

**QUEETS COHO  
Stock Assessment**

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## TABLE OF CONTENTS

TABLE OF CONTENTS.....	i
EXECUTIVE SUMMARY .....	ii
INTRODUCTION .....	1
STOCK DESCRIPTION .....	1
Location & Geography .....	1
Coho Production Components .....	3
Natural Coho Production .....	3
Supplemental Production .....	3
Hatchery Production .....	4
Management Objectives.....	5
Current Management Approach.....	6
ASSESSMENT OF STOCK STATUS.....	7
Spawning Escapements.....	7
Smolt Production .....	9
Natural.....	9
Supplemental Production Releases .....	12
Marine Survival .....	12
Harvest Impacts .....	13
Ocean Fishery Impacts.....	13
Terminal Fishery Impacts .....	14
Total Fishery Impacts .....	15
Discussion.....	15
CONCLUSION AND RECOMMENDATIONS .....	17
Appendix A – Preliminary Examination of Queets Coho Stock- Production Relations .....	19
Appendix B - Preseason Abundance Forecasts for Queets Coho.....	24

## EXECUTIVE SUMMARY

In 1997, 1998, and 1999, the Queets coho stock failed to meet the lower bound of its MSY escapement goal range. In 2000, the Council instructed the STT to complete a stock assessment of Queets coho in response to the retroactive application of overfishing criteria adopted under Amendment 14 to the Salmon Framework Management Plan (FMP), which became effective in September 2000.

In the 3 years when Queets coho were not anticipated to meet their MSY escapement goal, the QIN and WDFW agreed on annual management objectives, which were below the MSY range. Under Amendment 12, the overfishing definition required review of the stock status in the event of failure to achieve the management objective for 3 consecutive years. In 1998, the spawning escapement of 4,102 wild and 1,413 supplemental origin natural spawners exceeded the anticipated level of 4,030 total natural spawners. Consequently, an overfishing review was not required under Amendment 12. When NMFS approved Amendment 14 on September 27, 2000, the threshold for triggering an overfishing concern was changed and was applied retroactively. The threshold became the failure to achieve the MSY escapement range in three consecutive years. Because natural spawning escapement of Queets River coho salmon was less than the lower bound of the estimated MSY range for three consecutive years, the stock triggered an overfishing concern under Amendment 14, even though it did not meet the overfishing criteria under Amendment 12.

The STT evaluated the degree to which various factors (freshwater production, marine survival and harvest) may have contributed to the low spawning escapements in 1997 through 1999. Available information indicates that Queets coho, like many other stocks, suffered from recent production problems when marine survival of progeny was very low. The STT concludes that Queets coho are not overfished. Consequently, development of a rebuilding plan and criteria for determining an end of overfishing are not warranted at this time.

In 2000, the observed spawning escapement of 8,621 (7,939 wild, 682 supplemental) was within the spawning escapement range of 5,800-14,500 established for Queets coho. Spawning escapements in 2001 are also anticipated to exceed the lower end of the escapement range. Marine survival appears to have improved from the low levels observed during the mid-late 1990s. The STT believes that it is unlikely that Queets coho will trigger a conservation alert or overfishing concern in the near future.

The STT's preliminary examination of the historic relationship between spawners and subsequent production suggests that the current escapement range for this stock should be reexamined. The STT recommends that the Council and co-managers undertake a comprehensive review of available information to determine if the lower end of the current MSY escapement range is still appropriate.

The preseason forecasts of the ocean abundance of Queets Natural coho for the years 1997-1999 were all below the lower bound of the escapement goal range. The STT therefore concludes that abundance forecast estimation error did not contribute to the low spawning escapements of Queets coho from 1997 – 1999.

## INTRODUCTION

The Salmon Technical Team (STT) was instructed by the Pacific Fishery Management Council (Council) to complete a stock assessment of Queets coho in response to the retroactive application of overfishing criteria adopted under Amendment 14 to the Salmon Framework Management Plan (FMP), which became effective in September 2000. Prior to the adoption of Amendment 14, an overfishing concern was not triggered because escapements of Queets coho exceeded annual target levels established by agreement of the Quinault Indian Nation (QIN) and Washington Department of Fish and Wildlife (WDFW). The STT is responsible for determining the status of Queets coho and developing recommendations for any management changes to rebuild the stock for application beginning in 2002 (Section 3.2.3.2 of Amendment 14) if the stock is determined to be overfished.

Under Amendment 12 to the FMP, the management objective for Queets River coho salmon was to provide 5,800 to 14,500 natural spawners each year, a range that was expected to provide maximum sustainable yield (MSY). However, the FMP also states: "Under those orders for Washington coastal and Puget Sound stocks (U.S. v. Washington, 626 F. Supp. 1405 [1985] and *Hoh v. Baldrige* No. 81-742 [R] C), the treaty tribes and WDFW may agree to annual spawner targets that differ from the MSP or MSY objectives." Under Amendment 12, the overfishing definition required review of the stock status in the event of failure to achieve the management objective for 3 consecutive years. In 1997, 1998, and 1999, in light of anticipated poor marine survival and low forecast run sizes, the QIN and WDFW agreed on annual anticipated spawning escapement levels below the MSY range. Anticipated natural spawning escapement in 1997, 1998, and 1999 were 2,121 (wild), 4,030 (3,466 wild and 564 supplemental), and 5,749 (3,351 wild and 2,398 supplemental), respectively. In 1998, spawning escapement of 5,515 natural spawners (4,102 wild and 1,413 supplemental) exceeded the anticipated level of 4,030 total natural spawners. Consequently, an overfishing review was not required under Amendment 12.

When NMFS approved Amendment 14 on September 27, 2000, the threshold for triggering an overfishing concern was changed and was applied retroactively. The threshold became the failure to achieve the MSY escapement range in three consecutive years. Because natural spawning escapement of Queets River coho salmon was less than the lower bound of the estimated MSY range in 1997, 1998, and 1999, the stock triggered an overfishing concern retroactively, even though it did not meet the overfishing criteria under Amendment 12.

In 2000, Queets River coho stock achieved its escapement objective with 8,621 natural spawners (7,939 naturally produced and 682 supplemental spawners). Thus the stock would not currently trigger an overfishing concern

## STOCK DESCRIPTION

### Location & Geography

The Queets River drains the western slopes of the Olympic Mountains, entering the Pacific Ocean near the village of Queets on the Quinault Reservation. Originating high in Olympics, the 82.7 km long (871 linear stream km) Queets drains a watershed of approximately 1152 km<sup>2</sup>, making it the third largest river on the west coast of Washington (Figure 1).

The bedrock geology of the Queets basin consists of Tertiary sandstone with minor inclusions of basaltic rock overlain by accumulations of Pleistocene alpine glacial till and outwash, lacustrine deposits, and Holocene alluvium deposited by landslides and fluvial transport (Tabor, 1978.). The headwaters of the Queets flow through coastal temperate rainforest.

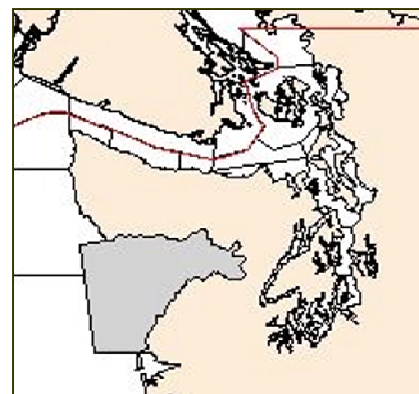


Figure 1. Vicinity map of Queets River

The Clearwater River is the largest tributary of the Queets; it drains an area of approximately 400 km<sup>2</sup> and enters the Queets River at the northwest corner of the Quinault Indian Reservation. Other major tributaries of the Queets River include the Salmon River, Matheny Creek, Sams River, and Tshletshy Creek.

The Queets watershed is almost entirely forested. A large majority of the Queets mainstem lies predominantly within the protected old growth forest of the Olympic National Park (Figure 2).

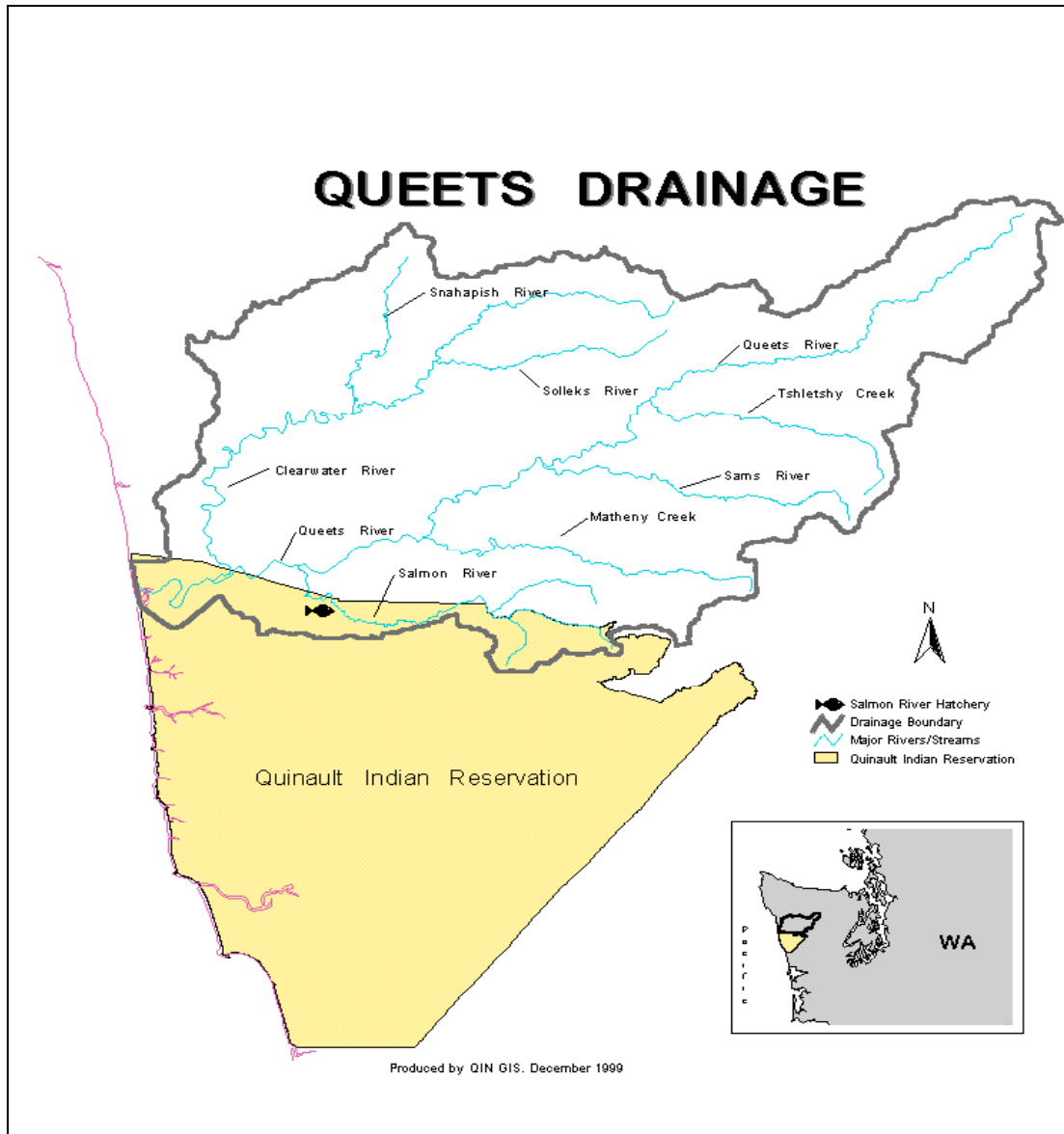


Figure 2. Queets watershed

The Clearwater River watershed has been subjected to intensive logging by the Washington State Department of Natural Resources (DNR) and private timber companies. The contrast between the upper

