Mid Hood Canal Chinook Recovery Planning Chapter

Submitted to the Shared Strategy for Puget Sound

by

Washington Department of Fish and Wildlife
and
Point No Point Treaty Tribes

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Introduction

Two independent Chinook populations have been identified in Hood Canal – mid Hood Canal and Skokomish (PSTRT 2004). Recovery planning for the Skokomish Chinook population will be addressed separately (for explanation, see immediately following section). This chapter describes current planning for recovery of mid Hood Canal Chinook. In the present application, mid Hood Canal refers to the watersheds of the Dosewallips, Duckabush and Hamma Hamma rivers.

This chapter has been prepared by the Co-managers (Washington Dept. of Fish and Wildlife and the Point No Point Treaty Tribes – WDFW and PNPTT) working with staff of the Hood Canal Coordinating Council (HCCC). Local governments have not yet directly participated in the planning; however, the expectation is that a process will be developed to include them and other watershed partners in the future. The Hood Canal Coordinating Council is a good forum to engage local support and government leaders.

Mid Hood Canal Chinook planning has focused on habitat, hatchery and harvest strategies as the means to implement Chinook recovery. The Co-managers have appropriately led hatchery and harvest planning efforts because they have jurisdiction in these areas. In addition, the Co-managers and HCCC have prepared a habitat analysis using the Ecosystem Diagnosis and Treatment (EDT) method to evaluate priorities and potential benefits of habitat protection and restoration actions. This analysis is, in a sense, an extension of the HCCC's efforts in developing a habitat recovery strategy (HCCC 2004), a strategy that has involved the counties, non-governmental organizations and others. The habitat analysis presented here is intended to assist and extend the previous habitat restoration planning efforts.

A previous draft of this chapter was completed June 30, 2004. The Puget Sound Technical Recovery Team (TRT) reviewed the draft and provided comments. The previous draft notably lacked a discussion of limiting factors and any analysis of habitat protection and restoration actions. Discussions of these topics are included and details of recovery planning specific to Skokomish Chinook are for the most part eliminated in this version of the chapter. We have attempted to address the TRT's comments on the previous draft.[1]

This recovery planning chapter is specific to mid Hood Canal Chinook but is part of a larger process to address the recovery plan requirements of Puget Sound Chinook as a listed species under the Endangered Species Act. The chapter begins with a brief

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[1] See cover letter for specific references of additions and modifications to the chapter.

description of the planning status of Skokomish Chinook, followed by a detailed description of all aspects of current planning for mid Hood Canal Chinook. The sections on mid Hood Canal Chinook include an assessment of limiting factors, a description of recovery goals, discussions of habitat protection and recovery, harvest management and hatchery management and, finally, consideration of the integration of habitat, harvest and hatchery recovery strategies.

Recovery of Skokomish Watershed Chinook

The Skokomish River is the largest river in Hood Canal and is believed to have historically supported a Chinook population with diverse life histories (PSTRT 2004). Because of its size, the river system historically also likely produced the majority of Chinook in the Hood Canal basin. The Skokomish Chinook population is now substantially reduced from what it was in its abundance, diversity, spatial distribution and productivity, but because of its history and potential is a critical component of Chinook recovery in Hood Canal.

Completion of a Skokomish Chinook-specific recovery chapter has been delayed owing to time constraints but also affected by concerns about potential effects from recovery planning upon ongoing Cushman Project litigation. The Cushman project is a hydropower development on the north fork of the Skokomish River. The Skokomish Tribe and the project owner, City of Tacoma, are in litigation over federal licensing of the project.

The current absence of a recovery chapter has not stopped recovery activities affecting Chinook in the Skokomish River. A list of habitat protection and restoration projects, either completed or funded, is provided in Appendix A. Also, the management of harvest and hatcheries is taking Skokomish Chinook recovery into account. Specific management provisions for the Skokomish Chinook management unit are described in the harvest and hatchery management plans (PSIT and WDFW 2004, WDFW and PSTT 2004) that have been prepared as part of section 4(d) rule permitting required for Puget Sound Chinook as a listed species under the Endangered Species Act.

The completion of the Skokomish recovery chapter will require work primarily in determining recovery goals, identifying limiting factors and in formulating the habitat protection and recovery strategy; refinement of the harvest and hatchery strategies is also needed. Additionally, a means to accomplish the work given the litigation concerns must be found. The Skokomish Tribe is expected to have a key role in the recovery planning, but WDFW, other PNPT Tribes and the HCCC would also participate. The amount of time required to complete the Skokomish Chinook recovery chapter is uncertain, but it may be possible finish the chapter by December 2005.

Mid Hood Canal Chinook Limiting Factors

History and Status of Mid Hood Canal Chinook

For recovery planning purposes, the Puget Sound Technical Recovery Team (PSTRT) has identified two Chinook populations that historically and currently exist within the geographic boundaries of the Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU): Mid Hood Canal Rivers Chinook and Skokomish River Chinook (PSTRT 2004). The mid Hood Canal Rivers Chinook population is comprised of Chinook sub-populations located in the Dosewallips, Duckabush and Hamma Hamma watersheds.

The PSTRT concluded that the historical population structure of Chinook in Hood Canal has been lost or substantially modified due to human manipulation of watersheds and Chinook populations. The PSTRT also determined that extensive diversity of the historical Skokomish River population(s) has been lost, including both early-returning Chinook life histories that are no longer expressed and genetic diversity in general owing to effects of extensive introductions of non-native hatchery fish. Early reports on salmonid use of Hood Canal streams documented early-returning Chinook life histories in the Skokomish, Dosewallips, Duckabush, and Hamma Hamma rivers, but more recently only late-returning Chinook are known to be present. Strong genetic similarities of the present Chinook populations to Green River Chinook also suggest the historical genetic characteristics of both the early- and late-returning populations have been replaced or substantially altered by Green River-origin hatchery Chinook that have been extensively released in the region (Myers et al. 1998).

As is the case throughout Puget Sound, it is not clear to what extent the Chinook spawning regularly or occasionally in smaller independent tributaries to Hood Canal may have been demographically linked to the two identified independent populations. NOAA Fisheries assessed the status of Chinook populations in eastern Hood Canal streams and concluded that the Union, Tahuya, and Dewatto rivers probably did not historically support self-sustaining Chinook populations and that Chinook presently occurring in the streams were primarily the result of hatchery introductions or straying from hatchery releases in other Hood Canal streams (NOAA Fisheries 1990). The PSTRT (2004) states that further work will be needed to determine whether Chinook intermittently using small streams contribute to the viability of independent Chinook populations and the recovery of the ESU.

The following information is taken from the profile of the Mid Hood Canal Management Unit in the Co-managers' Chinook harvest management plan (PSTT and WDFW 2004); the management unit corresponds to the mid Hood Canal Chinook independent population.

Chinook spawn in the Hamma Hamma River mainstem up to RM 2.5, where a barrier falls prevents higher access. Spawning can occur also in John Creek when flow permits access. A series of falls and cascades, which may be passable in some years, block access to the upper Duckabush River at RM 7, and to the upper Dosewallips River at RM

14. Spawning may also occur in Rocky Brook Creek, a tributary to the Dosewallips. Most tributaries to these three rivers are inaccessible, high gradient streams, so the mainstems provide nearly the entire production potential.

The mid Hood Canal rivers Chinook population is comprised of Chinook local sub-populations in the Dosewallips, Duckabush and Hamma Hamma watersheds and these sub-populations are at low abundance. Current Chinook spawner surveys are typically limited to the lower reaches of each stream. In the Hamma Hamma River, the majority of the Chinook spawning habitat is currently being surveyed. In the Dosewallips and Duckabush rivers, however, the areas surveyed are transit areas and do not include all spawning areas. Upper reaches of the Dosewallips and Duckabush have been more routinely surveyed since 1998, but few Chinook adults or redds have been observed. Prior to 1993 no reliable estimates are available because all escapement estimates for these rivers were made by extrapolation from the Skokomish River.

The following table describes natural spawning escapement of Mid Hood Canal fall Chinook salmon for the years 1993 through 2004.

River	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Hamma Hamma	28	78	25	11	na	172	557	381	248	32	95	49
Duckabush	17	9	2	13		57	151	28	29	20	12	0
Dosewallips	67	297	76	na		58	54	29	45	43	87	80
Total	142	384	103	na		287	762	438	322	95	194	129

In 1992, the Salmon and Steelhead Stock Inventory (SASSI) classified Hood Canal summer/fall Chinook as a single stock of mixed origin (both native and non-native) with composite production (sustained by wild and artificial production) (WDF et al. 1992). The combination of recent low abundances (in all tributaries except the Skokomish River) and widespread use of hatchery stocks (often originating from sources outside Hood Canal) led to the conclusion in SASSI that there were no remaining genetically unique, indigenous populations of Chinook in Hood Canal. A study is currently underway to characterize the genetic profile of Chinook juveniles and adults in the Mid Hood Canal rivers' population.

Stock status of Hood Canal summer/fall Chinook was rated as “Healthy” in 1992, but was primarily due to the abundance of hatchery Chinook. In 2002, when SASSI was updated, mid Hood Canal Chinook were classified as a single stock, comprised of Chinook salmon that currently spawn in the Hamma Hamma, Duckabush and Dosewallips watersheds (WDFW 2002). In 2002, the stock status was rated as “Critical”, primarily because of chronically low spawning escapements whose average escapement abundance, over the 1991-2002 period, failed to meet the established low escapement threshold of 400 Chinook (which is approximately 50% of the current escapement goal in the Hood Canal Salmon Management Plan (HCSMP 1986)).

Climate as a Limiting Factor

Pacific Northwest climate is a key driver in determining when, where, and how much water is available in Washington State. Climate and its effects on ocean processes, weather, streams and estuaries is a complex subject.

The available data for mid Hood Canal Chinook are insufficient to examine the possibility of climate as a limiting factor. Escapement and run size estimates are not reliable prior to 1993 (see following sub-section addressing harvest). The time frame for comparing climate changes to Chinook abundance estimates is too limited for a useful assessment. However, Mid Hood Canal Chinook spawn in the Hamma Hamma, Duckabush, and Dosewallips rivers at about the same time and in the same reaches as summer chum salmon. Since a longer, reliable record of summer chum abundance estimates exists, and climate changes relative to summer chum abundance have been reviewed, an indirect consideration of climate effects relative to mid Hood Canal Chinook is possible.

Hood Canal summer chum declined in abundance beginning with the 1979 adult return. A review by the Co-managers of the potential impacts of climate on Hood Canal summer chum salmon in the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000) identified general patterns of climate that may have contributed to the changes in summer chum salmon status. The following summarizes possible effects of climate change since 1977 and the potential effects on summer chum salmon that should also apply to mid Hood Canal Chinook:

- *Ocean effects*: The phenomena of fluctuations in ocean conditions, namely the El Nino-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), have received a great deal of recent attention in the Pacific Northwest fisheries community because of increasing evidence that these fluctuations can have profound effects on the growth and survival of Pacific salmon and other types of fish. The ocean productivity effects on mid Hood Canal Chinook survivals are not measurable due to lack of reliable stock abundance data. The recent success of fall chum salmon in Hood Canal suggests it is unlikely that changes in marine survival significantly contributed to the decline of summer chum. But no clear evidence exists regarding ocean effects on mid Hood Canal Chinook. In addition, at least for Washington State, there is a potential confounding factor; the PDO drives our climate, which directly influences stream flow patterns, and thus affects freshwater and estuarine salmon survivals (personal communication, Jim Ames, WDFW).

- *Estuarine effects*: Regional climate patterns (e.g., rainfall and air temperatures) are affected by changes in ocean conditions related to ENSO events and shifts in the PDO. These are the kinds of changes that can influence the productive capacity of estuaries, however, at this time it is not known to what degree climate shifts may or may not have affected estuaries or contributed to decline of summer chum and mid Hood Canal Chinook.

- *Freshwater effects, spawning and incubation flows*: The increase in peak incubation flows after the PDO shift in 1977 is substantial (+31% for the Duckabush River, the only mid Hood Canal watershed with a useful flow record), and increased flow related mortalities of incubating eggs and fry in the gravel are a likely result. The elevated incubation flows may well have been a contributing factor to the lack of recovery and continued decline of summer chum (and mid Hood Canal Chinook) in the early 1980's. Increased intra-redd mortality resulting from higher incubation flows could have been exacerbated by the major reduction in spawning flows that occurred beginning in 1986. The major decline that occurred in September/October average stream flows (-49% in Duckabush River) has several potentially serious consequences for mid Hood Canal summer chum and Chinook. The early return and spawning timing of mid Hood Canal summer chum and Chinook makes them particularly vulnerable to reductions in stream flow. Low flows and elevated water temperatures could delay the entry of the fish to spawning streams, which could increase their susceptibility to predation. Once in the stream, they would be forced to spawn in mid channel areas, exposing resulting eggs and alevins to increased levels of mortality during subsequent high flow events. A continuation of the combination of low flow patterns during spawning and elevated incubation flows of recent years could slow the recovery rate of mid Hood Canal summer chum and Chinook.

- *Climate in relation to human caused impacts*: Climate shifts like those observed in the past 30 years, with their associated stream flow changes, likely posed little threat to Chinook before the cumulative effects of habitat changes from human development became manifest. Human changes to Hood Canal stream and estuarine ecosystems have diminished the natural resiliency of summer chum and Chinook habitat, rendering populations more vulnerable to climate shifts.

Habitat as a Limiting Factor

There have been two recent evaluations of habitat limiting factors in the mid Hood Canal watersheds. A technical team of biologists from state, tribal and non-governmental organizations under the auspices of the Washington State Conservation Commission conducted one evaluation. The other evaluation was done by the Co-managers and used a tool called the "Ecosystem Diagnosis and Treatment" or EDT method (Lestelle et al. 2004). Following are summaries of the results of these efforts.

Washington State Conservation Commission: This assessment of limiting factors for salmon habitat in mid Hood Canal watersheds used a multi-species approach. The technical team conducted an extensive review of historic and current Hood Canal watershed and shoreline conditions (Correa 2003). Although the approach was multi-species, the estuarine / nearshore and lower river analyses of limiting factors are applicable to habitat recovery efforts for Chinook.

Key findings for factors of decline for each watershed are summarized in Table 3.1 and are outlined below:

- Dosewallips River watershed

    - Loss of channel complexity, side channels and floodway from levee construction, bank hardening, and splash dam; loss of in-channel wood; estuarine marsh affected by levees and filling

- Duckabush River watershed

    - Loss of estuarine complexity and connectivity through highway construction; floodplain and side channel access lost from lower river development; loss of riparian vegetation in lower river; loss of in-channel wood

- Hamma Hamma River watershed

    - Loss of channel complexity and in-channel wood in lower river due to dredging, bank hardening and channelization; bed instability, and sedimentation in lower Johns Creek at least partially as a result of landslides associated with road failures and clearcutting; impaired connectivity and loss of tidal prism in the estuary from dredging and diking; restricted tidal action caused by the Highway 101 causeway; isolation of estuarine marsh

In each watershed, the lower river and estuary was most impacted by historic development patterns and past logging practices. The need for restoration of natural processes to the river and estuarine systems was a continuous theme.

Table 3.1. Summary of habitat quality ratings in Washington Conservation Commission limiting factors analysis for Water Resource Inventory Area 16 (Correa 2003).

Stream Name/Segment	Access	Floodplain Connectivity	Floodplain Habitat	Fine Sediment	LWD	% Pool	Pool Frequency	Pool Quality	Bank Stability	Sediment Supply	Mass Wasting	Road Density	Riparian Condition	Water Temperature	Dissolved Oxygen	Hydrologic Maturity	% Impervious	Nutrients
__Dosewallips__																		
Dose RM 0.0-3.6	G	P	G	DG	P	DG	DG/G	P	P	P	G	F	P	G	DG	DG	G	P
Dose RM 3.6-12.5	G	P	P	DG	P	DG	DG/G	P	P	G	G	G	G/P	F/G	DG	DG	G	P
Rocky Brook	G	NA	NA	DG	P	P	G	P	DG	DG	P	P	DG	F/G	DG	G	G	DG
__Duckabush__																		
Duck RM 0.0-5.0	G	F/P	P		P/F	F	DG	DG	DG	DG	P	F	P/F	F/G	DG	F	G	P
Duck RM 5.0 - 8.0	G	NA	NA			DG	DG	DG	G	DG	P	G	G	DG	DG	G	G	P
__Hamma Hamma__																		
Hamma RM 0.0-1.5	G	P	F	DG	P	F	DG	DG	G	G	DG	P	P	G	DG	DG	G	F/P
Hamma RM 1.5-2.3	G	NA	NA	DG	P	F	DG	DG	G	DG	DG	P	G	DG	DG	DG	G	F/P
Johns Creek	G	F	F	F	P/G	F	DG	P	DG	P	P	F	P/F	F	DG	G	G	F/P

P poor   F fair   G good   DG data gap   NA not applicable

<u>EDT Analysis of Limiting Factors</u>: Habitat attributes were rated by the Co-managers for each river reach in the three watersheds. The EDT analyses summarized the priorities for Chinook habitat restoration based on limitations to habitat attributes. For each watershed, attributes related to habitat diversity, channel stability, key habitat quantities, flow, and sediment load were shown to be the most limiting (Figures 3.1, 3.2, 3.3).

Dosewallips Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			**Attribute class priority for restoration**															
Geographic area	**Protection benefit**	**Restoration benefit**	***Channel stability/landsc.1/***	***Chemicals***	***Competition (w/ hatch)***	***Competition (other sp)***	***Flow***	***Food***	***Habitat diversity***	***Harassment/poaching***	***Obstructions***	***Oxygen***	***Pathogens***	***Predation***	***Sediment load***	***Temperature***	***Withdrawals***	***Key habitat quantity***
Dose 1	◯	○	●				•		●						●			●
Dose 2		∘	⬤				●		⬤						●			●
Dose 3	○	◯	●				●		⬤						●			●
Dose 4	∘		•				●	•	⬤									●
Rocky Brook			⬤				●		⬤	•					●			●

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯	High	○	Medium	∘	Low	☐	Indirect or General
⬤		●		•		☐	

Figure 3.1. Description of habitat attributes limiting Dosewallips Chinook viability and a summary of protection and restoration priority ratings

Duckabush Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Duck 1	○	◯	⬤				●		⬤						●			●
Duck 2	◯	○	●				•		•						●			•
Duck 3	◯	○	●				●	•	⬤									
Duck 4	○	◦	●				•	•	●						●			●
Duck 5	○		●				•		●									⬤

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯	High	○	Medium	◦	Low		Indirect or General
⬤		●		•			

Figure 3.2. Description of habitat attributes limiting Duckabush Chinook viability and a summary of protection and restoration priority ratings.

Hamma Hamma Fall Chinook
Protection and Restoration Strategic Priority Summary

Geographic area priority			Attribute class priority for restoration															
Geographic area	Protection benefit	Restoration benefit	*Channel stability/landsc.1/*	*Chemicals*	*Competition (w/ hatch)*	*Competition (other sp)*	*Flow*	*Food*	*Habitat diversity*	*Harassment/poaching*	*Obstructions*	*Oxygen*	*Pathogens*	*Predation*	*Sediment load*	*Temperature*	*Withdrawals*	*Key habitat quantity*
Hamma 1	◯	◯	⬤				•		●						●			●
Hamma 2		○	⬤				•		●						●			●
Hamma 3	○	◦	•				●		⬤						●			•
John Creek 1	◦	○	●				●		●						●			•
John Creek 2			●				•	•	⬤						●			●

1/ "Channel stability" applies to freshwater areas; "channel landscape" applies to estuarine areas.

Key to strategic priority (corresponding Benefit Category letter also shown)

A		B		C		D & E	
◯	High	○	Medium	◦	Low		Indirect or General
⬤		●		•			

Figure 3.3. Description of habitat attributes limiting Hamma Hamma Chinook viability and a summary of protection and restoration priority ratings.

For the three watersheds, habitat conditions related to successful egg incubation were most limiting in all reaches (Appendix B). Typically, habitat conditions related to fry colonization and, in some areas, pre-spawning holding were also important limiting factors. General trends also indicated that protection and restoration efforts in the lower watershed would have the most effect on population parameters.

The habitat project actions listed in Table 5.1 were developed to address the key limiting factors identified by the technical team during both the WRIA 16 limiting factors analysis and the EDT analysis. Specific information from the EDT analysis will be important to plan and prioritize individual habitat protection and restoration projects as opportunities arise for implementation.

Harvest as a Limiting Factor

Assessment of harvest as a limiting factor is constrained by lack of data. While the Co-managers have estimated mid Hood Canal Chinook escapements and reconstructed mid Hood Canal Chinook runs over the past 35 years or so, the quality of these estimates was poor until 1993. Prior to 1993, mid Hood Canal Chinook spawner surveys were either non-existent or very limited. Escapements were estimated by using Skokomish River escapement estimates as an index or, in the case of Dosewallips, applying a multiplier to the annual peak spawner count (Smith and Castle 1994). Since run reconstruction is primarily dependent on escapement values, the poor quality of escapement estimates impacted the quality of run size estimates.

Beginning in 1990, terminal commercial fisheries, that potentially affected mid Hood Canal Chinook, diminished to low levels and have remained so until the present. So for the time since 1992 when good escapement data exist, terminal commercial fisheries harvests have been very low and any impacts would have been from preterminal fisheries. A brief recent history of fishing that affected mid Hood Canal Chinook provides some indication of how harvest may have been a limiting factor.

Prior to 1974, Hood Canal was closed to commercial salmon fisheries except for some on-reservation fishing in the Skokomish River. Recreational salmon fishing was permitted and regulated by daily catch and possession limits. The Hood Canal commercial fishing closure was the result of State legislation extending back to the 1930s that designated Hood Canal as a salmon preserve. Commercial salmon fishing began to develop in 1974 in response to the Boldt Decision (U.S v. Washington, No. 9213) that affirmed the western Washington Tribes treaty fishing rights and effectively ended the Hood Canal salmon preserve designation. Treaty and non-treaty Chinook commercial fishing commenced and grew in Hood Canal through the 1980s.

This new post-1973 commercial fishing effort was managed with emphasis on the Chinook produced by WDFW hatcheries on the Skokomish River and at Hoodsport. Harvest in mixed stock areas was managed to take advantage of the large hatchery production and accommodate hatchery escapement needs. Management to protect naturally produced fish occurred only in the extreme terminal areas (within 1000 feet of the stream mouths in marine waters and within the streams). Natural Chinook were designated as “secondary” management stocks under this management regime as described in the 1986 Hood Canal Salmon Management Plan (HCSMP 1986) and hatchery Chinook were designated as “primary” management stocks. Since hatchery escapement goals are less, proportional to run size, than are natural escapement goals, the natural stocks would have been susceptible to over-harvest (i.e., not meeting escapement goals) in mixed stock fisheries managed to meet only hatchery escapement goals. Contributing to the harvest effects were the preterminal fisheries outside Hood Canal, including Washington troll, Washington net, Washington recreational and Canadian fisheries, and the recreational fisheries in Hood Canal. Canadian fisheries dominated the preterminal impacts on Puget Sound stocks and were generally higher in the 1980s than they are today.

Hood Canal, commercial mixed stock fisheries catch information is shown in the following table. Combined treaty and non-treaty harvests are shown for catch areas 9A, 12, 12A and 12B, extending from the Hood Canal Bridge south to Ayock Point, which incorporates the approximate upper two thirds of Hood Canal. These catches would include hatchery Chinook (predominantly) but also natural stocks (primarily of the Skokomish but including mid Hood Canal watersheds). The catch information in the table shows the pattern of terminal commercial fishing in these Hood Canal mixed stock areas since 1974.

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Catch	9,312	587	1,932	2,515	1,909	4,324	7,292	3,539	3,376	2,506	4,779	6,780	4,218	5,252	4,473

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Catch	901	550	51	132	34	42	9	15	76	101	38	375	97	2	127

The catches can be seen to build through the 1980s, but then to decrease to substantially lower levels beginning 1990 and continuing to the present. These data suggest that the mid Hood Canal Chinook population was susceptible to Hood Canal commercial mixed stock harvest that, in combination with that of other fisheries, could have limited escapements and impacted the mid Hood Canal Chinook population during the 1980s. The mixed stock fisheries harvest fell off for a number of reasons, including reduced tribal effort owing to higher fishing costs in the northern areas (personal communication, Nick Lampsakis), general lower survivals of Chinook potentially affected by reduced ocean survival, State policy changes regarding commercial fisheries, and the initially pending but later realized ESA listing of Puget Sound Chinook as a threatened species.

A new management approach was developed in the 1990s where natural Chinook (specifically mid Hood Canal Chinook) was no longer treated as a “secondary” management stock in Hood Canal and was protected in managing the Washington State preterminal and terminal fisheries. Beginning in 2001, mid Hood Canal Chinook was incorporated in the FRAM model as part of the annual preseason fisheries planning process. In recent years, mid Hood Canal Chinook has been a “driving stock” because of its low expected escapements and has been a major factor in limiting fisheries during preseason fisheries planning to ensure its protection (see below harvest management section).

In conclusion, while data is lacking to demonstrate conclusively that harvest was a limiting factor for mid Hood Canal Chinook, the recent history of Chinook fishery management shows natural Chinook were not protected from terminal mixed stock fisheries during the 1980s when Hood Canal Chinook fishing was at its peak. The potential exists for harvest to have been a limiting factor during this period. More recently, from 1990 to the present, fishing effects on Chinook survival continue, primarily owing to preterminal (predominantly Canadian) fisheries; recent total fisheries exploitation rates are estimated to be in the low 30-percentile range. See also the analysis of current harvest effects in the sub-section, Potential Harvest Effects on the VSP Parameters of Diversity and Spatial Distribution, within the harvest management section.

Hatcheries as a Limiting Factor

Hatcheries in Hood Canal have produced large numbers of Chinook for harvest, mitigated for natural Chinook production lost due to habitat degradation, and, more recently, are being used as a tool to rebuild a natural Chinook population. However, hatcheries may pose potential risks to natural Chinook populations in Hood Canal, as briefly summarized, below.

Hatchery Chinook adults that do not return to the hatchery, but stray onto natural spawning grounds, may interbreed with natural Chinook adults, compete with or displace natural adults from favorable spawning areas, and produce juveniles that could compete with natural juveniles for food and space in freshwater or estuarine areas. Alone and in combination, these interactions can potentially reduce the number of natural Chinook eggs or juveniles that survive, reduce the fitness of natural populations and, thus, affect the reproductive success of the natural Chinook.

Hatchery Chinook fry, fingerlings, or yearlings that are released directly from a hatchery into natural production areas can also pose risks by competing with, preying on, and/or interacting with natural Chinook juveniles. Other species (e.g., coho and steelhead smolts) that are released from hatcheries into natural production areas could prey on natural Chinook juveniles. The result, again, could be the survival of fewer natural Chinook.

Mid Hood Canal Chinook have been exposed to each of these potential risks. A brief history of hatchery programs that may have affected mid Hood Canal Chinook provides some indication of how hatcheries may have been a limiting factor.

A variety of hatchery Chinook stocks from outside of the Hood Canal watershed were used to begin the hatchery programs that release Chinook in Hood Canal. WDFW Hoodsport Hatchery was started in 1952, WDFW George Adams Hatchery fall Chinook originated in 1961 from Hoodsport Hatchery stock, and LLTK has since the mid 1990s operated hatchery facilities that produce Chinook derived from George Adams Hatchery Chinook. The Hoodsport Hatchery Chinook program was started with several years of releases derived from Soos Creek Hatchery (Green River) summer/fall Chinook until the Hoodsport program became largely self-sustaining. Transfers of Chinook into Hood Canal hatcheries continued into the 1980's and included Chinook from Tumwater Falls (largely derived from Soos Creek), Voights Creek (Puyallup basin), Big Beef Creek, Minter Creek (South Puget Sound), and Trask River (Oregon) hatchery Chinook populations. In the early 1990's, a new stock transfer policy designed to foster local hatchery brood stocks was developed (WDF 1991) and out-of-basin transfers of eggs and juveniles were greatly reduced.

The actual contribution of these various hatchery donor stocks to the initial genetic composition of Hood Canal Chinook hatchery programs is unknown. Genetic analysis of hatchery samples collected in 1998 indicates that George Adams and Hoodsport hatchery Chinook are most genetically similar to each other and to other Chinook originating from South Sound hatcheries. It appears, though, that Hood Canal area populations may have formed a group differentiated from south Puget Sound populations (see also below discussion of mid Hood Canal Chinook genetics), possibly indicating that some level of adaptation may be occurring following the cessation of transfers from south Sound hatcheries (Marshall, 2000).

The occurrence or number of hatchery adults that strayed onto natural production areas in Hood Canal was not known until recently, primarily because there was no method to identify hatchery Chinook and there was little or no monitoring. Beginning in the 1980's, some (e.g., 450,000 of about 6 million) hatchery Chinook were marked and/or coded-wire tagged and some hatchery adults were subsequently recovered in Hood Canal streams, but mostly in the Skokomish River and eastern Hood Canal streams. Few fish identified as hatchery strays were recovered in mid Hood Canal rivers, but the majority of hatchery Chinook are not identifiable (i.e., are not marked or tagged).

Substantial numbers of Chinook fry have been released from Hood Canal hatcheries into mid Hood Canal rivers, but the impact on natural Chinook is unknown. A total of about 4.1 million, 3.7 million, and 117 million Chinook fry were released into the Hamma Hamma, Duckabush, and Dosewallips rivers, respectively, during the period 1958 through 1992. Chinook fry were not released into each river each year and most releases ranged from about 50,000 to about 117,000 fry per year in the Hamma Hamma River, from about 112,000 to about 614,000 fry per year in the Duckabush River, and from about 167,000 to about 600,000 fry per year in the Dosewallips River. Fry outplanting into mid Hood Canal rivers was terminated in 1991, coincident with implementation of the new stock transfer policy mentioned above.

Genetic characterization of the mid Hood Canal Chinook has, to date, been limited to comparison of adults returning to the Hamma Hamma River in 1999 with other Hood Canal and Puget Sound populations. These studies, although not conclusive, suggest that returns to the Hamma Hamma River are not genetically distinct from the Skokomish

River returns, or recent George Adams and Hoodsport hatchery broodstock (A. Marshall, WDFW unpublished data). The reasons for this similarity are unclear, but straying of Chinook that originate from streams further south in Hood Canal, and hatchery stocking, could be contributing causes. No genetic samples have been collected from Chinook in the Duckabush or Dosewallips rivers, primarily due to the low numbers of returning adults that make sampling difficult. Sampling of naturally produced juvenile Chinook from mid Hood Canal Rivers may provide additional insights. In a status review of Puget Sound Chinook, Myers et al. (1998) concluded that strong genetic similarities of the present Hood Canal Chinook populations to Green River Chinook suggested the historical genetic characteristics of both the early- and late-returning natural populations have been replaced or substantially altered by Green River-origin hatchery Chinook that have been extensively released in the region.

