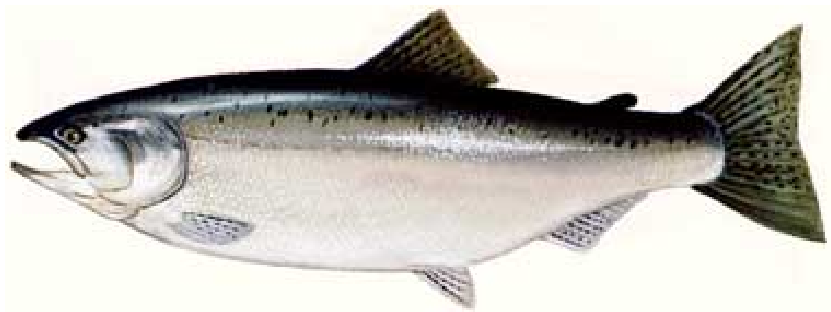

Skokomish River Chinook Salmon Recovery Plan

Skokomish Indian Tribe

Washington Department of Fish and Wildlife

December, 2007

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Introduction

On March 24, 1999, the National Marine Fisheries Service (NMFS) listed all naturally spawned populations of Chinook salmon (*Onchorhynchus tshawytscha*) and twenty-six artificial propagation programs within the Puget Sound evolutionarily significant unit (ESU) as a threatened species under the Endangered Species Act (ESA). This listing included Chinook populations of the Skokomish Watershed and those from the George Adams and Rick's Pond Hatcheries.[1] The threatened species status was reaffirmed on June 28, 2005.[2]

This listing under the ESA requires NMFS to develop and implement recovery plans for the conservation and survival of Chinook salmon within the Puget Sound ESU. The NMFS Puget Sound Technical Review Team (TRT) identified Hood Canal as one of five biogeographical regions within the Puget Sound ESU.[3] Each biogeographical region has unique physical and habitat features, including topography and ecological variations, where groups of Chinook salmon have evolved in common. Skokomish Chinook salmon, along with the Mid-Hood Canal stocks, are the two recognized independent populations within this region (Ruckelshaus et al. 2006). The recovery of two Hood Canal populations is essential for meeting their viability criteria for the long-term survival of the species in the Puget Sound ESU (Puget Sound Shared Strategy 2007).

This recovery plan was developed by the Skokomish Indian Tribe and the Washington Department of Fish and Wildlife. ,

Vision for Skokomish Salmon Recovery

Defining recovery goals, strategic objectives, and implementation actions within this recovery plan begins with establishment of a vision statement for the recovery region.

> *In the Skokomish Watershed, the co-managers will develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.*

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[1] The Hoodsport Hatchery was not included due its lack of an extant local natural Chinook salmon population.

[2] Federal Register, Vol. 64, No. 56, pp. 14308-14328 and Vol. 70, No. 123, pp. 37160-37204.

[3] The others include the Strait of Georgia, Strait of Juan de Fuca, Whidbey Basin, Central/South Sound

Realizing this vision means:

1. Achieving healthy and harvestable populations of listed and non-listed species,
2. Meeting the recovery goals for abundance, productivity, spatial distribution, and diversity for Chinook salmon and other ESA-listed species,[4]
3. Recognizing and preserving the social, cultural, and economic values derived from the Skokomish ecosystem by tribal and non-tribal communities.

The Skokomish Watershed's future condition will be determined by the vision of today. In order to reach desired conditions, there must be adequate and appropriate habitat for all salmonid life stages and free access to that habitat. Harvest must be at levels that do not diminish populations beyond their ability to sustain themselves. Hatcheries cannot contribute more risks than benefits to the ecosystem and the salmonid populations. Hydropower must protect, not diminish, Chinook salmon and other species.

Achievement of the desired future condition will be a long-term endeavor. However, the "future" within the context of this planning effort, can be defined within a 50-year timeframe. Within that period, actions taken will improve conditions for the key listed species. Rebuilding Skokomish River Chinook salmon is based on achieving defined recovery roles for habitat, hatcheries, harvest, and hydropower. Recovery roles for each "H" include strategic objectives that provide milestones that mark achievement of goals. Implementation actions achieve the strategic objectives, and eventually recovery goals.

Skokomish Watershed Salmon Recovery Goals

The long-term goals to accomplish within a 50-year timeframe for the Skokomish Watershed also guide short-term efforts as well. These long-term goals are:

Goals are general statements of how this plan will achieve the Vision for Skokomish Salmon

[4] Abundance, productivity, spatial distribution, and diversity are the four characteristics used to assess viable salmonid populations (VSP). More explanation is available in McElhany et al. 2000).

For Chinook salmon

- ➡ Provide for abundant, productive, and diverse self-sustaining Chinook salmon throughout its historical distribution in the watershed. The plan seeks to accomplish this goal by:

  a. Attaining abundances that are similar to those that occurred before extensive modification of the watershed in the last century (VSP Characteristic: Abundance);

  b. Expanding the abundance and distribution of naturally producing fall (later-retuning) Chinook salmon in the South Fork (VSP Characteristic: Abundance and Spatial Structure);

  c. Reestablishing a self-sustaining, natural population of early-returning Chinook salmon in the North Fork (VSP Characteristic: Diversity, Abundance, and Spatial Structure);

  d. Attaining productivities that assure a low risk of extinction of the populations (VSP Characteristic: Productivity); and

  e. Attaining productivities that assure sustainable harvest (VSP Characteristic: Productivity).

For other salmonids

- ➡ Provide significant contributions to reintroduce extirpated species and the recovery of other important species at risk and other key species that interact to support healthy salmonid ecosystems.

- ➡ Secure and enhance natural production of other salmonids.

- ➡ Assure that the economic, cultural, social, and aesthetic benefits derived from the Skokomish ecosystem will be sustained in perpetuity.

While many of the goals and subsequent actions identified in this plan may benefit all salmonids in the Skokomish Watershed, its primary intent is to focus on the restoration of Chinook salmon. A future comprehensive recovery plan eventually will be developed that addresses all salmonids in the watershed.

Skokomish Watershed Salmon Recovery Strategies

> Strategic objectives are specific, quantifiable, time-sensitive milestones that mark the path to successful achievement of goals.

Strategic objectives established for habitat, harvest, hatcheries, and hydropower create milestones for measuring the success of the plan in achieving the goals for Chinook salmon recovery. Specific discussion on each of these strategies and their implementation actions are presented in the habitat, harvest, harvest, hatchery, and hydropower chapters

Plan Format

In accordance with federal law, such plans minimally must incorporate the following elements:

- A description of site-specific management actions necessary to achieve recovery of the species,
- Objective, measurable criteria which, when met, would result in a determination that the species be removed from the list;
- Estimates of the time and costs required for achieving the plan's goal.[5]

Recovery plans must also incorporate the legal obligations incurred by the federal government through treaty rights reserved through the 1855 Treaty of Point No Point.[6] Furthermore, the plan must consider the impacts to other listed species within the watershed. Currently, this includes bull trout, summer chum, and steelhead.

The structure of this recovery plan focuses on meeting both ESA requirements and treaty obligations. The chapters include:

1. Chinook Salmon Profile
2. Habitat Recovery Strategy
3. Harvest Management Strategy
4. Hatchery Management Strategy
5. Hydropower Management Strategy
6. Integration of Habitat, Harvest, Hatchery, and Hydropower Strategies

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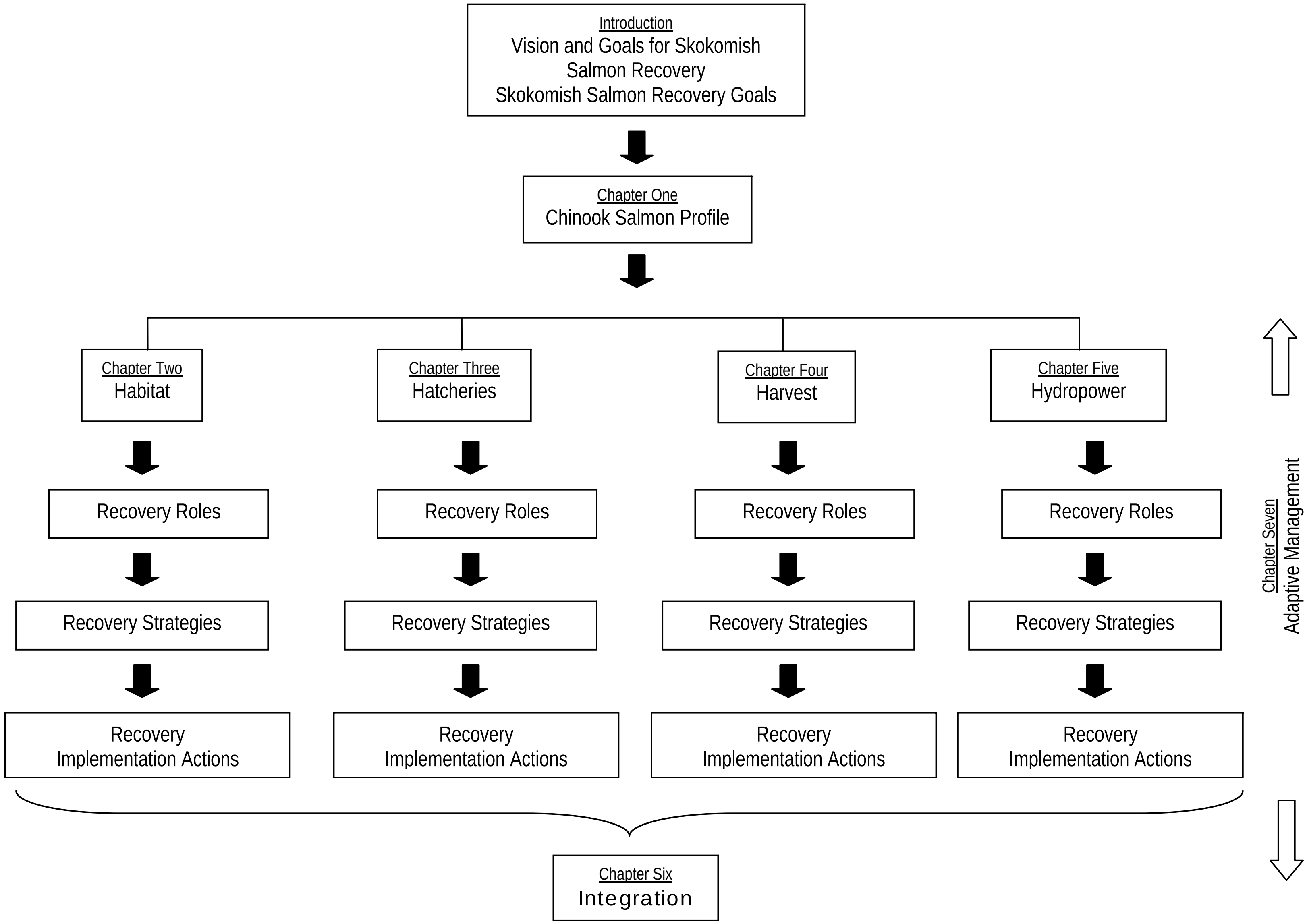
[5] Recovery of Species under the Endangered Species Act (ESA)
[6] Treaty with the S''Klallam, 1855.