Queets and the Clearwater has provided fertile ground for research, primarily by the University of Washington (Naiman, 1998) and the DNR. The Salmon River is contained almost entirely within the Quinault Indian Reservation. Matheny Creek and Sams River flow principally through land managed by the United States Forest Service.

### **Coho Production Components**

The Queets River system supports various species of salmonids including coho, cutthroat, winter and summer steelhead, and spring-summer and fall chinook. Coho use almost all of the accessible tributaries draining into the Queets River.

The Queets coho run is managed as a unit under the determinations of the U.S. District Court in *U.S. v. Washington*, 384 F. Supp. 312 (W.D. Wash. 1974), and *Hoh Indian Tribe v. Baldrige*, 522 F. Supp. 683 (W.D. Wash. 1981). There are three components to the run: (1) natural; (2) supplemental; and (3) hatchery.

### **Natural Coho Production**

Natural coho production in the Queets system has been extensively studied since the 1970s. Research indicates that the dynamics of coho populations in the Queets are quite complex; the dependence of the species upon different habitat types during different life history stages makes the stock susceptible to a variety of factors that affect environmental conditions at certain times of the year.

The capacity of various tributaries of the Queets to support coho populations varies depending upon their positions within the watershed and geomorphologies that result in different types of habitat. Naturally-produced coho are dependent on a variety of habitat types within the Queets basin: (1) lower mainstem; (2) low gradient tributaries; (3) off-channel ponds; (4) upper mainstem; and (5) high gradient tributaries (Lestelle et. al. 1993). Utilization of these habitat types varies, depending upon life history stage. Low and high gradient tributaries and the upper mainstem are the primary spawning areas, although some spawning also occurs in the lower mainstem and the outlet channels of off-channel rearing habitats. The lower mainstem and lower gradient tributaries are the primary areas used for summer rearing with other habitat types occupied to a lesser degree. Lower gradient tributaries and off-channel ponds are most heavily utilized during the overwintering period, while juvenile coho rarely occupy upper mainstem and high gradient tributaries during this life history stage.

Coho smolts have been trapped annually since 1979, and coded-wire-tags (CWTs) have been applied to fish collected at various locations since 1981. Research by Peterson (1985) suggests that fish migrating from off-channel ponds return to their natal streams for spawning since CWTs from fish tagged in off-channel ponds were recovered from carcasses and brood stock collection operations in high gradient tributaries and the upper mainstem. In contrast, coho smolts tagged in tributaries return predominantly to the tagging site to spawn.

### **Supplemental Production**

The status of Queets coho in relation to the escapement range established for this stock has frequently limited ocean and terminal fisheries. Survival of naturally-produced fish has been low relative to coho produced in Puget Sound. In addition, the complexity of the freshwater life history patterns of coho combined with an unstable environment such as the Queets watershed causes substantial variability in the freshwater survival of Queets coho. To address chronic production problems in the Queets system, a supplementation program was undertaken beginning with the 1984 brood. The program has been modified over time as results of supplementation efforts have become available.

The supplementation project is designed to stabilize and improve the weak stock status. Wild coho broodstock are captured from the portion of the basin being supplemented. Resulting progeny are released back into the general area of adult capture to minimize or eliminate the risk of genetic change. Currently, progeny are reared to yearling-size smolts before being released into natural or semi-natural ponds located in the upper portion of the basin for acclimation (early supplementation efforts also involved seeding underutilized rearing habitat with fry). Once released, yearlings are weaned from their hatchery diet during their residence in the ponds and are allowed to migrate of their own volition.

All supplemental production is marked to facilitate evaluation and ensure that none of the fish returning as adults are utilized for broodstock.<sup>1</sup> Therefore, any supplemental production is only one generation removed from the wild population. Returning fish are allowed to spawn naturally with the intent to provide a reliable source of fry to seed rearing habitat throughout the system. Recovery data indicate that adults from supplemental releases return to spawn predominantly in suitable habitat in close proximity to the acclimation areas where the smolts were held shortly prior to release.

The Queets supplementation program is unique on the Washington Coast. The supplementation project was initially conducted as a joint effort by WDFW and QIN. The QIN has conducted nearly 100% of the work since the early 1990's. From 1990 through 1995, the project was funded as a Pacific Salmon Treaty research project.

### **Hatchery Production**

The QIN operates a fish culture facility at river mile 4 on the Salmon River, a major tributary to the Queets. Coho reared at that facility are of early-timed stock from the Quinault National Fish Hatchery. The early and compressed run timing of Salmon River hatchery coho enables the terminal area fishery to mount a more intensive fishery on the hatchery component than the wild stock component (Figure 3). Wild stock concerns played an important role in the placement and development of the Salmon River facility. The Salmon River watershed consists of only 7% of the total Queets Basin. Therefore, any affects of naturally spawning hatchery fish would be minimized by location and spawning timing of the hatchery coho. Early hatchery spawning places the hatchery stock at a competitive disadvantage compared to the wild stock. Although hatchery production has been occurring for several years, it is apparent that wild production still occurs based on the bi-modal spawning timing within the Salmon River.

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<sup>1</sup> Supplemental groups have been 100% visually marked with a ventral clip previous through the 1996 brood year. The 1997 brood year supplemental groups was 100% adipose clipped. The ventral fin clip was selected because it was believed to result in less mortality than the pectoral fin clip. Other external marks were considered but not used due either to their experimental, still-in-the-development-stages design, our inexperience with other techniques or high cost and inefficient application of certain marks.

Two external marks were required to differentiate between supplementation fish released from remote sites on the Clearwater River and those released from remote sites on the Queets River. A visual mark was required to enable broodstock crews to avoid using supplemented coho for spawning another generation and to minimize handling stress in the broodstock collection nets. The mark was also used by spawning ground surveyors in their mark sampling of coho carcasses throughout the river system.

The adipose clip was not employed because it was sequestered as an indicator of CWTed hatchery coho from Salmon River. Two different external marks were required to determine if Clearwater released fish would stray to the Queets and vice-versa. As the project proceeded, it became evident that fish acclimated to and released as smolts from sites in the Clearwater and Queets basins homed almost invariably to their basin of release.

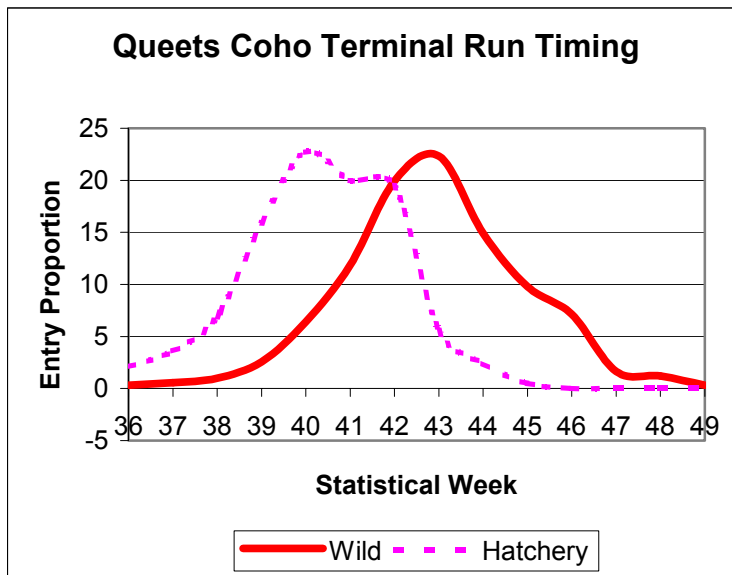


Figure 3. Terminal run timing of Queets natural and hatchery coho.

### Management Objectives

**Natural Production:** Queets coho are managed for natural production, that is, fishery impacts are constrained to try to maintain spawner abundance within the range of maximum sustainable harvest over the long-term. The natural and supplemental components are managed to achieve an annual spawning escapement level determined by agreement of WDFW and QIN.

The current spawning escapement range (5,800 - 14,500 adults) was developed during the early 1980s as a result of two workshops sponsored by the National Marine Fisheries Service (NMFS), Quinault Treaty Area Tribes (Quinault, Quileute, and Hoh), U.S. Fish and Wildlife (USFWS), and Washington Department of Fisheries (WDF) to evaluate the technical basis for setting escapement goals for coho originating in rivers along the Northwest Coast (Lestelle et.al. 1983). The spawning escapement range was derived by estimating maximum smolt production from available habitat and estimates of smolt production per female at two spawner densities: (1) low spawner density where productivity is presumed to be linear and (2) spawning density associated with maximum smolt production.

**Supplemental Production:** The primary objective of the supplementation effort is to augment natural spawning escapement while maintaining the long-term fitness of the stock. The project was designed to stabilize and improve natural coho abundance to reduce the likelihood that the chronic weak status of the stock would continue.

**Hatchery Production:** Impacts of ocean fisheries outside of Council jurisdiction and variations in marine survival rates have undermined the capacity of the coho run to meet the needs of the tribal community. Fish and fishing have always been central to the culture and economy of the Queets village on the Quinault Indian Reservation. Because of the extended run timing of coho, the status of the returning run has a profound effect on the ability of tribal fisheries to harvest chinook and steelhead. In the past two decades, the status of coho has been frequently depressed and the social fabric of the community has suffered as a result.