In conclusion, the scientific literature indicates that artificial production in hatcheries may pose risks to wild Chinook salmon populations. These potential risks include: 1) genetic impacts, which affect the loss of diversity within and among populations and reproductive success in the wild; 2) ecological impacts, such as competition, predation, and disease; and 3) demographic impacts, which directly affect the physical condition, abundance, distribution, and survival of wild fish (WDFW and PSTT 2004).

The actual impact is unknown and difficult to determine, but hatchery programs may have contributed to limiting the abundance and productivity of mid-Hood Canal Chinook. Many of the potential risks of hatchery programs have been or are being addressed by the Co-managers (see below hatchery management section).

Predation by Seals as a Limiting Factor

WDFW and the University of Washington Cooperative Fish and Wildlife Research Unit researched harbor seal predation on salmon in Hood Canal for four years, 1998 - 2001. Recent renewed interest in the Hood Canal project, triggered by Orca preying on the harbor seals, may lead to additional research. The four years of research on salmon predation by seals was conducted at the mouth of several Hood Canal watersheds including Hamma Hamma, Duckabush, Dosewallips and Quilcene. Observations of salmon kills by seals were recorded at selected time periods and extrapolated to estimate numbers of salmon taken by seals in each year and watershed. It was not possible to distinguish species of salmon during these surveys. An effort was made to allocate the estimated salmon kills among species for 1998 and 1999 (Jeffries et al. 2001) based on relative sizes of species escapements to the rivers, but because of variables in the run timing and accuracy of escapement estimates (not to mention the potential for preferential seal selection of prey by species or differences in success of seal pursuits by species), the attempt at allocation among salmon species is of questionable reliability. Table 3.2 describes the extrapolated estimate of total number of salmon kills by year and watershed for the years 1998 through 2001.

Table 3.2. Estimates of daytime and 24 hour harbor seal predation on salmon species in Hood Canal Rivers 1998-2001 (London et al. 2003).

Observation dates	**Total observation hours**	**Quilcene Bay**	**Dosewallips River**	**Duckabush River**	**Hamma Hamma River**
1998 (5 Sept - 20 Nov)	817				
Daytime		212	100	40	16
24 hr		414	202	84	27
1999 (15 Aug - 11 Nov)	1,212				
Daytime		71	171	256	100
24 hr		134	336	482	190
2000 (15 Aug - 29 Oct)	600				
Daytime		147	81	162	114
24 hr		305	218	441	250
2001 (12 Aug - 1 Nov)	478				
Daytime 24 hr		----	--264 [1]	--1,801 [1]	----

[1] Only 24 hr estimate currently available.

Results include both daytime only and extrapolation (based on daytime observations) to 24-hour estimates of salmon preyed upon by seals. The presence of pink salmon in 1999 and 2001 likely affected the estimates in these two years (London et al. 2003). Because the results apply to all salmon species within the time frame cited in Table 3.2, it is not possible to distinguish the effect of seal predation on Chinook in the mid Hood Canal watersheds. Nevertheless, it is reasonable to assume that Chinook would have been vulnerable to seal predation and, given the relatively small recent Chinook escapements, seals may be a factor limiting survival.

In addition to the seal predation observations, the research included collecting and analyzing fecal (scat) samples each year (except no samples were taken in the Hamma Hamma River in 2000 and 2001). Salmon were found to be the third most frequently occurring prey category in the diet of the Hood Canal harbor seals, with a percent frequency of occurrence of 27.4. Only Pacific Hake and Pacific Herring had higher percent frequencies of occurrence (75.1 and 42.7, respectively) (London et al. 2003). It's important to note, however, that Jeffries et al. (2001) observed the predation on salmon was by a small number of seals, (two to six individuals in the lower reaches and estuary of a river).

In conclusion, research has shown that harbor seals may be taking hundreds salmon from each mid Hood Canal rivers and while specific information on Chinook is not available, it is likely the mid Hood Canal population is being affected. Seal predation may have been and may continue to be a limiting factor on mid Hood Canal Chinook.

Mid Hood Canal Chinook Recovery Goals

Federal, State and Tribal fisheries biologists and managers have recently developed abundance and productivity targets for threatened Chinook salmon populations in Puget Sound. These recovery goals allow fisheries managers, local governments, watershed planning groups and funding agencies to assess progress of protection and recovery actions; they also provide a stimulus to development of new recovery projects. The Puget Sound Shared Strategy Forum hopes to combine recovery goals and action plans from all Puget Sound watersheds having Chinook populations listed as threatened into a comprehensive recovery plan for presentation to the National Marine Fisheries Service (NMFS). Recovery goals will assist NMFS in determining under what conditions and when “de-listing” of threatened Chinook populations may take place.

The Puget Sound Technical Review Team evaluates population viability using four key characteristics for viable salmonid populations (VSP) (McElhany et al. 2000): abundance, productivity/growth rate, diversity and spatial structure. Planning targets are meant to be based on the same four factors: 1) Abundance – the number of fish needed to assure the population will persist over time (provides a buffer); 2) Productivity – how many fish are produced per adult spawner (promotes re-building the population); 3) Diversity – the variations in genetic and physiological characteristics such as age distribution at maturity, spawning timing or migration path (provides flexibility); and 4) Spatial structure – the geographic diversity and distribution needed to protect against a catastrophic occurrence in one location.

The current focus in setting the recovery goals is on Chinook abundance and productivity. A tool called the “Ecosystem Diagnosis and Treatment” or EDT method (Lestelle et al. 2004) has been used to model the parameters for recovery of the Chinook populations. The method assesses habitat conditions and Chinook life history information from within the watersheds, incorporating data from local studies and biologists. The EDT analysis is based on properly functioning conditions (PFC) for freshwater habitats (NMFS 1996) plus pristine estuarine conditions to describe two Chinook population characteristics (abundance and productivity) that should exist under recovery.

The following planning targets for abundance and productivities were developed for the Hamma Hamma, Duckabush, and Dosewallips Chinook sub-populations of mid Hood Canal Chinook based on results generated by the EDT method.

Chinook sub-population	Escapement planning targets (with productivity in parentheses *)		Mean escapement (1993-2004)
Hamma Hamma R.	1000 (1.0)	250 (3.0)	152
Duckabush R.	1200 (1.0)	325 (3.0)	31
Dosewallips R.	3000 (1.0)	750 (3.0)	84
* Note: Productivity is expressed as adults produced per spawner			

The planning targets are based on assessments of properly functioning habitat and recent marine survivals. They represent a range of escapements and the associated productivities (or adult returns per spawner) that would constitute recovery. The range is needed to show that abundance and productivity are related, and even under recovery conditions, will tend to vary inversely (i.e., the productivity declines when the abundance increases and vice versa). Thus, the range of related target escapements and productivities shown represents the recovery goals. The range also represents the significant uncertainty that exists in our understanding of Chinook salmon populations and their ecosystems. It is important to note that even the lower escapement target for returning adult Chinook in each sub-population is substantially higher than the mean escapement from 1993 to 2004.

The recovery targets provide tangible goals against which the progress of Chinook recovery efforts may be measured. The Co-managers can help increase the abundance of Chinook returns to the watersheds by limiting harvest and through hatchery supplementation, but improving productivity (that also affects abundance) can only occur with protection and restoration of habitat.

Diversity and spatial recovery goals have not yet been developed. For now, it is anticipated that management of hatcheries and fisheries harvest, along with efforts to protect and restore habitat, will help to maintain and eventually improve Chinook population diversity and spatial structure.

Mid Hood Canal Chinook Habitat Protection and Recovery

Key Past and Present Salmon Habitat Planning Efforts in Hood Canal

Habitat planning efforts in Hood Canal promote protection and restoration of ecosystem health as the key to recovery efforts. Emphasis on restoration of natural processes, such as sediment supply and flow regimes, is common to all of the current planning efforts and result in multi-species benefits. Hood Canal has a strong network of resource advocates, including the Co-managers and local government staff, working closely together to improve technical information and provide adaptive management for habitat planning efforts as new information becomes available.

However, recovery planning efforts for Chinook will require engagement of local, state, federal and tribal governments, business interests, environmental groups, salmon enhancement groups, among others. The foundation for a Hood Canal Chinook salmon habitat recovery plan exists in the current and completed planning efforts. However, more work with stakeholders and their engagement in the Shared Strategy is necessary to develop and achieve Chinook habitat goals.

Chinook salmon habitat planning goals often overlap with Hood Canal summer chum salmon habitat goals. Both summer chum and Chinook spawn in the lower river and move to the estuaries and nearshore marine waters in early life stages. While the

Dosewallips, Duckabush, and Hamma Hamma watersheds are the primary focus of this document, Chinook spawning has been observed in most of the other summer chum rivers and streams. Both species are present in the nearshore marine environment for extended periods of time and overlap in distribution in marine waters. Therefore, habitat protection and restoration goals from summer chum recovery planning efforts for the Chinook systems and nearshore marine waters will benefit Chinook as well. Potential for implementation of habitat actions by local, state, federal and tribal governments is strengthened when benefits are obtained for more than one species. A brief description of key past and present habitat planning efforts in Hood Canal follows.

Summer Chum Salmon Conservation Initiative: The Summer Chum Salmon Conservation Initiative (SCSCI, WDFW and PNPTT 2000) outlines habitat goals for summer chum habitat in lower river and marine / estuarine waters. The key habitat factors for summer chum are directly applicable to Chinook habitat recovery strategy. The SCSCI executive summary states:

> *Several key habitat factors are degraded in nearly all watersheds:*
>
> 1. *Forest conditions along streams used by summer chum are degraded. These stands are dominated by small trees and deciduous species, and are frequently too narrow to provide quality habitat for summer chum.*
> 2. *In-stream habitat is also degraded. In most watersheds stream-side development, water withdrawal, and channel manipulations (removal of large wood, dredging, bank armoring) have severely damaged salmon habitat.*
> 3. *Floodplains have been diked for residences and businesses and converted for agriculture. This has reduced the storage area of floodwaters. Habitat is degraded in the diked portions of the channel that is not allowed to meander naturally across the floodplain.*
> 4. *Most subestuaries have been developed for human use, which has resulted in loss or degradation of summer chum rearing habitat. Road and dike construction, ditching, dredging, filling, and other modifications have all taken their toll. In spite of their importance to salmon, these habitats have received only limited conservation attention to date.*

In the SCSCI Appendix 3.5, Simenstad describes the reliance of summer chum on estuarine and nearshore marine waters. Juvenile Chinook are considered to be more dependent on estuaries than chum (Healy 1982) due to length of residence and diversity of life histories within estuaries. Less is known about dependence on nearshore marine waters for both species, although both are present in shallow waters during spring and summer. The conclusions from SCSCI for importance of estuaries and nearshore for chum are equally applicable to Chinook recovery.

> *Restoration and mitigation of degraded nearshore habitat should be equally important to recovery of sustainable summer chum populations as any recovery actions in freshwater or estuarine deltas. In conjunction with subestuary delta habitat restoration or mitigation, the integrity of nearshore corridors needs to be enhanced or restored through removal or modification of major man-made structures that disrupt the maintenance of natural nearshore attributes. This would involve not only removal or modification of*

> *shoreline structure that impedes fish migration, but should also promote restoration of natural nearshore processes.*

If there is one guiding concept to the ideas expressed in this document, it is that estuarine nearshore summer chum and Chinook habitat is an essential segment in a continuum that bridges their natal freshwater with open ocean rearing ecosystems. Ignoring causes for decline and actions for recovery within the estuarine landscape will likely neutralize any significant recovery actions in individual watersheds or subestuary deltas. Much work remains to validate our hypotheses related to the importance of the estuarine landscape to summer chum; nonetheless, even our present-day knowledge base is sufficient to indicate that failure to act on estuarine landscape-scale recovery will postpone or prevent recovery of summer chum and Chinook in Hood Canal.

Current Hood Canal Summer Chum Salmon Recovery Planning: The Hood Canal summer chum salmon recovery plan is in development at this time and is complementary to Chinook planning (HCCC in prep. 2005). This recovery plan builds on the aforementioned Summer Chum Salmon Conservation Initiative, focusing on habitat protection and restoration. We expect salmon habitat planning for the Hood Canal watershed to be coordinated into a strategy beneficial to both species.

Hood Canal Coordinating Council Salmon Habitat Recovery Strategy: The Hood Canal Coordinating Council (HCCC) was designated as the Lead Entity for the Hood Canal watershed in 2000 for coordination of salmon recovery projects from local, state, federal and tribal governments, environmental groups, regional fish enhancement groups and other interested citizens. The Hood Canal Coordinating Council's Salmon Habitat Recovery Strategy for the Hood Canal and Eastern Strait of Juan de Fuca (HCCC 2004) is the result of five years of local collaboration, with periodic updates based on emerging scientific and technical information. Although multi-species in overall approach, the strategy is an excellent guide for prioritizing habitat recovery actions and places Chinook habitat in the highest prioritization categories as indicated in the following extract:

> ***HCCC Salmon Habitat Recovery Strategy Scientific Information and Technical Foundation***
>
> *The foundation for the Strategy is more than five years of local collaboration to define salmon habitat recovery in Hood Canal (HC) and the Eastern Strait of Juan de Fuca (SJF). The LEPAC [Lead Entity Process Assessment Committee] discussions for Strategy revisions focused on updating scientific and technical information and including community interests to improve our overall approach to project prioritization. Consistent with previous versions, the revised Strategy prioritizes Endangered Species Act (ESA)-listed and Salmonid Stock Inventory (SaSI)-critical stocks for restoration and protection actions. The revised Strategy goes further by adopting a conservation biology approach within three eco-regions of Hood Canal, represented roughly by Water Resource Inventory Area (WRIA) boundaries, in an attempt to conserve the regional genetic and habitat diversity within the Summer Chum Salmon ESU.*
>
> *In addition, priority habitat action areas within each watershed are defined by the distribution of salmonid species and their supporting habitats and watershed processes. Potential habitat actions are proposed for each watershed based on accumulated information and analyses such as the Limiting Factors Analysis (LFA) and other watershed analyses.*

> *Priority habitat action areas for nearshore environments are also recommended based on the developing but limited research available for this critical environment.*
>
> *The highest priority for the Strategy is to protect and restore what we have documented as the focal species' habitat and the watershed processes that support and maintain that habitat. Within watersheds, the Strategy prioritizes habitat supporting ESA-listed stocks, then habitats supporting other anadromous salmonids, followed by all other freshwater habitats. This approach outlines the Priority 1, Priority 2 and Priority 3 Action Areas for Tier 1, Tier 2, and Tier 3 watersheds.*

In the HCCC strategy, Chinook habitat receives the highest rating by tier and priority. Dosewallips, Duckabush, Hamma Hamma and Skokomish are Tier 1 watersheds. Priority 1 habitats within freshwater streams are defined by either ESA listed species distribution and/or contributing natural processes to functions of Priority 1 segments. Therefore, Hood Canal Chinook habitat is in Dosewallips, Duckabush, Hamma Hamma and Skokomish are Tier 1 and Priority 1, the highest prioritization available.

In addition, habitat in nearshore marine waters has been prioritized in the Habitat Recovery Strategy (HCCC 2004) through the lead entity process to reflect the level of certainty in their importance to ESA listed species in the region.

Priority-1	**• Estuarine deltas associated with Tier I watersheds** • Tidal marsh complexes and eel grass meadows historically contiguous and within 1 mile of Tier 1 estuarine deltas
Priority-2	• Estuarine deltas associated with Tier 2 watersheds • All other tidal marsh complexes and eel grass meadows **• Kelp forests and shallow-water shorelines within 1 mile of Tier 1 and Tier 2 estuarine deltas**
Priority-3	• All other estuarine delta habitat **• Kelp forests and shallow-water shorelines farther than 1 mile from Tier 1 and Tier 2 estuarine deltas**
Priority -4	• Non vegetated sub tidal habitats **• Non shallow-water shorelines**

> *The prioritization of our Tier 1 estuarine deltas is based on the hypothesis that for juvenile Chinook salmon (Reimers, 1973; Levings et al. 1989), shorter estuary residence periods result in lower survival than longer estuary residence periods, and that degraded estuarine habitat limits rearing opportunities as freshwater juvenile salmon populations increase (Beamer et al., 2003.) We hypothesize that natal, estuarine habitat use by juvenile summer chum salmon is also density-dependent, especially for degraded systems, limiting summer chum recovery.*

As such, Chinook habitat in Dosewallips, Duckabush, Hamma Hamma and Skokomish estuaries are Priority 1 habitats, the highest available prioritization. Recent project lists for SRFB funding reflect this strategy and Chinook habitat restoration or protection is featured in many project proposals to SRFB and other potential funding sources.

Regional Hood Canal Habitat Issues: The HCCC Salmon Habitat Recovery Strategy (HCCC 2004) describes regional issues of concern affecting salmonid habitat in the following excerpt that pertain directly to Chinook habitat:

> *There are some problems that are "regional" in nature and must be addressed through a more complex approach of multiple landowners, agencies and organizations. These problems cross watershed, county and WRIA boundaries. They pose special challenges for those engaged in salmon recovery efforts. These problems are physically large, very costly and complicated to address. Nonetheless, they can and must be addressed, and when they are, their remediation will post huge gains for all salmonids and other estuarine dependent fauna in the Hood Canal and Eastern Strait of Juan de Fuca.*
>
> *Two of those currently identified high priority regional problems are:*
>
> • ***Physical blockage, destruction of habitat, and functional degradation of estuaries and alongshore processes by earthen fill causeways supporting US Highway 101 along the west side of Hood Canal and along the eastern Strait of Juan de Fuca.*** *This problem impacts, to different degrees, five of the major west side drainages identified as Tier 1 and 2 (the Skokomish, Lilliwaup, Hama Hama, Duckabush, and Dosewallips Rivers) as well as Salmon and Snow Creeks along the eastern Strait of Juan de Fuca. To address this problem, the Washington State Department of Transportation (WSDOT) and it's salmon recovery partners will need political support locally because of the disruptions to the public and local land owners that any realignment or reconstruction work would entail. WSDOT will also need political support and substantial amounts of funding from the State Legislature and the US Congress, because of the high costs of the various projects that would be required to address this issue, and because of the lower funding priority of Highway 101 relative to other roadways in the state.*
>
> • ***Sediment delivery to many major rivers and streams from erosion and mass wasting on US Forest Service roads.*** *This problem impacts streams all along the west side of Hood Canal and in the eastern Strait of Juan de Fuca. To address this problem the US Forest Service (USFS) will need local political support to close many of the failing roads that are no longer used for logging access, and to upgrade and stabilize roads still used for resource protection and management, or for recreation. The USFS will also need political support and substantial amounts of funding from the US Congress because of the high cost of this program. An adequate and stable budget for road maintenance is also needed to reduce risks of sedimentation from inadequately maintained roads in the future. The USFS Access and Travel Management Plan (2003) has laid out a comprehensive and prioritized approach to managing their road networks.*
>
> It is important to note here that the USFS has made great progress in addressing road impacts in the Eastern Olympic region, as documented below in Implementation of Habitat Protection and Recovery Efforts in Hood Canal, and that the road networks in the mid Hood Canal drainages are less problematic than in other drainages.

Dissolved Oxygen in Hood Canal Marine Waters: Dissolved oxygen levels in Hood Canal remain at historic low levels, particularly in the southern Canal. The Puget Sound Action Team identifies three major factors that create conditions that lead to low oxygen levels in the Canal:

- Limited water circulation
- Stratification of water that discourages mixing of surface-to-deeper water, and

- A continuing influx of both natural and human-influenced nutrients such as nitrogen, which causes rich plankton and algae blooms, which later die and decompose, using up oxygen in the process.

Oxygen levels typically decline to lowest levels in late summer. When dissolved oxygen is below 3 parts per million (ppm), marine life are acutely affected. More mobile animals, like fish, may seek shallow water while sessile or slow-moving animals cannot. Deeper dwelling fish, e.g. rockfish, have been observed in large numbers in shallow waters in the Canal in recent years. Fishing for bottomfish has been closed several times by WDFW and remains closed indefinitely to protect marine resources. Salmon are thought to be mobile enough to avoid most of the effects of low dissolved oxygen but more study is needed. The long-term consequences of low dissolved oxygen levels to marine life are not well understood. Local groups and county, state and federal entities are joining forces to study and identify the potential causes through the Hood Canal Dissolved Oxygen Program. Updated information can be found at their website http://www.hoodcanal.washington.edu/. The Puget Sound Action Team and the Hood Canal Coordinating Council developed the Preliminary Assessment and Corrective Actions Plan to describe human contributions to the problem within their existing knowledge constraints and proposed some initial actions to address those problems. That plan is available at the HCCC website http://www.hccc.cog.wa.us/.

Nearshore-Marine Planning Efforts: A regional chapter of Shared Strategy is under development specific to nearshore-marine issues to incorporate initiatives like the Puget Sound Nearshore Ecosystem Restoration Project and technical and implementation issues best addressed at the Puget Sound regional scale. Initial work will be completed describing the linkages between nearshore-marine habitat type and salmonid population spatial structure and diversity in Puget Sound; this information can then be applied to Hood Canal Chinook recovery. The goal of the nearshore component is to develop actions and planning area commitments to undertake those actions that protect and restore those places of significance to salmon. Commitments could define immediate actions while also preserving opportunities as scientific efforts improve our understanding of how and where nearshore and marine habitats and processes contribute significantly to the viability of salmon populations (Shared Strategy 2003).

In addition, extensive assessment and restoration/conservation actions have been undertaken within the Hood Canal region that continue to improve both our understanding and the physical habitat conditions in the region. Assessments include:

- Point No Point Treaty Council assessment of historical changes to estuaries and nearshore habitats in Hood Canal and eastern Strait of Juan de Fuca (PNPTC in prep. 2005)
- Highway 101 Causeway Study (HCSEG 2003)
- Juvenile salmonid use of tidal creek and independent marsh environments in north Hood Canal: summary of first year findings (Hirschi et al. 2003)
- Juvenile salmonid use in south Hood Canal (Skokomish Tribe in prep. 2005)

- Washington Conservation Commission's Habitat Limiting Factors Analyses for WRIA 16, and resulting geo-database of restoration project opportunities in the nearshore environment (based on Correa 2003 and HCCC 2004)

Watershed Planning Efforts: WRIAs 15, 16 (the latter incorporating the northern portion of WRIA 14 that drains into Hood Canal), and 17 are in the process of developing watershed plans scheduled for completion in 2004. As explained within the draft HCCC summer chum salmon recovery plan (HCCC in prep. 2005):

> *Chapter 90.82 RCW provides a process to plan and manage water resources in designated water resource inventory areas (WRIA). Each WRIA under this process has established Planning Units, comprised of councils of governmental and non-governmental entities to perform two tasks: 1) determine the status of water resources in a watershed and 2) resolve the often conflicting demands for the water, including ensuring adequate supplies for salmon (WRIA 17, 2003). The WRIA Planning Units are to develop a watershed plan that accomplishes these tasks. RCW 90.82 further states that the watershed plan shall be coordinated or developed to protect or enhance fish habitat in the management area. Watershed plans are to be integrated with strategies, developed under other processes, to respond to potential and actual ESA listings of salmon and other fish species*

Water issues are particularly relevant to Chinook recovery as adult fish enter the rivers during late summer and early fall. Low flow conditions can limit fish access, affect spawning distribution, and impact survival of eggs and alevins in the gravel.

Local Planning Document Updates: Many local governments are revising critical area ordinances (CAO) and updating comprehensive plans to comply with Growth Management Act (GMA) requirements. Land use planning should be the fundamental tool for protection of Chinook habitat.

EDT Analysis for Habitat Protection and Recovery for Mid Hood Canal Chinook

Description of Approach: In the mid Hood Canal watersheds, the EDT method was used initially by the Co-managers to develop abundance and productivity targets for Hamma Hamma, Duckabush, and Dosewallips Chinook sub-populations (see Chinook recovery goals section). In 2004, this effort was enhanced by review of model input and addition of build-out and habitat project scenarios. At that time, a technical group of biologists from the Washington Department of Fish and Wildlife, Hood Canal tribes and HCCC, who have extensive knowledge of Hood Canal watershed conditions, provided the model input. The technical team rated the habitat using a combination of data and expert opinion.

Chinook habitat was delineated into similar stream reaches based on gradient, confinement, and the locations of tributary confluences. For the Dosewallips, four reaches were included on the mainstem along with an estuarine reach and Rocky Brook creek for six total reaches. For the Duckabush watershed, five freshwater reaches were identified and an estuarine reach. Within the Hamma Hamma watershed, the technical team identified five reaches used by Chinook in freshwater and an estuarine reach for six total. Two of the five reaches were in John Creek. In the model, we assumed that 25%

of the Chinook are ocean-type fry migrant and 75% ocean-type fingerling migrant. Timing for spawning was run as September 17 – October 21.

Habitat characterization involved rating 46 habitat attributes for each reach. Attributes described habitat diversity, proportion of key habitat types, channel stability, fine sediment load, temperature, flow, competition and predation, chemicals and pathogens, and fish passage obstructions. In general, attributes were rated on a scale of 0 to 4, either as integers or continuous values as appropriate. EDT provides guidance for rating each attribute; some attributes have quantitative values associated with each rating, while others are more qualitative. Lestelle et al. (2004) provides in-depth information on the EDT model and methodology.

<u>Build-out and Habitat Protection Analysis</u>: In 2000, the technical team rated attributes for both current and estimated historic conditions. The EDT model was run for both of these habitat condition scenarios (current and historic) as well as for the “PFC+” scenario, i.e. properly functioning conditions (after NMFS 1996) in the freshwater environment and historical conditions in the estuarine environment.

In 2005, we also modeled “build-out” scenarios under current regulations and zoning within the Dosewallips and Duckabush watersheds. To model the two build-out scenarios, property was delineated into future build-out categories defined by land use zoning: 1) “modeled” build-out is the most probable build-out scenario for the watersheds and represents a moderate build-out scenario, and 2) “maximum” build-out represents all parcels developed to the maximum extent possible under current regulations. The modeled and maximum build-outs are based on the percent impervious area (IP) per watershed in the future (no time limit as it assumes the current land codes are in effect forever), according to the build-out codes that were assigned each parcel and that build-out code’s associated IP value. The build-out analysis is based on a work in progress being developed for the summer chum salmon recovery plan (HCCC in prep. 2005), though the approach may differ. Further, it is important to note here (and explained in more detail below) that the “maximum” build-out results are exaggerated and are unlikely to occur in the future.

Most of the mid Hood Canal Chinook watersheds are federal lands as noted in the descriptions of land use in these watersheds from the Hood Canal Salmon Recovery Strategy (HCCC 2004):

> *Dosewallips Land Use: The largest landowners in the Dosewallips River watershed are the Olympic National Park (47,231 acres) and the Olympic National Forest (22,028 acres), which together comprise 93% of the watershed. A significant portion of the National Forest land is protected as wilderness area. The remaining 7% is divided between privately-held forest lands, rural residential, park land and commercial uses. There are 34 acres of commercial zoning in the watershed, which is concentrated in the lower reaches. The predominant residential zoning in this watershed (678 acres) is one residence per 20 acres. The rural village center of Brinnon is located at the mouth of the river on what was historically an active alluvial delta.*
>
> *Duckabush Land Use: The Duckabush River watershed is similar to that of the Dosewallips River. Approximately 28,875 acres are within Olympic National Park and 15,681 acres are within*

> *Olympic National Forest, together comprising 89% of the watershed area. The remaining watershed is zoned for privately-held forest lands (3,725 acres), rural residential land use (1,414 acres), and parks (134 acres). There is no commercial or industrial-zoned land in the Duckabush River watershed. The predominant residential zoning in this watershed (863 acres) is one residence per five acres.*
>
> *Hamma Hamma Land Use: 95% public ownership (60% managed forest, 34% national park or wilderness); 5% private (mainly commercial forest with some agriculture and residence in lower 1.5 miles).*

The buildout analysis presented here applies only to the lower reaches of the Dosewallips and Duckabush watersheds within the jurisdiction of Jefferson County. Build-out for the lower reaches of the Hamma Hamma watershed was not modeled because this non-federal part of the watershed lacked the information needed for the modeling.

EDT habitat attributes were revised by reach for the modeled and maximum build-out scenarios based on the aforementioned impervious surface percentages (used as indicators of the magnitude of development effects). The modeled buildout scenario was also used as the baseline for modeling habitat protection and restoration measures, as it most closely represents probable future conditions.

Habitat Restoration Analysis: The HCCC provided the technical workgroup with a list of habitat protection and recovery projects specific to mid-Hood Canal Chinook for the Dosewallips, Duckabush and Hamma Hamma River watersheds. The project list was developed consistent with the WRIA 16 Limiting Factors Analysis (Correa 2003) and the Salmon Habitat Recovery Strategy (HCCC 2004); it is based on ecosystem restoration principles, seeking to protect and restore natural processes to the watersheds as best possible. Some of the projects have been under discussion for many years or are currently in planning stages. Other projects are conceptual and will require more work to lead to implementation. Our intent is to maintain and restore habitat functions working cooperatively with current landowners on habitat stewardship and restoration projects. Acquisition may be necessary to achieve some habitat goals, but is not warranted unless no other practical alternatives exist.

Habitat projects were divided into two groups:

1) Projects with high potential for implementation, assuming funding was available.
2) Projects with lower potential for implementation in the near future.

We believe the list of projects with high potential for implementation can be accomplished within ten years (the planning target time period requested by Shared Strategy), if funding is available. Habitat restoration and protection project combinations with general descriptions are listed in Table 5.1. A full list of habitat projects with more detailed descriptions is shown in Appendix C.

Table 5.1.Habitat restoration and protection actions for mid Hood Canal Chinook rivers grouped by potential for implementation. A full description of project actions is in Appendix C.

High Implementation Potential list

	Description	*Project Number (Appendix C)*
Dosewallips River	Estuary restoration projects	2, 3, 5-15
	Lower Dosewallips wood-riparian restoration	19-24
	USFS road decommissioning	27, 28, 41
	Rocky Brook confluence floodplain restoration	29
	Lower & Middle Dosewallips riparian-floodplain restoration and protection	20, 32a, 32b
	USFS land wood-riparian restoration	33-38, 40
	Elkhorn Campground recovery	39
Duckabush River	North estuary restoration	4, 7, 8
	USFS road decommissioning	9, 10
	Middle & Upper Duckabush wood-riparian recovery	12, 13
	Duckabush high quality habitat protection	14
Hamma Hamma River	USFS road decommissioning	7, 8
	Upper Hamma Hamma watershed recovery	12, 13

Lower Implementation Potential list

	Description	*Project Number (Appendix C)*
Dosewallips River	Wolcott Slough restoration	14, 15
	Lower Dosewallips floodplain / estuary restoration	2 – 18
	Lazy C floodplain restoration & wood addition	25
	Middle Dosewallips wood-riparian restoration	26
	Lower Wolcott Flats restoration	30
	Upper Wolcott Flats restoration	31
Duckabush River	Duckabush estuary restoration	2 – 8
	Olympic Canal tracts floodplain restoration	11
Hamma Hamma River	Hamma Hamma estuary restoration	2 – 6
	Lower river floodplain and side channel restoration	9, 10
	Lower river wood-riparian recovery	10, 11
	Johns Creek wood-riparian recovery	10, 11

The EDT model projected population parameters 1) for build-out scenarios without any habitat actions as related to current conditions and 2) for the habitat actions listed in Table 5.1assuming the base condition of a modeled potential build-out. Results are summarized in Table 5.2 below for both a 25-year and 100-year time lag to allow population effects. For comparison, historic conditions and PFC+ were also modeled. Co-managers used PFC+ values, modeled in 2001, as the “target” for habitat recovery.