7. Adaptive Management

Figure 1.1 illustrates how the vision, goals, and chapter in the plan relate to one another.

Additionally, four appendices provide contextual information specific to understanding the habitat, harvest, hatcheries, and hydropower chapters.

Figure 1.1. How the vision, goals, and chapters in the plan relate to one another.



Chapter One
Chinook Salmon Profile

Historically, the endemic Chinook salmon in the Skokomish Watershed included early returning spring runs. However, with construction of the Cushman dam, the introduction of hatcheries, habitat loss, and over-harvest, later returning summer/fall Chinook salmon now dominate the system.

This chapter profiles existing summer/fall and Lake Cushman Chinook as well as the extirpated run of spring Chinook.

Summer/Fall Chinook Salmon

The Salmon Stock Inventory (SaSI) 2006 identifies Skokomish fall Chinook salmon as a stock based on their distinct spawning distribution.

Fall Chinook currently returning to the watershed is an independent population composed of natural origin and hatchery-origin fish (WDFW and Puget Sound Treaty Tribes 2002 and Puget Sound TRT 2006). The Co-managers have recently initiated an effort to compile all available data needed to better estimate the proportions of natural-origin and hatchery-origin Chinook on the spawning grounds. From 1988 through 2006, preliminary estimates mostly range from about 20% to 80% hatchery-origin Chinook in the Skokomish River system natural escapement, with an average of about 60% (Draft PSIT and WDFW 2007).

Historically, there have been extensive transfers of Green River lineage Chinook salmon from South Puget Sound Hatcheries to Hood Canal hatcheries. Preliminary analysis of Skokomish basin adult spawners and juveniles suggests that the naturally spawning Chinook are largely, though perhaps not entirely, of George Adams and Hoodsport hatchery origin (Marshall 2000 cited in WDFW 2002).[7] Yet, there is evidence that since cessation of the transfers, subsequent Skokomish generations are now showing differences from South Puget Sound populations. This trend may possibly reflect some level of adaptations to local conditions or simply reproduction isolation (Marshall 2000).

Spawning currently occurs in the mainstem Skokomish up to RM 9.0, the South Fork primarily below RM 5.0, Vance Creek below RM 5.6, Purdy Creek, and in the North Fork below RM 16. Fall Chinook start returning to the system in late-July, with a majority of the run entering from mid-August to mid-September. Spawning occurs from September through October, with a peak in early-October. Skokomish Fall Chinook may also be straying to other watersheds in the

[7] From Hoodsport Fall Chinook HGMP 2002. Cites A. Marshall; page 9.

Hood Canal given the short distance between them. Smaller watersheds, such as the Dosewallips, Duckabush, and Hamma Hamma have Chinook spawners that may be largely driven by the Skokomish population or hatchery Chinook released in Hood Canal (Puget Sound TRT 2006).

Past studies found that the age of naturally spawning returning adults can vary from year to year. Table 1.1 shows the estimated percentage of returning adults by age group for the years 1992 through 2006.

Table 1.1. Age composition of Skokomish Chinook in the natural spawning escapement, 1992-2006 (Skokomish Chinook technical workgroup 2006)

Return Year	2-year old		3-year old		4-year old		5-year old		6-year old		
	No.	%	No.	%	No.	%	No.	%	No.	%	Total
1992	3	15.0%	3	15.0%	13	65.0%	1	5.0%	0	0.0%	**20**
1993	13	9.7%	42	31.3%	69	51.5%	10	7.5%	0	0.0%	**134**
1994	11	26.8%	11	26.8%	18	43.9%	1	2.4%	0	0.0%	**41**
1995	1	2.3%	26	60.5%	14	32.6%	2	4.7%	0	0.0%	**43**
1996	0	0.0%	2	18.2%	9	81.8%	0	0.0%	0	0.0%	**11**
1997	n/a		n/a		n/a		n/a		n/a		
1998	29	37.7%	37	48.1%	10	13.0%	1	1.3%	0	0.0%	**77**
1999	3	2.5%	84	70.6%	32	26.9%	0	0.0%	0	0.0%	**119**
2000	8	14.0%	5	8.8%	43	75.4%	1	1.8%	0	0.0%	**57**
2001	1	1.1%	58	65.9%	28	31.8%	1	1.1%	0	0.0%	**88**
2002	1	1.3%	24	32.0%	47	62.7%	3	4.0%	0	0.0%	**75**
2003	0	0.0%	21	27.3%	55	71.4%	1	1.3%	0	0.0%	**77**
2004	1	1.7%	17	28.3%	41	68.3%	1	1.7%	0	0.0%	**60**
2005	3	1.1%	127	47.4%	123	45.9%	15	5.6%	0	0.0%	**268**
2006	32	14.2%	39	17.3%	148	65.8%	6	2.7%	0	0.0%	**225**

Naturally spawned juvenile fall Chinook typically migrate to saltwater during the spring and early summer of their first year of life as fingerlings (Lestelle and Weller 1994). As with most Hood Canal and North Puget Sound fish, adults generally continue migration to the mouth of the Strait of Juan de Fuca and northern coastal areas of British Columbia, particularly in the Strait of Georgia, though as with adults, there is significant variation in juvenile and sub-adult life history trajectories. For example, we know that natural origin and wild origin Chinook juveniles have been documented in small tidal creek mouths and coastal lagoons interspersed along our marine shorelines (Hirschi et al. 2003), in addition to open shoreline and offshore areas (Bax et al. 1980). Further divergence in life history trajectories exists in sub-adult stages as Chinook are well known to residualize as blackmouth in Puget Sound and Hood Canal waters. Nearshore catches of juvenile Chinook occurred from March to June in two recent studies, though peak counts varied between April and June (Hirschi et al 2003, SAIC 2006). Finally, it is also clear that juveniles from other Chinook populations in the

Georgia Basin utilize Hood Canal's marine waters for rearing. Chinook salmon spawn naturally in the Skokomish River and return to George Adams Hatchery in the Skokomish watershed (Table 1.2).

Table 1.2. Natural and hatchery Chinook spawning escapement in the Skokomish watershed (SaSI 2002[8], Skokomish Chinook technical workgroup 2006)

Year	Natural Escapement	Hatchery Escapement	Total Escapement
1988	2,666	4,930	7,596
1989	1,204	2,556	3,760
1990	642	2,186	2,828
1991	1,719	3,068	4,787
1992	825	294	1,119
1993	960	612	1,572
1994	657	495	1,152
1995	1,398	5,196	6,594
1996	995	3,100	4,095
1997	452	1,885	2,337
1998	1,177	5,584	6,761
1999	1,692	8,227	9,919
2000	926	4,033	4,959
2001	1,913	8,816	10,729
2002	1,479	8,834	10,313
2003	1,125	10,034	11,159
2004	2,398	12,278	14,676
2005	2,032	16,018	18,050
2006	1,209	12,356	13,565

The escapement goal for Skokomish Chinook salmon is 3,650 adult spawners; 1,650 natural spawners and 2,000-hatchery spawners.

The Puget Sound Technical Recovery Team has not prepared escapement abundances and planning ranges for natural origin Skokomish Chinook salmon. If these numbers were available, it could represent the predicted equilibrium abundance associated with the habitat characteristics necessary for supporting a persistent population (Puget Sound TRT 2002).

[8] Estimates of naturally spawning Chinook salmon are based on counts of live spawners and/or redds in the mainstem and N.F. Skokomish from RM 2.2 to 15.6, S.F. Skokomish from RM 0.0 to 0.8 (or 2.2) , in Purdy Creek from RM 0.0 to 5.5, and in Hunter, Vance, and McTaggert creeks. Hatchery escapements are based on counts at the George Adams Hatchery rack at Purdy Creek, a lower Skokomish River Tributary. The total escapement values for this stock are the sums of the natural and hatchery escapements.

Spring Chinook Salmon

The Skokomish Watershed once supported diverse runs of spring Chinook salmon in the mainstem, North Fork and South Fork. Dechamps (1954 and 1957) reported that spring and summer fish were reported to have migrated upstream of Cushman Dam No. 1 on the North Fork Skokomish. Early spring runs used the upper and lower South Fork until the 1950s when abundance initially declined. Later spring runs continued to use the first five miles of the South Fork and thirteen miles of the North Fork when flows and habitat were suitable. However, as early as 1991, fisheries literature designated Skokomish spring Chinook salmon as extinct (Nehlsen et al. 1991) due to overfishing and dam construction (James 1980).

The Skokomish Watershed historically produced the largest population of natural spawning Chinook salmon of any system in Hood Canal. Lichatowich (1992) reviewed several methodologies estimating the pristine production estimates for the North Fork Skokomish. Table 1.3 contains those estimates Lichatowich relied on to develop his own estimates for total spring Chinook salmon production at a 70% harvest rate.[9]

Table 1.3. Estimated ranges of pristine production of spring Chinook salmon in the North Fork Skokomish River [10]

Author	Pre-Harvest Estimate	At 70% Harvest Rate
Lichatowich (1992)	30,000 – 60,000	9,000 – 18,000
James (1980)	60,605	1,820
Winter (1988)	32,420	9,726
Barr (1985)	66,750	20,025

Lake Cushman Chinook Salmon

A small, self-sustaining population of landlocked Chinook salmon exists above Cushman Dam No. 1 in the Lake Cushman Reservoir. Genetic analysis of the landlocked upper North Fork Chinook salmon failed to reveal stock origin. Sampled adults also exhibited limited genetic variability (Marshall 1995), which suggests that the stock has had persistently low abundance or started from a small number of founders. Kolb and Tweit (1993) speculate that these fish represent a unique, but fortuitous adaptation to the pre-inundated Lake Cushman or a more recently introduced stock.

[9] Lichatowich adjusted the estimates by James, Winter, and Barr to reflect total production, and in the case of Barr, to include the full length of the North Fork.
[10] Preseason Report I, Stock Abundance Analysis for 2006 Ocean Salmon Fisheries, Chapter I Abundance Projections

The Lake Cushman stock spawns in the North Fork between RM 28.2 and 29.9 during the month of November.

The co-managers have yet to determine stock status for Lake Cushman Chinook salmon. Under the ESA, all naturally produced fish listed as "threatened" require protection. The Northwest Fisheries Science Center considers Lake Cushman Chinook salmon to be part of the Puget Sound Chinook salmon ESU (Myers et al. 1998, NMFS 1999), but the Puget Sound Technical Recovery Team did not identify them as a remnant of the historical population or as a viable independent population (Puget Sound TRT 2006).

