ESA-listed Hood Canal Summer Chum Salmon: A brief update on supplementation programs, extinction risk, and recovery goals

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Abstract

Hood Canal summer chum (including the eastern Strait of Juan de Fuca) were listed as threatened under the Endangered Species Act in 1999. Recovery planning and implementation were underway prior to the listing, with harvest reductions and supplementation programs enacted in the early 1990's. Runsizes of summer chum have been on the rise since the mid-1990's, with the 2004 return being the largest on record. The average harvest rate has declined from nearly 55% before recovery actions were implemented, to less than 10% in the subsequent years. Extinction risks have decreased for all stocks classified at high or moderate risk of extinction prior to implementation of recovery actions. Supplementation programs have succeeded in reducing the extinction risk of several stocks that were at critically low levels prior to supplementation and these stocks have demonstrated strong returns of both supplementation-origin and natural-origin fish in recent years. Reintroduction programs also appear to be succeeding, with natural-origin spawners returning to two streams where summer chum had been extinct for more than 10 years.

Interim recovery goals for summer chum have been developed by the Washington Department of Fish and Wildlife and the Point No Point Treaty Tribes based on historic population sizes, and include abundance, escapement, productivity, and diversity targets. These interim goals will be reviewed and revised as more is learned about the population dynamics of Hood Canal summer chum. Summer chum populations are not yet meeting the co-managers' abundance-based recovery goals, due in part to the requirement that all stocks meet recovery abundance thresholds over a period of 12 years. The outlook for summer chum, however, is certainly much brighter than it was just 10 years ago.

Introduction

Hood Canal summer chum in Hood Canal (including stocks in the Strait of Juan de Fuca) experienced a severe decline in abundance in the 1980's. Abundances reached record lows in 1989 and 1990, with less than 1,000 spawners escaping to the region each year. In 1992, the state and tribal co-managers implemented harvest reductions aimed at protecting summer chum, and together with the U.S. Fish and Wildlife Service and local citizen groups, initiated three hatchery supplementation programs utilizing native brood stocks. In 1999, the Hood Canal summer chum Evolutionarily Significant Unit was listed as threatened under the Endangered Species Act. In 2000, the co-managers completed

the Summer Chum Salmon Conservation Initiative (SCSCI) (WDFW and PNPTT, 2000), a recovery plan that formalized and expanded on the recovery efforts already initiated for Hood Canal summer chum.

Since recovery efforts for Hood Canal summer chum were initiated, six supplementation and three reintroduction programs have been undertaken. Harvest rates on summer chum have been severely curtailed, and are currently managed under the harvest management plan described by the SCSCI. Harvest rates dropped from an average of 54.7% during the years of decline (1980-1991) to an average of 9.8% after reductions (1992-2004). A variety of habitat restoration and protection projects have been undertaken on summer chum streams and estuaries. Reports covering stock assessment, management, and supplementation activities from 2000-2002 have been completed, and the co-managers have identified interim recovery goals for summer chum. This paper gives general updates on population trends, extinction risks, and supplementation programs for Hood Canal summer chum, and briefly explains the co-managers' interim recovery goals. For more detailed information, consult the SCSCI report series available on the Washington Department of Fish and Wildlife (WDFW) website.

Abundance Trends and Extinction Risk

Abundances of summer chum in Hood Canal declined from the late 1970's through the early 1990's (Figure 1). All stocks of summer chum in Hood Canal except the Union River suffered declines in abundance during this period, with several stocks becoming extinct, and several others being classified at high risk of extinction based on methods presented by Allendorf et al. (1997) (Table 1). In the Strait of Juan de Fuca, the decline started approximately 10 years later, with a noticeable and lasting drop in abundance in 1989. By 1992, seven of the twelve summer chum stocks known to have inhabited Hood

