies used to determine and monitor impacts to listed stocks is included in the following sections of this report:

Chapter 3. SUMMARY OF SELECT AREA FISHERIES
- Run-Size Forecasts
- Season Setting Process
- Data Collection
- In-Season Management
- Winter, Spring and Summer Fishery Impacts
- Fall Fishery Impacts
- Table 3.1

Treatment of the test fishery is technically inadequate in determining if a stock of concern was present and at what frequency. If the sole basis for this determination is CWT recovery, then the test fishery may not adequately sample for these rare recovery events.

Most test fishing for site selection was based on presence/absence of salmonids. Absence of non-local stocks was one of the primary selection criteria for establishment of the sites. For spring chinook visual stock identification, rather than recoveries of coded-wire tags was used to identify non-target (upriver) stocks in order to maximize sample size. Visual stock identification allows for classification of all collected fish, rather than just those with coded-wire tags.

Additional detail is provided in the following sections of this report:

Chapter 4. TEST FISHING
- Table 4.1.

Economic components (costs and benefits) are not part of ongoing monitoring and evaluation, but should be.

Previously, economic benefit in terms of ex-vessel value and personal income impacts were calculated annually to track the value of the project. Monitoring of all project costs, especially those associated with non-SAFE facilities, is difficult and therefore not conducted. The forthcoming economic evaluation by Davis and Radtke (In Preparation) will address both costs and economic benefits of the SAFE Project. This product may serve as a template for future economic monitoring.

Also see the following chapter in this report:

Chapter 8. ECONOMIC BENEFIT

Production goals are unclear. What is meant by “full implementation” is not specified. The question of the cost-effectiveness of further expansion is not addressed.

Chapter 10 details the future plans for the SAFE project, including short-term actions and production goals and potential long-term production capabilities. Current, near-term and potential long-term species and site-specific production numbers are presented in Table 10.1.

The reported 80-90 percent harvest rates of SAFE stocks are extremely high. The report should verify these rates and demonstrate that they are achievable without unwarranted impacts on local fishes.

Based on coded-wire tag recoveries from hatcheries, stream surveys and all regional fisheries (ocean and freshwater) average harvest rates of 1994-2000 brood spring chinook, fall chinook and coho produced by the SAFE project have averaged 91.2, 97.0 and 98.0 percent, respectively. These exceptionally high harvest rates, as documented in Chapter 5, are driven by the liberal harvest opportunities afforded by terminal fisheries. Because select area fishing sites are geographically removed from the mainstem Columbia River with little need for broodstock escapement to perpetuate the program, harvest rates unique to this program can be realized. Impacts to non-target stocks are minimized since these sites were selected primarily based on limited use by non-local stocks. Specifically, 1) spring chinook are not endemic to any SAFE tributaries, 2) fall chinook are present in very low numbers (primarily strays from other hatchery programs) and 3) early stock coho were either not endemic or were extirpated from SAFE tributaries long ago. Fishing regulations including area, gear, and time restrictions further limit impacts to non-target stocks. Mesh size regulations are used to limit handle of steelhead and sturgeon. Fishing area boundaries and season structure constrain fishing to areas and times when non-local stocks have the lowest chance of being in the select areas. For instance, select area fishing seasons for spring chinook either do not occur during mid-March through late April when upriver species may enter these sites, or have been constrained to the upper most sections to minimize interception potential. Fall select area seasons end after October to avoid handle of chum and native late-stock coho. Weekly landing limits and mesh restrictions constrain harvest of sturgeon in select areas within allowed management guidelines. No fishing occurs during November through mid-February to avoid steelhead with further protection provided by minimum mesh restrictions during the winter season (mid-February to mid/late March). Sport harvest is directed on hatchery stocks through mark-selective regulations.

Additional detail is provided in the following sections of the report:
Chapter 3. SUMMARY OF SELECT AREA FISHERIES
Winter, Spring and Summer Commercial Fisheries
Results of Winter, Spring and Summer Fisheries
Fall Commercial Fisheries
Results of Fall Fisheries
Recreational Fisheries
Chapter 5. RUN RECONSTRUCTION

The rationale for importation of a non-local stock is not explained, but should be.

Rogue River stock fall chinook were selected for propagation by the SAFE project because of their high quality, improved survival and absence of other indigenous fall chinook stocks. In addition, their southern migration pattern allows for harvest opportunities along the entire Oregon coast. Initial straying was addressed through project modifications, with current stray rates of less than 1.8 percent; well below levels accepted by NOAA Fisheries.

See the following section of this report:
Chapter 2. REARING AND RELEASE OF ANADROMOUS FISH STOCKS FROM SELECT AREA FACILITIES
Select Area Bright Fall Chinook
Chapter 5. RUN RECONSTRUCTION
Fall Chinook (SAB)

Efforts to regularly apply CWT for assessment are laudable, but there is concern that given the survival levels quoted, the numbers of tags applied appear to be marginal. Is there a statistical basis for the numbers and what questions are they designed to address?

In most cases the SAFE project has attempted to represent annual releases from each site by coded-wire tagging a portion of each normal release group. Due to budget constraints these representative tag groups are often limited to approximately 25,000 fish regardless of the number of fish released. Higher tagging rates are utilized when more precision is required to determine differences between treatment and control study groups. Due to the nature of select area fisheries, marginal tagging rates are offset by high harvest and fishery sampling rates.

The report does not thoroughly explain how decisions about project modifications are made, and how costs and benefits inform those decisions.

A variety of mechanisms are used to formulate decisions regarding project direction and modifications. Public opinion, including desires of the fishers, is obtained at annual public meetings, through daily contacts and via the Columbia River Compact hearing process. These public opinions and staff ideas are discussed and debated at regular bi-monthly coordination meetings. Those ideas with joint support are further investigated to determine cost and feasibility of implementation. Those actions or changes that are deemed appropriate are executed in cooperation with the pertinent agencies.

For example, the contractors have concluded that with the main focus of the project shifting toward increased production, use of personnel needs to change. Adequate benthic data and water quality information has been acquired to allow for the project to reduce staff previously assigned exclusively to this function. The water quality specialist position is being eliminated. Other seasonal staff positions in the Washington portion will be consolidated, effectively reducing staffing by another 2.0 FTE. In FY 2008 another 0.75 FTE in project management will be eliminated and consolidation of functions realized. Re-deployment of ODFW and CEDC staff to more efficiently cover fish cultural activities will better utilize available human resources. Gnat Creek Hatchery staff will assume the primary role of feeding net-pen fish at the Blind Slough site, which is nearby the hatchery. This will free up CEDC staff to assist in fish cultural support at the Klaskanine Hatchery, which is close to the SF Klaskanine facility. Other ODFW staff will have duties re-assigned to better meet the needs of the Klaskanine Hatchery, while still covering their sampling, surveying and data collection duties. Consolidation of the SAB program with CEDC at the SF Klaskanine Hatchery and the Youngs Bay net pens will further reduce program costs. All these efficiencies will make it possible for production increases of 1.25 million smolts at Deep River, Klaskanine and SF Klaskanine facilities without the need for significant funding increases.

This issue has also been discussed in the following section of this report:

Chapter 10. FUTURE PLANS

Expectations about how long BPA mitigation funding of this fishery should continue are not discussed, nor are possibilities for cost sharing between the region and local interests according to the distribution of project benefits and responsibilities for power system mitigation.

Prior to the initiation of the feasibility study launched in 1993, BPA began investing in the Youngs Bay terminal fishery project with substantial infrastructure purchases and support for other costs. By 1993 BPA had invested $280,000 in the CEDC Fisheries Project. The project had by that time received funding totaling nearly $2 million from a variety of local, state and federal sources. Oregon State provided a direct biennial appropriation for the operation of the SF Klaskanine Hatchery. Eyed eggs and/or fingerlings from state hatcheries were provided at no cost to the program. Salmon for All persuaded local fishers to assess themselves a 5 percent fee on fish harvested in Youngs Bay, and the fish buyers agreed to match that amount. Grants from diverse organizations, agencies and local governments were included in the early funding. Other in-kind support for the project included pathogen exams by ODFW, tagging and trucking of fish on various occasions, and equipment sharing.

On-going funding and in-kind support continues from both ODFW and WDFW. Both states provide gametes (usually eyed eggs) and logistical support for the program. In-kind SAFE project contributions include 920,000 eyed spring chinook eggs for the Gnat Creek Hatchery, 1.725 million fingerlings and/or pre-smolts from Mitchell Act facilities in Oregon, and 400,000 eyed spring chinook eggs from two WDFW hatcheries.

Oregon R&E Board has funded a majority of the SAB program since 1991, providing annual operation funds for Big Creek and Klaskanine Hatchery operations associated with the broodstock program, as well as a portion of the grow-out in the net pens in Youngs Bay. The R&E also underwrote feed costs for acclimating coho received from Eagle Creek Hatchery.

Total investment into the SAFE and pre-SAFE program by BPA is approximately $15.4 million, while non-BPA funding over that same period totals just under $4 million, excluding in-kind contributions. The project contractors believe that the SAFE project (renamed to Select Area Fisheries Enhancement) will continue to be funded in part by BPA but will be able to attract other funding support (Table 11.1). With present infrastructure capable of producing additional smolts at a significantly reduced cost per unit, justification for investment by other entities is attractive. CEDC is actively soliciting funding from Congress for capital improvements and some operating dollars, as well as other non-governmental sources. Additional funding from BPA is likely to remain proportionally level while accounting for modest increases due to inflationary factors.

Estimated out-year BPA funding needs as proposed in the FY 2007-2009 BPA SAFE proposal:

	2010	2011
Oregon	$643,495	$659,482
Washington	$768,955	$788,179
CEDC	$429,716	$442,607

Table 11.1. Summary of planned and potential regional and local participation in the SAFE project.

Funding Source or Organization	Item or Service Provided	FY 2007 Est Value ($)	FY 2008 Est Value ($)	FY 2009 Est Value ($)	Cash or in-kind?	Status
Fishermen and Processors	Voluntary assessments	$50,000	$50,000	$50,000	Cash	Confirmed
Mitchell Act Funds	Coho pre-smolts from Oxbow, Cascade and Sandy hatcheries	$517,500	$517,500	$517,500	In-Kind	Confirmed
Mitchell Act Funds	Tagging and marking of broodstock coho at Grays River Hatchery	$6,500	$6,500	$6,500	In-Kind	Confirmed
NOAA	SF Klaskanine dam removal/low-head diversion system	$0	$120,000	$0	In-Kind	Under Development
ODFW, R&E	Funds for SAB fall chinook broodstock program	$86,000	$86,000	$86,000	Cash	Under Development
ODFW	Funds for coded-wire tag sampling work	$13,448	$13,850	$14,265	Cash	Under Review
ODFW	Funds for propagation facility	$86,016	$123,351	$123,351	Cash	Under Review
ODFW	Gnat Creek Hatchery housing maintenance	$6,000	$6,000	$6,000	In-Kind	Confirmed
ODFW	SF Klaskanine Hatchery dam removal and screening upgrade	$60,000	$ 0	$ 0	In-Kind	Under Development
ODFW	Eye spring chinook eggs from Willamette Hatchery for Gnat Creek Hatchery	$ 0	$ 0	$12,000	In-Kind	Under Development
ODFW	Green coho eggs for SF Klaskanine Hatchery	$ 0	$ 0	$22,000	In-Kind	Under Development
ODFW	Green coho eggs for Klaskanine Hatchery increased production	$ 0	$23,000	$23,000	In-Kind	Under Development
ODFW	Eyed spring chinook eggs from Willamette Hatchery	$24,500	$24,500	$24,500	In-Kind	Confirmed
USFWS	Upgrades at SF Klaskanine, Klaskanine and Gnat Creek hatcheries	$ 0	$1,400,000	$ 0	Cash	Under Development
USFWS	Production increases at Gnat Creek (spring chinook) and SF Klaskanine and Klaskanine (coho) hatcheries	$ 0	$ 0	$300,000	Cash	Under Development
WDFW	Capital improvements of Grays River Hatchery	$3,500	$3,500	$3,500	In-Kind	Confirmed
WDFW	Eyed eggs from Lewis and Cowlitz hatcheries	$9,000	$9,000	$9,000	In-Kind	Confirmed

ODFW - Oregon Department of Fish & Wildlife
ODFW R&E - Oregon Department of Fish & Wildlife Restoration & Enhancement Program
USFWS - United States Fish & Wildlife Service
WDFW - Washington Department of Fish & Wildlife

The report does not provide information on costs of achieving project goals. This is a major omission in terms of evaluating either the likely cost-effectiveness of continuing investments or the appropriate level of such investments.

Because cost considerations are absent, the report presents only a partial picture of project benefits (gross, rather than net incremental benefits). Maximizing the value of harvest, as well as the project overall, requires a consideration of both costs and benefits and how they change under different conditions.

These two concerns were the primary reason for pursuit of a comprehensive economic analysis of the SAFE project. Past attempts by project staff have focused entirely on economic benefits without estimating costs. The summary of the status of the economic analysis is discussed in Chapter 8.

Also see the following section of this report:
Chapter 10. FUTURE PLANS

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APPENDIX A

SELECT AREA FISHERY EVALUATION PROJECT

ENVIRONMENTAL MONITORING REPORT

1994 THROUGH 2003

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ENVIRONMENTAL MONITORING REPORT

INTRODUCTION

The SAFE Project Environmental Monitoring Program has two objectives. The first is to assess the environmental suitability of water bodies being considered for fish rearing and to monitor water quality parameters of these water bodies while fish are being reared to document their continuing suitability. Achieving this goal is part of a larger effort involving social and political considerations such as land ownership, access, and the popularity of the project with residents of the area.

The environmental considerations include hydrographic parameters such as depth and flow patterns and accessibility for fishing vessels. Biological considerations include the lack of native fish or other species listed under the Endangered Species Act (ESA) that might be harmed by the fish rearing or subsequent harvest of the returning net pen fish. Water quality parameters of concern are temperature, dissolved oxygen, pH, turbidity and conductivity. The benthic fauna of the water body is examined as a long-term indicator of environmental health.

The second objective of the SAFE Environmental Monitoring Program is to monitor the effects of the fish rearing activities on the environmental health of the water bodies where the net pen operations are located. This is done with input from the state regulatory bodies that have jurisdiction over environmental issues.

BACKGROUND

Net pens are located at eight sites. Three sites are in Washington; one in Steamboat Slough and two sites in Deep River at Robert Fauver’s property about a half mile downstream from the highway 4 bridge, and the other at Walter Kato’s property about a half mile upstream from the highway 4 bridge. Five sites are in Oregon; one at Tongue Point, one at the Marine and Environmental Research and Training Station (MERTS) facility near Tongue Point, one in Blind Slough, and two in Youngs Bay at Tide Point and the Yacht Club site.

The net pen facilities at Youngs Bay and Tongue Point have production levels that require National Pollutant Discharge Elimination System (NPDES) permits (40 CFR 122,24) issued by the Oregon Department of Environmental Quality (ODEQ). Under these permits the net pens at Youngs Bay and Tongue Point are allowed a 15-meter mixing zone extending in all directions from the net pen structure. No environmental impact is permitted outside of the mixing zone as compared with reference conditions, and no impact which adversely effects aquatic life or any beneficial use is permitted within the mixing zone. The purpose of the monitoring effort at these locations is to determine if these criteria are at risk of being violated so that corrective measures can be taken.

The production levels at Steamboat Slough, the two Deep River sites, Blind Slough, and the MERTS site are below the level that would require discharge permits. These five locations incur minimum impact, and the purpose of the monitoring effort at these sites is to document any environmental changes that may occur under the net pens as compared to a reference condition. The MERTS site is new and in the future it is anticipated that production here will increase. The Tongue Point facility is expected to be vacated and the equipment moved to the MERTS site.

Raising fish in net pens has been practiced in various parts of the world for decades. The following environmental issues have arisen in different places and situations where net pens have been employed for fish farming (Brooks, Kenneth M et al. 2002). Each issue is addressed as it pertains to the SAFE net pen operations.

- Introduction of non-native fish
  With the exception of the SAB fall chinook, only fish stocks native to the Columbia River basin are reared in the SAFE net-pen operations. These are coho salmon (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*).

- Introduction of non-native disease from non-native fish
  The one-time transfer of non-native SAB fall chinook did not result in the introduction of non-indigenous disease, and all other stocks are native.

- Concentration of parasitic sea lice (*Lepeophtheirus salmonis*) around the net pens that can infect wild fish
  Since the SAFE net pens are all located in fresh water, sea lice are not a problem.

- Aesthetic impact on the surroundings
  Part of the site selection process for net pens is to meet with people in the area to make sure that the net pens will be welcome. There have been no complaints about the aesthetics of the net pens.

- Predator Control (birds, otters, seals, etc)
  With the exception of permitted trapping of otters at Oregon sites, only non-lethal forms of predator control are used in the SAFE net-pen operations. Nets are placed over the top of the net pens to limit predation by birds. Wires that deliver a mild electric shock are tacked around the net pens to reduce access to the pens by otters. Live traps are also used occasionally so the otters can be relocated. Seals and sea lions have not created problems.

- The quality of farmed fish for human consumption has been questioned as a result of the diet of the fish, which consists of manufactured fish food usually containing dye.
  Fish raised by the SAFE project are raised to smolt size in the net pens. During this time they are fed manufactured fish food pellets that do not contain dye. When they reach the smolt stage they are released to migrate out to the ocean where they spend their adult life feeding on natural food sources.

- Impact of therapeutic compounds (pharmaceutical and pesticides) on non-target species
  The principal use of therapeutic compounds at some net pen sites has been to control sea lice. Sea lice are not an issue for the SAFE project net pens being at fresh-water sites. Erythromycin and Oxytetracycline are the only therapeutic compounds used by the SAFE project on the fish when they are in the net pens. The fish are not released until at least three weeks after being treated with the compounds to avoid human consumption. No environmental impact is expected to occur as a result of the use of erythromycin by the SAFE project. However, the monitoring program is designed to detect such an impact should it occur.

- Sediment Chemistry (nitrogen, phosphorus, zinc, copper, ammonia, hydrogen sulfide, Eh)
  Since antifouling agents are not used on the net pen structures, and production during the course of a year is lighter than at commercial production facilities where sediment chemistry parameters have been adversely affected, it is not anticipated that these parameters would be affected enough to produce an unacceptable impact. However, the monitoring program is designed to detect impacts from changes in sediment chemistry.

- Sediment Total Organic Carbon (TOC) to Grain Size relationship
  This relationship may be affected by the generation of organic materials from the net pens. It is monitored by laboratory analysis and by visual observation.

- Accumulation of organic matter (fouling organisms, uneaten fish food, fish feces, fish carcasses)
  This is the principle environmental impact of concern for the SAFE project net pen operations. The input of organic matter creates a localized impact. This differs from a systemic impact in that it is confined to the areas under the net pens. It is unlikely to spread and produce systemic effects. The focus of the monitoring program is to determine that the impact is small in intensity and limited to the mixing zone under and around the net pens. When there is an input of organic matter to a particular location it settles to the bottom sediments where it produces a range of effects as the input is increased. At low levels the first effect is an increase in the population density of those species that can utilize the organic matter. As the input increases, the species that can utilize the organic matter are increasing in numbers at the expense of species that cannot utilize the organic input or are not tolerant of high levels of organic material. As the input increases further, other species disappear from the area leaving only one or two hardy species. Finally, as the input exceeds the ability of the environment to keep up with the rate of input of the organic material, it begins to decay bacterially and deplete the dissolved oxygen at the surface of the sediment creating an anoxic layer. This would be considered to be an unacceptable impact.

  There are four sources of organic matter from the net pen operations. The first results from the presence of the net pen structures. They provide surfaces in the water column for aquatic species to attach. When these structures are disturbed, such as when work is done on the nets or when the fish are released, the attached organisms and organic debris fall to the surface of the underlying sediment. The second source of impact is from uneaten fish food that passes through the bottom of the nets and can accumulate on the bottom beneath the net pens. The third source of impact is from the waste produced by the fish. Much of this waste is in the form of ammonia in solution and is quickly diluted and carried away by the current. It is not likely to have any measurable impact on the large water bodies where the net pens are located. However, the solid waste produced by the fish can also accumulate under the net pens, adding to the other sources of organic material. The fourth source of organic input results when fish die and are not removed from the net pens, but instead, sink to the bottom of the pens and decay.

The environmental impact of the type of net pen salmon rearing being conducted by the SAFE project tends to be small when compared with commercial net pen fish production. The fish are not grown to marketable size in the SAFE net pens, and the fish usually occupy the net pens for only a part of the year. This allows a period of recovery for the environment around the net pens.

Two additional considerations for the SAFE project that are not encountered by most commercial operations are a result of the fish being released to migrate to the ocean and then return to the location of the net pens.

- Impact of released smolts on threatened or endangered species
  Site selection by SAFE project includes a test fishery and stream surveys to determine the absence of species that are protected and could be adversely affected by the presence of smolts upon their release from the net pens.

- Impact of returning fish and fishing activity on threatened or endangered species
  The test fisheries and stream surveys indicate that the harvest of the net pen fish can be conducted without significant impact on other non-target species.

QUALITY ASSURANCE

All work is done following Good Laboratory Procedures and in accordance with the Quality Assurance Project Plan associated with this project (DEQ, Quality Assurance Project Plan) (EPA Guidance for Quality Assurance Project Plans) (Water Quality Monitoring Technical Guide Book July 1999) (PSEP, Collection of Environmental Data 1997).

METHODS AND MATERIALS

Water Chemistry

Physicochemical parameters are monitored at the proposed net pen site using one of two instrument clusters to record temperature, pH, dissolved oxygen, conductivity and turbidity (PSEP, Conventional Water Quality Variables and Metals in Fresh Water 1990) (PSEP, Measuring Conventional Marine Water-Column Variables 1991). These instruments are contained in both the HydrolabJ Surveyor 3 Datalogger with an H_2O Datasond and the HydrolabJ Surveyor 4A Datalogger with a Surveyor 4 Datasond. One of these instruments is deployed at each net pen location for one 24-hour period each month coinciding with the growing season. The instruments are calibrated with standards according to the manufacturer's instructions. The data is generated in electronic files that are downloaded directly into a personal computer.

Sediment Chemistry

Baseline sediment chemistry samples are collected for Total Organic Carbon (TOC) and Grain Size Distribution at both a prospective net pen site and a reference site (PSEP, Measuring Conventional Sediment Variables 1986). These samples are collected by using a core plunge sampler to collect 2-inch diameter cores. When the coring device is retrieved the top flap valve is opened. The core is extruded through the top of the sleeve and the top 5 cm section of a core is cut off into a jar. One sample for each TOC and grain size is collected from the proposed net pen site and from the reference site.

Monitoring Benthic Populations

Baseline samples are collected for benthic population structure at both a prospective net pen site and a reference site (R.W. Plotnikoff and J.S. White1996) (PSEP, Analyzing Subtidal

Benthic Macroinvertebrate Assemblages 1987). These benthic samples are collected using a core sampler to collect 3-inch diameter cores (nominal). When the coring device is retrieved, the core sleeve is separated from the device. The core is extruded through the top of the sleeve. The overlying water is allowed to run into a plastic tub to capture any epibenthic animals that may swim into the overlying water. The top 5 cm section of a core is cut off into the tub and then the water and sediment is transferred to a one-gallon plastic bucket with lid. Sediment samples are sieved through a 500-micron mesh sieve and the materials retained on the sieve are fixed using a 10 percent buffered formalin solution. After one to four days the samples are transferred to 70 percent ethanol. They are stained with rose bengal to aid in sorting. Each sample is sorted under a binocular dissecting microscope and all of the animals are removed and stored in ethanol. These animals are identified and enumerated. This is the source of the benthic population data provided for each net pen location in the Results and Discussion section.

ASSESSING SITE SUITABILITY FOR FISH REARING

The following steps are taken to identify a water body suitable for net pen operations:

- Identify water bodies with suitable depth and access to fishing vessels
- Measure physicochemical parameters
- Investigate the history of the site for the possible presence of toxic waste
- Sample sediment for benthic population structure and sediment chemistry
- Investigate ownership and resident's interest
- Determine if natural fish runs exist, which would be in conflict with a net pen fisheries
- Conduct a test fishery to determine if a conflict with endangered species exists

Data Interpretation

Physicochemical data is displayed on a Figure to determine if any parameters are outside of the acceptable range for the culture of salmon. Sediment TOC and grain size distribution data is baseline data used for comparison with data collected during salmon rearing to assess any changes resulting from the net pen operation.

The benthic population structure is examined for the presence of pollution tolerant species, the absence of pollution sensitive species, and the absence of long lived species that are expected to be present in the lower Columbia River estuaries. These factors are used to assess the suitability of the site for salmon rearing. The benthic macro invertebrate data also provides baseline data used to detect any future changes.

MONITORING THE ENVIRONMENTAL IMPACT OF NET PEN OPERATIONS

The SAFE net pen facilities operate under the environmental regulations of the state in which they are located. Both Oregon and Washington conform with the National Clean Water Act (40 CFR 122,24). Under this act the net pens are considered to be concentrated aquatic animal feeding operations. As such, net pen operations that hold 20,000 pounds of fish or more, or feed 5,000 pounds of food or more during any calendar month are required to have a discharge permit. The facilities at Steamboat Slough in Washington, and Blind Slough in Oregon operate below this production limit. Monitoring at these sites is voluntary.

The facilities at Tongue Point, Youngs Bay (Tide Point), and Youngs Bay (Yacht Club) all produce more than this limit, therefore an NPDES Permit is required. Environmental monitoring is required by the conditions of the permit at these locations. At sites where discharge permits are required, the permit allows for a mixing zone that extends 15 meters from the net pen structure in all directions.

The production levels at the facilities in Deep River, Washington and the MERTS site in Oregon have been less than that which requires a discharge permit, and monitoring at these sites has been voluntary. However, both of these sites are expected to be expanded to a level requiring a permit in the future, and the monitoring is expected to become mandatory and expanded.

The ability of the monitoring effort to detect an environmental impact depends on the degree of resolution that the monitoring design provides (Ferraro et al. 1989, 1991, 1992). More resolution usually requires that more samples be collected and processed, and therefore it requires more effort and greater expense. Since the regulated party has an interest in minimizing expense, the design of the monitoring program at sites where a permit is required is developed with the consensus of the state agency that issues the discharge permit.

Monitoring Benthic Populations

There are three net pen sites operating under NPDES discharge permits. The perimeter of the mixing zone at these sites is sampled to insure there is no environmental impact outside of the mixing zone. Stations are selected at points along the perimeter of the mixing zone and replicate samples are collected for benthic population analysis at each station. In addition, samples are collected from a station under each set of net pens to monitor the impact of the fish rearing activities and determine whether an unacceptable condition is developing.

Three Reference stations are identified for each site operating under a permit. These Reference stations are representative of the biological and chemical conditions that are normal for that body of water. Core samples are collected for benthic population analysis at each reference site to compare with benthic population analysis of the samples collected at the perimeter of the mixing zone and also with the samples collected from under the net pens.

As described in the Background section, monitoring the net pen sites that do not require a discharge permit is done to detect any changes in the environment under the net pens that may be attributed to the fish rearing activities. At these sites samples are collected from one station under both the net pens and one Reference station.

Core samples are collected for benthic population structure analysis at each station. Samples are collected at the end of the growing season when the impact of the fish rearing should be at a maximum. Samples are collected again before the beginning of the next growing season from any station where an impact had been detected by the June monitoring and from one Reference station to measure the recovery of the net pen site.

Reference Site Selection

In order to determine if changes in the benthic population structures under the net pens are a result of the fish rearing activity or of some other change affecting the entire water body, the impact site must be compared to a reference site. The reference sites are located by hand held Global Positioning System receivers that are accurate to approximately 10 meters (PSEP, Station Positioning 1998). They should be close enough to the impact site as to experience the same influences as the impact site, but well outside of the influence of the fish rearing activities. The reference sites should be of approximately the same depth and have the same flow patterns, sediment chemistry, and benthic community structure as the impact site.

Sediment Chemistry

TOC and grain size distribution are monitored by collecting core samples as previously described. One sample is collected for TOC analysis and one for grain size analysis from each station where samples are collected for benthic macro invertebrate. These samples are collected near the end of the growing season.

Sedimentation

The accumulation of organic mater from uneaten fish food or other net pen wastes is inferred from the measurements of TOC and grain size distribution of the samples collected from beneath the net pens. In addition, sediment samples are taken from beneath each net pen for visual inspection of the surface layer for the development of an anoxic condition. A log is kept of observations from each sample such as the presence of any anoxic condition as evidenced by the depth of the surface redox layer, the smell of hydrogen sulfide, the blackening of the surface, the presence of live sediment dwelling animals, and any other pertinent observations.

Data Interpretation

Analysis of benthic invertebrate samples produces a list of species present and the numbers of each species for each station sampled. With this information various characteristics of the invertebrate population of the impact sites and the perimeter sites can be compared to those of the reference sites.

The parameters of taxa richness (number of species present), abundance (the total number of animals present), and dominance (percent of population composed of the dominant species) at the Reference stations are compared to these parameters measured at the stations on the perimeter of the mixing zone and at the Impact stations under the net pens. In addition, significant differences in each species between stations is also analyzed. This allows for the assessment of the differences in species that may be sensitive to, or tolerant of, this type of impact. These population parameters are compared to those from Reference stations using the Wilcoxon Rank Sum Analysis (Lyman, O 1984). This statistical analysis allows 90% confidence when analyzing three samples from each population. When comparing an Impact station or a Perimeter station to three Reference stations, 95% confidence is attained. In the line Figures that follow, red dots on the data points indicate a statistically significant difference between the Reference station and the Impact station.

RESULTS AND DISCUSSION

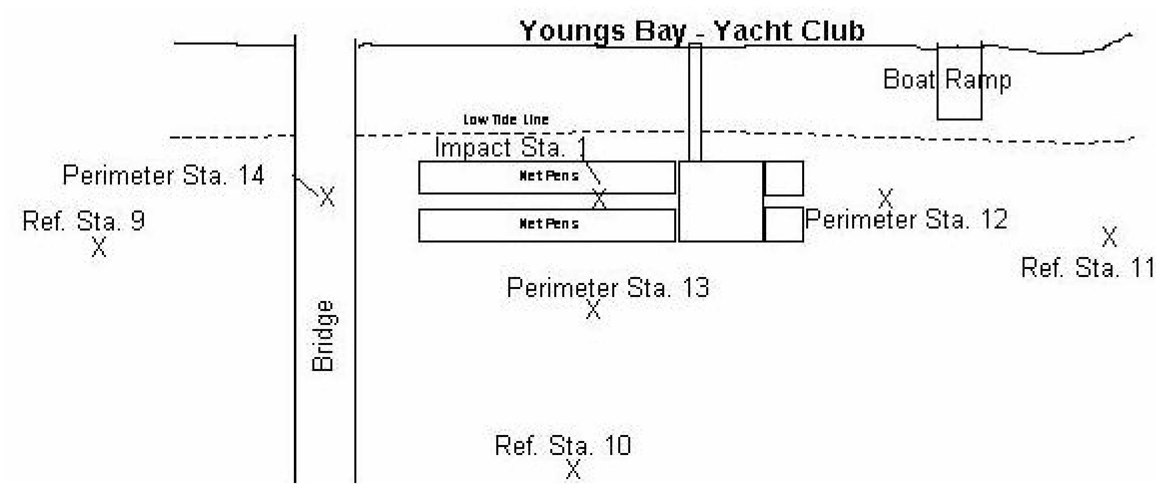
Youngs Bay, Yacht Club

This facility in Youngs Bay is located just upstream of the Warrenton/Astoria Highway bridge over Youngs Bay. Youngs Bay is located close to the mouth of the Columbia River and is subject to salt-water influence, especially during the summer months when rainfall is low as indicated by the specific conductivity readings. There is a fresh water influence from the Lewis and Clark, Youngs, and Klaskanine rivers. Fish rearing began here through the 1996 – 1997 season. The first samples were collected during the preceding summer of 1996.

This site is subject to several sources of impact besides the net pen fish rearing activities. Most notably, the net pen pier is also used by a number of commercial fishing boats. At the peak of the fishing season there may be as many as 50 fishing boats tied up. Other influences are a bridge about fifty feet to the west, a public boat ramp just to the east, an abandoned cannery just east of the ramp, and the use of the net pen pier by the public for recreational fishing and other activities. The impact on the environment in this area must be taken in the context of all of the activities that occur at this site.

This facility has a production level that requires an NPDES discharge permit issued by ODEQ. A mixing zone has been defined by ODEQ as extending 15 meters out from the edge of the net pen facilities in all directions. The permit specifies that no environmental impact is to occur outside of the mixing zone. The location of sampling stations is illustrated in the drawing below. Three samples are collected from each station for benthic macro invertebrate analysis, one is collected for TOC, and one is collected for grain size Analysis. Sampling stations are located on three sides of the mixing zone. The fourth side of the mixing zone is too close to shore to monitor.

The permit also specifies that there shall be no sedimentation within the mixing zone that adversely affects aquatic life or any beneficial use. This could occur if organic matter accumulates faster than the environment can absorb it. A sampling station is located under the net pens.



In addition to the station where samples are collected for macro invertebrate analysis and sediment chemistry, a core sample is collected from under each net pen. Each of these cores is visually inspected to insure that the organic material is not accumulating faster than the environment can absorb it. If this were to occur, patches of an anaerobic surface “mat” would be expected to appear. This may be accompanied by the odor of hydrogen sulfide. The light brown oxidized surface layer would disappear and live animals would be absent. A log is kept with the observations from each core. There are three Reference stations associated with this net pen facility site to provide a more accurate assessment of the normal benthic invertebrate populations and sediment chemistry of the area.

The plan for monitoring the environmental impact at this facility was written and approved by ODEQ prior to the end of the fish rearing season in June 2002. Prior to this, only benthic macro invertebrate samples were collected, and they were only collected from the Impact station under the net pens and from one Reference station. Therefore, historical comparisons can only be made between these two stations.

The sediment at this facility is not as organically rich as the Blind Slough or Deep River sites. They are similar in TOC to sediments at Tongue Point and the Tide Point/Bornstein facility. They are organically richer than those at Steamboat Slough where the sediments are coarser and more sandy as a result of the strong currents. The TOC at each sampling station is provided in Table 1. for the two years that TOC samples were collected.

Table 1. Total Organic Carbon of the Sediments of the Youngs Bay, Yacht Club Stations

Station	June 2002	June 2003
Impact station 1	2.68	0.94
Reference station 9	1.58	1.05
Reference station 10	0.89	2.15
Reference station 11	1.42	1.54
Perimeter station 12	1.78	1.49
Perimeter station 13	1.34	2.00
Perimeter station 14	2.33	1.53

Figure 1. shows the population density at this facility. The first summer samples were collected before fish rearing began in the summer of 1996, and sampling continued through the summer of 2003. Fall sampling began in 1996, just before fish were added, and continued through the fall of 2002; the last samples that have been analyzed at the time that this report was written.

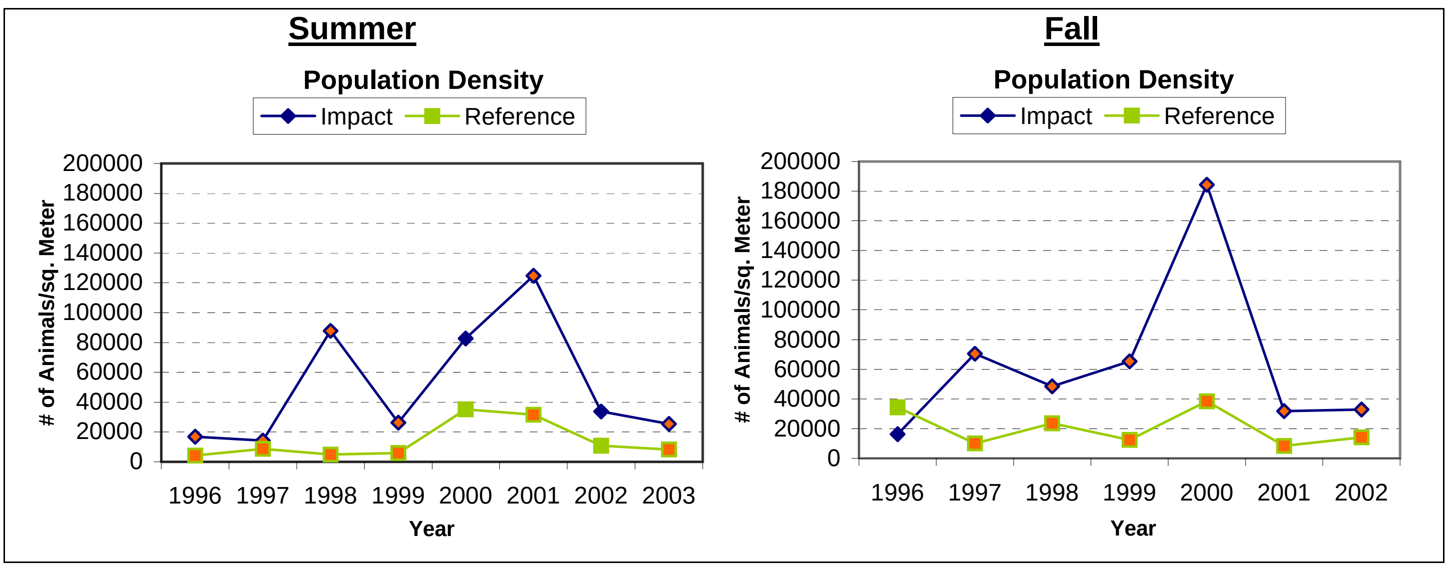


Figure 1. Summer and fall macro invertebrate population density, Youngs Bay Yacht Club facility (YB,YC), 1996-2003.

The population at the Impact station is consistently more dense than the population at the Reference station in the summer, even before fish rearing began, when the difference was small but statistically significant. The initial difference is probably due to the other influences on this station that were described earlier in this section. By the end of the second year of fish rearing activity the difference has increased, and in some years the difference in population density between the two stations is very large. Spikes in the population density occur in the summers of 1998, 2000 and 2001. The spikes that occurred in the summers of 2000 and 2001 occurred at the Reference station, as well as at the Impact station, so this was due to system-wide environmental conditions. However, the increase in density was much larger at the Impact station than at the Reference station.

The fall samples of 1996 show that the population density at the Reference station is slightly higher than at the Impact station. After the start of fish rearing at this site the population is consistently and significantly more dense than the population at the Reference station. This indicates that the organic material that is added to the environment at the Impact station is not depleted. Some fish are held in the net pens at this facility through the summer and early fall in some years. This may contribute to the lack of recovery.

