

Ongoing Supplementation Programs for Summer Chum Salmon in the Hood Canal and Strait of Juan de Fuca Regions of Washington State

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Abstract

Supplementation is being applied as a strategy to reduce the short-term extinction risk of summer chum salmon populations in the Hood Canal and eastern Strait of Juan de Fuca regions and to aid in their recovery. Appropriate indigenous broodstocks are also being used to reintroduce summer chum to watersheds where they have recently been extirpated. These programs are being operated consistent with rigorous standards presented in the Summer Chum Salmon Conservation Initiative, a joint state-tribal plan to recover healthy, self-sustaining populations. We provide here descriptions and results of monitoring and evaluation activities, and general program assessments for individual supplementation and reintroduction programs. Overall, broodstocks have been collected each year that represent the donor populations, genetic sampling has been conducted, the hatchery programs have met established survival rate objectives and production goals, and fish reared and released have been marked to assist in determining the contribution of the programs to the summer chum populations. Each of the programs is ongoing and some have just recently begun. Several of the programs were initiated in 1992 and have been very successful in contributing to the return of adult summer chum. Monitoring and evaluation is ongoing.

Introduction

The Hood Canal and Strait of Juan de Fuca summer chum stocks were identified by NOAA Fisheries (previously National Marine Fisheries Service) as an Evolutionarily Significant Unit (ESU) and were listed in 1999 as a “threatened” population under the Endangered Species Act. Prior to the listing, the co-managers, Washington Department of Fish and Wildlife (WDFW) and the Point No Point Treaty Tribes (PNPTT) had begun the development of a summer chum salmon recovery plan. The Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000) was completed in the spring of 2000, and the artificial propagation components were subsequently authorized under a NOAA Fisheries Endangered Species Act 4(d) rule as adequately conservative for protection of summer chum; additionally, NOAA Fisheries determined these actions were likely to be beneficial to summer chum (Federal Register 2000).

In Washington State, the term “supplementation” is generally defined as the use of various artificial culture techniques to facilitate the recovery of wild salmon populations at risk of extinction, while minimizing deleterious effects on the wild population (see Tynan et al., this volume). The decision to use supplementation as a tool to assist the recovery of Hood Canal and

Strait of Juan de Fuca summer chum stocks at high risk of extinction built upon the successes of an earlier South Puget Sound summer chum supplementation program (see Ames and Adicks 2003, this volume), coupled with the strong performance of hatchery fall chum programs at a number of Hood Canal hatcheries.

Criteria for Summer Chum Supplementation

With the listing of multiple Washington State salmon populations as “threatened” or “endangered” under the Endangered Species Act, the standards for conducting supplementation projects have become increasingly rigorous. Since most of the supplemented populations are at risk of extinction, it is appropriate for recovery efforts to meet high operational standards to minimize possible deleterious effects of hatchery practices.

The Summer Chum Salmon Conservation Initiative (SCSCI, WDFW and PNPTT 2000) is a recovery plan that requires all hatchery supplementation efforts meet a strict set of criteria (see Tynan et al. 2003, this volume). First, supplementation is to be used *only* when a summer chum stock is at risk of extinction, or to develop a broodstock in support of summer chum reintroduction to previously occupied habitats. Second, only the local, native fish will be used as a broodstock source (except for reintroduction projects). Third, the plan requires operational standards to minimize impacts to natural populations from potential hazards including: 1) partial or total hatchery failure resulting in a loss of summer chum that had been placed in the hatchery, 2) ecological effects from predation, competition or disease transfer, 3) genetic effects from loss of genetic variability between or within populations, 4) effects from selection or reducing the population size of donor stocks, and 5) effects on other salmonid populations and species. And finally, the plan includes monitoring and evaluation requirements to measure the effects of supplementation on the target stock and other summer chum populations.

Ongoing Supplementation and Reintroduction Programs

Supplementation has been applied as a strategy to help recover summer chum populations in Hood Canal and the eastern Strait of Juan de Fuca since 1992. Several programs were initiated before the SCSCI was completed, but all programs were subsequently evaluated and brought into compliance with the SCSCI. There are currently six supplementation and two reintroduction projects distributed throughout the Hood Canal and Strait of Juan de Fuca summer chum ESU (Figure 1). Programs initiated in 1992 include Big Quilcene River, Lilliwaup Creek, and Salmon Creek supplementation projects. Re-introduction of summer chum into Chimacum and Big Beef creeks began in 1996 and additional supplementation programs were initiated on Hamma Hamma River in 1997, on Jimmycomelately Creek in 1999, and on Union River in 2000. Cooperators participating in the projects with the co-managers include Hood Canal Salmon Enhancement Group (HCSEG), North Olympic Salmon Coalition, Wild Olympic Salmon (WOS), Long Live the Kings (LLTK), and U.S. Fish and Wildlife Service (USFWS). Programs are operated using WDFW and USFWS hatcheries, a private hatchery operated by LLTK, and remote site facilities operated by the cooperators with oversight provided by WDFW.

Monitoring and Evaluation

Critical objectives of the SCSCI include the monitoring and evaluation of the effects of supplementation on the natural summer chum populations and of the effectiveness of the programs in recovering summer chum. The basic approach is to collect information that will help determine: 1) the degree of success of each project; 2) if a project is unsuccessful, why it failed; 3) what measures can be implemented to adjust a program that is not meeting objectives for the project; and 4) when to stop a supplementation project.