Table 5.2. Productivity, abundance, diversity, and capacity estimates for mid Hood Canal Chinook using the EDT model. Proposed habitat actions and two build-out scenarios were modeled and projected for 25-year and 100-year time frames. Results are presented without harvest or hatchery interactions.

25-year time lag for population effects

		Build-out		**Habitat Actions[1]**		**Historic**	
	Current	**Modeled**	**Maximum**	**High[2]**	**Low[3]**	**Conditions**	**Target[4]**
Dosewallips River							
Productivity	3.9	3.5	2.5	10.0	11.0	15.5	8.8
Abundance	1248	1150	890	2876	3285	4723	2973
Diversity	100%	100%	100%	100%	100%	100%	100%
Capacity	1681	1618	1471	3196	3615	5049	3353
Duckabush River							
Productivity	3.8	3.3	2.5	7.0	9.0	14.8	8.6
Abundance	554	472	890	734	1155	2074	1232
Diversity	100%	91%	100%	96%	100%	100%	100%
Capacity	752	681	1471	857	1299	2224	1395
Hamma Hamma River							
Productivity	3.4	NA	NA	5.2	11.0	15.2	8.7
Abundance	438	NA	NA	528	1012	1508	1006
Diversity	100%	NA	NA	100%	100%	100%	100%
Capacity	619	NA	NA	655	1113	1615	1137

100-yr time lag for population effects

		Build-out		**Habitat Actions[1]**		**Historic**	
	Current	**Modeled**	**Maximum**	**High[2]**	**Low[3]**	**Conditions**	**Target[4]**
Dosewallips River							
Productivity	3.9	3.5	2.5	10.9	11.3	15.5	8.8
Abundance	1248	1150	890	3055	3432	4723	2973
Diversity	100%	100%	100%	100%	100%	100%	100%
Capacity	1681	1618	1471	3363	3765	5049	3353
Duckabush River							
Productivity	3.8	3.3	2.5	7.7	9.8	14.8	8.6
Abundance	554	472	890	801	1273	2074	1232
Diversity	100%	91%	100%	96%	100%	100%	100%
Capacity	752	681	1471	921	1417	2224	1395
Hamma Hamma River							
Productivity	3.4	NA	NA	5.2	11.1	15.2	8.7
Abundance	438	NA	NA	528	1003	1508	1006
Diversity	100%	NA	NA	100%	100%	100%	100%
Capacity	619	NA	NA	655	1102	1615	1137

[1] includes "modeled" build-out as baseline conditions

[2] "High" refers to habitat projects with high potential for implementation within 10 years (see Table 5.1)

[3] "Low" refers to habitat projects with lower potential for implementation (see Table 5.1)

[4] Target values are derived from PFC+ conditions estimated in 2001

Build-out impacts to population parameters when compared to current conditions were relatively minor if development was consistent with the modeled build-out scenario. This is mostly due to the fact that 93% and 89% of the Dosewallips and Duckabush watersheds, respectively, are owned and managed by the United States Forest Service and National Park Service, with that ownership being distributed broadly across the upper and middle reaches. However, the maximum build-out scenario resulted in substantial decreases in the parameter values. Given the approach to the modeled maximum build-out analysis, it is unlikely that many of the land parcels will be developed to the maximum potential – a moderate development pattern is much more likely given land use controls and existing uses. In other words, higher build-out is possible under current regulations, though not likely given current land use practices. Potential adverse impacts to the Chinook habitat and populations related to higher density development in the watershed and the resulting impacts to habitat forming processes and functions may be an important implication of the modeled maximum build-out analysis.

Results of the EDT analysis indicate that target recovery values would be close to being achieved for the Dosewallips River within 25 years (assuming the projects are implemented within 10 years) if:

- Habitat protection and restoration projects of equal or better habitat value of the entire High Implementation Potential list are successfully implemented
- Current development regulations are implemented and enforced
- Habitat conditions degrade no more than is predicted for modeled potential build-out
- The assumptions and attribute ratings for EDT are correct

However, our analysis does not indicate that similar results could be achieved in the Duckabush and Hamma Hamma watersheds in the 25-year time frame, though significant progress is possible. Clearly, more intensive habitat protection and restoration actions are necessary to achieve the target level restoration for these watersheds.

It is evident that implementation of the High Implementation Potential actions and current regulations alone are not sufficient to produce the targeted results in the Hamma Hamma and Duckabush watersheds. If all of the habitat projects are implemented (Low Implementation Potential list), numbers and values will approach the targets within 25 to 100 years.

<u>Grouped Habitat Actions Analysis</u>: We also combined habitat projects into smaller "action" groups to determine which of the projects would have the most benefit, if needed to achieve goals. We again used the modeled build-out as baseline conditions to investigate the effects of these habitat actions on population parameters into the future.

The ranking of benefits of habitat restoration and protection actions to Chinook productivity and abundance combined, over 25-year and 100-year time frames, were generally similar for all three mid Hood Canal watersheds. Restoration and protection of riparian vegetation and in-channel wood were consistently ranked as providing the highest benefits to Chinook productivity and abundance in the Dosewallips, Duckabush, and Hamma Hamma rivers (Table 5.3, Appendix D and E). However, restoration of riparian vegetation moved some habitat project actions higher in the ranks over a 100-year time frame when compared to the 25-year time frame.

In the Dosewallips watershed, riparian vegetation and in-channel wood placement affected Chinook population parameters most along with restoration of the lower river floodplain and estuary (Table 5.3). The riparian / wood projects are primarily located within public forest land and have a high potential for implementation provided funding is available. The top ranked project (projects 33-38 & 40) also ranked highest for productivity and abundance individually; and some project benefits increased over time (Appendix D and E). The ranking of project actions addressing riparian restoration from RM 6-12, during a 25-year time frame, does not indicate its overall importance when compared with values for abundance and productivity in the 100-year time period. Addressing riparian conditions wherever feasible appears to be an important aspect of watershed restoration for Chinook recovery.

Within the Dosewallips lower river floodplain and estuary, the project actions to relocate State Park infrastructure in the lower campground (#4 in Appendix C) and remove levees in the lower river (#16-18 in Appendix C) appear to have the most impact on success of the project. Without these components, the ranking of the lower river and estuary restoration action drops substantially. However, these elements may be difficult to implement. A recommended approach, consistent with the Summer Chum Salmon Recovery Plan, would be to initiate a Lower Dosewallips River Comprehensive Floodplain Management Plan. This would serve to formalize an approach to flood protection and salmon habitat recovery that meets the needs of both people and fish.

The highest ranked project within the Duckabush watershed (Duckabush Olympic Canal tracts) may be difficult to implement (Table 5.3). Implementation of the remaining habitat actions of the High Implementation Potential list may not be adequate for habitat recovery without additional measures. Given the potential to increase Chinook abundance and productivity values, a plan to mitigate the impacts of the development in the lower river at Olympic Canal tracts should be initiated as a high priority. This may take the form of a Lower Duckabush River Comprehensive Floodplain Management Plan, as is being recommended in the Summer Chum Salmon Recovery Plan for the Duckabush River.

Most of the key habitat recovery actions in the Hamma Hamma watershed take place on private property and may be difficult to implement. Restoration of in-channel wood and riparian vegetation in the lower river appears to be the most important of the projects modeled. Continued work with the landowners to implement these projects is needed to achieve recovery goals.

Table 5.3. The ranking of benefits to Chinook productivity and abundance combined, over 25-year and 100-year time frames, of habitat restoration and protection actions in mid Hood Canal rivers.

Dosewallips River Watershed

Implementation List	Action Name	HCCC Project list (Appendix C)	Productivity & Abundance Ranks 25-yr time lag	Productivity & Abundance Ranks 100-yr time lag
high	USFS wood - riparian restoration	33-38, 40	**1**	**1**
high	USFS RM 6 to 12 wood restoration	33-38	**2.5**	**5**
low	Lower Dosewallips floodplain/estuary restoration	2-18	**3.5**	**4.5**
high	Middle Dose riparian-floodplain restoration and protection	32A	**3.5**	**4**
high	USFS RM 6 to 12 riparian restoration	32B	**5.5**	**2**
high	Lower Dosewallips wood-riparian restoration and protection	19-24	**6.5**	**6**
low	Lower Dosewallips floodplain restoration	16-18	**7.5**	**7.5**
high	USFS road decommissioning restoration and protection	27-28, 41	**9**	**10**
low	Dosewallips estuary restoration	2-15	**9.5**	**9.5**
low	Lazy C floodplain and wood restoration	25	**10**	**9.5**
low	Upper Wolcott Flats restoration	31	**10**	**10.5**
high	Dosewallips estuary restoration excluding Day Use Area	2-3, 5-15	**10.5**	**11**
low	Middle Dosewallips wood-riparian restoration	26	**12**	**11.5**
low	Lower Wolcott Flats restoration	30	**14**	**13**
high	Rocky Brook confluence floodplain restoration	29	**15**	**15**
low	Wolcott Slough restoration	14-15	**16**	**16**
high	Elkhorn Campground recovery	39	**17**	**17**

Duckabush River Watershed

Implementation List	Action Name	HCCC Project list (Appendix C)	Productivity & Abundance Ranks 25-yr time lag	Productivity & Abundance Ranks 100-yr time lag
low	Duckabush Olympic Canal tracts	11	**2**	**2**
high	USFS road decommissioning (restoration and protection)	9-10	**2.5**	**3**
high	Middle Duckabush wood-riparian recovery	12-13	**2.5**	**1.5**
low	Duckabush estuary restoration	2-8	**4**	**4.5**
high	Upper Duckabush wood-riparian recovery	12-13	**4.5**	**4.5**
high	Duckabush high quality habitat protection	14	**5.5**	**5.5**
high	North Duckabush estuarine restoration	4, 7, 8	**7**	**7**

Hamma Hamma River Watershed

Implementation List	Action Name	HCCC Project list (Appendix C)	Productivity & Abundance Ranks 25-yr time lag	Productivity & Abundance Ranks 100-yr time lag
low	Lower Hamma Hamma wood-riparian recovery	10-11	**1.5**	**1**
low	Lower Hamma Hamma floodplain and side channel restoration	9-10	**2.5**	**2.5**
low	Hamma Hamma estuary restoration	2-6	**4**	**4.5**
high	Upper Hamma Hamma watershed recovery	12-13	**4**	**4.5**
low	Johns Cr wood-riparian recovery	10-11	**5.5**	**4.5**
high	USFS road decommissioning (restoration and protection)	7-8	**6.5**	**6.5**

The technical team noted that large-scale estuarine projects (e.g. Hamma Hamma estuary and Duckabush estuary restoration) produced mixed results in the EDT population parameter modeling (Appendix D and E). These projects address key natural processes for watershed health (e.g., lower river sediment transport and connectivity to tidal channels) that may not respond well to the habitat attributes as currently considered in EDT. The results of the estuarine habitat projects should be viewed with some caution and a direct comparison to freshwater projects may not be warranted during project prioritization.

Habitat Protection and Restoration Hypotheses

Based on these analyses, we propose the following hypotheses for habitat protection and restoration:

- Regulatory protection will be adequate for Chinook recovery if watershed development occurs as expected and current regulations are maintained or improved and adequately implemented.
- Effective implementation of the habitat protection and restoration projects will significantly recover Chinook populations as indicated by EDT results and measured by VSP parameters.

Habitat Recovery Strategy

Implementation of Habitat Protection and Recovery Efforts in Hood Canal: The emphasis on protection and restoration of Chinook habitat is evident in recent project lists developed for the Washington State Salmon Recovery Funding Board (SRFB) funding rounds, projects under development and in completed projects. The Hood Canal Coordinating Council, as the Hood Canal Lead Entity, is highly successful in obtaining funding for habitat projects and promoting strong partnerships to ensure success. The HCCC Salmon Habitat Recovery Strategy (HCCC 2004) is more than a document – it is being implemented. For example, the following protection and restoration activities have been completed or funded (modified from HCCC 2004):

Dosewallips River projects

Protection Activities Completed or Funded:

- *Dosewallips Watershed Assessment in progress by Port Gamble S'Klallam Tribe*
- *Olympic National Forest Watershed Analysis completed in February 1999*
- *East Jefferson County Salmonid Refugia Report 2003 (SRFB contract#00-1816)*
- *WRIA 16 Salmonid Refugia Report 2003 (SRFB contract#00-1829)*
- *Washington Conservation Commission WRIA 16 Limiting Factors Analysis for riverine and nearshore June 2003*
- *Designated as a Key Watershed by USFS (high priority anadromous salmon restoration)*
- *Ecosystem Diagnosis and Treatment completed for Chinook and on-going for summer chum*
- *Majority of estuary and existing distributary sloughs owned by Washington State Parks*
- *Upper Sylopash Slough acquisition funded (SRFB contract#02-1482)*
- *'Powerlines' acquisition of 90 acres funded (SRFB 2005)*
- *7721 meters of road designated for decommissioning in 2003 USFS A&TM Plan (all in Rocky Brook) (but not funded)*
- *2581 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (mainstem) (but not funded)*

Restoration Activities Completed or Funded:

- *14,187 meters of USFS roads decommissioned (all in Rocky Brook)*
- *Dosewallips Estuary Restoration Project funded by SRFB in 2003*
- *HCSEG Highway SR101 Causeway Study (SRFB contract #00-1806), revised draft completed August 2003*

Duckabush River projects

Protection Activities Completed or Funded:

- *124+ acres of estuary and tidelands purchased by WDFW in 1970s*
- *Olympic National Forest Watershed Analysis completed in May 1998*
- *Washington Conservation Commission WRIA 16 Limiting Factors Analysis for riverine and nearshore June 2003*
- *East Jefferson County Salmonid Refugia Report 2003 (SRFB contract#00-1816)*
- *WRIA 16 Salmonid Refugia Report 2003 (SRFB contract#00-1829)*
- *100% of USFS land is under Wilderness, Late Successional Reserve, or Adaptive Management for Research (0.01%) designation*
- *Designated as a Key Watershed by USFS (high priority anadromous salmon restoration)*
- *Ecosystem Diagnosis and Treatment completed for Chinook and on-going for summer chum (but not fully funded)*
- *13048 meters of road (13 segments) designated for decommissioning in 2003 USFS A&TM Plan (but not funded)*
- *1205 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)*

Restoration Activities Completed or Funded:

HCSEG Highway SR101 Causeway Study (SRFB contract #00-1806), revised draft completed August 2003

Hamma Hamma River projects

Protection Activities Completed or Funded:

- *USFS Watershed Analysis completed in July 1997*
- *Washington Conservation Commission WRIA 16 Limiting Factors Analysis for riverine and nearshore June 2003*
- *WRIA 16 Salmonid Refugia Report 2003 (SRFB contract#00-1829)*
- *Ecosystem Diagnosis and Treatment completed for Chinook and on-going for summer chum (but not fully funded)*
- *34,519 meters of road (23 segments) designated for decommissioning in 2003 USFS A&TM Plan (but not funded)*
- *9217 meters of road (4 segments) designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)*

Restoration Activities Completed or Funded:

- *8891 meters of USFS roads decommissioned*
- *Rearing ponds constructed by HCSEG*
- *HCSEG Highway SR101 Causeway Study (SRFB contract #00-1806), revised draft completed August 2003*

Key Elements of the Habitat Protection and Restoration Strategy:

- Implement the habitat protection and restoration actions of the High Implementation Potential list, with highest priority to actions with most benefit as per the EDT analysis:

  - Dosewallips watershed
    - Riparian and in-channel wood restoration
    - Estuarine restoration
  - Duckabush watershed
    - USFS road decommissioning
    - Riparian and in-channel wood restoration
  - Hamma Hamma watershed
    - Upper Hamma Hamma watershed recovery
    - USFS road decommissioning

- Develop strategies and partnerships to address highest priority habitat actions as per the EDT analysis of the Lower Implementation Potential list:

  - Dosewallips watershed
    - Levee relocation and estuarine restoration in developed areas
    - Floodplain restoration in developed areas
  - Duckabush watershed
    - Floodplain and channel restoration in developed areas of the lower river
    - Estuarine restoration to include SR 101 causeway mitigation
  - Hamma Hamma watershed
    - Riparian and in-channel wood restoration in the lower river
    - Floodplain restoration in the lower river
    - Restoration of Johns Creek watershed

- Coordinate with other salmon habitat recovery efforts to find common objectives for habitat protection and restoration. Implement a common strategy where possible.

- Protect current habitat conditions from degradation

- Implement and enforce current land use regulations

- Revisit and revise the habitat action list and strategy as needed based on updated information on watershed conditions and biological information

Habitat Adaptive Management

Current habitat protection and restoration planning implemented through the HCCC and including the development, review and updating of the Hood Canal Salmon Habitat

Recovery Strategy (HCCC 2004) is incorporating adaptive management features. Additional work is needed though, focusing more specifically on habitat adaptive management planning. Generally, it is understood that further study is needed to assess watershed conditions over time and to determine corrective actions necessary to achieve our recovery goals. Monitoring is needed to:

- Assess watershed conditions over a long time period
- Respond to large scale changes in watershed conditions
- Assess implementation of habitat protection and restoration actions to determine if they are working as expected.
- Assess watershed development impacts

In addition, the intent is to work together and be consistent with the habitat adaptive management strategy that is being developed as part of the Hood Canal summer chum recovery plan (HCCC in prep. 2005).

Future Actions and Commitments

Strong partnerships for salmon habitat recovery are already in place through concurrent and past Hood Canal strategic planning efforts. These partnerships will be essential as land use planning is incorporated into an overall Chinook habitat recovery strategy. The HCCC summer chum draft recovery plan (HCCC in prep. 2005) recommends the following approach to secure involvement of the stakeholders in recovery efforts:

> *Design a summer chum salmon recovery Plan to provide:*
>
> - *the Counties with certainty regarding development, growth and land use,*
> - *certainty for Tribal goals and objectives, and*
> - *certainty for private landowners.*
>
> *Certainty means that the Plan will strive to give the Counties, Tribes and public a clear understanding of salmon recovery, the actions that it will take to achieve recovery, and at what economic cost. It is not clear how much biological diversity, population structure, and abundance will be necessary for the long-term recovery of summer chum salmon. NOAA Fisheries scientists will ultimately recommend whether these biological and population structure elements will likely be met by the Plan. Recovery and long term sustainability of a threatened species require adequate reproduction for replacement of losses due to natural mortality factors (including disease and stochastic events), sufficient genetic robustness to avoid inbreeding depression and allow adaptation, sufficient habitat (type, amount, and quality) for long-term population maintenance, and elimination or control of threats (which may also include having adequate regulatory mechanisms in place).*
>
> *Scientific studies and technical assessments can only provide a part of the answer. "Society must decide what degree of biological security would be desirable and affordable if it could be achieved, i.e., the desired probability of survival or extinction of*

natural populations, over what time and what area, and at what cost" (NRC 1996). The plan will articulate the costs and develop actions that can be implemented in a reasonable timeframe.

The Plan must also:

- *Give credit for salmon recovery actions and measures that have been taken to date by the Counties and Tribes, and*
- *Show that the burden of salmon recovery goes beyond local governments (to State and Federal governments and associated entities).*

The Hood Canal Coordinating Council is a good forum to engage local support and government leaders. The HCCC is a watershed based Council of Governments that was established in 1985 in response to concerns about water quality problems and related natural resource issues in the watershed. County Commissioners of Jefferson, Kitsap and Mason Counties and elected Tribal Council members from the Skokomish and Port Gamble S'Klallam Tribes are on the HCCC Board of Directors. It also has a slate of Ex-Officio Board Members composed of state and federal agency representatives. The Council also has Cooperating Partners who work with it on various projects and programs.

Ideally, land use planning serves the purpose of identifying potential conflicts between development projections and Chinook habitat requirements and finding effective approaches to address conflicts. While local governments have been involved in Chinook salmon recovery projects and some progress has been made in land use planning and regulation, much still remains to be done to protect and restore Chinook habitat. Participation of the local governments, and other interested local groups and citizens, in Chinook recovery is essential for its long-term success. If the Shared Strategy is to be successful in Hood Canal, it must engage the governments and other local entities of the region.

Mid Hood Canal Chinook Harvest Management

The Co-managers have recently prepared a harvest management plan (HMP) describing harvest management guidelines for the Chinook of Puget Sound, including Hood Canal (PSIT and WDFW 2004). This document has been prepared in response to the listing of Puget Sound Chinook as a threatened species and the associated requirement that such a plan be prepared as part of the process to qualify harvest as a permitted activity under section 4(d) of the Endangered Species Act. The harvest management guidelines of the HMP apply to planning annual harvest regimes for the 2004 – 2009 management years. The Co-managers' rationale behind and process for annual planning of the Chinook fisheries are described in the document. Specific approaches are described for each Chinook management unit within Puget Sound, including the two management units (mid Hood Canal and Skokomish) in Hood Canal. The overall objectives of the HMP are to:

> *Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound Chinook populations, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.*

The intent of the HMP is to constrain harvest to the extent necessary to enable rebuilding of natural Chinook populations in the Puget Sound ESU, provided that habitat capacity and productivity are protected and restored. It includes explicit measures to conserve and rebuild abundance, and preserve diversity among all the populations that make up the ESU. The ultimate goal of the HMP, and of concurrent efforts to protect and restore properly functioning Chinook habitat, is to rebuild natural productivity so that natural Chinook populations will be sufficiently abundant and resilient to perform their natural ecological function in freshwater and marine systems, provide related cultural values to society, and sustain commercial, recreational, ceremonial, and subsistence harvest.

Since the HMP includes detailed descriptions of the approaches to harvest management of the Hood Canal Chinook management units, it is the basis for and primary reference of the following Hood Canal harvest management descriptions. Still another description is provided in Appendix F to this chapter, which describes harvest management actions affecting Hood Canal Chinook in three categories: within Hood Canal, within Washington State, and in Canadian waters. The appendix focuses on the processes of harvest management.

The remainder of this harvest management section covers the topics of harvest management hypotheses, harvest management actions, recent harvest and escapement information, 2005 harvest management planning, and harvest adaptive management.

Harvest Management Hypotheses

The mid-Hood Canal Chinook population is made up of three sub-populations located in the Dosewallips, Duckabush and Hamma Hamma watersheds (PSTRT 2004). For the purpose of harvest management, the Co-managers have identified the mid Hood Canal population as a management unit. Following are the harvest management hypotheses for this management unit, reflecting harvest management objectives. Also described are the underlying assumptions of the hypotheses and an outline of management strategies.

The hypotheses are 1) fisheries subject to Co-managers' harvest management will not impede the restoration and maintenance of a sustainable, locally adapted, natural-origin mid Hood Canal Chinook population and 2) maintenance and improvement of the abundance, productivity, diversity and spatial distribution of the mid Hood Canal Chinook sub-populations will not be impaired by the Co-managers' harvest management.

Assumptions underlying the hypotheses include:

- No directed harvest on mid Hood Canal Chinook will occur until there is sufficient recovery to accommodate harvest.

- Incidental harvest of mid Hood Canal Chinook in mixed stock Chinook fisheries and fisheries directed at other species can be controlled so as not to impede recovery.
- There is coincident and effective protection and restoration of properly functioning Chinook habitat in the watershed and estuaries.
- Hatchery management actions effectively support and do not impede recovery.
- Harvest can be managed to remove fish randomly from the population of returning adults; i.e., there is little to no bias in selection of fish by size, sex or timing, and there is no geographically selective bias affecting spatial distribution.
- Harvest management is effective in limiting takes of fish.
    - Preseason forecasting is sufficiently effective in managing fisheries.
    - Regulation and enforcement of fisheries meets objectives for controlling fisheries.
    - Harvest monitoring and record keeping are accurate and complete.
    - Escapement estimates are accurate and complete.
    - Adaptive management is an effective learning tool that improves harvest management over time.
- Harvest management accounts for potential effects of exploitation on abundance, productivity, diversity and spatial distribution.
- Effective coordination amongst the various fisheries management entities (international, federal, state and tribal) exists.

Harvest management strategies are described in detail in the Co-managers' harvest management plan for Puget Sound Chinook (PSIT and WDFW 2004) and are summarized below in the Harvest Management Actions section and Appendix F. Following is a brief outline of management strategies:

- Prohibiting fisheries specifically directed at mid Hood Canal Chinook until recovery is sufficient to support such fisheries.
- Managing fisheries by limiting exploitation rates, using harvest time and area closures, to remove or minimize negative effects on Chinook salmon productivity, abundance, diversity and spatial distribution.
- Pre-season forecasting for planning and implementing fisheries.
- Adequate fisheries regulation and enforcement to limit harvest within planning objectives.
- Adequate provisions for catch monitoring and escapement estimation.
- Coordination of management actions among the management entities.
- Learning and adapting harvest management over time.

Harvest Management Actions

The Co-managers plan and implement fisheries each year. Following are descriptions of the strategies and guidelines used. Appendix F provides additional information about specific regulatory measures in Hood Canal and factors affecting harvest management planning.

The management objective for the mid Hood Canal Management Unit is to maintain and restore sustainable, locally adapted, natural-origin Chinook sub-populations. Management efforts will initially focus on increasing the abundance in the Management Unit and its local, natural sub-populations. Fisheries are being restricted to accommodate the escapement objectives.

During the recovery period, fisheries in southern U.S. areas, outside Hood Canal, will be managed to achieve a preterminal rate of exploitation of no more than 15%, as estimated by the Fisheries Regulation Assessment Model (FRAM). This exploitation rate is based on George Adams Hatchery Chinook coded wire tag information because no mid Hood Canal Chinook tag data currently exist to separately assess the exploitation of the mid Hood Canal management unit. Fisheries outside Hood Canal include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and the marine commercial and recreational fisheries in Puget Sound

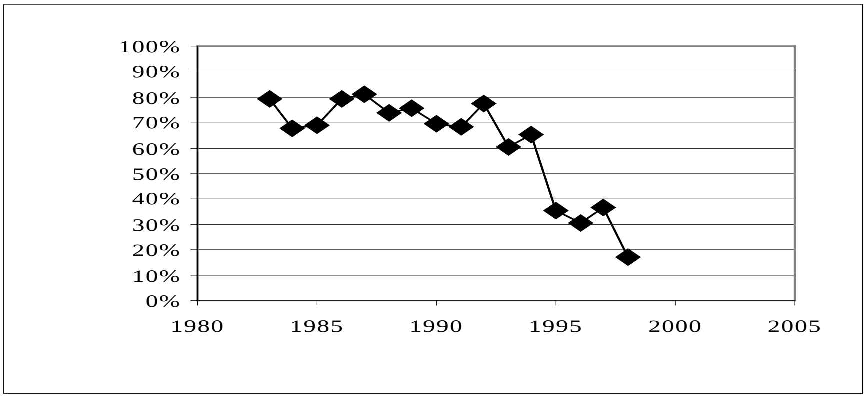
The migratory pathway and harvest distribution of mid Hood Canal Chinook are also assumed to be similar to that of the Skokomish River indicator stock, although that stock's returning mature salmon continue past the mid Canal area and reach the Skokomish River, farther south. The FRAM simulation model suggests that the terminal (Area 12C) and extreme-terminal (in-river) fisheries may harvest up to 25% of the Skokomish terminal run. However, terminal-area fisheries at the far southern end of Hood Canal, near the mouth of or in the Skokomish River, are not believed to harvest significant numbers of adults returning to the mid Hood Canal watersheds. Time and area restrictions are believed to be effective in relieving harvest pressure on the mid Hood Canal sub-populations.

When the upper threshold of 750 spawners (established as interim escapement target in the Hood Canal Salmon Management Plan (HCSMP 1986)) is not expected to be met, recreational and commercial fisheries will be adjusted to the extent necessary to exert a preterminal exploitation rate of no more than 15%, or meet the escapement target, whichever occurs first. These measures shall also include the closure of freshwater fisheries that are likely to impact adult spawners of these sub-populations.

A low abundance threshold of 400 Chinook spawners has been established for the mid Hood Canal management unit, which is approximately 50% of the current escapement goal for the mid Hood Canal sub-populations. If escapement is projected to fall below this threshold, further conservation measures will be implemented in pre-terminal and terminal fisheries to reduce mortality and ensure that the projected preterminal exploitation rate does not exceed 12.0%. The best available information indicates that escapement has been below the low abundance threshold in four out of the last five years. The Co-managers recognize the need to provide across-the-board conservation measures in this circumstance, and to avoid an undue burden of conservation falling on the terminal fisheries.

Recent Harvest and Escapement Information

Over the last twenty years, exploitation rates of Skokomish Chinook have decreased and presumably mid Hood Canal Chinook have been affected similarly. The following figure, generated from post-season FRAM model runs, shows harvest exploitation rates of Skokomish Chinook declining substantially between 1991 and 1998. Since 1998, Skokomish exploitation rates have increased somewhat (not shown in figure). Note that exploitation rates are calculated as the expected number of fishery-related mortalities divided by the expected total run size including the escapement.



Exploitation rate declines of similar magnitude to that shown in the above figure have occurred in other regions of Puget Sound as well (PST and WDFW 2004). These declines generally indicate Chinook harvest effects have been substantially curtailed by current harvest management conservation efforts.

The following table describes mid Hood Canal Chinook spawning escapement estimates for the years 1993 through 2004.

Return Year	Mid Hood Canal Chinook			
	Dose.	Duck.	Hamma	Total
1993	67	17	28	142
1994	297	9	78	384
1995	76	2	25	103
1996	na	13	11	na
1997	na	na	na	na
1998	58	57	172	287
1999	54	151	557	762
2000	29	28	381	438
2001	45	29	248	322
2002	43	20	32	95
2003	87	12	85	184
2004	80	0	49	129

As shown in the table, escapement has been below the mid Hood Canal management unit’s low threshold of 400 spawners in four of the most recent five years, and has exceeded the upper threshold of 750 spawners only in 1999.

2005 Harvest Management Planning

Based on the final FRAM model run of Washington fisheries at the conclusion of the 2005 PFMC / North of Falcon fisheries planning effort, the anticipated exploitation rates and escapement for mid Hood Canal Chinook for 2005 are as follows.