Chapter Two
Habitat Recovery Strategy

The Role of Habitat in Recovery

> Vision for Skokomish Salmon Recovery
>
> In the Skokomish Watershed, the co-managers will develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.
>
> Goals for Skokomish Salmon Recovery
>
> 1. Provide for abundant, productive, and diverse self-sustaining Chinook salmon throughout its historical distribution in the watershed. The plan seeks to accomplish this goal by:
>   a. Attaining abundances that are similar to those that occurred before extensive modification of the watershed in the last century;
>   b. Expanding the abundance and distribution of naturally producing fall (later-retuning) Chinook salmon in the South Fork;
>   c. Reestablishing a self-sustaining, natural population of early-returning Chinook salmon in the North Fork;
>   d. Attaining productivities that assure a low risk of extinction of the populations; and
>   e. Attaining productivities that assure sustainable harvest.
> 2. Provide significant contributions to reintroduce extirpated species and the recovery of other important species at risk and other key species that interact to support healthy salmonid ecosystems.
> 3. Secure and enhance natural production of other salmonids.
> 4. Assure that the economic, cultural, social, and aesthetic benefits derived from the Skokomish ecosystem will be sustained in perpetuity.

The role of habitat in achieving Chinook salmon recovery goals focuses on the hypothesis that restoring and protecting physical and biological processes within the Skokomish watershed will form and sustain habitat capable of fully supporting viable spring and summer/fall Chinook salmon populations.

This approach reflects the model that ecosystems are a dynamic interaction between spatial and temporal variations in the larger landscape. As vegetation, geology, climate, and gross reach morphology (controls) interface over time, they create variable natural processes that in turn result in a range of local environmental conditions. Salmon and Chinook salmon in particular, have adapted successfully to this range of historic environmental conditions (Beechie and Bolton 1999; Beechie et al. 2003).

The introduction of intensive land uses into the Skokomish Watershed after 1850 significantly altered the balance of how these natural processes formed habitat. Land uses substantially changed the frequency and magnitude of natural processes, creating a sea change in the basic functions of the ecosystem. The net impact of this altered environment has negatively affect the fitness and survival of Chinook salmon. Other salmonids, as well as many other animal and plant species, similarly have faired poorly within this altered ecosystem.

Within the marine and freshwater environment of the Skokomish Watershed, the habitat forming processes most disrupted by land use that result in the greatest impact to Chinook salmon viability include:

- Sediment Supply, Transport, and Distribution
- Riparian Function
- Hydrology/Tidal Prism
- Fluvial Geomorphology
- Fish Access/Habitat Connectivity

Habitat recovery strategies, therefore, promote restoration of disrupted natural processes, and conversely, protect those that remain intact.

Habitat Recovery Strategic Objectives

There are ten general strategic objectives for achieving the habitat goals for Chinook salmon recovery within the Skokomish Watershed and nearshore:

<u>Strategic Objective 1</u>: Restore and monitor habitat forming flow regimes and channel geometry

A key element to the overall restoration of natural processes that form essential habitat for Chinook salmon is the restoration of sufficient flows to the watershed. In the North Fork and mainstem Skokomish Rivers, the loss of habitat-forming flows from the Cushman Project have disrupted sediment supply, transport, and distribution; fluvial geomorphology; and habitat connectivity. Land cover changes in the upper South Fork and Vance Creek headwaters also create impacts on Chinook salmon through reduced summer flows and increases in magnitude, frequency, and duration of high flow events, effects which can be ameliorated by optimizing high forest cover and reducing impervious surfaces and ditches.

Restoration of flow regimes following a normal annual hydrograph will allow significant in-roads in restoring spatial structure within the watershed that will lead to increased abundance, productivity, and diversity for Chinook salmon.

Restoration of flows to historic conditions is not possible under current conditions. An adaptive management strategy involving oversight by a technical committee (including fluvial geomorphologists) will be essential to complete the strategy to coordinate development and implementation of flow patterns and ensure proper data collection and interpretation. It will be critical to monitor flows to determine if the forms and patterns of historic channel geometry are constructed and maintained. Such long-term oversight will facilitate recommendations for managing the intensity and frequency of flows necessary making appropriate adjustments to channel geometry.

Strategic Objective 2: Establish and implement a collaborative road map for consensual agreement between interested stakeholders and governments on restoration of floodplain and channel functions

While dikes, levees, and roads provide flood protection and transportation benefits to valley residents, they conversely diminish channel complexity and off-channel habitat for Chinook salmon, resulting in a loss of side channel habitat and access to floodplains. This loss has significantly affected the fitness and survival of salmon in the river. By restoring the historic fluvial geomorphology and floodplain and channel functions of the lower Skokomish River (including Vance Creek and other lower tributaries), Chinook salmon will regain spawning, rearing, and migratory habitat that has been lost. Devising and selecting appropriate approaches on how to return the river to a natural, productive, and sustainable course will be a challenging public process.

For any plan to succeed, it will need to detail where existing levees should be either setback or maintained, where flooding and channel avulsion risks are too high to afford the development of additional infrastructure, where and how channel capacity should be increased, and where and how to restore channel structures such as a complex channel network, habitat heterogeneity, and woody debris jams.

The US Army Corps of Engineers Skokomish River Basin Ecosystem Restoration and Flood Damage Reduction General Investigation seeks to find this common ground between salmon recovery and flood protection. The project focuses on developing remedial actions and finding common agreement among stakeholders in the valley regarding acceptable approaches for restoring a sustainable river channel capable of providing critical habitat for salmon.

This project is moving forward currently. However, if sufficient federal funding is not allocated to support the General Investigation, then a contingency plan will need to be developed to create the collaborative road map within five years.

<u>Strategic Objective 3</u>: Complete existing high priority projects for restoration of the Skokomish Estuary and develop and implement priorities for other identified nearshore and estuary projects in Hood Canal

The nearshore and estuary provide critical refuge, feeding, and rearing functions for juvenile Chinook salmon. However, filling, diking, and nearshore development and its impacts have eroded the capacity of these environments to provide this function for them. The Skokomish Delta has lost approximately 600 acres of saltwater marsh and associated channels. In addition to this direct loss of salmonid habitat, loss of marsh and tidal channels indirectly affects the food web in lower Hood Canal, sediment transport, formation of diverse habitat conditions, and marine water quality.

A major concern with Hood Canal is the deterioration of water quality, particularly in low dissolved oxygen levels. Restoring marsh habitat and the tidal prism will allow natural biological processes to improve water quality. This will require a wide array of projects that include the removal of dikes and levees in the delta to addressing the causes of water quality deterioration. These improvements will manifest themselves as direct benefits to increased productivity and abundance.

Many of the needed habitat restoration and conservation corrective actions have been previously identified and prioritized through workgroups, including the co-managers, coordinated by the Hood Canal Coordinating Council. Funded or completed projects in the watershed are noted in Appendix B. Besides the natal Skokomish estuary, as many as 300 other restoration and conservation corrective actions have been identified to move Skokomish Chinook salmon, Mid-Hood Canal Chinook salmon, summer chum salmon, steelhead trout, and other important aquatic species to a status of low risk of extinction. For recovery of these imperiled stocks, a long-term, strategic set of priorities for implementing this suite of nearshore actions will need to be developed based on a foundation of improved local and regional science.

<u>Strategic Objective 4</u>: Protect high quality habitat

Despite past and on-going degradation, high quality habitat still exists within the Skokomish Watershed. These areas can feature intact riparian zones, channel complexity, habitat connectivity to spawning and rearing habitat, near-normal hydrological function, and high water quality. This strategic objective seeks to ensure protection in upstream areas by maintaining the riparian reserve program in USFS reaches and also by protecting high quality and future potential high quality areas in the floodplain and estuarine reaches of the Skokomish Watershed. Protection can be achieved through promotion of good land stewardship by incentive or education, acquisition or conservation easements, as well as land use regulations.

High quality habitat teaches how natural processes historically created and maintained habitat for Chinook salmon within the Skokomish Watershed. It serves as a model for future restoration efforts.

Strategic Objective 5: Restore floodplain connectivity processes

Levees and other flood control measures in the mainstem Skokomish River have significantly altered fluvial geomorphology as a key habitat-forming process for Chinook salmon. Because these structures inhibit over-bank flow, side-channels, and channel migration, there is considerable loss of channel complexity and habitat connectivity. The impact to habitat has been a reduction in pool and secondary habitats and loss of fish access to off-channel, side-channel, and wetland habitats. The impact to fish has been a significant loss of spawning and rearing opportunities.

Of the many habitat restoration actions within the Skokomish Watershed, levee set back, modification or removal probably is one of the most controversial due to its potential high impact to private property and road systems. Although the US Corps of Engineers General Investigation remains a critical pathway for moving forward with this strategy, we should also continue to restore floodplain connectivity when and where it is appropriate as the Corps study proceeds.

Strategic Objective 6: Restore channel forming processes

Mainstem and tributary channels have been greatly simplified with loss of habitat complexity and function over the last century. As European settlement has occurred, upper watersheds have been impacted by resource extraction methods, and a hydroelectric facility has been built and operated. Channel forming processes include hydraulic forces created by woody debris and log jams, wood recruitment from intact riparian forests, lateral scour and migration from habitat-forming flow events, and sediment transportation and routing.

Although many corrective actions implementing this strategic objective can proceed immediately without delay (riparian forest restoration, woody debris loading, flow remediation, etc.), a thorough analysis will need to be completed (i.e. US Corps of Engineers General Investigation) and road map outlined so that we can affect channel processes holistically and in their proper sequence.

<u>Strategic Objective 7</u>: Restore fish access

The Lake Kokanee and Cushman Dams are complete barriers to historic fish spawning and rearing habitat in the North Fork Skokomish. Both dams currently lack structures or programs to facilitate fish passage upstream or downstream. If access were restored beyond these barriers, Chinook salmon would gain approximately 12 miles of spawning and rearing riverine habitat, along with access to tributaries and off-channel habitat. Lake Cushman, approximately 7 ½ miles in length, would also provide rearing opportunities. A final strategy for fish access restoration will be determined as part of the Cushman operations discussions (see Chapter 5 Hydropower).

Additional fish passage barriers exist in the Skokomish Watershed that must be retrofitted to ensure complete access. Examples include the McTaggert diversion and three culverts in the McTaggert and Gibbons Creek basin in the middle North Fork Skokomish.

<u>Strategic Objective 8</u>: Decommission roads and maintain and stabilize remaining road network in the upper watersheds

Erosion, mass wasting, altered sediment delivery, and altered hydrology resulting from extensive logging roads in private and public forestlands are contributing to the decline in aquatic functions in Vance Creek, the South and North Forks, and the mainstem Skokomish River. The impacts to Chinook salmon spawning and rearing areas are significant, with particular concerns around aggraded channels, low flows, erosion and scour of the substrate, and decreased water quality.

To overcome these disruptions, logging roads and associated ditchlines noted for high or medium aquatic risk should be decommissioned to reduce sediment loading. All roads in current use should be upgraded to comply with Forest Practices rules and regulations, with a comprehensive maintenance and stabilization work plan implemented.

Accomplishment of this strategic objective would benefit by long-term support for the Skokomish Watershed Action Team efforts in the upper watersheds.

<u>Strategic Objective 9</u>: Develop appropriately in the watershed to reduce habitat impacts to salmon

Land uses have manipulated the normal spatial and temporal variations in landscape processes (vegetation, geology, climate, and gross reach morphology). The deleterious nature of such impacts has been detrimental to Chinook salmon populations and other salmon stocks in the Skokomish Watershed.