Each project is to be fully consistent with the intent and implementation of the monitoring and evaluation component for supplementation programs identified in the SCSCI and described in Tynan et al. (2003, this volume). The recommendations for monitoring and evaluation in the SCSCI respond to concerns regarding the uncertainty of summer chum supplementation and reintroduction effects by addressing the following four elements:

Element 1 - The estimated contribution of supplementation/reintroduction program-origin chum to the natural population during the recovery process;

Element 2 - Changes in the genetic, phenotypic, or ecological characteristics of populations (target and non-target) affected by the supplementation/reintroduction program;

Element 3 - The need and methods for improvement of supplementation/reintroduction activities in order to meet program objectives, or the need to discontinue a program because of failure to meet objectives; and

Element 4 - Determination of when supplementation has succeeded and is no longer necessary for recovery by collection and evaluation of information on adult returns.

Monitoring and evaluation were managed for individual projects, consistent with the above four elements as follows:

Fish marking, mark recovery, and adult returns - The summer chum salmon juveniles (either embryos or fry) produced by each supplementation program are mass-marked (otolith-marked or fin-clipped) prior to release. Spawning ground surveys are conducted throughout the summer chum escapement period to enumerate spawners and to collect information on fish origin and age composition. Examination of otoliths or fin clip ratios from spawned adults provides a method to estimate the number of supplementation (hatchery) fish versus the number of naturally spawning (wild) fish and assists in determining the contribution of the supplementation program to the target population.

Genetic and age sampling - In order to detect any changes in genetic characteristics of populations, periodic allozyme and/or DNA samples have been collected from summer chum since most supplementation programs were started, for comparison to earlier collections. DNA samples are being analyzed to develop a baseline for summer chum (e.g., see Small and Young 2003, this volume); and analysis of allozyme samples is in progress. Scales are also collected to age the adult fish (WDFW and PNPTT 2001).

Broodstocking and egg sources - To fully represent the demographics of donor populations, summer chum broodstock are collected randomly as the fish arrive at temporary fish traps (operated by WDFW or project sponsors) in proportion to the timing, weekly abundance, and duration of the total return. Fish not retained as broodstock are released upstream of trap sites to spawn naturally.

Hatchery operations - Records of fish cultural operations are regularly maintained and compiled. Project sponsors in collaboration with WDFW, prepare annual reports which summarize protocols and procedures, temperature unit records by developmental stage, ponding dates, feeding, rearing and release methods, production and survival data, and recommendations for facility or protocol improvements (e.g., see WOS 2000).

Fish health - Fish health is monitored by a WDFW or USFWS fish health specialist in accordance with procedures in the co-managers disease control policy. Summer chum broodstock are sampled for the incidence of viral pathogens, there has been no significant mortality of broodstock or juveniles from unknown causes, and fish health condition of fry from all projects prior to release has been good.

Hatchery survival rates - The SCSCI establishes survival rate objectives during incubation and rearing of 90% from green egg to eye-up, 99.5% from eye-up to swim-up, and 95% from swim-up to release. Survival rates are monitored and the summer chum supplementation programs have generally been successful in meeting the objectives.

Individual Project Reports

The description of monitoring and evaluation activities for one supplementation project and one reintroduction project in the Strait of Juan de Fuca are provided below in individual project reports. The SCSCI (WDFW and PNPTT 2000: Appendix Report 3.2) provides more complete descriptions of the programs, including program objectives, operating procedures and objectives, and broodstock and production data through brood year 1998. A supplemental report to the SCSCI (WDFW and PNPTT 2001) updates the information through brood year 2000, and an additional supplemental report is in preparation with information through brood year 2002.

Salmon Creek - Strait of Juan de Fuca Region

The supplementation program begun on Salmon Creek in 1992 was originally conceived by a local citizen's group, Wild Olympic Salmon, with two basic objectives: 1) to contribute to the restoration of a healthy, natural, self-sustaining Salmon Creek population while maintaining the genetic characteristics of the native stock, and 2) to create surplus adult returns for use as a donor stock for the reintroduction of summer chum into Chimacum Creek. The Salmon/Snow summer chum stock was rated as high risk of extinction based on a precipitous decline in abundance during the 1989-1991 return years, just prior to initiation of supplementation (WDFW and PNPTT 2001).

The Salmon Creek program is comprised of the following: 1) collection of indigenous summer chum broodstock at a temporary WDFW trap at river mile 0.2 on Salmon Creek; 2) holding and spawning of broodstock at the trap site; 3) transfer of eggs and milt to WDFW Dungeness Hatchery for fertilization and initial incubation; 4) otolith marking of eyed eggs (at either WDFW Dungeness Hatchery or Hurd Creek Hatchery, both located on the nearby Dungeness River) and transfer of eyed eggs to vertical stack incubators at a remote site hatchery on Houck Creek, a Salmon Creek tributary; 5) hatching, ponding and initial feeding of fry for two weeks at the Houck Creek site; 6) transfer of fry to saltwater net pens in Discovery Bay within the freshwater plume of Salmon Creek; and 7) rearing of fry to ~1 gram in net pens and release into Discovery Bay. Beginning with brood year 2001, the use of the saltwater net pens was discontinued and fry were either reared in freshwater to approximately 1 gram or volitionally released as unfed fry from remote site incubators.

A summary of the production for each brood year of the project is provided in Table 1. From 1992 through 2002, about 2% to 16% of the total return was used as broodstock. The program has generally met the production targets for number, size, and date of fry released. During 2000, there was a bloom of *Chaetoceros* (a spiny diatom which entangles in gills) in the saltwater net pens in Discovery Bay during April and, as a precautionary measure per a fish health specialist recommendation, the fish were released early at an average size of ~0.6 gram.