Management Unit	Within Hood Canal Exploitation Rate	Southern U.S. Preterminal Exploitation Rate	Southern U.S. Exploitation Rate	Total Exploitation Rate (South. U.S. & Canada)	Projected Spawning Escapement
Mid Hood Canal	0.4%	12.0%	12.4%	31.8%	185

The table shows that 2005 preseason harvest management planning provides for limiting the preterminal U.S. exploitation rate to no more than 12 % as required by the management guideline in effect when the mid Hood Canal management unit's escapement is projected below the low threshold of 400 spawners; the projected escapement for 2005 is 185 spawners. The total expected exploitation rate is approximately 32 %, of which just over 12% is attributed to southern U.S. fisheries and about 20% to Canada (there is no projected Alaskan harvest). Note that a 0.4% exploitation rate is attributed to within Hood Canal terminal fisheries. The projected breakdown of mid Hood Canal harvest is 34 Chinook in southern U.S. and 53 Chinook in Canada, summing to a total 87 Chinook.

A simple assessment of risk under current harvest conditions can be made using estimates of mid Hood Canal productivities and the current exploitation rate. The Co-managers' EDT analysis of the mid Hood Canal watersheds estimated productivity under current conditions without harvest to be 3.9, 3.8 and 3.4 recruits per spawner for the Dosewallips, Duckabush and Hamma Hamma rivers, respectively. Assuming the projected 2005 total exploitation rate of 32% and looking at the sub-population with the lowest productivity of the three (Hamm Hamma), the recruits per spawner after harvest would be 2.3 (i.e., 3.4 x (1.0 - .32) = 2.3). This value exceeds 1.0, indicating more adults would be returned to the stream than had parented them and suggesting that current harvest management planning would not impede recovery[2].

The specific Hood Canal fishery regulations are described in the 2005 treaty/non-treaty salmon package prepared by the Co-managers following the 2005 PFMC/North of Falcon preseason planning process (WWTT and WDFW 2005). A general description of Hood Canal fishery regulatory provisions in recent years is contained in Appendix F under the description of "Chinook Harvest Management within Hood Canal". Also described in Appendix F are the circumstances, limitations and opportunities for harvest management under the Pacific Salmon Treaty, including management of the Canadian fisheries.

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[2] However, application of this same assessment to stream reaches, indicates that the furthest downriver reach in the Duckabush River is vulnerable under current harvest conditions. See below section, Potential Harvest Effects on the VSP Parameters of Diversity and Spatial Distribution.

Use of Rebuilding Exploitation Rates as a Management Tool

Rebuilding exploitation rates (RERs) can be an effective tool for controlling harvest risks during recovery of a salmon management unit. Ideally, the RER is used as a ceiling exploitation rate in the planning and implementation of fisheries affecting the management unit. The RER is set at a level low enough to assure stable or increasing escapement. It is derived from a recruitment function (e.g., the Ricker spawner-recruit curve) that recognizes the inverse relationship of abundance (escapement) and productivity (recruits per spawner); that is, as abundance decreases, productivity increases and as abundance increases, productivity decreases. The RER is derived using the recruitment function and is based on the current condition or performance of the management unit. Additional details about the RER and an example of its application are provided in section 6.4 of the Co-managers' harvest management plan for Puget Sound Chinook (PSIT and WDFW 2004).

Because the RER depends on the recruitment function and current performance of the management unit, information about the management unit's spawner-recruit relationship is needed. Normally, this information is developed over time by monitoring the numbers and ages of fish harvested and escaping to the spawning grounds, so that brood years may be reconstructed and numbers of recruits may be related to numbers of spawners. With a sufficient number of reconstructed brood years, a recruitment function may be derived to serve as the basis for determining an RER.

In the case of the mid Hood Canal Chinook management unit, there is no spawner-recruit data to develop a recruitment function. The current Hamma Hamma coded wire tagging program (see below section on harvest adaptive management) should eventually provide the information needed, so that the Co-managers can estimate a mid Hood Canal Chinook RER and may use it as a management tool (the coded wire tagging program would also lead to improved exploitation rate estimates, a substantial improvement on the indirect approach currently used). But collection of sufficient data may take as long as ten years or more.

An alternative would be to use Skokomish River hatchery coded wire tag data that has been collected for many years up to the present. However, to develop a recruitment function for use in determining an RER, a cohort analysis of these data and new run reconstruction (that estimates run size by brood year) are required. The Co-managers have recognized the need for these analyses but have not been successful in acquiring funding to accomplish them. In the mean time, lacking good data to estimate an RER, the Co-managers' are using an alternative approach to control the exploitation rate on mid Hood Canal Chinook (see above sub-section, Harvest Management Actions, and Appendix F).

Another approach would be to use the recruitment function derived through EDT analysis to consider an RER estimate and its possible application. This indirect approach is not based on actual performance of the Chinook management unit and may not be appropriate. Nevertheless, the Co-managers plan to explore this approach. An RER may be helpful in negotiations with Canada (regarding its relatively high Chinook exploitation rates) over the renewal of the Pacific Salmon Treaty annex in 2009.

Potential Harvest Effects on the VSP Parameters of Diversity and Spatial Distribution

Comments by the Puget Sound TRT on the previous draft of this chapter suggested diversity and spatial distribution be addressed as part of harvest management and also suggested the EDT analysis be incorporated in harvest planning. Following is an assessment of EDT results, focusing on differences in productivity (recruits per spawner), abundance (escapement) and diversity (life history pathways) between the mid Hood Canal Chinook watersheds and stream reaches within the watersheds. The implications for harvest management are also addressed.

Tables 6.1a, 6.1b, and 6.1c describe the results of EDT model runs for the Dosewallips, Duckabush and Hamma Hamma watersheds, respectively. For each of the three tables, in the column titled “Population”, the entire watershed and reaches within the watershed are specifically identified as subjects for EDT analysis. Where the specific reaches are identified, the analysis assumes spawning only occurs in that reach. In this way, a spatial breakdown by reach of the EDT results for diversity, productivity, capacity and equilibrium abundance is presented (as indicated by the column headings) and comparisons between the reaches (and between watersheds) can be made. Note that for each watershed and reach, two EDT analyses are shown, one representing current conditions (without harvest) and one representing historical conditions.

Table 6.1a. Dosewallips EDT Results by Reach

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Dosewallips Chinook - Entire River	Current without harvest	100%	3.9	1,670	1,240
	Historic potential	100%	15.5	5,049	4,723
Dose 1 - mouth upstream to end of floodplain devel	Current without harvest	100%	4.3	628	483
	Historic potential	100%	15.9	1,408	1,320
Dose 2 - Floodplain development to Rocky Brook	Current without harvest	100%	3.5	164	117
	Historic potential	100%	17.1	429	404
Dose 3 - Rocky Br. to just d.s. of Stony Brook	Current without harvest	100%	3.8	744	547
	Historic potential	100%	16.6	2,701	2,538
Dose 4 - Just d.s., of Stony Brk. to Dose Falls	Current without harvest	100%	5.6	136	112
	Historic potential	100%	12.5	465	428

Table 6.1b. Duckabush EDT Results by Reach

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Duckabush Chinook - Entire River	Current without harvest	100%	3.8	752	554
	Historic potential	100%	14.8	2,224	2,074
Duck 1 - mouth (Hwy 101) to upstream extent of rev	Current without harvest	90%	1.5	110	37
	Historic potential	100%	14.2	556	517
Duck 2-3 - Revetments to gradient change @ top of	Current without harvest	100%	4.4	437	338
	Historic potential	100%	15.8	1,119	1,048
Duck 4-5 - Top of Canyon to barrier falls @ Little	Current without harvest	100%	3.3	191	133
	Historic potential	100%	12.1	519	476

Table 6.1c. Hamma Hamma EDT Results by Reach

Population	Scenario	Diversity index	Productivity	Capacity	Abundance
Hamma Chinook - Entire River	Current without harvest	100%	3.4	619	438
	Historic potential	100%	15.2	1,615	1,508
Hamma 1-2 - Mouth (Hwy 101) to gradient change (18	Current without harvest	100%	3.0	380	254
	Historic potential	100%	14.9	1,040	970
Hamma 3 - Gradient change to 600' below barrier fa	Current without harvest	100%	4.3	126	97
	Historic potential	100%	14.8	301	281
John 1-2 - entire John Crk.	Current without harvest	100%	3.7	118	86
	Historic potential	100%	16.3	287	269

First, let us consider how the results for the three entire rivers compare under current conditions and assuming no harvest effects. The "Current without harvest" scenario in the "Scenario" column of each figure identifies the row for that scenario that shows results for diversity index, productivity, capacity and equilibrium abundance. Looking at this first row in Tables 6.1a, 6.1b and 6.1c, provides the means of comparing the entire river results between the Dosewallips, Duckabush and Hamma Hamma. The results indicate that the diversity index (i.e., percentage of historical life history pathways) is at 100% for all three rivers and productivity (recruits per spawner) is 3.9 for Dosewallips, 3.8 for Duckabush and 3.4 for Hamma Hamma. The capacity and equilibrium values indicate that the current potential number of fish produced is highest for Dosewallips, and substantially less for Duckabush and Hamma Hamma. What these results suggest relative to harvest management is that the productivity is very similar between the three rivers with the Hamma Hamma being at a just slightly higher risk of harvest impact on recruits per spawner. Potential fish production on the Hamma Hamma and Duckabush rivers is shown to be just under half that of the Dosewallips river, indicating potentially higher vulnerability to harvest impacts for these two rivers.

Ideally, model runs of the scenario, "current conditions with harvest effects", would be available to assess impacts from harvest. Unfortunately, such an EDT model run incorporating current exploitation rates was not available at the time this report was prepared. But, a rough approximation of "current conditions with harvest effects" can be made by simply reducing, proportionate to the current exploitation rate, the productivity and equilibrium abundance results for "current conditions without harvest effects"[3]. For example, with Dosewallips, the productivity would become 2.65 recruits per spawner (i.e., 3.9 x (1.0 - .32) = 2.65) and the equilibrium abundance would become 843 fish (i.e., 1,240 x (1.0 - .32) = 843) based on values in Table 6.1a and assuming an exploitation rate of approximately 32% (the latter value is the projected 2005 rate – see above section, 2005 Harvest Management Planning). Similar values calculated for Duckabush would be 2.58 recruits per spawner and an equilibrium abundance of 377 fish, and for Hamma Hamma would be 2.31 recruits per spawner with an equilibrium abundance of 298 fish (based on information shown in Tables 6.1b and 6.1c, respectively, and assuming the exploitation rate of 32%). These calculations indicate that the Hamma Hamma is most vulnerable to harvest effects since it has the lowest values of productivity and equilibrium abundance under these projections of current conditions with harvest effects. The Hamma Hamma productivity value of 2.31 recruits per spawner exceeds 1.0 by a fair margin, indicating more adults would be returned to the stream than had parented them and suggesting current harvest management provisions do not impede recovery. However, based on results of these simple assessments, indications are that harvest management should be sensitive to differences in vulnerability between the three mid Hood Canal Chinook sub-populations. Note that it is not appropriate to estimate the effect of harvest on EDT diversity index values by simple proportional reductions of the values based on the exploitation rate; assessment of the harvest effect on the diversity index would require an EDT analysis that incorporates harvest.

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[3] These rough approximations do not reflect actual values that would be generated by EDT analysis, but are adequate for the present purpose.

Vulnerabilities relative to spatial distribution may be further considered at the level of stream reaches within the three watersheds. Table 6.1a breaks down the Dosewallips into four reaches[4], Table 6.1b breaks down the Duckabush into three reaches, and Table 6.1c breaks down the Hamma Hamma into three reaches. Some of the reaches defined for the original EDT analysis have been combined as deemed appropriate for this assessment (e.g., reach "Duck 2-3"). The EDT results show significant differences between reaches within a watershed and between the individual reaches and the entire river of each watershed. For example, in the Dosewallips watershed (Table 6.1a) under current conditions, the "Dose 2" reach shows the lowest productivity at 3.5 recruits per spawner compared to the highest productivity of "Dose 4" at 5.6 recruits per spawner; the Dosewallips' "Entire River" productivity is 3.9 recruits per spawner. Also, for the Dosewallips watershed under current conditions, equilibrium abundance varies from a low of 112 fish in the "Dose 4" reach to 547 fish in the "Dose 3" reach, with the "Entire River" equilibrium abundance shown to be 1,240 fish (Table 6.1a).

Among the three watersheds, the most vulnerable reach is shown by the EDT results to be "Duck 1" with estimates under current conditions of productivity at 1.5 recruits per spawner and of equilibrium abundance at 37 fish (Table 6.1b). The next most vulnerable reaches, as indicated by current productivity values, are "Hamma 1-2" with productivity at 3.0 and "Duck 4-5" with productivity at 3.3 (Tables 6.1c and 6.1b, respectively). Based on current equilibrium abundance, the next most vulnerable reaches are "John 1-2" at 86 fish and "Hamma 3" at 97 fish (Table 6.1c).

The simple assessment of current harvest-related risk, applied as described above to the three watersheds, may also be applied to individual stream reaches. Beginning with the most vulnerable reach, "Duck 1", the current productivity without harvest is 1.5 recruits per spawner (Table 6.1b) and the assumed exploitation rate is 32% (see above section, 2005 Harvest Management Planning). In this case the recruits per spawner after harvest would be 1.02 (i.e., 1.5 x (1.0 - .32) = 1.02). This value shows the recruits just exceed spawners, suggesting that at the current exploitation rate, continuing natural Chinook production in the reach is at the tipping point and is at risk. Of course, this reach has the most degraded habitat in the Duckabush River (compare EDT results of "Current without harvest" with "Historic potential" in Table 6.1b) and the primary need is to protect and restore that habitat. Nevertheless, at the current exploitation rate, Chinook production in the reach is indicated to be vulnerable. Applying the same assessment to the next two potentially vulnerable mid Hood Canal reaches gives the following results: for "Hamma 1-2", the recruits per spawner with current harvest is estimated to be 2.04 and for "Duck 4-5", the estimate is 2.24. In the latter two cases, harvest doesn't appear to impede recovery.

These assessments suggest that Chinook spawning in some stream reaches are substantially less productive, especially where habitat conditions are degraded. Under these circumstances, harvest may exacerbate the effects of the poor habitat in a given reach, the lowermost reach of the Duckabush being the prime example. In conclusion, it

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[4] Because of the very limited access of Chinook to Rocky Brook, it is not included in this assessment.

would appear that habitat conditions in combination with harvest could affect the spatial distribution and diversity of Chinook within the mid Hood Canal watersheds. This effect merits further investigation. The new EDT-population model, described below in the mid Hood Canal Hatchery Adaptive Management section, may prove to be an effective tool for additional assessment.

Harvest Adaptive Management

The Co-managers' Chinook harvest management plan (PSIT and WDFW 2004) includes a section on monitoring, assessment and adaptive management. In that section it is noted that performance of Chinook fishery management will be evaluated annually to assess whether management objectives were met and identify factors affecting success or failure. This assessment will be documented in an annual report completed by mid February each year so that it may be utilized during the late winter / early spring annual pre-season fisheries planning process. This section of the Co-managers' plan goes on to generally discuss monitoring and assessment activities related to Chinook harvest adaptive management.

Most of the assessment and monitoring activities are not new. The Co-managers rely heavily on assessment and monitoring to build information upon which Chinook run forecasts are made and that serve as the basis for annual fisheries planning. In a sense, adaptive management has been a part of fisheries planning and implementation for a long time. The Point No Point Treaty Tribes and WDFW have for many years prepared a report annually that updates catch and escapement information and provides run forecasts for all salmon management units of Hood Canal, including mid Hood Canal Chinook (e.g., PNPTC and WDFW 2004). Beginning 2001, the Co-managers have been producing Chinook post-season reports; for example, see 2003-04 fishing season report (WDFW and PSIT 2004). Generally, the assessments and monitoring needed to check and improve harvest management effectiveness are known. With adequate resources, it is expected that under the Co-managers' harvest management plan and associated ESA 4(d) rule permit, adaptive management will occur. Harvest adaptive management should be integrated with adaptive management of the hatchery and habitat strategies, so that over time, coordinated adjustments can be made, based on what we learn about Chinook biology and behavior and about the success of recovery measures taken.

The nature of harvest management requires that for adaptive management to be effective and efficient, it must be coordinated across all Puget Sound Chinook management units. Recognizing this need, Table 6.2 includes some widespread adaptive management needs but also focuses on summarizing assessments, tasks, tools and monitoring to be used in adaptive management of harvest for mid Hood Canal Chinook. The general status of funding is also described in the table.

Table 6.2. Descriptions of harvest adaptive management assessments/tasks and associated monitoring/tools required, time frames and funding status.

Assessment/ Task	Rationale/ Direction	Monitoring/ Tools Required	Time Frame: Implementation/ Use	Funding	Funding Availability
Ensure harvest adaptive management continues to be coordinated across all management units	Harvest management is a complex process that integrates planning across management units.	Continued use of current tools/models and monitoring, and incorporation of new tools as they become available.	Continuing. Short & long term.	Continuing	Currently available.
Provide for integration & address interactions of harvest with habitat and hatchery (all parties involved in recovery).	Adaptive management must be integrated to succeed.	Some monitoring applies to all Hs; e.g., escapements, runsizes, productivity.	Continuing. Short & long term.	To be determined in course of completing adaptive management plans.	To be determined in course of completing adaptive management plans.
Estimate Chinook escapement returns to the mid Hood Canal watersheds.	Tracks escapement trends. Provides input to run forecasts. Accounts for differences in spatial distribution.	Spawner surveys to estimate HORs and NORs.	Continuing. Short & long term.	WDFW	Currently available.
Estimate harvests – but noting there are no current fisheries targeting mid Hood Canal Chinook.	Measures success in meeting harvest objectives. Contributes to current run reconstruction and forecasting.	Use of fish tickets, catch monitoring and coded wire tag sampling.	Continuing. Short & long term.	WDFW and Tribe.	Current funding available but more needed.

Table 6.2 (cont.) Assessment/ Task	Rationale/ Direction	Monitoring/ Tools Required	Time Frame: Implementation/ Use	Funding	Funding Availability
Track regulatory and enforcement effectiveness.	Measures success in meeting harvest management objectives.	Based on enforcement patrol reports.	Continuing. Short & long term.	WDFW and Tribes.	Currently available.
Prepare annual harvest management reports.	Consistent with P.S. Chinook harvest management plan.	Tribes and WDFW have history of annual reports for Hood Canal. Puget Sound post-season reports began in 2001.	Continuing. Short & long term.	WDFW and Tribe.	Currently available.
Develop new Chinook fisheries simulation model to replace or supplement FRAM. Applies to P.S. Chinook in general.	Provide more effective support of pre-season harvest planning.	Requires major modeling effort.	Short and long term.	WDFW and Tribes	Currently not available.
Use of modeling tools, widespread and locally.	To help synthesize and evaluate information.	Models include FRAM, EDT-population, RER estimator and, when available, new Chinook fisheries simulation model.	Continuing. Short and long term.	WDFW and Tribes.	Some currently available.

Table 6.2 (cont.) Assessment/ Task	Rationale/ Direction	Monitoring/ Tools Required	Time Frame: Implementation/ Use	Funding	Funding Availability
Mid Hood Canal Chinook cohort analysis and new run reconstruction.	To improve run forecasting. Provide basis for estimating exploitation rates and RER. Look at major Chinook population changes & trends.	Coded wire tagging and sampling in mid Hood Canal watersheds. Cohort analysis and new run reconstruction using the Skokomish data now and the Hamma Hamma data in future.	Continuing tagging and sampling, and Skokomish cohort analysis & new run reconstruction in short term. Mid Hood Canal cohort analysis & new run reconstruction in long term.	WDFW and Tribe	Coded wire tagging and sampling covered. Addit. funding needed for cohort analysis and new run reconstruction.
Improve estimates of mid Hood Canal Chinook exploitation rates.	Provides check on meeting harvest management objectives.	Requires cohort analysis and new run reconstruction.	Long term.	WDFW and Tribe.	To be determined
Estimate a mid Hood Canal Chinook rebuilding exploitation rate (RER).	To improve management of harvest risk.	Requires cohort analysis and new run reconstruction in short term (using Skokomish data) and long term (using Hamma Hamma data). Also, in short term, explore use of EDT population parameters to estimate RER.	Long and short term.	WDFW and Tribe.	Currently not available for Skokomish data analysis.
Assess distribution of mid Hood Canal Chinook throughout the watersheds.	To determine extent of distribution and signal the need for new mgt actions	Spawner surveys, snorkel surveys.	Same as immediately above	Currently WDFW.	Same as immediately above.

Table 6.2 (cont.) Assessment/ Task	Rationale/ Direction	Monitoring/ Tools Required	Time Frame: Implementation/ Use	Funding	Funding Availability
Assess genetic, demographic and ecological characteristics of the mid H Chinook population.	To check for possible major changes or trends (including NOR/HOR ratios, spawner & juvenile spatial distribution, and diversity reflected in genetic profiles, life hist. and biol. charact.) and assess harvest management responses.	Spawner surveys (for escapement estimates, escapement distribution, NOR/HOR ratios, genetic profiles, biol. character.), juvenile trapping (for hatch & wild emigrant estimates, genetic profiles, life hist. info. & biol. character.), snorkeling surveys for juvenile distribution and habitat use.	Continuing current programs, but need to initiate new programs. Short and long term.	Currently WDFW.	WDFW covers spawner surveys, genetic sampling. Several parties fund juvenile trapping. Funding needed for genetic analysis, additional trapping, and snorkel surveys.
Assess progress toward sustainable population and Co-managers' recovery goals.	Based on tracking major changes and trends, measured by productivity, abundance, diversity and spatial distribution.	From escapement estimates, cohort analysis and new run reconstruction. Also may include use of EDT-population model.	Continuing. Long term.	WDFW and Tribe.	Currently available.
Prepare for 2009 PST annex negotiations with Canadians.	Canada's exploitation rates on mid Hood Canal Chinook are relatively high.	Estimation of mid Hood Canal RER may offer compelling argument. The negotiations would address a regional (southern U.S.) problem with Canadian Chinook exploitation and would need to be managed as a coordinated effort.	Long term.	WDFW and Tribes	Preparing analyses and argument may require additional funding.

Mid Hood Canal Chinook Hatchery Management

Chinook salmon have been propagated in hatcheries within the Puget Sound region since before 1900. The earliest purpose for hatcheries was to produce large numbers of fish for harvest. As salmon habitat was altered or destroyed by dams, forestry, and urbanization, mitigation for lost natural production and fishing opportunity became a major purpose for hatchery production. Over the last 20 years, the purposes for hatcheries have evolved to include rebuilding wild populations, preserving unique genetic races, and reintroducing fish to areas where they have been extirpated (WDFW and PSTT 2004).

In Hood Canal, the Puget Sound Salmon Management Plan (PSSMP 1985) and Hood Canal Salmon Management Plan (HCSMP 1986) are federal court orders that currently control both the harvest management rules and hatchery production schedules for salmon under *U.S.* v *Washington* (1974, the Boldt Decisions) management framework. For hatcheries, these management plans include 1) descriptions of standard modes of operating hatchery programs developed under regional planning by the Co-managers (equilibrium brood documents and equilibrium brood programs), 2) annual descriptions and review of the operating objectives and changes from the standard program that can be used for annual planning (Future Brood Document and Co-managers' Fish Disease Policy), 3) regional management plans to coordinate co-manager activities and priorities, 4) exchange of technical information and analyses through coordinated information systems, and 5) dispute resolution.

Hatchery production continues to be important to the tribes and people of the State of Washington. However, in addition to the benefits provided by artificial production, the scientific literature indicates that artificial production may pose risks to wild Chinook salmon populations. These potential risks include: 1) genetic impacts, which affect the loss of diversity within and among populations and reproductive success in the wild; 2) ecological impacts, such as competition, predation, and disease; and 3) demographic impacts, which directly affect the physical condition, abundance, distribution, and survival of wild fish (WDFW and PSTT 2004).

The Co-managers are required, under the Endangered Species Act, to obtain permits from NOAA Fisheries for hatchery operations affecting Puget Sound Chinook. They have submitted Resource Management Plans (RMPs) for hatchery Chinook and for hatchery non-Chinook species as part of the permitting requirements under section 4(d) of the Endangered Species Act (WDFW and PSTT 2004, PSTT and WDFW 2004). These plans describe how the Co-managers are managing hatchery programs to help conserve some Puget Sound Chinook natural populations (e.g., Hamma Hamma) and also to control potential hatchery impacts on natural Chinook populations (i.e., for programs that augment Chinook harvest and non-Chinook species programs). In support of this effort, the Co-managers have also prepared an EIS and Hatchery Genetic Management Plans (HGMPs). The HGMPs describe planning and operation of the individual hatchery programs at every hatchery facility. Virtually all of the Co-managers' hatchery management planning relevant to Puget Sound Chinook is described in these documents.

Chinook Hatchery Program Goals

The goals of the hatchery Chinook salmon programs in Hood Canal are to: 1) produce fish for tribal, commercial, and recreational harvest; 2) aid in recovery and re-establishment of natural populations; and 3) provide mitigation for reduced natural production in the Skokomish River system, primarily caused by hydroelectric dams on the North Fork Skokomish (WDFW and PSTT 2004). These goals are consistent and supportive of the overall goal of the Co-managers to protect, restore, and enhance the productivity, abundance, and diversity of salmon and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries, non-consumptive fish benefits and other cultural and ecological values. The Co-managers have developed and implemented a conservation hatchery program and harvest hatchery programs for Chinook in Hood Canal.

Hatchery Management Hypotheses

In their technical guidance for watershed groups, the Puget Sound TRT and Shared Strategy Staff Group (2003) suggest that plausible hypotheses be developed for how hatchery management actions affect the current and future VSP characteristics of Chinook populations. In Hood Canal, the management hypotheses are similar and complementary for the hatchery program designed primarily to recover a Chinook sub-population and for hatchery programs designed primarily for harvest.

For the Chinook conservation hatchery program (i.e., Hamma Hamma Chinook supplementation), the hatchery management hypotheses are that properly implemented hatchery management 1) reduces the risk of extinction for the critically low Chinook sub-population and 2) helps rebuild the population to numbers that will be naturally sustainable without significantly negative effects upon demographic, genetic and ecological processes that determine productivity, spatial distribution, diversity, and abundance levels of the natural population.

For Chinook harvest hatchery programs (e.g., Hoodsport George Adams hatcheries and LLTK Rick’s Pond), the hatchery management hypotheses are that properly implemented hatchery management 1) does not impede the recovery of natural populations and 2), over the long term and with adequate habitat restoration, does not have significantly negative effects upon demographic, genetic and ecological processes that determine productivity, spatial distribution, diversity, and abundance levels of the natural population.

The following key assumptions underlie these hypotheses:

- Habitat recovery will be sufficient to support productive and sustainable natural Chinook populations.
- The conservation hatchery program will produce Chinook smolts that return as adults at levels sufficient to rebuild the Chinook population.
- The conservation hatchery program is successful in meeting its objectives/standards with respect to brood stock collection, spawning, incubation, rearing, disease control, and release of Chinook .

- The harvest hatchery programs will provide fishing opportunity without impeding recovery of natural populations.
- The harvest programs for hatchery Chinook and the non-Chinook hatchery programs for chum, pink, coho and steelhead are successful in implementing measures intended to minimize negative effects on viability of natural Chinook populations (e.g., impacts of interbreeding, predation or competition) and those measures do avoid such impacts.
- The natural populations will ultimately meet the abundance and productivity recovery goals (this assumption is also dependent on habitat protection and recovery).

Hatchery Management Actions

Numerous hatchery management actions have been implemented in Hood Canal since Puget Sound Chinook were listed under the ESA in 1999. The following hatchery management strategies have been or are being implemented in Hood Canal, consistent with the hatchery management hypotheses, to help achieve Chinook recovery goals:

- Implement a supplementation program on the Hamma Hamma River with the intent to restore a healthy, natural, self-sustaining population of fall Chinook; increase population productivity by including natural broodstock in the program.
- Implement measures for hatchery Chinook and non-Chinook programs with intent to minimize negative effects on viability of natural Chinook populations (e.g., to avoid negative ecological impacts).
- Increase population diversity by discontinuing the use of non-local hatchery stocks and by reducing potential spawning with natural stocks; e.g., use of non-Hood Canal hatchery stocks was discontinued in 1991.
- Increase population productivity by reducing the number of hatchery origin fish from some hatchery programs in natural spawning areas; e.g., discontinue rearing/release of hatchery Chinook yearlings in saltwater netpens to reduce potential straying and spawning by hatchery Chinook in natural spawning areas.
- Increase population productivity by reducing potential ecological interactions in freshwater and estuarine areas; e.g., eliminate release of hatchery Chinook fry into natural production areas.
- Monitor, assess and adaptively manage programs to meet hatchery objectives and standards and ultimately the recovery goals.
- Coordinate management actions among the management entities.

Current Chinook Hatchery Programs

The specific Chinook hatchery programs, their objectives and standards, as well as monitoring, assessment and adaptive management are described below. Current Chinook hatchery facilities in Hood Canal are operated by WDFW (Hoodsport, George Adams and McKernan hatcheries), Long Live the Kings (Rick’s Pond), and the Hood Canal Enhancement Group in cooperation with WDFW (Hamma Hamma rearing ponds).

Hatchery Genetic Management Plans (HGMPs) for each Chinook program provide a thorough description of each hatchery operation including the facilities used, methods employed to propagate and release fish, measures of performance, status of ESA-listed stocks that may be affected by the program, anticipated listed fish "take" levels, and description of risk minimization measures applied to safeguard listed fish. HGMPs for each Chinook program are available (WDFW 2004).

The following table describes the Hood Canal hatchery facilities that supported Chinook production during brood year 2004, the number of Chinook released, and the watershed of release.

	Fall Chinook released		Watershed of release
Production facility	Fingerling	Yearling	
George Adams	3,800,000		Skokomish
Hoodsport	2,800,000	120,000	Finch Cr.
McKernan	Transfer to Tumwater Falls Hatchery, South Sound, 200,000 yearlings		Deschutes
Hamma Hamma	110,000		Hamma Hamma
Rick's Pond		120,000	Skokomish
Total Production	6,710,000	240,000	

<u>George Adams Hatchery fingerling fall Chinook:</u> This hatchery program is operated to provide Chinook for harvest while minimizing adverse effects on ESA-listed fish. The hatchery Chinook production also provides mitigation for reduced natural production in the Skokomish system, primarily caused by hydroelectric dams on the North Fork Skokomish; the Skokomish Tribe, whose reservation is located near the mouth of the river, has a reserved treaty right to harvest Chinook salmon. Production of Hood Canal fingerling fall Chinook began at George Adams Hatchery in 1961. Broodstock are collected and spawned, eggs are incubated, and fry are reared at George Adams Hatchery for release into Purdy Creek, a tributary to the Skokomish River. Some Chinook production is coded-wire tagged and George Adams Hatchery has been a Pacific Salmon Treaty index station since 1985. In addition, since 1995 George Adams Hatchery has released Double-Index Tag (DIT) groups of 225,000 adipose-fin clip/coded-wire tagged Chinook fingerlings and 225,000 coded-wire tagged Chinook fingerlings (with no adipose-fin clip). Tag groups provide data on hatchery Chinook catch contributions, run timing, total survival, migration patterns and straying into other watersheds and the DIT groups each provide an index group for Hood Canal wild fingerling fall Chinook. In addition, WDFW intends to mass mark Chinook fingerling production and will work with the tribal Co-managers to agree on an identifiable mark and plan. The HGMP provides a detailed description of the performance indicators addressing the benefits and risks of the Chinook hatchery program and describes the monitoring and evaluation plan (HSRG 2003).