The primary objective of the Salmon River hatchery production is to provide harvest opportunities to preterminal and terminal area fisheries. U.S. preterminal ocean fisheries north of Cape Falcon have been operating under weak stock considerations with fixed quotas. Because all production components are aggregated for purposes of treaty:nontreaty allocation, opportunities arise to provide for differential harvest impacts. The general intent was to have as much of the hatchery production as possible contributing to these quotas, thereby reducing the overall wild coho impacts. For terminal area fisheries, the production of an early-timed hatchery run provides the capacity to harvest hatchery fish at a higher rate than wild fish. The differential run timing of hatchery from the natural and supplemental runs is intended to provide maximum opportunity to harvest hatchery fish while minimizing the incidental harvest of commingled stocks of wild coho and other species.

Salmon River hatchery fish are not mass marked, but are double index tagged to provide a means to assess non-retention mortality in mark-selective fisheries.

**Current Management Objectives for Populations Within the Queets basin:**

Individual Population	Management Objective	Basis for Objective
Queets Natural	Obtain escapements in the escapement range to optimize future returns	Manage for natural production
Queets Supplemental	Obtain wild broodstock to contribute to natural spawning	Increase natural production
Salmon River Hatchery	Provide early timed coho	Augmentation of Catch

**Current Management Approach**

Allowable impact levels on the Queets stock are established through the PFMC preseason planning process and "North of Falcon" forum, with in-river fisheries established through discussions between QIN and WDFW. Annual abundance forecasts for individual stocks drive the North of Falcon process (Appendix B).

The status of the Queets stock has been chronically weak and has frequently been a limiting consideration in establishing allowable harvest levels for ocean fisheries. Generally, predicted ocean impacts on the Queets stock are based on results from the Coho FRAM model; in-river impacts are based on anticipated harvest rates from fishing schedules. Annual management regimes for ocean and in-river fisheries are documented in agreements between QIN and WDFW each season.

Queets coho were managed under a *Hoh v. Baldrige* framework plan for Washington coastal stocks until the mid 1990s. The framework plan has not been renewed, but QIN and WDFW have continued to cooperate in establishing management regimes that attempt to meet the needs of fisheries within the limitations resulting from the status of the resource.

Without agreement between QIN and WDFW, the salmon FMP stipulates that escapements for Queets coho are to fall within the established MSY range of 5,800 to 14,500 adults. When escapements within this range are not possible, QIN and WDFW have established fishing regimes for ocean and inriver fisheries that are expected to result in anticipated and mutually agreed levels of spawning escapements. When the Queets stock is depressed, management of inriver fisheries is directed at commingled stocks of returning hatchery coho, chinook, and steelhead so that impacts on naturally-spawning fish are minimized. When spawning escapements fall substantially below the established range, the QIN and WDFW have adopted management regimes that are intended to increase spawning escapements by an amount they found to be acceptable over brood year levels.

## ASSESSMENT OF STOCK STATUS

Naturally produced Queets coho rear in freshwater for approximately 18 months prior to their seaward migration during May-June. The vast majority of adults mature as three years olds after spending 18 months in marine waters (some sexually mature males return as two years old jacks). The National Marine Fisheries Service described the status of Olympic Peninsula coho as follows:

*Coho salmon abundance within this ESU is moderate, but stable. These stocks have been reduced from historical levels by large scale habitat degradation in the lower river basins, but there is a significant portion of coho salmon habitat in several rivers protected within the boundaries of the Olympia National Park. This habitat refuge, along with the relatively moderate use of hatchery production (primarily from native stocks), appears to have protected these coho salmon stocks from the serious losses experienced in adjacent regions. While there is continuing cause for concern about habitat destruction and hatchery practices within the ESU, the BRT concluded that there is sufficient native, natural, self-sustaining production of coho salmon that this ESU is not in danger of extinction and is not likely to become endangered in the foreseeable future unless conditions change substantially. (NMFS 1995, p 131.)*

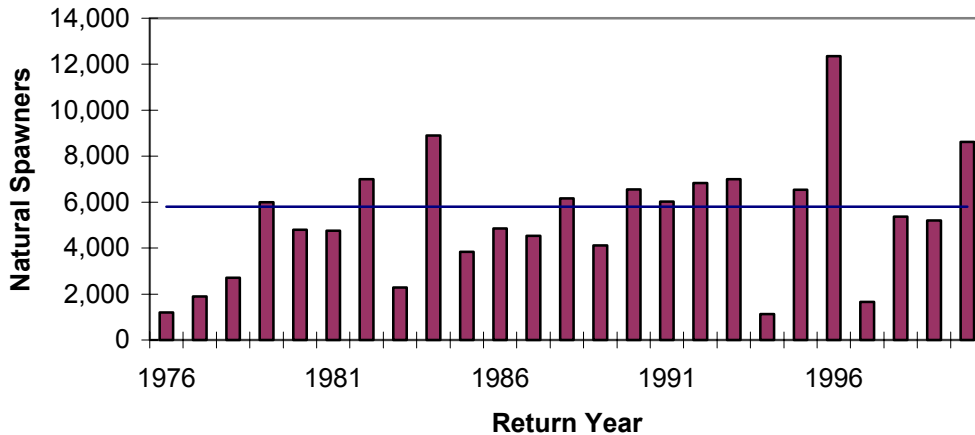
### Spawning Escapements

Estimates of spawning escapements for Queets coho are available for 1976 through 2000 (Table 1). Each year, escapement is estimated through spawning ground surveys that expand observed redd counts by standard expansion factors of one (1) adult male and one (1) female per redd. Expansion factors were validated through a study in the West Branch of the Hoquiam River (Annual Reports to the Northwest Indian Fisheries Commission, 1988, 1989, 1990). The QIN has conducted the vast majority of the adult and juvenile population assessment work on the Queets since the late 1980's. Estimates of wild, supplemental, and hatchery composition of natural spawners are based on CWT recoveries. During the 1990s, wild-origin spawners ranged from slightly over 1,000 to nearly 9,000; the contribution of fish produced by supplementation efforts to natural spawning escapements ranged from less than 100 to 3,600; hatchery escapements ranged from 1,400 to nearly 6,000, but are not counted as natural spawning escapement. Available data indicate that Salmon River hatchery fish home to and are either trapped for broodstock or spawn naturally within Salmon River. Hatchery and natural coho spawning in the Salmon River are distinguished by timing.

**Table 1.** Queets natural terminal area spawning escapements.  
 Excludes wild broodstock taken for the supplementation program.  
 Source: QIN 2000.

<b>Escapement Year</b>	<b>Wild</b>	<b>Suppl</b>	<b>Total Natural</b>	<b>Hatchery</b>
1976	1,200		1,200	100
1977	1,900		1,900	300
1978	2,700		2,700	600
1979	6,800		6,800	1,600
1980	4,700		4,700	2,400
1981	4,800		4,800	2,400
1982	7,000		7,000	4,500
1983	2,282		2,282	1,100
1984	9,200		9,200	4,042
1985	4,001		4,001	1,228
1986	5,160		5,160	3,654
1987	4,747		4,747	2,401
1988	4,288	3,897	8,185	4,782
1989	4,501	693	5,194	1,872
1990	5,422	1,793	7,215	4,123
1991	6,525		6,525	4,129
1992	6,266	922	7,188	1,402
1993	5,020	2,208	7,228	5,938
1994	1,105	95	1,200	2,901
1995	6,181	592	6,773	2,385
1996	8,993	3,574	12,567	5,191
1997	1,851		1,851	2,137
1998	4,102	1,413	5,515	3,504
1999	4,791	521	5,312	3,551
2000	7,939	682	8,621	3,065

In 1997, 1998, and 1999, the Queets River coho natural spawning escapement fell below the lower bound of the MSY escapement goal range (Figure 4). We believe that this failure was due primarily to poor marine survival. Harvest impacts were dramatically reduced in these years and, while curtailment of harvest could have met the escapement goal in 1998, available evidence does not indicate that harvest is the primary cause of the escapement shortfall.



**Figure 4. Natural spawning escapement of Queets coho salmon. Escapement includes natural spawners from both wild and supplemental production, and the horizontal line represents the lower bound of the MSY escapement goal range.**

### Smolt Production

#### Natural

Natural smolt production has been estimated annually since the early 1980's through smolt trapping, tagging, and recapture experiments. The QIN installs smolt traps at as many as 18 various tributaries and overwintering ponds each spring. From the early 1980s through the early 1990s, WDFW operated a trap in the lower Clearwater River where smolts were recovered to provide a smolt yield estimate through mark-recapture of tagged fish.

Time series of smolt production are available for the Clearwater and the entire Queets system separately (Table 2). The Clearwater smolt production is estimated by a simple mark-recapture program via a scoop trap located near the mouth of the Clearwater River. Smolt production from the Queets basin is estimated from data collected during night seining operations in the lower Queets mainstem. The estimate is made through the use of a linear programming model that incorporates the CWT, fin clip data, and Clearwater scoop trap data.

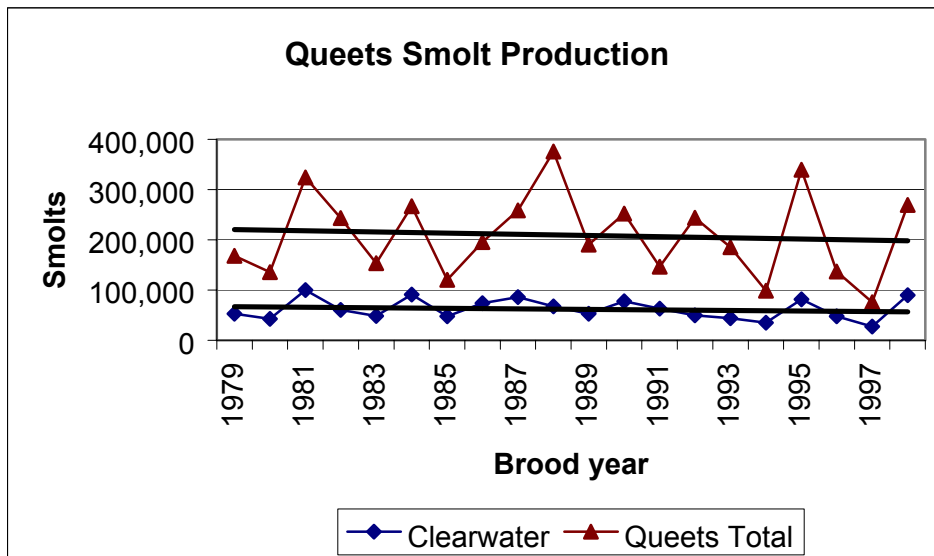
**Table 2.** Queets natural smolt production. Source QIN 2000.