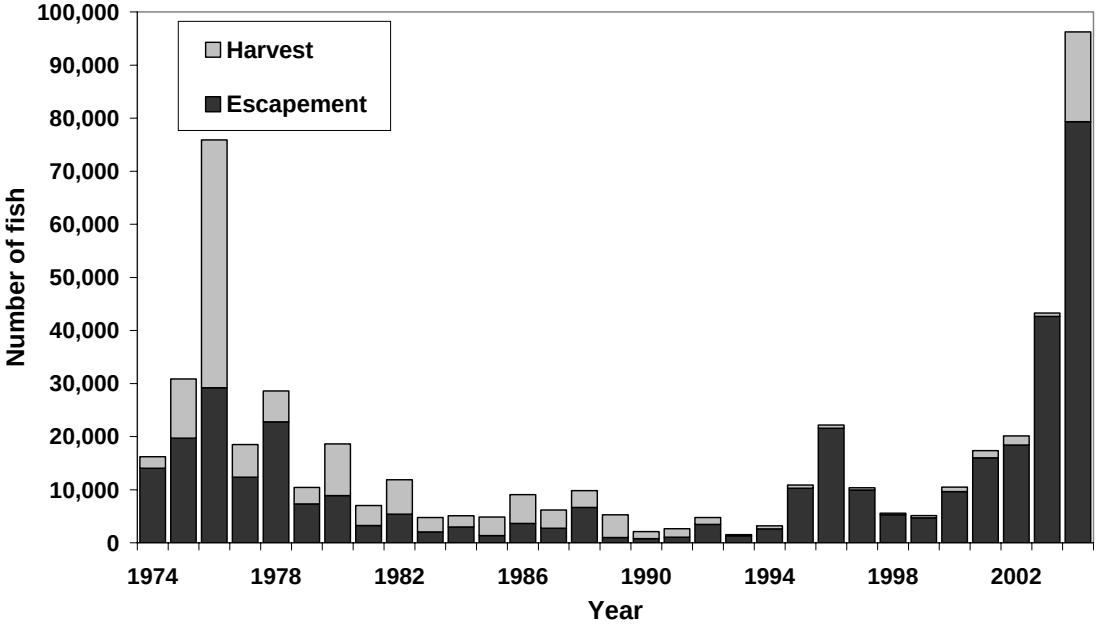

Figure 1. Total escapement and harvest of summer chum salmon returning to Hood Canal and the Strait of Juan de Fuca, 1974-2004.

Table 1. Mean escapement, effective populations size, total population size, population trend, and extinction risk rating for Hood Canal and Strait of Juan de Fuca summer chum stocks for the 4-years proceeding onset of recovery actions, and the most recent 4 years. Extinction risk calculations are based on methodology proposed by Allendorf et al. (1997).

Stock/years	Escapement (4-year mean)	Effective Population Size (Ne)	Total Population Size (N)	Population Trend	Extinction Risk Rating
Hood Canal					
Union					
1988-1991	391	281	1,406	Stable	Moderate
2001-2004	5,064	3,646	18,230	Increasing	Low
Lilliwaup					
1988-1991	88	63	315	Chronic decline/depression	High
2001-2004	580	418	2,088	Increasing	Moderate
Hamma Hamma					
1988-1991	154	111	555	Chronic decline/depression	High
2001-2004	1,775	1,278	6,390	Increasing	Low
Duckabush					
1988-1991	175	126	631	Chronic decline/depression	High
2001-2004	2,995	2,156	10,780	Increasing	Low
Dosewallips					
1988-1991	234	168	842	Chronic decline/depression	High
2001-2004	5,308	3,822	19,109	Increasing	Low
Big/Little Quilcene					
1988-1991	89	64	319	Chronic decline/depression	High
2001-2004	15,437	11,115	55,572	Stable/increasing	Low
Strait of Juan de Fuca					
Snow/Salmon					
1989-1992*	283	204	1,018	Precipitous decline	High
2001-2004	5,303	3,818	19,091	Increasing	Low
Jimmycomelately					
1989-1992*	244	176	879	Precipitous decline	High
2001-2004	610	439	2,196	Increasing	Moderate
Dungeness	No data	N/A	N/A	N/A	Special concern

*1989-1992 escapement values used due to later onset of decline of Strait of Juan de Fuca stocks.

Canal were extinct, and six were rated at moderate or high risk of extinction, and and one was of unknown status.

Populations rebounded to higher levels quickly in the mid-1990's, after the initiation of harvest reductions and several supplementation programs. Larger escapements were seen from 1995-1997 for the major streams entering the west side of Hood Canal, including a new record escapement for Big Quilcene in 1996, although a significant portion of the Quilcene return was thought to be of supplementation origin (see supplementation section for details on supplementation programs & their evaluation). Abundances were down again in 1998 and 1999 (although still five times higher than abundances just prior to recovery efforts), but began to increase in 2000. The lower abundances in 1998 and 1999 were likely caused by high stream flows during the incubation periods of the 1995 and 1996 broods, and corresponding reduced survival. The 2003 and 2004 escapements were the largest on record, with a total of over 79,000 fish escaping to the region in 2004. However, 2004 is the peak return year in a strong 4-year runsize cycle and production will likely decline in 2005 as the run cycles down from the high year. Mark data indicates that 75% of the fish returning in 2003 were of natural origin, indicating that success has not been limited to supplementation-origin fish. Analysis of otoliths collected in 2004 is ongoing, but a similar high contribution of natural-origin recruits (NORs) is expected.