<u>Rick's Pond yearling Chinook:</u> This hatchery program is operated to provide Chinook for harvest while minimizing adverse effects on ESA-listed fish. The yearling Chinook

production at Rick's Pond on the lower Skokomish River began in 1996 and is funded by the Puget Sound Recreational Enhancement account, a program supported by a fee charged to recreational salmon anglers in Puget Sound. Broodstock are collected and spawned, eggs are incubated, and fry are reared at George Adams Hatchery. About 75,000 Chinook fry are transferred to Rick's Pond for rearing to yearling and release into the Skokomish River in April. In addition, about 50,000 fry are transferred to LLTK Lilliwaup Hatchery for rearing; these fish are then transferred to Rick's Pond in April for final rearing and release into the Skokomish River in June. Some Chinook production is coded-wire tagged and tag groups provide data on catch contributions, run timing, total survival, migration patterns and straying into other watersheds. In addition, WDFW intends to mass mark Chinook fingerling and yearling production and will continue to work with the tribal Co-managers to agree on an identifiable mark and plan. For example, in 2003 and 2004, all yearling production was adipose-fin clipped. The HGMP provides a detailed description of the performance indicators addressing the benefits and risks of the Chinook hatchery program and describes the monitoring and evaluation plan.

Hoodsport Hatchery fingerling and yearling fall Chinook: This hatchery program is operated to provide fish for harvest while minimizing adverse effects on ESA-listed fish. Production of Hood Canal fingerling fall Chinook began at Hoodsport Hatchery in 1952. Broodstock are collected and spawned, eggs are incubated, and fry are reared at Hoodsport Hatchery for release into Finch Creek, a tributary to Hood Canal. Some Chinook production is coded-wire tagged. Tag groups provide data on catch contributions, run timing, total survival, migration patterns and straying into other watersheds. In addition, WDFW intends to mass mark Chinook fingerling and yearling production and will continue to work with the tribal Co-managers to agree on an identifiable mark and plan. For example, 1.5 million fingerlings and all yearling production was adipose-fin clipped for brood year 2003 and all fingerling and yearling Chinook production was adipose-fin clipped for brood year 2004. The HGMP provides a detailed description of the performance indicators addressing the benefits and risks of the Chinook hatchery program and describes the monitoring and evaluation plan (HSRG 2003).

Hamma Hamma River fall Chinook supplementation program: The goal of this hatchery program, a cooperative effort between Long Live the Kings, Hood Canal Salmon Enhancement Group, and the Co-managers, is to restore a healthy, natural, self-sustaining population of fall Chinook to the Hamma Hamma River. The current objectives are to 1) develop and maintain, in the long term, a population comprised of naturally spawning Chinook on the Hamma Hamma River; 2) boost the numbers of naturally produced Chinook in the Hamma Hamma River using Chinook adults returning to the Hamma Hamma River and George Adams Hatchery as the donor stocks; and produce a maximum of 110,000 fed fry each year (55,000 fry each from the two donor stocks; and 3) monitor, evaluate and report on the effectiveness of the restoration program. From 1995 through 1999, the program used eggs from George Adams Hatchery and fish were reared at remote hatchery sites on John Creek in the Hamma Hamma basin and released there. However, given concerns by the Co-managers and NMFS regarding the continued use of George Adams broodstock, an agreement was reached that broodstock in 2000 would consist of a cross between George Adams females and naturally-returning Hamma

Hamma males. Beginning in 2001, the current hatchery program was established and uses Chinook adults returning to both the Hamma Hamma River and to George Adams Hatchery as broodstock; and a component of the program is to evaluate the risks and benefits of using natural-origin versus hatchery-origin broodstock for the Chinook recovery program. Hatchery progeny of George Adams broodstock and Hamma Hamma are adipose-clipped and differentially otolith-marked to distinguish them from each other and from Chinook juveniles produced naturally in the Hamma Hamma River. A screw trap is operated in the Hamma Hamma River to capture and enumerate outmigrating Chinook juveniles of hatchery and natural origin. The escapement of Chinook adults in the Hamma Hamma is estimated each year and Chinook adults are sampled for tags and marks. This monitoring of Chinook juveniles and adults will allow a simultaneous assessment of survival rates for naturally-spawned Chinook and for the two hatchery groups during rearing, to juvenile outmigration, and as returning adults. Monitoring and evaluation is ongoing. For brood year 2004, all Chinook fry in the program were released early (or lost) due to a broken pipe at the remote rearing site. A technical workgroup decided, for brood year 2004 only, to replace the lost production with George Adams Hatchery Chinook and, to distinguish these fish from naturally produced fish, all of the Chinook were coded-wire tagged and adipose-clipped. Because of low spawner returns to the Hamma Hamma River since 2002, the Co-managers plan to convene a workgroup to review the hatchery program and consider the need for changes in its operation and future direction.

Defining Chinook Hatchery Management Programs under the ESA

The Co-managers, under the Endangered Species Act, are in the process of obtaining permits from NOAA Fisheries for hatchery operations affecting Puget Sound Chinook. They have submitted Resource Management Plans (RMPs) for hatchery Chinook and for hatchery non-Chinook species as part of the permitting requirements under section 4(d) of the Endangered Species Act (WDFW and PSTT 2004, PSTT and WDFW 2004). In support of this effort, the Co-managers have also prepared an EIS and Hatchery Genetic Management Plans (HGMPs). The HGMPs describe planning and operation of the individual hatchery programs at every hatchery facility.

The Chinook RMP lists the following General Principles to guide the management of hatcheries (WDFW and PSTT 2004):

- Hatchery programs need clearly stated goals, performance objectives, and performance indicators
- Hatchery programs need to assess, manage, and reduce risks associated with potential interactions between coho, steelhead, sockeye, chum and pink salmon hatchery programs and natural populations listed under ESA. Brood stock collection, fish health, and rearing and release strategies of non-Chinook species are areas of potential interactions between hatchery programs and protected wild stocks.
- Hatchery program managers need to coordinate with fishery managers to maximize benefits and minimize biological risks so that they do not compromise overall plans to conserve salmon population protected by ESA.

- Hatchery programs will be based on adaptive management, which includes having adequate monitoring and evaluation to determine whether the hatchery program is meeting its objectives. Protocols will be in place for making revisions to the program based on risk evaluations, the best available monitoring and research information, and the adaptive management process.
- Hatchery programs must be consistent with the plans and conditions identified by Federal courts with jurisdiction over tribal harvest allocations
- Hatchery programs will monitor as management intent and wherever practical the "take" of listed salmon occurring as a result of the program and will provide that information as needed.

As affirmed in the Co-managers' RMP and the HGMPs developed for each Chinook hatchery program, hatchery programs in Puget Sound must adhere to a number of guidelines, policies and permit requirements in order to operate. These constraints are designed to limit adverse effects on cultured fish, wild fish and the environment that might result from hatchery practices. Operational objectives and standards include brood stocking and production targets, fish spawning, rearing and transfer protocols, minimizing negative interactions with listed species (i.e., natural Chinook and summer chum), maintaining stock integrity and genetic diversity, maximizing survival and controlling fish pathogens, and ensuring compliance with state and federal water quality standards. WDFW utilizes manuals and guidelines that specifically describe hatchery practices for spawning, transfers, disease control, maintenance of genetic diversity, and controlling effluent effects on water quality. More detailed descriptions of the objectives and standards are provided in the Hood Canal Chinook HGMPs. For example, the following is a list of guidelines, policies and permit requirements that govern hatchery operations:

> *Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington*: These guidelines define practices that promote maintenance of genetic variability in propagated salmon (Hershberger and Iwamoto 1981).
>
> *Spawning Guidelines for Washington Department of Fisheries Hatcheries*: Assembled to complement the above genetics manual, these guidelines define spawning criteria to be used to maintain genetic variability within the hatchery populations (Seidel 1983).
>
> *Stock Transfer Guidelines*: This document provides guidance in determining allowable stocks for release for each hatchery. It is designed to foster development of locally-adapted broodstock and to minimize changes in stock characteristics brought on by transfer of non-local salmonids (WDF 1991).
>
> *Fish Health Policy of the Co-managers of Washington State*: This policy designates zones limiting the spread of fish pathogens between watersheds, thereby further limiting the transfer of eggs and fish in Puget Sound that are not indigenous to the regions (NWIFC and WDFW 1998).
>
> *National Pollutant Discharge Elimination System Permit Requirement*: This permit sets forth allowable discharge criteria for hatchery effluent and defines

acceptable practices for hatchery operations to ensure that the quality of receiving waters and ecosystems associated with those waters are not impaired.

Non-Chinook Hatchery Programs

Hatchery operations in Hood Canal also support programs for summer chum, fall chum, pink, coho and steelhead. The following table describes the Hood Canal hatchery facilities that have been supporting non-Chinook production, the number of fish released, and the watershed of release.

Production Facility	Fish released					Watershed
	Coho	Fall chum	Summer chum	Pinks	Steelhead	
George Adams	300,000					Skokomish
						Skokomish
McKernan		10,000,000				Skokomish
Enetai		2,500,000				Enetai Cr.
WDFW Coop.		15,000				Nordstrom Cr.
		35,000				Trib. 14.01xx
Hoodsport		12,000,000		500,000		Finch Cr.
Little Boston		500,000				L. Boston Cr.
Remote sites: HCSEG (RFEG 6) and WDFW		15,000				Trib. 14.0124
		125,000				Sweetwater Cr.
			100,000			Hamma Hamma
			42,000			Union R.
			125,000			Tahuya R.
					2,000	Hamma Hamma
LLTK Lilliwaup			100,000			Lilliwaup R.
					1,700	Hamma Hamma
Big Beef (UW/WDFW)			86,000			Big Beef Cr.
Port Gamble netpen	400,000					Port Gamble Bay
Quilcene NFH	400,000					Quilcene R.
Quilcene netpen	200,000					Quilcene Bay
Total Production	1,300,000	25,190,000	453,000	500,000	3,700	

The General Principles listed above for Chinook hatchery programs also apply to non-Chinook hatchery programs. Hatchery programs for non-Chinook must also minimize any negative impacts to ESA-listed Chinook or summer chum salmon and measures have been implemented. The coho and steelhead programs include the provision of delaying release until after April 15 to reduce potential predation on the ESA-listed species of Chinook and summer chum salmon. The expectation is that the delay in release of the larger coho and steelhead yearlings (age 1+) will provide the opportunity for the smaller Chinook and summer chum juvenile emigrants (age 0+) to move out of the river and estuary in time to avoid becoming prey to the larger fish. The fall chum and pink salmon programs include the provision of delaying release until after April 1 to reduce potential adverse impacts due to competition and/or behavioral modifications to natural summer chum in the watershed. All programs are also managed to control potential disease pathogens that might affect the natural salmonid populations in the watershed. Details of the Hood Canal non-Chinook hatchery programs are described in the respective HGMPs and in the non-Chinook RMP (PSTT and WDFW 2004) and are consistent with guidelines in the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000).

Hatchery Reform

Hatchery management is a dynamic process, changing over time through monitoring, review and adaptive management. Another process currently affecting the direction of hatchery management in Washington State is the Puget Sound and Coastal Washington Hatchery Reform Project. An independent panel of scientists called the Hatchery Scientific Review Group (HSRG) leads the project. This project, begun at the behest of Washington State's congressional representatives in 1999, is meant to be a comprehensive hatchery reform effort to conserve indigenous genetic resources, assist with natural population recovery, provide for sustainable fisheries, conduct scientific research, and improve the quality and cost effectiveness of hatchery programs (HSRG 2004). Over the last three years, the HSRG has reviewed hatchery programs within all the regions of Puget Sound and the Coast and made specific recommendations.

As part of its task, the HSRG used information provided by the Co-managers to assess the hatchery programs of the Hood Canal region in early 2003. The HSRG prepared and distributed a report with its recommendations in March 2004 (HSRG 2004). The HSRG, by virtue of its independent scientific review, has advised and provided technical, not policy, recommendations for hatchery reform to the Hood Canal Co-managers[2]. The Co-managers and USFWS prepared responses to the recommendations and these were included in the 2004 HSRG report. In February 2005, the Co-managers provided the HSRG with a hatchery reform progress report for Hood Canal (Hood Canal Co-managers, 2005).

Chinook Hatchery Programs: Following is a description of the course of actions taken by the Co-managers in addressing hatchery reform and the HSRG recommendations for Chinook programs.

Big Beef Creek Chinook:

- The Co-managers agreed with the HSRG recommendation to discontinue the program. It was terminated in 2003.

Finch Creek (Hoodsport) Chinook:

- The HSRG recommended the Chinook programs be reduced in size to address loading and density concerns, as well as provide consistency with harvest goals and goals for other stocks.

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[2] The U.S. Fish and Wildlife Service also participates in Hood Canal hatchery reform as it relates to programs of the Quilcene National Fish Hatchery

- In 2003, the Co-managers jointly reviewed all of the Hoodsport Hatchery programs. The Co-managers decided in 2004 to reduce the size of several programs to provide acceptable loading and density levels as well as reduce surplus of hatchery fish (see summary of program reductions in Appendix G). Specifically, Chinook fingerling production was reduced from 3.0 million to 2.8 million and Chinook yearling production was reduced from 250,000 to 120,000.
- The HSRG recommended monitoring harvest, surplus hatchery fish, hatchery broodstock and smolt quality (growth trajectory, pre-release size and other measures). The intent of the Co-managers is to continue to monitor harvests. In support of this intent, WDFW initiated a coded-wire-tagging program in 2004. WDFW continues to monitor hatchery broodstock and surplus Chinook each year. WDFW also continues its current record keeping protocol that includes growth measurements, pre-release size estimates and other measurements throughout the course of incubation and rearing at the hatchery.
- The HSRG recommended maintaining varied release strategies and adjusting the Chinook programs based on successful strategies.

  The Co-managers continue to release fingerling and yearling Chinook at Hoodsport Hatchery. As noted above, the Co-managers will also continue to monitor harvests and escapements and will consider possible program changes to improve success in the future.
- The HSRG recommended external mass marking of Chinook releases in support of selective fisheries to increase harvest of hatchery fish

  WDFW supports external mass marking of Chinook. The tribes remain concerned about the impact of external mass marking on the coast-wide coded-wire-tagging program and question the potential impacts of new selective fisheries on allocation between treaty and non-treaty fishers.

  The Co-managers negotiated agreements and 1.5 million and 2.25 million Chinook fingerlings were externally mass marked and released from Hoodsport Hatchery during 2004 and 2005, respectively; of these, 200,000 were also coded-wire tagged each year. In addition, all Chinook yearlings released in 2005 (brood year 2003) and to be released in 2006 (brood year 2004) are externally mass marked and 100,000 are also coded-wire tagged each year.

  Discussions are ongoing between the Co-managers aimed at reaching a long-term agreement regarding mass marking of Chinook at Hoodsport and George Adams hatcheries.

Hamma Hamma Chinook:

- The HSRG recommended a plan be developed to replace the Hamma Hamma Chinook program’s George Adams sourced eggs with eggs from natural-origin spawners, and to include a specific endpoint for use of the George Adams eggs.

The intent of the program, in using both George Adams and natural origin broodstocks, was to evaluate and compare the success of the two broodstock sources. The evaluation, proposed by WDFW, began with brood year 2001 and included monitoring of emigrants and adults. Assessment is assumed to last no longer than twelve years.

- The HSRG recommended monitoring distribution, growth and survival of fingerlings in the river to assess river fry capacity, and to adjust the program commensurately.

  The WDFW, Long Live the Kings, Hood Canal Salmon Enhancement Group and tribes jointly continue to monitor Chinook emigrants using a screw trap in the lower river.

Skokomish Chinook:

- The HSRG recommended monitoring the status and productivity of the natural Chinook population, which would require mass marking the hatchery-origin fish to distinguish them from the natural-origin spawners.

  WDFW supports external mass marking of Chinook . The tribes, although supportive of monitoring the status and productivity of the naturally spawning Chinook , are concerned about the implications of external mass marking on the coast-wide coded-wire-tagging program and impacts of new selective fisheries (tied to mass marking) on allocation between treaty and non-treaty fishers.

  As noted in the HSRG 's 2004 report, double-index tagging of Chinook began with the 1995 brood at George Adams Hatchery and currently provides a tool to monitor the incidence of hatchery strays and the status of the naturally spawning Chinook population. In addition, all Chinook yearlings to be released from Rick's Pond on the Skokomish River in 2005 (brood year 2003) were externally mass marked and 100,000 (of 125,000) were coded-wire tagged.

- The HSRG recommended reducing the density of fish in culture to achieve higher quality of fish at release.

  The Co-managers jointly reviewed all of the Skokomish River hatchery programs in 2003, including the Chinook programs. The decision was made in 2004 to eliminate or reduce the size of several programs to bring loading and density levels to acceptable guidelines (see summary of program reductions in Appendix G). Consistent with this decision, the WDFW is pursuing elimination of the South Sound Chinook production (200,000 yearlings) at McKernan Hatchery.

- The HSRG recommended that (1) hatchery-origin fish not constitute more than one-third of natural spawners, (2) the hatchery broodstock include an average of 10-20% natural origin fish annually, and (3) genetic divergence between the natural spawners and hatchery spawners be quantified with this information to adjust broodstock guidelines. These recommendations were in support of the development of an integrated hatchery program as indicated by the HSRG immediately following region-wide recommendation.

The Co-managers believe development of an integrated Skokomish River Chinook program must be tied to habitat recovery. The extremely degraded habitat conditions currently within the Skokomish River, and the time it takes to improve such habitat, are key to managing for an integrated hatchery program. The Co-managers will consider the above HSRG recommendations in development of an integrated hatchery program. However, since the above recommendations were made, additional tools have been produced through the hatchery reform process (and more are likely to be forthcoming) to assist in the planning, development and subsequent management of an integrated hatchery program. This underscores the value of adaptive management, which allows the managers to make informed decisions in the face of uncertainty. See also the immediately following region-wide recommendations and comments, and the Co-managers response to the results of integrated hatchery program modeling for Skokomish Chinook in the next major section of this report.

<u>Region-wide Chinook Programs</u>:

- Underlying the HSRG's specific recommendations for each Hood Canal Chinook program is its region-wide recommendation that a conservation-rebuilding program be undertaken to develop a locally adapted, integrated stock of Chinook in the Skokomish River Basin. The HSRG further stated: This developing natural population must be, at least for the short term, sustained by hatcheries. This concept is not without risk. However, it is based on a "hedge-your-bet" approach to conserve and protect a locally adapting stock until the time that improved habitat can support a natural, self-sustaining population. Elements of this recommendation include:
    - Domestication selection should be minimized through the use of rearing protocols and environmental conditions that produce smolts that mimic as closely as possible the morphological, behavioral and physiological characteristics of wild fish rearing in the river.
    - This integrated conservation approach should incorporate natural spawners into the broodstock on a regular basis and in numbers to assure that hatchery populations always favor the genetic makeup of the natural spawners.
    - Other Hood Canal rivers might be used as supplemented refugia for the developing Skokomish native stock and as a hedge against catastrophic loss within the Skokomish River Basin, as has happened in recent years due to flooding and other environmental events.

The Co-managers agree that over the long term, a Chinook conservation-rebuilding program should occur in the Skokomish River, leading to a locally adapted self-sustaining population; however, the conservation-rebuilding effort must be tied to habitat recovery. The Co-managers also support use of hatcheries during the interim in which habitat recovery occurs. We believe this use should serve the critical functions of maintaining treaty-fishing

> opportunity and mitigating for decreased salmon production owing to loss and degradation of habitat. Conservation of the in-river naturally spawning population component will be a challenge because, at least initially, the hatchery component must be relatively large to maintain protection of treaty rights and implement mitigation. The means to conserve and protect a locally adapting Chinook stock in the interim will be explored by the Co-managers, taking into account the recommendations of the HSRG. It should be noted that the direction of recovery will be affected by the planning and permitting processes required for Chinook as a listed species under ESA.

Non-Chinook Hatchery Programs: The HSRG report for the Hood Canal region (HSRG 2004) also reviews and provides recommendations for the fall chum, summer chum, coho, pink, and steelhead programs in Hood Canal hatchery facilities, along with Co-manager responses. These programs are also discussed in the hatchery reform progress report for Hood Canal (Hood Canal Co-managers, 2005).

Hatchery Facilities: The HSRG also provided some recommendations for capital improvements and other modifications to Hood Canal hatchery facilities in order to maximize the benefits of hatchery production and minimize potential adverse effects of hatcheries. The Co-managers generally support the HSRG's recommendations; however, additional funding is required for implementation. For example, HSRG recommendations included:

- Install pollution abatement ponds at George Adams, Hoodsport, and McKernan hatcheries.
- Rebuild Pond 9 at George Adams Hatchery to provide better flow distribution and to address fish densities and loading rates.
- Upgrade adult collection facility at George Adams and McKernan hatcheries so that sorting of returning adults is possible.
- Replace intake and hatchery water supply lines, provide groundwater for incubation, and upgrade incubation facilities and saltwater pumping system at Hoodsport Hatchery.
- In order to maximize benefits from hatchery production, take into account facility water and space availability in determining the optimum species mix.
- Provide the needed equipment for fish culture and biological sampling (fish pumps, crowders, sorting facilities, abatement ponds, etc.).

Monitoring and evaluation: In order for hatcheries to adequately follow the general principles of scientific defensibility and informed decision making, the HSRG also supports the need for increased monitoring and evaluation capabilities at hatchery facilities. The Co-managers have been working to respond to most of these HSRG recommendations. This would include the acquisition of the equipment necessary for these activities, such as:

- equipment for adult handling to improve both the recovery of evaluation data and to facilitate safe passage upstream of natural-origin fish;
- equipment to facilitate adult collection for inclusion in integrated hatchery brood stock population management;

- equipment for monitoring and evaluating the population status of integrated hatchery stocks and associated natural spawning populations;
- equipment for improving hatchery inventory, monitoring and predator control;
- opportunities to process data collections such as otolith reading, genetic sampling and mark recovery activities.

Co-manager Hatchery Production Technical Workgroup, 2003: As indicated above, the Co-managers reduced or discontinued production of many WDFW hatchery programs for Chinook and other species in 2004. The decision to make the changes was made in response to recommendations by a technical work group that reviewed all WDFW programs in 2003 after receiving the HSRG recommendations. The reduced hatchery production is summarized by species in the following table. A more detailed summary is provided in Appendix G.

Species	Current	Reduction	New
Chinook fingerling	6,800,000	200,000	6,600,000
Chinook yearling	250,000	130,000	120,000
Coho	500,000	200,000	300,000
Chum	30,000,000	8,000,000	22,000,000
Pink	1,000,000	500,000	500,000
Steelhead	50,000	50,000	0

In addition, other HSRG recommendations have recently been implemented. For example, (1) the release of 200,000 fingerlings from the Chinook program at Big Beef Creek was discontinued with brood year 2003 since the program was not meeting the research and education goals described for the program; and (2) the release of 2.2 million fall chum fry from Quilcene National Fish Hatchery was discontinued with brood year 2003 since the program conferred no significant harvest benefits.

Hatchery Adaptive Management

The Co-managers use a variety of tools and processes to minimize, monitor and evaluate the potential adverse effects of hatcheries. As described in the RMPs, these stem from the Co-managers' General Principles for operating hatcheries and include development of hatchery and genetic management plans (HGMPs), risk assessments for each of the potential adverse effects (Benefit Risk Assessment Procedure [BRAP]), Section 7 consultations with NMFS (NOAA-Fisheries) on tribal hatcheries, extensive discussions with NOAA-Fisheries staff, and independent scientific review of hatcheries by the Hatchery Scientific Review Group (HSRG). This multifaceted review, described in Table 7.1 in conjunction with numerous actions previously initiated by the Co-managers, has resulted in significant improvements in Chinook salmon hatchery programs in Puget Sound (including Hood Canal), and extensive commitments to monitoring and evaluation and adaptive management.

Table 7.1 Potential adverse effects associated with hatcheries addressed by the Co-managers' General Principles and the application of different tools used to assess the effects (source: WDFW and PSTT 2004).

Co-managers General Principles	**Sources of Potential Effects Addressed**	**Hatchery and Genetic Management Plans**	**Benefit-Risk Assessment Procedure**	**Section 7 consultation**	**Hatchery Scientific Review Group**
• Goals, objectives, performance standards	Inappropriate management decisions	Sections 1.6, 1.7, 1.8, 1.9, 1.10	Uses HGMP	Yes	Yes—Important focus of review
• Priorities for brood stock collection	Brood stock mining, minimizing "take"	Sections 6.2.1 and 6.2.2	Genetic Hazard, Demographic Hazard	Yes	Yes
• Protocols to manage risks associated with hatchery operations	Loss of genetic variation, disease, demographic losses from catastrophic facility failures	Sections 7, 8, 9, and 10; Sections 7.8 and 5.8	Uses HGMP and supplemental information	Yes	Yes
• Assess and manage ecological and genetic risks to natural populations	Loss of genetic variation, reproductive success, competition, predation	Sections 4.2, 5.8, 6.2.4, 6.3, 7.2, 7.9, 8, 9.1.7, 9.2.10, 10.11, 11.2	Genetic Hazard 1-3; Ecological Hazard 1-3; Demographic Hazard 1-2; Facility Effect Hazard 1-3.	Yes	Yes
• Coordination with fishery management programs	Genetic effects, demographic effects	Sections 3.1, 3.2, and 3.3	Uses HGMP	Yes	Yes
• Adequate facilities	Catastrophic facility failures, disease, domestication	Section 4, 5, 7.6, 9.2.9, and 9.2.10	Genetic Hazard 2; Ecological Hazard 1; Facility Effect Hazard 1.	Yes	Yes—Important focus of review
• Adaptive management and monitoring & evaluation	Inappropriate management decisions; monitoring, evaluation, and research effects	Sections 1.9, 1.10, and 11	Intent is to use risk assessment results to identify areas for monitoring, evaluation and research	Yes	Yes
• Monitor "take" of listed fish	All of the above	To be included	Not directly addressed	To be done	No

<u>Current Hatchery Adaptive Management Strategy</u>: Our current approach to adaptive management is to use the previously described assumptions underlying the hatchery management hypotheses as the basis for considering tests of the hypotheses (see above sub-section, Hatchery Management Hypotheses). Following is a description of the key assumptions and how adaptive management applies to each of them. In this discussion of adaptive management, the current focus is on the rationale behind adaptive management and on what monitoring is needed to assess progress and test the hypotheses. What is not included here, but we plan to develop later in 2005, is a specific process that describes in

detail how assessments will be made, the time frame for review of monitoring results and assessments, triggers or criteria that lead to decisions and implementation of corrective actions, and what those actions may be. Information on the future development of the adaptive management program is provided at the end of this section. A discussion of each assumption relative to adaptive management follows.

1) *Habitat recovery will be sufficient to support a productive and sustainable natural Chinook population.* This assumption recognizes that habitat improvement is the most important factor in the recovery of natural Chinook salmon to sustainable levels. Adaptive management as it applies to the habitat recovery strategy is at least as important as hatchery adaptive management (see separate description of adaptive management for the habitat strategy). Not specifically addressed, but implied, is the importance of harvest management in meeting the recovery goals, and consequently the need for adaptive management of the harvest strategy (see separate description of adaptive management for the harvest strategy). Recovery and adaptive management of the hatchery, habitat and harvest strategies must be integrated for recovery to succeed (see below discussion of integration of the three strategies).
2) *The hatchery program will produce Chinook smolts that return as adult spawners at levels sufficient to rebuild the Chinook population, and*
3) *The hatchery program is successful in meeting its objectives and standards with respect to brood stock collection, spawning, incubation, rearing, disease control, and release of Chinook.* These are the assumptions that directly address the effectiveness of hatchery production in producing Chinook spawners within the Hamma Hamma River. To assess these assumptions, hatchery operations are monitored, to ensure good quality smolts are produced, as is the spawner escapement to the Hamma Hamma River that results from the hatchery production.

   Effective assessment of the hatchery program operation and its fish production requires monitoring of the fish culture process. The fish culture process follows protocol based on established Washington Department of Fish and Wildlife (WDFW) operational objectives and standards addressing broodstock collection, fish spawning and fertilization, incubation, fish rearing, transferring eggs and fish, releasing fish and controlling fish pathogens. Part of the protocol is detailed record keeping of the entire fish culture process. Records are kept of water quality, numbers of adults returning to the hatchery, numbers and sex of fish spawned, numbers of eggs fertilized and their survival to eyed stage and to hatching, timing of adult returns, numbers of eggs hatching and numbers of fish at release. Records also include feeding rates and schedules, fish growth rates and survivals, and the numbers and sizes of fish at release. Detailed information is collected on fish health, including testing for pathogens and recording of disease incidents and treatments. Additional details are contained in the Hamma Hamma Chinook Hatchery Genetic and Management Plan (HGMP). Such record keeping has for many years been, and continues to be, the standardized approach by which WDFW tracks and evaluates its hatchery programs for all species.

The WDFW estimates annual Chinook escapement throughout the mid Hood Canal Chinook (Hamma Hamma, Duckabush, and Dosewallips) rivers based on surveys of redds throughout the spawning season. The Co-managers have marked otoliths or adipose-clipped all hatchery Chinook releases in the Hamma Hamma River (in brood year 2004, all hatchery Chinook releases were coded wire tagged). The tags are recovered by sampling catches from intercepting fisheries and carcasses are sampled for tags and otoliths in the river. Sex, scales (for aging), and length of fish are also sampled. The otolith mark and coded wire tag information is used to estimate the proportions of natural origin and hatchery origin Chinook in the spawning escapements. The hatchery program's success in returning spawners to the river is thus evaluated. When sufficient coded wire tag data have been collected (over several brood years), cohort analysis may be done to improve estimates of run sizes and exploitation rates.

Outmigrant juvenile sampling within the Hamma Hamma River will continue to provide information on distribution, timing and potential interactions (e.g., potential predation and competition effects) of the salmon species (hatchery and wild). Juvenile sampling should also provide at least an index of juvenile abundance over time.

Genetic samples of hatchery and wild Chinook will continue to be collected to track genetic diversity over time. The intent is to provide further information on the genetic source and status of existing Chinook populations and/or any change in genetic diversity as a result of hatchery programs.

