



Hatchery Reform for Salmon Recovery	
Ken Currens, Hatchery Genetics Section Manager, NWIFC	Moderator
Thom Johnson, District Fish Biologist, WDFW Co-authors: Kyle Adicks, WDFW; Jim Ames, WDFW; Chris Weller, Point No Point Treaty Council; Tim Tynan, NOAA Fisheries	Hood Canal Summer Chum
Kip Killebrew, Hatchery Fisheries Biologist, Stillaguamish Tribe	Stillaguamish Summer Chinook

Moderator Remarks

Ken Currens

Hatchery Genetics Section Manager, NWIFC

There are many examples now of hatchery programs that focus on salmon recovery, but the two examples discussed here provide particularly good models. The two programs differ in many ways. One is relatively new while the other is one of the longest running recovery programs in Puget Sound. One program is geared to a very short timescale. It has a sunset schedule for finishing and a plan for ending the program. The other program is planned for the long-term and may operate for 40-50 years, which is about the amount of time needed for the habitat to recover. Also, one program covers a fairly large geographical scale and the other is focused on a unique stock in a very small tributary of the river.

The similarities between the programs are what drive their success. Both programs have been well-designed from the beginning. They both fulfill the HSRG's recommendation to set and develop plans for reaching goals. Both programs are successfully

implementing their plans and maintaining their commitment to stay on track. Finally, and most importantly, both programs are lead by motivated and talented personnel.

Hood Canal Summer Chum

Thom Johnson, District Fish Biologist, WDFW (Co-authors: Kyle Adicks, WDFW; Jim Ames, WDFW; Chris Weller, Point No Point Treaty Council; Tim Tynan, NOAA Fisheries)

“This work is so important, and is of such high quality, that its results deserve wide dissemination in the scientific community.” — Thom H. Johnson

Thank you for the invitation to speak today. We are very grateful for this opportunity to tell you about our Summer Chum Salmon Conservation Initiative and the supplementation approaches we have taken to help recover the ESA-listed Hood Canal/Strait of Juan de Fuca summer chum salmon.

Summer chum abundance reached record lows in 1989 and 1990 with fewer than one thousand spawners returning to the Hood Canal/Strait of Juan de Fuca region. Of the 16 recognized stocks, seven were extinct by 1991 and four were considered to have a high risk of extinction. At that time, the run size had fallen from a typical 10,000-30,000 fish to fewer than 1,000 fish. Habitat degradation, over-harvest, and poor freshwater conditions were identified as factors for the decline.

Commitment to Salmon Recovery Efforts

In 1992, the co-managers began planning conservation measures needed to preserve and rebuild these populations. Protective actions that were under our control were immediately implemented. We provided summer chum protection from harvest in fisheries and we started hatchery-based stock preservation programs. But we also recognized the need for a comprehensive plan for recovery, which would include addressing habitat issues. The key premise here is that a summer chum salmon population threatened with extinction cannot be recovered to viable population levels with harvest and hatchery measures alone. Commensurate and timely improvements in the condition of the habitat critical for summer chum salmon survival are necessary to recover the listed

populations to healthy levels.

The Hood Canal and Strait of Juan de Fuca summer chum salmon Evolutionarily Significant Unit (ESU) was listed as threatened under the Endangered Species Act in 1999. WDFW and the Point No Point Treaty Tribes published a summer chum recovery plan, the Summer Chum Salmon Conservation Initiative (SCSCI), in 2000. The SCSCI identified the status of regional stocks, factors for their decline, and artificial propagation, habitat and fisheries harvest management measures that were necessary to recover summer chum in the region. In 2001, NOAA Fisheries approved the hatchery and harvest components of the SCSCI as beneficial to the recovery of summer chum salmon. In 2003 and 2004, the hatchery component also received very favorable reviews from the Hatchery Scientific Review Group (HSRG). In 2005, the Hood Canal Coordinating Council submitted a summer chum recovery plan for review by NOAA Fisheries that includes habitat measures, as well as the hatchery and harvest components developed under the SCSCI.

It is important to note that harvest rates on summer chum have been severely curtailed and are currently managed under the harvest management plan described by the SCSCI. For example, harvest rates dropped from an average of 54.7% during 1980-1991 (the years of decline) to an average of 9.8% during 1992-2004. This presentation, however, will primarily focus on the hatchery programs designed and implemented to help recover summer chum.



Hatchery Program Standards and Reporting

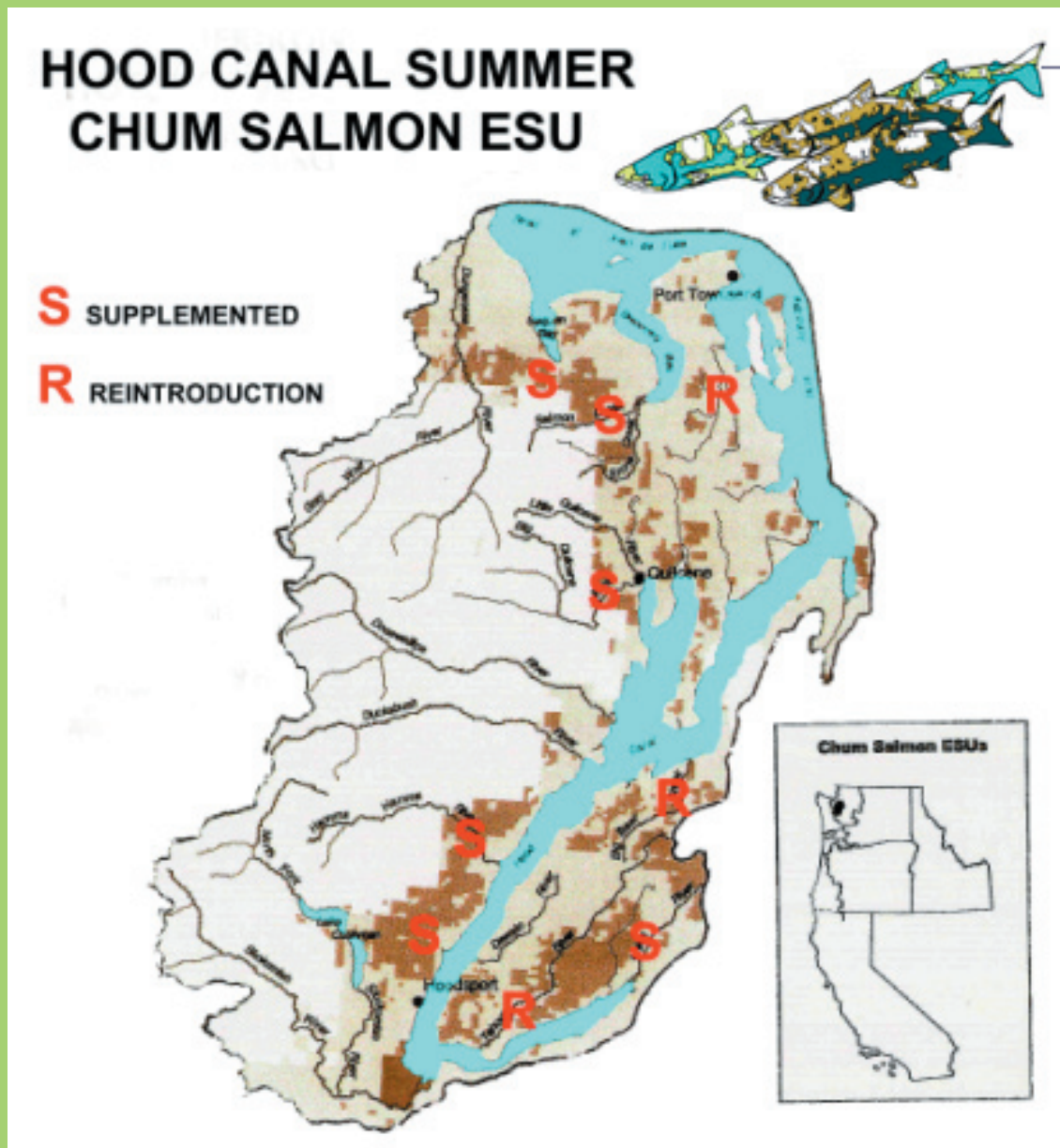
In developing the hatchery component of the SCSCI, the co-managers identified objectives and the rationale for supplementation programs and reviewed their benefits and risks. Tynan et al. also provides a complete description and discussion (See Tynan, T.J., C. Weller, and T.H. Johnson. 2003. Supplementation standards for recovering ESA-listed threatened summer-run chum populations in the Hood Canal and Strait of Juan de Fuca regions