Human development of the land undoubtedly will continue into the future, but it must occur without disrupting natural processes. Local, state, and federal governments can play a major role through development regulations and appropriate public facilities and infrastructure improvements. However, it will be the conscious, individual effort of every citizen with direct or indirect interest in the Skokomish Valley that will have the greatest impact. Recovery efforts need to emphasize the importance of helping people recognize their connection and responsibility not to just salmon specifically, but to the entire ecosystem as a whole.

Appropriate floodplain development should follow a reasoned development plan that strongly considers salmon recovery needs, flood risk, avulsion risk, agricultural opportunity, and transportation needs. A portion of this type of review is currently being conducted by the US Corps of Engineers General Investigation as led by project co-sponsors including Mason County and the Skokomish Tribe.

Strategic Objective 10: Work to understand the implications of global climate change on salmon recovery and to develop strategies to address potential habitat and flow effects.

The future for precipitation, temperature, and sea level are uncertain, though they are certain to change. Temperatures on a global scale are increasing, which will cause less precipitation to fall as snow. These additional rain and rain on snow events may cause increased peak flows, while less snow pack may decrease summer low flows and increase water temperatures. Sea levels may rise between 4 and 35 inches in lower Hood Canal, creating increased erosion on marine shorelines.

Additional work is needed to improve our knowledge of the consequences of global climate change in our local environment and to prepare and adapt our strategies and actions to address the causative mechanisms and their consequences. Continuing restoration work in upper watersheds to reduce the potential for mass wasting and erosion-driven delivery of sediments, as well as restoring channel complexity, channel capacity, and riparian quality in the upper and lower watersheds will help prepare for these changes and reduce their impacts. Local resource and land use authorities should work with the scientific community to disseminate and integrate information on these subjects as it becomes available.

Habitat Implementation Actions

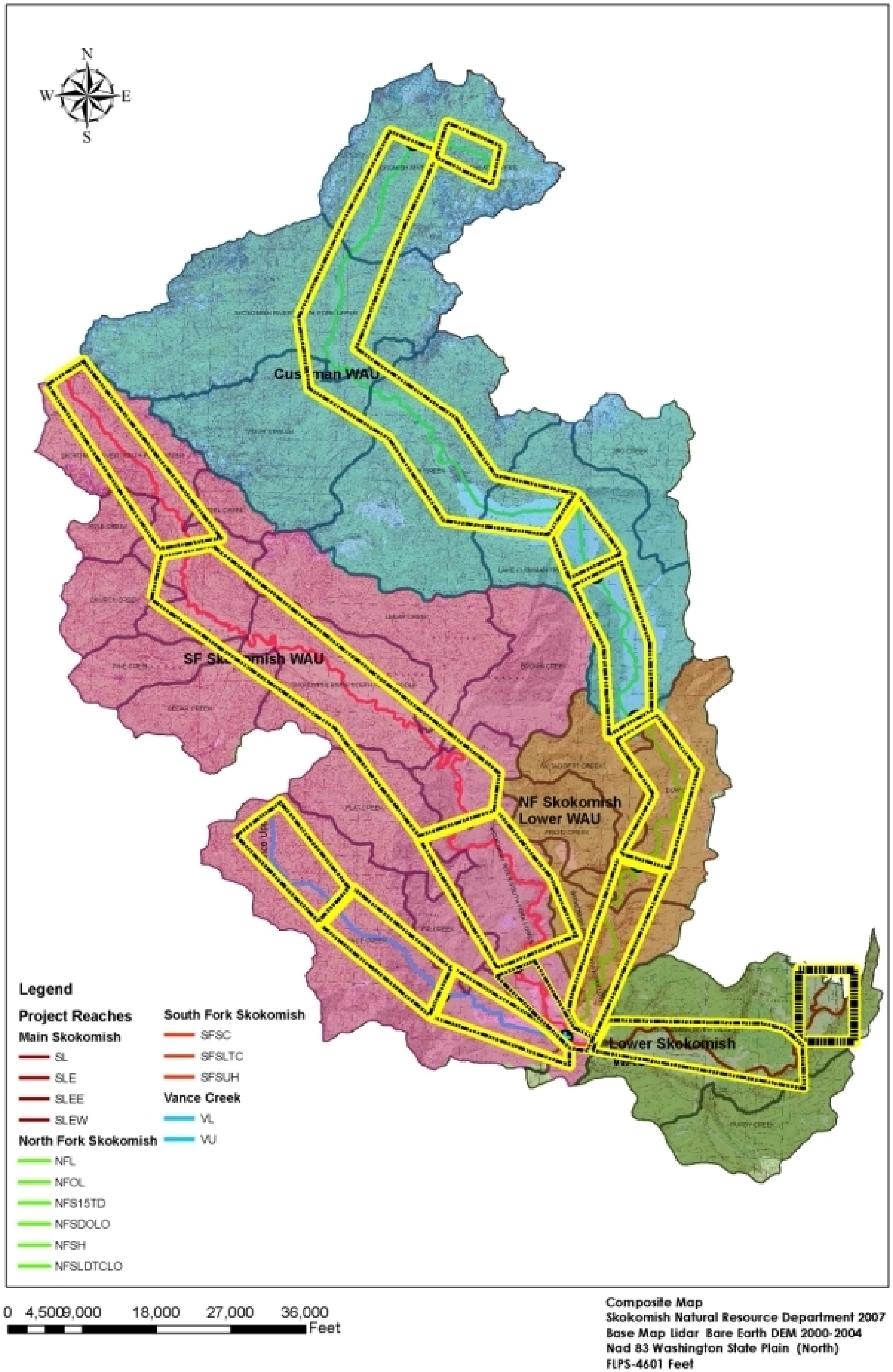
To meet the goals and strategies for restoring and protecting natural processes that create habitat for Chinook salmon within the Skokomish Watershed, this plan proposes a series of specific implementation actions on a reach-level scale.

Restoration actions seek to repair disrupted natural processes while protection actions preserve those that remain intact. Tables 2.1 through 2.12 on the following pages list those actions necessary for restoring or protecting natural processes, including (1) sediment supply, transport and distribution, (2) tidal prism, (3) freshwater hydrology, (4) riparian function, (5) water quality, (6) biological processes, and (7) channel complexity. The tables also describe, for each natural process, (1) the original conditions, (2) disruptions and resultant effects to fish abundance, productivity, spatial structure, and diversity, and (3) proposed recovery actions and anticipated benefits to fish. High priority projects have been previously identified through salmon habitat recovery strategy work of technical groups (e.g. HCCC salmon habitat strategy development, Limiting Factors Analysis) and are in various stages of project development or implementation. Other projects are not as developed, but are important to consider as opportunities to advance these projects emerge.

The process for selecting these actions involved analyzing original reach conditions (circa 1850) and evaluating current conditions as to whether they represent disrupted or intact natural processes.

The anticipated schedule for initiating and completing these actions extend over three distinct timeframes: Three to Five Years, Ten Years, and greater than Fifty Years. These schedules reflect both the complexity of the type of action and the time necessary to achieve the desired result.

Figure 2.1. Skokomish River Reaches identified in Tables 2.1 through 2.12



Nearshore Habitat Implementation Actions

The nearshore areas of Puget Sound and Hood Canal provide ecosystem services for Chinook salmon during the transitional period of their life histories. For some Chinook salmon, the nearshore serves as a migration corridor from natal spawning streams to the Pacific Ocean while others may spend their entire lives in inland marine waters, as in the case of residualized blackmouth.

The nearshore is the area of land and water lying between the forested uplands above marine shorelines, through the intertidal zone, and down into shallow water where light can penetrate to deliver energy to the food web. A complex interaction of dynamic physical, chemical, and biological processes form and maintain nearshore structures and functions that also can induce other processes.

Larger scale physical processes, such as continental uplift and glaciations, created the context for today's environment by laying the basis on which moderate scale processes can act. Examples of these moderate scale physical processes include sheet erosion, mass wasting, sediment supply, transport and deposition, wave energy, and tidal regimes. Upon this foundation, biological processes build additional structure and function in the nearshore through vegetation establishment and production. Examples include submerged aquatic vegetation beds and their epiphytes, intertidal salt marsh complexes, and shoreline/bluff riparian areas. Additional biological processes capture and distribute energy (i.e. trophic and predator/prey interactions) throughout the food web beyond that initial primary productivity. Often, complex interactions among various levels of processes must be present to provide the ecosystem services upon which various species depend. A prime example of this complexity is the requirement of tidal inundation, sediment supply, transport, and distribution, and water and substrate quality as affected by the biological production processes that produce overhanging vegetation, all critical to successful forage fish spawning in the upper intertidal areas of our inland marine shorelines.

Juvenile salmonids have been shown to depend on these nearshore habitats and processes for many aspects of their various life histories. Natal estuaries like the Skokomish delta provide four general functions for juvenile salmonids (Simenstad 1982; William and Thom 2001):

- Refuge from predation and extreme physical and chemical events
- Feeding opportunities and growth for successful rearing

- Mixing areas for fresh and salt waters that provide for a juvenile salmon's physiological transition through smoltification

- Migratory corridors

In addition to natal estuaries, juvenile Chinook inhabit non-natal stream deltas (both small and large), alongshore salt marsh complexes, and fringing, shallow water corridors (Hirschi et al. 2003; Beamer et al. 2003; Bahls 2004). They also use all critical habitats formed by shoreline and watershed processes found within estuarine, sub-estuarine, and nearshore environments. Open water habitats within Hood Canal, Puget Sound, the Strait of Juan de Fuca, and the Pacific Ocean are also important to Chinook salmon life histories during their marine phase of anadromy, within the context of these four general functions.

The Skokomish River delta is a key feature of the lower Skokomish. The boundary of this area roughly extends from Highway 106 to the east and south and Highway 101 to the west. There are approximately 990 acres of unvegetated tidal flats. Historically, vegetated wetlands covered another 519 acres before diking and flooding improvements in the late 1900's. The shape of the delta is typical of fjords; an isolated shallow region along a normally steep shoreline (Jay and Simenstad 1996).

Human settlement and the development of shoreline and watersheds have altered habitat forming processes and habitat structures both directly and indirectly. Nearshore stressors include shoreline modifications (bank armoring, jetties, groins, dikes, landfill, dredging, overwater structures), removal/degradation of riparian areas and woody debris on the beaches, eutrophication and decreased dissolved oxygen concentrations, stormwater and wastewater, food web impacts, toxins and other contaminants, and watershed erosion, among others. Other Chinook salmon recovery plans (South Sound 2005) and salmon habitat limiting factors analyses (Washington Conservation Commission June 2003) have developed and reviewed lists of nearshore stressors thoroughly, which will not be repeated here.