The structure of the benthic macro invertebrate population in Youngs Bay is more complex than at the other net pen sites. At other sites the benthic macro invertebrate population is dominated by *Oligochaeta*. Youngs Bay has been invaded by the non-indigenous New Zealand mud snail, *Potamopyrgus antipodarum*, a very hearty and prolific species. This species has come to dominate the benthic macro invertebrate population in most years but other species are also present in high population densities. The *amphipod Americorophium* spp. sometimes outnumber the mud snail. Figure 2. shows the relationship between the density of the population of these species and that of the whole population during the summer. While the *Oligochaeta* are always present, they do not dominate the population as they do in other locations. At the Impact station of this facility it is the mud snail that is best able to utilize the organic material that results from the fish rearing activities.

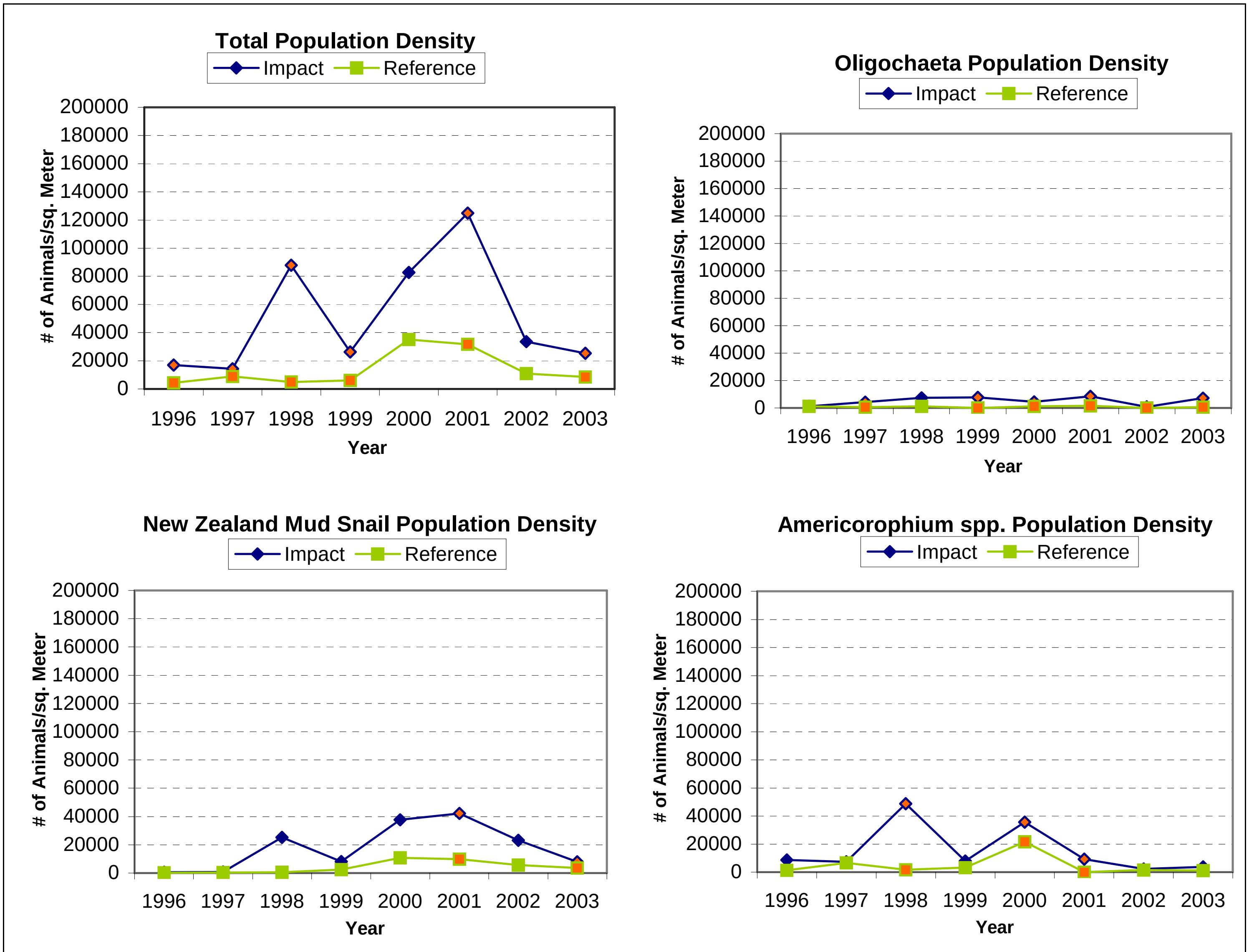


Figure 2. Population density of dominant species compared to total population at Youngs Bay Yacht Club facility, 1996-2003.

Figure 3. shows the effect of the organic enrichment on the number of species present at the impact and Reference stations in the summer and fall of each year that samples were taken.

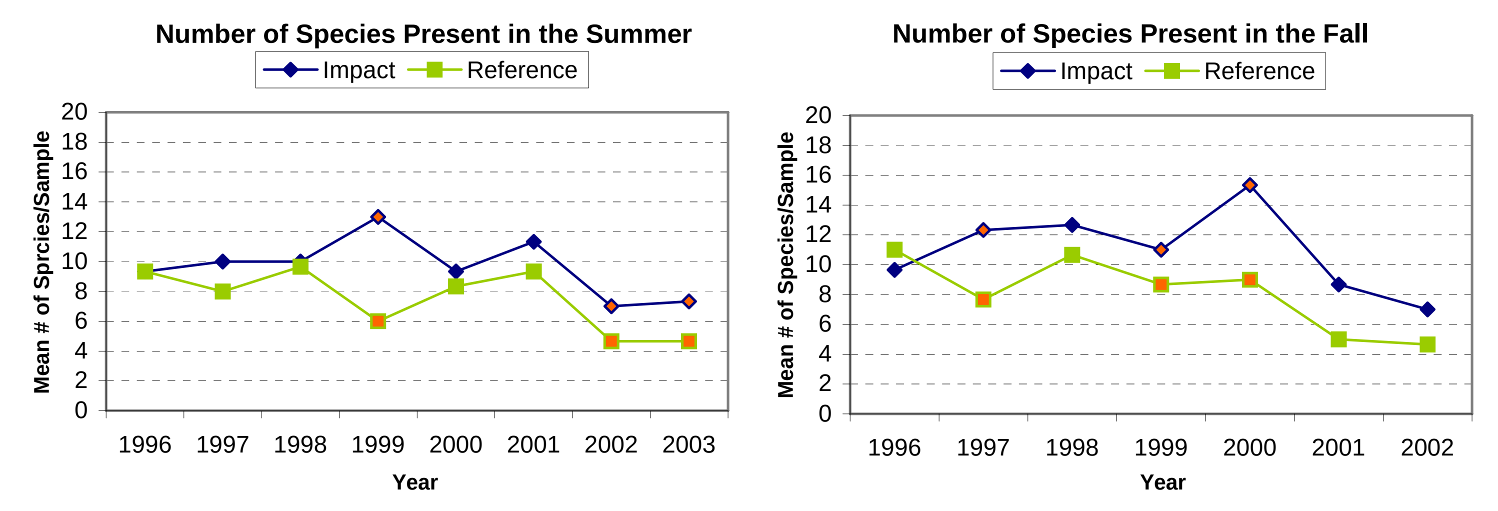


Figure 3. Mean number of species present in Youngs Bay Yacht Club facility samples, spring versus fall, 1996-2003.

Just as the population density is higher at the Impact station in both the summer and the fall, the number of species is also usually greater at the Impact station. In this complex environment there are more species able to take advantage of the infusion of organic material.

The long-term data shows a measurable response in the basic population parameters to the organic enrichment associated with net pen fish rearing. This response persists through the summer and fall months when fish rearing activities are at a minimum. However, there is no indication at this time that the environment under the net pens is unable to absorb the organic materials generated at this facility. The number of species that utilize the material actually increases and there has been no indication of the development of an anoxic condition beneath the net pens.

Beginning in the summer of 2002 the monitoring plan was implemented that was developed to meet the permit conditions. As described previously, this plan requires that samples be collected from stations on the perimeter of the mixing from three Reference stations instead of just one. Having three Reference stations allows for statistical confidence of 95 percent and better represents the variability of the environment.

Two years of data does not permit a long-term analysis of the data or the detection of trends. Therefore, the data does not allow an historical view of the Perimeter stations or of the two additional Reference stations.

Figure 4. shows the benthic macro invertebrate data collected from all of the stations at this site where samples were collected under the current work plan in the summer of 2002.

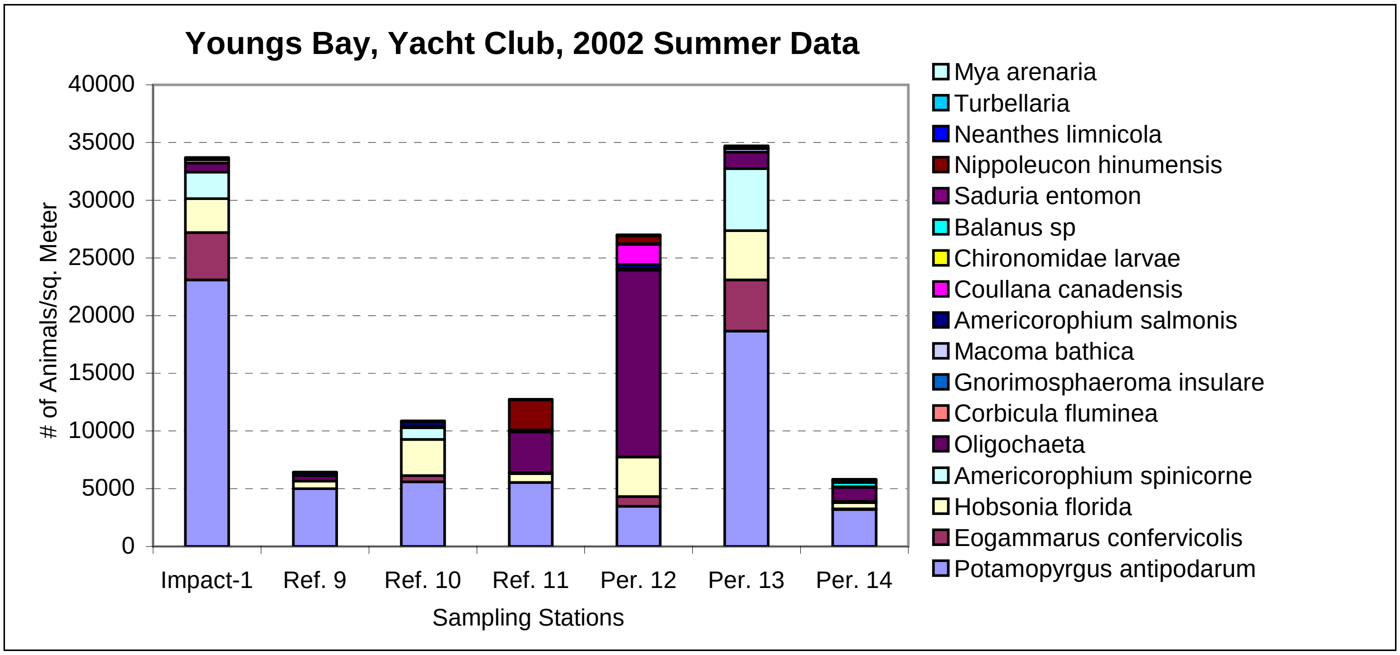


Figure 4. Macro invertebrate data, population size and composition at Youngs Bay Yacht Club facility, summer of 2002.

The Impact station shows a disproportionately dense population of the mud snail in the samples. However, due to variability between the samples, neither the population density of the mud snail or the overall population density is significantly different from the reference condition. The population density of three species was consistent enough to detect a statistically significant difference. This difference is seen in *Eogammarus confervicolus*, *Americorophium spinicorne* and *Corbicula fluminicola*, all of which were more dense at the Impact station than at the Reference station.

Perimeter station 12 differs from the reference condition in that it has a greater population density, a greater number of species, and more dense populations of *Oligochaeta* and *Coullana canadensis*. These parameters are consistent with a response to organic enrichment. There should be no detectable environmental impact at this station. If this condition persists, it may be necessary to take steps to reduce the amount of organic matter reaching this side of the mixing zone.

While the Figure shows a large difference in several population parameters at Perimeter stations 13 and 14, overall population density, the density of the mud snail population and to a lesser extent the population density of *Hobsonia florida* and *Americorophium spinicorne*, the samples are too variable to detect any statistically significant difference. There is no detectable impact at Perimeter stations 13 and 14.

Figure 5. shows the benthic macro invertebrate data collected from all of the stations at this facility in the summer of 2003. The most notable feature of this Figure is at Perimeter station 14. This station is located under the Warrenton/Astoria Highway bridge. The type of sediment under this bridge and the debris from bridge work and other activities associated with the bridge create an environment unique from Reference stations and all of the other stations. This environment, at the time of this sample collection was very hospitable to the amphipod, *Americorophium salmonis*. It is this species that accounts for the huge population increase at Perimeter station 14. While this species benefits from organic enrichment that accompanies net

pen fish rearing activities, it is the physical characteristics of the habitat that contribute to the dense population of the amphipod.

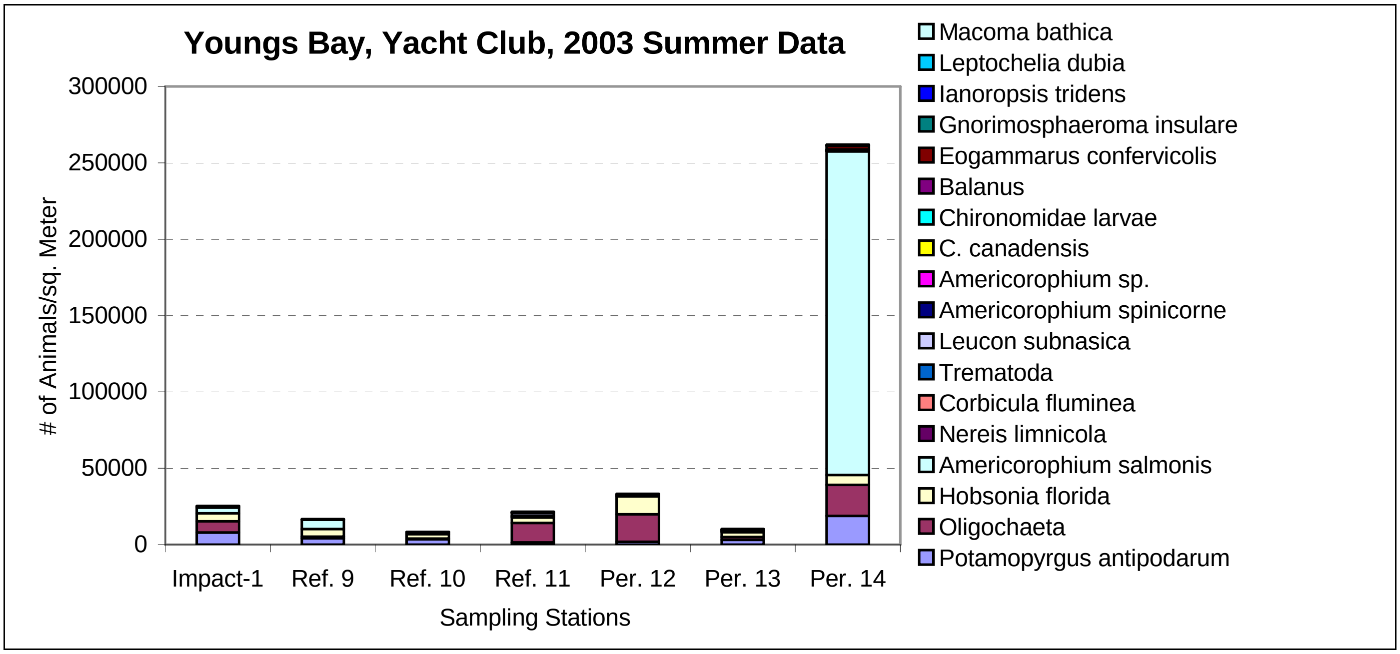


Figure 5. Macro invertebrate data, population size and composition at Youngs Bay Yacht Club, summer of 2003.

By eliminating this species from the Figure, the Figure better illustrates the relationship between the populations at the various stations. Figure 6. illustrates the benthic macro invertebrate population structure at this facility in the summer of 2003 with the *A. salmonis* data eliminated from Perimeter station 14.

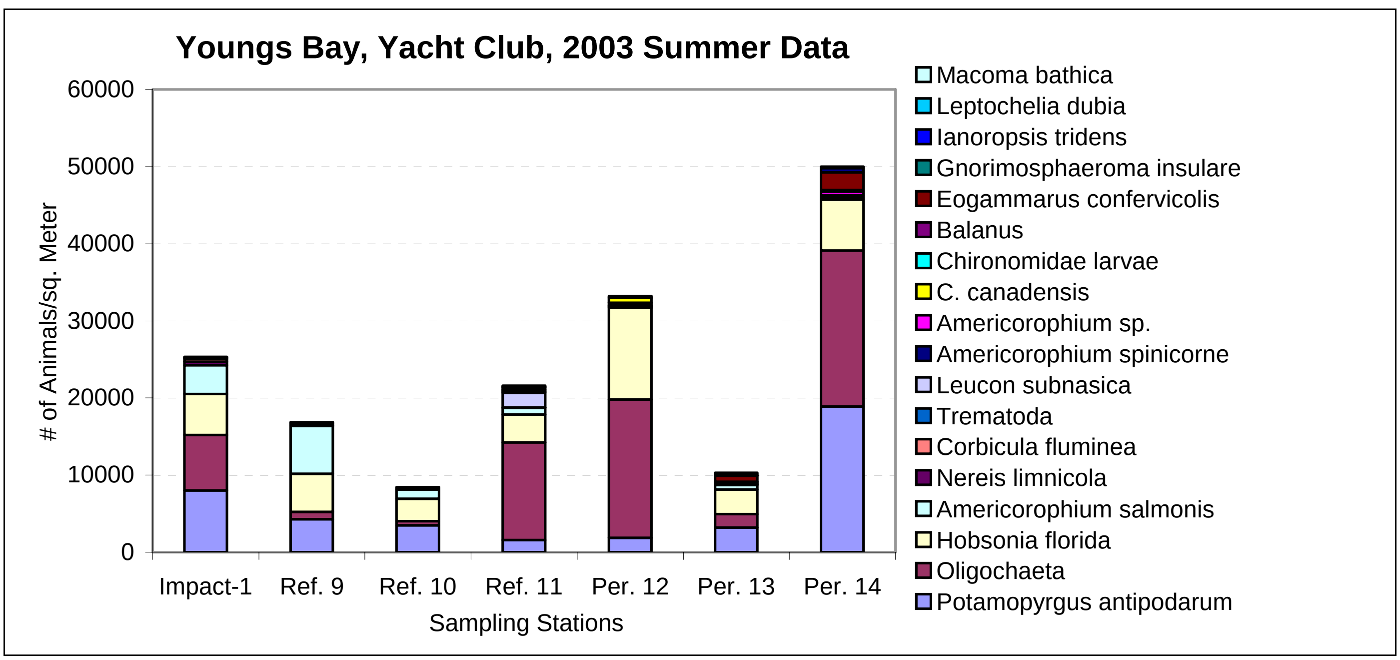


Figure 6. Macro invertebrate data, population size and composition at Youngs Bay Yacht Club site, summer of 2003, with *A. salmonis* eliminated from perimeter Station 14.

The Impact station does not differ significantly from the reference condition in any of the general population parameters. It is not more dense, the number of species does not differ, and there is no significant difference in the percent of the population comprised of the dominant species. However, the population of *Potamopyrgus antipodarum*, the mud snail, is more dense at the Impact station, as is the populations of the *Polychaeta* worm *Nereis Limnicola* and the bivalve, *Corbicula fluminea*. This indicates organic enrichment.

Perimeter station 12 shows indications of organic enrichment again this year. Although there are no significant differences in the general population parameters, the population of both the *Oligochaeta* and the *Polychaeta* worm, *Hobsonia florida* are more dense than the reference condition. The amphipod, *A. salmonis* is absent from this station.

Perimeter station 13 does not differ significantly from the reference condition again this year.

The population measurements of *A. salmonis* at Perimeter station 14 contains a statistical oddity. Two of the samples contained large numbers of the amphipod, and the third had none. Therefore, despite the large number of this species at Perimeter station 14, the statistical analytical method used to assess differences, the Wilcoxon Rank sum analysis, does not detect a difference in the population density of this species between this station and the Reference stations. With or without this species, Perimeter station 14 differs from the reference condition in that it has a more dense total population and a more dense population of the mud snail and of *Hobsonia florida*. This station is also showing indications of organic enrichment.

Sediment core samples were taken from under each net pen in the summers of 2002 and 2003. In both years and from under each net pen every sediment core had a measurable oxidized surface layer, the presence of live animals, and no signs of a surface mat of decaying organic material. There is no indication that an anoxic condition is developing under the net pens.

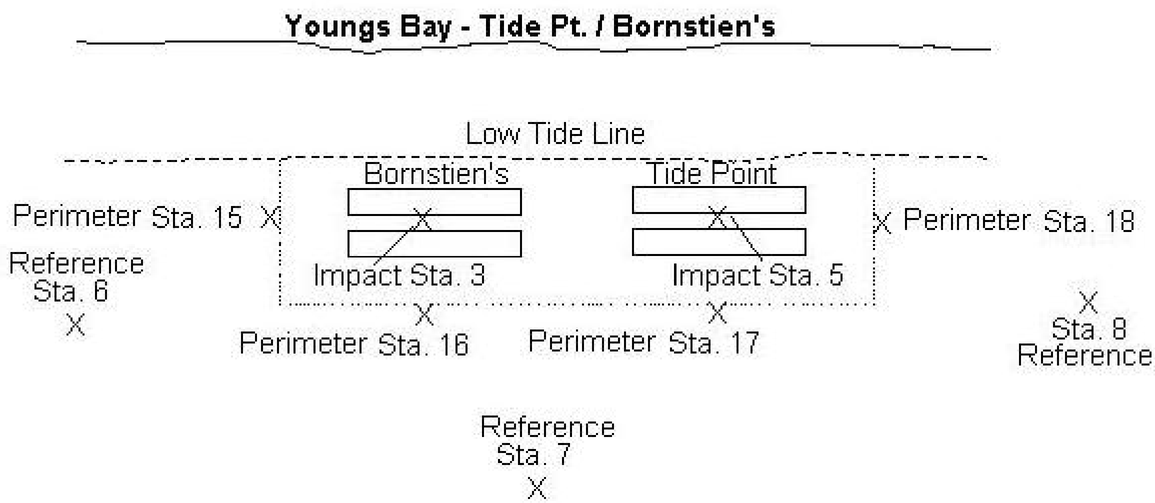
Perimeter stations 12 and 14 lie downstream of the net pens during the incoming tidal currents and the outgoing tidal currents respectively. Perimeter station 13 does not lie downstream of the net pens so the currents do not carry wastes from the net pens to this Perimeter station. The two stations that lie in the paths of currents show indications of organic enrichment. This is not allowed by the discharge permit. These stations must be closely monitored in the future, and if this condition persists, then changes may be necessary in the management practices at this facility.

Youngs Bay, Tide Point/Bornstein

The Tide Point and Bornstein facilities in Youngs Bay are located about 0.5 miles upstream from the Warrenton/Astoria Highway bridge near the north shore of Youngs Bay. There is a salt-water influence especially in the summer months when the rainfall is low. Freshwater influence comes from the Lewis and Clark, Youngs and Klaskanine Rivers. This location experiences strong tidal currents and is well flushed.

These facilities consist of two sets of net pens that are close together. They operate under the Youngs Bay NPDES discharge permit issued by ODEQ. For the purpose of environmental monitoring they are treated as having a common mixing zone. The permit specifies that no environmental impact is to occur outside of the mixing zone. Sampling stations are specified, and at each station three samples are collected for benthic macro invertebrate analysis; one for TOC and one for grain size analysis. Sampling stations are located on three sides of the facility on the edge of the mixing zone. There are four Perimeter stations associated with this net pen facility site. The forth side of the mixing zone is too close to shore to monitor.

There are three Reference stations associated with this net pen facility to provide a more accurate assessment of the normal benthic macro invertebrate populations and sediment chemistry of the area. The location of the sampling stations relative to the net pens is illustrated in the Figure below. The scale is not intended to be accurate.



The permit also specifies that there shall be no sedimentation within the mixing zone that adversely affects aquatic life or any beneficial use. This could occur if organic matter accumulates faster than the environment can absorb it. A sampling station is located under each set of net pens.

In addition to the station where samples are collected for macro invertebrate analysis and sediment chemistry, a core sample is collected from under each net pen. Each of these cores is visually inspected to insure that the organic material is not accumulating faster than the environment can absorb it. If this were to occur, patches of an anaerobic surface "mat" would be expected to appear. This may be accompanied by the odor of hydrogen sulfide. The light brown oxidized surface layer would disappear and live animals would be absent. A log is kept with the observations from each core.

The sediment at this facility is not as organically rich as sites such as Blind Slough or Deep River. The substrate contains much woody debris and mudstone making it very difficult to sample. The sediments are similar in TOC to sediments at Tongue Point and the Youngs Bay, Yacht Club facility. They are organically richer than those at Steamboat Slough where the sediments are coarser and more sandy as a result of the strong currents. The TOC at each sampling station is provided in Table 2. below for the two years that TOC samples were collected.

Table 2. Total organic carbon of the sediments of the Tide Point Bornstein's stations, 2002-2003.

Station	June 2002	June 2003
Impact Sta. 3	2.28	1.66
Impact Sta. 5	3.8	2.90
Ref. Sta. 6	2.53	1.40
Ref. Sta. 7	2.1	0.89
Ref. Sta. 8	1.81	1.69
Perimeter Sta. 15	2.1	1.94
Perimeter Sta. 16	1.34	1.46
Perimeter Sta. 17	1.01	1.25
Perimeter Sta. 18	1.25	0.71

The Bornstein net pens have only been in operation since the fall of 2002. It has not been active long enough to detect any long-term trends. The following long-term trends pertain only to the Tide Point net pens. Figure 7. compares the Impact station and Reference station population density history in the summer just after the fish rearing season and in the fall, after several months of inactivity prior to the next season.

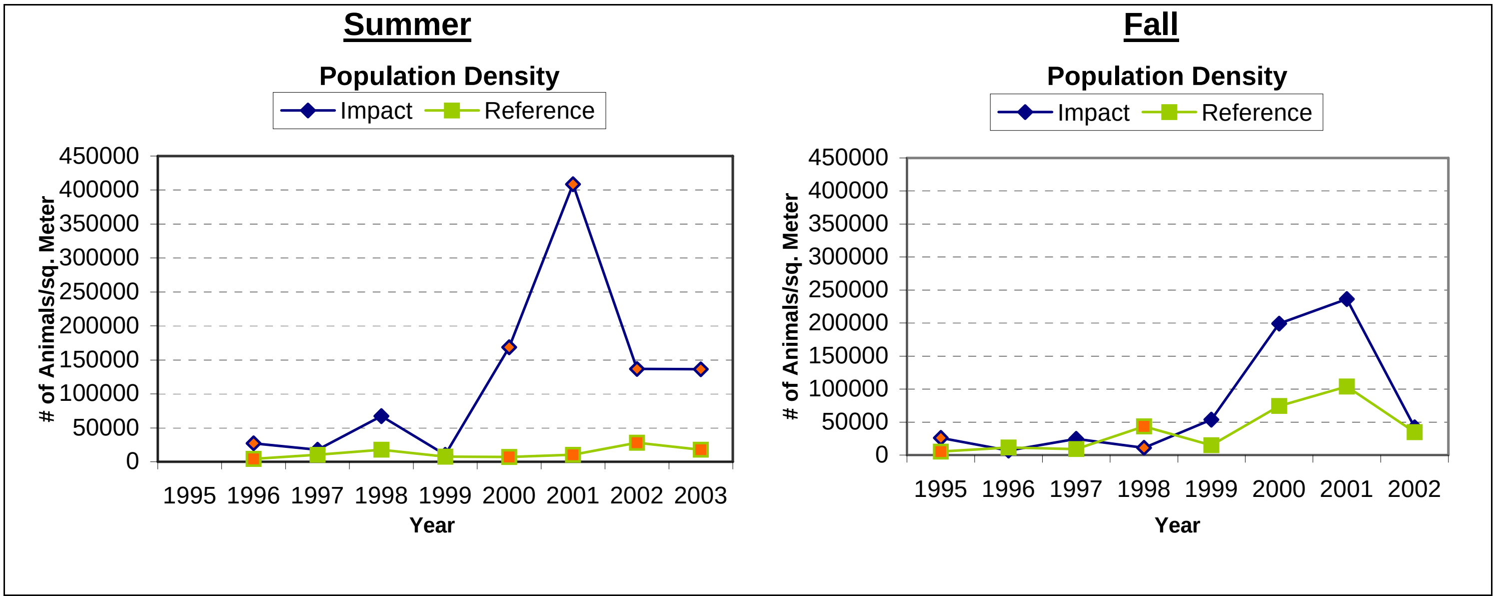


Figure 7. Macro invertebrate population density at Youngs Bay Tide Point facility, summer versus fall, 1995-2003.

The populations started out being slightly but significantly more dense at the Impact stations in both the fall of 1995 and the following summer of 1996. After this there is no difference in population densities between the Impact station and the Reference station in the summer until 2000. After the summer of 2000 the population density at the Impact station increases over that of the Reference station significantly and by a wide margin. This situation persists through the summer of 2003. During the fall months there is seldom any significant difference in population density, and the Reference station is sometimes more densely populated than the Impact station. This indicates that the organic enrichment that occurs at the Impact station does not persist through the months of inactivity.

The benthic macro invertebrate population structure at this facility is dominated by the mud snail, *Potamopyrgus antipodarum*, most years. Amphipods of the genus *Americorophium* frequently constitute a large percent of the population, especially at the Impact station. The *Oligochaeta* do not dominate the populations at this facility as they do at facilities further up the Columbia River.

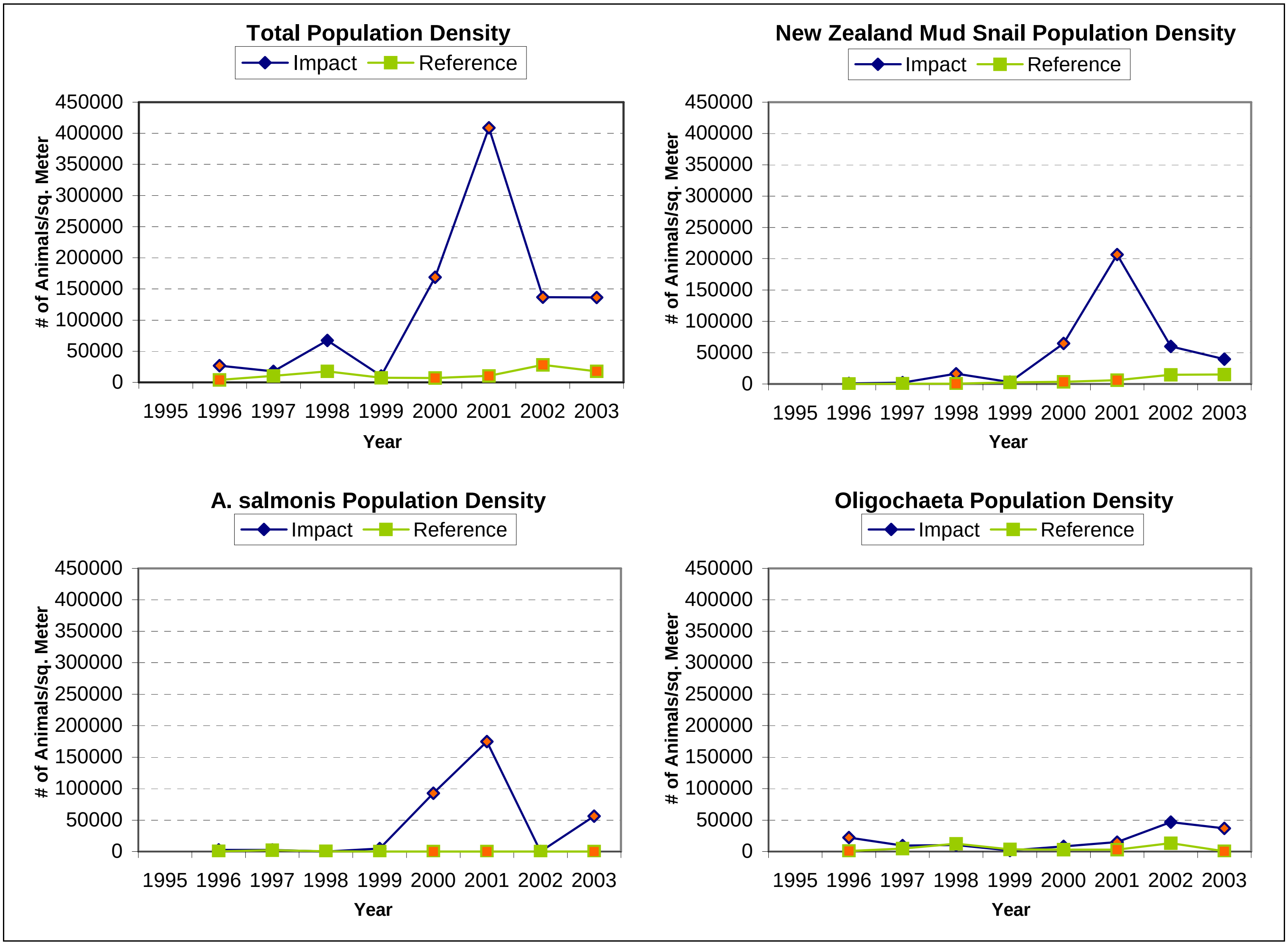


Figure 8. Population density of dominant species compared to total population at Youngs Bay Tide Point facility, 1995-2003.

The large population density increases in the summers of 2000 and 2001 are driven primarily by the mud snail and *Americorophium salmonis*, but other species that increased in density were amphipod *Eogammarus confervicolus* and the *Polychaeta* worm *Hobsonia florida*. Increases of this nature were seen at other facilities and, to some extent, at the Reference stations, as well as the Impact stations. However, at this facility the increase in population density was seen almost entirely at the Impact station and among taxa that are able to utilize the organic material produced by the fish rearing activities.

The trend of increasing benthic macro invertebrate population density at the Impact station in recent summers is reason to be concerned about the impact of organic enrichment of the environment at this facility. However, since the situation does not appear to persist over the months of inactivity it is not of as much consequence as it would be if it persisted. Other population parameters do not show a detectable trend of response to the organic enrichment. Future monitoring will detect any increased response to the fish rearing activities.

The current work plan specifies that the edge of the mixing zone will be sampled to insure that any environmental impact that occurs will be confined to the mixing zone. This plan was adopted just before the summer of 2002 samples were collected. This has only provided two years of samples for the Perimeter stations. Two years of data do not permit a long-term analysis of the data or the detection of trends. However, the data for those two years provides a snap shot to determine if the facility is in compliance with the rule that there will be no impact beyond the mixing zone.

The Figure 9. shows a large increase in population density at both of the Impact stations as compared to the Reference stations. This density increase is statistically significant at both stations. At Impact station 3 the increase is due to the significant increases in the *Oligochaeta*, the amphipods, *Americorophium spinicorne* and *Eogammarus confervicolus*, *Corbicula fluminea* as well as and *Hydroida* colonies. At Impact station 5 the increase is due to the mud snail, *Potamopyrgus antipodarum, Americorophium spinicorne* and *Eogammarus confervicolus*, *Polychaeta* worm, *Hobsonia florida, Turbellaria* and *Hydroida* colonies. Both stations also have a greater number of species. Increases in these taxonomic groups indicates population increases due to organic enrichment.

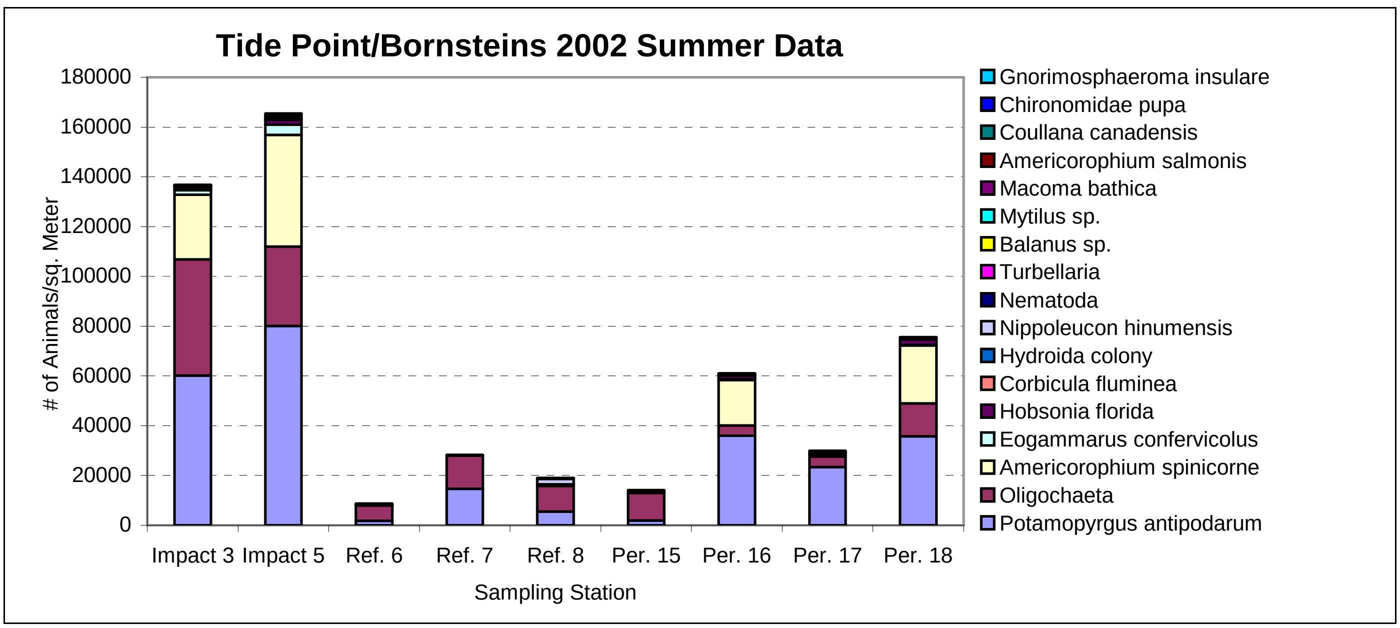


Figure 9. Macro invertebrate data, population size and composition at Youngs Bay Tide Point facility, summer of 2002.