of Washington. Proc. of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop.

Department of Fisheries and Oceans, Vancouver, B.C. Canada.) Rigorous standards were developed and applied to minimize the potential negative effects of hatchery practices. A few examples are:

- Use hatcheries only when stock is at high risk of extinction; or to develop broodstock to support reintroduction programs
- Use local, native fish as broodstock source

Figure 1 — Map of Program Locations



- Limit duration to three generations (12 years) maximum
- Apply hatchery operation standards
- Require monitoring and evaluation
- Apply new information as it becomes available (adaptive management)

The hatchery programs are operated by WDFW, the U. S. Fish and Wildlife Service, and Long Live the Kings at their respective facilities, and also at remote site facilities operated by cooperators with WDFW oversight. The co-managers are grateful for the involvement of many cooperators, including the Hood Canal Salmon Enhancement Group, Wild Olympic Salmon, North Olympic Salmon Coalition, and Long Live the Kings. We could not do these programs without their assistance and expertise.

Under the SCSCI, six supplementation programs and three reintroduction programs were phased in between 1992 and 2003. Programs were distributed throughout the ESU and include those on Salmon, Chimacum, and Jimmycomelately creeks for Strait of Juan de Fuca populations and those on Big Quilcene, Lilliwaup, Hamma Hamma, Union, and Tahuya rivers and Big Beef Creek for Hood Canal populations.

Operational standards for summer chum hatchery programs were also established in the SCSCI and implemented to minimize potential hazards of hatchery programs to natural summer chum populations. Potential hazards identified and addressed included:

- Partial or total hatchery failure;
- Ecological impacts to natural-origin summer chum through predation, competition, and disease transfer;
- Genetic effects to the propagated and unsupplemented populations from loss of genetic variability between or within populations; and
- Risks to other salmonid populations and species.

The SCSCI established other standards for hatchery operations, including:

- Using broodstock that represents the demographics of the donor population
- Fish health criteria are monitored for adults and fry
- Survival rate objectives are established and monitored
- Records are regularly maintained and compiled
- Reports are prepared which summarize protocols and procedures, rearing and release methods, production, survival, and recommendations for improvements

Monitoring and evaluating the effects of supplementation on the natural summer chum populations and the performance of the overall program in recovering summer chum are critical objectives of the SCSCI. Monitoring and evaluation requirements were established and implemented to measure the effects of supplementation on the supplemented stocks and on other natural summer chum populations.

Since 1997, all supplementation fish have been mass-marked, with adipose fin clips used for Quilcene and up to 14 program-unique otolith marks for all other programs. Beginning with the adult return in 2001, all supplementation origin recruits were identifiable as supplementation fish and also could be identified to program of origin. Summer chum adults returning to all 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 contribution of supplementation-origin fish, by brood year. Monitoring also generates genetic data, which was used to develop a DNA baseline for summer chum and enable the detection of any changes in the genetic characteristics of the population before, during, or after supplementation.



Many volunteers assist with collecting monitoring data, and monitoring creates a variety of educational opportunities about salmon, habitat, salmon management, and the scientific process.

The co-managers prepare reports to summarize, analyze, and interpret all data collected and suggest any necessary program revisions. The reports assess the effectiveness and effects of the supplementation and reintroduction programs and any needed adjustments are made to meet the objectives of the SCSCI. The reports are readily available at <http://www.wdfw.wa.gov/fish/chum/library>.

SCSCI Hatchery Program Reviews

The HSRG reviewed the summer chum programs in 2003 and 2004 and provided comments and recommendations, which included:

- Continue the existing programs consistent with the SCSCI including collecting and analyzing all data necessary to evaluate the programs' success.
- The SCSCI is a well-designed, well-conducted program that appears to be achieving its goals.
- The program may serve as a prototype for similar efforts in the future.
- Ensuring complete monitoring and evaluation will be crucial.

The NOAA Fisheries Salmon Recovery Science Review Panel also reviewed the program in 2004, as follows:

- The program is notable for its dual commitment to not only hatchery and harvest management measures, but also to habitat improvement to follow the ESA mandate of restoring numbers of fish and the ability of the natural environment to sustain fish.
- This program has developed a rigorous set of protocols for conservation-driven hatchery programs.
- In cases where recovery objectives have been met, hatchery programs have ceased. Thus, the focus of this restoration program falls unambiguously on promoting recovery of wild stocks and the habitat required to sustain them.

- This work is so important, and is of such high quality, that its results deserve wide dissemination in the scientific community.

Examples of Supplementation and Reintroduction Programs

We provide here a brief overview of two supplementation and two reintroduction programs in the Hood Canal and Strait of Juan de Fuca region.