The biggest gap in proposing specific recommendations for actions that benefit Chinook salmon recovery in the Hood Canal nearshore is the lack of information about the linkages between fish and habitats and the relative importance of those linkages. Another informational gap focuses on the issue of the extent and location of nearshore habitat needed by Chinook salmon. However, significant certainty does exist regarding recommended actions in both natal and small and large, non-natal estuarine deltas, especially on recognized high-value actions, such as habitat connectivity. Actions with moderate certainty include high value projects such as marine riparian re-vegetation and existing vegetation protection in lower priority areas at greater spatial distances from natal watersheds, or vice versa low value actions closer to natal watersheds. At the other extreme end of the certainty spectrum are benefits from actions that are often only indirectly associated with Chinook salmon nearshore functions, such as soft shore stabilization alternatives that do not restore sediment or vegetation processes but have less impact than traditional (e.g. concrete bulkhead) alternatives.

To address these issues, this recovery plan prioritizes actions in the nearshore based on best available science and several conceptual models proposed for nearshore habitat conditions and alterations (South Puget Sound Recovery Plan 2005; HCCC 2005). Our approach is to restore habitat-forming processes within prioritized nearshore habitat areas.

- Priority 1 areas include estuarine deltas; tidal marsh complexes; eelgrass meadows; riparian areas; shallow water shorelines; and, water quality within five miles of natal Chinook salmon watersheds.

- Priority 2 areas include all other estuarine deltas, tidal marsh complexes, eel grass meadows, riparian areas, shallow water shorelines, and water quality.

- Priority 3 areas include all other habitats, except non-vegetated subtidal flats (Priority 4).

Non-physical-process oriented conditions that create direct mortality of juveniles or adults, such as derelict fishing gear, or hatchery competition/predation, are Priority 1 items as well.

The Washington Conservation Commission's salmon habitat limiting factors analyses prepared for WRIAs 15, 16, and 17 recommended nearly 300 site-specific actions for nearshore and estuary restoration that would reverse or minimize nearshore stressors. Migrating Skokomish Chinook salmon potentially encounter all of these areas. A geo-database maintained by the Hood Canal Coordinating Council spatially documents and organizes these 300 nearshore actions. Broader, basin-wide recommendations include:

- Protection/restoration of alongshore sediment supply, transport, and distribution

- Protection/restoration of large and small estuaries, deltas, and salt marsh complexes

- Protection/restoration of riparian structure and function

- Removal of intertidal fill, and protection from future shoreline modifications
- Improved treatment of stormwater, wastewater, toxins
- Removal of creosote piles and other abandoned piles
- Improved best management practices, including consolidation of docks, rail launches, stairs, etc; bulkhead replacement with soft bank technologies; mooring buoys; etc

Additional and/or complementary recommended actions to reverse or minimize affects of nearshore stressors were developed for the Hood Canal basin by Shared Strategy and the Puget Sound Action Team (Shared Strategy, 2005), including:

- Protect water quality, including improving dissolved oxygen levels
- Protect against catastrophic events such as oil spills
- Consider wastewater reclamation and reuse retrofits of all sewage discharges in lower Hood Canal
- Increase the tidal prism and estuarine connectivity at all Highway 101 river crossings in Hood Canal

Priority Protection Implementation Actions

Frissell et al. (2000) identified the Skokomish River Estuary (RM 0-6) as one of the more intact estuaries in Puget Sound and recommended it for protection under a Category 2 protection status. The estuary and this section of the river has altered conditions, but offers extensive areas of cedar wetland and other naturally forested wetlands used by all salmon species in the Skokomish system.

> Category 2: Priority refugia with altered ecological integrity.
>
> These areas are known to be somewhat altered from historic conditions, but at least some fish populations appear to be self-sustaining and resilient. These areas are not pristine, but frequently constitute the best of what salmon habitat remains within highly developed basins (Frissell et al. 2000).

Table 2.1. Nearshore, Marine Shorelines and Estuary to RM 1.5: Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution – Estuary
Original Conditions – Estuary Estuarine sediments are recruited from the watershed, transported back and forth within the estuarine delta by freshwater (gravity) and saltwater (tidal) forces, and distributed in the intertidal within mudflats and salt marsh complexes and in the subtidal on the mudflats and delta face. These fine sediments are important for supporting vegetation communities (both vascular and algal), benthic invertebrates, migrating salmonids, and the marine food web.
Disruptions • Distribution of sediments is drastically altered from original conditions as decreased flows and diking/channeling have disconnected estuarine marshes and fine sediment deposition. This has also steepened and reduced in magnitude the face of the Skokomish delta, reducing eel grass abundance and thus critical early rearing habitats. • Sediment supply to the estuary has been modified by increased coarse and fine materials from uplands management/road failures, though these coarse sediments have been accumulating in the lower river valley so far due to decreased flow conditions from the Cushman project. Reduced flow conditions also decrease sediments available to the estuarine wetlands, which changes physical habitat and plant and invertebrate communities supporting juvenile salmonids, and threatening their long-term viability.
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Loss of life history trajectories

Table 2.1 Continued

Sediment Supply, Transport, & Distribution – Estuary
Recovery Actions Three- to Five-Year Actions • Estuarine Dike Removal on Nalley Island Slough and east cell. Restoration of critical salt marsh, tidal channels, and intertidal estuarine habitat for fish and shellfish. Improved sediment distribution should improve flood conditions and Hood Canal water quality as well as salmon recovery. Areas to be restored include dikes and fill on both sides of the estuary and on the island. • Assess need for additional logjams at head of Nalley Island to maintain two distributary channels. • Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Flow restoration will assist in sediment transport and distribution, and will thus help recover estuarine wetlands. Ten-Year Actions • Assess opportunity to remove or bridge sections of the river road levee and increased logjam densities to increase water and sediment distribution over the estuarine wetlands • Assess need for further conservation of Tahuya River estuarine wetlands
Benefit to Fish Abundance • Increased survival Productivity • Increased amount and quality of rearing habitat Spatial Structure • Distribute juveniles over a larger area Diversity • Increased opportunity for various life history trajectories

Sediment Supply, Transport, & Distribution – Marine Shorelines
Original Conditions – Marine Shorelines Shoreline sediments are recruited mostly from the shorelines themselves during both chronic and acute erosional episodes, as well as from adjacent watersheds. Sediment transport is driven primarily by wind, wave, and tidal action, with cumulative movement driven by the predominant wind direction, in a process called littoral drift. These gravels, sands, and fines are transported along the middle to upper intertidal fringe until they are ultimately deposited in either an accretion shoreform (spits, tombolos, simple linear beaches) or are driven offshore to subtidal areas out of the littoral drift cell. This process is important in maintaining shoreline structure and providing functions for forage fish spawning and salmon rearing and migration.

Table 2.1 Continued

Sediment Supply, Transport, & Distribution – Marine Shorelines

Disruptions

- Distribution of sediments is drastically altered from original conditions as sediment recruitment/supply from marine shorelines has been interrupted by shoreline modifications such as armoring, jetties, landfill, and dredging. Sediment transport is also affected by these shoreline modifications in that there is less to transport and the modified shoreline interrupts drift cell transport both actively and passively. Final deposition of these sediments is significantly altered from less available sediments and shoreline modifications associated with historic accretion shoreforms. The process driving this, wind and wave action, remains intact, so addressing shoreline modifications could be a successful approach to restoring sediment distribution.

Effect to Fish

<u>Abundance</u>

- Reduced chances of spawning over time reduces the number of fish
- Limited ability to rear and grow reduces the number of fish

<u>Productivity</u>

- Reduced quality and quantity of spawning and rearing habitat

<u>Spatial Structure</u>

- Loss of access to some types of habitat for adults and juveniles

<u>Diversity</u>

- Loss of life history trajectories

Recovery Actions

<u>Three- to Five and Ten Year Actions</u>

- Shoreline areas east and north of the Skokomish delta have been significantly modified, with some shorelines suffering 100% armoring and many accretion shoreforms diminished or vanished. Assess opportunities to restore shoreline functions through process replacements such as beach nourishment with gravel and sand and softshore protections.
- Develop and begin to implement a Hood Canal-wide nearshore restoration strategy, building on efforts by HCCC.
- Dewatto shorelines are relatively functioning now and should be protected from additional shoreline modifications.
- Hoodsport shorelines are also significantly altered by modifications, though process restoration is feasible in places such as Potlach State Park through fill removal and beach nourishment.
- Generally throughout the Canal, protect functioning drift cells and restore processes where possible. Process replacements may be necessary in some areas.

Table 2.1 Continued

Sediment Supply, Transport, & Distribution – Marine Shorelines
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Increased amount and quality of rearing habitat • Increased carrying capacity of Marine shorelines Spatial Structure • Distribute juveniles over a larger area Diversity • Increased opportunity for various life history trajectories

Freshwater Hydrology
Original Conditions Freshwater hydrologic regimes control/affect marine waters and habitats through freshwater/saltwater interchange processes in Hood Canal, sediment deposition in estuaries and delta faces, and beach habitat and organism complexity through freshwater seeps. Freshwater mixing provides for an osmoregulatory transition for salmon smoltification.
Disruptions • Hydrologic cycles have been modified to show higher winter flows and lower summer flows as a result of forest management and impervious areas, which affects both small and large basins. • High flows alter geomorphology and can deposit sediments in marine areas over eelgrass and shellfish beds. Low flows can disconnect freshwater and saltwater bodies, directly limiting fish access and fish habitat. • The Cushman project has removed flow from the basin in volume, location, and timing, potentially affecting marine cycling and water quality. This has also decreased eelgrass beds in the Skokomish delta. This may also alter fish migratory pathways. • Construction of shoreline modifications such as landfill, bulkheading, riparian degradation, and de-watering affect the flow of freshwaters onto the beach face, decreasing habitat and organism diversity.
Effect to Fish Abundance • Eliminates habitat thereby reducing the number of fish Productivity • Reduces the quality and quantity of habitat for spawning due to reduced flows Spatial Structure • Loss of access to habitat types • Habitat loss due to reduced flows Diversity • Favors only a limited number of individuals and life stages

Table 2.1 Continued

Freshwater Hydrology

Recovery Actions

Three- to Five and Five + Year Actions

- Increase forest hydrologic maturity and conifer density
- Decrease impervious build-out, attempting to maintain less than 8% watershed imperviousness
- Manage stormwater so that sediments and contaminants are not carried into the marine waters at a rate higher than natural
- See Cushman Project modification above
- In addition to armoring discussion above in shoreline sediment supply, improve best management practices to improve freshwater hydrology on beach faces.
- Daylight lower Minerva Creek and restore connectivity

Benefit to Fish

Abundance

- Reduced mortality impact to juveniles

Productivity

- Restores the quality and quantity of habitat

Spatial Structure

- Regains habitat and access to that habitat, to distribute juveniles over a larger area

Diversity

- Improving habitat conditions likely will increase life history trajectory alternatives

Tidal Prism

Original Conditions

The tidal prism (tidal inundation and associated forces moving sediments and water across the intertidal face) provided a linkage between riverine and tidal forces that allowed intertidal habitats (lower channel mainstem, delta faces, blind tidal channels) to be formed and maintained. These diverse habitats in the estuary support a complex nutrient and food web beneficial to salmonids.