Numbers produced and survival rates by life stage for summer chum from the supplementation program at Salmon Creek Hatchery from 1992 through 2000 are presented in Table 2. Survival rates from fry release to adult return for summer chum reared in the supplementation program at Salmon Creek are estimated at 4.80%, 1.62%, 0.62%, 1.48% and >1% for the 1994, 1995, 1996, 1997, and 1998 brood years, respectively (Table 3).

The Salmon Creek supplementation program has been very successful in contributing to the return of adult summer chum. The program contributed an estimated 66, 529, 367, 407, and 1464 adults during the 1997, 1998, 1999, 2000 and 2001 return years, respectively. The number of supplementation-origin adults in the 1997 return is, however, an underestimate since otolith marks were difficult to identify on brood year 1994 adults. Supplementation-origin adults generally comprised from 46.6% to 73.4% of the total return to Salmon Creek from 1998 through 2001 (Table 4). The abundance of natural-origin spawners has increased from a mean of 194 adults during 1989-1991 (just prior to initiation of supplementation) to a mean of 587 adults during 1998-2001 (Figure 2). The total return to Salmon Creek during 2002 was 5517 adults, but otolith analysis is not yet available to distinguish natural-origin and supplementation-origin adults.

The Salmon/Snow summer chum stock is now rated as low risk of extinction based on the abundance of adults during the 1997-2000 return years (WDFW and PNPTT 2001). Beginning in 1996, eyed eggs collected from Salmon Creek adults were transferred to Chimacum Creek to reintroduce summer chum to that stream. This program is considered a range extension of the Salmon Creek summer chum and further reduces the stock's risk of extinction.

Chimacum Creek - Strait of Juan de Fuca Region

Chimacum Creek supported an indigenous summer chum population until the mid-1980s, when a combination of habitat degradation and poaching evidently led to their demise (WDFW and PNPTT 2000). Beginning with brood year 1996, eyed eggs from the Salmon Creek broodstock were transferred to, and released from, Chimacum Creek hatchery facilities to reintroduce summer chum to formerly occupied habitat.

The Chimacum Creek program is comprised of the following: 1) collection of indigenous summer chum broodstock at a temporary WDFW trap at river mile 0.2 on Salmon Creek; 2) holding and spawning of broodstock at the trap site; 3) transfer of eggs and milt to WDFW Dungeness Hatchery for fertilization and initial incubation; 4) otolith marking of eyed eggs (at either WDFW Dungeness or Hurd Creek Hatchery) prior to transfer of eyed eggs to vertical stack incubators at a remote site hatchery on Naylor's Creek, a Chimacum Creek tributary; 5) hatching, ponding, and rearing of fry at Naylor's Creek site; 6) transfer of one-half of fry to saltwater net pens in Port Townsend Bay near the mouth of Chimacum Creek; and 7) rearing of

fry to ~1 gram in net pens and release into Port Townsend Bay. A summary of the production for each brood year of the project is provided in Table 5.

During brood year 1999, fry reared at the Chimacum Creek Hatchery were released early (i.e., at 0.4 to 0.8 gram vs. goal of 1 gram) due to water quantity, water quality, and rearing vessel limitations. Several improvements were recommended (see WOS 2000) and were made at the hatchery (a freshwater facility) prior to brood year 2000. In addition, two saltwater net pens were installed near the mouth of Chimacum Creek to rear about one-half of the fry prior to release. Brood year 2000 and 2001 fry were successfully reared to a size of 0.8 to 1.2 grams in the freshwater and saltwater facilities and released during April and May. Fry reared at the freshwater and saltwater sites received different otolith marks so the rearing strategies can be evaluated. Since 2000, the program generally met the production targets for number, size, and date of fry released and there has been no significant mortality to unknown causes and fish health condition of fry prior to release was good.

The Chimacum Creek reintroduction program has been successful in contributing to the return of adult summer chum to a previously occupied stream. An estimated 38, 52, 903, and 864 summer chum returned to spawn in Chimacum Creek during 1999, 2000, 2001, and 2002, respectively. This was the first natural spawning by summer chum in Chimacum Creek since the mid-1980's.

Jimmycomelately Creek - Strait of Juan de Fuca Region

In the SCSCI, the Jimmycomelately (JCL) Creek summer chum stock was determined to be at a high risk of extinction and a supplementation project was recommended. A supplementation project was initiated with the 1999 brood year as a cooperative effort between WDFW, North Olympic Salmon Coalition, and Wild Olympic Salmon. The goal is to contribute to the restoration of a healthy, natural, self-sustaining population of summer chum that will maintain the genetic characteristic of the native JCL stock (WDFW and PNPTT 2001).

The JCL Creek program is comprised of the following: 1) collection of indigenous summer chum broodstock at a temporary trap at river mile 0.1 on JCL Creek; 2) holding and spawning of broodstock at the trap site; 3) transfer of eggs and milt to WDFW Hurd Creek Hatchery (located on nearby Dungeness River) for fertilization, initial incubation and otolith marking; 4) transfer of eyed eggs to (a) remote site incubators (RSIs) at remote facility on a spring-fed tributary to JCL Creek with volitional release from RSIs into 4' and 6' diameter tanks and (b) vertical stack incubators at a hatchery site on upper JCL Creek with ponding into circular tanks; and 5); rearing of fry to ~1 gram for release into JCL Creek near the estuary.