More information on these and other programs is reported in the following publications:

- Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty (PNPT) Tribes. 2001. Annual report for the 2000 summer chum salmon return to the Hood Canal and Strait of Juan de Fuca region. Supplemental Report No. 3, Summer Chum Salmon Conservation Initiative - An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region; December 2001. Wash. Dept. Fish. and Wildl. Olympia, WA. 123 p.
- Johnson, T.H. and C. Weller. 2003. On-going supplementation programs for summer chum salmon in the Hood Canal and Strait of Juan de Fuca regions of Washington State. Proc. of the Twenty-first Northeast Pacific Pink and Chum Salmon Workshop. Department of Fisheries and Oceans. Vancouver, B.C. Canada.
- Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty (PNPT) Tribes. Report on summer chum salmon stock assessment and management activities for 2001 and 2002. Supplemental Report No. 4, Summer Chum Salmon Conservation Initiative – An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca. October 2003. Wash. Dept. Fish. And Wild. Olympia, WA. 219 p.
- Adicks, K, J. Ames, and T. Johnson. 2005. ESA-listed Hood Canal Summer Chum Salmon: A brief update on supplementation programs, extinction risk, and recovery goals. Proceedings of the Twenty-second Northeast Pacific Pink and Chum Salmon Workshop. In press.

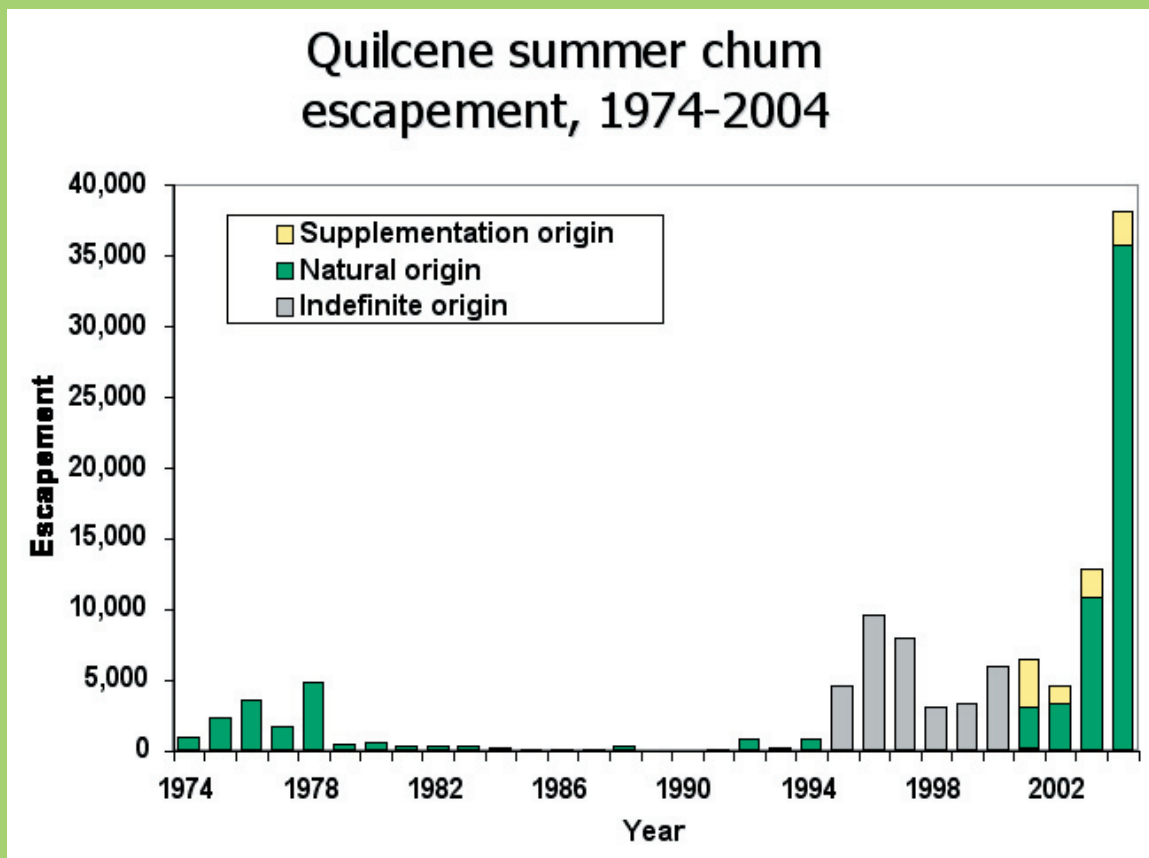
Big Quilcene River and Big Beef Creek – Hood Canal

A supplementation program was started on 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, as reported in the co-managers' annual report for the 2000 summer chum salmon return to the Hood Canal and Strait of Juan de Fuca region (see Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty (PNPT) Tribes, 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 QNFH; 2) spawning, fertilization, incubation and rearing at QNFH; 3) adipose-clipping of all fry (since 1997); and 4) release of fry at ~one gram into Quilcene River.

Beginning with brood year 1997, the summer chum fry released at QNFH were adipose fin-clipped to identify returning adults as either hatchery-origin or natural-origin fish. The supplementation program contributed 3,344, 1,258, 1,993, and 2,270 adults to the 2001, 2002, 2003, and 2004 returns, respectively. The abundance of natural-origin spawners has increased from an average of 89 adults during 1988-1991 (just prior to initiation of supplementation) to 2,884, 3,229, 10,739, and 35,775 adults during 2001, 2002, 2003 and 2004, respectively. This is an

Figure 2





encouraging sign, as it indicates that the Quilcene stock can produce large numbers of summer chum without the aid of supplementation.

Beginning in 1996, eyed eggs collected from Big Quilcene River adults were transferred to Big Beef Creek to reintroduce summer chum to that stream. This program is considered a range extension of the Big Quilcene summer chum and further reduces the stock's risk of extinction. To foster local adaptation of the reintroduced population, adults returning to Big Beef Creek were used as broodstock since 2001 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, 742, 896, and 1,916 summer chum returned to Big Beef Creek during 1999 through 2004, respectively. This represents the first natural spawning by summer chum in Big Beef Creek since the early-1980's.

Salmon Creek and Chimacum Creek – Strait of Juan de Fuca

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, as reported in the co-managers' annual report for the 2000 summer chum salmon return to the Hood Canal and Strait of Juan de Fuca region (see Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty (PNPT) Tribes, 2001.)