Perimeter station 15 has no statistical differences from the Reference condition.

Perimeter station 16 differs from the Reference condition in having a more dense overall benthic macro invertebrate population due to more dense populations of the mud snail, *Americorophium spinicorne* and *Hydroida* colonies. It also has more species.

Perimeter station 17 differs from the Reference condition in having more dense populations of the mud snail and *Americorophium salmonis* but not a more dense overall population.

Perimeter stations 16 and 17 have a different benthic substrate than the Reference stations. They have a great deal of large woody debris. This bottom structure also offers many crevices and sheltered spots that provide more protected habitat than the muddy bottom of other stations. The direction of current does not carry organic materials from the net pens in the direction of these stations. Therefore, it is unlikely that the increase in population at these stations is a result of the fish rearing activities. The differences in population are likely a result of the bottom structure at these stations.

Perimeter station 18 has no statistical differences from the Reference condition due to variability between the samples. However, there were a much larger number of animals in two of the samples. Since incoming tidal currents could carry materials to this station, and since the two species that were more numerous in two of the samples from this station than at the Reference stations benefit from organic enrichment, this station may be experiencing an impact from the fish rearing activities.

Figure 10. shows the benthic macro invertebrate data collected from all of the stations at this site in the summer of 2003. The most notable aspect of this Figure is the large population density at Perimeter station 16. This is a significant difference in overall population density from the Reference condition. This overall population density is due to a significantly more dense population of *Americorophium salmonis* and of the mud snail, *Potamopyrgus antipodarum*. Since the currents do not run in the direction that would carry organic material to this station, and since other Perimeter stations do not show any impact, it is unlikely that the differences between this station and the Reference condition in the benthic macro invertebrate population is a result of the fish rearing activity.

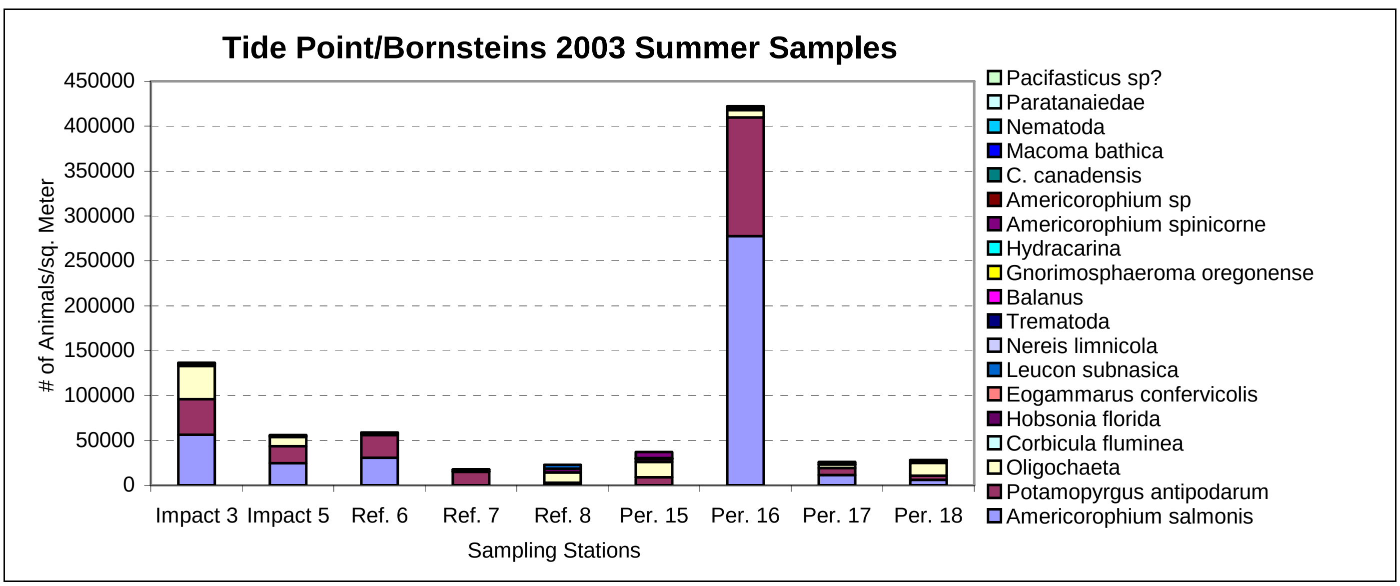


Figure 10. Macro invertebrate data, population size and composition at Youngs Bay Tide Point facility, summer of 2003.

Impact station 3 differs significantly from the Reference condition only in the population density of *Oligochaeta*. Samples also contained larger numbers of *Americorophium salmonis* and of the mud snail, *Potamopyrgus antipodarum* than the samples from the Reference stations, but there was too much variability in these numbers to detect a statistical difference.

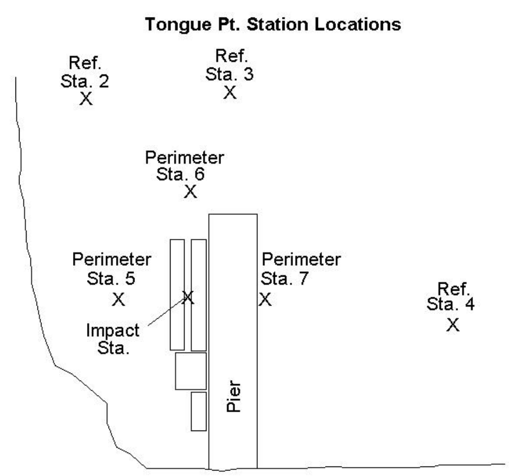
Impact station 5 has no statistical differences from the Reference condition.

Perimeter stations 15,17 and 18 have no statistical differences from the Reference condition.

The Tide Point/Bornstein facilities produce organic enrichment that creates a small but measurable impact at Impact station 3 under the net pens. The net pens at Impact station 5 have only been in operation for two years as of the time of the last sampling. The effect here is not yet pronounced enough to be reliably detectable at the resolution that the monitoring plan provides. In the future it is expected that the impact at this station will become more pronounced. The impact does not appear to persist through the months of inactivity and it is not expected to reach an unacceptable level.

The Perimeter stations that are in the direction of tidal currents do not show any Impact. The differences from the Reference condition that appear at Perimeter station 16, and to a lesser degree at Perimeter station 17, are believed to be due to the physical structure of the benthic substrate. The differences are not due to organic enrichment from the fish rearing activities because currents do not flow in the direction that would carry organic materials from the net pens to these stations.

Tongue Point and MERTS Facilities



The Tongue Point facility is located at the federal government's Job Corp pier, which is the second pier to the north from the boat ramp. This site was used by the U.S. Navy during World War II. It is inside of the channel formed by Tongue Point and Mott Island. There is a slight salt-water influence here, primarily during the months of low rainfall, but the predominant influence is from the main stem of the Columbia River and from the John Day River.

This facility has a production level that requires a NPDES discharge permit issued by the ODEQ. A mixing zone has been established and is defined by ODEQ as extending 15 meters out from the edge of the net pen facilities in all directions. The permit specifies that no environmental impact is to occur outside of the mixing zone. The location of sampling stations are specified, and at each station three samples are collected for benthic macro invertebrate analysis, one for TOC, and one for Grain Size Analysis. Sampling stations are located on three sides of the facility on the edge of the mixing zone. The forth side of the mixing zone is too close to shore to monitor.

The permit also specifies that there shall be no sedimentation within the mixing zone that adversely affects aquatic life or any beneficial use. This could occur if organic matter accumulates faster than the environment can absorb it. A sampling station is located under the net pens.

In addition to the station where samples are collected for macro invertebrate analysis and sediment chemistry, a core sample is collected from under each net pen. Each of these cores is visually inspected to insure that the organic material is not accumulating faster than the environment can absorb it. If this were to occur, patches of an anaerobic surface "mat" would be expected to appear. This may be accompanied by the odor of hydrogen sulfide. The light brown oxidized surface layer would disappear and live animals would be absent. A log is kept with the observations from each core.

There are three Reference stations associated with this net pen facility site to provide a more accurate assessment of the normal benthic invertebrate populations and sediment chemistry of the area. The location of the sampling stations relative to the net pens is illustrated in the Figure on the right.

The plan for monitoring the environmental impact at this facility was written and approved by ODEQ before to the end of the fish rearing season in June 2002. Prior to this, only benthic macro invertebrate samples were collected and they were only collected from the Impact station under the net pens and from one Reference station (Ref. Sta. 2). Therefore, historical comparisons can only be made between these two stations.

The sediment at this facility is not as organically rich as sites such as Blind Slough or Deep River, but the area is somewhat depositional in nature so the sediments are organically richer than those at Steamboat Slough where the sediments are coarser and more sandy as a result of the strong currents. The TOC at each sampling station is provided in Table 3. at the right for the two years that TOC samples were collected. The TOC increases slightly at the stations that are located further to the south.

Table 3. Total organic carbon of the sediments of the Tongue Point stations, 2002-2003.

Station	June 2002	June 2003
Impact station 1	1.32	1.45
Reference station 2	1.25	1.30
Reference station 3	1.28	1.39
Reference station 4	1.73	1.68
Perimeter station 5	0.85	1.43
Perimeter station 6	1.21	1.45
Perimeter station 7	1.65	1.52

Figure 11 indicates the population comparison between these two stations in the summer, just after the fish rearing season and in the fall prior to the start of the next season.

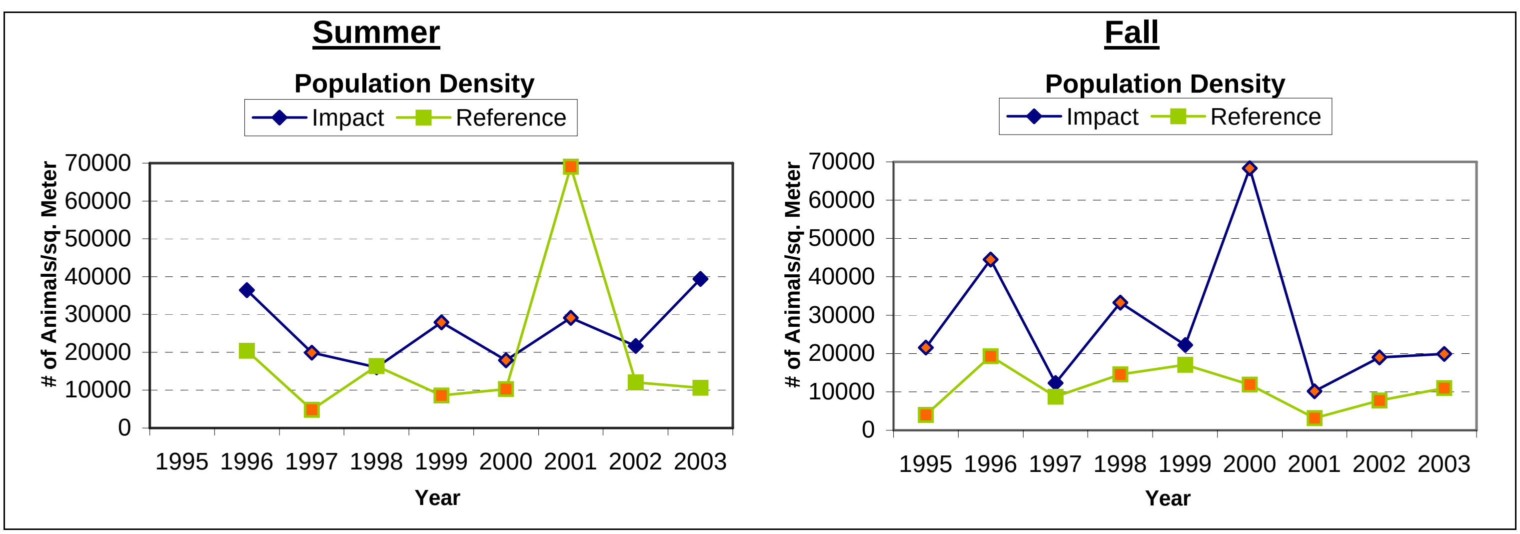


Figure 11. Macro invertebrate population density at Tongue Point facility, 1995-2003.

The population at the Impact station is usually more dense than at the Reference station. An exception to this occurs in June 1998 when the population density is about the same and in June 2001 when the population at the Reference station greatly exceeds that at the Impact station. This latter population increase resulted from an increase in a number of species. At the Impact station the *Oligochaeta* population density increased more than it did at the Reference station. However, the other species that increased dramatically at the Reference station did not increase at the Impact station, These species were *Coullana canadensis, Americorophium salmonis, Hobsonia florida* and *Potamopyrgus antipodarum. Oligochaeta* are not very sensitive to toxicants in the environment while most of these other species are. There may be some low level of toxic material present in the sediments around the pier that stifles the populations of more sensitive species.

It is notable that the population density at the Impact station is consistently greater in the fall, prior to the next growing season and after the site has been inactive for several months. This indicates that the Impact station is a richer habitat for macro invertebrates even well after the input of organic material has ceased. This could occur because the organic material is not depleted over the months after the cessation of fish rearing activity. This may not mean that the organic material is constantly increasing, but it may indicate that biological activity is occurring at a more intense or dynamic level.

The dominant taxonomic group, the *Oligochaeta*, is a more sensitive indicator of the long-term organic enrichment as shown in Figure 12 below. This Figure shows data that reinforces the probability that the Impact station is consistently more organically rich than the Reference station, even in the fall.

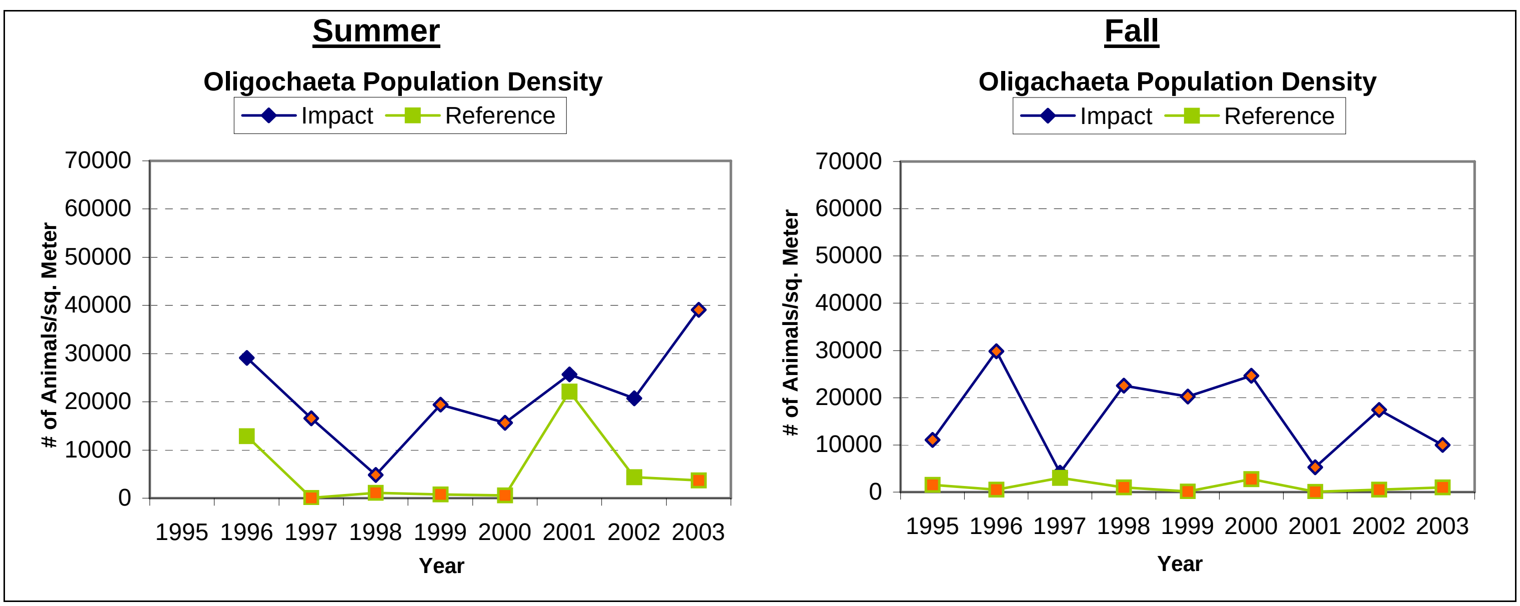


Figure 12. *Oligochaeta* population density at Tongue Point facility, summer versus fall, 1995-2003.

The benthic macro invertebrate population in the sediments at this facility are dominated by *Oligochaeta* at the Impact station, but at the Reference station the amphipod *Americorophium salmonis* is the dominant taxon in most years. This situation occurs both in the summer and the fall.

Figure 13. displays the percent of the population that is composed of the dominant species. *Oligochaeta* dominate at the Impact station, and the percent by which they are dominant over other taxonomic groups is increasing during the summer. As the input of organic material

increases, the taxonomic group that is best able to utilize this material is expected to increase its dominance of the population, eventually to the exclusion of other taxonomic groups. This appears to be occurring in the summer, when the impact of the fish rearing activities are the greatest. By the fall of each year this situation has changed. The degree by which the *Oligochaeta* dominate at the Impact station is little different from the degree by which the *A. salmonis* dominate at the Reference station and sometimes the *A*. salmonis are more dominant at the Reference station than are the *Oligochaeta* at the Impact station.

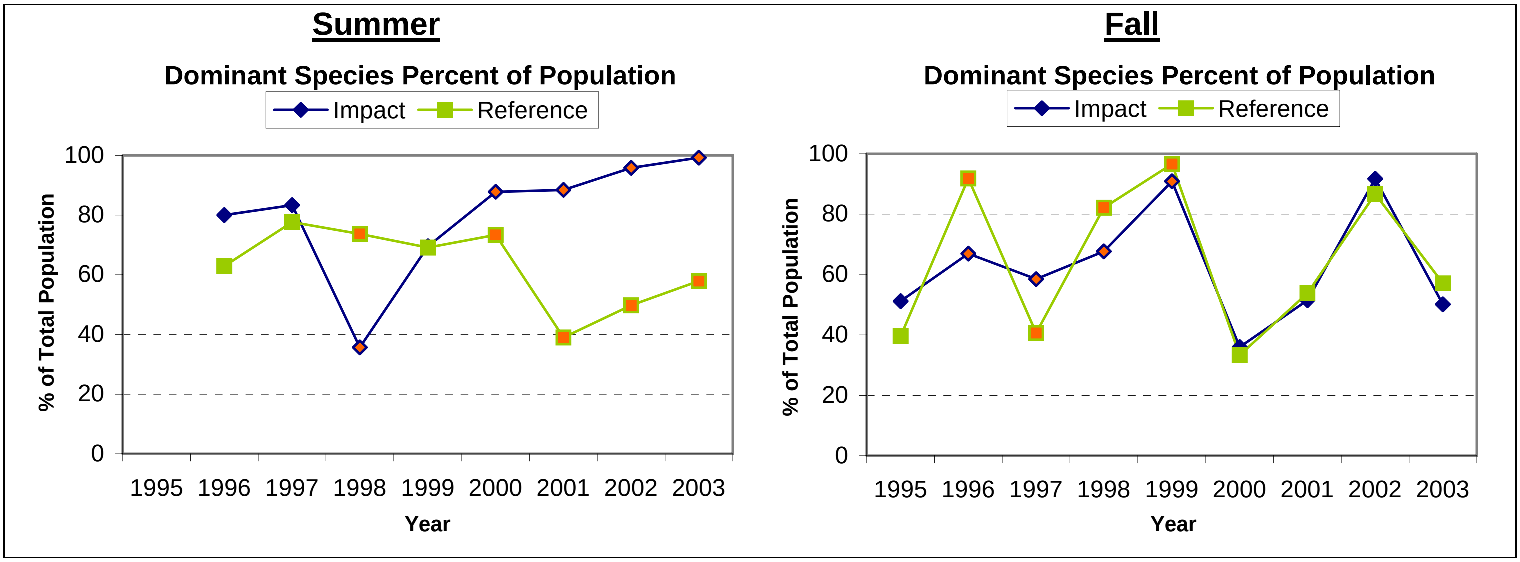


Figure 13. Percent of total population that is composed of the dominant species, summer versus fall, 1995-2003.

While the Impact station is heavily dominated by *Oligochaeta* in the summer, other species are reduced in numbers but have not been eliminated. As Figure 14. indicates, the number of species does not differ significantly between the Impact station and the Reference station in either the summer or fall samples except on two occasions, summer of 2002 and fall of 1999. This indicates that while the organic enrichment persists through the months of inactivity and has caused the *Oligochaeta* to be exceptionally dominant during the summer, the level of environmental impact has not reached the level where the Impact station is populated by just one species, and there has been no indication of the development of an anoxic condition beneath the net pens.

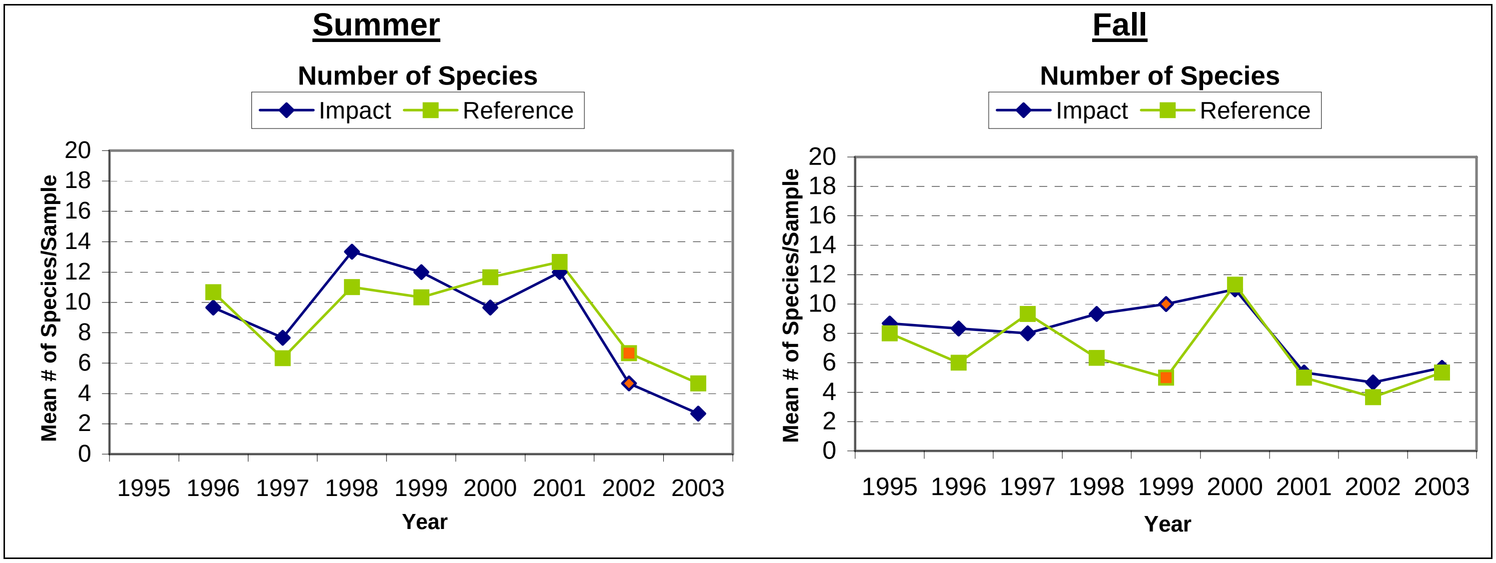


Figure 14. Mean number of species present in the Tongue Point samples, summer versus fall, 1995-2003.

Beginning in the summer of 2002 the monitoring plan was implemented that was developed to meet the permit conditions. As described previously, this plan requires that samples be collected from stations on the perimeter of the mixing zone as well as from the Impact station under the net pens. In addition samples are collected from three Reference stations instead of just one. Having three Reference stations allows for statistical confidence of 95 percent and better represents the variability of the environment.

Two years of data do not permit a long-term analysis of the data or the detection of trends. Therefore, the data does not allow an historical view of the Perimeter stations or of the two additional Reference stations.

Figure 15. shows the dominance of the *Oligochaeta* at the Impact station in the summer of 2002. Two other stations, Reference station 4 and Perimeter station 7, are dominated by *Oligochaeta* as well, but other taxa are better represented at these stations than at the Impact station. These stations are both located to the south of the Impact station and they are in the direction of higher sediment TOC. The high TOC may contribute to this situation. Dominance is shared by *Americorophium salmonis* at the other stations.

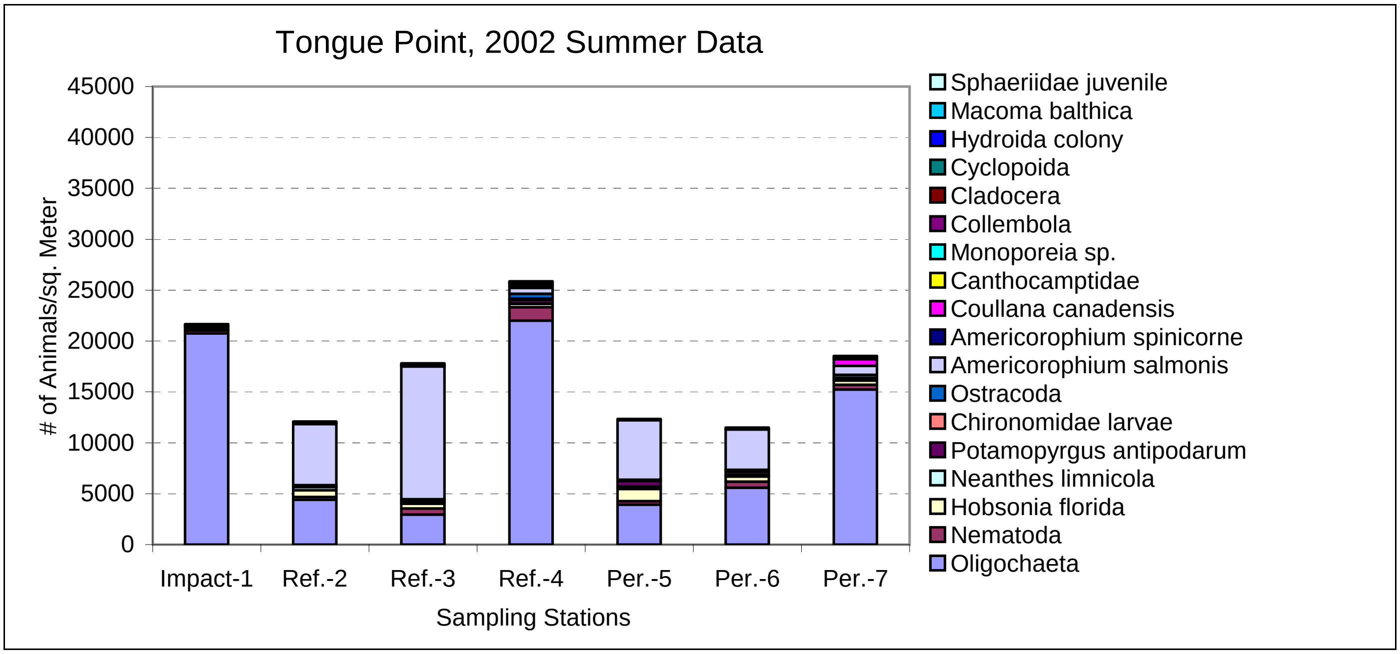


Figure 15. Macro invertebrate data, population size and composition at Tongue Point, summer of 2002.

In the summer of 2002 the Impact station differs significantly from the Reference stations in that it has fewer species, the dominant species comprises a larger percent of the population, and there is an absence of *A. salmonis*.

Perimeter station 7 differs only in having a greater number of the copepod, *Coullana canadensis*. This is not indicative of organic enrichment.

Figure 16. shows that the population density and dominance of *Oligochaeta* have increased at the Impact station, probably in response to the organic enrichment. The only significant differences are with the Impact station where the dominant species comprises a larger percent of the population, the *Oligochaeta* population is more dense at the Impact station than at the Reference stations, and *A. salmonis* is absent from the Impact station.

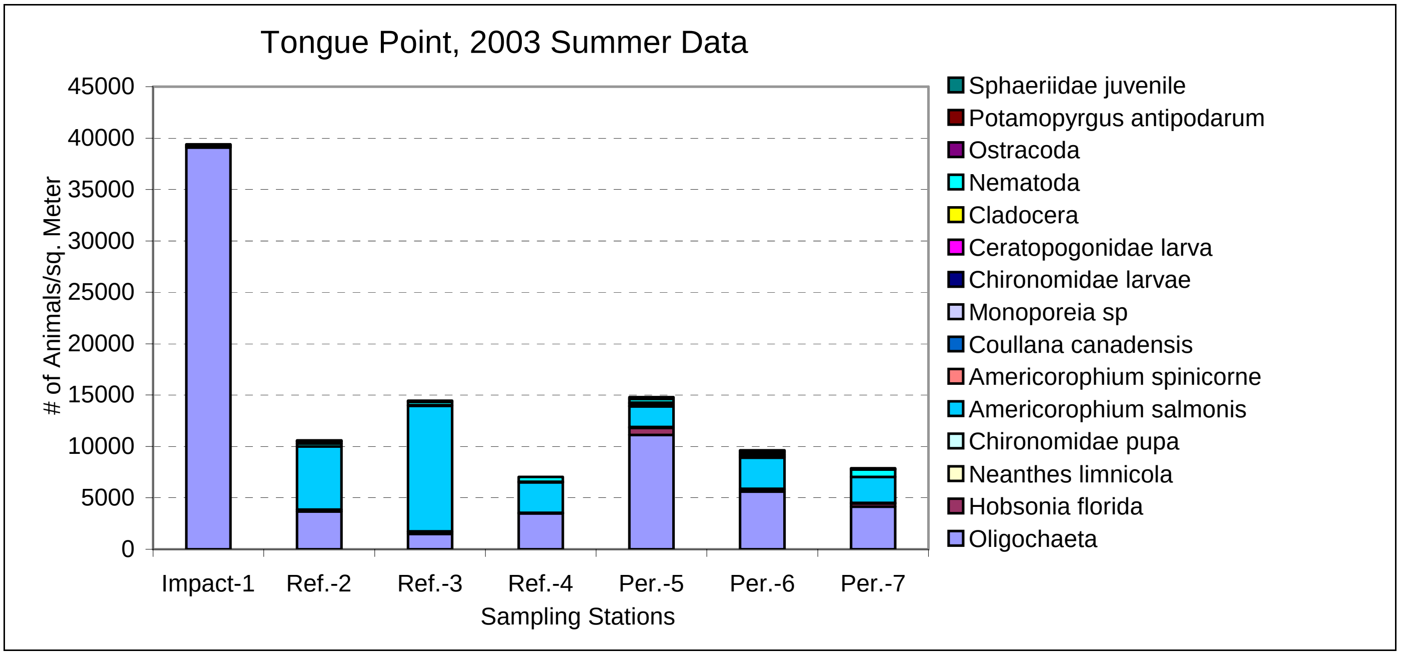


Figure 16. Macro invertebrate data, population size and composition at Tongue Point facility, summer of 2003.

Perimeter station 5 differs from the Reference stations in that it has fewer species, the population of *Oligochaeta* is more dense, the population of *Hobsonia florida* is more dense, and the population of *A. salmonis* is less dense. The increase in *Oligochaeta* is reason to be concerned about the possibility that this station may be impacted by the fish rearing activities. However, this situation did not exist in the summer of 2002 and the fish rearing has been in progress for several years, so this is probably not a trend.

Perimeter station 6 differs from the Reference stations only in that the population of *Oligochaeta* is more dense. As with Perimeter station 6 this is reason to be concerned about the possibility that this station may be impacted by the fish rearing activities. However, this situation did not exist in the summer of 2002 and the fish rearing has been in progress for several years, so this is probably not a trend.

As stated earlier, there is not enough data to determine whether any trends exist at any stations except the Impact station where the evidence clearly indicates organic enrichment.

Since it is currently planned to abandon this site and move the facility to the pier at the MERTS site owned by Clatsop Community College (CCC), there will not be time to determine if any trends exist with the Perimeter stations. Monitoring at the Impact station should continue through at least the summer 2005 to document the recovery of the Impact station. The MERTS dock is located about a mile southeast of the current Tongue Point facility. It is reached taking Liberty Lane from U.S. Highway 30.

MERTS

Baseline samples were first collected in the summer of 2002. They were collected from three Reference stations and the Impact station. Since the mixing zone is defined as extending 15 meters from the edge of the net pen facilities in all directions, and there were no net pens in place at the time, it was not possible to determine where the perimeter of the mixing zone will be.

Figure 17. represents baseline data from the samples collected in the summer of 2002. The populations at these stations are not very different from those at the Reference stations at the Tongue Point facility. *Oligochaeta* and the amphipod *A. salmonis* are present at all of the stations. However, *Oligochaeta* dominates the populations at the Impact site and at Reference station 2. The amphipod dominates the populations at Reference stations 3 and 4. The only significant difference between the Impact station and the Reference stations is a more dense population of the marine *Polychaeta* worm, and *Hobsonia florida* at the Impact station.

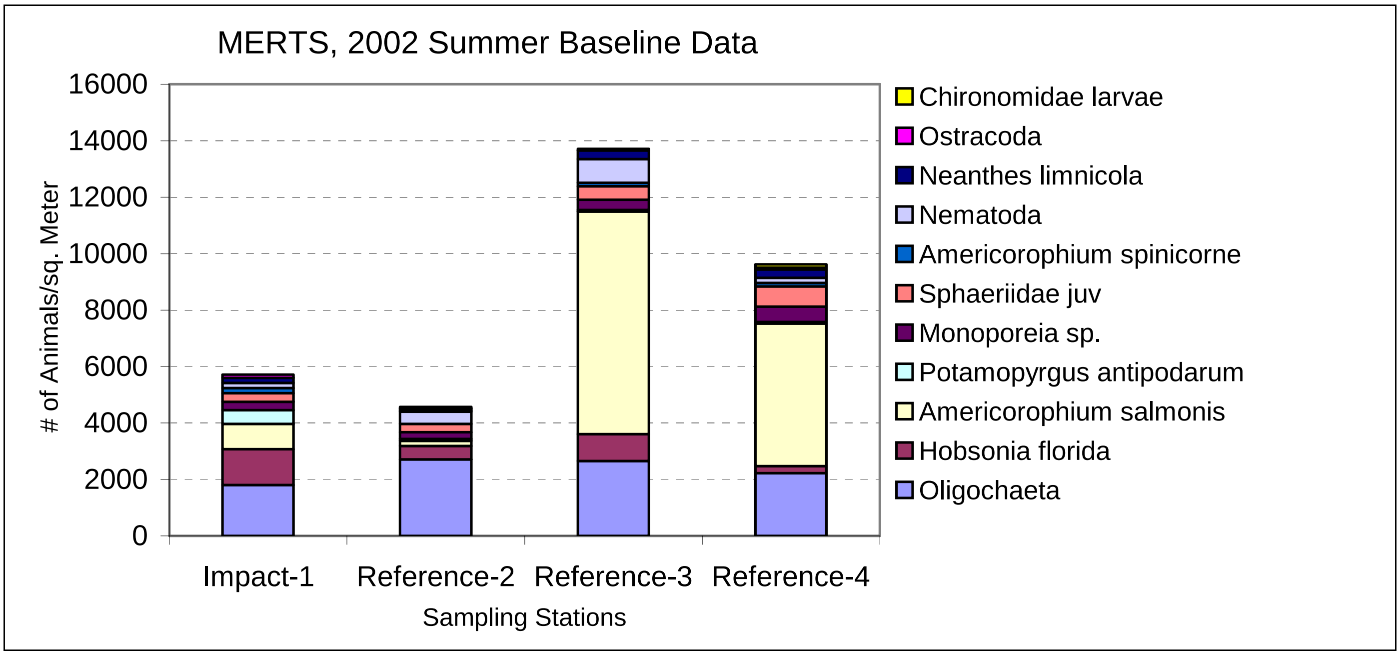


Figure 17. Macro invertebrate data, population size and composition at MERTS facility, summer of 2002.

Samples were also collected in the fall of 2002 after a small number of fish had been held in net pens at this facility. Figure 18. below shows that populations at both stations have decreased, probably due to seasonal changes, but the population at the Impact station is statistically different in four ways. It is significantly more dense, there are more species present, the population of *Oligochaeta* is more dense, as is the population of *Hobsonia florida*. This indicates some organic enrichment.

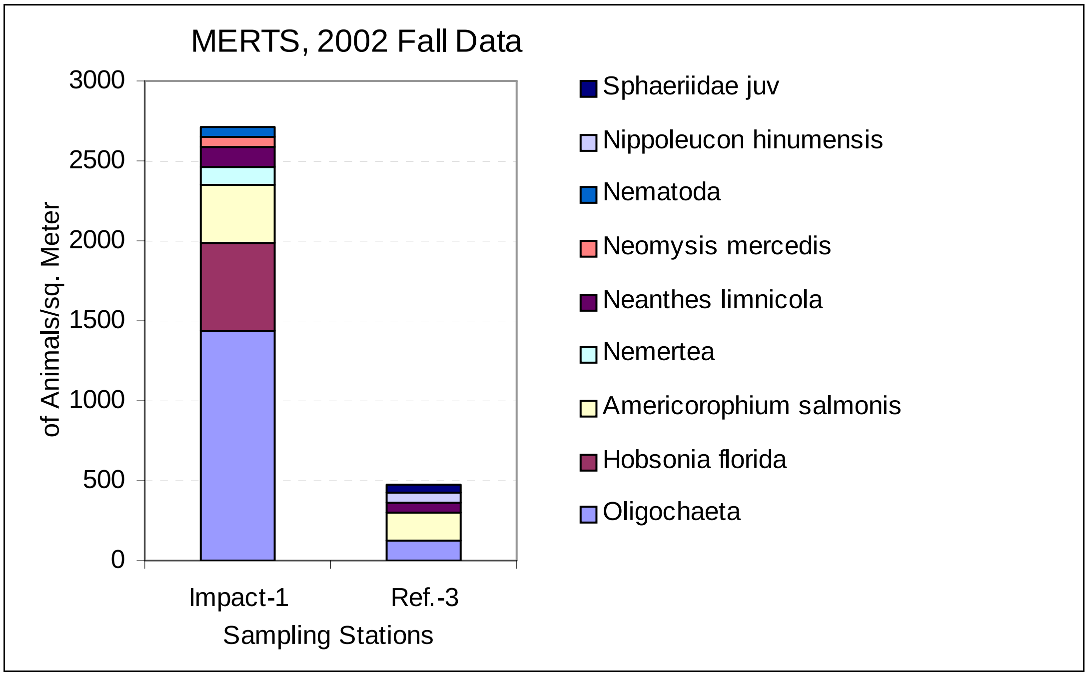


Figure 18. Macro invertebrate data, population size and composition at MERTS facility, fall of 2002.