A summary of the production for each brood year of the project is provided in Table 6. This program is only in its fourth year of operation. Beginning in 2002, examination of otoliths recovered from spawned adults will provide a method to determine the contribution of the supplementation program to the summer chum population.

The SCSCI also noted that habitat impacts are high and may be contributing to the risk to the population, and recommended that habitat protection and recovery measures should be addressed concurrent with supplementation project development. Habitat restoration projects have been prioritized, funded, and initiated in freshwater and estuarine areas of JCL Creek.

Big Quilcene River - Hood Canal Region

A supplementation program was started in the Big Quilcene River in 1992, in response to the critical condition of the stock, and to take advantage of a year expected to be relatively strong in the stock's return cycle. The program is operated by the USFWS at the Quilcene National Fish Hatchery (QNFH). Since 1996, the Quilcene program has also contributed eggs and fry to support the re-introduction program for summer chum at Big Beef Creek. The Big/Little Quilcene summer chum stock was rated in the SCSCI as high risk of extinction, based on a precipitous decline in abundance during the 1988-1991 return years, just prior to the initiation of supplementation (WDFW and PNPTT 2001).

The Big Quilcene supplementation program is comprised of the following: 1) collection of indigenous summer chum broodstock in Quilcene Bay or from returns to the USFWS Quilcene National Fish Hatchery; 2) spawning, fertilization, incubation and rearing at QNFH; 3) adipose-clipping of all fry (since 1997); and 4) release of fry at ~ 1 gram into Quilcene River. A summary of the production for each brood year of the project is presented in Table 7.

The QNFH also supported the reintroduction of summer chum into Big Beef Creek with transfers of eyed eggs and/or fry. Beginning in 2001, summer chum returning to Big Beef Creek were used as broodstock for that reintroduction program.

Beginning with brood year 1997, the summer chum fry released at QNFH were adipose-clipped to identify returning adults as either hatchery-origin or natural-origin fish. Hatchery-origin adults comprised 62% of age 3 spawners in 2000, 79% of age 3 and 45% of age 4 spawners in 2001, and 39% of age 3 and 68% of age 4 spawners in 2002 (pers. comm. T. Kane, USFWS). The supplementation program contributed 3318 adults and 1743 adults to the 2001 and 2002 returns, respectively; and supplementation-origin adults comprised 56% of the 2000 return and 43% of the 2001 return. The abundance of natural-origin spawners has increased from <120 adults during 1983-1991 (just prior to initiation of supplementation) to about 2300 to 2700 adults during 2001 and 2002.

High levels of adult returns appear to be associated with the supplementation program. In fact, escapement of the Big/Little Quilcene stock has exceeded the escapement criterion for program reduction. The criterion is that the annual total of hatchery-origin and natural-origin escapement exceed the mean 1974-1978 pre-decline escapement level (2,607 spawners) for four consecutive years. The program has been successful in building the returns to stable levels with escapements exceeding 2,700 fish every year since adult returns from supplementation began in 1995 (Table 8). Discussions are on-going to determine the appropriate scale of future releases from Quilcene NFH.

The Quilcene summer chum stock is now rated as low risk of extinction based on the abundance of adults during the 1997-2000 return years (WDFW and PNPTT 2001). The establishment of the Quilcene stock in Big Beef Creek is considered a range extension of the Quilcene summer chum, and further reduces the stock's risk of extinction.

Big Beef Creek - Hood Canal Region

Big Beef Creek supported an indigenous summer chum population until the mid-1980s. The reintroduction project began with brood year 1996, when eyed eggs from Quilcene stock summer chum were transferred from QNFH to Big Beef Creek to initiate the reintroduction of a summer chum population there. A summary of the production for each brood year of the project is provided in Table 9.

From 1996 through 1999, all summer chum eggs incubated and released at Big Beef Creek were transferred from QNFH. During 2000, a total of 26,890 green eggs were obtained from female summer chum returning to Big Beef Creek and 55,500 eyed eggs were transferred from QNFH. To foster local adaptation of the reintroduced population, adults returning to Big Beef Creek during 2001 and 2002 were used as broodstock, and no eggs were transferred from QNFH.

The Big Beef Creek reintroduction program has been successful in contributing to the return of adult summer chum to a previously occupied stream. An estimated 4, 20, 894, and 742 summer chum returned to spawn in Big Beef Creek during 1999, 2000, 2001, and 2002, respectively. The first natural spawning by summer chum in Big Beef Creek since the early-1980's occurred during 2001 and 2002.

Union River - Hood Canal Region

The Union River supplementation program is a cooperative effort between the Hood Canal Salmon Enhancement Group and WDFW and was initiated in brood year 2000. The strategy is to boost the abundance of the Union River population to allow for transfers of surplus fish for a reintroduction of summer chum to the Tahuya River using Union River stock. The goal is to reintroduce and restore a healthy, natural, self-sustaining population of summer chum in the Tahuya River. The supplementation program, its goal, objectives, and guidelines are consistent with the SCSCI (WDFW and PNPTT 2000).

The current program is comprised of the following: 1) collection of summer chum broodstock at a temporary trap at R.M. 0.3 on the Union River; 2) holding and spawning of broodstock at the trap site; 3) transfer of eggs and milt to WDFW George Adams Hatchery for fertilization and initial incubation; 4) transfer of eyed eggs from George Adams Hatchery to remote site incubators (RSIs) at Huson Springs facility on a tributary to Union River, with volitional release from RSIs into 16' x 3' x 3' fiberglass raceways; 5) transfer of swim-up fry from George Adams Hatchery to raceways at Huson Springs facility; 6) rearing of fed fry to ~1 gram for release into Huson Springs and/or for transport to a location near the Union River estuary for release.