The Salmon Creek program is comprised of the following: 1) collection of indigenous summer

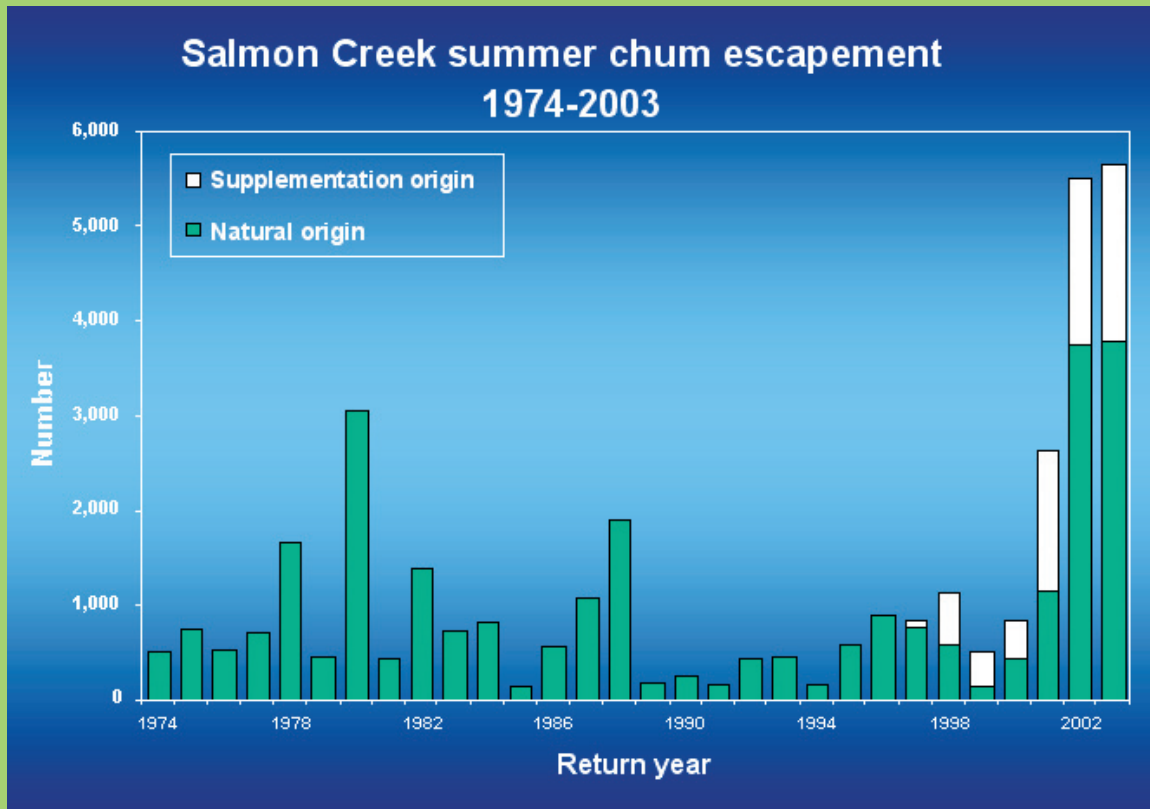
chum broodstock at a temporary WDFW trap at river mile 0.2 on Salmon Creek; 2) holding and spawning of broodstock at the trap site; 3) transfer of eggs and milt to WDFW Dungeness Hatchery for fertilization and initial incubation; 4) otolith marking of eyed eggs (at either WDFW Dungeness Hatchery or Hurd 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 ~one 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.

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, 366, 409, 1,470, 1,772, 1,868, and about 2,000 adults during the 1997 through 2004 return years, respectively. 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 about 3,000 adults annually during 2001-2004.

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.

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, 864, 558, and 1,093 summer chum returned to spawn in Chimacum Creek during 1999 through 2004, respectively. This represents the first natural spawning by summer chum in Chimacum Creek since the mid-1980's.

Figure 3



Current Outlook for the ESU

Summer chum salmon populations have increased in abundance due to harvest and hatchery management measures. Populations rebounded to higher levels quickly in the mid-1990's, after the initiation of harvest reductions and several supplementation projects. Larger escapements were seen from 1995-1997 for the major streams entering the west side of Hood Canal. Abundances were down again in 1998 and 1999 (although still five times higher than abundances just prior to recovery efforts), but began to increase again in 2000. The 2003 and 2004 escapements were the largest on record, with a total of over 79,000 fish escaping to the region in 2004. Mark data indicates that 74% and 83% of the fish returning in 2003 and 2004, respectively, were of natural origin, indicating that success has not been limited to supplementation-origin fish (Figure 4).

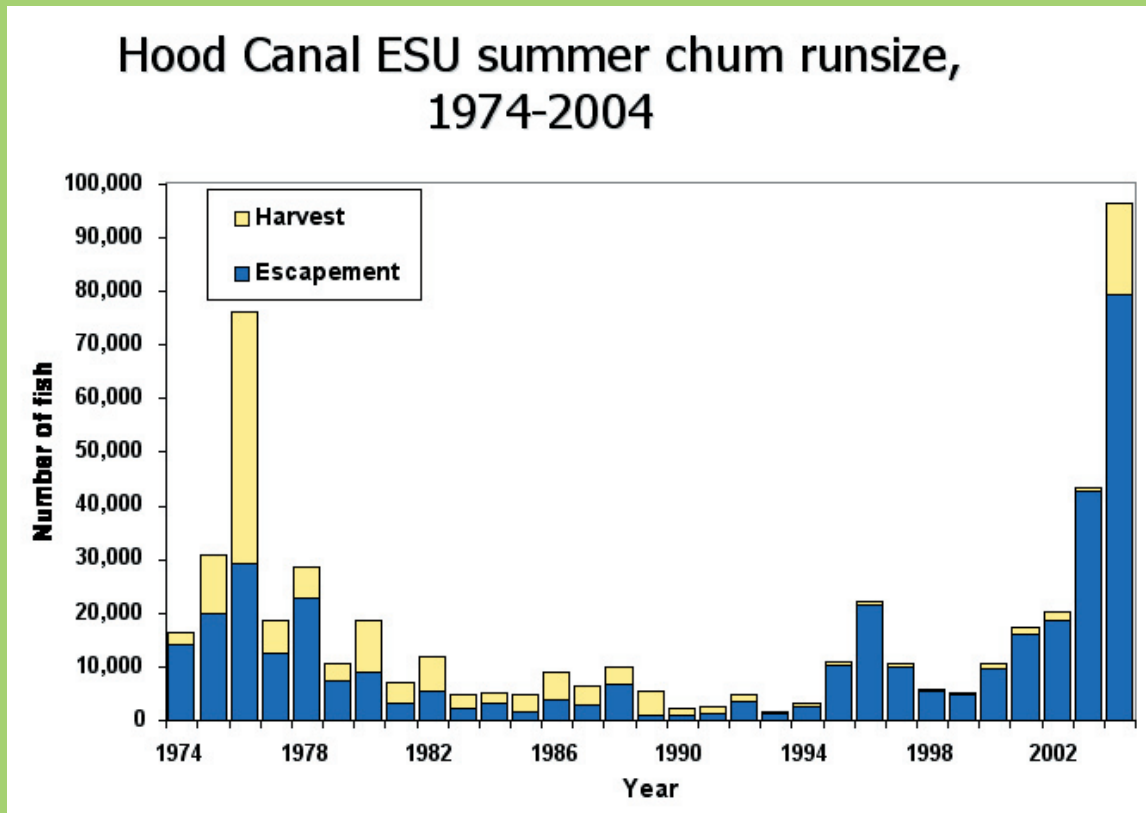
Next Steps

The progress towards recovery made so far is very encouraging, but funding and support for SCSCI programs will be necessary to sustain and monitor the recovery of summer chum salmon. Funding for staff positions is critical, but a WDFW chum biologist position was eliminated in 2005 due to budget cuts, and funding for the lead technician for the Strait of Juan de Fuca programs is not secure.