Extinction risks for all stocks have decreased since the onset of recovery activities, with increases in population sizes, and effective population sizes per generation greater than 500 for all but two stocks. Table 1 summarizes extinction risk criteria based on escapement data from the four years (one generation) before onset of recovery activities, and from the most recent four years. The extinction risk for all extant stocks has decreased. In addition, three stocks have been introduced into watersheds where the indigenous stock was extinct, further reducing the extinction risk for the donor stocks and reinitiating natural summer chum production in these streams.

Supplementation Programs

Artificial production was identified as an important tool for use in recovery of summer chum salmon, and supplementation programs were initiated early in the recovery process. Supplementation as a salmon recovery tool has been the subject of much debate, in part due to differing application of the term supplementation itself. Supplementation, as defined by the SCSCI, is "The use of artificial propagation to maintain or increase natural production while maintaining the long-term fitness of the target population, and keeping the ecological and genetic impacts to non-target populations within specified biological limits." Implicit in this definition is the intent to halt supplementation when the wild population has recovered.

The controversy surrounding the use of artificial production techniques to supplement depressed wild salmon populations is based on the uncertainty of whether this type of intervention would lead to irreversible losses of fitness and genetic diversity, and a concern that the hatchery programs would continue indefinitely to enhance fishing

opportunities. Because of past chum salmon supplementation successes (Ames and Adicks 2003), the co-managers were confident that well-founded hatchery programs would result in rapid increases in the numbers of returning fish and a corresponding reduction in extinction risk. The primary challenge facing the co-managers was to develop a set of protocols that would minimize deleterious effects on supplemented stocks.

The definition of supplementation used in the SCSCI is central to the strict criteria and standards used for selecting and conducting supplementation programs for Hood Canal summer chum. Supplementation is to be used only when a summer chum stock is at risk of extinction, or to develop a broodstock in support of a program to reintroduce summer chum to previously occupied habitats. Tynan et al. (2003) summarized the strict standards guiding supplementation programs set forth by the SCSCI. These standards included strategies for minimizing potential deleterious effects of supplementation, and requirements for monitoring and evaluation of supplementation programs. Schroder and Ames (2004) further detailed specific protocols to be followed during artificial production to insure the SCSCI standards are met. Early results of monitoring and evaluation of supplementation programs are presented in WDFW and PNPTT (2001, 2003). A brief overview, and some specifics on two of the programs are presented here.

Table 2 lists the supplementation (and reintroduction) programs undertaken to date for Hood Canal summer chum. Four of the programs have been terminated after reaching adult return targets (Quilcene, Salmon, Chimacum, and Union); two of those were terminated before the 3-generation (12-year) maximum duration was reached due to success in meeting adult return targets (Chimacum and Union).

Table 2. Brood years that summer chum salmon supplementation or reintroduction programs and mass marking of fry releases (otolith marking or adipose clipping) were initiated and terminated in Hood Canal and eastern Strait of Juan de Fuca streams; and the first year marked adults from the programs are/were expected to return.

Supplementation/ reintroduction program	Brood year program initiated	Brood year mass marking initiated	First year marked adults to return[1]	Brood year program terminated
Salmon Creek	1992	1993	1996	2003
Big Quilcene River[2]	1992	1997	2000	2003
Lilliwaup Creek[3]	1998	1997	2000	
Chimacum Creek (reintro.)	1996	1999	2002	2003
Big Beef Creek (reintro.)	1996	1998	2001	
Hamma Hamma Creek	1997	1997	2000	
Jimmycomelately Creek	1999	1999	2002	
Union River	2000	2000	2003	2003
Tahuya River (reintro.)	2003	2003	2006	

[1] First year of returning age 3 fish is shown. Most adults return at ages 3 and 4, with perhaps a few at ages 2 and 5.
[2] Adipose clip.
[3] Attempts to initiate supplementation efforts at Lilliwaup began in 1992, but broodstock collection efforts were largely unsuccessful until the 1998 brood, when a functional trap was first installed on the creek.