Disruptions

- Diking and channeling has restricted the tidal prism to a smaller portion of the former estuary, resulting in changes in sediment size and distribution, channel development, complexity, and connectivity, vegetation communities, biological processes, water quality, and fish access. Approximately 600 acres have been lost in the Skokomish Estuary, while many other areas in adjacent shorelines have also been impacted.
- Road building associated with Tacoma Power towers has altered tidal channels and the flow of sediment and water.
- The Northshore Road (Tahuya) and SR101 (Lilliwaup) have filled over salt marsh habitat and tidal/distributary channels, thereby decreasing available habitat and forcing migrating salmonids into a single channel.
- An illegal and abandoned development plan in the Dewatto River estuary has filled and diked critical salt marsh habitats, decreasing tidal/distributary channels from two to one. The tidal prism (tidal inundation and associated forces moving sediments and water across the intertidal face) providesa linkage between riverine and tidal forces that allows intertidal habitats (lower channel mainstem, delta faces, blind tidal channels) to be formed and maintained. These diverse habitats in the estuary support a complex nutrient and food web beneficial to salmonids

Table 2.1 Continued

Tidal Prism
Effect to Fish Abundance • Eliminates habitat thereby reducing the number of fish Productivity • Reduces the quality and quantity of habitat for rearing, distributing juveniles over a smaller area Spatial Structure • Loss of access to habitat • Reduces quality of habitat Diversity • Favors only a limited number of individuals and life stages
Recovery Actions Three- to Five-Year Actions • See Estuarine Dike Removal above • Reconnection of freshwater wetlands and side channels in upper estuary to support floodplain connectivity, increase available rearing habitat for salmonids • Remove fill and levee in Dewatto River estuary Five to Ten-Year Actions • The access road to the Tacoma Power towers should be improved or removed. Long-term planning should route towers onto SR101 and SR106. • Assess need to lengthen bridge span on Northshore Road in Tahuya River estuary to increase tidal prism and restore to two tidal/distributary channels • Assess need to lengthen bridge span on SR101 in Lilliwaup River Estuary to increase tidal prism and restore to two tidal/distributary channels
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Restores the quality and quantity of habitat Spatial Structure • Regains habitat and access to that habitat, to distribute juveniles over a larger area Diversity • Increased opportunity for various life history trajectories

Table 2.1 Continued

Riparian Function

Original Conditions

Vegetation communities in both estuarine and shoreline habitats provide for multiple processes, structure, and functions on which marine food webs and salmonids depend. For example, estuarine communities may develop as a result of change from emergent and forested freshwater marshes to low growing salt marsh communities, providing a diversity of habitats. Shoreline vegetation is usually a fringe of trees, shrubs, herbs, and grasses that also provide multiple functions. Historically, nearly all non-estuarine marine shorelines were loaded with downed trees, while most estuaries were also well supplied with wood from watershed sources. Riparian benefits include protection of water quality, slope and soil stability, organic, nutrient and invertebrate production, shade, microclimate (temperature, humidity), LWD recruitment and habitat structure, and wildlife habitat, among others.

Disruptions

- Levees have removed tidal prism, directly changing estuarine marshes into agricultural fields, which don’t provide similar riparian functions for fish.
- Marine edges in both the estuary and shorelines of Hood Canal have been cleared of vegetation in intertidal supratidal, bluff, and above bluff areas, significantly reducing functions provided.
- Lack of LWD on our beaches from human management of shorelines has resulted in loss of habitat diversity, cover and other functions critical to migrating and rearing juvenile salmonids.
- Decreased shading of upper intertidal areas impacts microclimate of beaches and reduces the efficacy of forage fish spawning.
- Most landslides are caused or at least affected by clearing for buildings and views.

Effect to Fish

Abundance

- Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity

- Survival reduced due to water temperature increases
- Reduction in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity

Spatial Structure

- Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity

Diversity

- Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity
- Reductions in abundance and productivity over time reduce diversity

Table 2.1 Continued

Riparian Function
Recovery Actions Three- to Five-Year and Ten-Year Actions • Provide incentives to protect intact riparian habitat through voluntary landowner agreements or conservation easements • Encourage best management practices through voluntary and regulatory programs • Replant native vegetation in areas where natural, habitat-forming processes can be recovered, or where enhancement of function and structure is available • Build on the HCCC's Marine Riparian Initiative • Continue trainings, outreach, and education for county planning staff, NGO and agency staff, volunteers, contractors, and landowners • Monitor and enforce easements and regulatory protections
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity • Improvements in shoreline complexity and structure • Increased forage fish success and greater Chinook salmon foraging opportunities Spatial Structure • Improves the quality of habitats throughout Marine Waters, and fish distribution over a larger area Diversity • Increased opportunity for various life history trajectories

Water Quality
Original Conditions Historically, properly functioning conditions in marine water quality provided an appropriate climate for juvenile and adult salmonids and their prey.
Disruptions Currently, marine water quality is significantly degraded as a result of natural and anthropogenic mechanisms that have decreased the availability of dissolved oxygen, and increased toxic substances and contaminants in the aquatic environment. Increased availability of nutrients can lead to eutrophy in marine receiving waters. Increased solar radiation from decreased riparian canopy cover has the ability to increase sediment and fringing water temperatures. Contaminants (including toxics) bioaccumulate in higher trophic levels of the predator-prey cycle and could decrease fitness in salmonids.

Table 2.1 Continued

Water Quality
Effect to Fish <u>Abundance</u> • Survival impact to juveniles, as well as growth impacts limiting fitness <u>Productivity</u> • Impacted food webs that could limit carrying capacity by decreasing growth rates • Toxic burden that could limit productivity <u>Spatial Structure</u> • Areas of poor water quality could limit juvenile fish distribution <u>Diversity</u> • Differentially impact various life history trajectories
Recovery Actions <u>Three- to Five-Year Actions</u> • Assess the impacts to salmonids from the decreasing marine water quality in Hood Canal • Assess the causative mechanisms for decreasing eelgrass conditions in Hood Canal • See riparian projects above • Continue outreach and education efforts to inform watershed residents of their impacts • Encourage best management practices • See stormwater management in freshwater hydrology above • Continue to address wastewater improvements • Support efforts of the Hood Canal Dissolved Oxygen Program to identify and develop corrective actions for water quality issues <u>Ten-Year Actions</u> • Continue to implement identified actions
Benefit to Fish <u>Abundance</u> • Increased growth and survival <u>Productivity</u> • Improved impacted food webs that could be limiting carrying capacity • Improve toxic burden that could be limiting productivity <u>Spatial Structure</u> • Improved areas of poor water quality that could be limiting juvenile fish distribution <u>Diversity</u> • Increased opportunity for various life history trajectories

Table 2.1 Continued

Biological Processes
Original Conditions Transformation and distribution of energy between and within primary, secondary, and tertiary producers and consumers drives the marine food web. Wood structure, vegetation communities, and open water habitats provided media for primary production, energy then transferred to consumers such as zooplankton, benthic invertebrates, shellfish, and prey fish. This energy was then used for other critical biological processes, such as reproduction, which then led to more food available for consumption by juvenile and adult salmonids. A strong Interdependency evolved within these food webs. Salmonid species were faced with inter and intraspecific predation and competition with other salmonids, but population characteristics evolved to "correct" themselves as a natural outcome of predation and competition interactions.
Disruptions • Our understanding of many of these food webs is fairly limited still, though several significant disruptions are well documented. • Vegetation communities along our streams and marine shorelines have been heavily impacted in quantity and quality, reducing food web robustness and connections. • Shoreline structure in the form of downed large woody debris has been nearly completely removed from shoreline intertidal reaches and estuaries, reducing surface area for primary production and secondary consumption, affecting immature salmonids prey base. • Open water habitats may be changing as a result of altered nutrient pathways and community assemblages, with the result bringing alterations to the marine food web, and possible disruptions to salmonid foraging. • Hatchery practices have dramatically increased the number of competitors and predators on juvenile salmonids, altering population equilibrium and interactions.
Effect to Fish <u>Abundance</u> • Survival impact to juveniles, as well as growth impacts limiting fitness <u>Productivity</u> • Impacted food webs that could limit carrying capacity by decreasing growth rates <u>Spatial Structure</u> • Decreased habitat complexity decreases spatial distribution <u>Diversity</u> • Differentially impact various life history trajectories

Table 2.1 Continued

Biological Processes
Recovery Actions Three- to Five and Five + Year Actions • See all actions under Riparian Function • In addition, restore lost woody structure on beach faces and in estuaries where appropriate • Assess the impacts of the changing marine food web on juvenile salmon, in a related effort to first action under Water Quality above • Assess inter- and intra-specific predation and competition as a related action to hatchery adaptive management plans • Continue nutrient enhancement in upper watershed • Pull pilings in marine waters
Benefit to Fish Abundance • Increased growth and survival Productivity • Improve impacted food webs that could limit carrying capacity • Address hypotheses of predation and competition Spatial Structure • Restore habitat distribution and complexity Diversity • Increased opportunity for various life history trajectories

Channel Complexity Functions
Original Conditions Wood recruitment, vegetation development, and channel meandering create and maintain complex habitats and distributary meandering channels, areas required for salmon rearing and migration.
Disruptions Channels have been straightened and simplified
Effect to Fish Abundance • Survival impact to juveniles, as well as growth impacts limiting fitness Productivity • Impacted food webs that could limit carrying capacity by decreasing growth rates Spatial Structure • Decreased habitat complexity decreases spatial distribution Diversity • Differentially impact various life history trajectories

Table 2.1 Continued

Channel Complexity Functions
Recovery Actions Three- to Five and Five + Year Actions • Improve channel complexity of Skabob Creek by adding LWD and riparian plantings. • Assess need for similar efforts and other fresh water and tidal sloughs. Re-meander if feasible and appropriate.
Benefit to Fish Abundance • Increased growth and survival Productivity • Restores the quality and quantity of habitat • Increases carrying capacity Spatial Structure • Distributes juveniles over a larger area Diversity • Increased opportunity for various life history trajectories

Mainstem Skokomish River Implementation Actions

The lower Skokomish River is 9.0 miles from the mouth of the estuary to the confluence of the North and South Forks at an elevation of approximately 50 feet. The low-gradient mainstem drains nearly 18 square miles in area. In this section, implementation actions for the Mainstem Skokomish River (RM 1.5 – RM 9.0) will be considered.

Under normal water conditions, tidal influence extends upriver to approximately river mile 3.0 in the mainstem Skokomish River

Six tributaries contribute another 11.3 stream miles to the mainstem. The four main tributaries are:

- Purdy Creek joins the mainstem at RM 3.6 and is the largest of these tributaries. It flows for about four miles and drains an area of around six square miles. The Washington Department of Fish and Wildlife operates the George Adams Hatchery on Purdy Creek at RM 1.0, which is now a barrier to fish access. Historically, a natural, impassable falls at RM 1.8 prevented anadromous fish use beyond this point.

- Spring-fed Weaver Creek flows for 1.3 miles in the agriculturally dominated Skokomish floodplain and joins the mainstem at RM 4.1. McKernan Hatchery is approximately at RM 2.0 .

- Hunter Creek, also spring-fed, flows for about 3.5 miles through mostly farmland before joining the mainstem at RM 6.3. Eells Springs Hatchery is approximately at RM 2.5.