Brood YR	Clearwater	Queets	Total
1979	52,900	115,400	168,300
1980	42,600	92,900	135,500
1981	99,800	224,472	324,272
1982	60,600	182,431	243,031
1983	48,200	105,541	153,741
1984	90,800	176,135	266,935
1985	47,500	73,150	120,650
1986	73,600	122,195	195,795
1987	86,000	172,711	258,711
1988	67,800	308,177	375,977
1989	52,600	138,103	190,703
1990	77,500	174,658	252,158
1991	63,100	83,215	146,315
1992	49,900	193,926	243,826
1993	43,900	141,700	185,600
1994	34,900	63,842	98,742
1995	81,500	258,287	339,787
1996	47,807	88,947	136,754
1997	27,314	48,763	76,077
1998*	98,831	226,564	322,395

\*preliminary

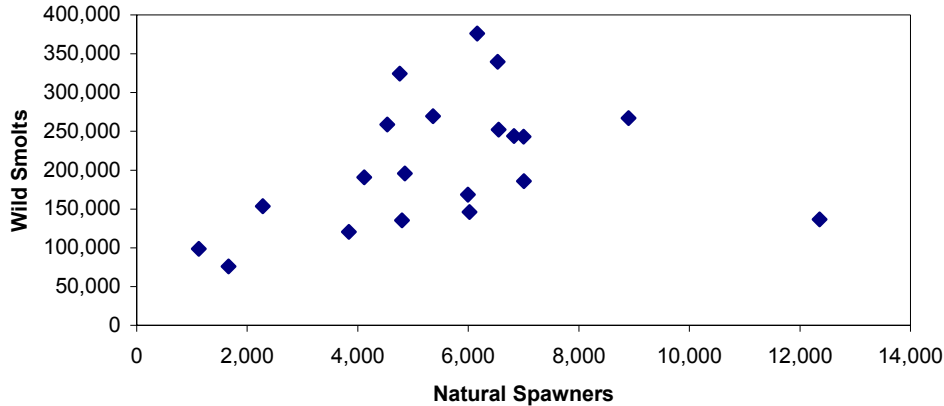
The smolt production for the Clearwater and the entire Queets system indicates a slight negative trend for the data set available (Figure 5). The total Queets smolt production has ranged from 76,000 – 375,000 since the 1980's. During the 2000 smolt season, the Quinault Indian Nation captured and tagged a record number of smolts (52,500).

Two components of freshwater production that could lead to low returns are insufficient spawning escapement, and decreased productivity of freshwater habitat reflected in smolt production per spawner.



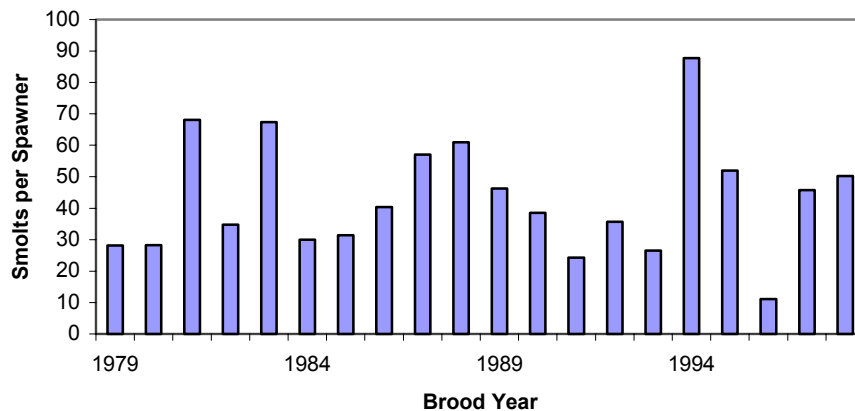
**Figure 5.** Estimated coho smolt production from Queets and Clearwater basins.

The CWTs used for smolt production estimates also provide estimates of harvest in ocean and terminal fisheries. Examination of the production relationship (Figure 6) suggests that for natural escapements greater than approximately 5,000 adult spawners, smolt production is relatively independent of spawning escapement. The returns from 1997 through 1999 were produced from spawning escapements in 1994 through 1996. Of these broods, only the 1994 escapement was less than the MSY escapement goal range of 5,800 to 14,500.



**Figure 6. Relationship between natural spawning escapement and subsequent smolt production for Queets River coho salmon.**

Estimates of smolt production per spawner (Figure 7), while quite variable, do not show any evidence of a declining trend over time. Peak fall flows during coho egg incubation contribute to the variability in smolt production per spawner. While there was extremely low productivity from the 1996 brood (1999 return year), the 1994 and 1995 broods experienced higher than average freshwater productivity. Total natural smolt production from the Queets basin shows the effects of low escapement in 1994 and low freshwater productivity in 1996 as the second and fourth lowest years of smolt production in the 20-year period for which we have estimates (Figure 5). However total smolt production from the 1997 brood was the lowest observed natural smolt production, and resulted in a spawning escapement of 7,939 in 2000.



**Figure 7. Freshwater productivity. Productivity was calculated as natural smolt emigration divided by the number of natural spawners from wild and supplemental production.**

River flow conditions may have affected production from the 1996 brood. In March of 1997, extremely high flows were observed over an extended period during the egg incubation and fry emergence of the 1996 brood. This event triggered the largest landslide observed in the Queets drainage in the last 30 years. A major landslide in the upper Solleks River (tributary to the Clearwater) brought an enormous quantity of debris and sediment into the Clearwater system, substantially changing channel characteristics. WDFW researchers have suggested that coho smolt production for the Clearwater River may be related to peak daily flows during the egg incubation period with high flows leading to high egg and fry mortality and thus low production.

### Supplemental Production Releases

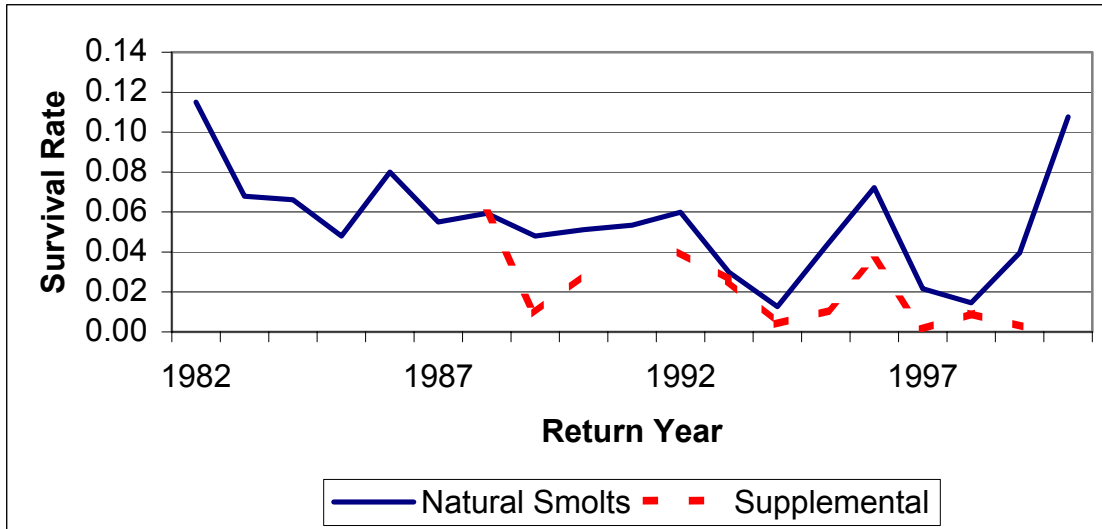
Queets coho have been supplemented since the 1985 brood (Table 3). In the initial years of the project, both smolt and fry were planted in habitat believed to be underseeded. Beginning with the 1989 brood, supplementation efforts released only smolts since the available data indicated that fry plants were not successful in increasing production. Production of the 1988 brood was lost due to an outbreak of disease. In the winter of 1999, high water during a severe storm flooded holding ponds; since the capacity to separate progeny by area of broodstock selection was lost, normal supplementation efforts could not proceed. All remaining production was ad-clipped and smolts were allowed to leave hatchery holding ponds on their own volition.

**Table 3.** Supplemental Releases of Queets Coho

Brood Year	Smolt year	Harvest year	Marked (CWTed)	Unmarked (non-CWT)	Total Supplemental Release
1985	1987	1988	72,210	64,790	137,000
1986	1988	1989	99,323	108,677	208,000
1987	1989	1990	96,075	182,925	279,000
1988	1990	1991			
1989	1991	1992	33,900	0	33,900
1990	1992	1993	72,162	130,665	202,827
1991	1993	1994	63,788	16,320	80,108
1992	1994	1995	84,978	32,136	117,114
1993	1995	1996	111,759	59,672	171,431
1994	1996	1997	38,669	1,415	40,084
1995	1997	1998	125,326	52,313	177,639
1996	1998	1999	216,146	8,041	224,187
1997	1999	2000	46,353	9,091	55,444
1998	2000	2001	0	0	0

### Marine Survival

Reconstructed adult runs divided by smolt emigration provide estimates of marine survival for both natural and supplemental production (Figure 8). While marine survival of supplementation fish has been consistently lower than that of natural production (likely due to the use of ventral fin clips to identify supplemental releases and potential losses from time of outplanting to migration), both show similar patterns. Because the record is longer and more complete for natural production than for supplementation, we will focus on the marine survival of naturally produced smolts.



**Figure 8. Marine survival of natural and supplemental smolts calculated as ocean recruits (marine catch + terminal run) divided by smolt outmigrants.**

There was a declining trend in marine survival in the 1980s and 1990s, and with the exception of the 1996 return year, the naturally produced runs from 1992 through 1999 consistently experienced the lowest marine survival. Low marine survival of Queets coho during the 1990s is consistent with current understanding of recent marine environmental regimes. The productivity in the marine environment of the California Current system has been relatively low since the late 1970s (the 1990s have been some of the lowest productivity years in this period).

In contrast, marine survival of the 1997 brood, which emigrated in 1999 and returned in 2000, was the highest observed since the 1979 brood. All indications are that during most of the 1990s, the California Current system experienced a protracted period of abnormally high temperature. During this time, subtropical and transitional assemblages of copepods and euphausiids dominated the plankton community (Peterson and Mackas, in press<sup>2</sup>). In the fish communities we also saw northward range extensions and increased abundance of species associated with warm water. In 1999, there was an abrupt disappearance of the subtropical neritic copepods from the coastal waters off Oregon and Washington, and a return of boreal and subarctic copepods in the plankton community. Large numbers of anchovies have also been spawning in the Columbia River plume, an event that has not occurred since the 1977 regime shift.