Since 1997, all supplementation fish have been mass marked, with adipose clips used for Quilcene, and program-unique otolith marks for all other programs. Beginning with the

2001 return, all supplementation origin recruits were identifiable as supplementation fish, and also could be identified to program of origin. Reintroduction fish were not necessarily marked for the first few years of the program, since the streams selected for reintroduction did not have extant summer chum populations, and all returns were assumed to be of supplementation origin.

Summer chum adults returning to Hood Canal streams are sampled for marks as a part of broodstock collection, and on the spawning grounds. This allows estimation of the proportions of natural-origin and supplementation-origin returns, and the evaluation of return rates and straying of supplementation-origin fish. Scales are also sampled, allowing analysis of age structure and productivity for natural origin fish, and analysis of contributions of supplementation-origin fish, by brood year. Sampling effort has increased each year, with over 4,100 fish sampled for scales and 3,500 for otoliths in 2004. From 2001 to 2003, percentages of supplementation-origin recruits declined each year, accounting for 45%, 37%, and 26% of annual summer chum returns. Those percentages will decrease even further as programs are terminated, and summer chum populations return to unsupplemented production.

Big Quilcene River

The Quilcene summer chum supplementation program was one of the original programs undertaken in 1992, and was the largest program undertaken in terms of numbers of fry produced. The program was operated by the U.S. Fish and Wildlife Service at the Quilcene National Fish Hatchery. In addition to rebuilding the Quilcene stock (in the Big and Little Quilcene rivers), the program was intended to supply fry for the reintroduction of summer chum to Big Beef Creek. Since 1995 (the first year of returns from the supplementation program), combined escapement to the Big & Little Quilcene has exceeded the pre-decline mean escapement; this led to a reduction in the target fry release number for the program in its last two years of operation (2002 and 2003). Because mass marking of fry did not begin until the 1997 brood, it is not possible to separate supplementation-origin returns from natural-origin returns until 2001. Data from 2001 through 2004 show supplementation returns ranging from 1,258 to 3,354 fish. Perhaps the most interesting development has been the number of natural-origin recruits returning to Quilcene in those years, with total escapement increasing from 3,229 in 2001 to 35,775 in 2004 (Figure 2). This is a very encouraging sign, as it indicates that the Quilcene stock can produce large numbers of summer chum without the aid of supplementation.

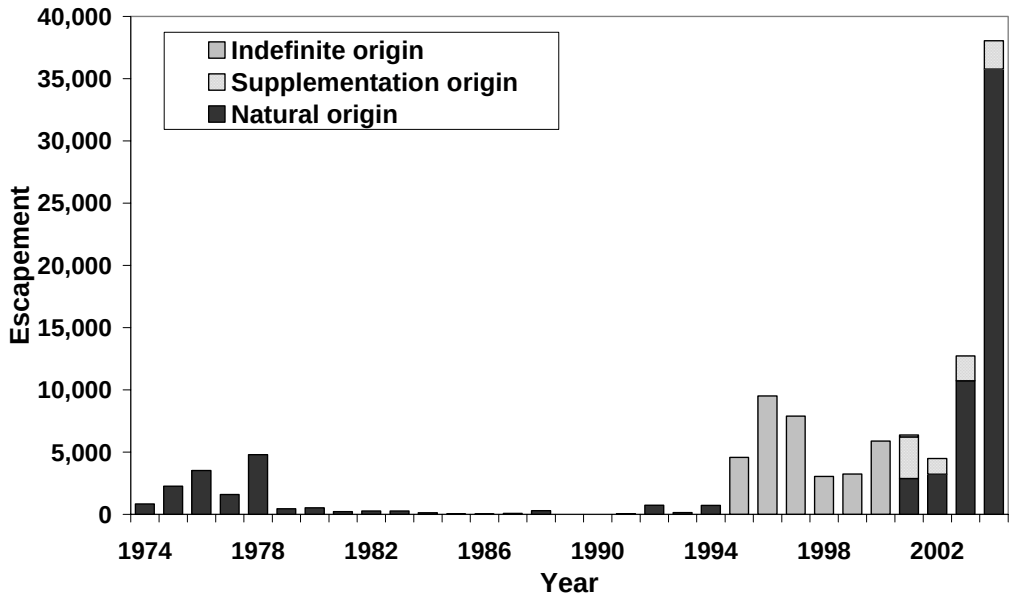

Figure 2. Escapement of summer chum salmon to Big and Little Quilcene rivers, 1974-2004.

Chimacum Creek.