This program is only in its third year. A summary of the production for each brood year of the project is provided in Table 10.

Discussion

The supplementation of Hood Canal and Strait of Juan de Fuca summer chum stocks at risk of extinction has been successful in substantially increasing the abundance of summer chum populations. The reintroduction of summer chum to habitats where the local fish have been extirpated has also demonstrated preliminary success. The most immediate benefit of the

increased run sizes and reintroductions has been a reduction in the extinction risk for the targeted stocks.

The ultimate goal of both supplementation and reintroduction projects is the establishment of abundant, self-sustaining populations composed of natural origin recruits. It can potentially take several decades to achieve this goal, and the correction of major factors for decline is necessary for recovery to be achieved. Thus, the results from project monitoring and evaluation activities presented here are considered to be preliminary, since the projects are too recent in origin to draw final conclusions. However, several insights are provided on the potential to recover summer chum stocks using supplementation, including:

- ! the risk of extinction was reduced from high to low for the Big Quilcene and Salmon Creek summer chum stocks following implementation of supplementation programs which contributed adult summer chum to the natural returns and spawning populations;
- ! summer chum were reintroduced into vacant habitat formerly occupied by summer chum on Big Beef and Chimacum creeks; this is initially considered to be a range extension of the donor stock and further reduces that stock's risk of extinction;
- ! indigenous summer chum broodstock can be collected in proportion to the timing, abundance, and duration of the total return to the stream and utilized in a supplementation program;
- ! indigenous-origin summer chum can be incubated, reared and released while following established protocols designed to address hazards with hatchery operations and associated risks to summer chum;
- ! supplementation programs can be incorporated into existing WDFW and USFWS hatcheries and utilize expertise and experience of current staff;
- ! new remote hatchery facilities can be developed and operated while minimizing the risk to summer chum;
- ! new partnerships in the recovery of summer chum can be developed and/or enhanced with community-based groups through supplementation programs; another significant benefit is the nurturing of a stewardship ethic towards wild fish and their recovery and the mutual exchange of ideas and information with dedicated constituents.

Although natural summer chum production is occurring in the region, it appears that impacts to natural processes in freshwater and/or estuarine ecosystems are limiting summer chum production in some years. This re-emphasizes the need for the summer chum recovery program to address all factors affecting summer chum production, including habitat, harvest, ecological interactions, and supplementation. Several habitat restoration and/or acquisition projects have recently been proposed, designed, and funded in the freshwater and estuarine areas of Salmon, Chimacum, and Jimmycomelately creeks along the Strait of Juan de Fuca and for several Hood Canal streams. Completion of these habitat projects, and others, will help restore habitat function and increase summer chum production and productivity. Harvest management

strategies and regimes implemented as part of the Summer Chum Salmon Conservation Initiative are expected to result in, on the average, total exploitation rates of 8.8% on Strait of Juan de Fuca stocks and 10.9% on Hood Canal stocks; these relatively low exploitation rates should also contribute to the recovery of summer chum. As discussed above, the supplementation programs have already contributed substantially to the summer chum adult returns to several streams.

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Table 1. Salmon Creek summer chum salmon supplementation program, brood years 1992-2002.

Brood year	Broodstock			Natural spawners	Percent removed	Fed fry ¹ released	Release size ¹ (gms)	Release date
	Males	Females	Total					
1992	35	27	62	371	14.3%	19,200	1.1	5/7/98
1993	29	23	52	400	11.5%	44,000	1.8	4/27/94
1994	12	12	24	137	14.9%	2,000	1.3	3/31/95
1995	35	18	53	538	9.0%	38,808	1.3	4/23/96
1996	59	50	109	785	12.2%	62,000 ²	1.3	4/8, 4/24/97
1997	60	50	110	724	13.2%	71,821 ²	1.0-1.3	3/31, 4/16/98
1998	65	56	121	1023	10.6%	67,832 ²	1.0-1.3	3/31, 4/21, 5/4/99
1999	34	31	65	434	13.0%	34,680 ²	1.3-2.6	4/23, 6/12/00
2000	71	65	136	710	16.1%	90,435 ²	0.6-1.1	4/14, 4/26/01
2001	77	77	154	2484	5.8%	18,110 ²	1.0-1.1	4/18, 4/27/02
2002	64	64	128	5389	2.3%	72,870 ³	0.35	3/1/02-4/18/02

¹ Release number and size data from Wild Olympic Salmon (1997; 1998) and WDFW files.

² Release numbers do not include 28,788; 36,840; 70,050; 39,170; 73,200; and 79,500 fry of Salmon Creek-origin, released into Chimacum Creek in 1997, 1998, 1999, 2000, 2001, and 2002, respectively.

³ Unfed fry release from remote site incubators

Table 2. Number of eggs, swim-up fry, and fry released and the survival rates by life stage for summer chum salmon reared in the supplementation program at Salmon Creek Hatchery, 1992 through 2000 brood years.