The changes that occurred in 1999 have persisted since then, and while it is too early to say that a regime shift has occurred, this bodes well for the marine survival of coho for at least the next couple of years.

### Harvest Impacts

#### Ocean Fishery Impacts

Queets coho migrate to the north and are more vulnerable to Canadian fisheries than they are to Council fisheries in U.S. waters. Beginning in 1997, Canada curtailed fisheries targeting coho salmon out of

<sup>2</sup> Peterson, W.T., and D.L. Mackas. In press. Shifts in zooplankton abundance and species composition off central Oregon and southwest British Columbia. Pisces Press.



concern for depressed Canadian coho stocks. While there has been a general declining trend in ocean fishery impacts on wild Queets coho since the 1982 return year, primarily due to restrictive management actions taken in U.S. fisheries, the coho conservation measures implemented by Canada are readily apparent as a dramatic decrease in ocean exploitation rates in 1997 (Figure 9).

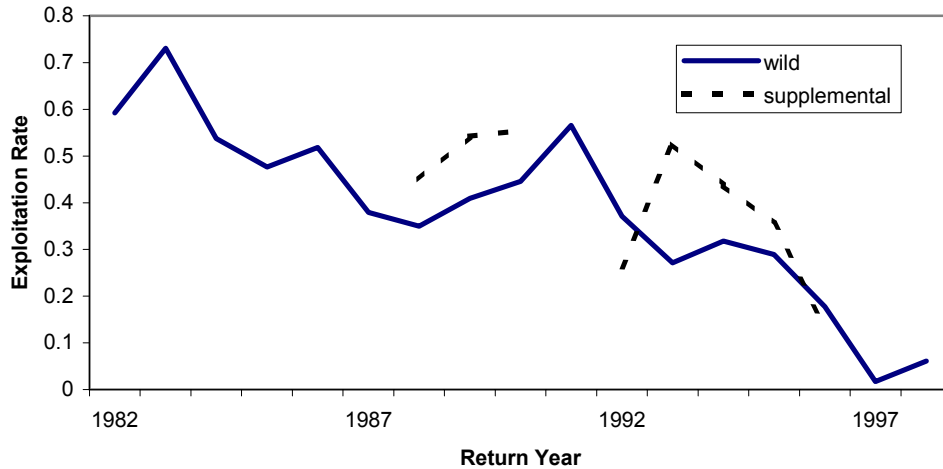


Figure 9. Queets River coho ocean exploitation rate. Exploitation rate calculated as ocean catch divided by ocean recruits (catch + terminal run).

### Terminal Fishery Impacts

Terminal harvest impacts on Queets River coho salmon have been highly variable, but during the low marine survival period beginning in 1992, the terminal harvest rate on wild coho has consistently been restrained to well below 20% for all tribal fisheries and freshwater sport fisheries combined (Figure. 10).

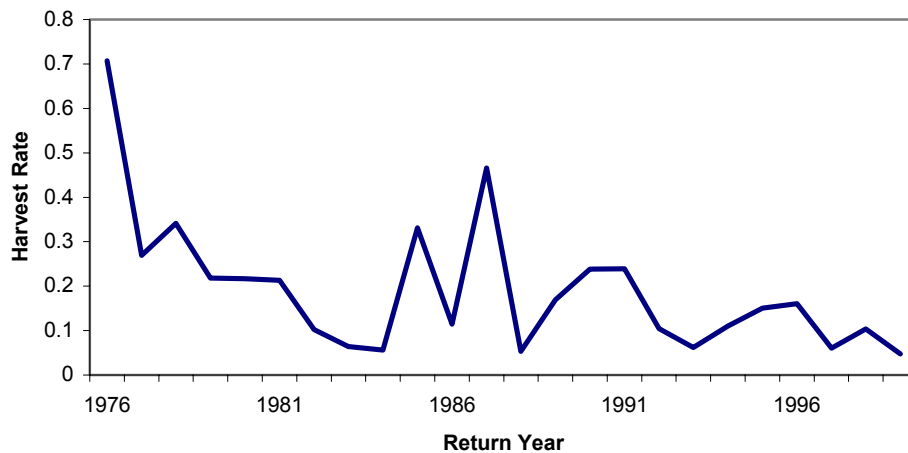
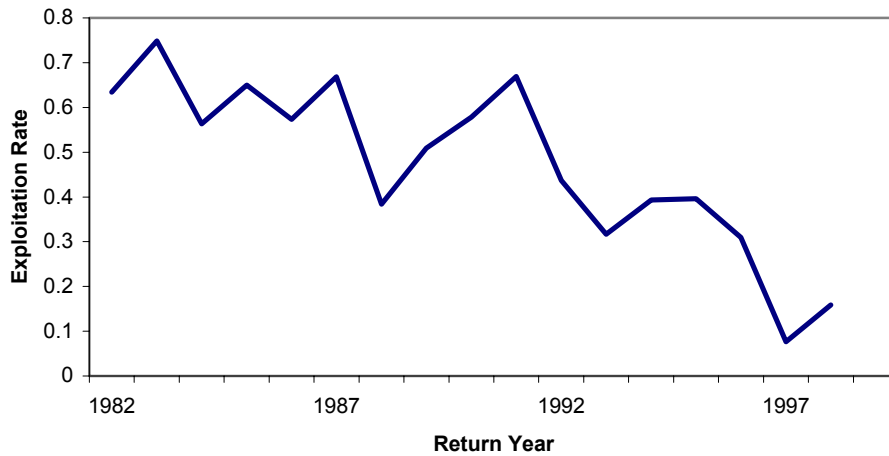


Figure 10. Terminal harvest rate of natural Queets River coho. Harvest rate calculated as tribal and freshwater sport harvest divided by terminal run size.

## Total Fishery Impacts

Total fishery impacts have declined in a pattern very similar to the decline in ocean fishery impacts (Figure 11). Fishery impacts have declined from exploitation rates on the order of 60 to 70% in the 1980's to less than 20% in the recent years when Queets coho natural escapement fell below the MSY goal range. Total fishery exploitation rate was estimated to be 7.7% in 1997 and 15.8% in 1998. Because the terminal harvest rate was even lower in 1999 than it was in 1997, Canadian fisheries directed at coho remained closed, and all U.S. ocean fisheries were selective for hatchery coho, total harvest impacts in 1999 and in 2000 were probably less than 10%.



**Figure 11. Total fishery exploitation rate. Exploitation rate calculated as (ocean + freshwater catch) divided by ocean recruits.**

## Discussion

With the information presented, it is possible to examine the relative contribution of different factors to the low escapements of Queets coho in 1997, 1998, and 1999. The STT analyzed the effects of each factor (freshwater survival, marine survival, and harvest) by assuming each factor remained constant over a number of years and examining what the resulting 1997 – 1999 escapements would have been.

If there had been average smolt production from the freshwater environment with no variability, and the broods had experienced the observed marine survival and fishing regimes since 1982, the MSY escapement goal would have been met in 1999 (Figure 12), but not in 1997 or 1998. Similarly, if there had been no fishing at all on Queets coho from 1997 – 1999, escapements would still have failed to achieve the goal range in 1997 and 1999 (Figure 14). On the other hand, if all broods had experienced marine survival equal to the average marine survival of the 1982 through 1988 return years (7.02%), the observed smolt production and fishing regimes would have produced spawning escapements within the MSY goal range in all three years even without any supplementation (assuming 10% total exploitation rates in 1999 and 2000). The period from 1982 through 1988 was selected arbitrarily, simply because it was a period of relatively high survival within the data set, all of which was collected since the marine regime shift that occurred in the late 1970s. In fact actual natural smolt production and fishing regimes would have produced escapements within the goal range in every year since 1988, except for 2000, if the smolts had experienced marine survival similar to that of the 1982 through 1988 returns (Figure 13).

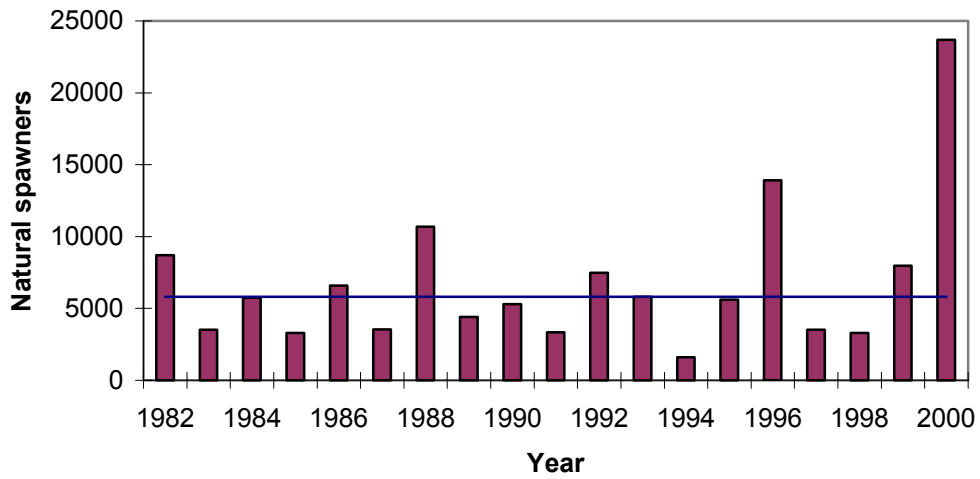


Figure 12. Effect of variability in freshwater production. Scenario generated by applying observed marine survival rates and fishing regimes to constant natural smolt production equal to the 1979 to 1997 average. A total exploitation rate of 10% was assumed for 1999 and 2000.