Chimacum Creek supported an indigenous summer chum population until the mid-1980's, when a combination of habitat degradation and poaching evidently led to their extinction (WDFW and PNPTT 2000). A supplementation program aimed at boosting numbers of summer chum in Salmon Creek was initiated in 1992 by Wild Olympic Salmon with the goal of using the Salmon Creek stock as the donor for reintroduction to Chimacum. Beginning in 1996, eyed eggs were transferred from Salmon Creek for incubation, rearing, and release as fed fry in the Chimacum watershed. Adult summer chum returned to Chimacum Creek in 1999, with the first resulting natural-origin recruits returning in 2002 (Figure 3). Initial estimates show that the first two broods of natural spawners after reintroduction have resulted in return rates greater than 4 recruits per spawner (R/S). Due to the number of fish returning from 2001-2003, and due to the success of natural origin spawners, Chimacum Creek hatchery releases were terminated after the 2003 brood, only 8 years after the first fry release.

It is important to note that although Chimacum Creek is now supporting its own summer chum run, the Chimacum stock is still considered to be extinct. For the present time, summer chum returning to Chimacum Creek are considered to be a range extension of the donor stock, Salmon Creek. The same idea applies to Big Beef Creek, whose summer chum are considered an range extension of the Quilcene stock, and will apply to Tahuya River, when reintroduced chum of Union River origin begin returning there.

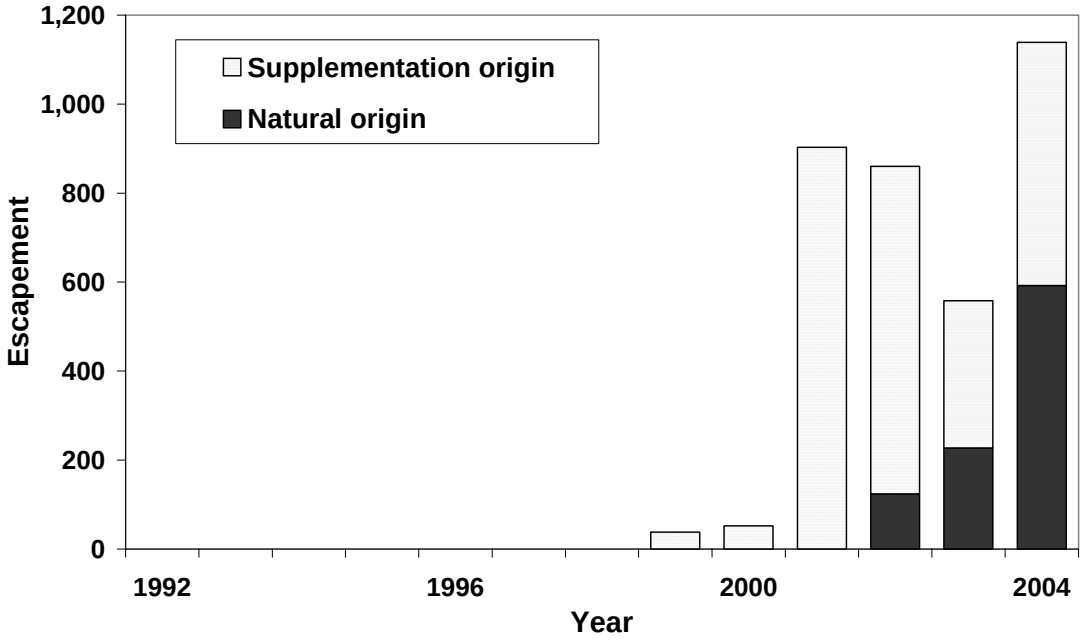

Figure 3. Escapement of summer chum salmon to Chimacum Creek, 1992-2004.

Other Supplementation Programs

Similar information is available for the other summer chum supplementation and reintroduction programs. For more information, refer to WDFW and PNPTT (2000, 2001, and 2003). Additional reports with updated data will be published on a regular basis in the future.

Recovery Goals

While the original SCSCI report provided the basis for protection and recovery of Hood Canal summer chum salmon, it did not describe specific recovery goals for summer chum. Supplemental Report No. 5 to the SCSCI (PNPTT and WDFW 2003) presents the co-managers' interim recovery goals for summer chum. The goals were developed with the information available at that time, with the expectation that the recovery standards will be reviewed and revised as more is learned about the population dynamics of Hood Canal summer chum.

The recovery goals were based on historic (pre-decline) population sizes, and include abundance, escapement, productivity, and diversity targets. While sporadic spawner escapement data for Hood Canal summer chum date back to the 1940's, reliable escapement and abundance data are available from 1974 to present. Because population declines for many stocks had begun by the late 1970's, there is limited data available representing pre-decline population sizes. Table 3 shows the period of time considered to represent pre-decline population sizes, and the average abundance during that period.