4) *The harvest hatchery programs for hatchery Chinook will provide fishing opportunity without impeding recovery of natural populations.* WDFW marks and/or coded-wire-tags a portion of the hatchery Chinook releases at George Adams, Rick's Pond and Hoodsport hatcheries. Sampling for coded wire tags and marks in fisheries, at hatcheries and/or on the spawning grounds should provide information to 1) reconstruct total abundance by brood year and 2) monitor straying of hatchery Chinook onto natural spawning grounds. Coded-wire tagging of Chinook released from the Hamma Hamma Chinook program was initiated with brood year 2004 and could provide useful information on harvest distribution and numbers in various fisheries for mid Hood Canal Chinook compared to other Hood Canal Chinook hatchery programs.

5) *The harvest hatchery programs for hatchery Chinook and the non-Chinook hatchery programs for chum, pink, coho and steelhead are successful in implementing measures intended to minimize negative effects on viability of natural Chinook populations (e.g., impacts of interbreeding, predation or competition) and those measures do avoid such impacts.* No hatchery pinks or coho are released into the mid Hood Canal Chinook streams; releases of hatchery steelhead smolts were discontinued in the Dosewallips and Duckabush rivers in 2003. Steelhead smolts are currently released in the Hamma Hamma River as part of wild stock supplementation program there. In all cases, measures that have been taken involve only the delay of steelhead releases in an effort to reduce

the likelihood of encounters with and predation on Chinook. We may be able to assess the effectiveness of these measures by implementing monitoring projects that include tracking the emigration of Chinook juveniles at traps in the mainstem and tributaries, snorkel surveying index areas throughout the system to determine relative species abundance, and surveying the estuary with seines and traps to assess distribution and co-occurrence of the species.

Ongoing steelhead spawner surveys provide information on the distribution of steelhead in the watersheds and, in conjunction with Chinook redd survey data, would provide an initial assessment of potential interaction between Chinook and steelhead.

6) *The rebuilt Chinook population will distribute throughout the known range within the Hamma Hamma watershed (this assumption is also dependent on habitat protection and recovery).* This assumption implies that successful recovery includes utilization of the available habitat, consistent with what occurred historically. It also addresses two of the viable salmonid population (VSP) parameters, diversity and spatial distribution (McElhany et al. 2000). The aforementioned Chinook spawner surveys (including identifying hatchery-origin recruits and natural-origin recruits) and screw trapping of juveniles on the mainstem Hamma Hamma River would provide information to serve as the basis for assessing Chinook distribution over time. Similar programs and/or monitoring efforts may be considered for the Dosewallips and Duckabush rivers in the future.

7) *The natural population will ultimately meet the abundance and productivity recovery goals (this assumption is also dependent on habitat protection and recovery).* This assumption reflects the desire of the Co-managers to see Chinook recovery pointing to the recovery goals described earlier. As the Chinook population approaches the goals, Chinook would become abundant enough to provide harvest opportunities as well as a sustainable population.

   Effective measurement of progress toward the goals will require cohort analysis and new run reconstruction so that the abundance levels and productivity can be estimated. Information needs depend on spawner surveys to estimate Chinook escapements to the mid Hood Canal rivers, effective collection of age data, and effective coded wire tagging and sampling of the hatchery Chinook . Assessment would be a long-term effort because estimates of productivity and abundance would be needed for at least five and likely more Chinook brood years (Chinook adults of up to five years of age would be expected to return for each brood).

Table 7.2 summarizes assessments and monitoring to be used in adaptive management of hatchery programs for mid Hood Canal Chinook. The general status of funding is also described in the table. The assessments and monitoring activities described should provide quantitative data to assess the VSP parameters of Chinook abundance, productivity, diversity and spatial distribution over time.

Table 7.2. Descriptions of hatchery adaptive management assessments and associated monitoring requirements, time frames and funding status.

Assessment	Rationale/ Direction	Monitoring Required	Time Frame: Implementation/ Results	Funding	Funding Availability
Integration & interactions of hatchery with habitat and harvest (all parties involved in recovery).	Adaptive management must be integrated to succeed. HSRG's "Managing for Success" procedure/tool may be helpful.	Some monitoring applies to all Hs; e.g., escapement numbers and distribution, runsizes and productivity.	Continuing. Short & long term.	To be determined in course of completing adaptive management plans.	To be determined in course of completing adaptive management plans.
Chinook culture operations.	Hatchery Chinook production (juv. & adults) depends on effective hatchery operations.	Broodstock collection, spawning & fertilization, incubation, rearing, release, disease control. Collecting data on water quality, feeding rates, survival, growth, etc., as described in HGMP.	Continuing. Short & long term.	Co-managers, Long Live the Kings, Hood Canal Salmon Enhancement Group	Currently available.
Returns to river from Chinook hatchery production.	Look at major changes & trends. Direct estimates of in-river hatchery effectiveness.	Spawner surveys to estimate HORs and NORs.	Continuing. Short & long term.	Co-managers, LLTK, HCSEG	Currently available.
Mid Hood Canal Chinook cohort analysis and new run reconstruction.	Estimates runsizes for complete picture of hatchery effectiveness. Looks at major changes & trends.	Coded wire tagging and sampling. Actual cohort analysis and run reconstruction in future.	Continuing. Long term.	Co-managers	Coded wire tagging and sampling covered. Addit. funding for future analysis.

Table 7.2 (cont.) Assessment	Rationale/ Direction	Monitoring Required	Time Frame	Funding	Funding Availability
Genetic, demographic and ecological characteristics of population.	To check for possible major changes or trends attributable to hatchery domestication.	Spawner surveys (for escapement estimates, escapement distribution, NOR/HOR ratios, genetic profiles, biol. character.), juvenile trapping (for hatch & wild emigrant estimates, genetic profiles, life hist. info. & biol. character.), snorkeling surveys for juvenile distribution and habitat use.	Continuing current programs, need to initiate new programs. Short and long term.	Currently Co-managers, Long Live the Kings, Hood Canal Salmon Enhancement Group	All cover spawner surveys, genetic sampling and some juvenile trapping. Funding needed for genetic analysis, additional trapping and snorkel surveys.
Non-Chinook hatchery program interactions with Chinook .	Evaluate effect of delayed release steelhead yearling releases. Assess possible ecological interactions due to distribution of steelhead.	Trapping juvenile salmonids in mainstem, juvenile surveys in river and estuary, steelhead spawner surveys. Data collected to assess overlapping abundance with Chinook .	Continuing current programs, need to initiate new programs. Short and long term.	Currently Co-managers, Long Live the Kings, Hood Canal Salmon Enhancement Group	All cover spawner surveys and some juvenile trapping. Funding needed for additional trapping, and snorkel surveys.
Distribution of Chinook throughout watershed.	To determine extent of distribution and signal the need for new actions.	Spawner surveys, juvenile trapping in tributaries, snorkel surveys.	Same as immediately above	Currently Co-managers, LLTK, HCSEG	Same as immediately above.
Progress toward recovery goals – productiv. & abund.	From cohort analysis and run reconstruction (see above).	Coded wire tagging and sampling.	Continuing. Long term.	Co-managers	Currently available.

Newly Available Tools for Hatchery Adaptive Management: The Co-managers used a qualitative model called the Benefit Risk Assessment Procedure (BRAP) in the development of the Chinook hatchery resource management plan. The BRAP model was the basis for a new model, developed recently by Ken Currens, Craig Busack and Lars Mobrand, that extends and improves upon the original. The new model, called the Risk Assessment Modeling Project (RAMP), provides for assessment of risks from hatchery domestication, hatchery predation/competition and hazards associated with hatchery facilities/operations. The RAMP model should be available to the Co-managers in the near future for use in assessing risks as a part of adaptive management.

Another new model, currently known as the EDT-population model, has been developed as an extension of EDT; it also is expected to be available in the near future. The EDT-population model incorporates harvest and hatchery applications with the EDT's habitat-based functions and, with alternative input scenarios, simulates outcomes over a defined period of years. Stochastic functions are incorporated in its simulations. This model is another tool the Co-managers may use in adaptive management planning.

Continuing Development of Hatchery Adaptive Management: To complete a hatchery adaptive management plan for mid Hood Canal (Hamma Hamma) Chinook, the Co-managers still need to develop a process for the periodic review of monitoring information that accounts for short term and long term expectations. The process should include criteria or triggers for actions to be taken based on the results of assessments and monitoring. For example, if adult returns are less than or more than set criterion levels, production may be increased or decreased, or if distribution of natural spawners remains limited (i.e., no indication of geographic expansion) over a span of years, an alternative action (e.g., change in hatchery fish release strategy) may be implemented. The hatchery adaptive management process would need to accommodate interactions with habitat and harvest conditions.

The HSRG will be working with the Co-managers to develop a new tool/process currently called "Managing for Success". This tool is intended to assist in the development of a hatchery-oriented adaptive management plan but should also provide for integration with other processes such as habitat recovery and harvest management. The Hood Canal Co-managers plan to work with the HSRG in 2005 to refine adaptive management for hatchery programs in Hood Canal, including the mid Hood Canal (Hamma Hamma) Chinook hatchery program. As with recovery planning and implementation on the whole, we view adaptive management as a continuing process subject to improvement over time.

Integration of Habitat, Harvest and Hatcheries

The relationship between and integration of the habitat, hatchery and harvest strategies is conveniently described by presenting runs of the "All H Analyzer" (AHA) model applied to the Hamma Hamma watershed, shown below in Figure 8.1. Following that, six questions are addressed to help demonstrate the integration of the three management strategies.

Use of the AHA Model to Demonstrate Integration

Before presenting the model results, there is the following description of the AHA model and how the model results are displayed below in Figure 8.1. The AHA model is a spreadsheet tool that while based on simple calculations, provides for sophisticated assessment. It was developed by the HSRG, based on theoretical work by the HSRG, WDFW, NOAA Fisheries and other scientists. Input data are the actual or assumed habitat productivity and capacity, harvest rates and hatchery operations in a watershed; the model allows managers to consider the effects of habitat, harvest and hatchery factors together as data inputs are changed in a series of model runs. The HSRG is planning to prepare a technical paper that includes a description of the model. An overview of the AHA is available at the hatchery reform web site (www.hatcheryreform.com, click on Publications).

The AHA model was originally developed to assess integrated hatchery program options. It also serves the present purpose of illustrating hatchery, habitat and harvest interactions. However, before addressing the AHA model in the latter context and because it is potentially important in the long term planning of Chinook recovery in the Hamma Hamma watershed, the theoretical concept of an integrated hatchery program is briefly described here. The concept is that that if conservation of the natural population is the objective, then the natural environment should drive the adaptation and fitness of a composite population of fish that spawns in a hatchery and in the wild. A hatchery program that operates within this concept is defined as an integrated program. The theoretical model incorporates the following three provisions that allow for an assessment of an integrated hatchery program:

a) The hatchery and wild components must be considered to be two parts of a composite population.

b) The influence of the hatchery and wild environments on adaptation of the composite population is determined by the proportion of natural broodstock in the hatchery and the proportion of hatchery origin fish in the natural spawning escapement. A means of estimating the influence of the natural environment is described by the following equation:

$$\text{PNI} = \text{pNOB} / (\text{pHOS} + \text{pNOB}),$$

where, pNOB is the proportion of natural spawners in the hatchery broodstock, pHOS is the proportion of hatchery spawners in the natural spawning escapement, and PNI is an index of the level of influence of the natural environment on the composite population.

c) The proportions are meant to be based on long-term average results.

Several guidelines were proposed for use with this theoretical model. Two of these apply most directly to planning and evaluating an integrated hatchery program:

a) The PNI must exceed 0.5 for the natural environment to drive adaptation (and for a hatchery program to be considered integrated) and,
b) in the case of stocks of moderate or high biological significance and viability, the PNI should be greater than 0.7 to ensure high levels of natural dominance.

It is recognized that this theoretical model is intended to help assess program benefits versus risks, given the status and goals of the stock. In this context, it applies to the present purpose of illustrating the integration of hatchery, habitat and harvest strategies in recovery planning.

Figure 8.1 describes the results of applying the AHA model to the Hamma Hamma Chinook sub-population. Across the top of the figure, five columns are labeled to describe alternative scenarios or model runs, the first labeled “Current–No Hatchery” and the last labeled “No Hatchery & PFC+”, with several other in-between scenarios described below.

Inputs to the model are shown to the left of the figure and are labeled Habitat, Harvest and Hatchery Program. The Habitat inputs begin, for the “Current-No Hatchery” scenario, with the values for current Hamma Hamma Chinook productivity and capacity estimated by EDT. The Harvest inputs of exploitation rates are in this case the same for natural origin and hatchery origin fish and are based on the 2005 final preseason FRAM model run (see above harvest management subsection, <u>2005 Harvest Management Planning</u>). Finally, the hatchery program inputs include goals for percentages of pNOB (percent natural origin fish in hatchery broodstock) and pHOS (percent of hatchery origin fish spawning naturally), and specific production/operation related information including broodstock number, annual smolt release and estimated recruits per spawner. There is also a switch to turn on a fitness loss adjustment, which is turned on for all model runs that include hatchery production. Note that unless a value for broodstock number is input, there is no hatchery function for the model run.

Results of the model runs are shown at the bottom of Figure 8.1 in the form of small figures depicting Natural Origin Recruits (NORs), Hatchery Origin Recruits (HORs) and Surplus HORs to the hatchery, to the spawning grounds (habitat) and to harvest. Also, at the bottom left of Figure 8.1 is a diagram showing the PNI (i.e., = pNOB / (pHOS + pNOB)) that is calculated for each scenario (or model run) and applies to evaluation of an integrated hatchery program. (The PNI is an index of the level of influence of the natural environment on the composite population.) Note that the range of PNI values at 0.5 and 0.7 (proposed integrated hatchery program thresholds described previously) are shown as heavy lines in the diagram. The following discussion of modeling for each scenario is based on the information shown in Figure 8.1.

The “Current-No Hatchery” scenario is meant to represent the Hamma Hamma Chinook stock without a hatchery program. The exploitation rates are set at the projected 2005 rate of 32%. Also, productivity is set at 3.4 recruits per spawner and capacity at 619 spawners, representing the EDT results for current habitat conditions without harvest.

The results for this scenario show only NORs on the spawning grounds (habitat) and in the harvest (see small figure at the bottom of the scenario column). These results are meant to approximate what might be expected to occur currently, on average, without hatchery influence. Note that escapement is 240, and harvest, which is entirely incidental in fisheries for other stocks, is approximately 115.

The next scenario is labeled "Current – Hatchery 1"; it assumes no change in habitat conditions or exploitation rate from the previous scenario, but includes the current hatchery program with a release of approximately 100,000 Chinook fingerlings. There is currently no sampled estimate of the ratio of NORs to HORs in the river, so an approximation of the proportions is made that conservatively assumes a relatively small proportion of spawner escapement would be NORs (20%) and most of the escapement would be HORs (80%). This translates to model inputs of a pNOB (proportion of natural origin fish in broodstock) goal of 20% (assuming no differential selection of NORs during in-river collection of broodstock) and a pHOS (proportion of hatchery origin fish spawning naturally) goal of 80%. The hatchery recruits per spawner input is set at 15 (based roughly on WDFW experience in western Washington). The results show that the majority of all adult returns would be HORs and the PNI would be approximately 0.2, indicating the hatchery program would not be integrated (by not exceeding the minimum PNI threshold of 0.5) under these conditions and assumptions. Escapement to the spawning ground has increased to approximately 750[5] and harvest has risen to about 360.

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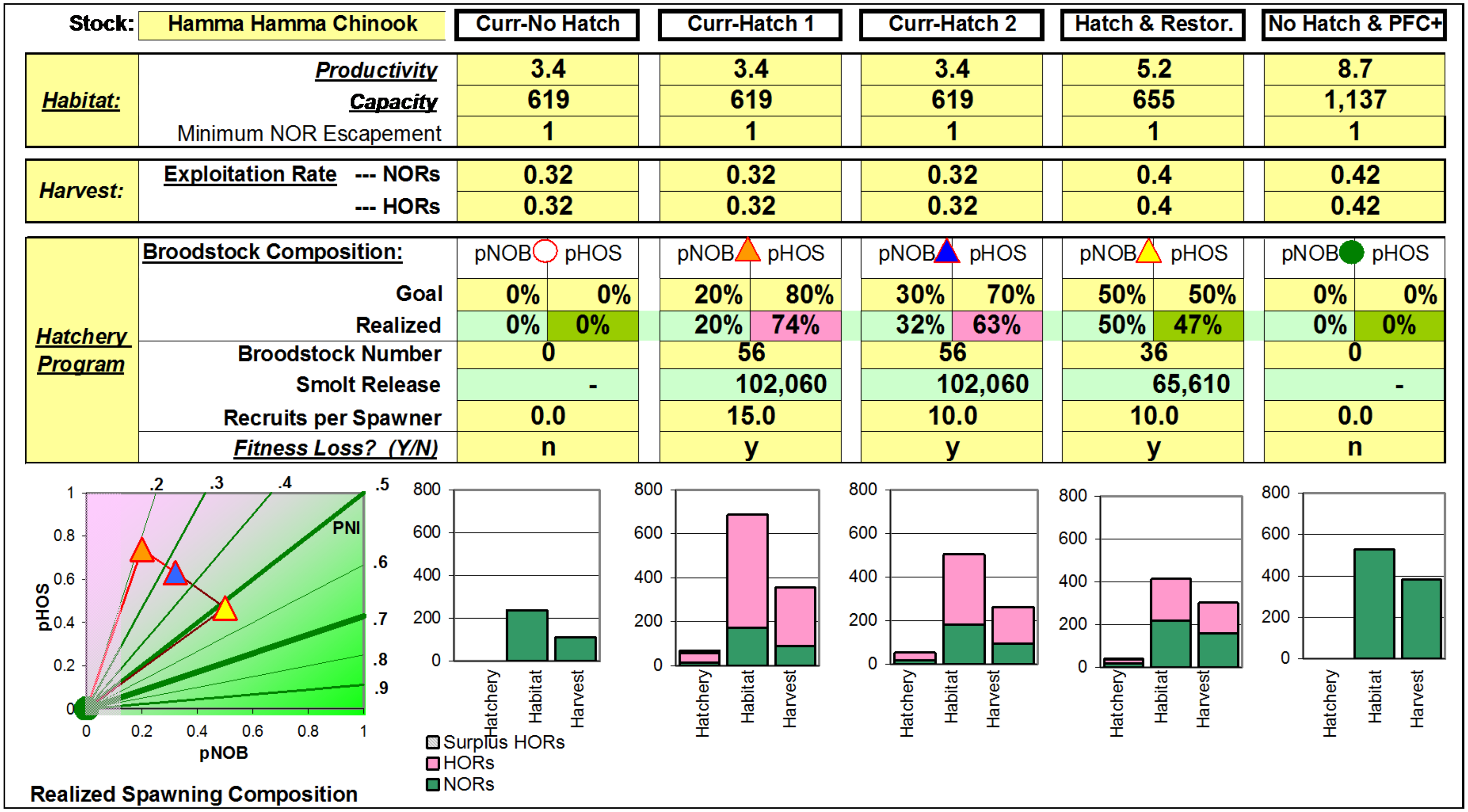
[5] The small figure, at the bottom of each scenario in Figure 8.1, shows numbers of NORS and HORs returning to hatchery, habitat (spawning grounds) and harvest. The assumption is made in this display that when a hatchery is operating, a proportion of the spawners return to a conventional hatchery facility. In the case of the Hamm Hamma program, there is no hatchery facility to collect returning spawners; the broodstock is collected directly from the river. So, even though the small figure shows hatchery returns, these are part of the total escapement subject to broodstock collection.



Stock:	Hamma Hamma Chinook	Curr-No Hatch		Curr-Hatch 1		Curr-Hatch 2		Hatch & Restor.		No Hatch & PFC+	
Habitat:	***Productivity***	3.4		3.4		3.4		5.2		8.7	
	Capacity	619		619		619		655		1,137	
	Minimum NOR Escapement	1		1		1		1		1	
Harvest:	**Exploitation Rate --- NORs**	0.32		0.32		0.32		0.4		0.42	
	--- HORs	0.32		0.32		0.32		0.4		0.42	
Hatchery Program	**Broodstock Composition:**	pNOB ○	pHOS	pNOB ▲	pHOS	pNOB ▲	pHOS	pNOB ▲	pHOS	pNOB ●	pHOS
	Goal	0%	0%	20%	80%	30%	70%	50%	50%	0%	0%
	Realized	0%	0%	20%	74%	32%	63%	50%	47%	0%	0%
	Broodstock Number	0		56		56		36		0	
	Smolt Release	-		102,060		102,060		65,610		-	
	Recruits per Spawner	0.0		15.0		10.0		10.0		0.0	
	Fitness Loss? (Y/N)	n		y		y		y		n	

Figure 8.1. Input values and results of model runs / scenarios for All H Analyzer (AHA) model - Hamma Hamma Chinook.

The “Current – Hatchery 2” scenario assumes hatchery recruits per spawner is 1/3 less than assumed in the previous scenario. The hatchery recruitment rate may actually be even less than this reduced input because Hamma Hamma escapement numbers have decreased substantially since 2001 with the hatchery program in effect. All other input values remain the same as for the previous scenario, except it is assumed the proportion of HORs on the spawning grounds would change with the lower hatchery recruitment and therefore estimates of pNOB and pHOS were input as 30% and 70%, respectively. The results show a ratio of NORs to HORs of approximately 0.37. The PNI value of .34 indicates this scenario still does not meet the PNI minimum criterion (to exceed 0.5) for an integrated hatchery. Because of the reduced hatchery return rate, spawning ground escapement is approximately 555 and harvest is about 260. These values would, of course, be lower if the hatchery’s return rate was actually less than 10 recruits per spawner. The results of this scenario help demonstrate the possible trade offs in management that likely will exist before the effects of habitat restoration are realized. The Co-managers would wish to maintain hatchery production at the current level to collect information from the coded wire tagging program important to harvest management and to monitoring the hatchery program. But there is also a desire to foster a locally adapted natural population and reduce the risk of hatchery domestication effects on that population; that would require reducing hatchery releases. At the same time, the hatchery returns can help maintain a higher spawning population, reducing the risk of extinction. Habitat improvements would help resolve the program questions, but that will take time.

The “Hatchery & Restoration” scenario assumes habitat values have risen, owing to EDT projections associated with potential restoration projects over the next 10 years (see above Table 5.2 in “EDT Analyses” subsection of the Mid Hood Canal Habitat Protection and Restoration section). Thus, productivity and capacity have risen to 5.2 recruits per spawner and 655 fish, respectively. In this scenario, the harvest exploitation rate is relaxed from 32% to 40% and hatchery production is reduced by approximately one third. The pNOB and pHOS goals are now set at 50% each, assuming the numbers of HORs and NORs returning to the river would be about equal (and still no NOR selective broodstock collection). The results show the NORs are approximately the same in the escapement and harvest. The PNI is now 0.52, just exceeding the minimum criterion for an integrated hatchery program. Spawning ground escapement is approximately 440 (by summing the hatchery and habitat values in the small figure at the bottom of the column – see footnote #5) while harvest is about 300. This scenario suggests that with habitat restoration and reduced hatchery production (or selective NOR broodstock collection, not shown), an integrated hatchery program is possible. Also the constraints on harvest exploitation may be relaxed a little (though harvest management decisions likely would depend on the status of the other two mid Hood Canal watersheds as well). This scenario suggests improvement in hatchery and harvest management options comes with improved habitat conditions.

The “No Hatchery & PFC+” scenario eliminates the hatchery program while assuming the Co-managers’ habitat recovery goals, specified by the EDT’s model parameters, are met (i.e., productivity of 8.7 and capacity of 1,137)[6]. The exploitation rate is set at 42%. Escapement, now consisting entirely of NORs, is close to 530 spawners and harvest is about 380 fish. In comparison to the previous scenario, these results suggest a population at lower risk, with number of spawners now exceeding 500, while allowing for more flexibility in managing harvest exploitation.

The series of model runs shown in Figure 8.1 demonstrate how habitat, hatchery and harvest actions may interact, in this case, based on selected model scenarios. A key consideration is the goal for managing the different components for Chinook recovery. With the goal of a sustainable, naturally adapted Chinook population, it is understood that constraints upon hatchery and harvest actions must exist to control risks while habitat is protected and restored. With habitat recovery these constraints may be relaxed while, in the process of recovery, accounting for specific interactions between habitat, hatchery and harvest actions (through adaptive management). For example, in the scenario, “Hatchery & Restoration”, with a projected level of habitat improvement over the next 10 years (resulting in 50% higher productivity but little increase in capacity, see changes in habitat productivity and capacity, Figure 8.1), hatchery production has been limited to achieve an integrated hatchery program, and an opportunity for relaxation of harvest constraints exists but at a trade off in numbers of spawners returning to the river. The situation improves substantially with habitat restoration to the Co-managers’ goal levels as shown in the above final scenario, “No Hatchery & PFC+” (a potentially longer term prospect), where the hatchery program may be eliminated, while providing opportunity for harvest management flexibility. In managing for recovery, hatchery and harvest actions must be complementary and responsive to habitat conditions because recovery will only occur with the restoration and protection of habitat. Overall, adaptive management should be coordinated between the habitat, hatchery and harvest strategies to accommodate this approach.

Integration Questions

Following are several questions and answers addressing the integration of habitat, harvest and hatcheries.

Re: harvest and habitat:

Q: Are harvest rates consistent with productivity of populations?

A: The Co-managers are managing for relatively low exploitation rates that would be expected to not impede recovery of the mid Hood Canal sub-populations (e.g., for 2005: the projected total exploitation rate is approximately 31.8%, of which 31.4% is pre-terminal and 0.4 % is terminal (within Hood Canal); the majority of the pre-terminal harvest, 19.4%, is attributed to Canada and the remaining 12.0% to southern U.S. – see above sub-section, 2005 Harvest Management Planning in the harvest

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[6] Habitat improvements beyond what has been projected for the next 10 years are possible, though they may take more time to implement; these are described in the above EDT habitat restoration and protection analysis – see sub-section, “EDT Analysis”, in the Mid Hood Canal Habitat Protection and Restoration section.

management section). This conclusion is supported by considering the 2005 total mid Hood Canal exploitation rate relative to productivity estimates for mid Hood Canal watersheds (using the EDT method); however, risk increases when reaches within the watersheds are considered (see answer to following question).

Q: Are harvest rates consistent with providing necessary spatial structure?

A: An assessment of harvest relative to spatial structure is provided in the above harvest management sub-section, Potential Harvest Effects on the VSP Parameters of Diversity and Spatial Distribution. The assessment, using EDT estimates of productivity in conjunction with the estimated total exploitation rate, indicates that on a watershed-by-watershed basis Chinook recovery is not impeded at the current exploitation rate. However, on a reach-by-reach basis, continuing Chinook production of one reach (the furthest downstream reach of the Duckabush River) is indicated to be at risk under the current exploitation rate; the habitat of this reach is severely degraded and requires measures for its protection and restoration. Other reaches within the three mid Hood Canal watersheds appear to be at lesser risk under current harvest conditions.

The question may be asked as to whether unaccounted selective fishing bias might exist in southern Hood Canal, possibly affecting the sub-populations of the mid Hood Canal management unit. The answer is that unexpected harvest impacts, including selective bias, appear unlikely because commercial fisheries in south Hood Canal (Areas 12C) are currently minimal except in the extreme terminal fishery of the Hoodsport Hatchery zone (Area 12H), where few if any interceptions of the natural sub-populations are believed to occur. Harvest by the pre-terminal recreational fisheries, which have the largest southern U.S. impact on mid Hood Canal Chinook, is assumed to be random with respect to the sub-populations.

Re: hatcheries and habitat:

Q: Are hatcheries used effectively to reintroduce and maintain populations where habitat is degraded?

A: With respect to the mid Hood Canal stock, artificial propagation is being used in the Hamma Hamma watershed to help rebuild the Chinook sub-population. Chinook straying from this program into the Dosewallips and Duckabush rivers may occur. The program is being closely monitored through the sampling of juveniles and adults in the Hamma Hamma watershed and adults in all three watersheds. Additional monitoring of the three watersheds is proposed. The effectiveness of the program depends in part on habitat protection and restoration and will not be determined until sufficient monitoring information is acquired. Success of the hatchery program depends on effective adaptive management.

Q: Are hatchery structures blocking access to important habitat?

A: No.

Re: harvest and hatcheries:

Q: Are harvest augmentation programs operated consistent with recovery of the ESU?

A: There is currently no mid Hood Canal augmentation program. The Hoodsport and Skokomish River harvest augmentation programs may affect the mid Hood Canal Chinook population owing to Chinook straying, and possible juvenile hatchery competition and predation by hatchery fish released as yearlings.

Q: Can production from hatchery harvest augmentation programs be caught without excessive harvest of natural fish?

A: The Co-managers limit fisheries on the mid Hood Canal harvest management unit to accommodate natural escapement objectives. Also, see answer to the above first question addressing harvest and habitat.

Concluding Remarks

Recovery of mid Hood Canal Chinook salmon depends on rebuilding productive, sustainable natural populations. Currently, harvest is being managed with the objective of not impeding recovery by limiting harvest exploitation rates in U.S. waters to relatively low levels and thereby accommodating Chinook escapement onto the spawning grounds. The risk of potential harvest impact on spatial distribution appears to be acceptable at this time, though continuation of Chinook production on the furthest downstream reach of the Duckabush watershed is vulnerable owing primarily to degraded habitat but affected by the current harvest rate. The hatchery program on the Hamma Hamma River is attempting to rebuild the Chinook run, while assessing the alternatives of using hatchery and local brood stocks. A strategy that incorporates habitat protection and restoration has been developed and assessed using the EDT method. If local governments commit to habitat protection and restoration, and if funding for restoration becomes available, it appears that significant strides toward the mid Hood Canal Chinook recovery goals can be made within 10 years. The Co-managers believe the uncertainties of habitat, harvest and hatchery management can be addressed with ongoing and planned monitoring and assessment projects, through coordinated adaptive management.

The key to recovery of productive, sustainable natural Chinook mid Hood Canal population is the habitat in the watersheds and estuary. Progress with recovery cannot occur without habitat protection and restoration. Hatchery production and harvest controls may help put spawners on the spawning grounds but if more abundant and productive habitat is not made available, productive natural runs cannot be sustained. Habitat recovery is a long-term process. Harvest management and hatcheries can provide stopgap measures to reduce extinction risk and help build the population, but over time the habitat must be restored and protected, for the natural Chinook population to prosper.

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Appendices

Appendix A. Skokomish River Projects

Appendix B. Detailed descriptions of effects of change in habitat attributes from historic to current conditions for each stream reach of the mid Hood Canal watersheds (Dosewallips, Duckabush and Hamma Hamma), based on EDT analysis.