The monitoring, analyses, evaluation, and hatchery operations that have helped the SCSCI programs to succeed have substantial costs. Otolith analysis is currently paid by the co-managers and the regional fish enhancement groups, but funding is year to year with an uncertain future. There is a large backlog of DNA samples without adequate funding to conduct needed analyses. In addition, funding for monitoring and evaluation will be required to measure the viability of the natural



Figure 4



populations even after the hatchery programs have ended. And last, but not least, funding and support are critical for habitat protection and restoration, because without habitat, summer chum abundance, productivity, and diversity recovery goals when reached may not be sustained.

We have been very fortunate to have the vision and involvement of community-based groups to help guide salmon recovery efforts. Again, we want to thank all of our partners. Local involvement and community outreach is key to making salmon recovery work. It is hard work and it takes a long time, but it can absolutely be successful. As Fin, the 25 foot long traveling salmon developed by Wild Olympic Salmon as an educational tool, says: "we need gnarly leaders to solve gnarly problems." We can do it. We can do it together.

Question & Response

Question (Bob Hayman, Skagit River Systems Cooperative): Thom, you said that your supplementation program would be used only when a stock was at high risk of extinction. Were there specific escapement numbers that you used as a standard to determine when you'd start a supplementation program?

Response (Johnson): The SCSCI used the procedures for measuring extinction risk as presented in Allendorf et al. (see Allendorf, F.W., D. Bayles, D.L. Bottom, K.P. Currens, C.A. Frissell, D. Hankin, J.A. Lichatowich, W. Nehlsen, P.C. Trotter, and T.H. Williams. 1997. Prioritizing Pacific salmon stocks for conservation. *Conservation Biology* Vol. 11. No. 1. p. 140-152.) Components included measures of escapement, effective population size, total population size, and a population trend. After

the SCSCI was completed, we went back and reevaluated all of the supplementation programs that we had already started and applied the same method; all but one program (Hamma Hamma) met the criteria for high risk of extinction. Now, any new programs implemented would have to meet the same high risk of extinction criteria.

Question (Hayman): That was genetic?

Response (Johnson): Yes, for the most part.

Question (Hayman): What were some of those numbers?

Response (Johnson): Data used in the extinction risk assessment are presented in Table 1.12 of the SCSCI. For example, four-year mean escapements for stocks rated at high risk of extinction were 38, 89, 226, and 103 adults for the Lilliwaup, Big/Little Quilcene, Snow/Salmon, and Jimmycomelately summer chum stocks.

Question (Hayman): Okay. The other thing. One of those programs you showed as an example had an average of 89 spawners per year?

Response (Johnson): Correct, that was Quilcene.

Question (Hayman): Did you use those spawners for your brood stock program?

Response (Johnson): Yes. However, 89 fish was the average over a four-year period. We specifically started the program in 1992 because summer chum abundance follows a four year cycle and 1992 was the high year of the anticipated four year cycle so we actually had 220 fish to choose from for broodstock.

Question (Unidentified speaker): So I'm curious; could you summarize what the monitoring costs are, either for the program or annually? Ballpark? If we have to do that everywhere, what is it going to cost us?

Response (Johnson): First, please keep in mind that this is the cost for monitoring an entire ESU with 6 supplementation programs and 3 reintroduction programs and naturally spawning stocks in 14 streams. We collect about 3,500 otoliths a year from all the different streams even if we don't have hatchery programs on them because we're looking for any straying of program fish as well as the supplementation returns to the natal streams. Otolith analysis costs about \$40,000 per year. For DNA analysis, we've currently done enough to get a DNA baseline from one brood year only from each of the eight different stocks. This year, Jim Scott and Craig Busack of WDFW facilitated getting us another \$20,000 to add to that baseline and actually do some additional DNA analysis. But we have thousands of samples archived that need to be looked at if we want to assess any potential genetic change to these populations as a result of these programs.

Question (Unidentified speaker): Do you have a sense of what you would need, if you could have the money you need for monitoring?

Response (Johnson): DNA analysis would be about \$16,000 per year and that's if we ran 8 stocks with 50 fish per stock each year. We may need to analyze more DNA samples from some stocks in some years, though, to answer specific questions and measure specific impacts. In addition, otolith analysis would cost about \$40,000 per year. The total, then, would be about \$56,000 per year to monitor and evaluate the entire summer chum ESU for DNA and otoliths.



Moderator Remarks

Ken Currens

Hatchery Genetics Section Manager, NWIFC

As a moderator's prerogative, I have to make a comment here. I think maybe you are convinced that both of these programs are flagship programs for hatchery reform. There is one thing I need to add, in particular, about the summer chum program. As a member of the Technical Recovery Team I had the opportunity to look at some of the data they were collecting as part of their monitoring: their scale analysis, otolith analysis, and genetic analysis. I've worked in the Columbia and the Puget Sound, and this is one of the best monitoring programs I have ever seen. It really provides the kind of data that you need to manage these kinds of programs the right way. The important thing there is it shows that we can do it. If we can do it with summer chum, we should be able to do it with other species as well.

Stillaguamish Summer Chinook

Kip Killebrew, Hatchery Fisheries Biologist, Stillaguamish Tribe

“Without the hatchery program there is a significant risk that Stillaguamish Chinook will go extinct.” — Kip Killebrew

The Stillaguamish watershed is the fifth largest watershed in Puget Sound and supports summer and fall Chinook. The Stillaguamish River empties into the upper part of Port Susan, which is very shallow. The Stillaguamish Chinook routinely encounter 80 degree water temperatures in Port Susan and 70 degree water temperatures in freshwater as they return in the summer and fall. The Stillaguamish watershed is still very rural, comprised of only 2% urban, 5% agriculture, 17% rural, and 76% forestry by area. Most of the urban areas are on the perimeter of the watershed.

The brackish Stillaguamish estuary has historically provided tidal habitat featuring high primary productivity that is critical for Chinook rearing. Much of the estuary has been diked to create farmland, and only about 15% of the estuary remains. Habitat losses in the watershed include:

- About 38% of the historical channel habitat has been lost in the lower watershed.
- Only about 30% of the floodplain remains forested in the lower watershed.
- 76% of freshwater wetlands have been lost.
- Old growth forest used to line the river; now most of the timber is second or third growth.
- Less than 50% of the watershed is covered with timber 25 years or older.