Samples were collected again in the summer of 2003. Figure 19 shows the normal variability among the Reference stations with *A. salmonis* dominating the populations at two of the Reference stations and *Oligochaeta* dominating Reference station 2. *Oligochaeta* also dominates the Impact station. Since only a low level of fish rearing activity has been taking place at this facility this may be indicative of some organic enrichment. However, the only statistically significant difference between the Impact station and the Reference stations is that the Impact station has a more dense population of *Hobsonia florida*.

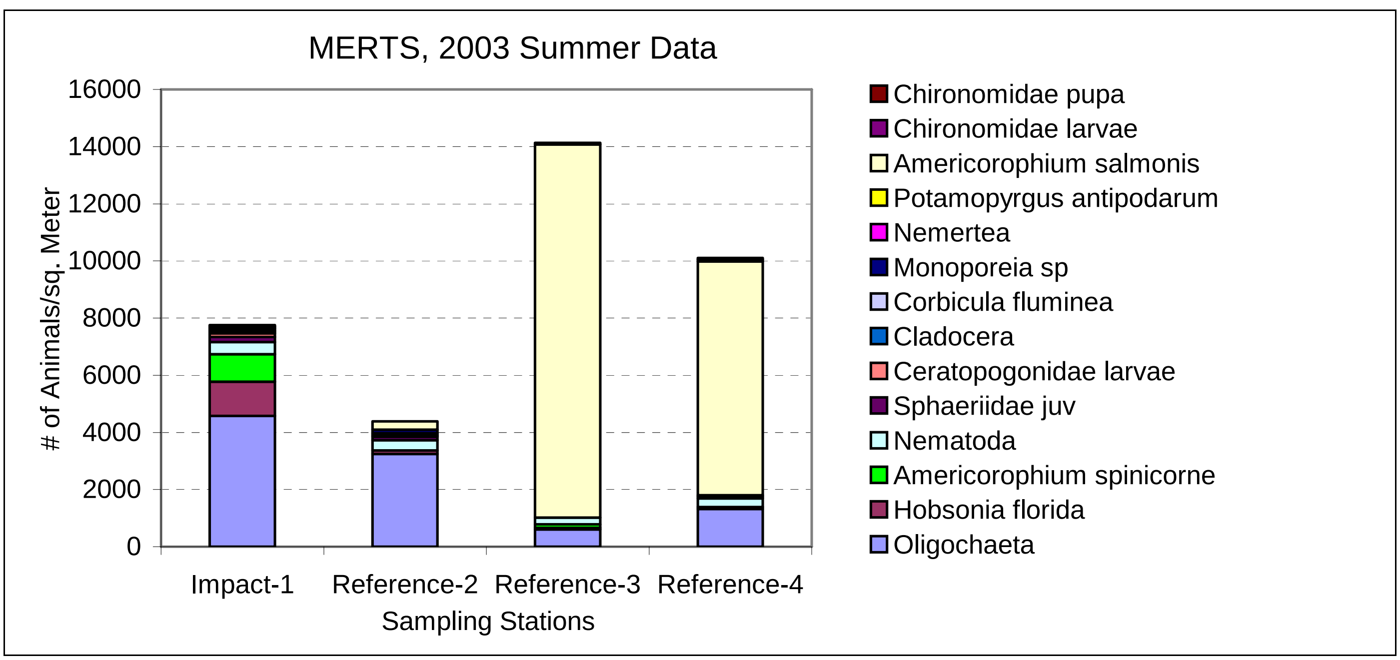


Figure 19. Macro invertebrate data, population size and composition at MERTS facility, summer of 2003.

This summer Perimeter stations will be established at the MERTS facility. As of the writing of this report, this site has had only a low level of fish rearing. As the facilities are moved from Tongue Point to this site the production level is expected to increase and the environmental monitoring effort will increase to meet the requirement of the discharge permit.

Blind Slough

The Blind Slough facility is located about 1.25 miles upstream from the confluence of Blind Slough and Knappa Slough, about 100 meters downstream from the Barendse Road bridge. Gnat Creek flows into Blind Slough. Production at this facility is below the level that would require a discharge permit. At this production level there is no mixing zone specified and the overall environmental impact is assumed to be low. Samples at this facility are collected from one station beneath the net pens and one Reference station.

This site is downstream from a former log dump and the sediments contain a lot of woody debris. The sediments at this site are very organically rich. TOC measured at the Reference station in the years 2002 and 2003 was 5.02 percent and 3.25 percent respectively. The TOC was 9.84 percent and 7.58 percent at the Impact station beneath the net pens in 2002 and 2003 respectively. This indicates an increase in organic richness of the sediments below the net pens due to the fish rearing activities. Since TOC samples have only begun to be collected recently it is too soon to detect any trends in TOC from direct measurements. However, benthic macro invertebrate samples have been collected since 1995, and trends in populations resulting from the input of organic material can be demonstrated. Figure 20. displays the overall density of the macro invertebrate population.

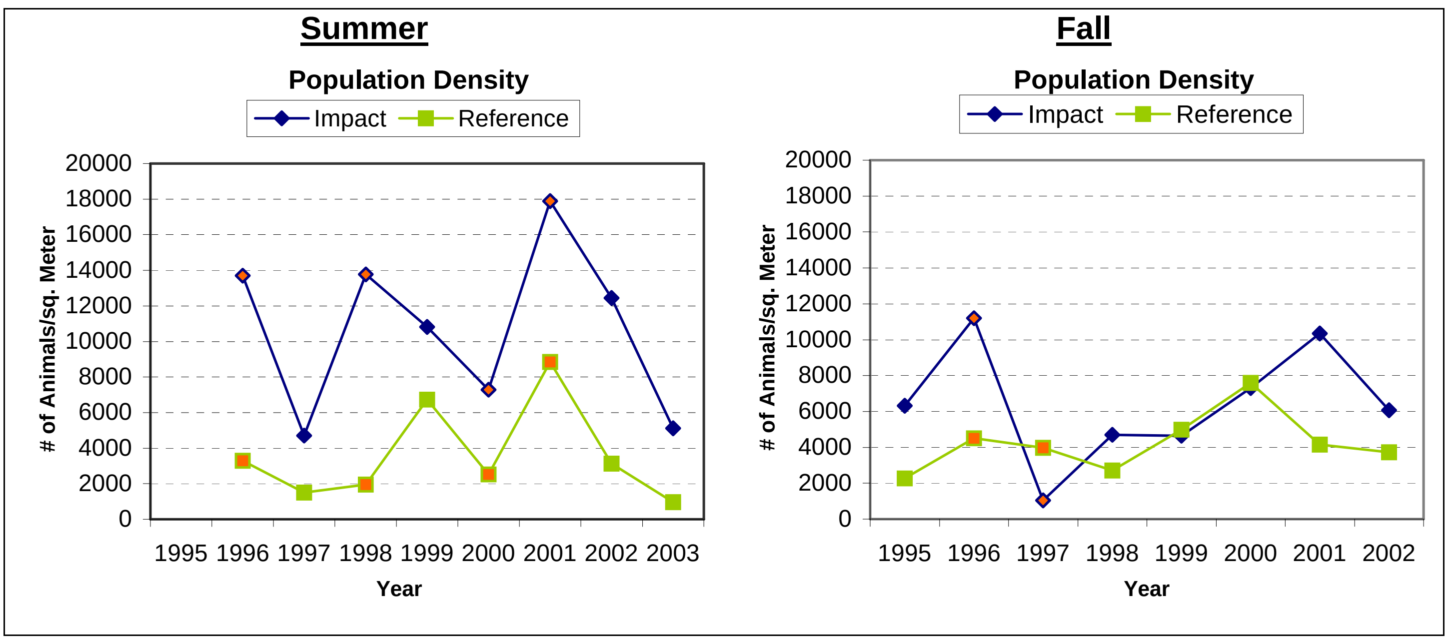


Figure 20. Macro invertebrate population density at Blind Slough facility, summer versus fall, 1995-2003.

Analysis of benthic macro invertebrate samples collected at the end of the growing seasons (summer) indicate that the size of the population under the net pens is consistently larger than the size of the population at the reference site. Analysis of the benthic samples collected in the fall, just before the start of the growing season, indicates that this situation ceases to exist after several months of inactivity between the end of the previous growing season and the start of the next growing season. The data does not indicate a trend towards an increasing population size at the Impact station. The controlling influence of the *Oligochaeta* on the overall population size is displayed by Figure 21

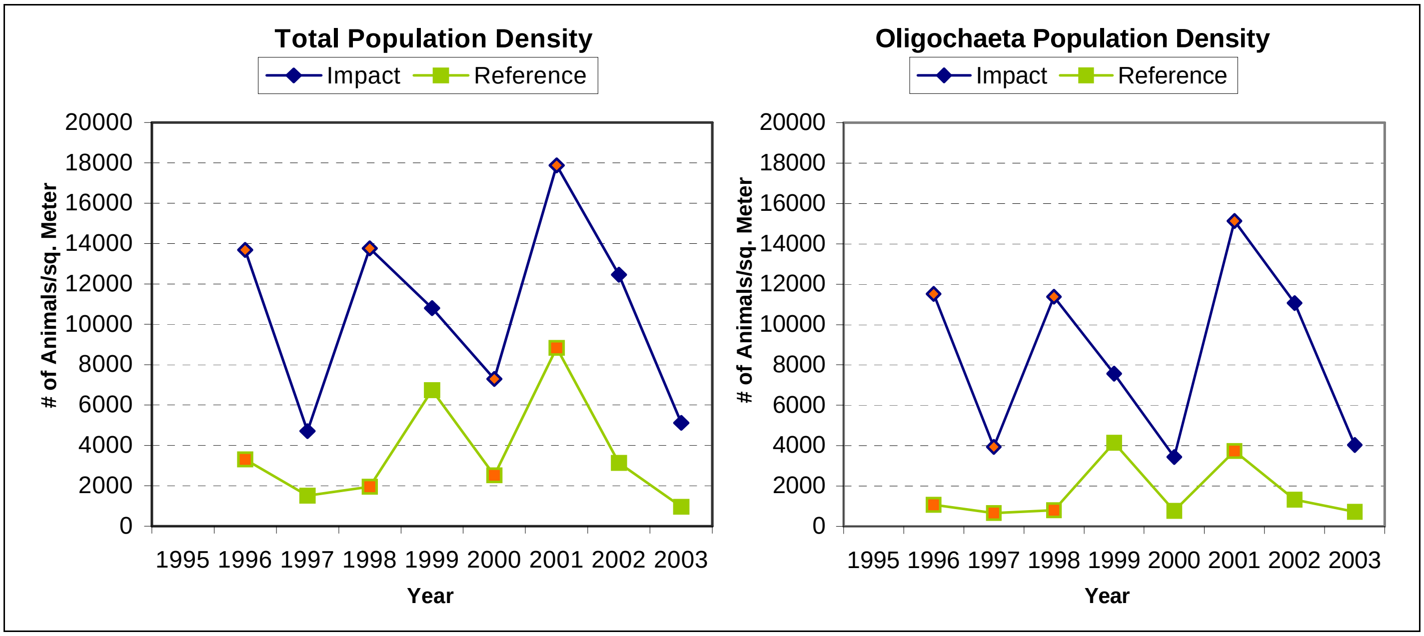


Figure 21. Summer population density of *Oligochaeta* compared to total population at Blind Slough facility, 1995-2003.

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Since *Oligochaeta* worms feed by processing sediment and utilizing the organic material in the sediment for food, this taxonomic group benefits from the organic input from the fish rearing activities. The population of *Oligochaeta* increases at the Impact station in response to the input of organic material. This causes the *Oligochaeta* to make up an even larger percentage of the overall population at this station than at the Reference station. Figure 22 below shows the increase in dominance of the most numerous species. Another taxonomic group that is usually present in large numbers is the *Chironomidae* (midge larvae). However, the *Oligochaeta* are by far the more dominant.

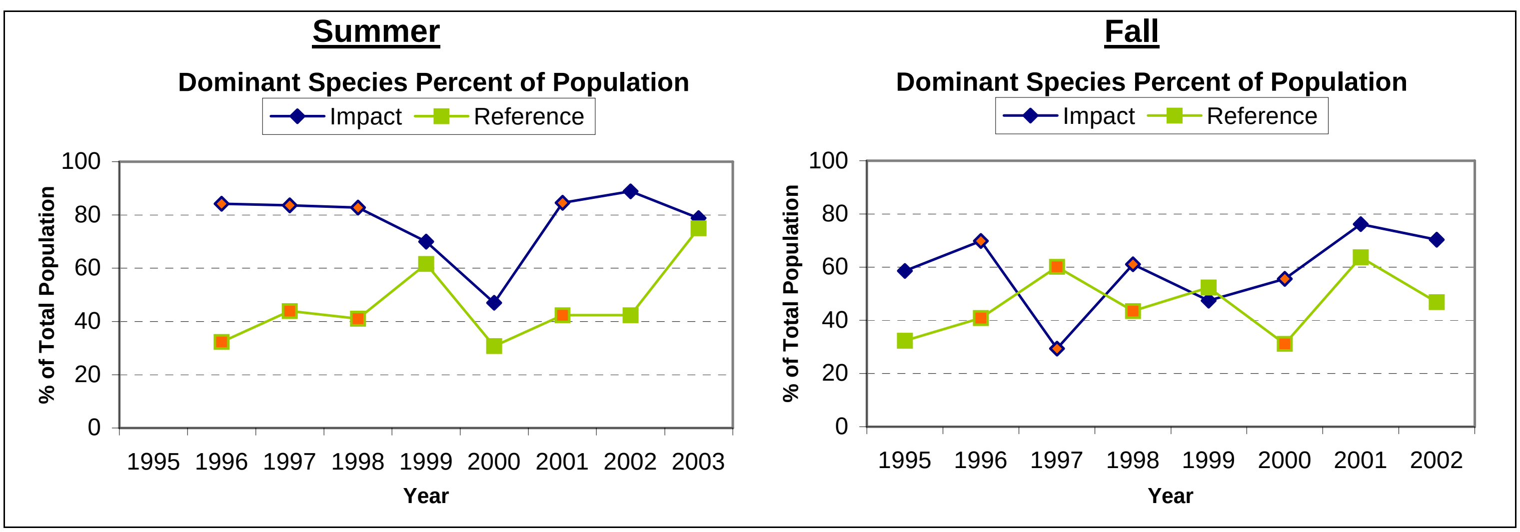


Figure 22. Percent of the total population that is composed of the dominant species at the Blind Slough facility, summer versus fall, 1995-2003.

Analysis of the fall samples indicates that this situation does not persist. In the fall the most dominant species is not consistently more dominant at the Impact site than at the Reference site.

Species richness can decrease with the input of organic material. As one or more species increases in number by utilizing the organic material, other species may disappear due to the increased competition. Figure 23 is produced from the benthic sample analysis and it shows that there are not consistently more species at the Reference site than at the Impact site. There are significantly more species at the Reference site in only one year, June 2001, and at other times there are more species present at the Impact site. Analysis of samples taken in the fall show that the number of species at the Impact site follows the number at the Reference site quite closely. There are no significant differences.

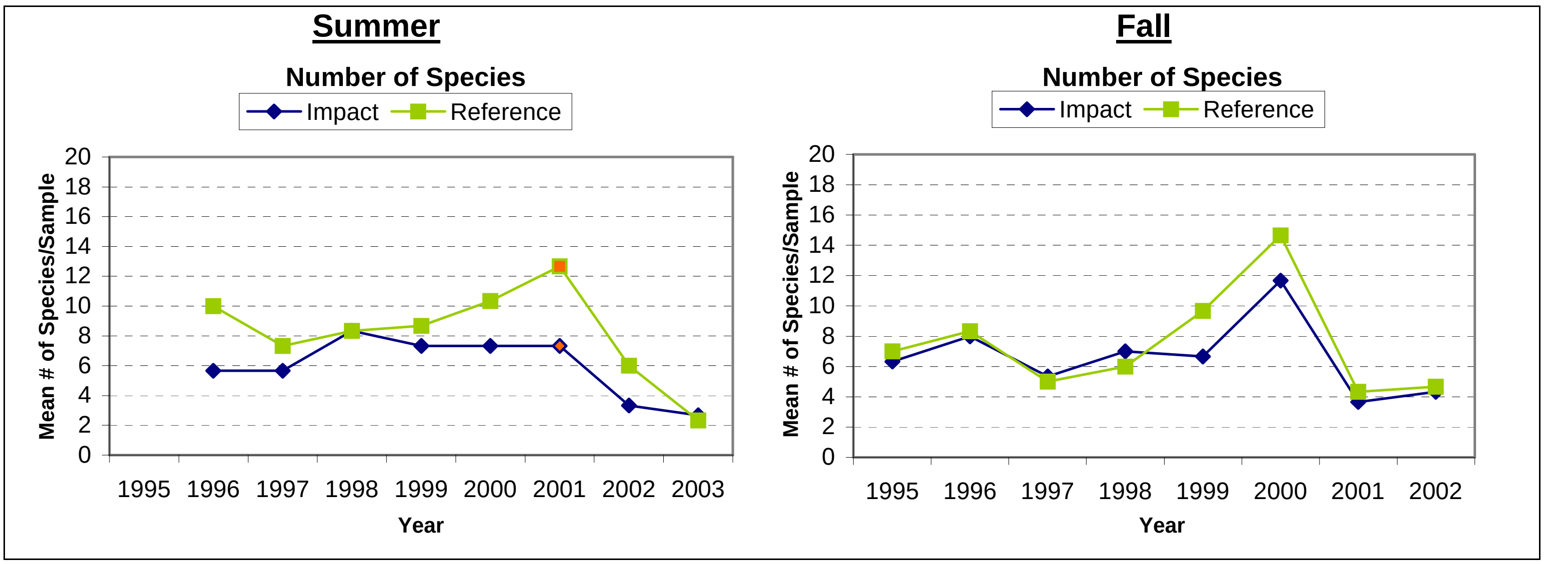


Figure 23. Mean number of species present in Blind Slough samples, summer versus fall, 1995-2003.

Analysis of the benthic populations at the Blind Slough facility indicates that the environmental impact of the salmon rearing activities at this site are slight and do not persist. The organic material being input to the environment at this location is being absorbed by the environment with a temporary increase of the population, predominantly the *Oligochaeta*. When the input of organic material ceases, the population decreases to background levels. The data indicates that the impact is not great enough to impact other population parameters such as species diversity, nor is there any indication that species have disappeared.

Upper Deep River, Walter Kato's

There are two SAFE net pen facilities in Deep River, Washington. This facility is located about a half mile upstream from the Washington State Highway #4 bridge over Deep River. This site is moderately well flushed. It is within the zone of tidal influence with current flowing upriver on an incoming tide and downriver on an outgoing tide. The river is about 75 meters wide here.

The sediment is organically rich with a lot of plant material and woody debris. The TOC at the Reference station was 4.09 percent and 3.47 percent at the end of the growing seasons in the years 2002 and 2003 respectively. The TOC was 2.64 percent and 4.08 percent at the Impact station at the end of the growing seasons in the years 2002 and 2003 respectively. Production at this station has increased over the years of operation but it is still below the level at which a permit would be required, so no mixing zone has been established. Benthic macro invertebrate samples are collected from the Impact station located under the net pens and from a Reference station.

As indicated in Figure 24 below, the population density is usually higher at the Impact station than at the Reference station at the end of the fish rearing season. The summer of 2000 presents the only exception to this. Population densities at the two stations are about the same by the time samples are collected in the fall each year. This indicates that the organic matter added to the sediment over the growing season has been absorbed.

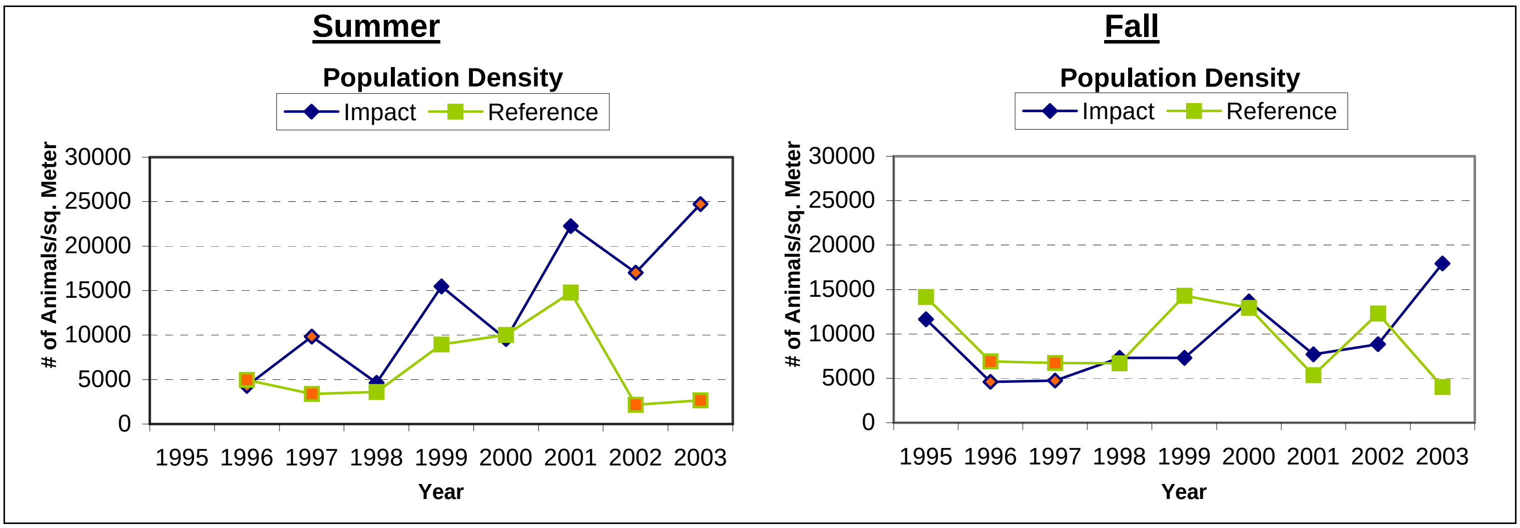


Figure 24. Macro invertebrate population density at the Upper Deep River facility, summer versus fall, 1995-2003.

The differences between the Reference station and the Impact station in the summer samples tends to be small during the earlier sampling years, although significant differences are detectable due to small sample variability. Over the last few years the population density at the Impact station is tending to increase significantly over that of the Reference station at the end of the growing season. This is probably due to an increase in the fish rearing activity, but it could indicate a build up of organic material. This is probably not the case since the fall samples do not show this pattern. The fall samples indicate that the macro invertebrate population is no longer responding to organic enrichment. While this increase in population density may not be a trend it should be monitored closely in the future.

The sediments at this net pen site are organically rich as is a common characteristic of the sediments in sloughs and bays on the lower Columbia River. *Oligochaeta* (worms) are ubiquitous in these fresh water environments. They often make up the most numerous taxon present in these sediments. This is the case at this Deep River net pen facility.

Since *Oligochaeta* process sediment to extract the organic material to meet their nutritional needs, their numbers often increase with the addition of organic material from the fish rearing activities. This is the case at this facility, as is indicated in the following Figures comparing overall population density to *Oligochaeta* population density. The *Oligochaeta* make up the largest percentage of the population, and they drive the increase in population density that occurs at the end of the fish rearing season.

As is indicated by Figure 25 of the *Oligochaeta* population below, it is the decline in *Oligochaeta* population after the rearing season in 2000 that resulted in the overall population decline at the Impact station that year.

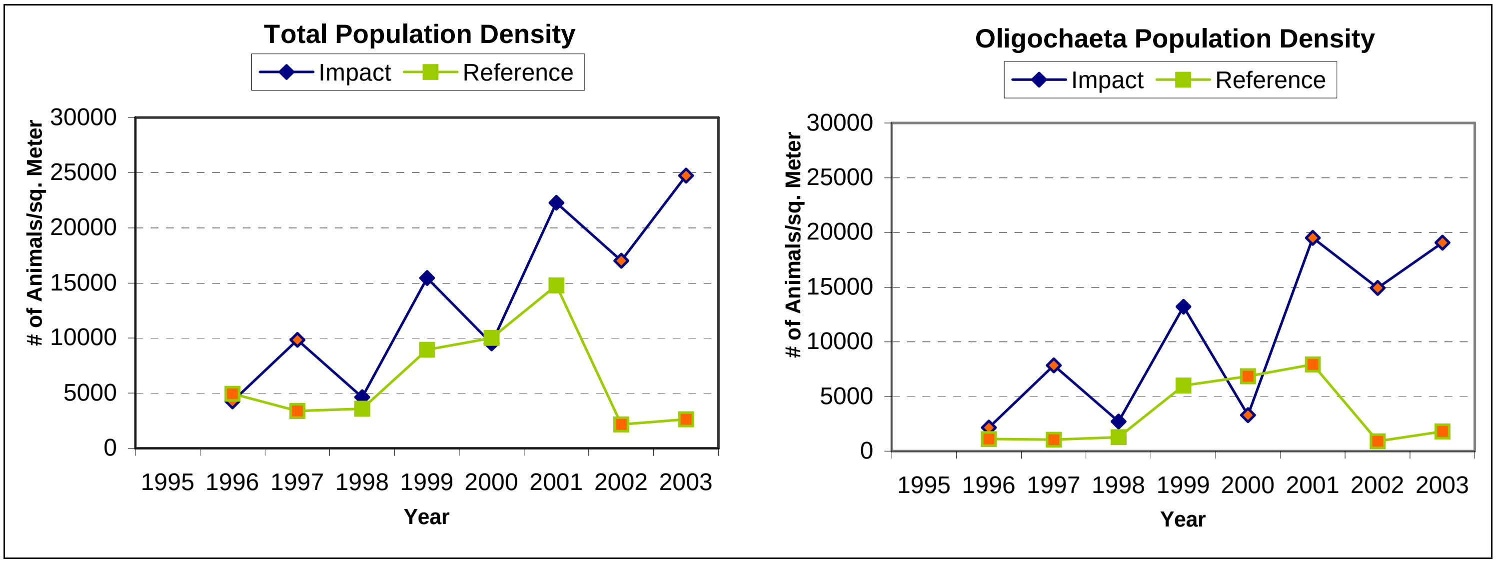


Figure 25. Summer population density of <u>Oligochaeta</u> compared to total population at Upper Deep River facility, 1995-2003.

As the <u>Oligochaeta</u> numbers increase, this taxonomic group makes up a larger percentage of the population at the Impact station than at the Reference station. This increases the percent of the population composed of the dominant species as indicated in Figure 26. below.

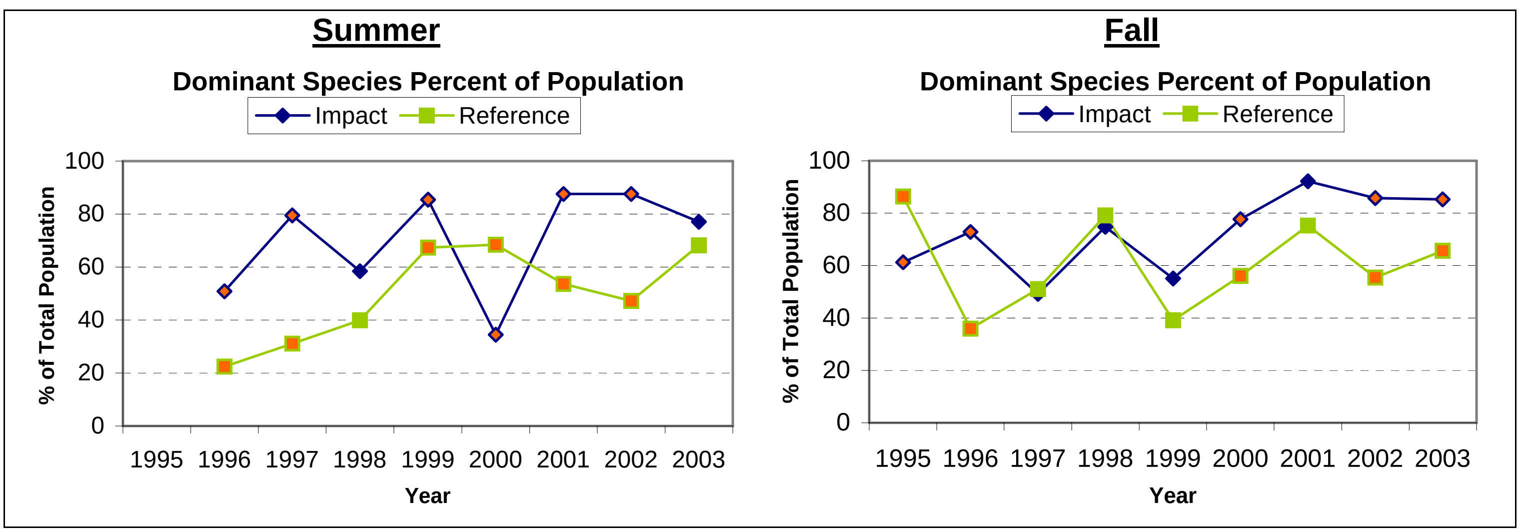


Figure 26. Percent of the total population that is composed of the dominant species at the Upper Deep River facility, summer versus fall, 1995-2003.

Since the *Oligochaeta* population density did not increase at the Impact station between the fall of 1999 and the end of the rearing season in 2000, the percent of the population composed of *Oligochaeta* was the lowest of any year so far. The population density of other taxonomic groups increased at this time as indicated in Figure 27. below. This is probably due to a lack of competition from the *Oligochaeta.*

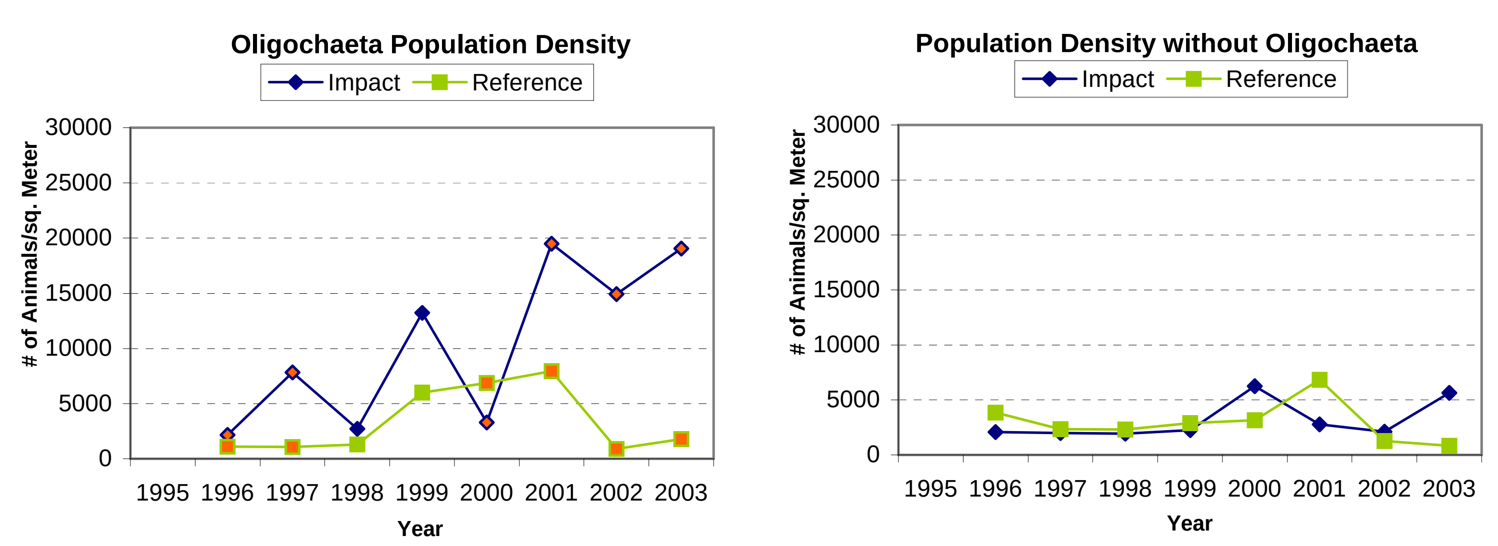


Figure 27. Comparison of the *Oligochaeta* population to all other taxa at the Upper Deep River facility, 1995-2003.

Analysis of the benthic populations at the Walter Kato Deep River facility indicates that the infusion of organic material resulting from the salmon rearing activities at this site are absorbed by the environment. This is indicated by the increase in the benthic population and the subsequent decrease after several months of inactivity. The organic material being input to the environment is being absorbed by benthic macro invertebrates, principally by the *Oligochaeta*.

The data indicates that the impact is not great enough to impact other population parameters such as species diversity, nor is there any indication that species have disappeared.

Salmon production levels at this facility may be increased in the future. If this occurs the production levels may necessitate a discharge permit which will require the establishment of a mixing zone and more extensive environmental monitoring.

Lower Deep River, Robert Fauver's

This is the second net pen facility in Deep River, Washington. This facility is located about a half mile downstream from the Washington State Highway #4 bridge over Deep River, about one mile downstream of the other Deep River site at Walter Kato's. Like the other Deep River site, this site is also moderately well flushed and the river is wider here, about 100 meters wide. It is also within the zone of tidal influence with current flowing upriver on an incoming tide and downriver on an outgoing tide. Fish were first added to the net pens at this site in the fall of 1997.

The sediment is also similar to that at the other Deep River facility and is organically rich with a lot of plant material and woody debris. The TOC at the Reference station was 4.09 percent and 3.47 percent at the end of the growing seasons in the years 2002 and 2003 respectively. The TOC was 2.46 percent and 5.78 percent at the Impact station at the end of the growing seasons in the years 2002 and 2003 respectively. Production at this station has also increased over the years of operation, but it is still below the level at which a permit would be required, so no mixing zone has been established.

The benthic macro invertebrate population structure at this station is similar to that at the other Deep River site as Figure 28. indicates.

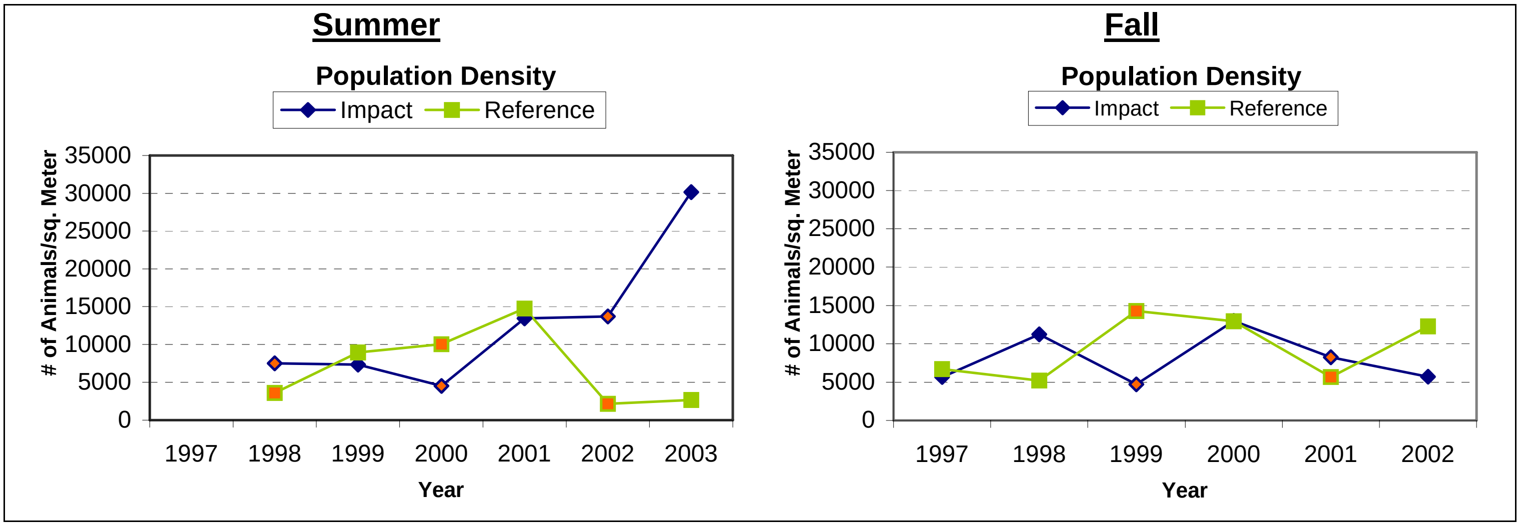


Figure 28. Macro invertebrate population density at Lower Deep River facility, summer versus fall, 1997-2003.

In the earlier years of operation the production was low and no trend is apparent at the level of resolution provided by this monitoring effort. When a statistically significant difference occurs the population at the Reference station is often more dense than at the Impact station. However, as the production increased, a trend is emerging with the population at the Impact station increasing over that at the Reference station by a large margin. No such trend is present in the population in the fall. The more dense population is as likely to occur at the Reference station as it is to occur at the Impact station in the fall, and the difference between the two stations is small, indicating that the organic material that had enriched the sediments at the Impact station has been depleted.

Oligochaeta is the dominant taxonomic group at this site, as it is at the other Deep River site. *Oligochaeta* processes sediment to meet their nutritional needs, and their numbers often increase with the addition of organic material to the sediment. This is the case at this facility as is indicated by Figure 29. comparing overall population density to *Oligochaeta* population density. The *Oligochaeta* make up the largest percentage of the population, and they drive the increase in population density that occurs after the fish rearing season.