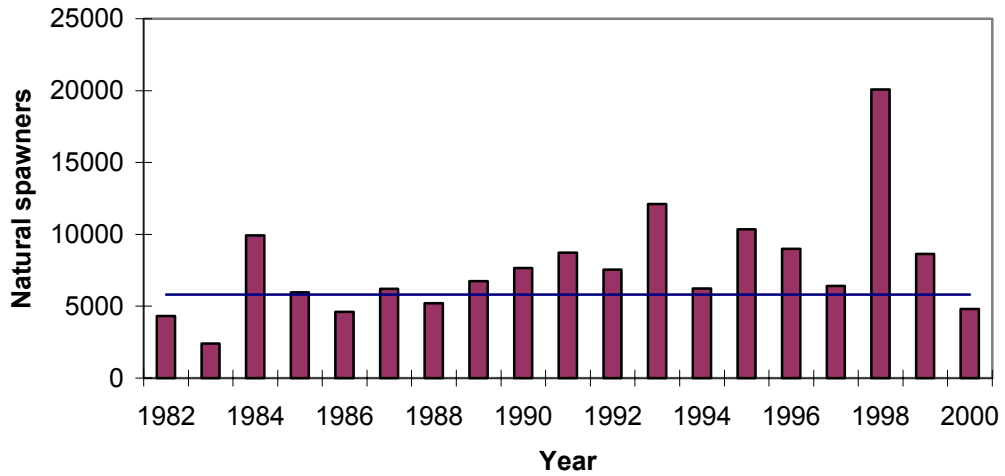
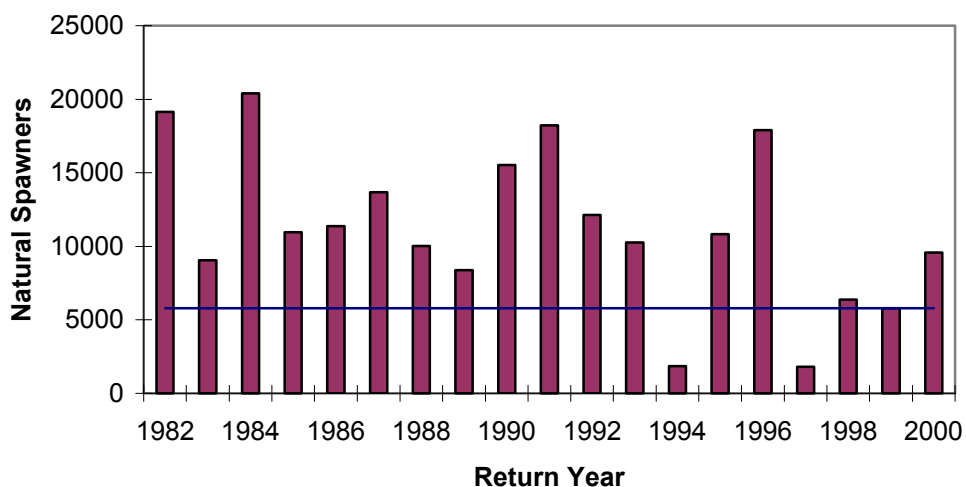


Figure 13. Effect of marine survival. Scenario generated by applying 1982-1988 average marine survival to observed natural smolt production and fishing regimes (10% total exploitation rate assumed in 1999 and 2000).



**Figure 14. Effect of harvest. Scenario generated by eliminating all harvest on observed ocean run sizes.**

Therefore, we believe that a protracted period of very poor marine survival in the 1990s was the primary cause of the Queets coho spawning escapements falling short of the lower bound of the MSY goal range from 1997 through 1999. While further reductions in fishing impacts could have met this lower bound in 1998, fishing impacts were maintained at low levels in all 3 years. Natural spawning escapement in both 1998 and 1999, while below the MSY goal range, exceeded 5,000 natural spawners and was within the range where smolt production appears to be relatively independent of spawning escapement (Figure 6). Although the spawning escapement in 1997 was one of the lowest on record, the progeny of that spawning run met the escapement goal in 2000, and escapement is projected to be within the goal range again in 2001. In addition, all indications are that the forecast for 2001 is a conservative one.

Abundance of Queets River coho is forecast by applying an assumed marine survival rate to smolt emigration estimates for the returning brood. The marine survival rate used for the 2001 forecast was 3.82%. If the 1999 smolt emigration had experienced 1982-1988 average marine survival (7%), the escapement in 2000 would have been below the lower end of the MSY range (Figure 14). Marine survival on the order of 12% would have been necessary to produce the observed 2000 abundance from the 1999 smolt emigration, and marine conditions experienced by smolts in 2000 were similar to those experienced by smolts in 1999. The fact that coho mark rates coastwide in 2001 have been consistently lower than forecast also argues that the returns of natural coho populations should be larger than forecast this year.

## **CONCLUSION AND RECOMMENDATIONS**

The STT evaluated the degree to which various factors (e.g., freshwater production, marine survival and harvest) may have contributed to the low spawning escapements in 1997 through 1999. Available information indicates that Queets coho, like many other stocks, suffered from recent production problems when survival of progeny was very low. The 1997 poor escapement resulted from low parent escapement and experienced high peak winter flows and had low smolt production, which was then subjected to poor marine survival. The 1998 escapement was the outcome of good smolt production that experienced very low marine survival. The 1999 escapement had good parent escapement, but experienced high winter flows and had relatively low smolt production. This brood was also impacted by

relatively low marine survival. The STT concludes that Queets coho are not overfished. Consequently, development of a rebuilding plan and criteria<sup>3</sup> for determining an end of overfishing are not warranted at this time.

In 2000, the observed spawning escapement of 8,621 (7,939 wild, 682 supplemental) was within the spawning escapement range of 5,800-14,500 established for Queets coho. Spawning escapements in 2001 are also anticipated to exceed the lower end of the escapement range. Marine survival appears to have improved from the low levels observed during the mid-late 1990s. The STT believes that it is unlikely that Queets coho will trigger a conservation alert or overfishing concern in the near future.

However, if escapement in 2001 is below the lower end of the established escapement range, the STT recommends that the Council initiate a full status review for this stock.

Fishing plans are developed annually by the Council and state and tribal managers to address concerns for individual stocks. Procedures to bring stocks in danger of overfishing to the attention of the Council through issuance of alerts, coupled with annual abundance forecasts and stock-specific planning provide adequate protection against overfishing.

The STT's preliminary examination of the historic relationship between spawners and subsequent production suggests that the current escapement range for this stock should be reexamined (Appendix A). The STT recommends that the Council and co-managers undertake a comprehensive review of available information to determine if the lower end of the current MSY escapement range is still appropriate.

The FMP under amendment 14 requires the STT to 'consider if excessive fishing has been inadvertently allowed by estimation errors...'. The preseason forecasts of the ocean abundance of Queets Natural coho for the years 1997-1999 were all below the lower bound of the escapement goal range (Appendix B). The STT therefore concludes that abundance forecast estimation error did not contribute to the low spawning escapements of Queets coho from 1997 – 1999.

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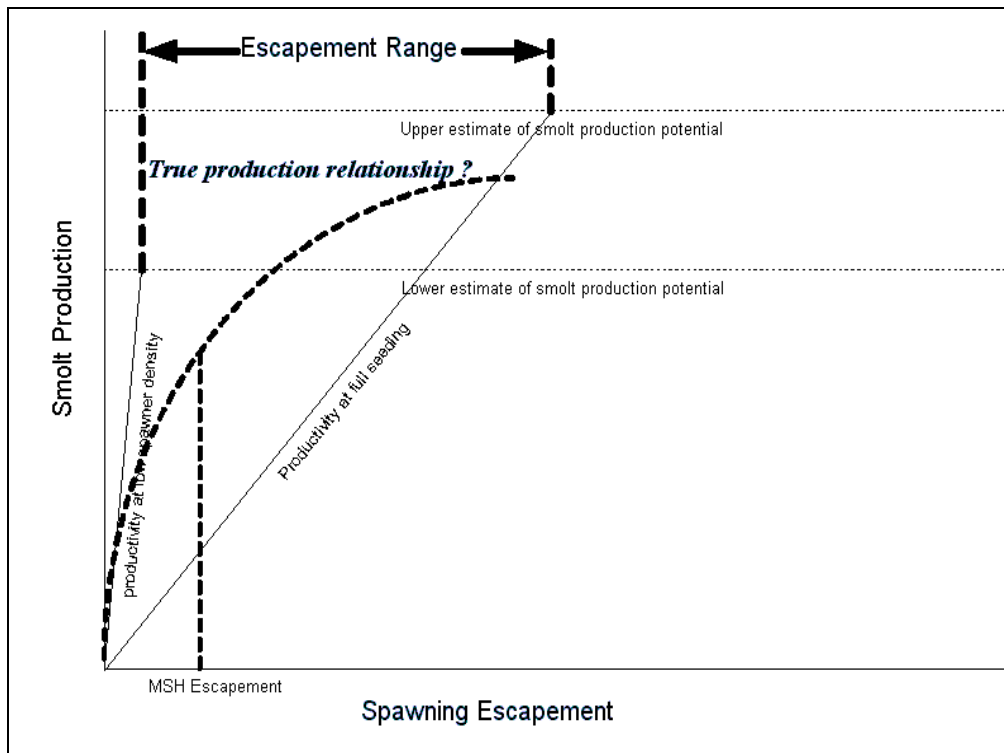
<sup>3</sup> The FMP specifies that criteria defining an end to overfishing are to be developed as part of a rebuilding plan.

## Appendix A – Preliminary Examination of Queets Coho Stock- Production Relations

### Derivation of Current Spawning Escapement Range

The current spawning escapement range for Queets coho was established in the early 1980s as a result of two workshops that were sponsored by the Quinault Treaty Area tribes (Quinault, Quileute, and Hoh), the Washington Department of Fisheries, the National Marine Fisheries Service, and the U.S. Fish & Wildlife Service to evaluate the technical basis for establishing escapement goals on Washington north coastal rivers. The spawning escapement range was derived from two estimates of smolt production capacity and two estimates of productivity. Estimates of habitat carrying capacity were derived from measurements of three habitat types: tributary, mainstem, and lakes/ponds multiplied by a range of utilization values drawn from the literature. Estimates of productivity (summer low flow) at low spawner density and at full seeding were also drawn from the literature. At that time, there was insufficient data to estimate these values for north coastal river systems.

The true form of the stock-production relationship was unknown; three types of models were considered: Ricker, Beverton-Holt, and rectilinear. The low end of the range was the number of spawners needed to produce the lower estimate of smolt capacity at low spawner density (highest efficiency); the upper end of the range was the number of spawners required to produce the higher estimate at the productivity estimated to fully seed available habitat. The Western District Court of Washington (*U.S. v. Washington*) determined that the true MSH escapement was likely to lie within this range in 1982.