Brood year	Number of eggs or fry					% Survival by life stage			Cumulative % survival		
	Total		Salmon Creek Hatchery			Salmon Creek Hatchery			Salmon Creek Hatchery		
	Green eggs	Eyed eggs	Eyed eggs	Swim-up fry	Fry released	Green egg to eyed egg	Eyed egg to swim-up	Swim-up to release	Green egg to eyed egg	Eyed egg to swim-up	Swim-up to release
1992	46,980	44,280	44,280	18,684	19,200	94.3	42.2	100.0	39.8	39.8	43.4
1993	—	46,300	46,300	26,837	44,000	—	58.0	100.0	—	—	95.0
1994	—	24,200	24,200	2,000	2,000	—	8.3	100.0	—	—	8.3
1995	41,750	39,200	39,200	38,808	38,808	93.9	99.0	100.0	93.0	93.0	99.0
1996	—	114,900 ¹	64,900	62,300	62,000	—	96.0	99.5	—	—	99.5
1997	133,340	112,900 ¹	72,900	71,011	71,821	87.7	97.4	100.0	82.5	82.5	98.5
1998	164,300	149,100 ¹	69,100	68,423	67,807	90.7	99.0	99.1	89.9	89.1	98.1
1999	87,350	78,300 ¹	29,200	28,950	28,400 ²	89.6	99.1	98.1	88.9	87.2	97.3
2000	174,550	165,400 ¹	91,350	90,755	90,435	94.8	99.3	99.6	94.1	93.8	99.0

¹ Total includes eggs taken for both Salmon Creek supplementation and Chimacum Creek reintroduction programs; all green eggs are incubated at Dungeness Hatchery and shipped as eyed eggs to Salmon Creek Hatchery and Chimacum Creek Hatchery.

² Does not include 6,300 fish transferred in June 1 at 256 fpp from Dungeness Hatchery and 6,280 released on June 12 at 175 fpp at RM 0.1 in Salmon Creek after rearing in freshwater there; total release was 34,680 fish for BY 1999.

Table 3. Return from fry to adult for summer chum salmon reared in supplementation program at Salmon Creek, as determined from otolith marks for the 1994, 1995, 1996, 1997 and 1998 brood years.

Stream	Brood year	No. fry released	Return year	Age	Number otolith-marked adults	Return rate by age
Salmon Cr.	1994	2,000	1996	2	—	—
			1997	3	46	2.30%
			1998	4	50	2.50%
			1999	5	0	0.00%
			Total		96	4.80%
	1995	38,800	1997	2	13	0.03%
			1998	3	471	1.21%
			1999	4	148	0.38%
			2000	5	5	0.01%
			Total		637	1.62%
	1996	62,000	1998	2	8	0.01%
			1999	3	219	0.35%
			2000	4	162	0.26%
			2001	5	0	0.0%
			Total		389	0.62%
1997	71,800	1999	2	0	0.0%	
		2000	3	231	0.32%	
		2001	4	727	1.17%	
		2002	5			
		Total		958	1.48%	
1998	67,800	2000	2	14	0.02%	
		2001	3	698	1.03%	
		2002	4			
		2003	5			

Table 4. Return from fry to adult for summer chum salmon reared in supplementation program at Salmon Creek, as determined from otolith marks for the 1997, 1998, 1999, 2000 and 2001 return years.

Return year	Total return	Age	Age comp (%)	No. of adults	Otolith marks		Supplementation program		
					(%)	No.	Brood year	No. fry released	Return rate by age
1997	834	2	3.6%	30	44.4%	13	1995	38,800	0.03%
		3	64.3%	536	8.6%	46	1994	2,000	0.29%
		4	30.5%	255	2.7%	7	1993	44,000	0.02%
		5	1.6%	13	0.0	0	—	—	—
						7.9%	66		
1998	1134	2	0.7%	8	100.0%	8	1996	62,000	0.01%
		3	60.0%	680	69.2%	471	1995	38,800	1.21%
		4	39.3%	446	11.2%	50	1994	2,000	2.50%
		5	0.0%	0	0.0%	0	1993	44,000	0.00%
						46.6%	529		
1999	499	2	0.0%	0	0.0%	0	1997	71,800	0.00%
		3	58.2%	282	75.2%	219	1996	62,000	0.35%
		4	40.7%	197	72.9%	148	1995	38,800	0.38%
		5	1.1%	5	0.0%	0	1994	2,000	0.00%
						73.4%	367		
2000	846	2	6.0%	51	27.3%	14	1998	67,800	0.02%
		3	64.5%	546	42.3%	231	1997	71,800	0.32%
		4	29.0%	245	66.0%	162	1996	62,000	0.26%
		5	0.5%	4	0.0%	0	1995	38,800	0.00%
						48.1%	407		
2001	2638	2	4.4%	116	33.3%	39	1999	34,680	0.06%
		3	42.6%	1125	62.1%	698	1998	67,800	0.97%
		4	52.9%	1397	52.1%	727	1997	71,800	1.17%
		5	0.0%	0	0.0%	0	1996	62,000	0.00%
						55.5%	1464		

Table 5. Chimacum Creek summer chum reintroduction program, brood years 1996-2002.

Brood year	No. eggs received	No. fed fry released	Release size (gm)	Release date
1996	50,000	28,788	0.4-1.5	3/23, 5/9/97
1997	40,000	36,840	0.7	3/27, 4/11, 4/19/98
1998	80,000	70,050	0.6-0.8	3/26, 3/28, 4/21/99
1999	41,300	39,170	0.4-0.8	3/20, 3/31, 4/7, 4/24/00
2000	74,050	73,300	0.8-1.2	4/5, 4/17, 4/18, 4/23, 5/3, 5/10/01 4/18, 4/27, 4/30, 5/2/02
2001	82,490	71,500	0.9-1.8	3/12/02
2002	58,000	8,000 ¹	0.35	

¹ Unfed fry released accidentally into tributary to Chimacum Creek due to tank overflow

Table 6. Jimmycomelately Creek summer chum supplementation program, brood years 1999-2002.