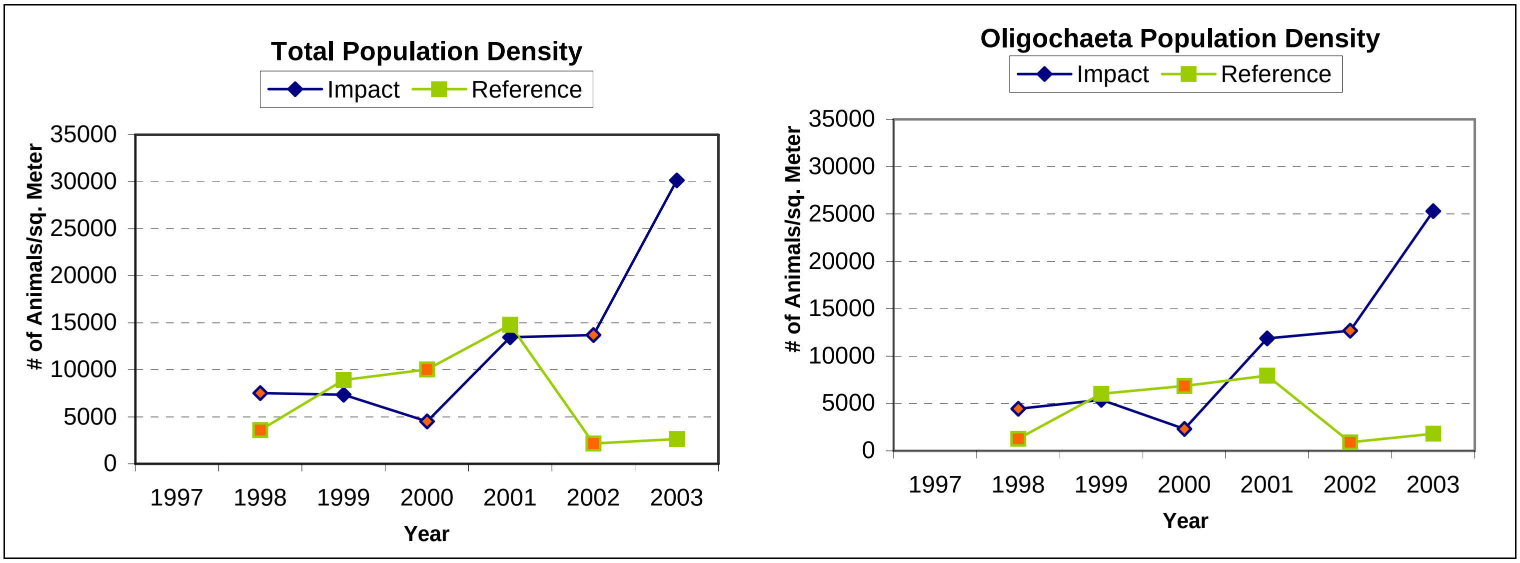


Figure 29. Summer population density of _Oligochaeta_ compared to total population at Lower Deep River facility, 1997-2003.

The *Oligochaeta* population density correlates closely with the overall population, but it more accurately reflects the organic enrichment occurring. The density of the *Oligochaeta* population is greater at the Impact station than at the Reference station each year except in the summer of 1999, when the Reference population density is slightly greater, and in the summer of 2000 when the *Oligochaeta* population shows the same decrease at the Impact station at this Deep River facility as it did at the other Deep River facility.

The trend of one taxonomic group dominating the population to a greater extent at the Impact station than at the Reference station, especially a taxon like *Oligochaeta*, is a measurable response to the fish rearing activities. Figure 30. shows that the dominant species, *Oligochaeta*, is usually more dominant at the Impact site than it is at the Reference site at the end of the fish rearing season in every year except 2000. In 2000 there was a decline in the *Oligochaeta* population at both Deep River Impact stations. The cause of this decrease has not been ascertained.

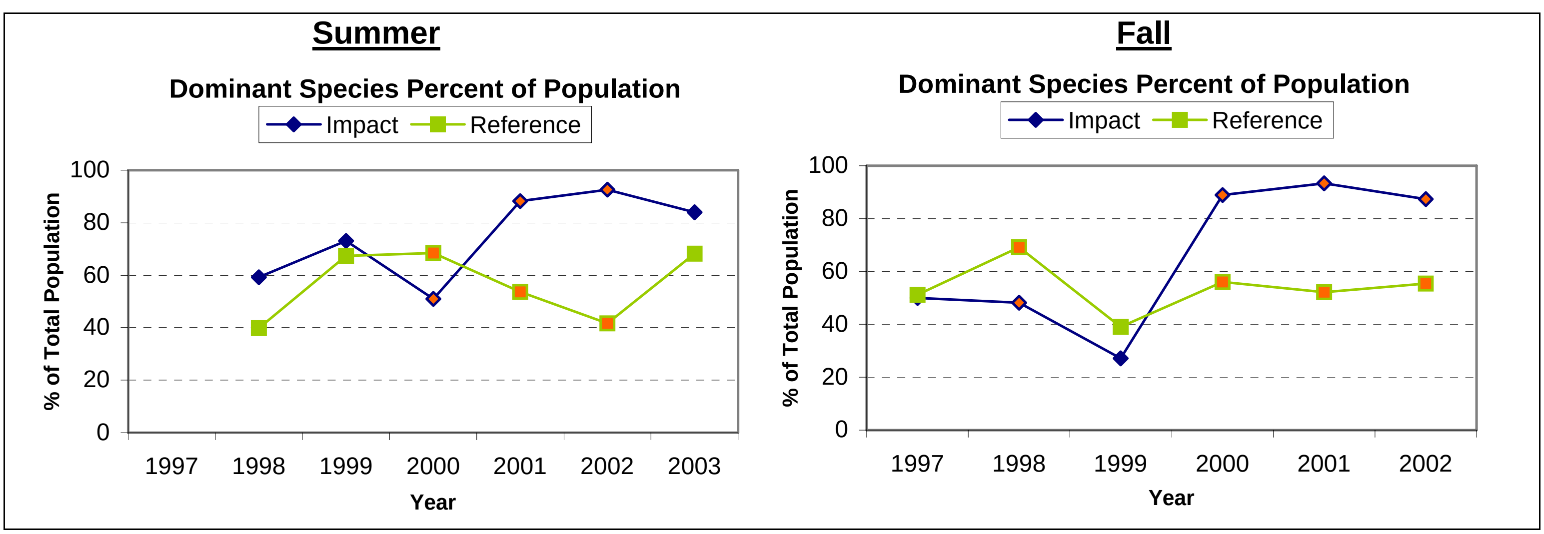


Figure 30. Percent of the total population that is composed of the dominant species at the Lower Deep River facility, summer versus fall, 1997-2003.

In the fall, after the year 1999, they have increased the extent to which they dominate the overall population at the Impact site. Since the previous Figures of the overall population size decreases in the fall, as does the population of *Oligochaeta*, this may be a seasonal affect. However, this should not be assumed.

Figure 31 shows the number of species present at the Impact and Reference stations in the summer at the end of the growing season, and in the fall just before the next growing season begins and after several months of inactivity.

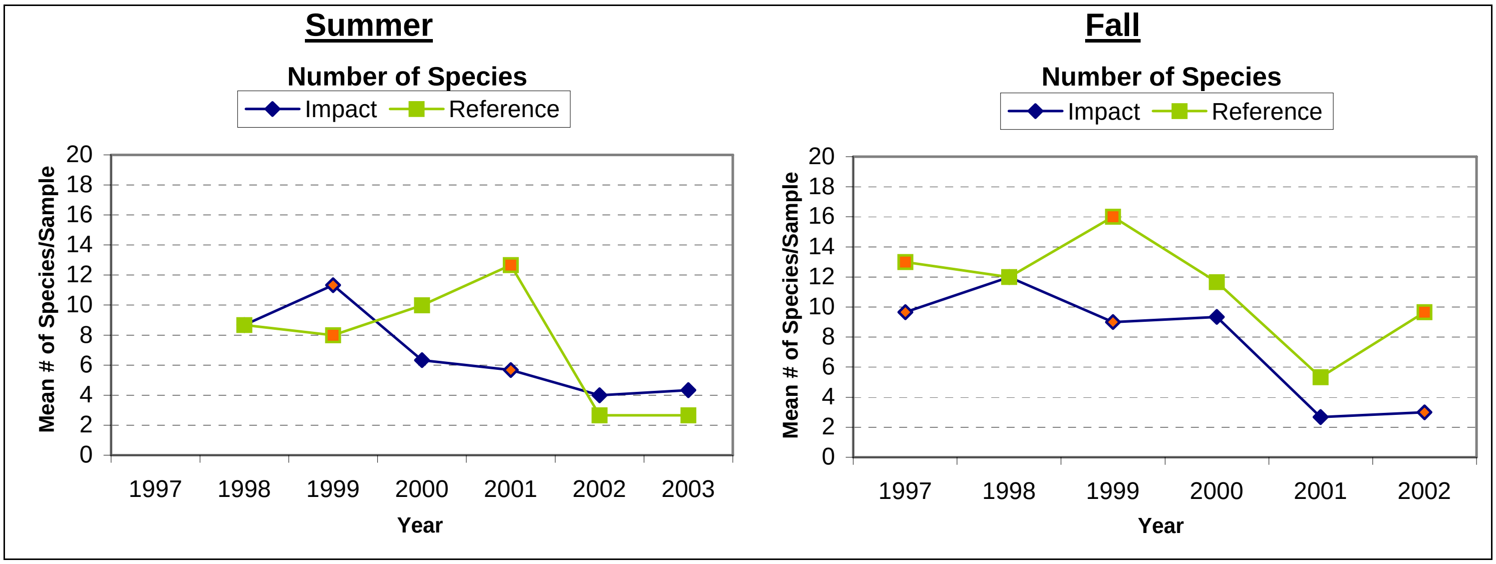


Figure 31. Mean number of species present at the Lower Deep River facility, summer versus fall, 1997-2003.

While significant differences occur between the Reference station and the Impact station there is no apparent trend in the summer population. However, the fall population shows the Reference station to have more species present in all of the last four years and significantly greater taxa richness in two of the last four years. The presents of fewer species at the Impact station than at the Reference station could indicate an environmental impact.

The population density data indicates that the environmental impact at this site is small and does not persist. However, the species dominance data and the taxa richness data suggests that there may be an impact that persists, or that only appears well after the fish rearing activity has ceased. These trends are unusual and it is necessary to see if they persist.

Steamboat Slough

Steamboat Slough is a side channel of the mainstream of the Columbia River between Price Island and the Washington shore, and it is open to the Columbia River at both ends. The salmon net pen facility is located about 200 meters upstream from the confluence of Skamokawa Creek, Steamboat Slough and the Columbia River. It is influenced by Skamokawa Creek and the Elochoman River but the main influence is from the strong tidal currents of the Columbia River. This situation is not conducive to the imprinting and homing instincts of the fish and returns to this facility have been poor. It is expected that this facility will be abandoned.

The strong tidal currents do not allow for much deposition and the sediments in Steamboat Slough are sandy with TOC levels lower than at other net pen sites. The TOC at the Reference site was 0.45 percent and 0.46 percent at the end of the growing seasons in the years 2002 and 2003 respectively. The TOC was 0.34 percent and 0.43 percent at the Impact site at the end of the growing seasons in the years 2002 and 2003 respectively. Production at this facility is below the level that would require a discharge permit.

Fish were first added to these net pens in the spring of 1998. They spent a shorter time in the pens this year than usual as they are normally added to the pens in the fall, and released in the late spring, usually in May. In later years fish were added and released following the usual schedule. Samples collected in the summer of 1998 and the following fall were collected before fish were added to the net pens, and they are baseline samples.

As indicated in Figure 32 the benthic macro invertebrate population size at the Impact station does not increase relative to that at the Reference station. There is no clear pattern, the population at the Reference station is sometimes larger than at the Impact station. While significant differences occur between the Reference station and the Impact station, either one may have the larger population in a given year.

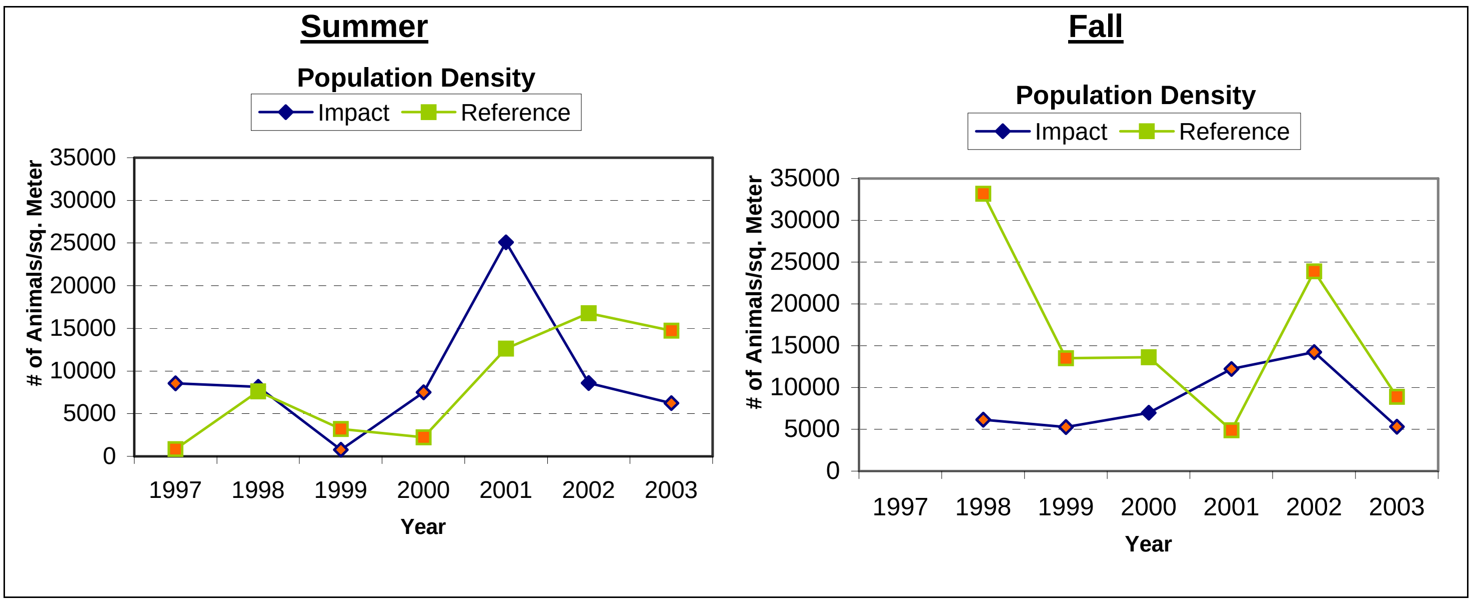


Figure 32. Macro invertebrate population density at the Steamboat Slough facility, summer versus fall, 1997-2003.

The composition of the population is diverse at both the Reference station and the Impact station. Two taxonomic groups are usually most dominant, *Oligochaeta* (worms) and The amphipod *Americorophium salmonis*. Several other taxonomic groups are also well represented. As a result the dominant species makes up a percentage of the population below 60 percent at both stations in the summer samples.

There is very little difference between the Reference station and the Impact station in percent dominance of the most dominant species at the end of the growing season or in the fall after a period of inactivity, as shown in Figure 33 below. When significant differences occur, the Reference station often has a larger percent of the benthic macro invertebrate population composed of one taxon. Also dominance is often greater at both stations in the fall, which may be a seasonal phenomenon.

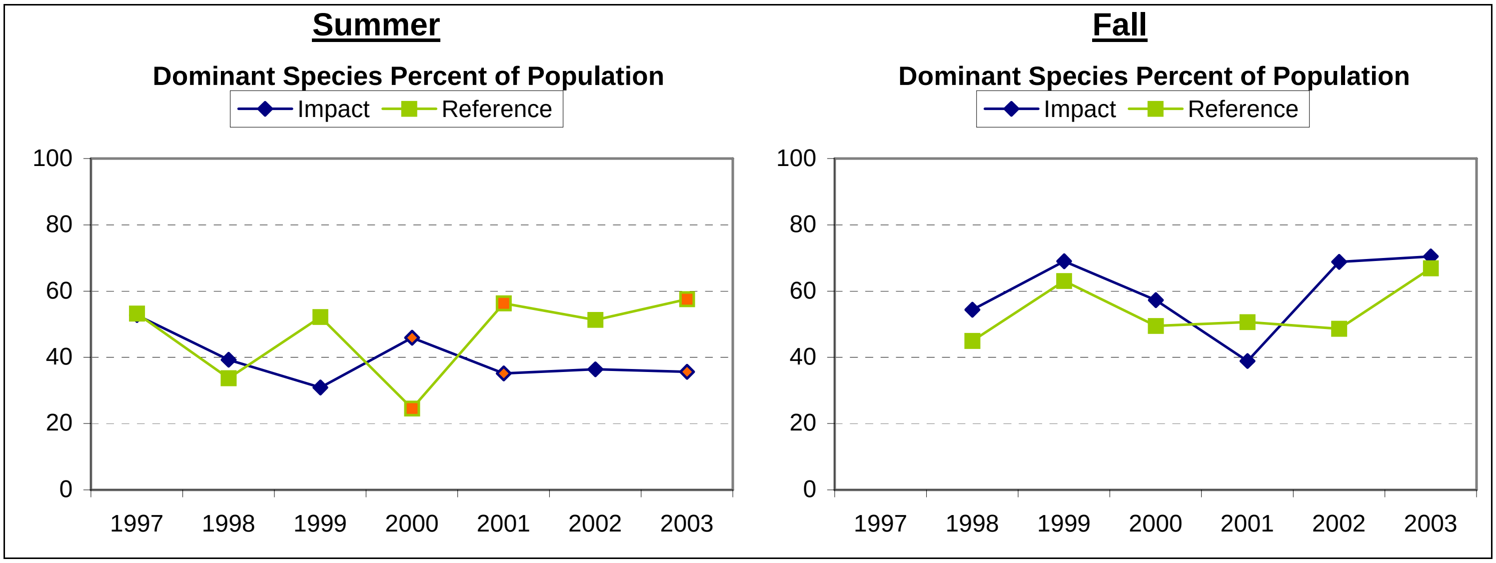


Figure 33. Percent of the total population that is composed of the dominant species at the Lower Deep River facility, summer versus fall, 1997-2003.

Figure 34 indicates that there is little difference between the Reference station and the Impact station in the number of species that make up the macro invertebrate populations in either the summer or the fall. There is no pattern in this population parameter.

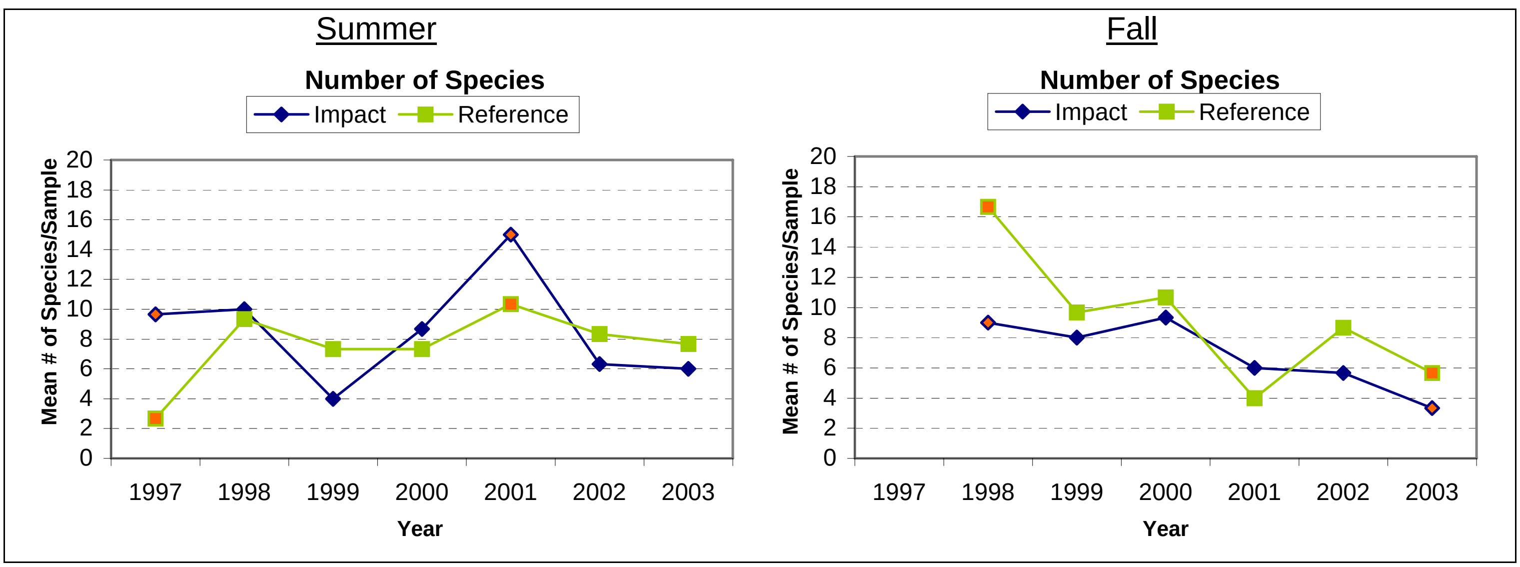


Figure 34. Mean number of species present in Steamboat Slough facility samples, summer versus fall, 1997-2003.

Due to the low production level and the high degree of tidal flushing there is no environmental impact at this site that is detectable at the level of resolution provided by this monitoring program.

SUMMARY OF THE ENVIRONMENTAL IMPACT

The SAFE Project operates at production levels that are relatively low compared to other net pen fish rearing operations where environmental problems have raised concerns. This is because the fish are not raised to marketable size in the net pens, instead they are released when they smolt and migrate out to sea. Since the fish are not usually held in the net pens all year, this allows for a period of recovery of the area from the slight impacts that are detected, primarily organic enrichment. When fish have been held at a facility all year it has been on an experimental basis, and so far it has only involved a small number of fish.

The Perimeter stations that have shown some impact that is not due to differences in benthic substrate are the stations at the Youngs Bay, Yacht Club facility that lie in the direction of the current, and these show only a slight increase in organic enrichment. With only two years of samples it is a little too soon to determine if a trend exists. Further sampling will help to clarify the situation at these stations.

WATER QUALITY PARAMETERS

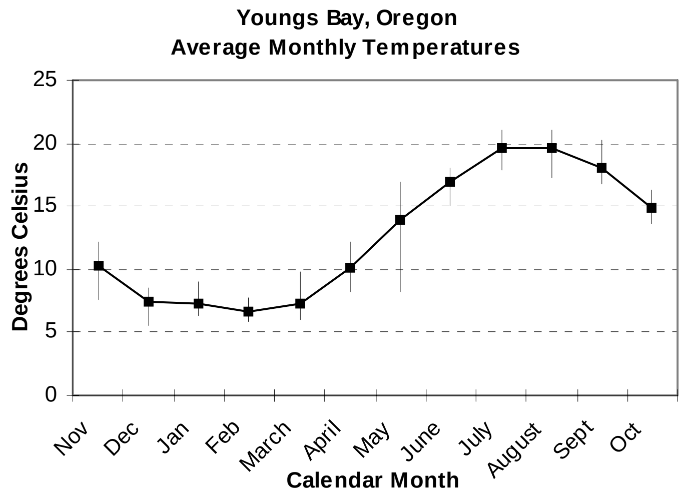
Documenting the ongoing suitability of the environment for the rearing of salmon at the various SAFE facilities is a component of this environmental monitoring program. To this end the HydrolabJ Surveyor 3 Datalogger with an H_2O Datasond, or the HydrolabJ Surveyor 4A Datalogger with a Surveyor 4 Datasond are deployed at each water body where net pen facilities are located as described in the Materials and Methods section.

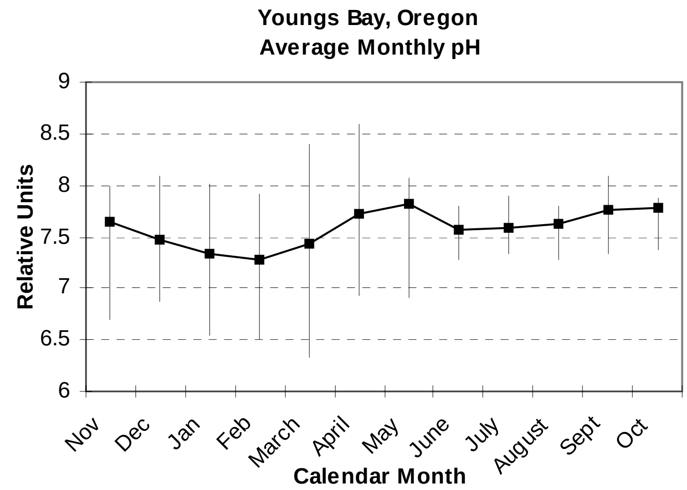
An instrument is deployed at each site every month for a 24-hour period. These instruments record temperature, dissolved oxygen, pH, turbidity and specific conductance. The instrument is placed about 2 meters below the water surface, between the net pens. The water bodies that have two net pen facilities, Youngs Bay and Deep River, are only monitored at one location.

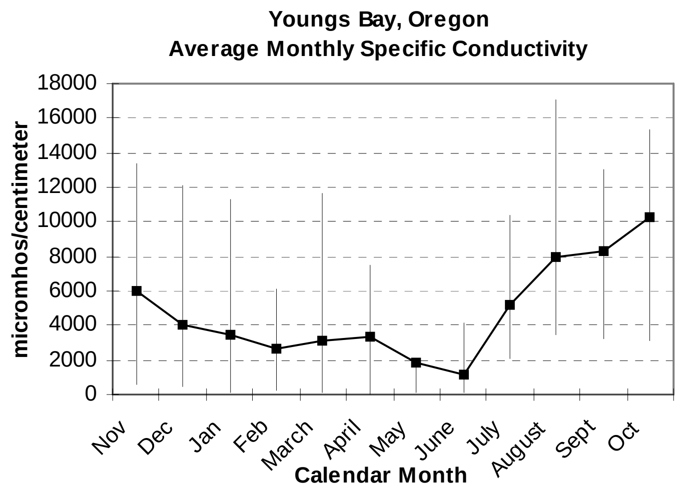
The following Figures summarize the data collected over the years during which fish were reared in the various net pen facilities. Each page displays the water quality for one of the water bodies. Each Figure displays one of the water quality parameters. The Figures show the average measurement of all of the years that data was collected for each month of the year. At each data point the vertical bars show the maximum and the minimum range that occurred during that month over the years.

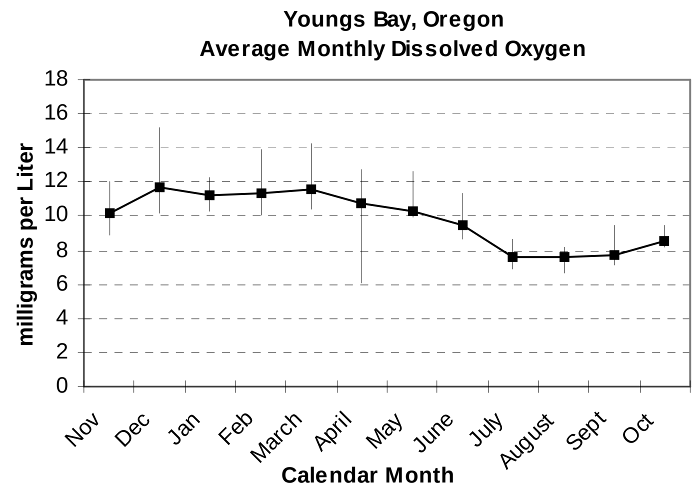
All of the physicochemical parameters measured are within the healthy tolerance range of the salmon being reared in the net pens by this project. Only the summer temperatures sometimes reach levels that may be stressful to salmon, but these occur during months when fish are usually not being hel

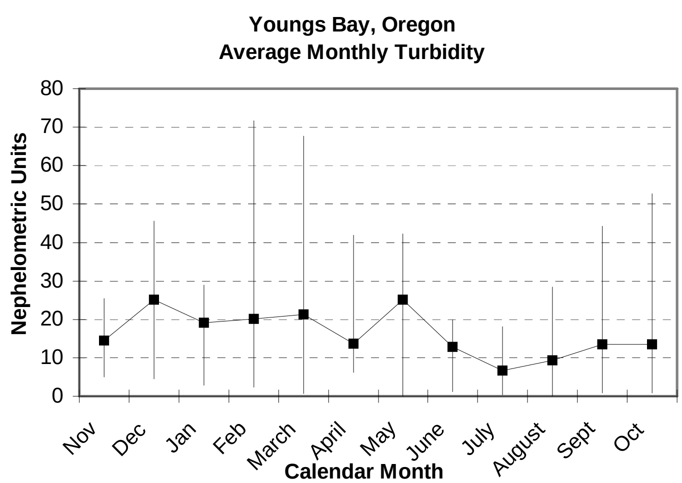
Youngs Bay, Oregon, Physicochemical Parameters, Data collected from 1994 to 2003

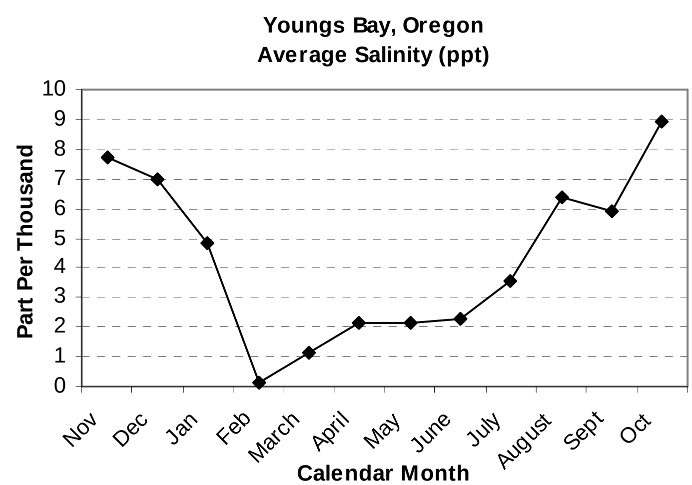






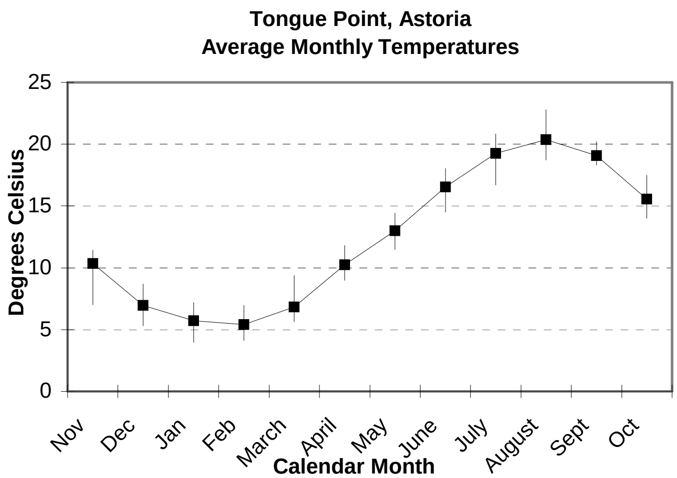


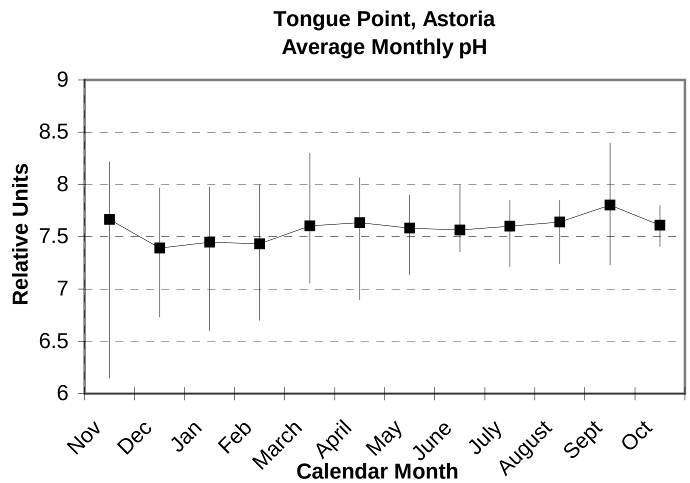


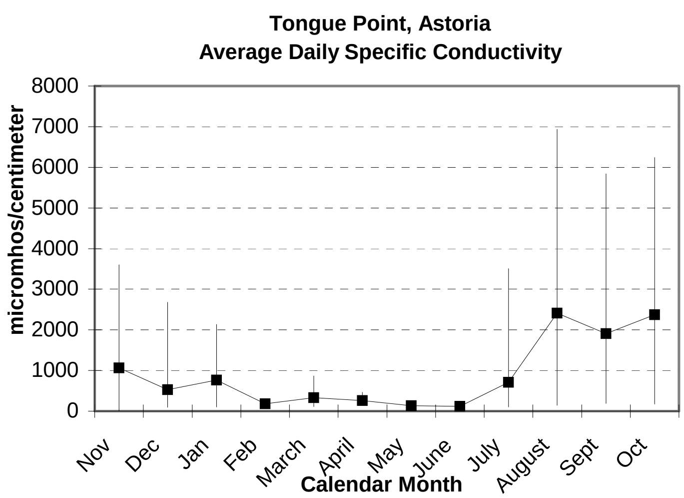


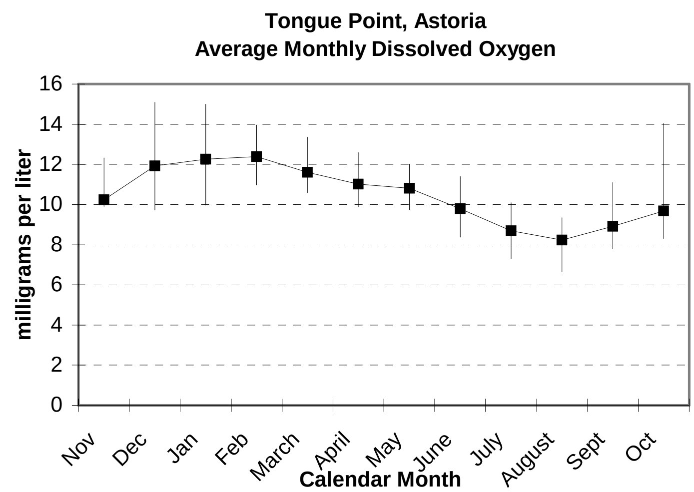
Note: Salinity measurements were taken starting in November 2002, only at Youngs Bay, Oregon due to the brackish environment that exists at this site.