Derivation of Spawning Escapement Range for Washington Coastal Coho

**Preliminary Stock-Recruit Analysis Based on Adult Production and Natural Spawning Escapement**

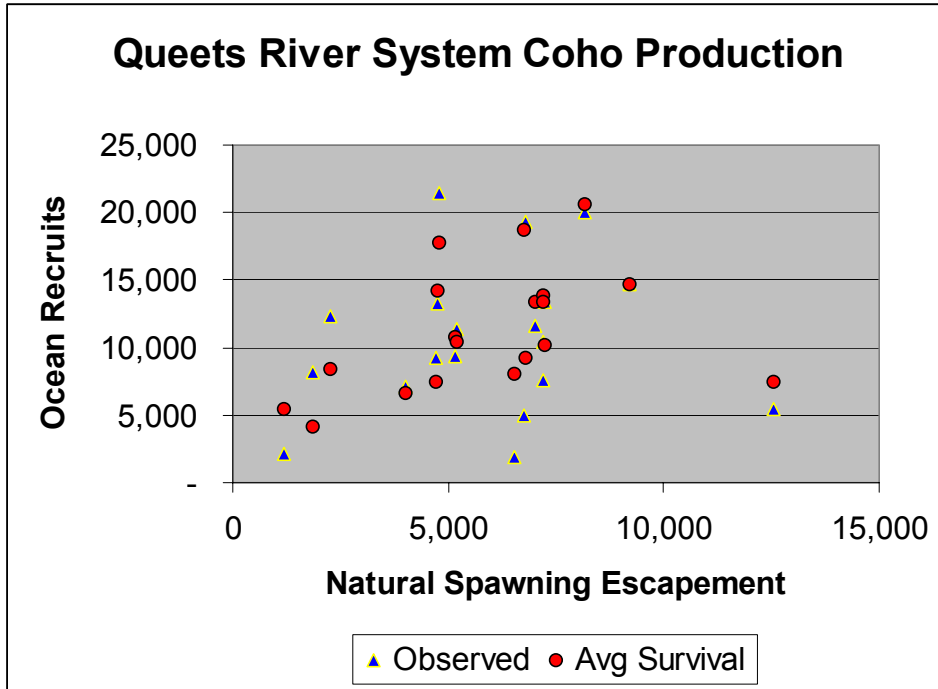
Since the time the escapement goal was established, additional information has become available to evaluate the relationship between production and parent spawning escapement for Queets coho. Smolt production is now believed to depend critically upon over-winter survival rather than summer flow conditions. The STT performed a preliminary analysis of available data relating production of Queets coho to natural spawning escapements. The data employed are presented in the table below. The column titled "Observed recruits" represents smolt production multiplied by the estimated marine survival rates for untagged smolts. The column titled "Average Recruits" represents smolt production multiplied by the 1979-1997 brood year average marine survival rate. This filters out the effect of variability in marine survival conditions, leaving the remaining "noise" in the data to any density dependent effects and variability in freshwater habitat conditions affecting juvenile survival.

**Queets Coho Production Data (BY 1997 preliminary; BY 1998 projected)**

Brood Year	Estimated Marine			Observed Recruits	Average Recruits
	Natural Escmt	Smolt Prod	Survival Rate		
1979	6,800	168,300	0.1150	19,355	9,252
1980	4,700	135,500	0.0679	9,200	7,449
1981	4,800	324,272	0.0661	21,434	17,826
1982	7,000	243,031	0.0479	11,641	13,360
1983	2,282	153,741	0.0800	12,299	8,452
1984	9,200	266,935	0.0550	14,681	14,674
1985	4,001	120,650	0.0593	7,155	6,633
1986	5,160	195,795	0.0479	9,379	10,764
1987	4,747	258,711	0.0511	13,220	14,222
1988	8,185	375,977	0.0534	20,077	20,669
1989	5,194	190,703	0.0599	11,423	10,484
1990	7,215	252,158	0.0299	7,540	13,862
1991	6,525	146,315	0.0127	1,858	8,043
1992	7,188	243,826	0.0428	10,436	13,404
1993	7,228	185,600	0.0722	13,400	10,203
1994	1,200	98,742	0.0216	2,133	5,428
1995	6,773	339,787	0.0146	4,961	18,679
1996	12,567	136,754	0.0396	5,415	7,518
1997*	1,851	76,077	0.1076	8,186	4,182
1998*	5,515	322,395	NA	NA	17,723

\* Preliminary

Observed and Average recruitment estimates produced by natural spawning escapements are depicted in the figure below.

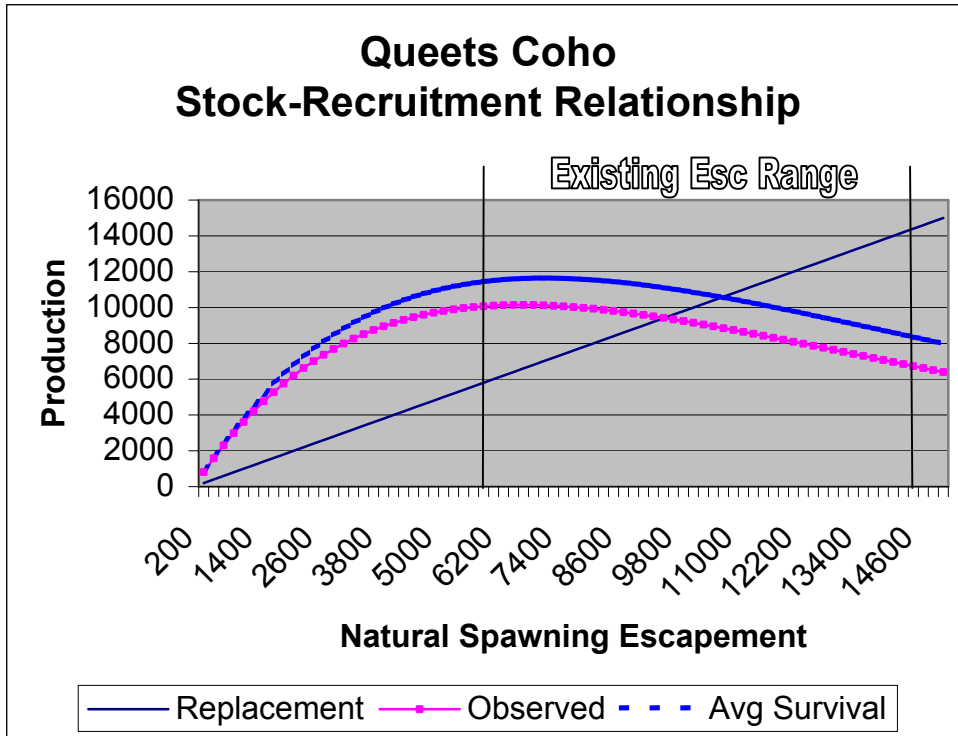


These data suggest that production of Queets coho peaks when natural spawning escapements approach 5,000 to 8,000 and that production may decrease at higher escapement levels. Data for the 1979-1997 brood years were fit to a standard Ricker Stock-Recruit model. Estimates of key statistics are summarized below. As is typical with stock-recruitment analysis, the data are “noisy.” A graph depicting the general form of the stock-recruitment relationship under observed and average survival assumptions is also presented.

<b>Queets Stock-Recruit Analysis (Ricker Model)</b>		
	<b>Observed</b>	<b>Average Survival</b>
R-squared	0.34451	0.5371
Alpha	4.557515	4.235651
Beta	0.00016	0.00013
MaxProd	10,279	12,269
Esc @ MaxProd	6,131	7,874
MSY	5,522	6,264
Esc @MSY	3,679	4,558
Exp Rate @ MSY	60%	58%

This simple analysis suggests that the MSY escapement level for Queets coho may lie below the lower end of the current spawning escapement range (5,800).





Estimates of escapement at maximum production were compared against those resulting from methods used to determine “full seeding” escapements for Oregon Coastal Natural Coho under Amendment 14. The spawning escapement associated with maximum production for Queets coho would be 6,900, using the average spawners/mile for the OCN stock. This value is comparable to the escapement at maximum production for Queets coho (6,100 to 7,900) estimated through stock-recruitment analysis.

Available data for Queets coho indicate that the stock is not in danger of extinction at escapement values much lower than the existing escapement range 5,800 spawners. Spawning escapements for this stock have been as low as 1,200 (in 1994). Using the 4 fish/mile value employed for the OCN stock, the “critical” spawning escapement level would approach 900.

**Relationships Between Smolt Production and Natural Spawning Escapements**

Figure 6 in the body of the report depicts data on smolts produced by natural spawning escapements in the Queets system. State and tribal co-managers may find it helpful to analyze these data to try to separate the effects of freshwater production from impacts of marine survival on adult recruitment when evaluating the current spawning escapement goal range.

Tributary Spawning Habitat for Coho Salmon in the Queets River System

Clearwater Tributary			Queets River (excluding Clearwater)		
Stream Name	WRIA	Miles	Stream Name	WRIA	Miles
lower tribs		1.0	Fisher	.0018	1.5
Hurst and tribs	.0025	7.4	Elk	.0019	5.4
Hunt	.0032	0.9	Harlow	.0134	1.5
Warring	.0033	0.2	McKinnon	.0138	2.4
Elkhorn	.0036	0.7	Salmon and tribs	.0139	18.9
Mink	.0037	1.2	Hibbard	.0156	0.5
Shale and tribs	.0041	6.3	Hartzell	.0156 A	0.3
WFK Miller and tribs	.0048	7.5	Tacoma	.0157	8.0
EFK Miller and tribs	.0049	5.5	Mud	.0163	3.1
Christmas	.0065	7.5	Matheny	.0165	11.8
Peterson	.0068	0.5	Ticket	.0198	3.7
Deception	.0070	1.5	Phelan	.0199	1.3
Prairie	.0071	0.5	North	.0202	2.1
Snahapish and tribs	.0077	10.8	Sams	.0205	7.0
Bull	.0085	1.0	unnamed	.0234	1.0
Stequaleho	.0094	1.8	unnamed	.0234A	0.8
Solleks	.0103	7.1	Coal	.0235	1.0
Kunamakst	.0117	0.2	Vein	.0237	2.2
misc. tribs		15.8	Tshletshy	.0240	2.5
			unnamed	.0265	0.6
			unnamed	.0266	0.8
			Harlow and trib	.0267	2.0
			Bob	.0269	0.5
			Paradise	.0274	2.0
			misc. tribs		6.9
SubTotal Tribs		77.4	SubTotal Tribs		87.8
Mainstem	.0024	34.5	Mainstem	.0016	22.2

Miles of Coho Spawning Habitat Queets System		221.9
OCN Values	Fish/mile	Comparable Spawning Escapement Levels for Queets Coho
"Critical Escapement"	4	888
Full seeding North	24	5,326
Full seeding North-Central	47	10,429
Full seeding South	12	2,663
Total OCN	31	6,879

## Appendix B - Preseason Abundance Forecasts for Queets Coho

Each year, a preseason abundance forecast of December Age-2 ocean recruits for Queets coho is developed jointly by QIN and WDFW. The methodology used for estimating the preseason abundance forecast is documented each year. The preseason forecasts for natural production based on estimates of smolt production multiplied by recent year average marine survival rates (Note: mortalities associated with selective fisheries in recent years are not taken into consideration in estimates of marine survival).