- Richert Springs is a spring-fed system of channels that merge with the mainstem at RM 8.0. Historically, this area was part of the mainstem. Flood events and gravel aggradation on the South Fork caused flows in the North Fork to back up, breach a dike, and then flow into Richert Spring The mouth of the North Fork Skokomish is considered now at RM 8.0

The USGS gauge located at RM 5.3 reports a mean discharge rate of 1,212 cfs for water years 1943-2005. The highest annual mean was 1,993 cfs in 1999 and the lowest annual mean was 635 cfs in 1977. The lowest daily mean of 99 cfs occurred on November 7, 1987 and the highest daily mean of 30,000 cfs occurred on December 20, 1994.

Priority Protection Implementation Actions

Frissell et al. (2000) identified the Richert Springs Complex and Mainstem Skokomish River (RM 7.0 to 8.0) under a Category 2 status. This area has a series of large natural springs as well as floodplain channels and ponds that receive heavy use by salmon and steelhead. Currently, the riverbed has relatively clean and stable gravel and thermally buffered flows.

> Category 2: Priority refugia with altered ecological integrity.
>
> Category 2 areas are known to be somewhat altered from historic conditions, but at least some fish populations appear to be self-sustaining and resilient. These areas are not pristine, but frequently constitute the best of what salmon habitat remains within highly developed basins (Frissell et al. 2000).

Table 2.2. Mainstem Skokomish River, RM 1.5 to RM 9.0 (Confluence of North and South Forks of the Skokomish River): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions High sediment load from Vance Creek and the SF Skokomish River. Abundant storage in bars and floodplain areas. Large gravels and cobbles drop out in upper reaches of the mainstem with the smaller sediments being sorted throughout the mainstem until only fine sediments making their way to the estuary.
Disruptions Sediment load increased due to hill slope and streambank erosion in the Vance Creek and South Fork Skokomish watersheds associated with forest management, including implementation of road networks. Large volumes of sediment are not easily transported through the mainstem. Cushman Project on the NF Skokomish River removes the flow from the North Fork that is needed in the mainstem to transport sediments leading to reach wide aggradation particularly near the confluence of the NF and SF Skokomish (~RM 9.0). Dikes disrupt lateral channel movement and valley floodplain processes, adding to the aggradation problem disrupting.
Effect to Fish <u>Abundance</u> • Degradation of spawning habitat by sediment accumulation has reduced chances of spawning over time and decreased the number of fish • Limited ability to rear and grow reduces the number of fish <u>Productivity</u> • Reduced amount and quantity of spawning and rearing habitat <u>Spatial Structure</u> • Loss of access to some types of habitat for adults and juveniles <u>Diversity</u> • Lose life history traits (timing), especially for spring Chinook

Table 2.2 Continued

Sediment Supply, Transport, & Distribution
Recovery Actions Three- to Five-Year Actions • Assess, stabilize, abate, and monitor fine and coarse sediment sources: a. Reduce sediment from roads b. Avoid timber harvest on steep slopes c. Remove/repair logging roads d. Monitor bed scour (multiple tributaries) and bed stability e. Assess impacts and determine alternatives for improving excessive gravel conditions in South Fork Skokomish and Vance Creek Cushman Project Operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Flow restoration will assist in sediment transport and distribution in the mainstem. Ten-Year Actions Develop and implement a strategy of controlled or managed freshets flow to restore historic sediment transport capacity. To avoid even more severe flooding problems, restoration of controlled freshets flows may require dredging of the mainstem downstream of the junction of the North and South Forks or other structural measures. Fifty-Year+ Actions • Develop a strategy to address flows needed to restore salmon habitat and to maintain historical salinities on the delta.
Benefit to Fish Abundance • Increased chances of spawning over time increases the number of fish Productivity • Increased amount and quantity of spawning and rearing habitat Spatial Structure • Access to a greater number of types of habitat for adults and juveniles Diversity • Gain in life history traits (timing), especially for spring Chinook salmon

Table 2.2 Continued

Large Woody Debris (LWD)
Original Conditions Large volume of LWD in the mainstem of the Skokomish River in log jams and forested islands due to upstream and adjacent riparian forests. Centuries of log aggradation that aided in island formation and complex/side channels.
Disruptions Reduced LWD recruitment potential from upstream sources due to widespread riparian harvest in Vance Creek and the SF Skokomish and their tributaries. Recruitment potential from the North Fork Skokomish River cut off with the development of the Cushman Project. LWD is not recruited or delivered from the NF Skokomish River to the mainstem below the dam. LWD was removed completely during the log drives at the beginning of the century and has been continually removed since them by local residents for flood control, commercial purposes, fence posts, and firewood. In the last decade, small logjams of LWD are starting to develop in the mainstem. Old growth LWD is scarce, with most LWD comprised of smaller pieces except for some large cottonwood which are taking the place of the old growth conifer recruitment.
Effect to Fish <u>Abundance</u> • High mortality impact to juveniles <u>Productivity</u> • Reduced quantity and quality of spawning and rearing habitat • Pushes juveniles to less desirable habitats • Lowers carrying capacity of river • Redds more susceptible to bed scour • Increases competition for some species <u>Spatial Structure</u> • Loss of quantity and quality of pools that result in fewer habitat types • Loss of access to other habitats (floodplain connectivity) <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions <u>Three- to Five-Year Actions</u> • Riparian corridor restoration/enhancement (Summer Chum Conservation Initiative, Bull Trout Recovery Plan, HCCC Salmon Strategy) to restore riparian forests in the Skokomish Valley floodplain supporting future wood recruitment and maintenance of channel complexity and channel sinuosity. • Plant and maintain riparian areas on both public and private properties; encourage forestry rather than conversion • Place conservation easements along the riparian corridor and reestablish riparian zone in floodplain tributaries • Protect intact habitat • Add instream wood strategically in conformance with the results of the General Investigation.

Table 2.2 Continued

Large Woody Debris (LWD)
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Increased amount and quantity of spawning and rearing habitat • Provides juveniles with desirable habitats • Increases carrying capacity of river • Loss of quantity and quality of habitat • Reds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat units • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Table 2.2 Continued

Hydrology
Original Conditions Flows moderated due to heavily forested basin upstream. Flows still somewhat variable due to upstream valley confinement, high gradients, and a high percentage of the basin in the rain- or snow-zone. Dissipated flows and decreased velocity as a result of the connected floodplain and complex channels in the Mainstem.
Disruptions Flow intensity from the South Fork Skokomish and Vance Creek increased due to road network and forest harvesting. Erosion processes accelerated with depositional landforms eroded. The removal of the NF Skokomish River flows with the development of the Cushman Project negatively impacted many of the natural processes of the mainstem Skokomish River including sediment and LWD routing and maintenance of floodplain and estuary habitats.
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to reduced flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to reduced flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions <u>Three to Five Year Actions</u> • Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the North Fork Skokomish River. Flow restoration will assist in sediment transport and distribution, and will help restore channel conveyance, to provide sediment migration flows, fish migration flows, increased spawning and rearing area, and to enhance fish and wildlife and water quality. • Ramping rates should also be managed to protect North Fork Skokomish aquatic resources from rapid increase is and decreases in flow regimes. Ten Year+ <u>Actions</u> • Develop and implement a strategy of controlled or managed freshets to restore channel conveyance, to provide sediment migration flows, fish migration flows, increased spawning and rearing area, and to enhance fish and wildlife and water quality. <u>Fifty-Year+ Actions</u> • Develop a strategy to address flows to maintain historical salinities and the delta.

Table 2.2 Continued

Hydrology
Benefit to Fish Abundance • Restores habitat for a greater number of fish Productivity • Restores the quality and quantity of habitat for spawning at original flow levels Spatial Structure • Regains access to habitat Diversity • Favors a greater number of individuals and life stages

Fluvial Geomorphology
Original Conditions Fluvial river system. Large channel migration zone and floodplain. Heavy sediment and LWD loading from upper watersheds and adjacent areas but abundant storage of sediment and LWD in bars, forested islands and other floodplain areas. Presence of side channels.
Disruptions Increase in sediment load from logging and road activities. Dike construction and filling of wetlands/side channels has reduced mainstem interaction with the floodplain. Large volumes of sediment are not easily transported through the mainstem. Cushman Project on the NF Skokomish River removes the flow from the North Fork that is needed in the mainstem to transport sediments leading to reach wide aggradation particularly near the confluence of the NF and SF Skokomish (~RM 9.0). Road network reduces channels in the valley.
Effect to Fish Abundance • Loss of juvenile rearing and adult migratory, holding and spawning habitats Productivity • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats Spatial Structure • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles Diversity • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook

Table 2.2 Continued

Fluvial Geomorphology

Recovery Actions

<u>Three- to Five-Year Actions</u>

- Develop a hydraulic model that explains the geomorphology of the valley, models action alternatives, and implements preferred or selected alternatives
- Remove or set back levees and dikes following a strategic, comprehensive restoration plan. May include: Culvert dikes to allow controlled flow through to overflow channels; road retrofitting, relocation, or removal.

<u>Ten-Year Actions</u>

- Restore hydrology to encourage channel formation

Benefit to Fish

<u>Abundance</u>

- Restores juvenile rearing and adult migratory, holding, and spawning habitats

<u>Productivity</u>

- Increases spawning and rearing habitat quality
- Increased carrying capacity of rearing habitats

<u>Spatial Structure</u>

- Removes barriers that limit upstream distribution of spawners and juveniles

<u>Diversity</u>

- Increases diversity due to removal of migration barriers to available habitats in upstream reaches
- Gain of life history traits, especially for spring Chinook

Table 2.2 Continued

Riparian Function

Original Conditions

Old growth riparian forest and heavily forested floodplain including forested islands, wetlands, and beaver ponds.

Disruptions

All original riparian forests removed due to conversion to agriculture and residential development. Remaining buffers are narrow and mixed hardwoods and conifer reducing potential LWD delivery and effectiveness.

Effect to Fish

<u>Abundance</u>

- Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

<u>Productivity</u>

- Survival reduced due to water temperature increases
- Reduction in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity

<u>Spatial Structure</u>

- Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity

<u>Diversity</u>

- Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity
- Reductions in abundance and productivity over time reduce diversity

Recovery Actions

<u>Three- to Five-Year Actions</u>

- Plant and maintain riparian areas on both public and private properties; encourage forestry rather than conversion
- Protect intact habitat

Benefit to Fish

<u>Abundance</u>

- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

<u>Productivity</u>

- Survival rates increase due to cooler water temperature
- Increase in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity

<u>Spatial Structure</u>

- Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity

<u>Diversity</u>

- Diversity improves due to increase in the quality habitats that contribute to abundance and productivity
- Improves abundance and productivity over time that contributes to diversity.