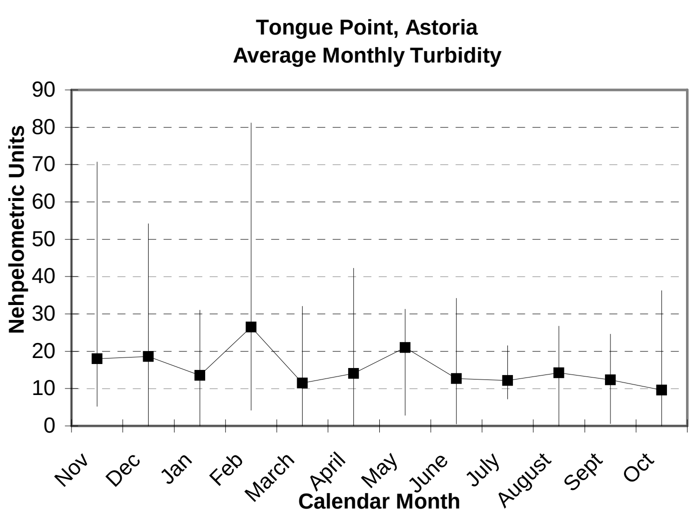
Tongue Point, Oregon, Physicochemical Parameters, Data collected from 1994 to 2003



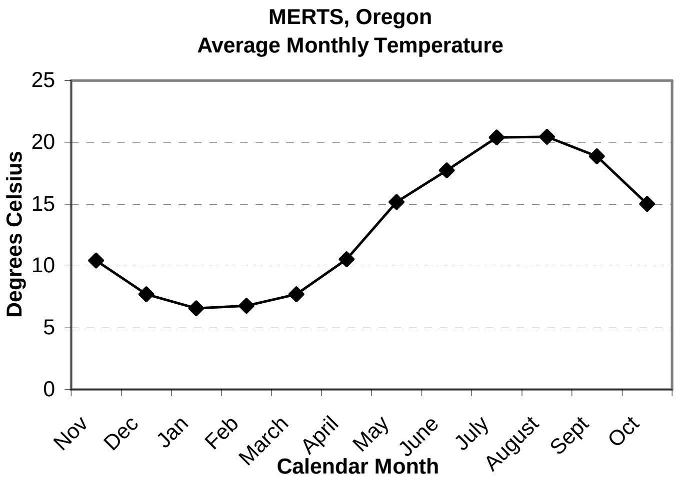


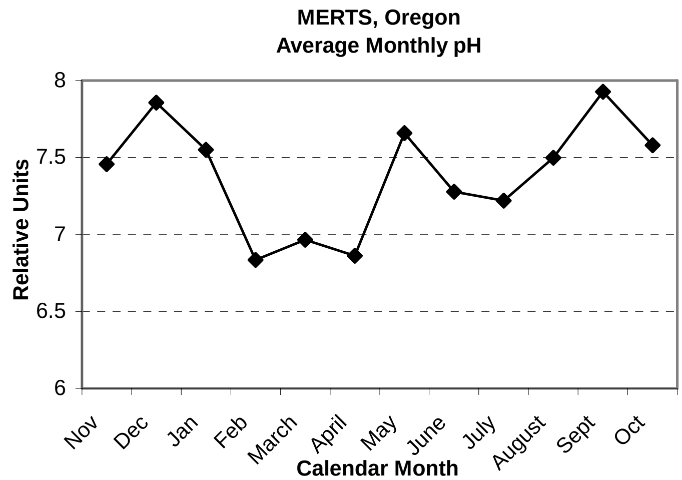


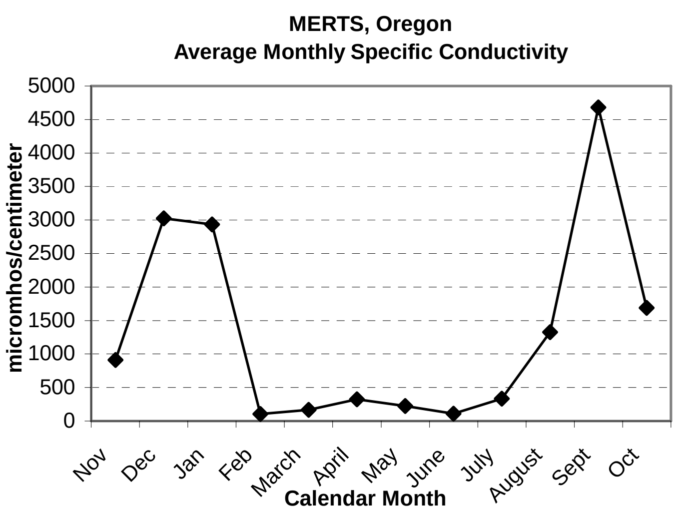


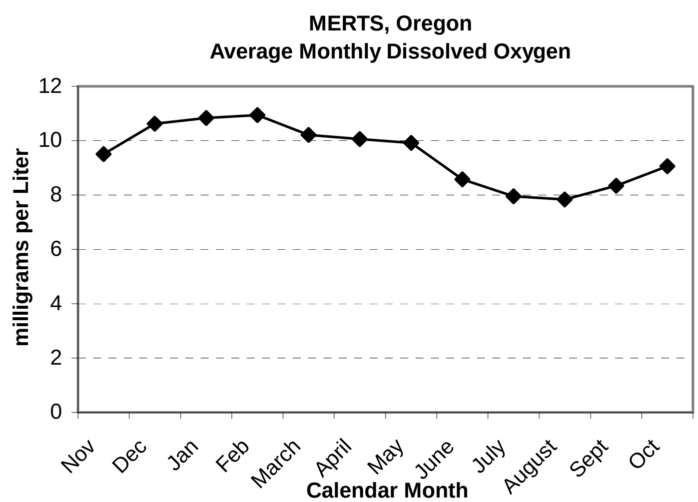


Marine and Environmental Research and Training Station (MERTS), Oregon, Physicochemical Parameters



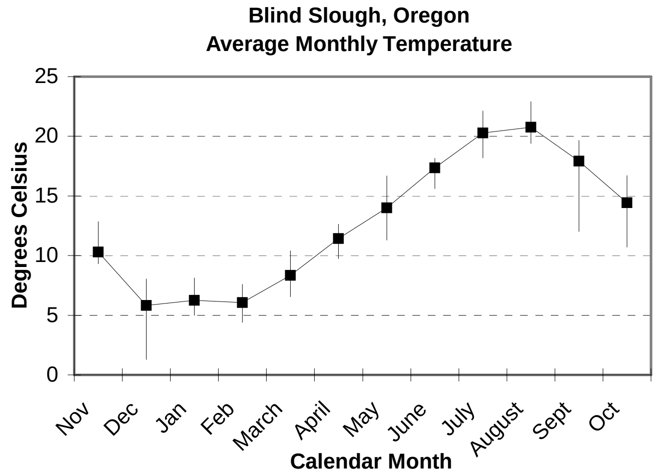


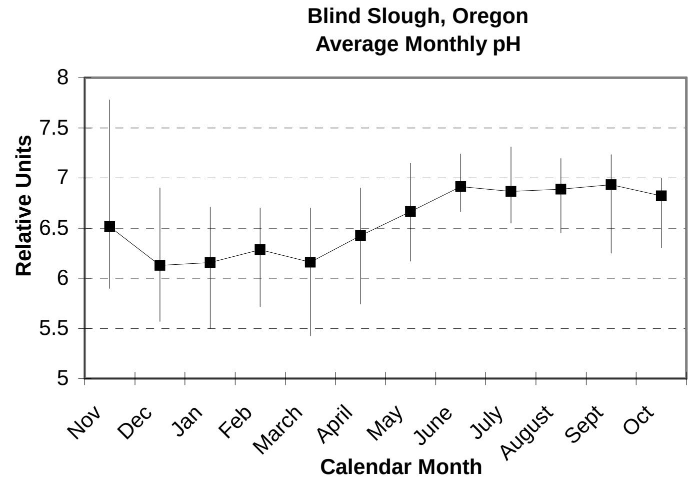


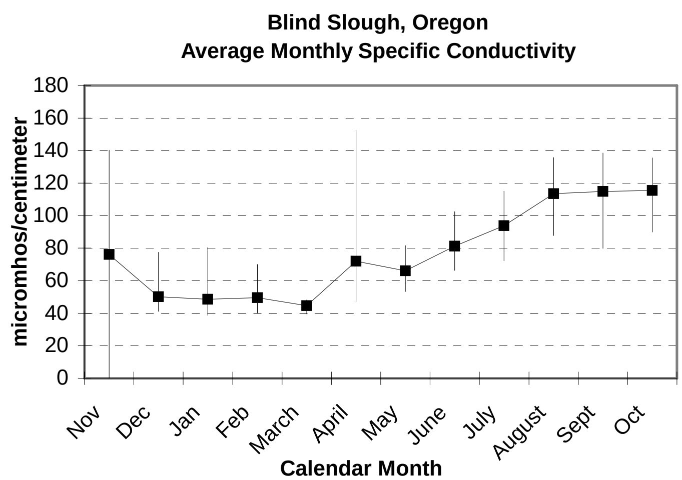


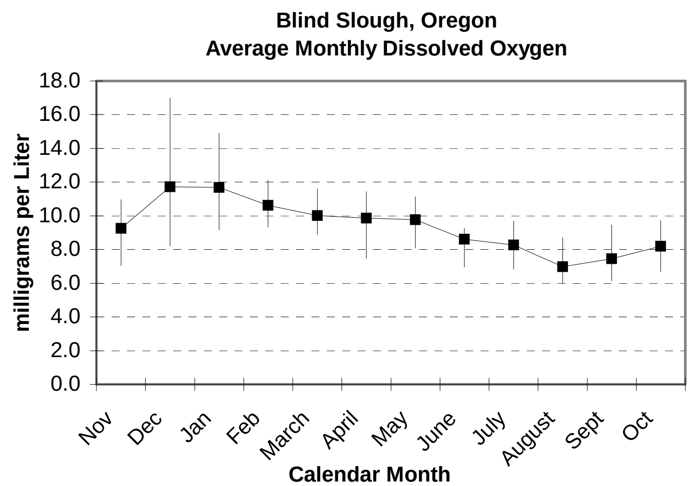
Note: sampling at this location began in June 2002. No turbidity data is displayed due to sensor failure.

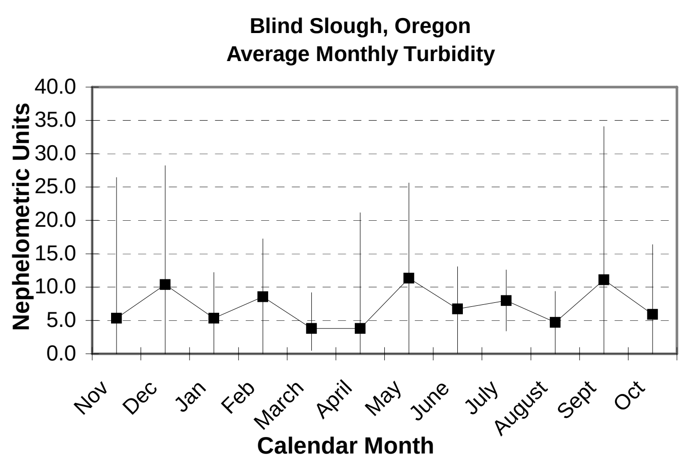
Blind Slough, Oregon, Physicochemical Parameters, Data collected from 1994 to 2003



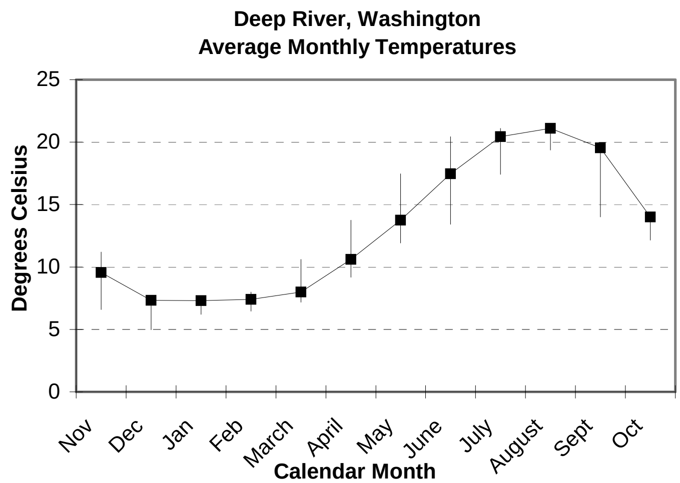


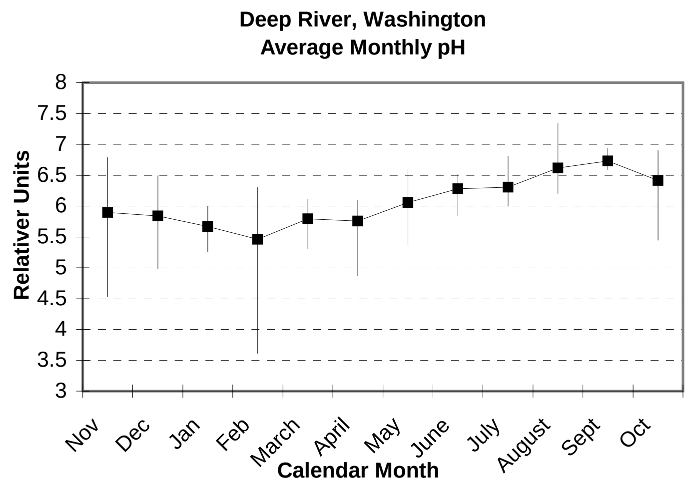


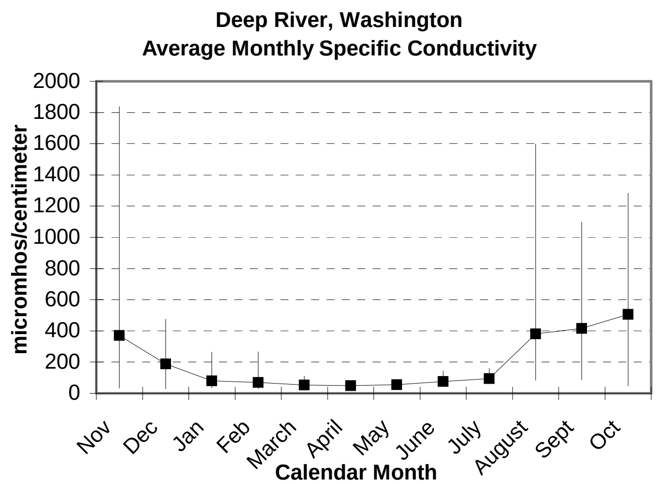


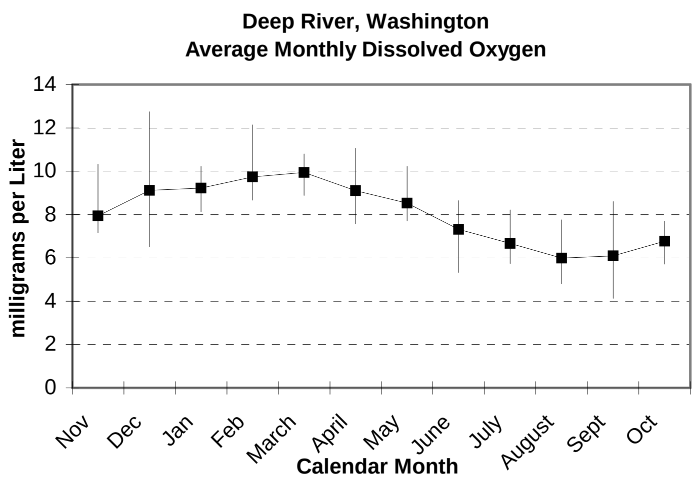


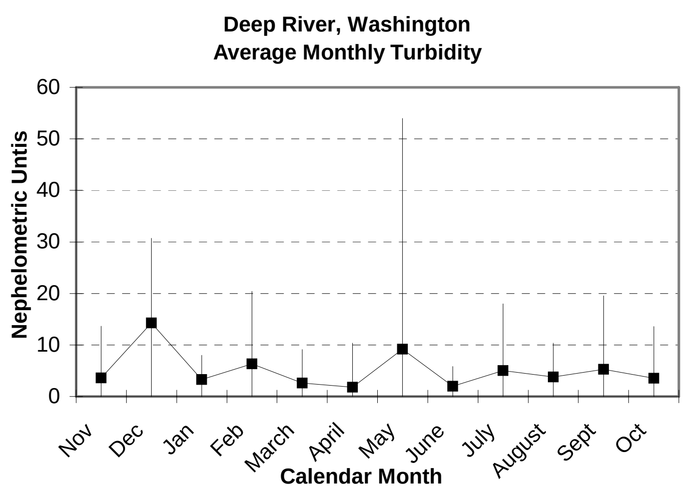
Deep River, Washington, Physicochemical Parameters, Data collected from 1994 to 2003



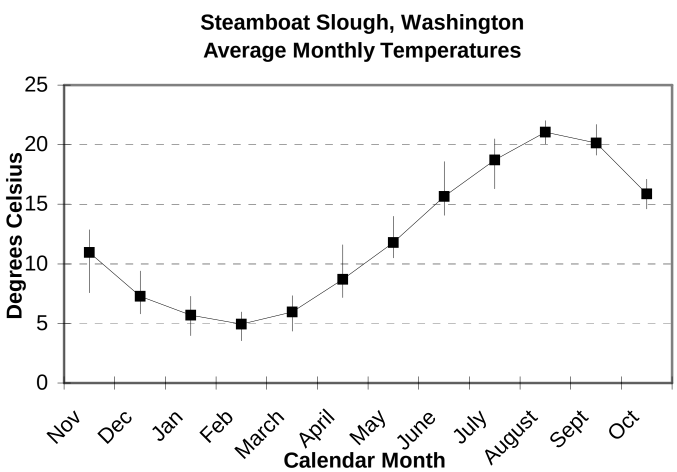


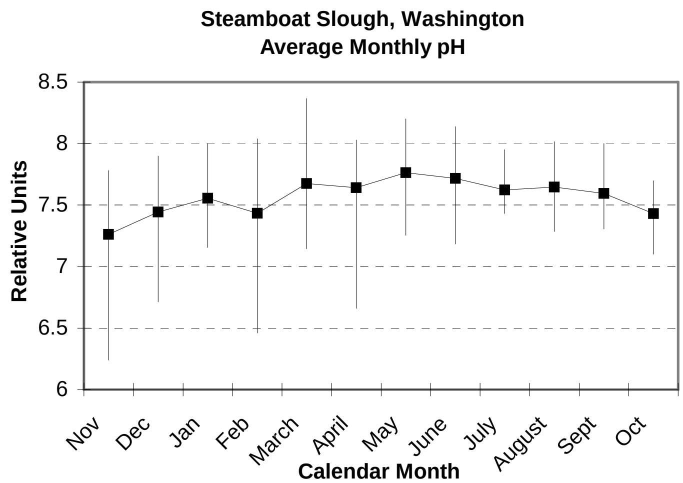


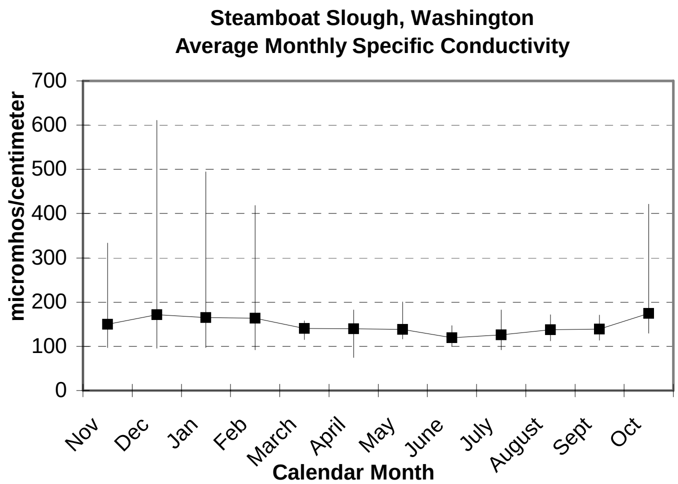


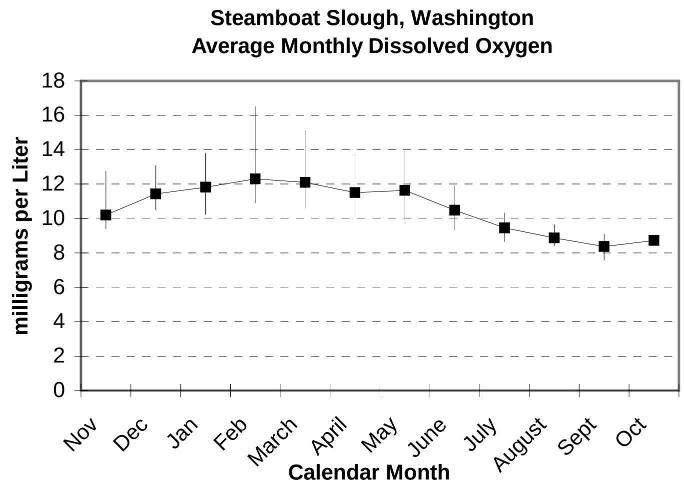


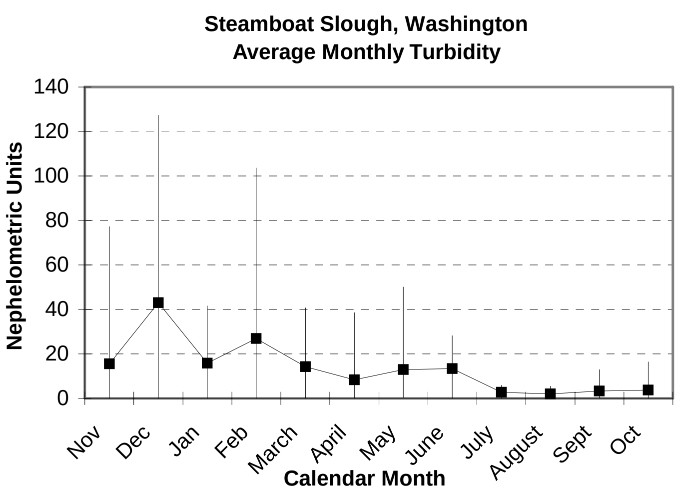
Steamboat Slough, Washington, Physicochemical Parameters, Data collected from 1994 to 2003











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Recommended Protocols for Sampling and Analyzing Subtidal Benthic Macroinvertebrate Assemblages in Puget Sound, January 1987

Recommended Guidelines for Station Positioning In Puget Sound, September 1998

Recommended Protocols for Measuring Conventional Water Quality Variables and Metals in Fresh Water of the Puget Sound Region, 1990

Recommended Guidelines for Measuring Conventional Marine Water-Column Variables in Puget Sound, 1991

Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound, March 1986, Minor corrections: April 2003

Recommended Quality Assurance and Quality Control Guidelines for the Collection of Environmental Data in Puget Sound, April 1997

R.W. Plotnikoff and J.S. White 1996 Taxonomic Laboratory Protocol for Stream Macro-invertebrates Collected by the Washington State Department of Ecology, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program Olympia, Washington 98504-7710, Publication No. 96-323

Water Quality Monitoring Technical Guide Book, The Oregon Plan for Salmon and Watersheds, July 1999, http://www.oweb.state.or.us/pdfs/monitoring_guide/monguide2001.pdf

APPENDIX B

SELECT AREA FISHERY EVALUATION PROJECT

ENVIRONMENTAL MONITORING REPORT

2004 AND 2005

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Washington Department of Fish and Wildlife
Vancouver, Washington

Prepared for:

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Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208

BPA Project No. 199306000

April 2006

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ENVIRONMENTAL MONITORING

The objective of the Select Area Fishery Evaluation (SAFE) Environmental Monitoring Program for the last two years has been to monitor the effects of the fish rearing activities on the environmental health of the water bodies where the net-pen operations are located and to monitor the water quality at the facilities to insure their suitability for fish rearing.

In addition the process of acquiring a National Pollutant Discharge Elimination System (NPDES) permit from the Washington Department of Ecology (WDOE) has begun. This permit will allow the expansion of the Deep River facilities.

The SAFE facility at Tongue Point, OR has been abandoned and the net pens have been moved to pilings near the Marine and Environmental Research and Training Station (MERTS) pier. The Steamboat Slough, WA location has also been abandoned, and those net pens are expected to be moved to Deep River to accommodate the expansion there. The abandoned facilities were monitored a year after activities ceased. No further monitoring is planned for these locations.

QUALITY ASSURANCE

All work is done following Good Laboratory Procedures and in accordance with the Quality Assurance Project Plan associated with this project (DEQ, Quality Assurance Project Plan) (EPA Guidance for Quality Assurance Project Plans) (Water Quality Monitoring Technical Guide Book, July 1999) (PSEP, Environmental Protocols). Data is analyzed using the Wilcoxon Rank Sum analysis (Lyman, 1984) to determine differences between stations.

Water Quality Parameters

Monitor the ongoing suitability of the water quality at the various SAFE facilities has been conducted for many years. All of the physicochemical parameters measured have been within the healthy tolerance range of the salmon being reared in the net pens by this project (Sewall et al, 2004). Only the summer temperatures sometimes reach levels that may be stressful to salmon, but these occur during months when fish are usually not being held.

A Hydrolab™ water quality probe has been deployed at each site every month for a 24-hour period. This instrument records temperature, dissolved oxygen, pH, turbidity and specific conductance. This instrument and the deployment is expensive and labor intensive and the instrument is nearing the end of its life expectancy. Since the water quality parameters measured by this instrument have not been outside of acceptable limits during the time when salmon are being held, it has been decided to adopt a less stringent and more cost-effective monitoring method.

The Hydrolab™ water quality probe will continue to be deployed at the Deep River facility until another water quality monitoring method is developed in cooperation with WDOE to meet the requirements of the NPDES permit. At the other facilities, temperature, dissolved oxygen (DO) and pH will be measured with hand-held meters several times per month. In addition temperature will be recorded on disc charts. Data collected shows that the parameters are all within the range expected for the lower Columbia River tributaries and the range suitable for salmonids. The Charts section of this Appendix show the water chemistry data for the last year that the Hydrolab™ probe was deployed at all SAFE locations.

ASSESSING THE ENVIRONMENTAL IMPACT OF THE FISH REARING ACTIVITIES

The environmental impact of the salmon net-pen activities in salt water has been well studied over the years (NOAA Technical Memorandum NMFS-NWFSC-49). Facilities operating in fresh water are less studied. Environmental impacts of the SAFE project net pens are monitored by collecting macro invertebrate samples from under the net pens and reference sites at the end of each growing season, and then comparing macro invertebrate population parameters of the impact and reference sites. In addition samples are collected again in the fall, just before the beginning of the next growing season, at any station where an impact was observed in the summer samples to measure recovery. The primary impact from the SAFE net-pen fish rearing activities is organic enrichment of the area under the net pens (Sewall, et al 2004).

The two Deep River, WA facilities; the Blind Slough, OR; Youngs Bay-Tide point, OR and the Youngs Bay-Yacht Club, OR facilities have all been operating long enough that there is long-term macro invertebrate data available from these facilities. The long-term population parameters of density, diversity and the percent dominance of the principle taxonomic groups at these facilities are presented as Charts at the end of this Appendix. In each case summer data collected at the end of the growing season is compared to data collected in the fall after a period of no activity. Significant differences are indicated by data points outlined in red.

Samples are also collected for sediment chemistry analysis. These samples are analyzed for total organic carbon (TOC) as a measure of organic enrichment, and grain size as a reference of the sediment structure.

Some of the net-pen facilities operated by the SAFE project have production levels that require National Pollutant Discharge Elimination System (NPDES) permits issued by the Oregon Department of Environmental Quality (ODEQ) in Oregon, and by the Washington Department of Ecology in Washington State. Under these permits, the net pens at Youngs Bay, OR and eventually the facility at MERTS, OR are allowed a 15-meter mixing zone extending in all directions from the net-pen structure. No mixing zone has been determined for facilities in Washington at this time. No environmental impact is permitted outside of the mixing zone as compared with reference conditions, and no impact which adversely effects aquatic life or any beneficial use is permitted within the mixing zone. Samples are collected at the perimeter of the mixing zone at these facilities to ensure that any environmental impact is confined to the mixing zone.

Steamboat Slough Facility, WA and Tongue Point Facility, OR

The net-pen facilities at Steamboat Slough, WA and Tongue Point, OR were abandoned at the end of the growing season in 2003. The sites of these facilities were sampled in the summer of 2004 to determine if they had recovered from any impact of the fish rearing activities. The macro invertebrate population structure at the impact site at both of these facilities does not differ significantly in the major population parameters of density and richness from the reference sites.

The TOC of the sediments at Tongue Point generally range between 1 percent – 2 percent; typical for the sediments around Tongue Point, MERTS and Youngs Bay. Table 1. shows the TOC values during the years they were measured. There is no indication of the TOC increasing as a result of the net-pen activities.

Station	June 2002	June 2003	June 2004
Impact Station	1.32	1.45	1.39
Reference Station 2	1.25	1.3	1.7
Reference Station 3	1.28	1.39	1.17
Reference Station 4	1.73	1.68	1.53
Perimeter Station 5	0.85	1.43	
Perimeter Station 6	1.21	1.45	
Perimeter Station 7	1.65	1.52	

Table 1. Total organic carbon measurements at the Tongue Point, OR facility.

Figure 1. below shows the population structure at the reference stations and the impact station at Tongue Point. The only difference at the Tongue Point facility is a reduction in the density of _Ostrocoda_ at the impact site; a minor species.

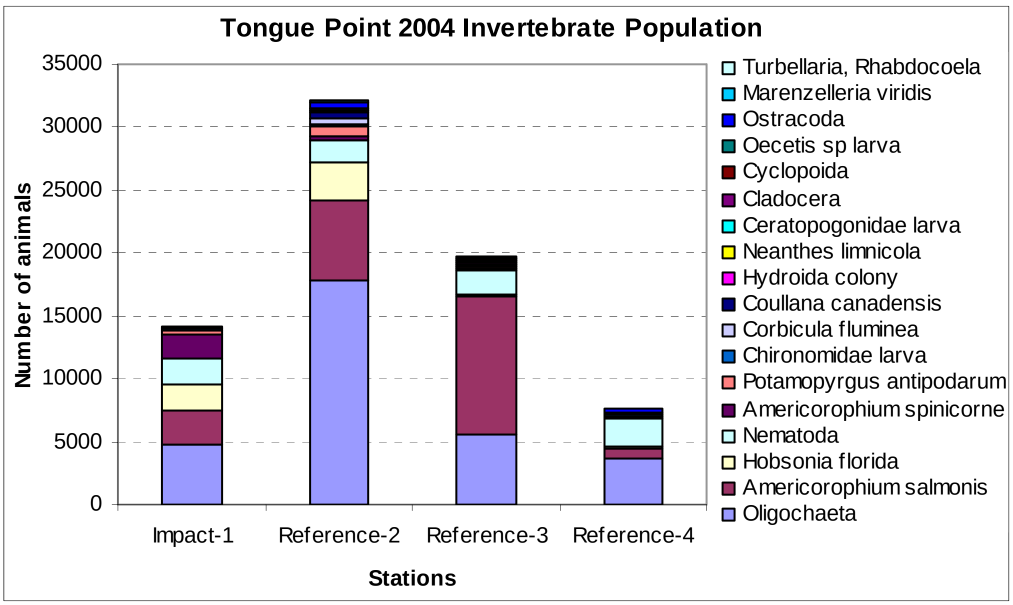


Figure 1. Macro invertebrate population size and composition at the Tongue Point, OR facility location after a year of inactivity.

Steamboat Slough is open at both ends to the mainstem of the Columbia River. The currents at this facility are quite strong, and the sediments are sandy with a low TOC content as shown in Table 2. below.

Station	June 2002	June 2003	June 2004
Impact Station 1	0.34	0.43	0.45
Reference Station 2	0.45	0.46	0.32

Table 2. Total Organic Carbon measurements at the Steamboat Slough, WA facility.

Figure 2. shows the population structure of the reference station and the impact station at the Steamboat Slough facility. The only difference at the Steamboat Slough facility is a reduction in the density of *Americorophium salmonis*; a minor difference from the reference site. These sites have recovered from any previous impact.

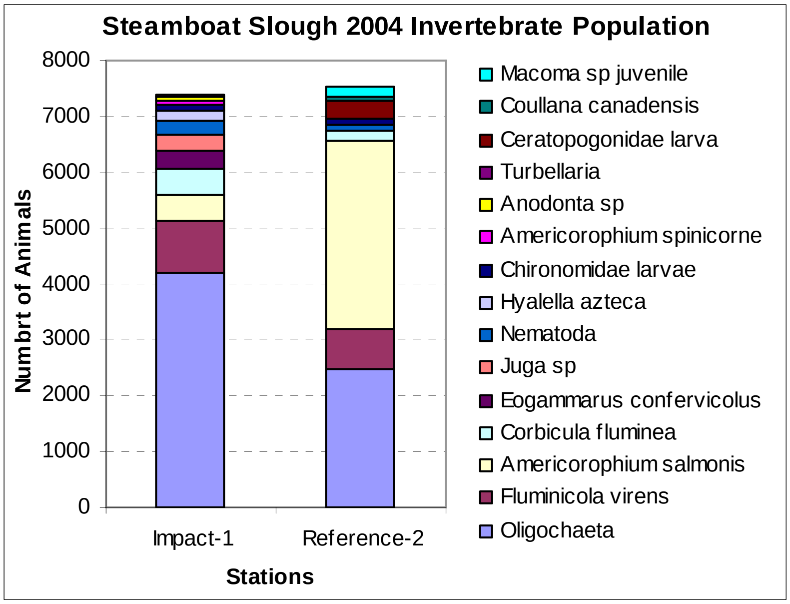


Figure 2. Macro invertebrate population size and composition at the Steamboat Slough, WA facility after a year of inactivity.

Blind Slough Facility, OR

The Blind Slough, OR facility is located over organically rich bottom sediments off the mainstem of the Columbia River. The TOC is consistently higher at the Impact station than at the Reference station as seen in Table 3. below.

Station	June 2002	June 2003	June 2004	June 2005
Impact Station 1	9.84	7.58	8.67	9.77
Reference Station 2	5.02	3.25	2.84	4.16

Table 3. Total organic carbon measurements at the Blind Slough, OR facility.

The benthic macro invertebrate population is dominated by *Oligochaeta* worms as shown in Figure 3. below.

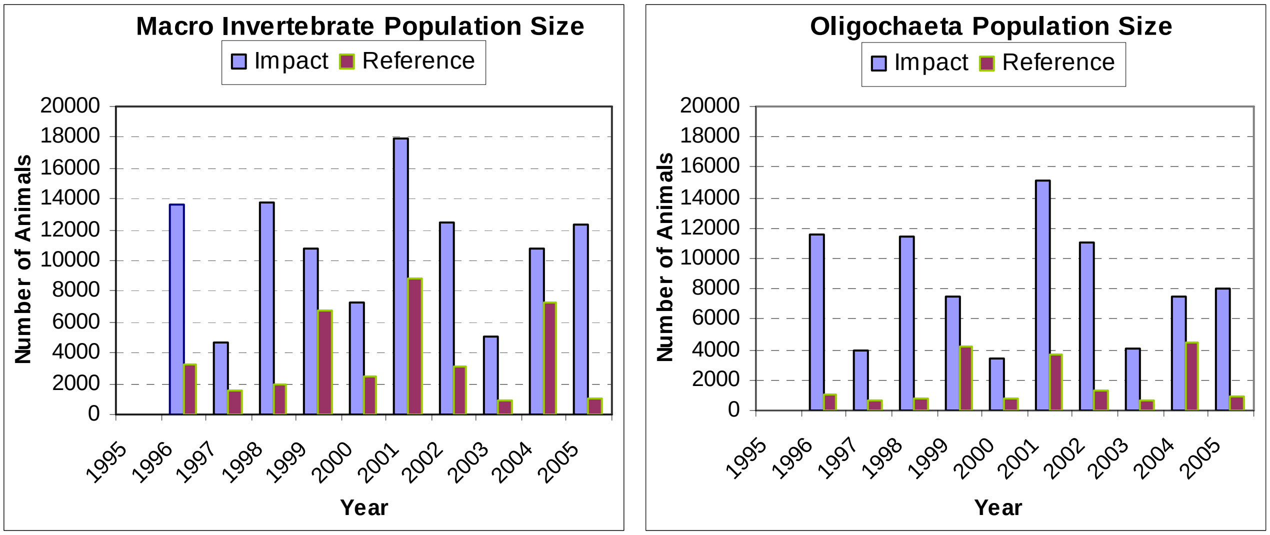


Figure 3. Oligochaeta population size compared to the total macro invertebrate population size at Blind Slough, OR site.

The macro invertebrate population is consistently denser at the impact station than at the reference station at the end of the growing season, but it usually returns to the density levels of the reference station by the beginning of the next growing season in the fall after laying dormant for a few months as shown in Figure 4.

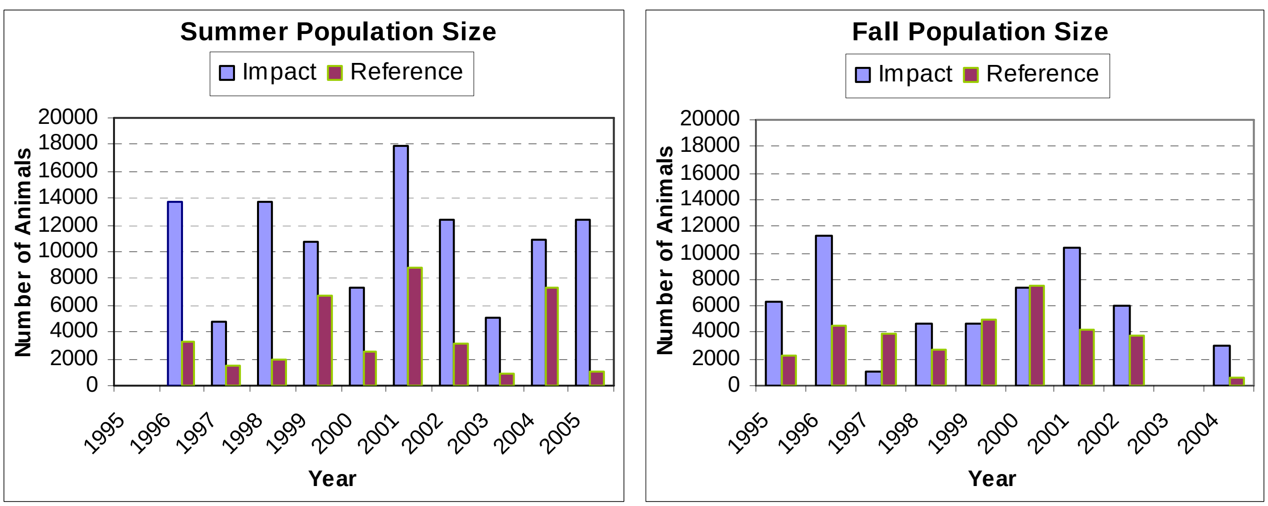
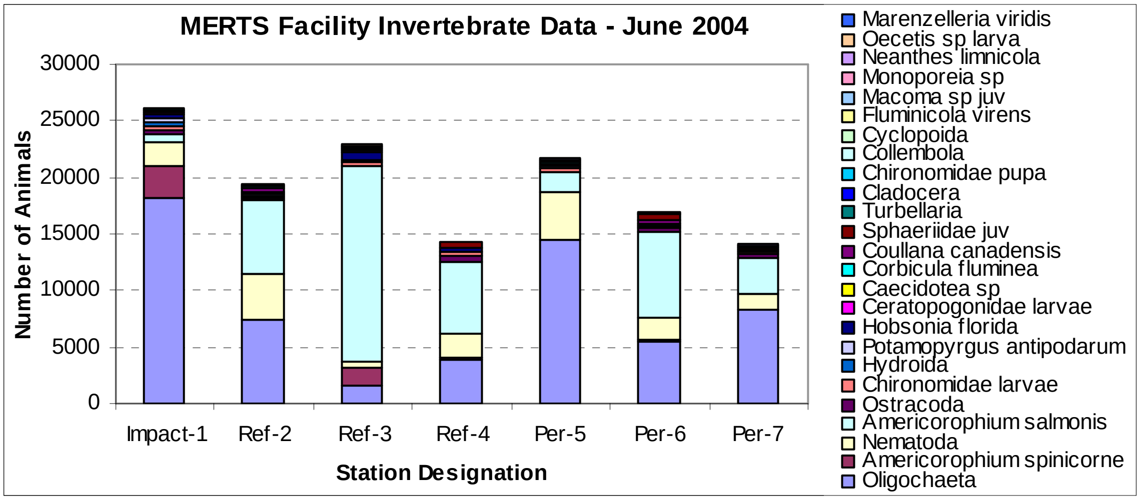


Figure 4. Density of summer macro invertebrate populations compared to density of fall populations at Blind Slough, OR site.

This is a minor impact and is considered acceptable by the regulatory agency, ODEQ. The production level at this facility is relatively low compared to some of the other facilities, and it is below the level that would require a discharge permit. There is no indication that an unacceptable environmental condition will develop at this facility at the current production levels.

MERTS Facility, OR

Net pens previously located at the Tongue Point Facility have been relocated to the new facility near the MERTS pier. Production at this facility is still low but it has the capacity to be greatly increased, so sampling here is conducted in the same way as at the higher production facilities. Samples are collected for benthic invertebrate analysis from the impact station located beneath the net pens, from three stations at the perimeter of the mixing zone and from reference stations outside any possible influence of the fish rearing activities (Figure 5).



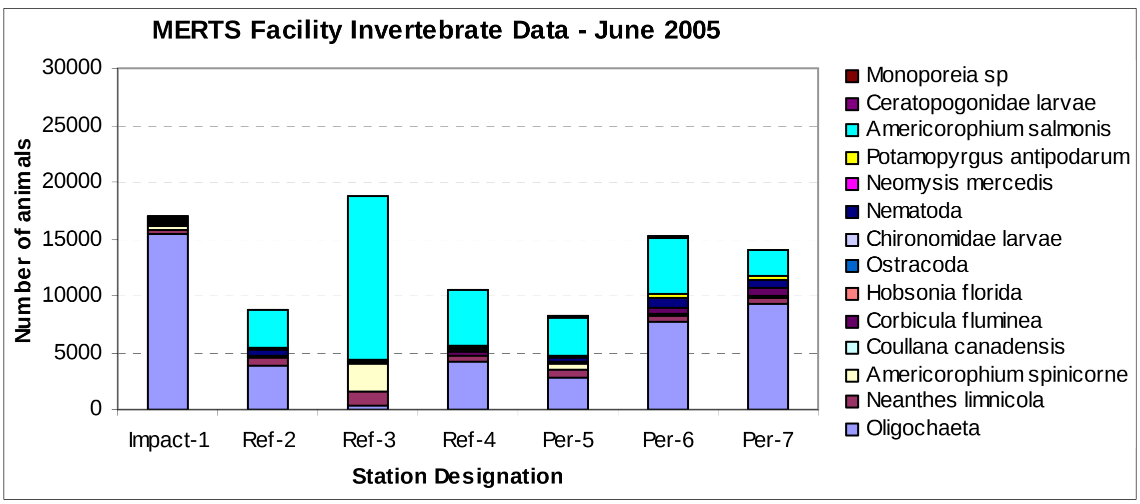


Figure 5. Invertebrate data collected at the end of the growing seasons in the summers of 2004 and 2005, MERTS, OR facility.