Glaciers and volcanic activity have left problematic geology with significant amounts of fine sediments, sand, silt, and clay. Logging roads and other forestry activities have contributed to major landslides as well as more gradual sediment erosion that has

covered and suffocated salmon eggs. Log road construction speeds the delivery of water to the river because rather than seeping through the sub-surface soil, the water hits ditches and gets fast-tracked to the river.

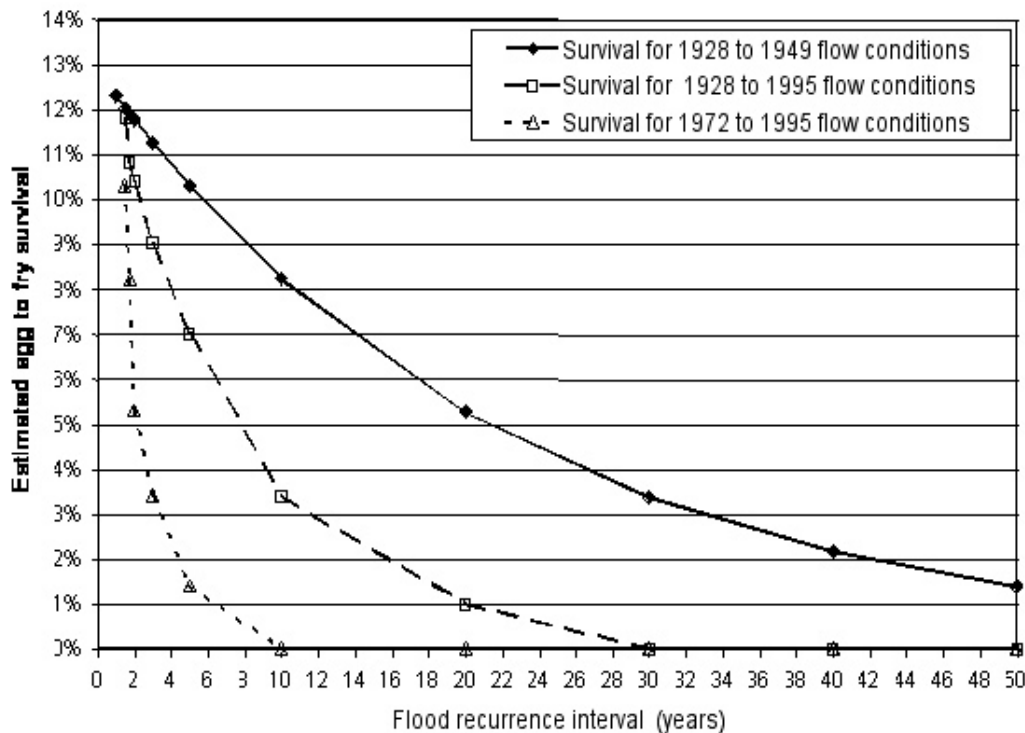
In the years 1977-2000, what was considered a historic 20-year flood event began to occur almost every year. At that level, when river flow reaches 20,000 cubic feet/second, replacement is not achieved for spawning stocks. Figure 1 shows the results of research that related flood frequency to the egg to fry survival rate. It shows that, currently, any time a three or four-year flood event occurs, the chance that enough eggs will survive to replace the population is less than 5%.

Even without any harvest, the escapement goals for Stillaguamish Chinook would have been reached in only three out of the last 17 years. So, even if harvest were shut down, it still would not have made a significant difference in the number of spawners. Back in the late 1970s and early '80s, the Stillaguamish Tribe was concerned about not only habitat problems but also harvest. Harvest rates in Puget Sound were approaching one million fish per year in the '70s, but were down to half of a million fish as late as the '90s. Exploitation rates on Stillaguamish Chinook were as high as 80% and 90% in the mid-80s. Given the status of habitat and harvest, the tribe felt they had to act, so they unilaterally halted their harvest in 1985. At that time, west coast sport and commercial fishermen were still harvesting Stillaguamish Chinook to the extent of 70%.



Figure 1

Estimated egg to fry survival v. flood recurrence interval for the North Fork Stillaguamish
 From Pess and Beamer, 1999



Stillaguamish Tribe Hatchery Program

In addition to ceasing harvest, the tribe decided to start a hatchery program. The goals and objectives of that hatchery program are to provide current and future generations the opportunity to continue their spiritual and cultural connections to salmon through fishing. The recovery objectives are: 1) to ensure short-term preservation and long-term restoration of the Chinook stocks and 2) to provide technical information through the US/Canada Indicator Stock Program on harvest rates and locations, migration timing, and productivity for North Puget Sound Chinook populations.

The performance standards to achieve the objectives of the Chinook program include:

- Maintain and then increase the numbers of Chinook spawners (abundance).

- Increase the ratio of natural to hatchery spawners (productivity) as habitat improves.
- Produce program fish that are similar to natural origin fish in life history strategies and morphology (diversity and spatial structure).
- Maintain the genetic diversity of the population.

Figure 2 demonstrates how the hatchery fits into the recovery scheme. The red line shows the current status of North Fork Stillaguamish Chinook productivity (recruits). Along the green curve that shows target productivity, the arrows indicate the goals after ten years of habitat improvement and after 50 years of habitat improvement. The hatchery maintains the fish above this red line and harvest is intended not to impede the vertical movement of the productivity (recruits per spawner curve). This means that as we repair and improve the condition

of the habitat, the habitat will be able to support larger numbers of Chinook spawning and rearing in the watershed and the agreed upon harvest rate will allow the necessary fish back to fully utilize the improved conditions/increased productivity.

Over the next ten years, we have estimated that it will cost \$44 million dollars to achieve a return of 10,000 fish. This includes 3,200 fish in the South Fork Stillaguamish and roughly 6,000 fish in the North Fork Stillaguamish. Long term, we expect much higher returns. These numbers are in the same range as the Technical Recovery Team's (TRT) planning targets for high productivity abundance for the two forks of the river.