Brood year	Broodstock			Natural spawners	Percent removed	Fed fry released	Release size (gms)	Release date
	Males	Females	Total					
1999	2	2	4 ¹	1	85.7%	3,880	1.0	4/8/00
2000	33	13	46	9	83.6%	25,900	1.0	4/20, 4/28/01
2001	36	32	68 ²	192 ²	23.9%	54,515	0.9-1.2	4/17, 4/26/02
2002	21	15	36 ³	6 ³	63.2%			

¹ Two additional females were trapped for brood stock, but could not be used because they were spawned out.

² Includes 4 male mortalities in brood stock due to lack of available females; an additional 24 pre-escapement loss due to predation in natural escapement.

³ Includes 8 male mortalities due to lack of available females and 1 female mortality in brood stock; an additional 15 pre-escapement loss due to predation in natural escapement.

Table 7. Quilcene National Fish Hatchery summer chum supplementation program, brood years 1992-2002

Brood year	Broodstock retained			Natural spawners	Percent removed	Fed fry released	Release size, g	Release dates(s)
	Males	Females	Total					
1992	225	186	411	320	56.2%	216,441	1.05	4/13/93
1993	19	17	36	97	27.1%	24,784	1.46	3/30/94
1994	184	178	362	349	50.9%	343,550	1.06	3/27/95
1995	243	256	499	4,029	11.0%	441,167	1.06	3/27/96
1996	438	333	771	8,479	8.4%	612,598	1.34	4/10/97
1997	296	261	557	7,339	7.1%	340,744	1.62	4/2, 4/15/98
1998	313	231	544	2,244	19.5%	343,530	1.28	3/8, 3/22, 4/2/99
1999	81	89	170	2,982	5.4%	181,711	1.03	3/9, 3/24/00
2000	187	195	382	5,126	6.9%	414,353	1.01	3/5, 3/19/01
2001	134	172	306	5,868	5.0%	351,709	0.98	3/3, 3/22/02
2002	174	181	355	3,662	8.8%			

Table 8. Total escapement to Big Quilcene River (natural spawners and hatchery spawned).

Return year	Total escapement
1974	795
1975	1,405
1976	2,445
1977	821
1978	2,978
mean 74-78	2,607
1979	345
1980	375
1981	138
1982	156
1983	64
1984	60
1985	44
1986	15
1987	8
1988	120
1989	1
1990	6
1991	49
1992	734
1993	136
1994	722
1995 ¹	4,520
1996	9,250
1997	7,874
1998	2,792
1999	3,153
2000	5,630
2001	6,185
2002	4,022

¹ First year of returns from supplementation program.

Table 9. Big Beef Creek summer chum reintroduction program, brood years 1996-2002.

Brood year	Males	Females	Total	Natural spawners	Percent removed	No. eyed eggs from QNFH ¹	No. fed fry released	Release size (gm)	Release date
1996	-- ¹	-- ¹	-- ¹	0	--	168,000 ²	204,000	0.5-0.7	2/7, 3/7/97
1997	-- ¹	-- ¹	-- ¹	0	--	157,000	100,280	0.8	2/9/98
1998	-- ¹	-- ¹	-- ¹	0	--	217,465	214,936	1.1-1.6	2/23, 3/15, 3/29/99
1999	-- ¹	-- ¹	-- ¹	0	--	40,298	39,800	1.4	3/10/00
2000	9	11	20	0	--	81,672 ³	80,550	1.4-1.8	2/26, 3/13/01
2001	34	34	68 ⁴	826	7.6%	--	80,925	1.4-1.7	3/4, 3/14, 3/25/02
2002	32	33	65 ⁴	677	8.8%	--			

¹ Eyed eggs received from Quilcene National Fish Hatchery (QNFH)

² Also received 40,000 swim-up fry from QNFH.

³ Includes 26,172 eyed eggs from Big Beef Cr. fish and 55,500 eyed eggs from QNFH.

⁴ Includes 2 broodstock mortalities in 2001 and 2 broodstock mortalities in 2002

Table 10. Union River summer chum supplementation program, brood years 1997-2002.

Brood year	Broodstock			Natural spawners	Percent removed	Fed fry released	Release size (gms)	Release date
	Males	Females	Total					
2000	30	32	62	682	8.3%	75,876	1.0	2/21, 2/27/01
2001	32	32	64	1486	4.3%	73,472	1.0	2/21, 2/27/02
2002	32	33	65	807	7.5%			