In addition a visual inspection is done on core samples taken beneath each net pen to look for the development of an anoxic condition. This facility is not as well flushed as other facilities operated by this project, and this could prove to be an issue if production levels increase. Even at the current low production level, there have been significant increases in the population densities of *Oliochaeta* at the impact station and at some of the perimeter stations. If this condition persists it indicates that the impact of the fish rearing activities is not confined to the mixing zone. The impact was also seen to persist into the fall when samples were collected in 2004 (Figure 6).

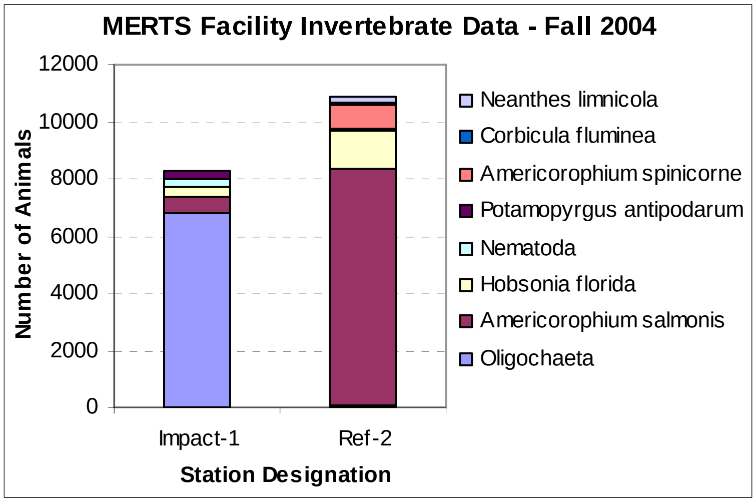


Figure 6. Invertebrate data collected at the beginning of the growing season in the fall of 2004 at the MERTS, OR facility.

The MERTS facility has not operated long enough to see any long-term trends, but evidence may indicate that organic enrichment persists through the summer period of non-use until the beginning of the next growing season. This could produce a long-term buildup of organic matter and the undesirable effect that results from it. At this time the TOC of the sediments under the net pens are normal for this area and are not increasing (Table 4). There are also indications that there is an impact of organic enrichment outside of the perimeter of the mixing zone at both ends of the facility. If future monitoring corroborates this early monitoring result it would be a violation of the NPDES discharge permit condition, especially if it increases with expanded production at this facility.

Station	June 2002	June 2003	June 2004	June 2005
Impact Station	1.72	1.76	1.67	1.89
Reference Station 2	1.68	1.72	1.3	1.43
Reference Station 3	1.12	0.99	1.11	0.94
Reference Station 4	1.28	1.09	1.22	1.16
Perimeter Station 5			1.75	1.68
Perimeter Station 6			1.35	1.64
Perimeter Station 7			1.59	1.63

Table 4. Total organic carbon measurements at the MERTS facility, OR facility.

Tide Point/Bornsteins Facility, Youngs Bay, OR

These two sets of net pens are located close enough together that they are treated as a single facility for the purpose of environmental monitoring and reporting. Production levels here require an NPDES discharge permit. The Bornsteins net pens are the newer of the two and they have not been operating long enough to measure any long-term trends. The Tide Point net pens have been in operation long enough to observe long-term trends, and since the physical environment around these facilities is very similar, it is reasonable to expect Bornsteins net pens to show the same long-term conditions as the Tide Point net pens.

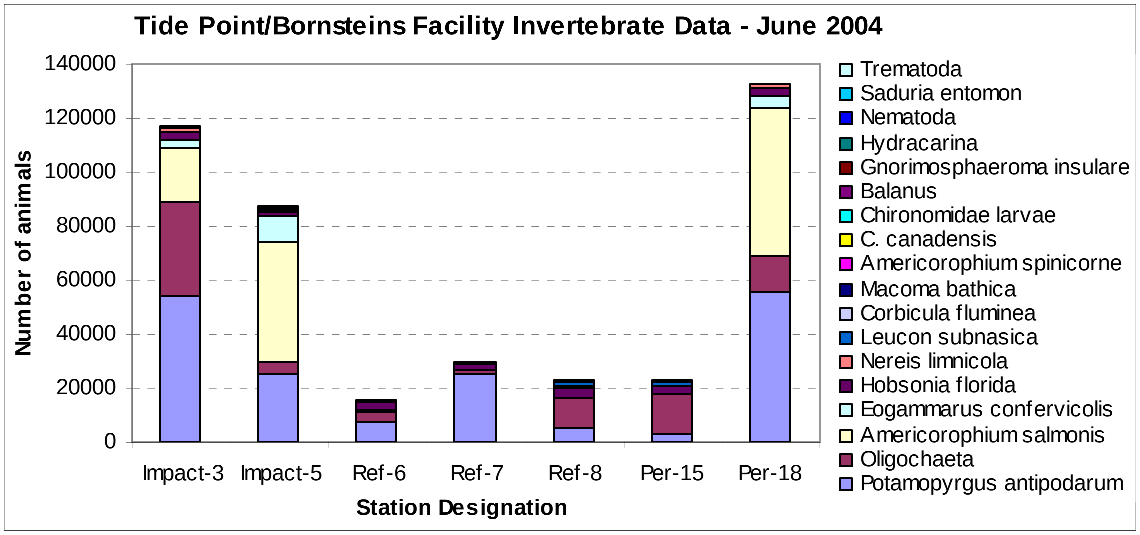
These pens are well flushed by the tidal currents and very little buildup of organic matter is expected. The TOC of the sediments in this area usually falls between 1 percent to 2 percent. However, Indications of organic enrichment exist in TOC samples taken from the impact station below the net pens at the end of each growing season (Table 5).

Station	June 2002	June 2003	June 2004	June 2005
Tide Point Impact	2.28	1.66	2.17	2.47
Bornsteins Station	3.8	2.9	1.97	3.11
Reference Station 6	2.53	1.4	1.8	1.86
Reference Station 7	2.1	0.89	1.17	1.48
Reference Station 8	1.81	1.69	1.79	1.41
Perimeter Station 15	2.1	1.94	1.92	1.84
Perimeter Station 16	1.34	1.46		
Perimeter Station 17	1.01	1.25		
Perimeter Station 18	1.25	0.71	0.3	1.29

Table 5. Total organic carbon measurements at the Tide Point/Bornsteins, OR facility.

Macro invertebrate samples also indicate organic enrichment in the sediments below the net pens. However, these conditions have always dissipated by the beginning of the following growing season as seen in the Chart of the long-term data from the Tide Point facility presented in the Charts section of this Appendix. In the rare cases where a statistically significant difference between the impact station and the reference station appears in the fall samples, it is as likely that the reference station is the one to show greater macro invertebrate population parameters than the impact station. This indicates that the differences are not the result of fish rearing activities.

Perimeter stations 16 and 17 are outside of the direction of current flow, and no impact from the net-pen activities has been detected at these stations, so sampling at these stations were terminated after the last samples were collected in the summer of 2003. An impact was detected at perimeter station 18 on the east end of the facility at the end of the last growing seasons in June 2004 and 2005 (Figure 7). No data is available to determine if this impact has persisted until the beginning of the following growing season or if it will continue in future years. If this situation does persist it would be a violation of the NPDES discharge permit under which this facility operates, however, at this time there are no environmental problems at this facility.



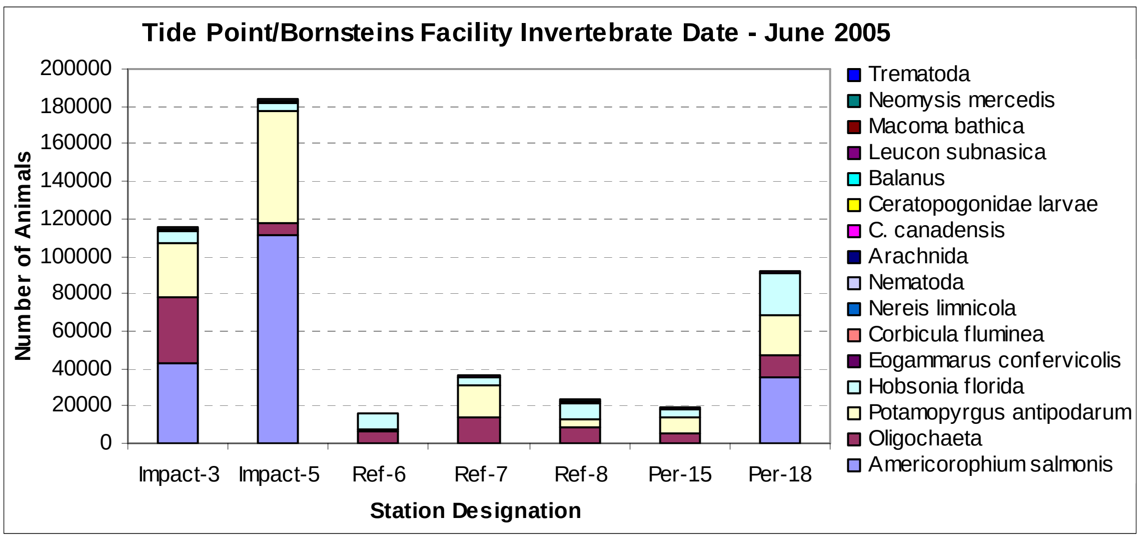


Figure 7. Invertebrate data collected at the end of the growing seasons in the summers of 2004 and 2005. Impact station 3 is Tide Point, OR and impact station 5 is Bornsteins, OR.

Kato's Facility, Upper Deep River, WA

This facility has been operating since 1995. During this time it has operated below the production limit that would require an NPDES discharge permit. However, the process of acquiring a discharge permit is in progress and production levels at this facility could be increased in the future.

The sediments of Deep River are higher in TOC than the sediments of other facilities further down the river such as in Youngs Bay and MERTS, OR facilities (Table 6).

Station	June 2002	June 2003	June 2004	June 2005
Impact Station 1	2.64	4.08	3.7	7.35
Reference Station 2	4.09	3.47	5.23	4.14

Table 6. Total organic carbon measurements at the Upper Deep River, WA facility.

In this naturally TOC environment the organic input of the net pens is not easily detected. This situation may change if production levels increase.

At the current low production levels little impact has been measured. Beginning in the summer of 2002 to present the population at the impact site began to be consistently denser than at the reference site, as seen in the chart of the long-term macro invertebrate population density data from the Upper Deep River facility presented in this Appendix. While the Wilcoxon Rank Sum statistical analysis (Lyman, O, 1984) does not always allow for the detection of significance, the trend is apparent. For example, no significant differences from the reference conditions were seen in the macro invertebrate population densities in samples collected from the impact station at the end of the growing season in June 2004, although the average population density was much greater at the impact site. However, samples collected at the end of the growing season in June 2005 showed a significant increase in population density at the impact site over that of the reference site.

The most common impact is an increase in the density of the population of *Oligochaeta* worms, which benefit from the organic enrichment. This produced an increase in the overall population density as seen in Figure 8. below.

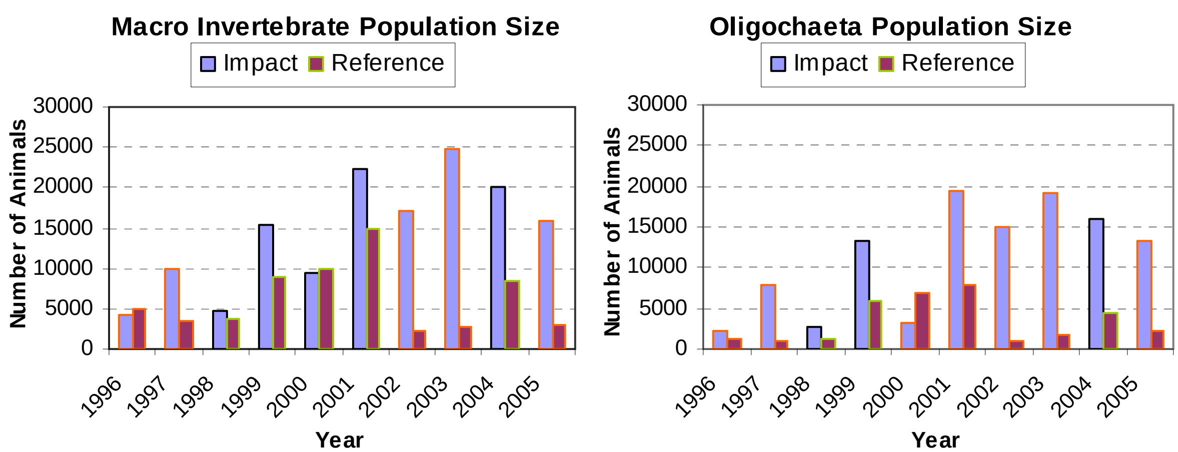


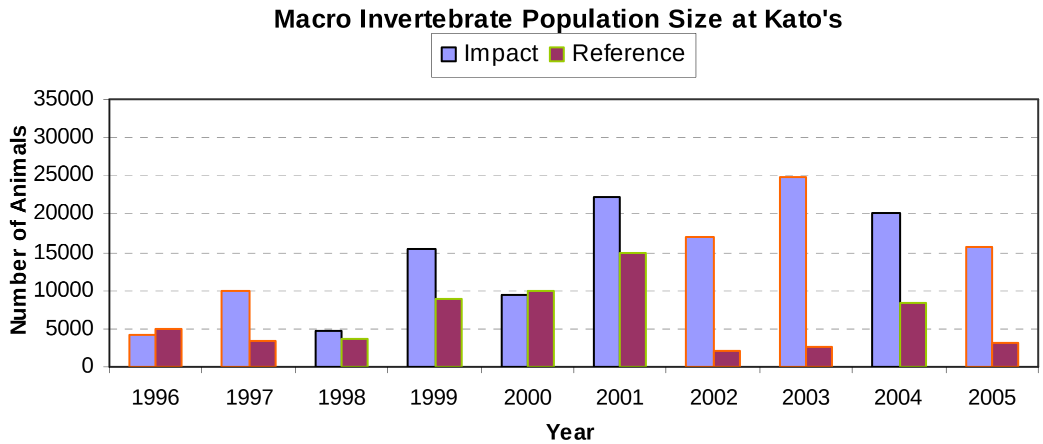
Figure 8. Total Macro invertebrate population compared to *Oligochaeta* population at the Upper Deep River, OR net-pen facility.

Data from samples collected at the beginning of the growing season in the fall of 2004 shows no significant differences at the impact site from the reference condition. Significant differences seldom persist through the summer to the beginning of the following growing season as seen in the chart of the long-term macro invertebrate population density data from the Upper Deep River, OR facility presented in this Appendix . The most common difference between the impact site and the reference site at the beginning of the growing season is in the number of species. However, it is as likely that there will be more species present at the reference site as at the impact site in any given year. This is not a result of net-pen activity. At the present production level there are no environmental problems anticipated at this facility.

Fauver's Facility, Lower Deep River, WA

This facility has also operated below the production limit that would require an NPDES discharge permit as with the upriver facility (Kato's). The process of acquiring a discharge permit is in progress for this facility also and the plan is to increase production levels at this facility in the future.

Environmental impacts at this facility have been similar to those observed at Kato's facility as seen in the chart of the long-term population characteristics of the macro invertebrate data of from the Upper Deep River, OR facility presented in this Appendix. Figure 9. compares the population density of the two facilities.



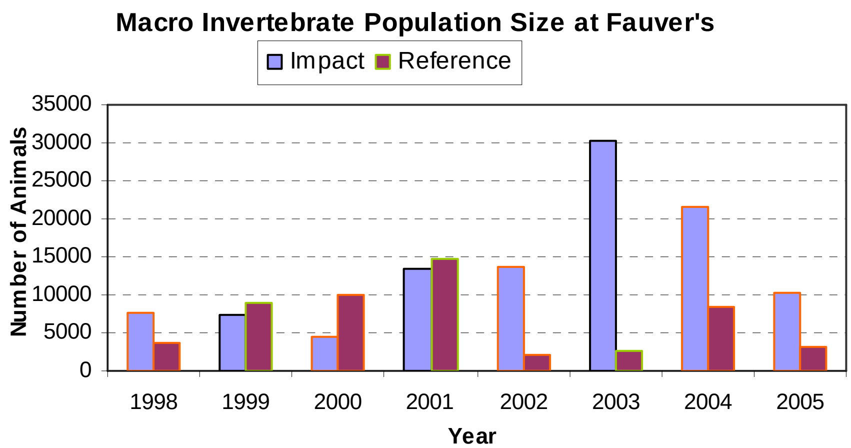


Figure 9. Comparison of the summer macro invertebrate population density of the upper and lower Deep River, OR net-pen facilities by year.

The low production levels have produced little measurable impact, and the observed impact does not persist through to the next growing season. However, beginning in the summer of

2002 and persisting to the present, the population density at the impact site has been consistently greater than at the reference site. With the level of production at this site expected to increase it will be important to continue to monitor the environmental impact at this facility.

Production levels, as well as the environmental conditions at this facility are practically identical to those at Kato's facility. The TOC of the sediments is seen in Table 7. below.

Station	June 2002	June 2003	June 2004	June 2005
Impact Station 2	2.46	5.78	2.26	2.46
Reference Station 2	4.09	3.47	5.23	4.14

Table 7. Total organic carbon measurements at the Lower Deep River, WA facility.

Yacht Club Facility, Youngs Bay, OR

The facility at the Yacht Club in Youngs Bay, OR has the highest production level of the SAFE net-pen facilities, and some fish are held in these pens into the summer months. Organic enrichment of the sediments under the net pens is evident. The population density is consistently greater and with more species present at the impact station under the net pens than at the reference station as seen in the Charts of the long-term population characteristics of the macro invertebrate data from the Youngs Bay, Yacht Club facility presented at the end of this Appendix. This situation persists through to the start of the next growing season in the fall.

Samples have been collected at the perimeter of this mixing zone for the last four years. Perimeter station 13 is located east of the net pens in a direction such that currents do not carry organic material to it from the net pens. No indication of an impact has been seen at this station and none would be expected, so sampling at this station has been eliminated. The other two perimeter stations are in the direction of tidal currents. These two stations could receive organic enrichment from the net pens.

The perimeter station 14 at the west end of the net pens was located under a bridge, which makes it difficult to distinguish the impact of the bridge and bridge-related activity from an impact of the net pens. This station was replaced by a station located 15 meters out from the bridge. No impact from the net pens has been found at this station.

The benthic community structure at this site is more complex than at the facilities previously discussed. Taxa that benefit from organic enrichment and are found in dense numbers are *Oligochaeta* worms and amphipods of the genus *Americorophium*. In addition these waters have been invaded by a non-indigenous species, the New Zealand Mud Snail (*Potamopyrgus antipodarum*). Densities of this species have been measures at over 100,000 animals per square meter, but more recent samples may indicate a decline in the population density of this species (Figure 10).

Perimeter station 12 in the direction of incoming tidal current has shown indications of organic enrichment. This station is located east of the net pens in the direction of the boat ramp. The macro invertebrate population at this station shows the influence of the net-pen activities and the deeper sediments have indications of heavy organic input. More extensive environmental monitoring is recommended at this facility.

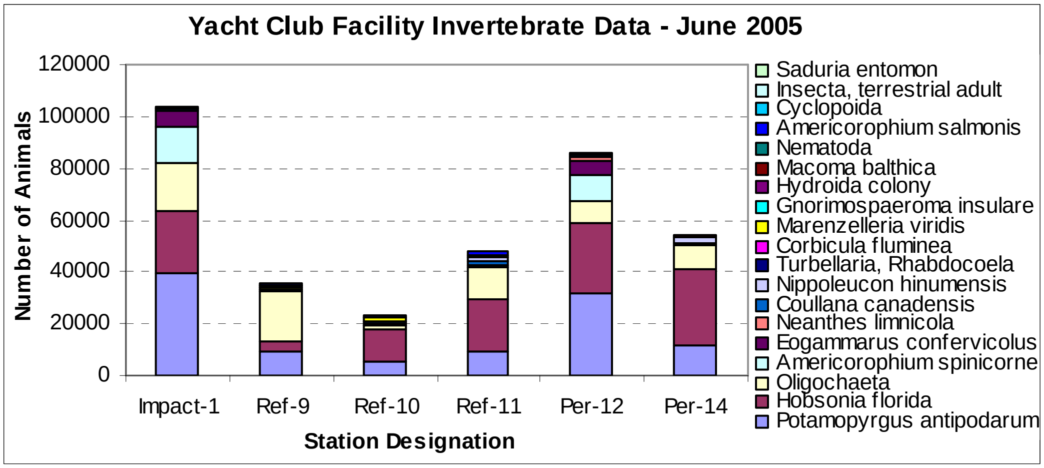


Figure 10. Invertebrate data collected at the end of the growing seasons in the summers of 2004 and 2005 at Youngs Bay Yacht Club, OR facility.

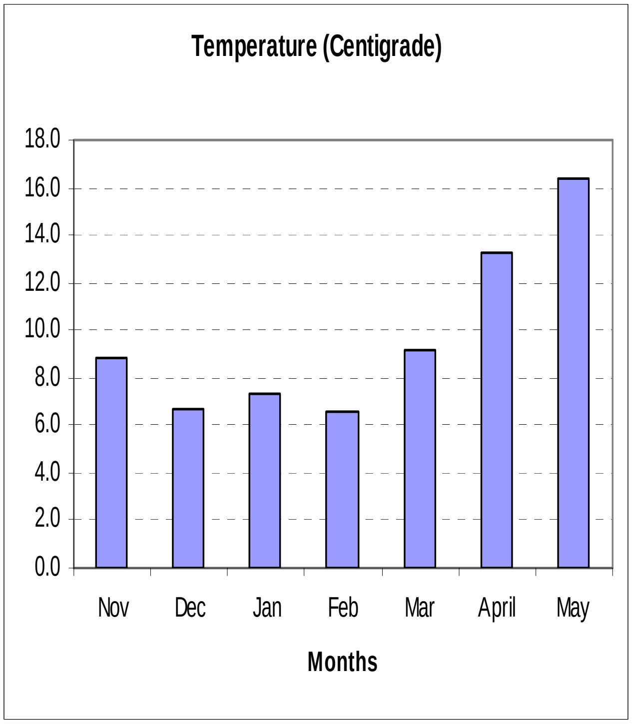
Benthic community analysis and visual inspection of sediment cores show indications of heavy organic enrichment. So far, the environment under the net pens has been able to absorb it without the development of anaerobic conditions on the sediment surface. An oxidized layer of one to three centimeters exists. However, deeper sediment is black and anaerobic. The heavy input of organic matter appears to be producing persistent conditions that could become unacceptable. However, as Table 8. below shows, there is no indication of elevated TOC of the sediments at this facility.

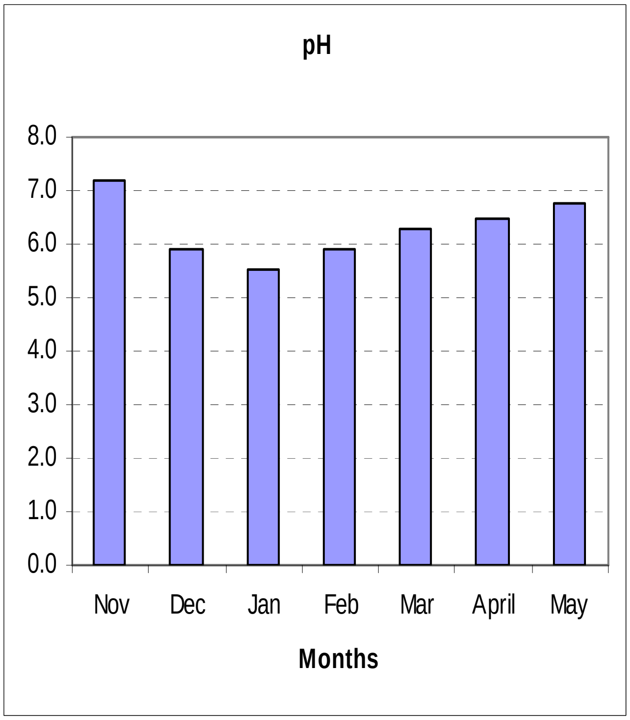
Station	June 2002	June 2003	June 2004	June 2005
Impact Station 1	2.68	0.94	1.44	1.10
Reference Station 9	1.58	1.05	1.13	1.15
Reference Station 10	0.89	2.15	1.44	0.91
Reference Station 11	1.42	1.54	1.72	1.69
Perimeter Station 12	1.78	1.49	1.06	1.37
Perimeter Station 13	1.34	2.00		
Perimeter Station 14	2.33	1.53	2.04	1.37

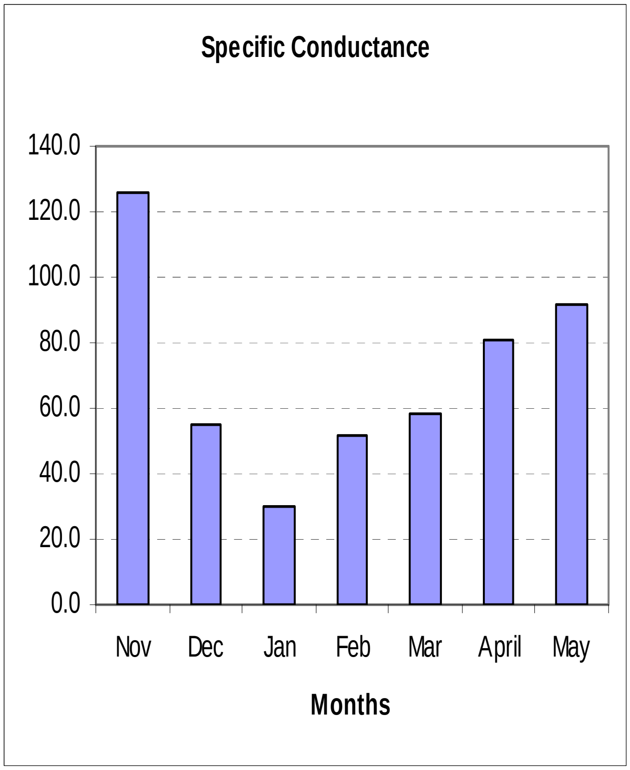
Table 8. Total organic carbon measurements at the Youngs Bay Yacht Club, OR facility.