In the mid-1980s there was a total return of Chinook to the Stillaguamish in the low 300's. We have added to the population, and the trend is generally up, and we want to see these numbers

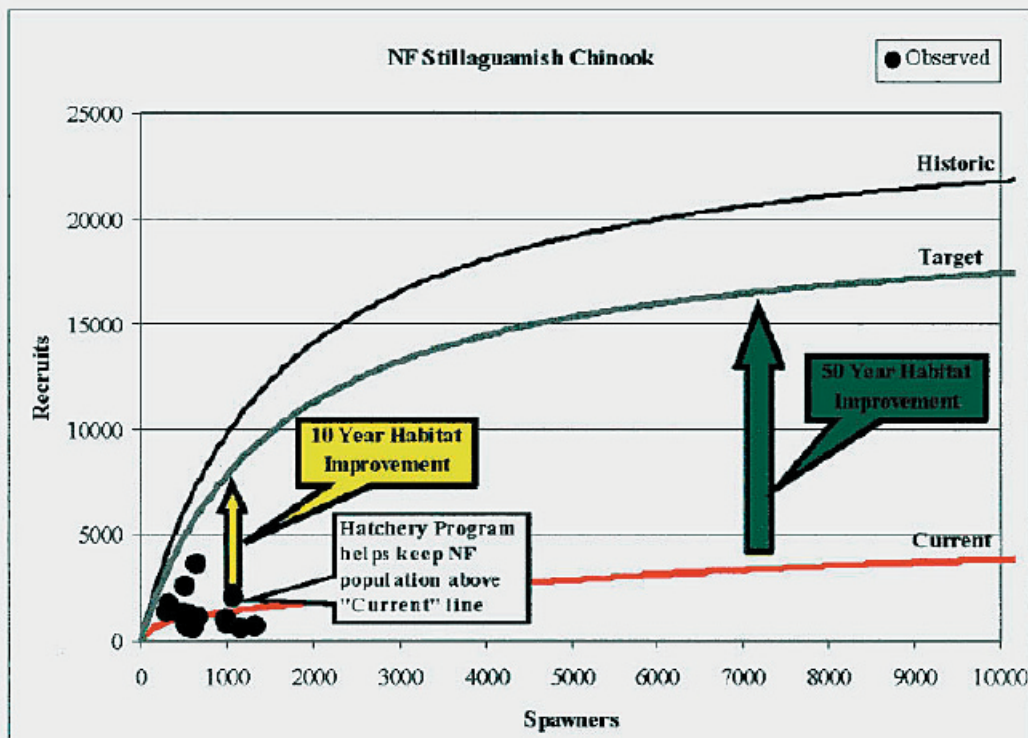
continue to increase. We're now getting spawning escapements in the 1,200's and the percentage of hatchery origin fish in the escapement should decrease with the total (wild + hatchery) increasing escapement, which appears to be happening.

Is There Any Evidence that We're Doing the Right Thing?

Thanks to Greg Blair and Lars Mobrand for running the Ecosystem Diagnostic Tool (EDT) model to do a risk assessment run for wild fish (Figure 3). What you see is the current hatchery program with all the current parameters that we have: low marine survival, harvest exploitation rate, and poor habitat conditions with the hatchery operating. This shows you what we're doing. Again, the model is an approximation, and this shows that the hatchery is adding on a significant number of program fish (red color) to the wild escapement (blue color). We also

Figure 2

Figure 17. Expected population response if habitat improves and harvest is managed at a low maximum exploitation rate.





ran the same model with the same parameters, but pulled out the hatchery program. After 30 years, the North Fork population would have declined down to a spawning escapement of near a hundred fish (blue color) instead of the current spawning escapements of over 1,000. I think this kind of modeling is important for us to do when we are trying to run a risk-benefit analysis of running hatchery programs.

Is there any evidence that this model is correct?

Figure 4 is the South Fork Stillaguamish population's

escapement. There is no hatchery restoration/supplementation program occurring in this watershed, and as you can see, from 1988 on, this population isn't making a whole lot of progress, and that is problematic for us because the South Fork run is even more in danger of going extinct than the North Fork population.

Preliminary runs with the All-H Hatchery Analyzer (AHA) on the Stillaguamish Chinook program indicate that the program is collecting the correct numbers of wild broodstock to maintain the genetic integrity of both the wild

Figure 3

NF Stillaguamish – Model Results

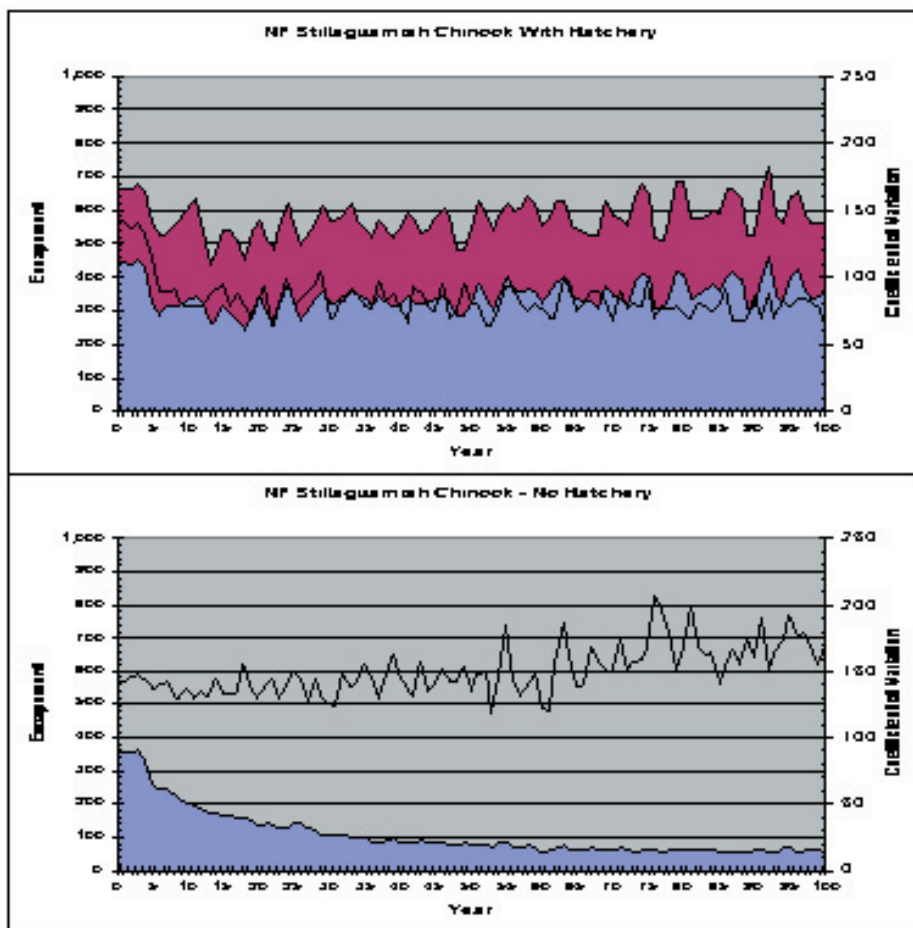
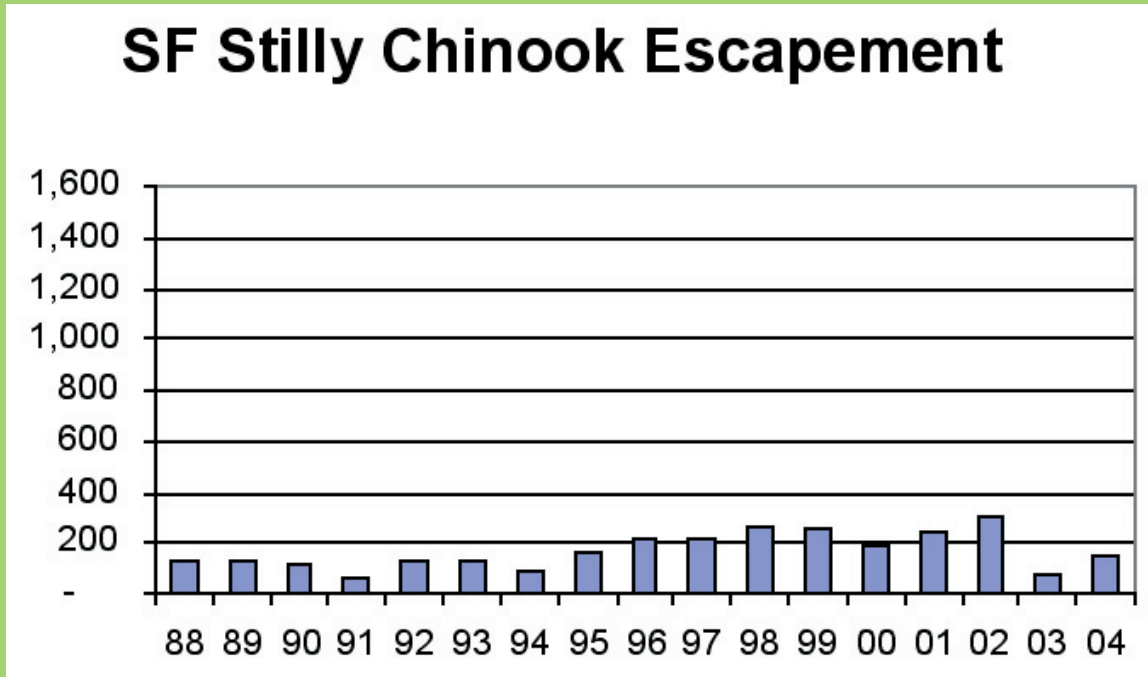