Appendix C1. Habitat Protection and Restoration Project List for the Dosewallips River

Appendix C2. Habitat Protection and Restoration Project List for the Duckabush River

Appendix C3. Habitat Protection and Restoration Project List for the Hamma Hamma River

Appendix D. Productivity of Mid Hood Canal Chinook Derived from EDT Analysis for Habitat Actions Implemented with Modeled Build-out as Baseline Conditions

Appendix E. Abundance of Mid Hood Canal Chinook Derived from EDT Analysis for Habitat Actions Implemented with Modeled Build-out as Baseline Conditions

Appendix F. Harvest Management Affecting Hood Canal Chinook Salmon

Appendix G. 2004 WDFW Hatchery Program Reductions

Appendix A - Skokomish River Projects

Protection Activities Completed or Funded:

- *USFS Watershed Analysis completed in 1995*
- *Army Corps of Engineers Early Action Study in 1995*
- *Skokomish River Comprehensive Flood Hazard Management Plan by Mason County (KCM) in April 1996*
- *Washington State DNR and Simpson Timber Company Watershed Analysis 1997*
- *905(b) Army Corps of Engineers Reconnaissance Study in 2000*
- *Washington Conservation Commission WRIA 16 Limiting Factors Analysis for riverine and nearshore June 2003*
- *WRIA 16 Salmonid Refugia Report 2003 (SRFB contract#00-1829)*
- *Designated as a Key Watershed by USFS (high priority anadromous salmon restoration)*
- *Ecosystem Diagnosis and Treatment on-going for summer chum in estuary/nearshore (but not fully funded)*
- *Skokomish River Reach Assessment funded by SRFB in 2004 as match to Corps of Engineers*
- *Skokomish Mainstem*
  Skokomish Salmon Recovery Team (SRFB contract #99-1652)
  Skokomish River Acquisition (SRFB contract #01-1387)
  Bourgalt Acquisition of 165 acres
- *Skokomish North Fork*
  9887 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)
  3920 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)
- *Skokomish South Fork*
  83,587 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)
  9523 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)
- *Vance Creek*
  6336 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)
  0 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)

Restoration Activities Completed or Funded:

Skokomish Mainstem and Estuary
  - *Skokomish River North Channel Oxbow and Plan (SRFB contract #99-1679 and 99-1689)*
  - *Bourgalt/North Channel Reconnection (SRFB contract #00-1081)*
  - *Nalley Slough Tide Gate and Levee Removal (Phase 1 – SRFB contract #01-1302)*
  - *Nalley Island Levee Removal (Phase 2 – SRFB contract #02-1560)*
  - *Nalley Slough Reconnection*
  - *Skabob Creek Bridge on Reservation Road*
  - *Skabob Creek Culvert Replacement with Bridge on SR106*
  - *Various levee setbacks?*

Skokomish North Fork
  4660 meters of USFS roads decommissioned

Skokomish South Fork
  - *133,167 meters of USFS roads decommissioned (including LeBar Creek – SRFB contract #01-1426)*
  - *Brown's Creek USFS Campground relocation*
  - *Rearing ponds constructed within floodplain and anadromous zone of South Fork, LeBar Creek, and Brown Creek in "bathtub" area (1994-5)*
  - *Riparian plantings and conifer release in anadromous zone of South Fork, LeBar Creek, and Brown Creek in "bathtub" area (1994-5)*

Vance Creek
  - *42,347 meters of USFS roads decommissioned*
  - *Riparian plantings in lower mainstem*

Appendix B. Detailed descriptions of effects of change in habitat attributes from historic to current conditions for each stream reach of the mid Hood Canal watersheds (Dosewallips, Duckabush and Hamma Hamma), based on EDT analysis.

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Dosewallips - Fall Chinook

Geographic Area:	Dose 1	**Stream:**	Dosewallips River
Reach:	mouth (rm 0.0) to upstream extent of floodplain developm't	**Reach Length (mi):**	2.50
		Reach Code:	Dose 1

Restoration Benefit Category:1/	B	**Productivity Rank:1/**	2	**Potential % change in productivity:2/**	304.2%
Overall Restoration Potential Rank:1/	2	**Average Abundance (Neq) Rank:1/**	2	**Potential % change in Neq:2/**	136.8%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	3	**Potential % change in diversity:2/**	10.8%
Preservation Benefit Category:1/	A	**Productivity Rank:1/**	1	**loss in productivity with degradation:2/**	-43.2%
Overall Preservation Rank:1/	1	**Average Abundance (Neq) Rank:1/**	1	**% loss in Neq with degradation:2/**	-96.6%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	2	**% loss in diversity with degradation:2/**	-40.3%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																		
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	23.7%	-3.2%	6							●							•		◯
Egg incubation	Nov-May	23.7%	-74.3%	1	⬤												⬤			◯
Fry colonization	Apr-May	57.1%	-15.5%	2	●				●	•	⬤									
0-age active rearing	Mar-Oct	82.0%	-2.2%	5	•						●									⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	100.0%	-3.7%	3					●		●									
Prespawning holding	Oct-Nov	23.7%	-15.1%	4					●		⬤									⬤
All Stages Combined		100.0%																		

1/ Ranking based on effect over entire geographic area. 2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⚫	⚪

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Dosewallips - Fall Chinook

Geographic Area:	Dose 2	**Stream:**	Dosewallips River
Reach:	Floodplain develop. To Rocky Bk. Confl.	**Reach Length (mi):**	0.90
		Reach Code:	Dose 2

Restoration Benefit Category:1/	C	**Productivity Rank:1/**	3	**Potential % change in productivity:2/**	125.5%
Overall Restoration Potential Rank:1/	3	**Average Abundance (Neq) Rank:1/**	3	**Potential % change in Neq:2/**	88.8%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	2	**Potential % change in diversity:2/**	15.5%
Preservation Benefit Category:1/	D	**Productivity Rank:1/**	4	**loss in productivity with degradation:2/**	-4.8%
Overall Preservation Rank:1/	4	**Average Abundance (Neq) Rank:1/**	4	**% loss in Neq with degradation:2/**	-16.0%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	4	**% loss in diversity with degradation:2/**	-9.8%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	9.2%	-6.2%	6							⬤	•						•		◯
Egg incubation	Nov-May	9.2%	-81.6%	1	⚫												⬤			◯
Fry colonization	Apr-May	39.8%	-12.6%	2	●				⬤	•	⬤									⬤
0-age active rearing	Mar-Oct	42.9%	-2.1%	5	•						●									⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	76.3%	-1.9%	3					●		●									
Prespawning holding	Oct-Nov	9.2%	-21.6%	4					●		⬤	•								⬤
All Stages Combined		76.3%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⚫	⭕

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Dosewallips - Fall Chinook

Geographic Area:	Dose 3			**Stream:**	Dosewallips River
Reach:	Rocky Bk. Confl. To just d.s. of Stony Brook			**Reach Length (mi):**	7.80
				Reach Code:	Dose 3
Restoration Benefit Category:1/	A	**Productivity Rank:1/**	1	**Potential % change in productivity:2/**	344.2%
Overall Restoration Potential Rank:1/	1	**Average Abundance (Neq) Rank:1/**	1	**Potential % change in Neq:2/**	202.6%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	1	**Potential % change in diversity:2/**	29.5%
Preservation Benefit Category:1/	B	**Productivity Rank:1/**	2	**loss in productivity with degradation:2/**	-36.1%
Overall Preservation Rank:1/	2	**Average Abundance (Neq) Rank:1/**	2	**% loss in Neq with degradation:2/**	-79.3%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	1	**% loss in diversity with degradation:2/**	-53.6%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	55.1%	-5.2%	6							⬤							•		◯
Egg incubation	Nov-May	55.1%	-73.7%	1	⬤												⬤			◯
Fry colonization	Apr-May	63.5%	-28.7%	2	●				⬤	•	⬤									⬤
0-age active rearing	Mar-Oct	36.4%	-8.7%	4	•					•	●									⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	64.9%	-5.8%	5					●		●									
Prespawning holding	Oct-Nov	55.1%	-15.9%	3					●		⬤									⬤
All Stages Combined		64.9%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	◦
Moderate	●	○
High	⬤	◯
Extreme	⚫	⭘

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Dosewallips - Fall Chinook

Geographic Area:	Dose 4	**Stream:**	Dosewallips River
Reach:	Just d.s. of Stony Bk. To Dosewallips Falls	**Reach Length (mi):**	3.60
		Reach Code:	Dose 4

Restoration Benefit Category:1/	D	**Productivity Rank:1/**	4	**Potential % change in productivity:2/**	57.2%
Overall Restoration Potential Rank:1/	4	**Average Abundance (Neq) Rank:1/**	4	**Potential % change in Neq:2/**	51.6%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	5	**Potential % change in diversity:2/**	1.8%
Preservation Benefit Category:1/	C	**Productivity Rank:1/**	3	**loss in productivity with degradation:2/**	-31.6%
Overall Preservation Rank:1/	3	**Average Abundance (Neq) Rank:1/**	3	**% loss in Neq with degradation:2/**	-60.1%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	3	**% loss in diversity with degradation:2/**	-31.4%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	9.9%	-6.4%	4							⬤							•		
Egg incubation	Nov-May	9.9%	-11.7%	2	●															
Fry colonization	Apr-May	9.9%	-37.4%	1	●				⬤	●	⚫									⬤
0-age active rearing	Mar-Oct	1.5%	-4.8%	6	•					•	⬤									⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	9.9%	-1.6%	5					●		●									
Prespawning holding	Oct-Nov	9.9%	-8.7%	3					●		●									○
All Stages Combined		9.9%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⚫	⭕

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Dosewallips - Fall Chinook

Geographic Area:	Rocky Brook	**Stream:**	Rocky Brook
Reach:	Confl. W/ Dose to grad. Change (>12%)	**Reach Length (mi):**	0.30
		Reach Code:	Rocky Brook

Restoration Benefit Category:1/	E	**Productivity Rank:1/**	5	**Potential % change in productivity:2/**	29.0%
Overall Restoration Potential Rank:1/	5	**Average Abundance (Neq) Rank:1/**	5	**Potential % change in Neq:2/**	29.7%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	4	**Potential % change in diversity:2/**	2.4%
Preservation Benefit Category:1/	E	**Productivity Rank:1/**	5	**loss in productivity with degradation:2/**	0.0%
Overall Preservation Rank:1/	5	**Average Abundance (Neq) Rank:1/**	5	**% loss in Neq with degradation:2/**	-0.5%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	5	**% loss in diversity with degradation:2/**	0.0%

					Change in attribute impact on survival															
Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	2.1%	-12.3%	3							⚫	●						•		○
Egg incubation	Nov-May	2.1%	-86.7%	1	⬤												⚫			○
Fry colonization	Apr-May	2.1%	-11.2%	4	●				⚫	•	⬤									⚫
0-age active rearing																				
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	2.1%	-1.2%	5					●		⚫									
Prespawning holding	Oct-Nov	2.1%	-26.3%	2					●		⚫	•								●
All Stages Combined		2.1%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	◦
Moderate	●	○
High	⚫	◯
Extreme	⬤	⭘

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Duckabush - Fall Chinook

Geographic Area:	Duck 1	**Stream:**	Duckabush River
Reach:	mouth (Hwy 101) to upstream extent of revetments	**Reach Length (mi):**	0.80
		Reach Code:	Duck 1

Restoration Benefit Category:1/	A	**Productivity Rank:1/**	3	**Potential % change in productivity:2/**	91.3%
Overall Restoration Potential Rank:1/	1	**Average Abundance (Neq) Rank:1/**	1	**Potential % change in Neq:2/**	92.5%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	1	**Potential % change in diversity:2/**	13.9%
Preservation Benefit Category:1/	B	**Productivity Rank:1/**	5	**loss in productivity with degradation:2/**	-3.2%
Overall Preservation Rank:1/	5	**Average Abundance (Neq) Rank:1/**	4	**% loss in Neq with degradation:2/**	-24.4%
(lowest rank possible - with ties)1/	4	**Life History Diversity Rank:1/**	5	**% loss in diversity with degradation:2/**	-0.2%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																	
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	20.6%	-6.1%	6							⚫							•		●
Egg incubation	Nov-May	20.6%	-80.8%	1	⬤												⚫			●
Fry colonization	Apr-May	68.9%	-15.2%	2	●				⚫	•	⚫									⚫
0-age active rearing	Mar-Oct	60.2%	-1.8%	5	•					•	●				•					⚫
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	100.0%	-4.4%	4					●		●									⚫
Prespawning holding	Oct-Nov	20.6%	-53.2%	3					●		⬤									⚫
All Stages Combined		100.0%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⚫	◯
Extreme	⬤	⭘

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Duckabush - Fall Chinook

Geographic Area:	Duck 2	**Stream:**	Duckabush River
Reach:	Revetments to Johnson Creek (WRIA 16.0355; hatchery)	**Reach Length (mi):**	1.30
		Reach Code:	Duck 2

Restoration Benefit Category:1/	B	**Productivity Rank:1/**	1	**Potential % change in productivity:2/**	105.3%
Overall Restoration Potential Rank:1/	3	**Average Abundance (Neq) Rank:1/**	3	**Potential % change in Neq:2/**	35.2%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	4	**Potential % change in diversity:2/**	0.3%
Preservation Benefit Category:1/	A	**Productivity Rank:1/**	1	**loss in productivity with degradation:2/**	-54.1%
Overall Preservation Rank:1/	2	**Average Abundance (Neq) Rank:1/**	1	**% loss in Neq with degradation:2/**	-77.9%
(lowest rank possible - with ties)1/	4	**Life History Diversity Rank:1/**	3	**% loss in diversity with degradation:2/**	-26.9%

					Change in attribute impact on survival															
Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	29.2%	-1.0%	6							•							•		⭘
Egg incubation	Nov-May	29.2%	-59.7%	1	⬤												⬤			⭘
Fry colonization	Apr-May	61.8%	-2.3%	3	●				●	•	●									
0-age active rearing	Mar-Oct	31.1%	-0.5%	5	•						•				•					●
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	79.4%	-1.7%	2					●		•									
Prespawning holding	Oct-Nov	29.2%	-4.1%	4					●		•									●
All Stages Combined		79.4%																		

1/ Ranking based on effect over entire geographic area.   2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⚫	◯
Extreme	⬤	⭘

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Duckabush - Fall Chinook

Geographic Area:	Duck 3	**Stream:**	Duckabush River
Reach:	Johnson Creek (WRIA# 16.0355; hatchery) to gradient change (1-2%) at top of canyon	**Reach Length (mi):**	2.00
		Reach Code:	Duck 3

Restoration Benefit Category:1/	B	**Productivity Rank:1/**	2	**Potential % change in productivity:2/**	96.9%
Overall Restoration Potential Rank:1/	2	**Average Abundance (Neq) Rank:1/**	2	**Potential % change in Neq:2/**	53.9%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	2	**Potential % change in diversity:2/**	4.6%
Preservation Benefit Category:1/	A	**Productivity Rank:1/**	2	**loss in productivity with degradation:2/**	-35.8%
Overall Preservation Rank:1/	1	**Average Abundance (Neq) Rank:1/**	2	**% loss in Neq with degradation:2/**	-57.1%
(lowest rank possible - with ties)1/	4	**Life History Diversity Rank:1/**	1	**% loss in diversity with degradation:2/**	-61.5%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	22.0%	-7.5%	6							⬤							•		
Egg incubation	Nov-May	22.0%	-56.3%	2	⬤															
Fry colonization	Apr-May	45.5%	-36.8%	1	●				⬤	●	⬤									
0-age active rearing	Mar-Oct	17.6%	-8.2%	5	•					•	⬤				•					
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	50.2%	-3.9%	3					●		●									
Prespawning holding	Oct-Nov	22.0%	-8.9%	4					●		●									
All Stages Combined		50.2%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Duckabush - Fall Chinook

Geographic Area:	Duck 4	**Stream:**	Duckabush River
Reach:	From top of canyon to Duckabush Rd. crossing	**Reach Length (mi):**	1.90
		Reach Code:	Duck 4

Restoration Benefit Category:1/	C	**Productivity Rank:1/**	4	**Potential % change in productivity:2/**	39.5%
Overall Restoration Potential Rank:1/	4	**Average Abundance (Neq) Rank:1/**	4	**Potential % change in Neq:2/**	26.8%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	3	**Potential % change in diversity:2/**	2.8%
Preservation Benefit Category:1/	B	**Productivity Rank:1/**	3	**loss in productivity with degradation:2/**	-18.6%
Overall Preservation Rank:1/	3	**Average Abundance (Neq) Rank:1/**	3	**% loss in Neq with degradation:2/**	-27.6%
(lowest rank possible - with ties)1/	4	**Life History Diversity Rank:1/**	2	**% loss in diversity with degradation:2/**	-29.0%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	18.0%	-2.3%	5							●							•		⬤
Egg incubation	Nov-May	18.0%	-60.1%	1	⬤												⬤			⬤
Fry colonization	Apr-May	28.2%	-8.7%	2	●				●	●	⬤									⬤
0-age active rearing	Mar-Oct	4.7%	-0.9%	6	•					•	●									⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	28.3%	-1.7%	4					●		•									
Prespawning holding	Oct-Nov	18.0%	-5.0%	3					●		●									⬤
All Stages Combined		28.3%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	◦
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Duckabush - Fall Chinook

Geographic Area:	Duck 5	**Stream:**	Duckabush River
Reach:	Duck Rd crossing to barrier falls at Little Hump	**Reach Length (mi):**	1.30
		Reach Code:	Duck 5

Restoration Benefit Category:1/	D	**Productivity Rank:1/**	5	**Potential % change in productivity:2/**	17.4%
Overall Restoration Potential Rank:1/	5	**Average Abundance (Neq) Rank:1/**	5	**Potential % change in Neq:2/**	11.5%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	5	**Potential % change in diversity:2/**	0.0%
Preservation Benefit Category:1/	B	**Productivity Rank:1/**	4	**loss in productivity with degradation:2/**	-17.0%
Overall Preservation Rank:1/	4	**Average Abundance (Neq) Rank:1/**	5	**% loss in Neq with degradation:2/**	-18.5%
(lowest rank possible - with ties)1/	4	**Life History Diversity Rank:1/**	4	**% loss in diversity with degradation:2/**	-21.0%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**															
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	10.2%	-2.0%	4							●									⬤
Egg incubation	Nov-May	10.2%	-28.9%	1	⬤															⬤
Fry colonization	Apr-May	10.2%	-5.8%	2	•				●		⬤									
0-age active rearing	Mar-Oct	0.1%	-0.3%	6							●									●
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	10.2%	-0.6%	5					●		•									
Prespawning holding	Oct-Nov	10.2%	-2.9%	3					●		•									●
All Stages Combined		10.2%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Hamma Hamma - Fall Chinook

Geographic Area:	Hamma 1	**Stream:**	Hamma Hamma River
Reach:	Mouth (Hwy 101) to John Creek confluence	**Reach Length (mi):**	1.10
		Reach Code:	Hamma 1

Restoration Benefit Category:1/	A	**Productivity Rank:1/**	1	**Potential % change in productivity:2/**	206.4%
Overall Restoration Potential Rank:1/	1	**Average Abundance (Neq) Rank:1/**	1	**Potential % change in Neq:2/**	98.4%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	1	**Potential % change in diversity:2/**	18.6%
Preservation Benefit Category:1/	A	**Productivity Rank:1/**	2	**loss in productivity with degradation:2/**	-22.6%
Overall Preservation Rank:1/	1	**Average Abundance (Neq) Rank:1/**	2	**% loss in Neq with degradation:2/**	-63.6%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	2	**% loss in diversity with degradation:2/**	-31.8%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	45.3%	-4.3%	5							●	•						•		◯
Egg incubation	Nov-May	45.3%	-80.2%	1	⚫												⬤			◯
Fry colonization	Apr-May	99.9%	-15.9%	2	●				●	•	⬤									●
0-age active rearing	Mar-Oct	26.3%	-0.5%	6	•						●				•					⬤
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	100.0%	-4.5%	4					●		●	•								●
Prespawning holding	Oct-Nov	45.3%	-18.7%	3					●		⬤	•								⬤
All Stages Combined		100.0%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⚫	⭕

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Hamma Hamma - Fall Chinook

Geographic Area:	Hamma 2	**Stream:**	Hamma Hamma River
Reach:	John Creek to gradient change 1800' upstream	**Reach Length (mi):**	0.30
		Reach Code:	Hamma 2

Restoration Benefit Category:1/	B	**Productivity Rank:1/**	4	**Potential % change in productivity:2/**	97.2%
Overall Restoration Potential Rank:1/	3	**Average Abundance (Neq) Rank:1/**	4	**Potential % change in Neq:2/**	42.3%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	3	**Potential % change in diversity:2/**	2.3%
Preservation Benefit Category:1/	D	**Productivity Rank:1/**	4	**loss in productivity with degradation:2/**	-6.2%
Overall Preservation Rank:1/	4	**Average Abundance (Neq) Rank:1/**	4	**% loss in Neq with degradation:2/**	-14.0%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	4	**% loss in diversity with degradation:2/**	-7.8%

					Change in attribute impact on survival															
Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	13.2%	-4.4%	4							●	•						•		
Egg incubation	Nov-May	13.2%	-80.1%	1	⬤												⬤			•
Fry colonization	Apr-May	32.8%	-4.4%	3	●				●	•	⬤									•
0-age active rearing																				
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	32.8%	-1.1%	5					●		●									●
Prespawning holding	Oct-Nov	13.2%	-18.8%	2					●		⬤	•								⬤
All Stages Combined		32.8%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Hamma Hamma - Fall Chinook

Geographic Area:	Hamma 3	**Stream:**	Hamma Hamma River
Reach:	Gradient change to 600' below impassable falls.	**Reach Length (mi):**	0.60
		Reach Code:	Hamma 3

Restoration Benefit Category:1/	C	**Productivity Rank:1/**	3	**Potential % change in productivity:2/**	132.5%
Overall Restoration Potential Rank:1/	4	**Average Abundance (Neq) Rank:1/**	3	**Potential % change in Neq:2/**	47.7%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	4	**Potential % change in diversity:2/**	0.7%
Preservation Benefit Category:1/	B	**Productivity Rank:1/**	1	**loss in productivity with degradation:2/**	-62.9%
Overall Preservation Rank:1/	2	**Average Abundance (Neq) Rank:1/**	1	**% loss in Neq with degradation:2/**	-100.0%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	3	**% loss in diversity with degradation:2/**	-21.8%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																	
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	19.6%	-6.3%	4							⬤							•		
Egg incubation	Nov-May	19.6%	-48.2%	1	●												⬤			○
Fry colonization	Apr-May	19.6%	-10.0%	2	●				⬤	•	⬤									●
0-age active rearing																				
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	19.6%	-1.0%	5					●		●									●
Prespawning holding	Oct-Nov	19.6%	-8.6%	3					●		●									●
All Stages Combined		19.6%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⬤	◯

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Hamma Hamma - Fall Chinook

Geographic Area:	John Creek 1			**Stream:**	John Creek
Reach:	Confluence With Hamma to S. Branch John Cr			**Reach Length (mi):**	1.20
				Reach Code:	John Creek 1
Restoration Benefit Category:1/	B	**Productivity Rank:1/**	2	**Potential % change in productivity:2/**	143.5%
Overall Restoration Potential Rank:1/	2	**Average Abundance (Neq) Rank:1/**	2	**Potential % change in Neq:2/**	55.0%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	2	**Potential % change in diversity:2/**	3.3%
Preservation Benefit Category:1/	C	**Productivity Rank:1/**	3	**loss in productivity with degradation:2/**	-15.7%
Overall Preservation Rank:1/	3	**Average Abundance (Neq) Rank:1/**	3	**% loss in Neq with degradation:2/**	-25.6%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	1	**% loss in diversity with degradation:2/**	-44.4%

Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	**Change in attribute impact on survival**																
					Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	19.8%	-5.9%	5							⬤							•		◯
Egg incubation	Nov-May	19.8%	-72.3%	1	⬤												⬤			◯
Fry colonization	Apr-May	21.8%	-17.5%	2	●				⬤	•	⬤									●
0-age active rearing	Mar-Oct	0.1%	-0.8%	6	•						●				•					
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	21.8%	-5.4%	4					⬤		●									
Prespawning holding	Oct-Nov	19.8%	-12.8%	3					●		⬤									⚪
All Stages Combined		21.8%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	•	∘
Moderate	●	○
High	⬤	◯
Extreme	⚫	⚪

Species/Component:	Fall Chinook
Restoration Potential:	Current Conditions versus Historic Potential
Restoration Emphasis:	Restoration or maintenance/improvement of historic life histories

Hamma Hamma - Fall Chinook

Geographic Area:	John Creek 2	**Stream:**	John Creek
Reach:	Confluence S. Branch John Cr. to 800' upstream of confluence (reach incl. S. Branch John Creek)	**Reach Length (mi):**	0.20
		Reach Code:	John Creek 2

Restoration Benefit Category:1/	D	**Productivity Rank:1/**	5	**Potential % change in productivity:2/**	10.4%
Overall Restoration Potential Rank:1/	5	**Average Abundance (Neq) Rank:1/**	5	**Potential % change in Neq:2/**	7.7%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	5	**Potential % change in diversity:2/**	0.0%
Preservation Benefit Category:1/	E	**Productivity Rank:1/**	5	**loss in productivity with degradation:2/**	-0.7%
Overall Preservation Rank:1/	5	**Average Abundance (Neq) Rank:1/**	5	**% loss in Neq with degradation:2/**	-1.3%
(lowest rank possible - with ties)1/	5	**Life History Diversity Rank:1/**	5	**% loss in diversity with degradation:2/**	-7.0%

					Change in attribute impact on survival															
Life stage	**Relevant months**	**% of life history trajectories affected**	**Productivity change (%)**	Life Stage Rank	Channel stability	Chemicals	Competition (w/ hatch)	Competition (other sp)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Spawning	Oct-Nov	2.1%	-4.5%	3							●							·		●
Egg incubation	Nov-May	2.1%	-67.8%	1	●												●			●
Fry colonization	Apr-May	2.1%	-3.1%	4	•				•	•	●									●
0-age active rearing																				
0-age migrant																				
0-age inactive																				
1-age active rearing																				
1-age migrant																				
1-age transient rearing																				
2+-age transient rearing																				
Prespawning migrant	Sep-Oct	2.1%	-0.6%	5					•		•									
Prespawning holding	Oct-Nov	2.1%	-8.9%	2					•		•									●
All Stages Combined		2.1%																		

1/ Ranking based on effect over entire geographic area.

2/ Value shown is for overall population performance.

Notes: Changes in key habitat can be caused by either a change in percent key habitat or in stream width.

Potential % changes in performance measures for reaches upstream of dams were computed with full passage allowed at dams (though reservoir effects still in place).

KEY

NA = Not applicable

	Loss	Gain
None		
Small	·	°
Moderate	•	◦
High	●	○
Extreme	⬤	◯

Appendix C1. Habitat Protection and Restoration Project List for the Dosewallips River

#	EDT Reach	Habitat	Action Type	Description
1	E,1,2,3,5	Watershed	Dosewallips 25-yr buildout	Buildout model
2	E	Estuary	Lower Distributary Reconnection	Remove low berm/dredge spoils on lowest river right
3	E	Estuary	Toe Armor Removal	Remove bank protection/riprap below SR101 on lower river right
4	E	Estuary	Campground and Day-Use Setback	Relocate infrastructure to improve channel, floodplain and riparian functions on river right
5	E	Estuary	Floodplain Reforestation	Plant riparian areas in Brinnon Flats/State Park where possible
6	E	Estuary	Large Wood Placement	Install key wood or engineered log jams to improve channel complexity. This should be limited to 3-5 structures, individually covering less than 10% of BFW
7	E	Estuary	Floodplain Reforestation	Plant open field on State Park property on river left
8	E	Estuary	Sylopash Slough Conservation	Acquisition of 3 acres and restore vegetation
9	E	Estuary	Sylopash Slough Culverts	Work with private landowner to remove and/or replace undersized culverts to improve tidal inundation and maintain key rearing area
10	E	Estuary	Salt Marsh Restoration	Remove low berm on State Parks property north of mainstem
11	E	Estuary	Salt Marsh Restoration	Remove low berm on State Parks property south of Sylopash Slough if sister project effective
12	E	Estuary	Delta and Floodplain Restoration	Work with private landowner to prevent and/or reduce potential impacts of flooding and (long-term) channel avulsion. This may require property purchase and/or setback levees.
13	E	Estuary	Shoreline Restoration	Remove barge on shoreline on southern edge of Dosewallips Estuary
14	E	Estuary	Walcott Slough Tidal Restoration	Restore tidal prism east of SR101 by removing access road, culverts, fill, pilings, and fish trap. This may require property purchase
15	E	Estuary	Walcott Slough Tidal Restoration	Restore tidal prism west of SR101 by increasing culvert size under SR101 and working with private landowners to enhance and increase upper tidal channels through development
16	1	Mainstem	Active Channel Restoration	Remove riprap levee on river right above SR101 but leave setback levees. Length is ~400m
17	1	Mainstem	Floodplain Restoration	Relocate campground, remove levees and fill on river right above SR101 to restore floodplain functions and channel stability. Would require SR101 Causeway retrofit

Appendix C1 (continued)

18	1	Mainstem	Levee Setback and Floodplain/Distributary Reconnection	Setback Brinnon Levee on river left above SR101. This would require significant property purchase, SR101 causeway retrofit, and channel restoration.
19	1	Mainstem	Floodplain Conservation	Purchase 90 acres of powerlines reach
20	1	Mainstem	Floodplain Conservation	Purchase remaining property in powerlines reach
21	1	Mainstem	Floodplain Reforestation	Conifer underplantings of about 100 acres
22	1	Mainstem	Floodplain and Channel Restoration	Install key wood and 6-10 ELJs to improve channel complexity and reconnect floodplain in lower powerline reach.
23	1	Mainstem	Floodplain and Channel Restoration	Install key wood and 4-6 ELJs to improve channel complexity and reconnect floodplain in upper powerline reach.
24	1	Mainstem	Side Channel Restoraiton	Improve morphology and LWD quantity in side channel below Lazy C
25	1	Mainstem	Floodplain Restoration and Conservation	Purchase and restore about 22 acres of Lazy C development, plus 2 to 3 additional acres of platted lands east of Lazy C. Restore ELJ and wood frequency, and riparian
26	2	Mainstem	Channel Habitat Diversity	Add key LWD pieces in partially confined reach
27	3,2,1	Watershed	USFS A&TM Plan	2 km of road decommissioning
28	3,2,1	Watershed	USFS A&TM Plan	2.6 km of road conversion to trail
29	3/ Rocky Brook	Mainstem/Tributary	Floodplain and Trib Conservation and Restoration	Purchase all or part of 5 lots (1-3 partially developed) for total of about 17 acres at Rocky Brook Confluence. Install key wood or ELJs to improve channel and floodplain complexity above and at alluvial fan and in RB.
30	3	Mainstem	Floodplain Restoration	Restore channel complexity and partial floodplain restoration through 1.5 km of Lower Wolcott Flats. A series of ELJs and key LWD will be needed, in addition to setback levees for infrastructure. Conifer Underplantings. May require purchasing 100m buff
31	3	Mainstem	Floodplain Restoration	Restore connection to and quality of 1 km of channel on private property in Upper Wolcott Flats. Install several large ELJs for connection, plus several smaller jams and placed, large key wood. Logjams upstream may be needed to raise bed and water surfa
32	2,3	Mainstem	Riparian and Floodplain Conservation	Conserve riparian corridor and floodplain functions along south shore from Powerlines Reach upstream to federal ownership.