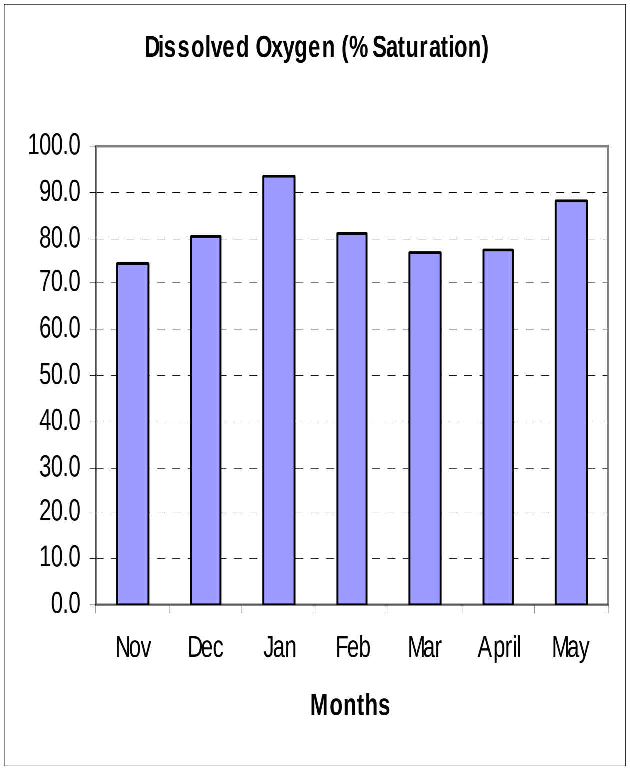
CHARTS

Blind Slough Water Chemistry

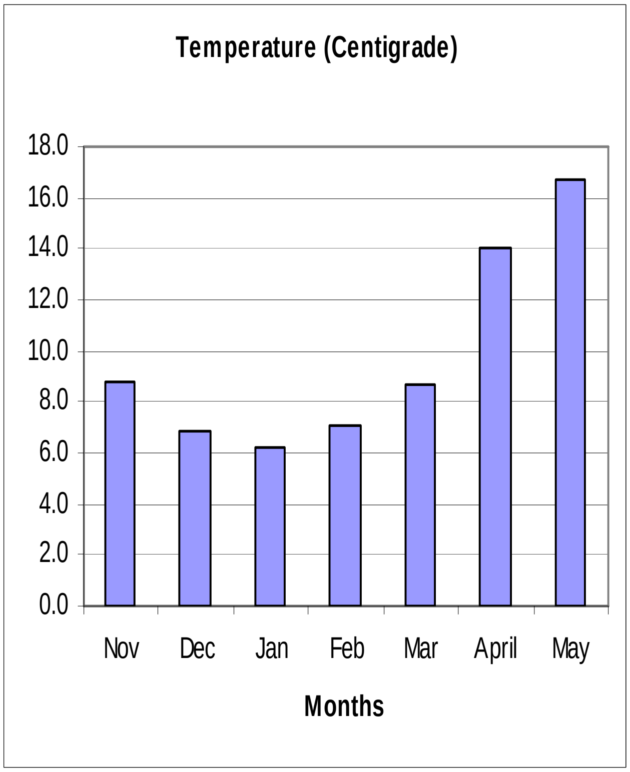


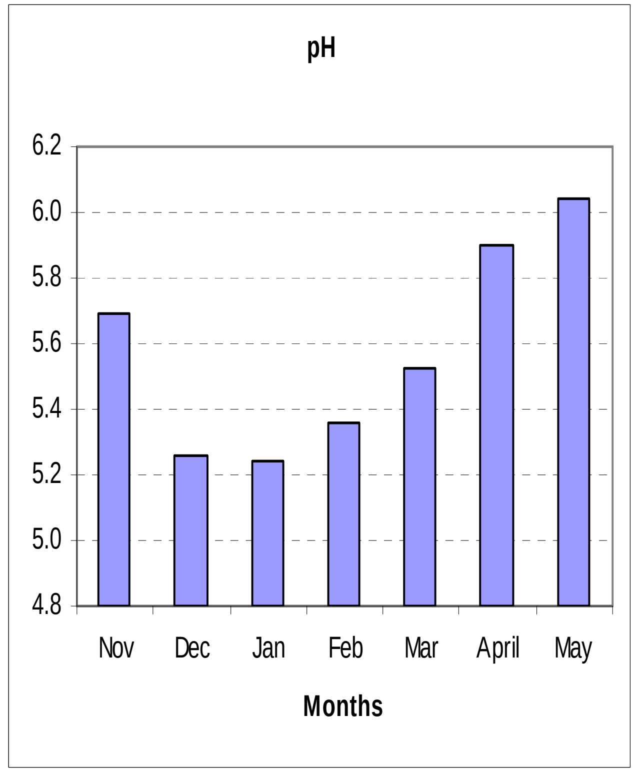


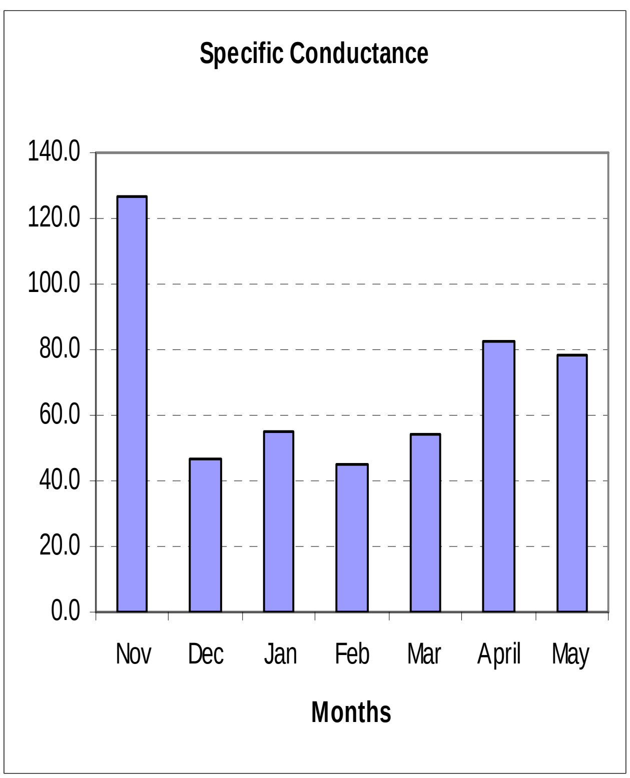


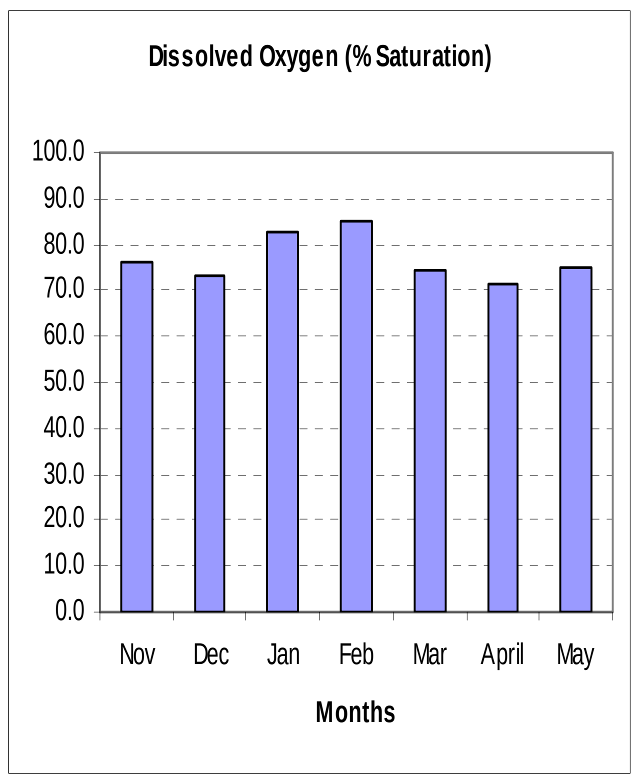


Deep River Water Chemistry

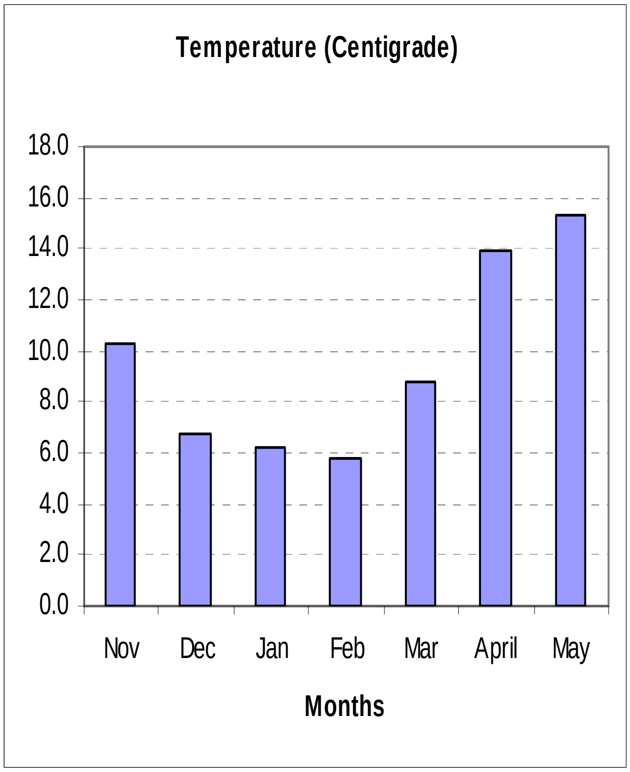


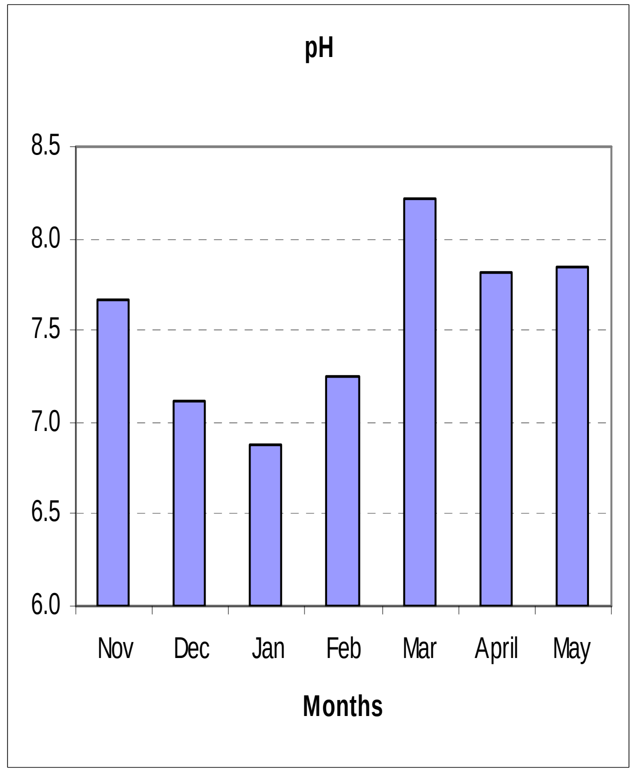


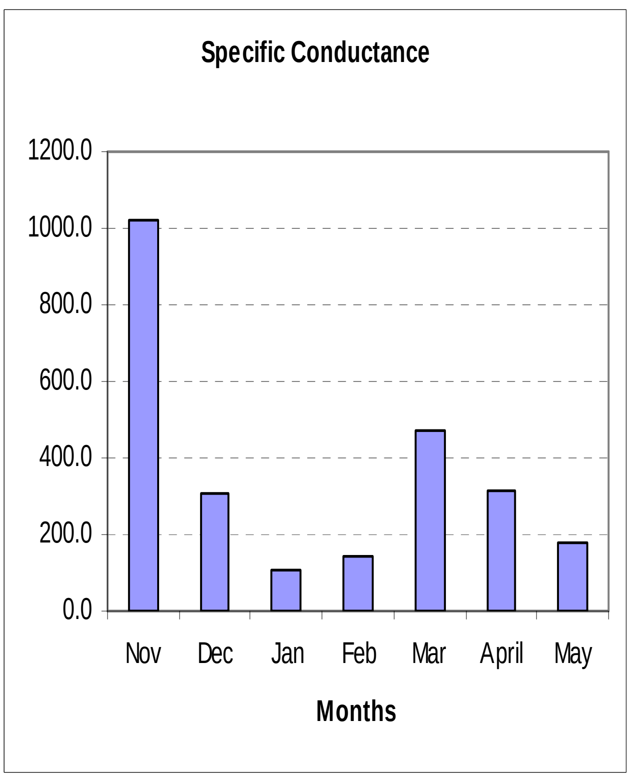


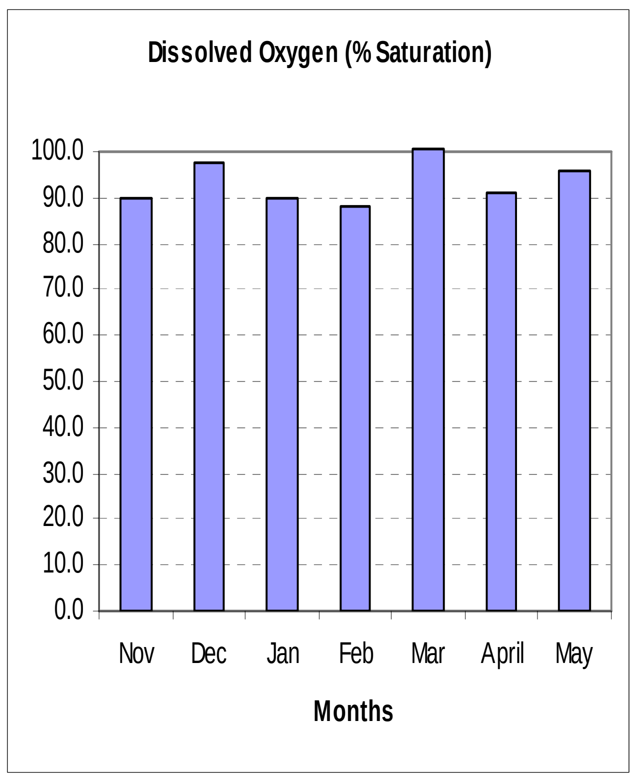


MERTS Water Chemistry

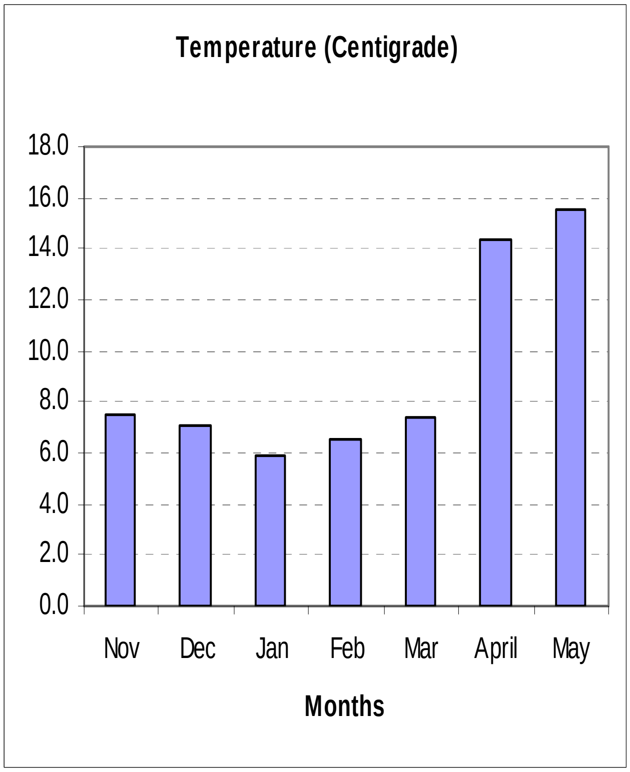


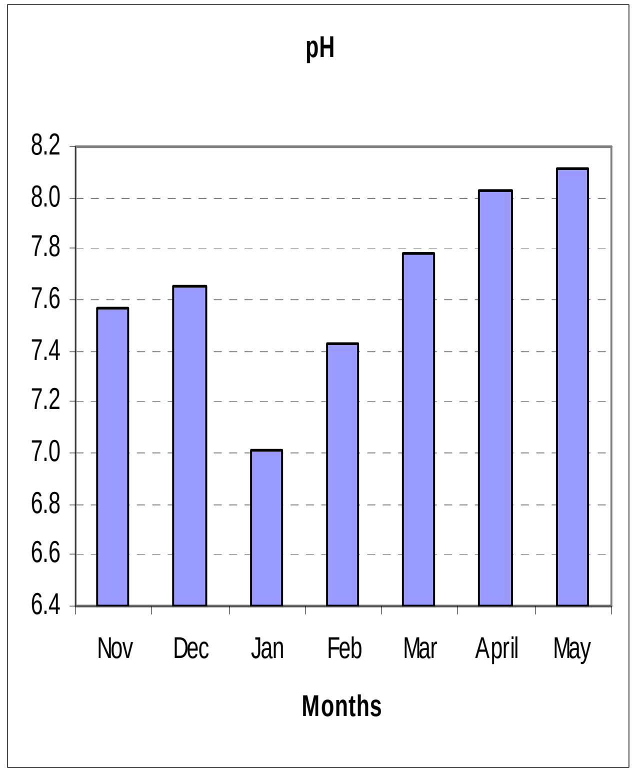


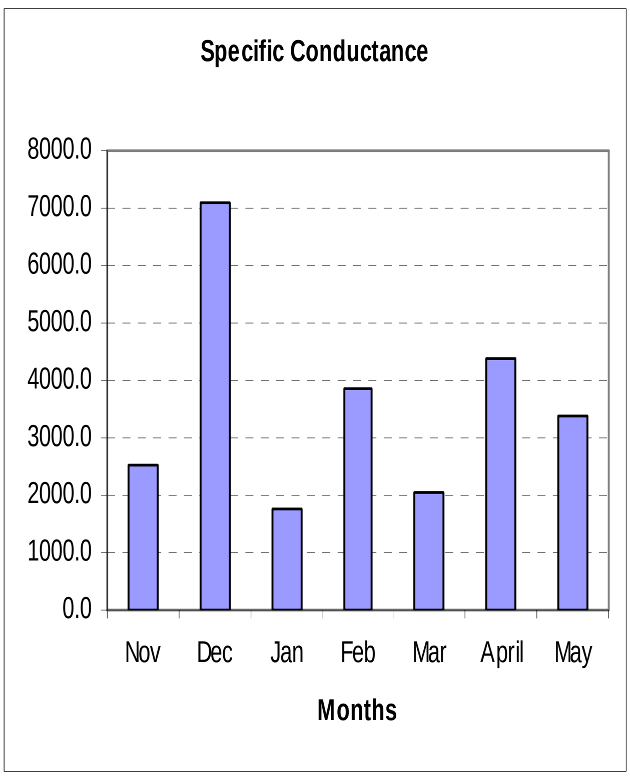


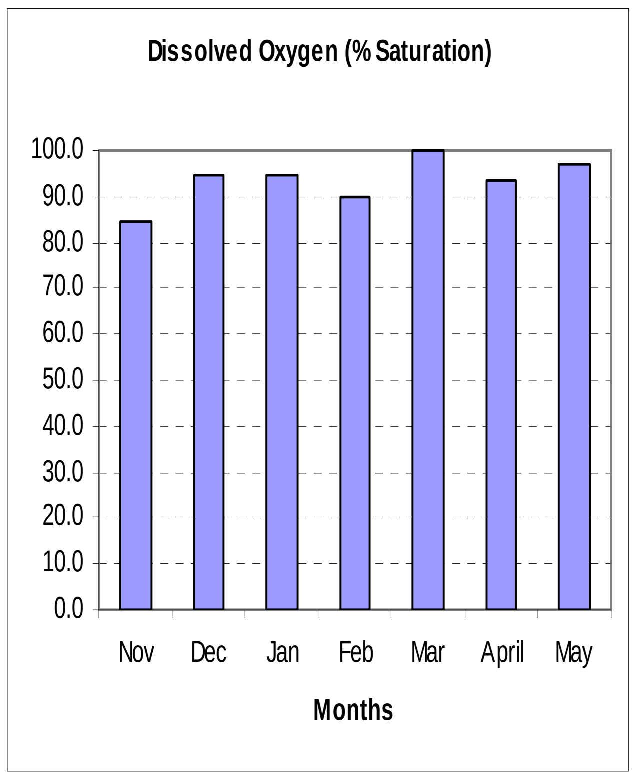


Youngs Bay Water Chemistry





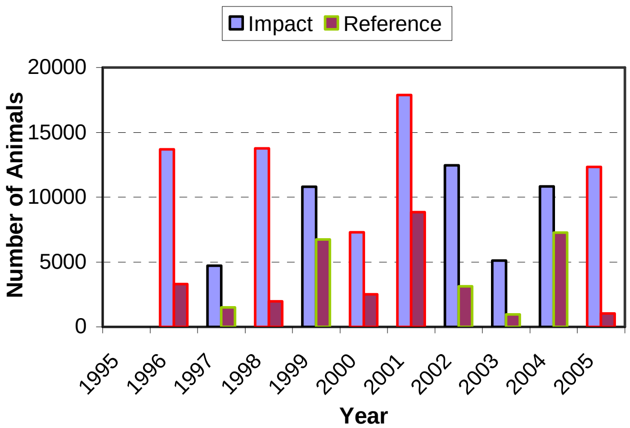




Blind Slough Population Parameters

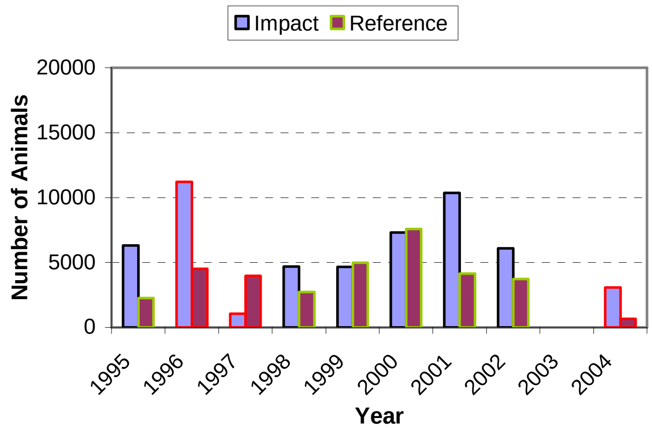
Summer

Population Size

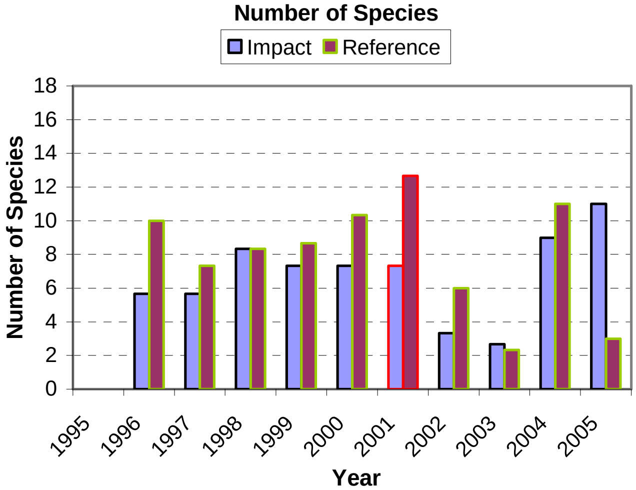


Fall

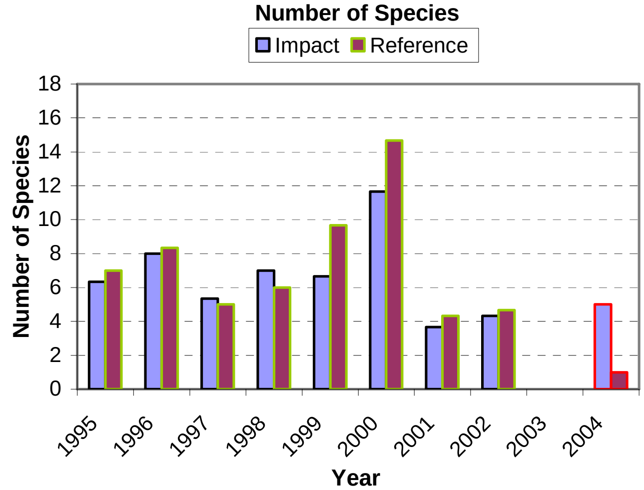
Population Size



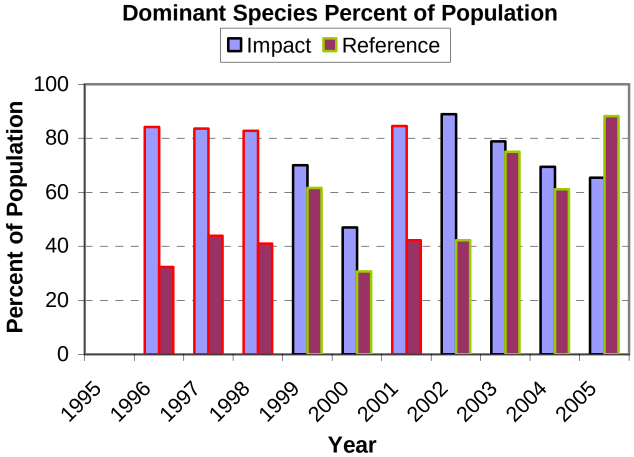
Number of Species



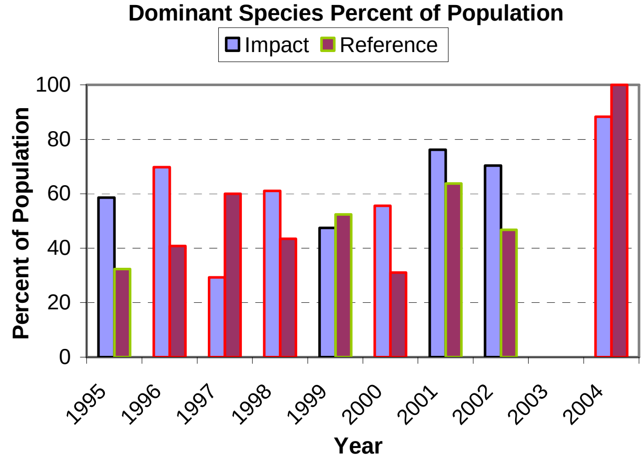
Number of Species



Dominant Species Percent of Population

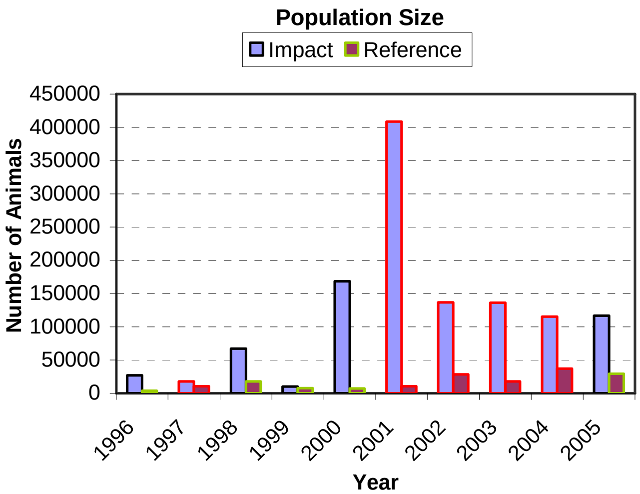


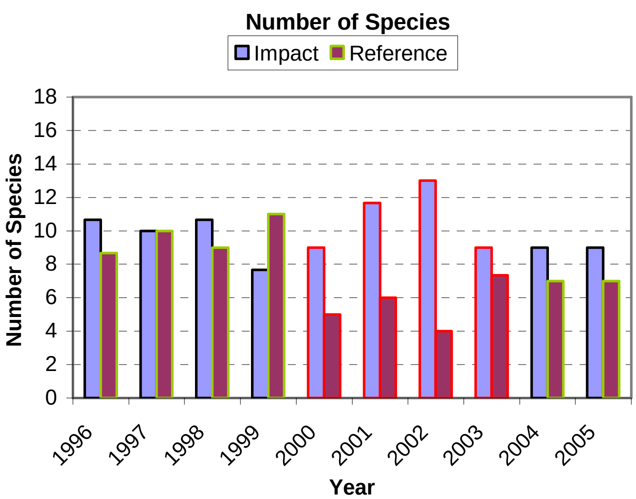
Dominant Species Percent of Population

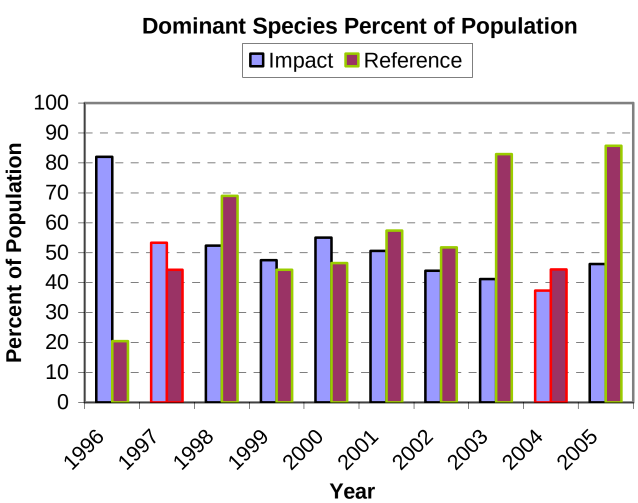


Youngs Bay, Tide Point Population Parameters

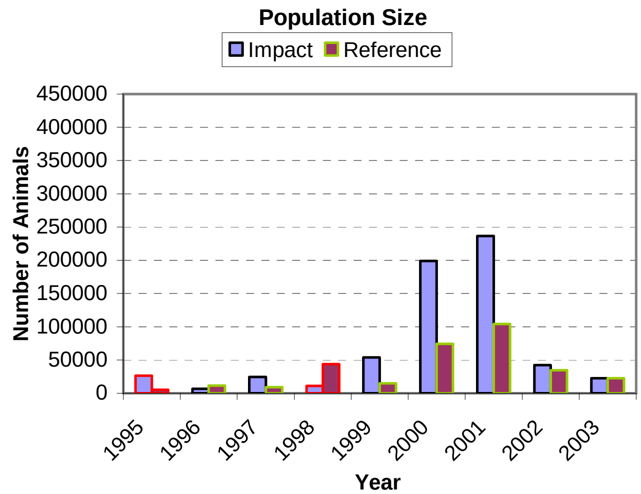
Summer

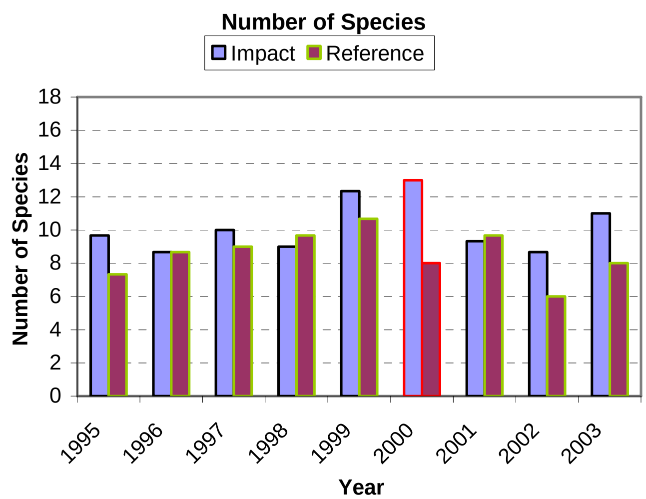


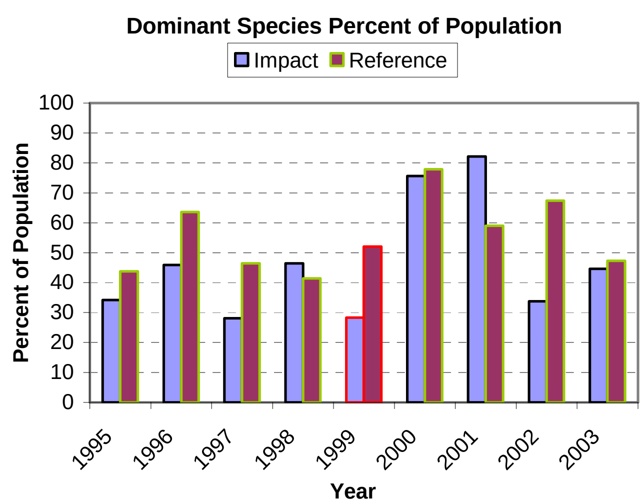




Fall

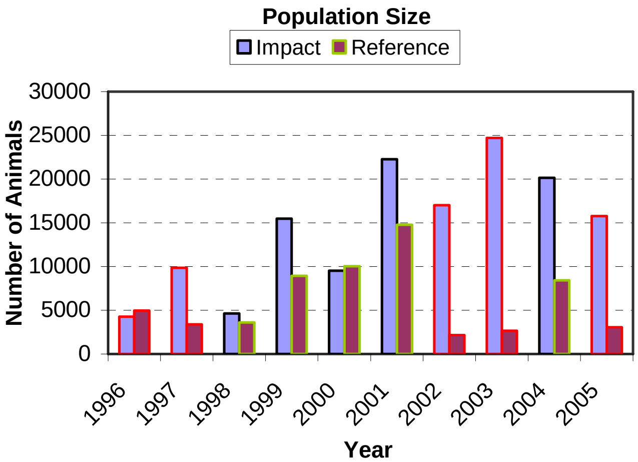


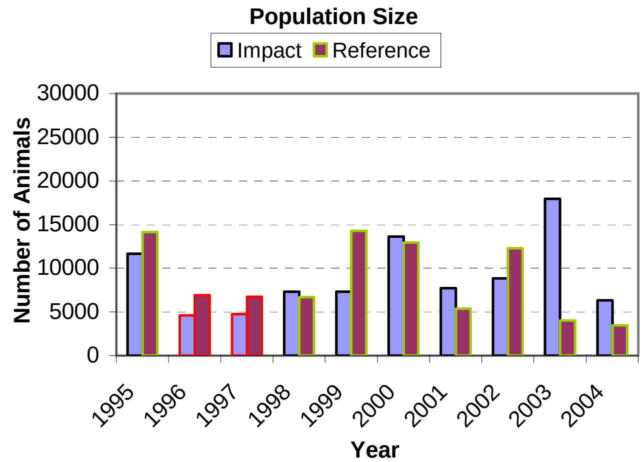


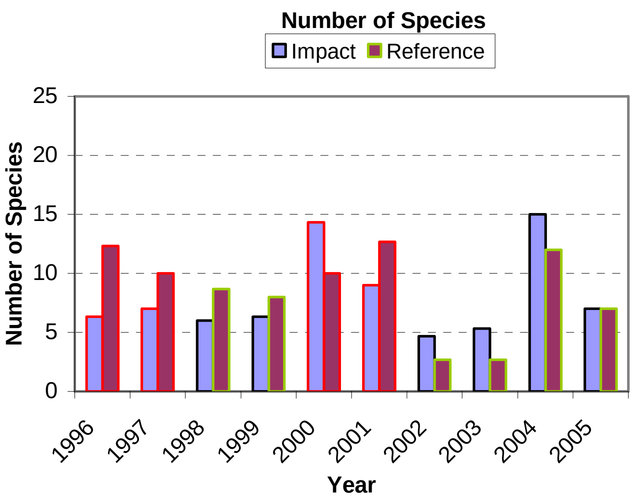


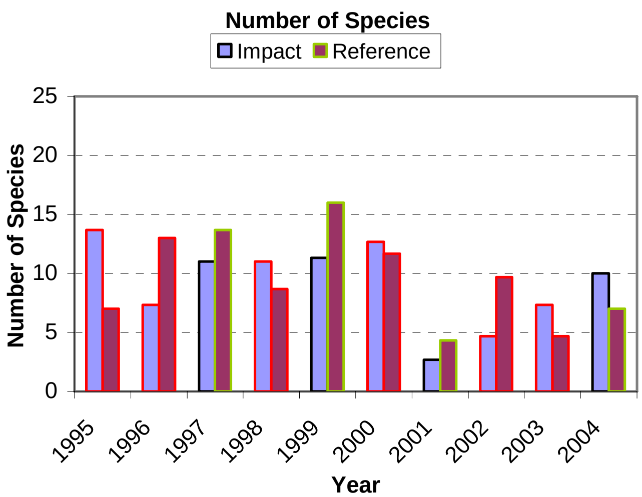
Upper Deep River Population Parameters

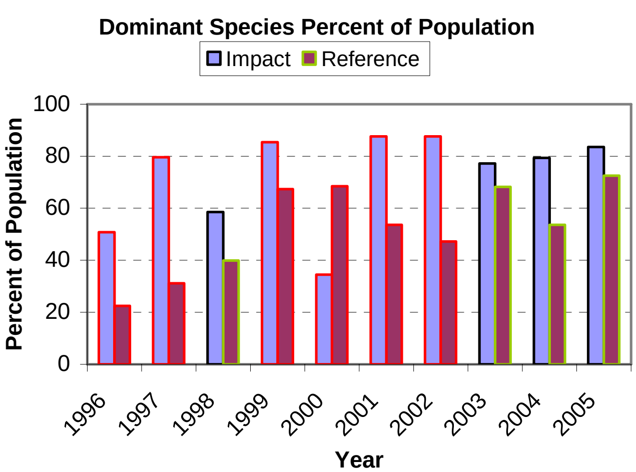
Summer | **Fall**

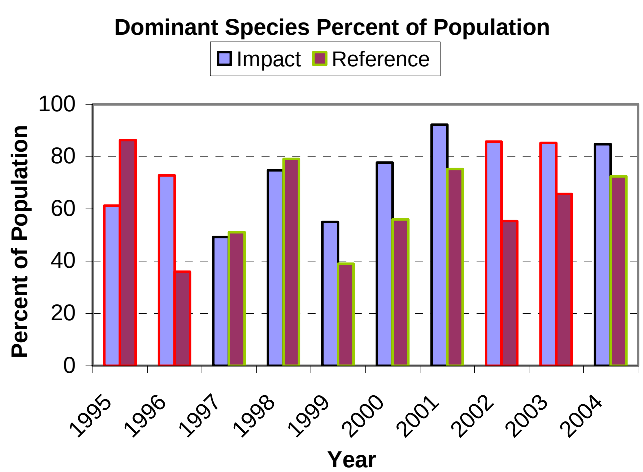










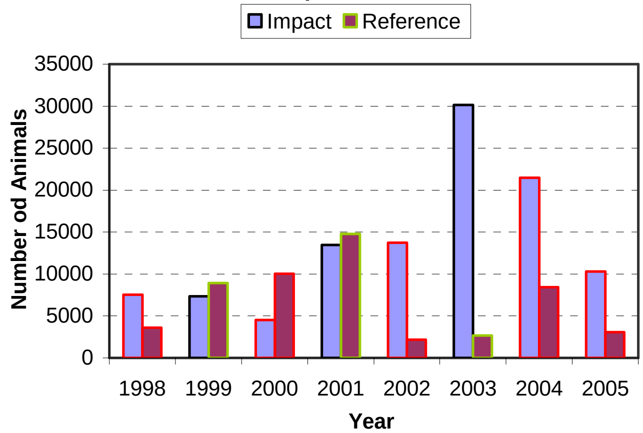


Lower Deep River Population Parameters

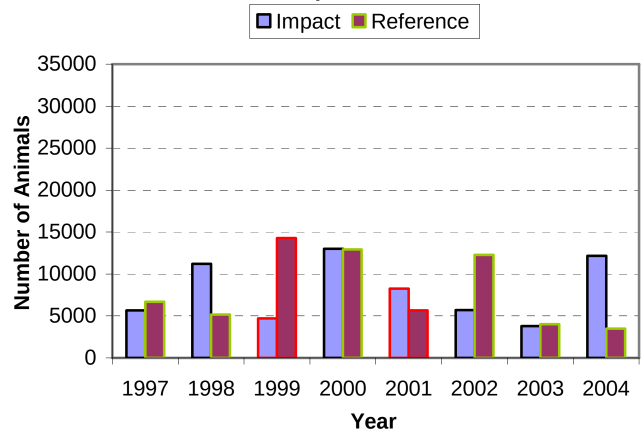
Summer

Fall

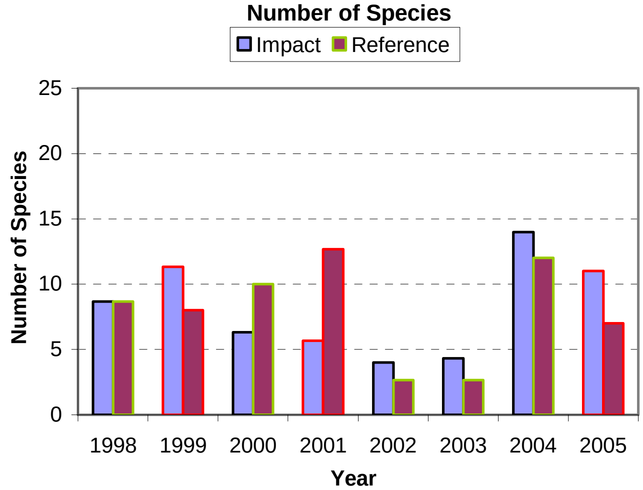
Population Size



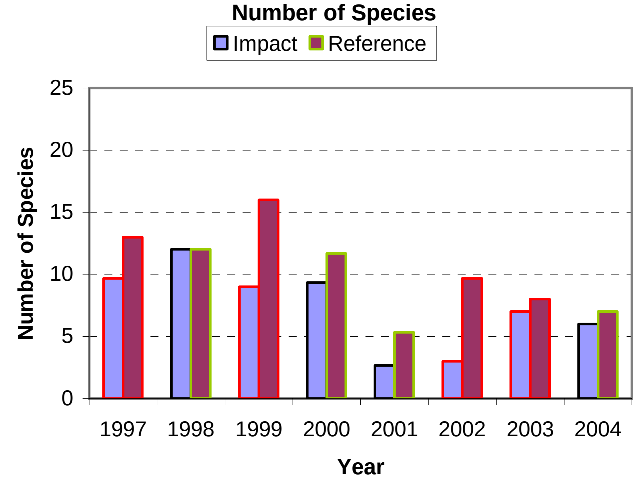
Population Size



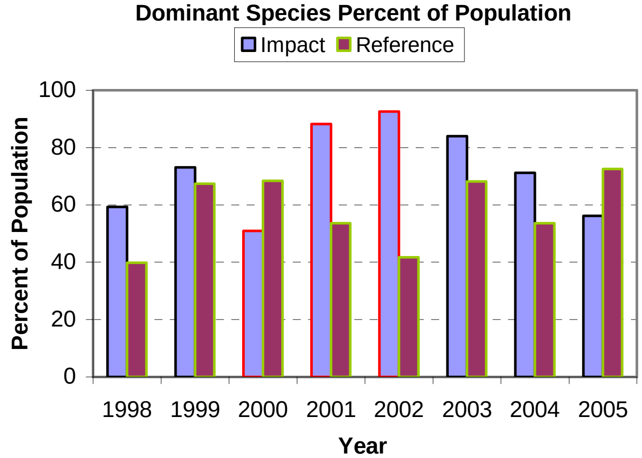
Number of Species



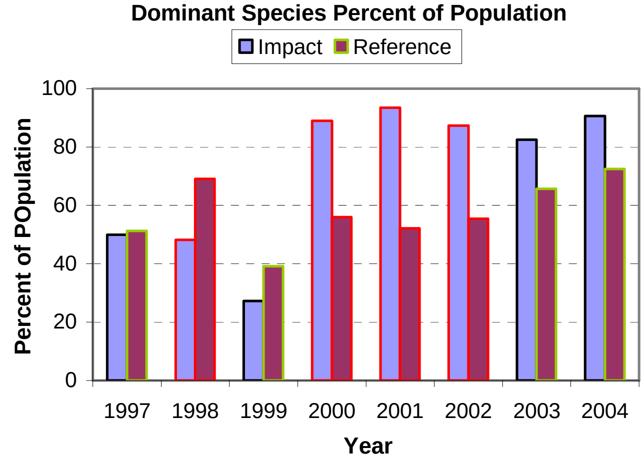
Number of Species



Dominant Species Percent of Population

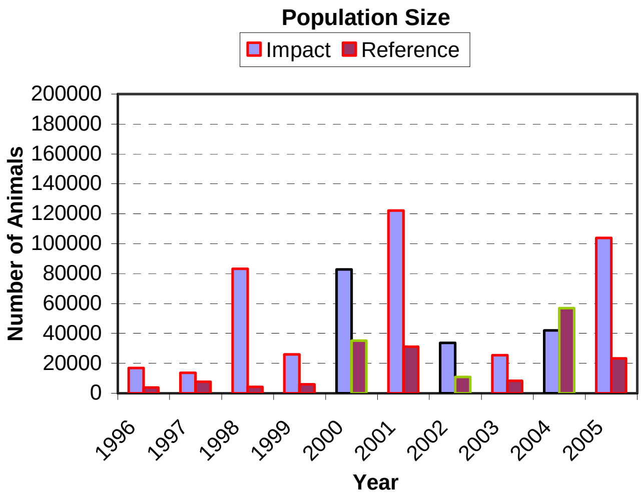


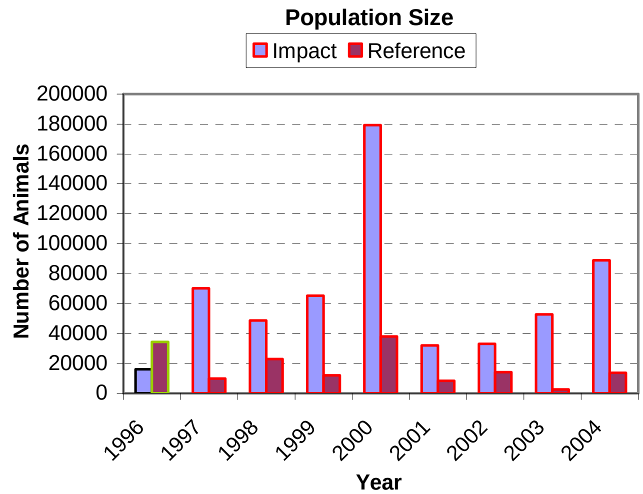
Dominant Species Percent of Population

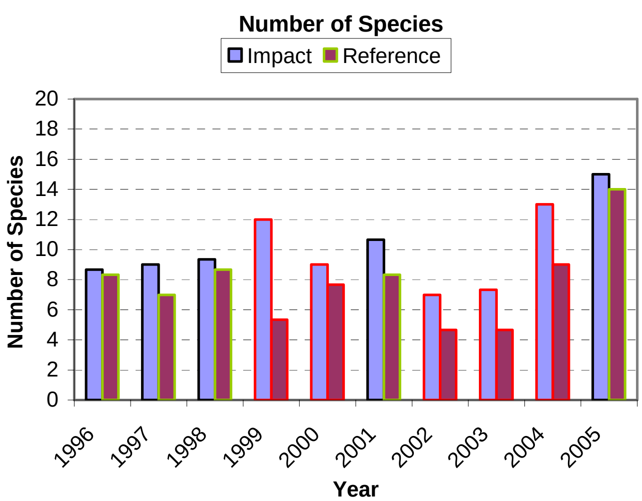


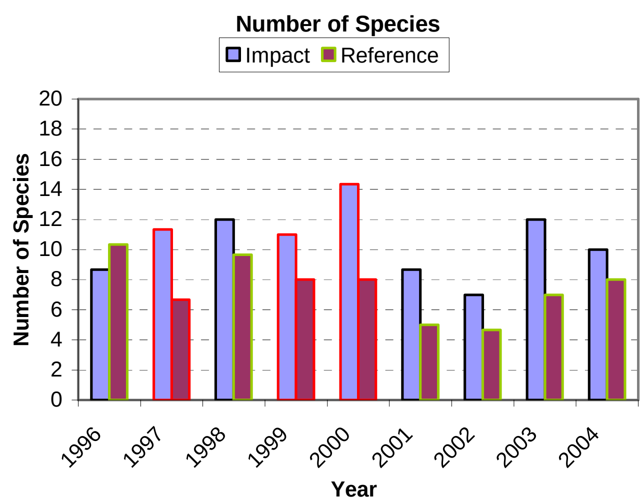
Youngs Bay, Yacht Club Population Parameters

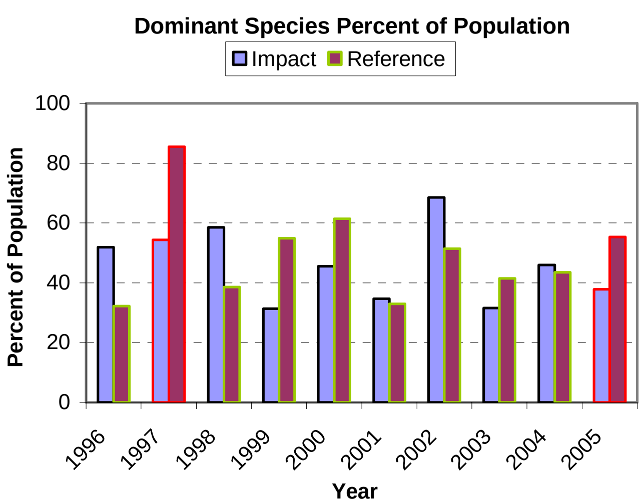
Summer | **Fall**

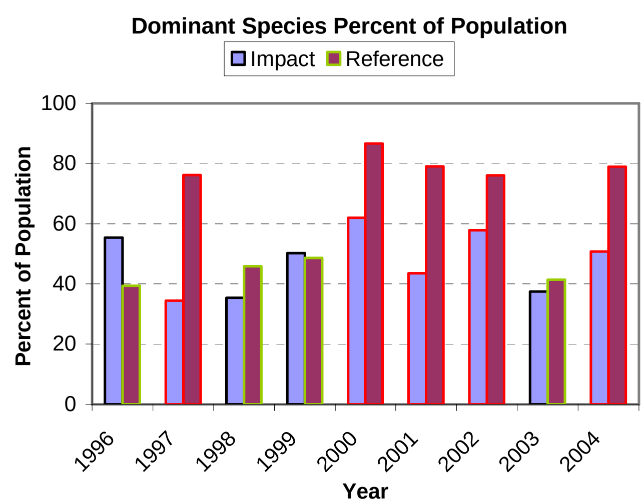












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