Figure 4



and hatchery fish. We also talked about Managing for Success and keeping track of how we do habitat and harvest management. I'd also mention the Shiraz model and model work by Corey Green and Eric Beamer on the Skagit as other models we can use to evaluate hatchery and habitat improvements. NOAA Fisheries has said that the program we've put together is one of six out of a hundred hatchery programs that is essential for the recovery of the Puget Sound Evolutionary Significant Unit (ESU), and without the program, there is a significant risk that Stillaguamish Chinook will go extinct.

HSRG Recommendations

The HSRG review confirmed the importance of this recovery program and highlighted recommendations for improvements that will make the program even better. They also confirmed that we were not going to recover this stock without significant habitat improvements.

One important benefit of the HSRG review was that it facilitated communication between the co-managers. The HSRG helped us clearly define our

goals and objectives. They raised the importance of having accurate stock and genetic information, and most critically, they provided funding and implementation recommendations. So many times we've been told that we have to implement things, but were never given the resources to do it.

100% of the HSRG technical recommendations for physical plant improvements at the Harvey Creek and White Horse Hatcheries have been funded. 98% of the recommendations have been completed, and I anticipate that by the end of the 2005-07 biennium, we will have implemented 100% of the HSRG technical physical plant recommendations.

Overview of Improvements to Date

We have spent over \$2 million in the 01-05 biennium in our watershed implementing HSRG recommendations, including monitoring and evaluation projects. Thanks to funding through the Hatchery Reform Project and the Bureau of Indian Affairs Cyclical Maintenance Rehab funds, we have made a number of improvements such as:

- New spawning shed



- New early rearing troughs at Harvey Creek
- New generator
- New well at Whitehorse providing 900 gallons per minute of additional water
- New raceways at the Whitehorse replacing old raceways built in the 1950's
- New de-gas tower at Whitehorse
- New spring diversion with aeration at Whitehorse
- New early rearing troughs at Whitehorse
- New incubation trays at Whitehorse

In addition, genetic work funded by the Hatchery Reform Project has been completed. The results of this work demonstrated that, in spite of dumping 7 million Green River fall Chinook in the Stillaguamish from 1950 to 1977, Stillaguamish summer Chinook were genetically discrete from that group. That was good news.

We have added a smolt trap that helps provide a lot of information about survival of hatchery and wild fish and how those fish differ in size and timing when coming out of the river. Total expenditures on Harvey Creek hatchery physical plant improvements were at \$200,000 (which represents ten years worth of my 638 Bureau of Indian Affairs hatchery repair and maintenance budget line item).

In addition to the \$44 million in habitat projects discussed earlier, an additional \$280,000 is needed for hatchery repair and maintenance projects, and a \$100,000 increase in operating costs. It costs us \$141,000 per year right now to do baseline monitoring and evaluation. More monitoring will require more money.

In summary, the program has been greatly improved as a result of the HSRG review process. I believe that we are successfully meeting our near-term goals and objectives for maintaining the North Fork population. Ultimately, meeting long-term objectives will require a collective commitment to restoring the habitat.

Question & Response

Question (Unidentified speaker): For both Thom and Kip, we've talked a lot over the years about "let's jump start populations with supplementation." That Quilcene example looked like a jump-start. Go in, boom, it goes up and looks like, you know, you're still at a low level on supplementation. Stillaguamish Chinook seemed to be hitting the glass ceiling. What are some simple rules of thumb to predict what's going to happen and whether jump-starting is going to work?

Response (Killebrew): Well, I think, at least from my perspective, you need to look at how far into the habitat degradation hole you're in. I think the combination of habitat degradation and over harvest combined with letting the run get pushed so low was a good justification for firing up the hatchery restoration program. To be quite honest, if we're going to recover habitat aggressively, then I'll be out of business sooner rather than later. If you're only going to give me a \$1 million a year to do habitat restoration, my ten-year \$44 million habitat recovery plan becomes a 44 year project.

Question (Alan Chapman): I think you showed a slide of the return for spawners for your natural origin fish related to flow conditions. Was that one of the slides you went by very quickly? Have you seen any improvement in the return for natural origin spawners?

Response (Killebrew): The problem in teasing out that information, Alan, is that the majority of the program fish are returning to spawn on the spawning grounds. They, in turn, produce offspring that contribute to the next generation, and so that's not an easy thing to tease out. Generally the population is increasing in size, and the percentage of first generation program fish coming back is decreasing, so I would make the assumption that the productivity is improving.