The supplemental and hatchery forecasts are estimated by the product of brood year smolt releases and an historical average of estimated marine survival rates for each respective smolt release.

### 1979-2001 Queets Preseason Abundance Forecasts for Natural and Supplemental Production.

CY	Natural (1000's of Fish)	Basis	Supplemental (1000's of Fish)	Basis
1979				
1980				
1981				
1982				
1983				
1984	4.1			
1985	6.6			
1986	3.9	75-82 BY Avg		
1987	8.3			
1988	10.3			
1989	13.6			
1990	13.6	Avg smolt-adult survival rate		
1991	16.1	Avg smolt-adult survival rate		
1992	11.7	79-87 BY Avg		
1993	12.9	84-88 BY Avg	NA	Incl in Natural
1994	6.9	82 BY	NA	Incl in Natural
1995	12.1	84-90 BY Avg	3.8	85-90 BY Avg
1996	8.3	84-91 BY Avg	4.8	85-91 BY Avg
1997	4.3	84-92 BY Avg	1.0	85-92 BY Avg
1998	4.2	lowest obs surv rate 84-93 BY	0.7	lowest obs surv rate since 85
1999	4.3	90-94 BY Avg	3.0	90-94 BY Avg
2000	2.7	92-95 BY Avg	0.8	92-95 BY Avg
2001	12.0	92-94 BY Avg	0.0	Flooding at production facility

Adult ocean recruits for natural and supplemental coho were relatively depressed in the mid-late 1990s. The steepness of the declining slope can be directly attributed to the reduced marine survival during the last five (5) years. The El Nino effects on the 1994 brood and resulting contributions need particular attention (Figure 1).

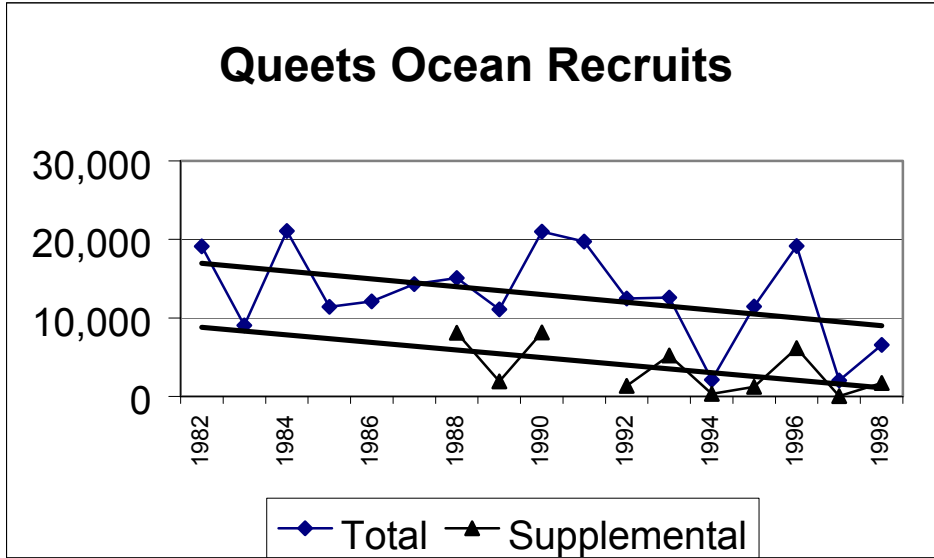


Figure 1. Estimated ocean recruitment of Queets natural and supplemental coho.

The forecast error based on preseason and postseason estimates of natural and supplemental recruits is depicted in Figure 2. The method for estimating the forecast may change from year to year based on anticipated ocean survival conditions. Negative values indicate that the preseason forecast was underestimated. Preseason forecasts and observed values of ocean escapement of natural production are reported in pre-season I, table III-3.

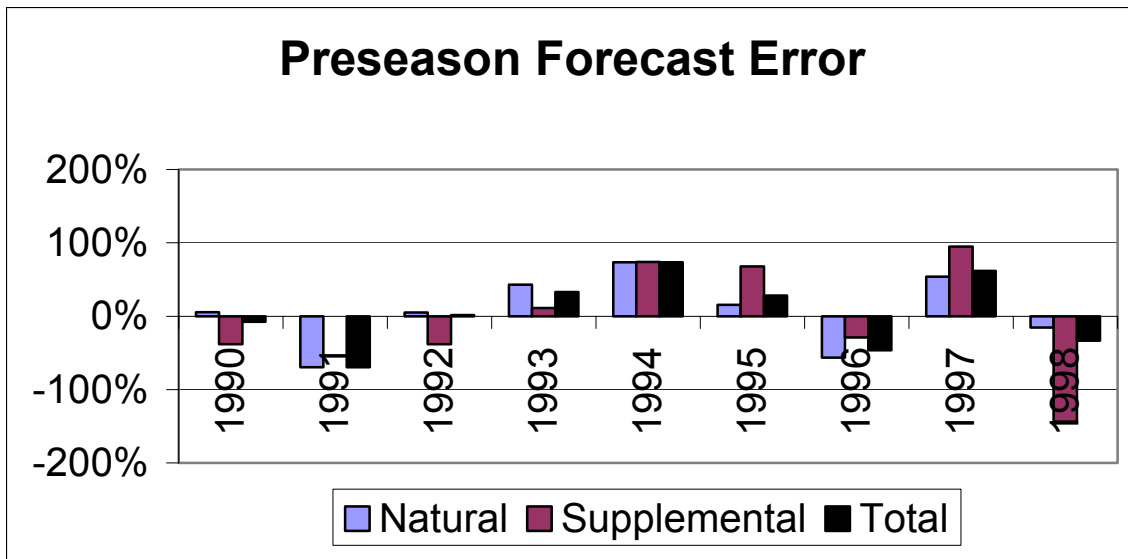


Figure 2. Preseason forecast error for Queets natural and supplemental production.

Preseason abundance forecasts for the hatchery component of the Queets coho run are summarized below.

Calendar Year	Hatchery (Thousands)	Basis
1979		
1980		
1981		
1982		
1983		
1984	1.9	
1985	4.9	
1986	4.2	75-82 BY Avg
1987	3.7	
1988	19.45	
1989	32.3	
1990	28.5	Avg smolt-adult survival rate
1991	21.9	Avg smolt-adult survival rate
1992	18.2	86-90 BY Avg
1993	29.8	83-88 BY Avg
1994	8.1	89 BY
1995	18.1	83-90 BY Avg
1996	23.3	83-91 BY Avg
1997	15.8	83-92 BY Avg
1998	4.6	lowest obs surv rate since 83
1999	10.8	90-94 BY Avg
2000	11.0	92-95 BY Avg
2001	10.0	92-95 BY Avg

Forecasts for Queets coho are driven by marine survival predictions. Survivals of Queets natural and supplemental coho are estimated through CWT data. Over the period of available data, the marine survival of natural and supplemental smolts has ranged from 1.3 to 11.5% and from slightly less than 1.0 to 5.9%, respectively (Figure 3 - Hooking mortalities associated with selective fisheries in recent years are not taken into account).

Marine survival has declined over time, primarily due to the highest observed marine survival rate for the 1982 return year and the poor marine survivals during the last 5 years. The preliminary estimate for survival of natural coho for the 1997 brood was the second highest on record.

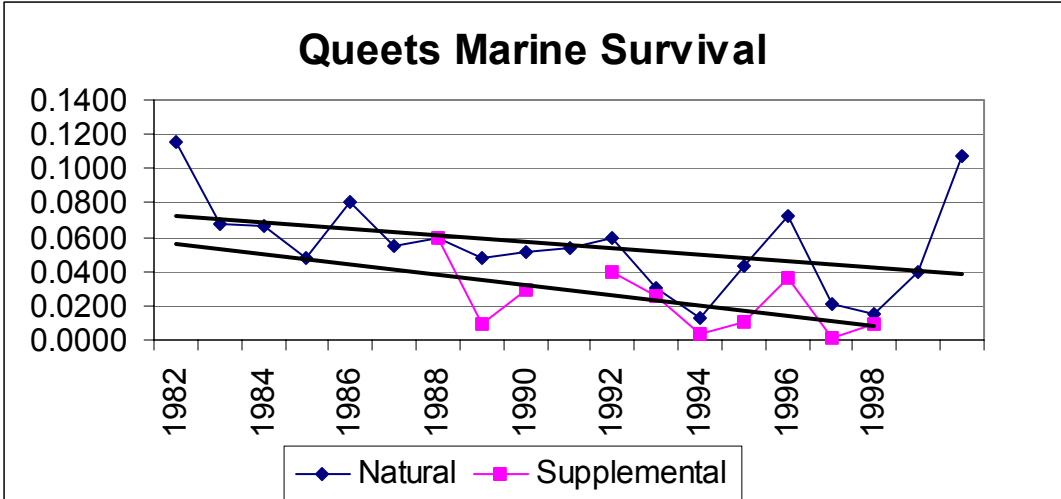


Figure 3. Estimated marine survival rate for Queets natural and supplemental coho smolts.

**Queets Coho Marine Survival Rate Estimates Based on CWTs**

<b>Bd Year</b>	<b>Queets Wild</b>		<b>Queets Supplemental</b>	<b>Salmon River</b>
	<b>Tagged</b>	<b>Untagged</b>		
1979	0.0966	0.1150		
1980	0.0570	0.0679		
1981	0.0555	0.0661		
1982	0.0402	0.0479		
1983	0.0672	0.0800		0.0262
1984	0.0462	0.0550		0.0338
1985	0.0498	0.0593	0.0594	0.0348
1986	0.0402	0.0479	0.0092	0.0234
1987	0.0429	0.0511	0.0292	0.0325
1988	0.0449	0.0534		0.0354
1989	0.0503	0.0599	0.0399	0.0126
1990	0.0251	0.0299	0.0258	0.0282
1991	0.0107	0.0127	0.0039	0.0081
1992	0.0360	0.0428	0.0105	0.0120
1993	0.0606	0.0722	0.0358	0.0251
1994	0.0182	0.0216	0.0013	0.0085
1995	0.0123	0.0146	0.0092	0.0193
1996	0.0333	0.0396	0.0027	0.0135
1997*	0.1076			

\* Preliminary