Appendix C1 (continued)

33	3	Mainstem	Floodplain Restoration	Restore channel complexity below 6 mile bridge with full scale wood/ELJ restoration (6-12). Conifer Underplantings
34	3	Mainstem	Floodplain Restoration	Restore channel complexity at Forest Service boundary with full scale wood/ELJ restoration (6-12). Conifer Underplantings
35	3	Mainstem	Floodplain Restoration	Restore channel and floodplain complexity around Camp Acacia with full scale wood restoration, given private property concerns. Conifer Underplantings. May require purchasing floodplain buffers, setback levees, building relocation.
36	3	Mainstem	Floodplain Restoration	Restore channel and floodplain complexity above Camp Acacia with 2-3 ELJs or key wood placement.
37	3	Mainstem	Floodplain Restoration	Restore channel complexity at Steelhead Campground through addition of dozens of Key Pieces, removal of sediment plug at top of enhancement ponds, road bed, and 200 m of low riprap.
38	3	Mainstem	Floodplain Restoration	Restore channel and floodplain complexity below washout with full scale wood/ELJ restoration (5-10).
39	4	Mainstem	Floodplain Restoration	Restore channel complexity around Elkhorn Camp with removal of infrastructure and riprap, while adding key wood in smaller jams.
40	3,4,5	Mainstem	Riparian Restoration	Restore riparian conditions RM6 to 12 USFS
41	Rocky Brook	Watershed	USFS A&TM Plan	6 km of road decommissioning

Appendix C2. Habitat Protection and Restoration Project List for the Duckabush River

#	EDT Reach	Habitat	Action Type	Description
1	E,1,2,3	Watershed	Duckabush 25-yr buildout	Buildout model
2	E	Estuary	Estuarine Restoration	Elevate SR101 across estuarine delta to restore tidal connectivity and native vegetation
3	E	Estuary	Floodplain/Distributary Reconnection	Reconnect northern distributary channel with the Duckabush River
4	E	Estuary	Dike Removal	Remove dike along north side of estuary along Robinson Road
5	E	Estuary	Dike Removal	Remove dike along south side of estuary and upstream of SR101
6	E	Estuary	Estuarine Restoration	Reconfigure intersection of SR101 and Duckabush River Road to reconnect Pierce Creek Slough
7	E	Estuary	Floodplain/Distributary Reconnection	Improve connection of the small creek flowing through undersized culvert into the nw corner of Duckabush estuary
8	E	Estuary	Floodplain/Distributary Reconnection	Restore Pierce Creek and tidal connectivity by bridging Shorewood Road and restoring floodplain and riparian function; may require property purchase
9	?	Watershed	USFS A&TM Plan	13 km of road decommissioning
10	?	Watershed	USFS A&TM Plan	1.2 km of road conversion to trail
11	1	Mainstem	Floodplain Restoration	Restore sinuosity and natural channel/floodplain configuration in artificially-confined reaches downstream of BPA power lines by removing riprap, bulkheads and fill, which may require purchase of residential lots, building relocation, and wood addition
12	1,2,3,4,5	Mainstem	Floodplain Restoration	Restore stream channel habitat complexity through key large woody debris and log jam addition in mainstem and through large woody debris addition in the Murhut and Cliff subwatersheds
13	1,2,3,4,5	Mainstem	Floodplain / Riparian Restoration	Plant and maintain riparian areas on both public and private properties in lower mainstem and in the Murhut/Cliff subwatersheds.
14	1,2,3,4,5	Mainstem	Floodplain Conservation	Conserve remaining high quality riparian and floodplain habitat

Appendix C3._ Habitat Protection and Restoration Project List for the Hamma Hamma River

#	EDT Reach	Habitat	Action Type	Description
1	all	Watershed	Hamma Hamma 25-yr buildout	Buildout model
2	Estuary	Estuary	Estuarine Restoration	Remove levees/dikes and armoring, particularly mainstem dike, the dike along the north side of the estuary, and other minor dikes to restore mainstem and tidal channels, and estuary function
3	Estuary	Estuary	Shoreline Restoration	Remove pilings from existing spit
4	Estuary	Estuary	Saltmarsh Restoration	Remove exotic vegetation in the vicinity of shellfish facility and replant with native conifers and shrubs
5	Estuary	Estuary		Elevate SR101 across estuarine delta to restore tidal connectivity and native vegetation
6	Estuary	Estuary	Shoreline Restoration	Remove bulkhead and fill that forms an unused part of a parking lot to the north of shellfish facility to restore salt marsh habitat
7	Estuary 1,2,3	Watershed	USFS A&TM Plan	34.5 km of road decommissioning
8	Estuary 1,2,3	Watershed	USFS A&TM Plan	9.2 km of road conversion to trail
9	1,2	Mainstem	Floodplain Restoration	Restore natural channel-forming processes and floodplain connectivity in artificially-confined reaches of lower mainstem by removing riprap and groins; may require jam addition
10	1,2, J1, J2	Mainstem	Floodplain Restoration	Restore stream channel habitat complexity through key large woody debris and log jam addition in mainstem and LWD in John's Creek
				Assess, conserve, and restore riparian conditions
11	all	Mainstem	Floodplain Restoration	i. Anadromous zone
12	all	Mainstem	Floodplain Restoration	ii. Above anadromous zone as recommended in Watershed Analysis pp 2.6-18 -19
13	all	Mainstem	Floodplain Restoration	iii. Lake riparian areas damaged by recreation (see Watershed Analysis)
14	all	Mainstem	Floodplain Restoration	iv. Silviculture treatment of upland problem areas, with emphasis on Jefferson and Cabin Creek watersheds, to increase hydrologic maturity

Appendix D. Productivity of mid Hood Canal Chinook derived from EDT analysis for habitat actions implemented with modeled build-out as baseline conditions

Dosewallips River Watershed

			Productivity Rank		**Productivity Values**	
Implementation List	**Action Name**	**HCCC Project list (Appendix __)**	**25-yr time lag**	**100-yr time lag**	**25-yr time lag**	**100-yr time lag**
high	USFS wood - riparian restoration	33-38, 40	1	1	*6.2*	*6.9*
high	USFS RM 6 to 12 wood restoration	33-38	2	5	*5.1*	*5.1*
high	Middle Dose riparian-floodplain restoration and protection	32A	3	4	*4.9*	*5.2*
high	Lower Dosewallips wood-riparian restoration amd protection	19-24	4	3	*4.9*	*5.4*
low	Lower Dosewallips floodplain/estuary restoration	2-18	5	6	*4.8*	*4.8*
high	USFS RM 6 to 12 riparian restoration	32B	6	2	*4.7*	*6.8*
high	USFS road decommissioning restoration and protection	27-28, 41	7	9	*4.4*	*4.4*
low	Lazy C floodplain and wood restoration	25	8	7	*4.4*	*4.5*
low	Lower Dosewallips floodplain restoration	16-18	9	8	*4.4*	*4.5*
low	Upper Wolcott Flats restoration	31	10	11	*4.1*	*4.1*
low	Middle Dosewallips wood-riparian restoration	26	11	10	*4.0*	*4.3*
low	Dosewallips estuary restoration	2-15	12	13	*4.0*	*4.0*
high	Dosewallips estuary restoration excluding Day Use Area	2-3, 5-15	13	14	*3.9*	*4.0*
low	Lower Wolcott Flats restoration	30	14	12	*3.8*	*4.0*
high	Rocky Brook confluence floodplain restoration	29	15	15	*3.8*	*3.8*
low	Wolcott Slough restoration	14-15	16	16	*3.5*	*3.6*
high	Elkhorn Campground recovery	39	17	17	*3.5*	*3.5*

Appendix D (continued)

Duckabush River Watershed

Implementation List	Action Name	HCCC Project list (Appendix __)	Productivity Rank 25-yr time lag	 100-yr time lag	Productivity Values 25-yr time lag	 100-yr time lag
high	Middle Duckabush wood-riparian recovery	12-13	1	1	*5.0*	*6.1*
high	USFS road decommissioning (restoration and protection)	9-10	2	2	*4.4*	*4.4*
low	Duckabush Olympic Canal tracts	11	3	3	*4.2*	*4.3*
high	Upper Duckabush wood-riparian recovery	12-13	4	4	*4.0*	*4.2*
high	Duckabush high quality habitat protection	14	5	5	*3.7*	*3.7*
low	Duckabush estuary restoration	2-8	6	6	*3.6*	*3.6*
high	North Duckabush estuarine restoration	4, 7, 8	7	7	*3.4*	*3.4*

Hamma Hamma River Watershed

Implementation List	Action Name	HCCC Project list (Appendix __)	Productivity Rank 25-yr time lag	 100-yr time lag	Productivity Values 25-yr time lag	 100-yr time lag
low	Lower Hamma Hamma wood-riparian recovery	10-11	1	1	*7.8*	*8.4*
low	Lower Hamma Hamma floodplain and side channel restoration	9-10	2	2	*5.0*	*5.1*
low	Upper Hamma Hamma watershed recovery	12-13	3	3	*4.7*	*4.7*
high	Johns Cr Sediment loading restoration		4	4	*4.6*	*4.6*
low	Johns Cr wood-riparian recovery	10-11	5	5	*4.3*	*4.5*
low	USFS road decommissioning (restoration and protection)	7-8	6	6	*4.2*	*4.2*
high	Hamma Hamma estuary restoration	2-6	7	7	*4.0*	*4.0*

Appendix E. Abundance of mid Hood Canal Chinook derived from EDT analysis for habitat actions implemented with modeled build-out as baseline conditions

Dosewallips River Watershed

			Abundance Rank		Abundance values	
Implementation List	**Action Name**	**HCCC Project list (Appendix __)**	**25-yr time lag**	**100-yr time lag**	**25-yr time lag**	**100-yr time lag**
high	USFS wood - riparian restoration	33-38, 40	1	1	*1769*	*1879*
low	Lower Dosewallips floodplain/estuary restoration	2-18	2	3	*1738*	*1742*
high	USFS RM 6 to 12 wood restoration	33-38	3	5	*1593*	*1593*
high	Middle Dose riparian-floodplain restoration and protection	32A	4	4	*1524*	*1648*
high	USFS RM 6 to 12 riparian restoration	32B	5	2	*1495*	*1871*
low	Lower Dosewallips floodplain restoration	16-18	6	7	*1478*	*1556*
low	Dosewallips estuary restoration	2-15	7	6	*1477*	*1562*
high	Dosewallips estuary restoration excluding Day Use Area	2-3, 5-15	8	8	*1461*	*1485*
high	Lower Dosewallips wood-riparian restoration amd protection	19-24	9	9	*1422*	*1473*
low	Upper Wolcott Flats restoration	31	10	10	*1403*	*1403*
high	USFS road decommissioning restoration and protection	27-28, 41	11	11	*1379*	*1379*
low	Lazy C floodplain and wood restoration	25	12	12	*1347*	*1376*
low	Middle Dosewallips wood-riparian restoration	26	13	13	*1308*	*1348*
low	Lower Wolcott Flats restoration	30	14	14	*1289*	*1309*
high	Rocky Brook confluence floodplain restoration	29	15	15	*1278*	*1278*
low	Wolcott Slough restoration	14-15	16	16	*1199*	*1252*
high	Elkhorn Campground recovery	39	17	17	*1161*	*1161*

Appendix E (continued)

Duckabush River Watershed

Implementation List	Action Name	HCCC Project list (Appendix __)	Abundance Rank 25-yr time lag	 100-yr time lag	Abundance values 25-yr time lag	 100-yr time lag
low	Duckabush Olympic Canal tracts	11	1	1	*682*	*705*
low	Duckabush estuary restoration	2-8	2	3	*598*	*600*
high	USFS road decommissioning (restoration and protection)	9-10	3	4	*573*	*573*
high	Middle Duckabush wood-riparian recovery	12-13	4	2	*566*	*668*
high	Upper Duckabush wood-riparian recovery	12-13	5	5	*551*	*567*
high	Duckabush high quality habitat protection	14	6	6	*517*	*517*
high	North Duckabush estuarine restoration	4, 7, 8	7	7	*495*	*499*

Hamma Hamma River Watershed

Implementation List	Action Name	HCCC Project list (Appendix __)	Abundance Rank 25-yr time lag	 100-yr time lag	Abundance values 25-yr time lag	 100-yr time lag
low	Hamma Hamma estuary restoration	2-6	1	2	*659*	*624*
low	Lower Hamma Hamma wood-riparian recovery	10-11	2	1	*635*	*653*
low	Lower Hamma Hamma floodplain and side channel restoration	9-10	3	3	*568*	*571*
low	Johns Cr Sediment loading restoration		4	5	*513*	*513*
high	Upper Hamma Hamma watershed recovery	12-13	5	6	*508*	*508*
low	Johns Cr wood-riparian recovery	10-11	6	4	*506*	*514*
high	USFS road decommissioning (restoration and protection)	7-8	7	7	*484*	*484*

Appendix F Harvest Management Affecting Hood Canal Chinook Salmon

Hood Canal chinook are divided into two management units for the purpose of harvest management: Skokomish and mid-Hood Canal. Specific guidelines have been developed by the co-managers to protect all chinook managements units based on their current status. Generally, the more at risk a management unit is, the more restrictive are the limitations on intercepting fisheries. In some years, including 2005, mid-Hood Canal chinook has been a "controlling stock" because its poor status imposes strong limitations on preterminal, mixed stock fisheries during annual planning for Washington State fisheries. The long-term objective is to rebuild the Hood Canal natural populations to levels that are sustainable and will support fisheries. In the interim, harvest is being managed to keep exploitation rates low enough to not impede recovery and harvest surplus fish.

Current harvest management actions that potentially affect Hood Canal chinook may be viewed in three categories: 1) in Hood Canal, 2) in the State of Washington, and 3) in Canadian and Alaskan waters. Each category is addressed below followed by concluding remarks.

Chinook Harvest Management in Hood Canal

The harvest restrictions may vary from year to year depending on the status of the Hood Canal chinook management units and the need to protect other chinook stocks and other species. Recently, Hood Canal fisheries have been most limited by the need to protect the mid-Hood Canal management unit. The pattern of fisheries in recent years has been as follows:

- In marine waters:
    - No commercial non-treaty chinook fishing and no treaty commercial chinook fishing in marine waters north of Ayock Point (i.e., within the approximate northern two thirds of the Canal).
    - Treaty set gillnet fishing allowed from Ayock Point to town of Union (Area 12C) – restrictions to season and days per week apply.
    - Treaty beach seine, treaty subsistence and non-treaty recreational fisheries allowed within the Hoodsport Hatchery zone (Area 12H) near the town of Hoodsport – restrictions on season, days of week and, for recreational fishery, number of fish per day apply.
    - Non-treaty recreational and treaty subsistence fisheries in north Hood Canal (Area 12) and Quilcene/Dabob Bay (Area 12A) – restrictions on season and, for recreational fishery, number of fish per day, apply.
- In freshwater areas:
    - No non-treaty recreational or treaty commercial or subsistence fisheries in rivers where significant numbers of chinook are present except for the Skokomish River.
    - Non-treaty recreational and treaty subsistence fishery allowed in Skokomish River - restrictions on season and, for recreational fishery, number of fish per day, apply.

As previously stated, the Hood Canal fisheries are managed in conjunction with the mixed stock fisheries outside of Hood Canal to limit harvest to levels that meet harvest objectives. The Hood Canal Fisheries planning, each year, is part of the larger planning effort for all of Washington State.

Chinook Harvest Management for the State of Washington

Chinook harvest management planning in Washington State, and adjacent areas of the Pacific Ocean, is complex, involving a multiplicity of Federal and State management agencies, Treaty tribes and other entities interacting through formalized processes in the early part of each year. The outcome of the annual planning effort is a fisheries plan that contains specific regulations that will be implemented to manage salmon harvests. Following is a brief description of the major processes involved in chinook planning, followed by brief discussion of how Hood Canal chinook are affected.

Each year, planning for fisheries of chinook (and coho) in Washington is implemented through a process known as PFMC / North of Falcon preseason planning. PFMC is the acronym for the Pacific Fisheries Management Council, a federally mandated council that, among other things, proposes to the Secretary of Commerce management provisions for the ocean salmon fisheries within the United States' Exclusive Economic Zone that extends 200 miles off the coast of Washington. "North of Falcon" identifies the region from Cape Falcon (just south of the Columbia River, on the Oregon coast) to the U.S. / Canada border, within the PFMC's jurisdiction in which the relevant preseason planning occurs. Because ocean fisheries planning cannot effectively occur without the consideration of inside fisheries (i.e., for the Columbia River, Washington coast, Strait of Juan de Fuca and Puget Sound), preseason planning for the inside fisheries is incorporated in the process. Preseason planning takes place in March, but includes preparation beginning the previous December or earlier and involves follow-up in April, often extending into the summer and fall fishing season. The process occurs in a series of scheduled meetings and depends on results of the simulation modeling of alternative fisheries' scenarios, using the Fisheries Regulation Assessment Model (FRAM).

Another process that affects annual chinook fisheries planning in Washington is that of the Pacific Salmon Commission (PSC), and its Southern Panel, which oversee the implementation of the Pacific Salmon Treaty between the U.S. and Canada. A treaty annex specifies how the salmon resources are to be managed, protected, and any harvests shared between the countries (see also the following section). Each year, details of abundance forecasts, fisheries assessments, monitoring and fishing proposals are reviewed and decisions on fisheries implementation and management are made. Of primary importance to Washington State chinook fisheries planning is the annual forecast of Canadian interceptions of U.S. chinook that is authorized by the Pacific Salmon Treaty and predicted to occur. This forecast is an essential input for the FRAM modeling. The PSC process begins in January and intersects with the PFMC / North of Falcon process in March.

The fact that chinook salmon of the Puget Sound Chinook ESU, including the Hood Canal populations, are listed as a threatened species under the Endangered Species Act, has brought another process into chinook fisheries planning. To meet requirements for permitting of fisheries under section 4(d) of the Endangered Species Act, the Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife (WDFW) have prepared a Puget Sound Chinook harvest management plan that will serve as the basis for review and implementation of the 4(d) permitting by NOAA Fisheries Service. The latest version of the harvest management plan (Puget Sound Indian Tribes and WDFW 2004), applicable to years 2004 through 2009, has been recently completed. The plan includes specific provisions for protecting individual chinook stocks (including mid-Hood Canal and Skokomish) when they fall within defined low and recovering levels of abundance. The provisions of this chinook harvest management plan are used as a management guideline during the PMFC / North of Falcon fisheries planning process.

An understanding of how harvest management is applied to Hood Canal chinook each year may be best described by stepping through the annual fisheries planning process:

1) A preliminary forecast of the expected returns of the mid-Hood Canal and Skokomish management units, under average prior fisheries interceptions, is made in January. This forecast, along with similar forecasts for other chinook management units, is used as input to the FRAM simulation model, to generate initial projections of fishery harvests and escapements. By this means, a preliminary assessment is made to identify those management units that may be at critical or recovering status and thus would require protection to limit fisheries impacts upon them. This information on management units' status helps inform the continuing FRAM simulation modeling process, the results of which provide the basis for management decisions.

   The criteria for determining a management unit's status vary depending on the specific stock. With respect to mid-Hood Canal, if the forecasted escapement is less than 400 fish, the management unit is deemed to be at low status; if it is between 400 and 750 fish, it is deemed to be at recovering status. If the mid-Hood Canal chinook escapement is projected to be at above 750 fish, no special protective provisions are expected, though efforts would be made to manage for the escapement goal, currently set at 750 fish.

   The criteria for the Skokomish management unit take into account its management as a composite population (including naturally and artificially produced chinook). If the forecasted escapement is less than 1,300 fish, in aggregate of natural and hatchery chinook, or less than 800 natural chinook, the management unit is at low status. If the forecasted escapement is between 1,300 and 3,650 chinook in aggregate, and between 800 and 1,650 natural chinook, the unit is at recovering status. Projected escapements above 3,650 aggregate and 1,650 natural chinook lead to management for escapements at the levels of 3,650 in aggregate and 1,650 natural chinook.

2) If a stock is at low or recovering status, defined limits to harvest exploitation rates (again varying depending upon the stock) are implemented in evaluating fisheries alternatives. In the case of mid-Hood Canal chinook: a) if the forecast escapement places the management unit at recovering status (as described above), subsequent planning for southern U.S. fisheries (using the FRAM model) is limited to <u>not</u> allowing that unit's preteminal southern U.S. chinook harvest exploitation rate to exceed 15%; b) if the forecast escapement places the unit at low status, subsequent preterminal southern U.S. fisheries planning is limited by a chinook preterminal exploitation rate ceiling of 12%, and may be further limited based on additional fisheries modeling criteria (Puget Sound Tribes and WDFW 2004). Also, at low status, terminal (within Hood Canal) and extreme terminal (at the source) harvest management actions would be taken to manage for meeting the mid-Hood Canal critical escapement threshold.

   The situation for Skokomish chinook is as follows: a) if the forecast escapement indicates recovering status (see above), planning (using the FRAM model) is limited to not allowing the unit's preterminal southern U.S. chinook harvest exploitation rate to exceed 15%; however, if the model indicates recruit abundance is still insufficient for the aggregate escapement goal (3,650 spawners) to be met, or if the model's projected natural escapement falls below 1,200 spawners, or if the hatchery escapement is projected below 1,000 spawners, then additional terminal and extreme terminal fisheries management measures will be taken with the objective of meeting or exceeding these spawner levels; b) if the forecast escapement places the unit at low status, subsequent preterminal southern U.S. fisheries planning is limited by a chinook preterminal exploitation rate ceiling of 12%, and may be further limited based on additional fisheries modeling criteria (Puget Sound Tribes and WDFW 2004). Also, at low status, terminal and extreme terminal harvest management actions would be taken to manage for meeting the Skokomish chinook critical escapement thresholds.

3) As the PFMC / North of Falcon fisheries planning proceeds, information is updated, and FRAM simulations are generated, looking for the appropriate fishing levels and balances to protect chinook stocks based on their status. This process involves considering management controls such as the timing and locations of the various fisheries from the ocean to the terminal areas. The FRAM model accumulates the exploitation rates for each stock to check against the rate limits defined by the stock status.

4) Once the FRAM model runs have been completed and alternative fisheries regimes have been reviewed, a decision is made by the PFMC on ocean fisheries and the Washington State co-managers (WDFW and the tribes) agree on an annual plan for the inside fisheries (e.g., Hood Canal and Puget Sound). This fisheries plan includes the specific times, locations and other provisions (e.g., chinook release requirement, size limit) of all the inside fisheries to occur that year.

As indicated, the level of impacts from southern U.S. fisheries (preterminal, terminal and extreme terminal) on Hood Canal chinook depends on each management unit's status and the results of fisheries planning for the year. Currently, the southern U.S. (i.e., south of the Canadian border) harvest of Hood Canal chinook is due primarily to marine recreational fisheries and to a much lesser degree, Puget Sound net, U.S. troll, and subsistence fisheries. Harvests and escapements of Hood Canal chinook are described below in a separate section.

Harvest Management in Alaskan and Canadian Areas (under the Pacific Salmon Treaty)

As mentioned previously, the Pacific Salmon Treaty (PST) adds another layer to the management of chinook harvest. Harvest management under jurisdiction of the PST is considered here because Canadian fisheries currently have a substantial fishery-related impact on Hood Canal chinook salmon. Alaskan fisheries have a relatively small impact.

The salmon life history includes migration through waters outside the salmon's native country, where the salmon are susceptible to harvest by the other country. The PST addresses the concerns of both the U.S. and Canada about the other country's harvest effect upon its home-origin fish and about each country's right to harvest fish in its waters irrespective of the fish origin. These concerns, pertaining to all species of salmon, exist between the southern U.S. and Canada, and between Alaska and Canada. The treaty includes specific harvest management provisions to address these concerns. Coincidentally, the treaty provisions affecting Alaskan fisheries bear not only upon Alaskan interceptions of Canadian - origin fish but also upon Alaskan interceptions of fish originating from the southern U.S.

The PST was signed in 1985. Annexes to the treaty contain the specific salmon management provisions. The most recent update to the annexes was agreed to in 1999 and is applicable through 2008. Annex IV, Chapter 3 applies to southern chinook salmon, originating from central / southern British Columbia and the southern U.S. (PSC 2000). Under the PST, chinook-intercepting fisheries are divided into two types: Aggregate Abundance Based Management (AABM) fisheries and Individual Stock Based Management (ISBM) fisheries. Specific rules apply to each category separately. The AABM fisheries are managed by planning and accounting for the aggregated catch of stocks within each fishery's area and time frame. Management focus is on the specific fishery not the stocks. For each fishery, the annual target catch level is selected using a harvest rate index (also called abundance index and expressed as a portion of the catch for the 1979-1982 base period) that is determined by the annual chinook pre-season abundance forecast or in-season abundance estimate, whichever is applicable. Annual fishery regulations (including fishing area/time openings and fish size limits) are prepared and implemented to achieve the target catch level of each AABM fishery. A computer model is used to calculate catch levels and help determine the annual fishery regulations. There are three AABM fisheries: Southeast Alaska (sport, net and troll), Northern British Columbia troll / Queen Charlotte Islands sport, and West Coast of Vancouver Island (troll and outside sport).

The ISBM fisheries address the harvest and conservation requirements of individual stocks or groups of stocks, the intent being to achieve maximum sustained yield or another agreed biologically based objective. The pool of ISBM fisheries includes the various British Columbia "inside fisheries" and southern U.S. fisheries (north of Cape Falcon). Indicator chinook salmon stocks, representative of each ISBM fishery, are monitored through a coast-wide coded wire-tagging program. The south Puget Sound marine net and sport and freshwater sport and net fisheries, including the fisheries of Hood Canal, are in combination designated as an ISBM fishery. A defined index, computed preseason based on forecasted abundance and fishing plans (and evaluated post season), was to be used to manage the individual ISBM fisheries, the planning and evaluation being based in part on indicator stocks; however, use of this approach requires first that the escapement dependent objectives be reviewed and agreed upon by the two countries. Since no agreement on ISBM stock escapement objectives currently exists, the default management approach is to reduce the total mortality rate, relative to a 1979-1982 base period, by 36.5 percent and 40 percent respectively for the Canada and the U.S. fisheries. Again computer simulation modeling is used to help determine the annual fisheries controls necessary to meet the mortality rate criteria. The ISBM fishery management controls currently do not present limits upon the management of southern U.S. chinook fisheries. Interceptions by Canada and Alaska of southern U.S. origin chinook are estimated, as part of the AABM/ISBM fisheries planning effort, and are made available to the PFMC / North of Falcon planning process to assist with preparation of the annual fisheries plan for Washington State (as noted above).

Because Puget Sound Chinook were listed as threatened under the Endangered Species Act, the U.S. federal government was required under section 7 of the Act to conduct consultations that considered the impacts of chinook harvest management under the PST. The consultations were completed and the U.S. Department of State (USDof S) and National Marine Fisheries Service (NMFS) issued a Biological Opinion in November 1999 (USDof S and NMFS 1999). The analysis, within the Biological Opinion, included estimates of Recovery Exploitation Rates (RERs) for some northern Puget Sound chinook stocks (that had sufficient coded wire tag information to allow such estimates). These RERs were target exploitation rates considered low enough to allow recovery of the stocks to viable population levels. An assessment was made that suggested the limitations on exploitation rates under the PST were insufficient to meet the RERs for several Puget Sound chinook stocks (and by implication other chinook stocks for which inadequate information existed to develop RERs). However, it was decided that rejection of the treaty provisions (that is, the 1999 treaty updates) by the U.S. was unlikely to result in a better or more restrictive management regime in the near future. Also, the U.S. government noted that mechanisms existed within the treaty provisions to address deficiencies that become apparent with respect to individual stocks (though conditions must be met for these mechanisms to be implemented) and expressed concern about the loss of other benefits associated with the treaty. In conclusion, the U.S. government decided that management actions under the PST were not likely to jeopardize continued existence of Puget Sound chinook.

The co-managers have expressed concern about the potential impacts of Canada and Alaska on Puget Sound chinook under provisions of the PST. The concern is that Washington State bears the disproportionate burden of fisheries restrictions to protect chinook and there continues to be a risk of under escapement for some depressed Puget Sound chinook stocks given the already existing high interceptions of Puget Sound chinook salmon by Canadian fisheries. The co-managers continue to work for improved protection of at risk chinook stocks under the PST. However, opportunity for change in the PST management process is not likely at least until the annex to the treaty is renewed effective in 2009.

Concluding Remarks

Through complicated management processes, addressing all Washington fisheries as well as those of Canada and Alaska, the co-managers (WDFW and tribes) have worked to substantially limit harvest effects upon depressed chinook stocks including those of Hood Canal. Currently, harvest exploitation rates are kept at relatively low levels in Washington State, consistent with the management goal of not impeding chinook recovery. The co-managers will attempt to incorporate management provisions that better protect at risk Washington chinook stocks from the impacts of Canadian and Alaskan fisheries in the future.

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Appendix G 2004 WDFW Hatchery Program Reductions

The following table describes the 2004 WDFW Hood Canal hatchery program reductions (numbers of fish released) by facility and summarizes the total production changes by species.

Facility	Species	Current	Reduction	New
George Adams	Chinook fing.	3,800,000	0	3,800,000
	Coho	500,000	200,000	300,000
	Fall Chum	5,000,000	5,000,000	0
	Trout	410,000	410,000	0
McKernan	Fall Chum	10,000,000	0	10,000,000
	S. Sound Chin. Yearl.	200,000	200,000*	0*
Eells Springs	Steelhead	50,000	50,000	0
Skok. System Total	Chinook fing.	3,800,000	0	3,800,000
	S. Sound Chin. yearl.	200,000	200,000*	0*
	Coho	500,000	200,000	300,000
	Fall Chum	15,000,000	5,000,000	10,000,000
	Steelhead	50,000	50,000	0
	Trout	410,000	410,000	0
Hoodsport	Chinook fing.	3,000,000	200,000	2,800,000
	Chinook yearl.	250,000	130,000	120,000
	Fall Chum	15,000,000	3,000,000	12,000,000
	Pink	1,000,000	500,000	500,000
Hood Canal Total	Chinook fing.	6,800,000	200,000	6,600,000
	Chinook yearl.	250,000	130,000	120,000
	S. Sound Chin. yearl.	200,000	200,000*	0*
	Coho	500,000	200,000	300,000
	Fall Chum	30,000,000	8,000,000	22,000,000
	Pink	1,000,000	500,000	500,000
	Steelhead	50,000	50,000	0
	Trout	410,000	410,000	0