The average pre-decline population size values were adopted as the abundance recovery thresholds.

Table 3. Recovery escapement and abundance thresholds as established by co-managers (PNPTT and WDFW 2003), and pre-decline time periods used for determining recovery abundance thresholds.

	Pre-decline	Escapement	Abundance
Hood Canal Stocks	**period**	**threshold**	**threshold**
Quilcene	1974-1978	2,860	4,570
Dosewallips	1974-1980	1,930	3,080
Duckabush	1974-1980	2,060	3,290
Hamma Hamma	1974-1979	3,790	6,060
Lilliwaup	1974-1978	1,960	3,130
Union	1974-2000	340	550
Strait of Juan de Fuca Stocks			
Salmon/Snow	1974-1989	970	1,560
Jimmycomelately	1974-1989	330	520

Unfortunately, historic age data were inadequate to estimate brood specific returns, meaning that recruits per spawner (R/S) values cannot be calculated. However, annual escapement and abundance data can be used to estimate overall productivity of summer chum salmon during that period. For the purposes of recovery, the co-managers selected a productivity threshold of 1.6 R/S. This goal was close to historic productivity estimates for Hood Canal summer chum, and within the range of productivities observed for other chum populations. It was believed that meeting this productivity goal, along with abundance targets, would ensure sustainability and could accommodate lessening some of the restrictions on fisheries. Targets for escapement were set by dividing the abundance targets by the productivity targets (Table 2), meaning that these three targets are interlinked.

In addition to setting these escapement, abundance, and productivity thresholds, the recovery goals specify criteria for meeting the thresholds. For each stock, the mean natural-origin abundance and spawning escapement must exceed the thresholds over the most recent 12 years. In addition, the natural-origin abundance and escapement of each stock cannot be lower than the stock's critical thresholds (as described in the SCSCI) in more than 2 of the most recent 8 years, or more than once in the most recent 4 years. Finally, the R/S rate for natural origin spawners must average at least 1.6 over the most recent 8 brood years for which estimates exist, and no more than 2 years of 8 shall fall below 1.2 R/S.

To address diversity, the recovery goals also specify that the 8 extant stocks of Hood Canal summer chum must all meet their individual stock criteria. This means that as a whole, the regional escapement and abundance must exceed the sum of the individual stock thresholds. The decision to require recovery of all extant stocks was based in part on the fact that nearly half of the summer chum stocks recognized to have existed historically are now extinct. In addition to this regional abundance requirement, the

harvest, habitat, and supplementation approaches outlined by the SCSCI were all designed to be supportive of population diversity.

Despite recent abundant returns of Hood Canal summer chum, it will be some time before stocks can meet recovery thresholds over the period of twelve years required by the recovery goals. In addition, only a few broods of R/S data have been collected, while 8 full broods are required for stocks to meet the productivity requirement. These interim goals will be revisited as more is learned about summer chum population dynamics and productivity. One important issue remaining involves how to include reintroduced summer chum populations in recovery goal setting.

Conclusions

The overall goal of the SCSCI is "To protect, restore and enhance the productivity, production, and diversity of Hood Canal summer chum salmon and their ecosystems to provide surplus production sufficient to allow future directed and incidental harvests of summer chum salmon." The SCSCI acknowledged that both short-term and long-term measures would be necessary to meet that goal. Recent returns of summer chum to Hood Canal indicate that the short-term measures have been highly successful. Harvest reductions and supplementation programs, along with favorable freshwater and marine conditions have all contributed to recent success. The total abundance and escapement of summer chum in 2004 were the largest on record for Hood Canal. Although summer chum stocks are not yet meeting the co-managers' recovery targets, recent returns are a positive sign that the goals can be met.

The true test of success will be in the long-term, as supplementation programs are discontinued, and as summer chum potentially face less favorable freshwater and marine survival regimes. There is good reason to be optimistic that summer chum can remain at abundances higher than pre-supplementation levels even after supplementation is stopped, as has happened with past chum salmon supplementation programs (Ames and Adicks 2003). Continued monitoring of escapement and abundances, careful management of harvest rates, and commensurate protection and/or restoration of habitat critical to Hood Canal summer chum are all imperative if the goal of the SCSCI is to be met. On-going data collection will contribute to better understanding of the population dynamics of Hood Canal summer chum, and will help to focus long-term management actions to maximize benefits to summer chum.

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