HOOD CANAL SUMMER CHUM SALMON ESU

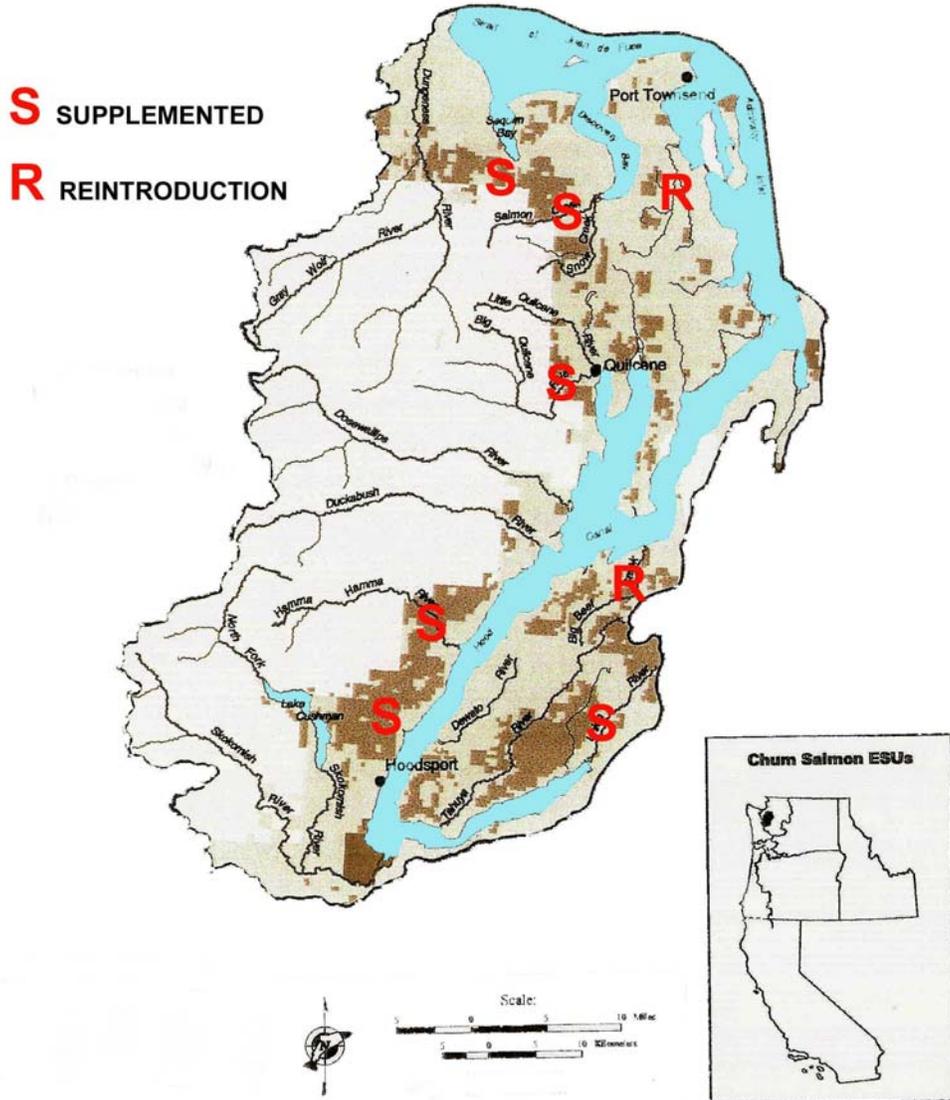


Figure 1. Map of the Hood Canal summer-run chum salmon Evolutionarily Significant Unit (ESU). The locations of ongoing supplementation (S) and reintroduction (R) programs for summer chum populations are shown.

Salmon Creek summer chum

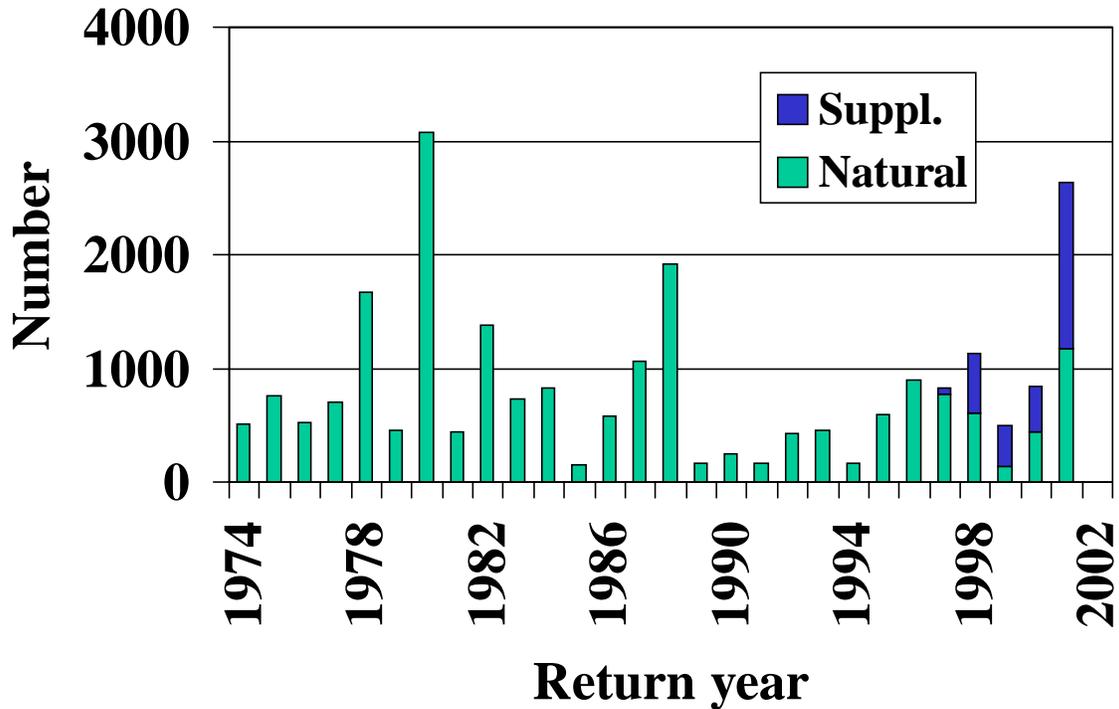


Figure 2. Return of adult summer chum salmon to Salmon Creek, 1974 through 2001. A supplementation program was initiated in 1992 and contributed adults to the return beginning in 1995. Natural-origin and supplementation-origin adults can be distinguished based on otolith marks beginning with return year 1997; however, supplementation-origin adults are underestimated in 1997 (see text).