Table 2.2 Continued

Fish Access and Habitat Connectivity
Original Conditions Perennial flow. Spring Chinook salmon move through this reach from March through August to their spawning areas in the NF Skokomish and SF Skokomish Rivers. Juvenile rearing in side channels and floodplains created through habitat complexity.
Disruptions Access is available but may be affected in mid to late summer by low streamflow and subsurface conditions in the upper mainstem Skokomish River affecting early returning adults and movement and rearing of juvenile salmonids.
Effect to Fish <u>Abundance</u> • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon <u>Productivity</u> • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity <u>Spatial Structure</u> • Barriers preventing upstream migration of adult salmon force distribution into lower stream reaches, affecting salmon abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. <u>Diversity</u> • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure
Recovery Actions <u>Ten-Year Actions</u> • Develop a comprehensive plan to address sediment aggradations. Restoration of controlled freshet flows would probably require dike setback or removal and dredging of the mainstem. • Assess potential to restore access to stream channels upstream of the Eel Springs Hatchery intake on Swift Creek. • Restore fish passage, within Ten-acre Creek and Purdy Creek above hatchery: one at George Adams Hatchery, two undersized culverts upstream of the hatchery on Skokomish Valley Road and a driveway culvert on the ditched section. • Assess potential to restore access to wetlands upstream of McKernan Hatchery.

Table 2.2 Continued

Fish Access and Habitat Connectivity

Benefit to Fish

<u>Abundance</u>

- Opens suitable habitat beyond barriers for increased Chinook salmon production

<u>Productivity</u>

- Increases Chinook salmon utilization in lower stream reaches
- Increased nutrients provided from salmon carcasses from upstream areas improves stream productivity

<u>Spatial Structure</u>

- Removes barriers preventing upstream migration of adult salmon
- Reduces competition and risk to the population from environmental factors

<u>Diversity</u>

- Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed
- Diversity increases due to gain of spatial structure

North Fork Skokomish River Implementation Actions

The North Fork Skokomish, actually a continuance of the mainstem, becomes distinguishable as a separate section at RM 9.0 and flows for another 29 miles upstream to its headwaters in the Mount Skokomish-Mount Stone area. The total drainage area of the North Fork is approximately 118 square miles.

At RM 17.3, Tacoma Power's Cushman Dam No. 2 creates the first impassable fish barrier on the North Fork. Built in 1930, the 235-foot dam creates Kokanee Reservoir, which at its fullest is 480 feet in elevation, about 150 acres in surface area, 4½ miles of shoreline, and two miles in length. Penstocks from Kokanee Reservoir divert approximately 96% of the North Fork flow directly to turbines at the powerhouse located at Highway 101. The powerhouse then discharges water directly into Hood Canal, thereby completely removing these flows from the Skokomish Watershed. In 1988, Tacoma Power began the release of 30 cfs into the North Fork per agreement with WDOE and increased this amount to 60 cfs in 1999 voluntarily.

As the North Fork gains elevation, it becomes a free-flowing river again for about 1½ mile. At RM 19.5, Cushman Dam No. 1 rises 175 feet above the riverbed to create the 4,010-acre Cushman Lake Reservoir at a maximum elevation of 738 feet. The dam, built and operated since 1925 by Tacoma Power, has created a reservoir of 9.6 miles in length with 23 miles of shoreline. Inundation by the dam eliminated the historic 400-acre Lake Cushman, approximately 11.5 miles of river channel, and all of the associated floodplains. At RM 28, the North Fork once again becomes a free-flowing river for the next 13 miles to its headwaters in the Mount Skokomish and Mount Stone area.

The USGS gauge located at RM 10.1 (1.1 miles above the confluence) reports a mean discharge rate of 117 cfs for water years 1944-2005. The highest annual mean was 311 cfs in 1951 and the lowest annual mean was 36.6 cfs in 1977. The lowest daily mean of 1.4 cfs occurred on September 14, 1951 and the highest daily mean of 6,630 cfs occurred on November 4, 1955.

The USGS gauge located below the Cushman Dam at RM 16.5 reports a mean discharge rate of 56.9 cfs for water years 1988-2005. The highest annual mean was 117 cfs in 1996 and the lowest annual mean was 33.1 cfs in 1989. The lowest daily mean of 4.9 cfs occurred on June 14, 1988 and the highest daily mean of 3,570 cfs occurred on December 19, 1995.

The USGS Staircase gauge located at RM 29.2 reports a mean discharge rate of 510 cfs for water years 1924-2005. The highest annual mean was 762 cfs in 1999 and the lowest annual mean was 256 cfs in 1930. The lowest daily mean of 17 cfs occurred on September 23, 1930 and the highest daily mean of 9,980 cfs occurred on November 3, 1955.

The only major tributary of the North Fork below Cushman Dam No. 2 is McTaggert Creek, which joins the North Fork at RM 13.3. This creek is 5.6 miles in length and has a two important tributaries Frigid and Gibbons Creeks. Upriver from Cushman Dam No. 1, the North Fork has an extensive network of tributaries.

Table 2.3. North Fork Skokomish River, Confluence to Lower End of Canyon (RM 9.0 to RM 15.5): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution

Original Conditions

- Efficient sediment transport through reach
- Moderate sediment supply.
- Sediment load tempered by upstream lake
- Alluvial fan in lower ¾ mile

Disruptions

- Alluvial fans at all tributary junctions due to low flows
- Tributaries supply limited sedimentation (plus bank erosion)
- Average size of sediments coming into the system is smaller

Effect to Fish

Abundance
- Reduced chances of spawning over time reduces the number of fish
- Limited ability to rear and grow reduces the number of fish

Productivity
- Reduced amount and quantity of spawning and rearing habitat

Spatial Structure
- Loss of access to some types of habitat for adults and juveniles

Diversity
- Lose life history traits (timing), especially for spring Chinook

Recovery Actions

Three- to Five-Year Actions
- Assess, stabilize, abate, and monitor fine and course sediment sources
  a. Reduce sediment from roads
  b. Avoid timber harvest on steep slopes
  c. Remove/repair logging roads
  d. Monitor bed scour (multiple tributaries) and bed stability
- Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Optimal releases for sediment movement in the Main Stem would be a discharge down the North Fork which, when combined with the South Fork flows maintains as high a discharge as possible from the Main Stem without inducing flooding (estimated at about 5,000 cubic feet per second)

Table 2.3 Continued

Sediment Supply, Transport, & Distribution

Benefit to Fish

Abundance
- Increased chances of spawning over time increases the number of fish

Productivity
- Increased amount and quantity of spawning and rearing habitat

Spatial Structure
- Access to a greater number of types of habitat for adults and juveniles

Diversity
- Gain in life history traits (timing), especially for spring Chinook salmon

Large Woody Debris

- High LWD loading in log jams, side channels and exposed bars.
- Forested islands, particularly in lower reach alluvial fan.

Disruptions

- Upstream sources eliminated
- Large, complex log jams eliminated
- Riparian conditions degraded

Effect to Fish

Abundance
- High mortality impact to juveniles

Productivity
- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

Spatial Structure
- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

Diversity
- Favors only a limited number of individuals and life stages

Table 2.3 Continued

Large Woody Debris
Recovery Actions Three- to Five-Year Actions • Restore lost LWD supply Ten-Year Actions • Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat.
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Increased amount and quantity of spawning and rearing habitat • Provides juveniles with desirable habitats • Increases carrying capacity of river • Loss of quantity and quality of habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat units • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Hydrology
Original Conditions • High percentage of basin in rain on snow zone and heavily forested. • Glacial stream • Original lake moderated peak flows • Natural flows provided efficient sediment transport • Bank erosion and channel migration provided woody debris input and created and maintained complex habitat. • Peak flows likely ranged between 20,000 – 35,000 cfs.
Disruptions • Transport of LWD and sediment limited because of reduced flow and lower gradient • Loss of floodplain connectivity and spawning/rearing habitat due to low flows • Elimination of channel forming flows • Periodic, excessive non-ramped flows that flush eggs and strands fish • Natural hydrograph gone. Most of natural flow removed out of basin. Minimum flows of 30 cfs (1988) and 60 cfs (late 1990's)

Table 2.3 Continued

Hydrology

Effect to Fish

Abundance
- Eliminates habitat thereby reducing the number of fish

Productivity
- Reduces the quality and quantity of habitat for spawning due to reduced flows

Spatial Structure
- Loss of access to habitat types
- Habitat loss due to reduced flows

Diversity
- Favors only a limited number of individuals and life stages

Recovery Actions

Ten Year+ Actions
- Develop and implement a strategy of controlled or managed freshets to restore channel conveyance, to provide sediment migration flows, fish migration flows, increase spawning and rearing area and to enhance fish and wildlife and water quality.

Benefit to Fish

Abundance
- Restores habitat for a greater number of fish

Productivity
- Restores the quality and quantity of habitat for spawning at original flow levels

Spatial Structure
- Regains access to habitat

Diversity
- Favors a greater number of individuals and life stages

Fluvial Geomorphology

Original Conditions
- Recessional outwash floodplain with complex habitat included forested islands, side channels and large log-jams.
- Coarse sediment provided Chinook salmon spawning habitat.
- Alluvial fan in lower ¾ mile.

Disruptions
- Decrease in channel width
- Alluvial fan complex at mouth eliminated – from several channels to just two
- Loss of original floodplains due to low flows and lack of high flows
- Loss of channel complexity and sinuosity
- Channels lack wood of adequate diameter

Table 2.3 Continued

Fluvial Geomorphology

Effect to Fish

Abundance
- Loss of juvenile rearing and adult migratory, holding and spawning habitats

Productivity
- Spawning and rearing habitat quality reduced
- Reduced carrying capacity of rearing habitats

Spatial Structure
- Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles.

Diversity
- Reduces diversity due to migration barriers to available habitats in upstream reaches
- Loss of life history traits, especially for spring Chinook

Recovery Actions

Three- to Five-Year Actions
- Protect intact habitat

Ten-Year Actions
- Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat.

Benefit to Fish

Abundance
- Restores juvenile rearing and adult migratory, holding, and spawning habitats

Productivity
- Increases spawning and rearing habitat quality
- Increased carrying capacity of rearing habitats

Spatial Structure
- Removes barriers that limit upstream distribution of spawners and juveniles

Diversity
- Increases diversity due to removal of migration barriers to available habitats in upstream reaches
- Gain of life history traits, especially for spring Chinook

Table 2.3 Continued

Riparian Function
Original Conditions Old growth riparian forests with forested islands. Hardwoods and mixed forested in floodplain areas and areas of active channel migration.
Disruptions • Floodplain invaded by alder forests due to lack of flow regime • Moved from large conifer to small diameter alder (outcome is simplified channels) • Loss of forested islands • Loss of riparian function (add to other riparian disruptions)
Effect to Fish <u>Abundance</u> • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Survival reduced due to water temperature increases • Reduction in quality rearing habitat (pools) affects carrying capacity and productivity. • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity <u>Spatial Structure</u> • Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity <u>Diversity</u> • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity
Recovery Actions <u>Three- to Five-Year Actions</u> • Riparian corridor restoration/enhancement to restore riparian forests for supporting future wood recruitment and maintenance of channel complexity and channel sinuosity • Protect intact habitat

Table 2.3 Continued

Riparian Function

Benefit to Fish

Abundance
- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity
- Survival rates increase due to cooler water temperature
- Increase in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity

Spatial Structure
- Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity

Diversity
- Diversity improves due to increase in the quality habitats that contribute to abundance and productivity.
- Improves abundance and productivity over time that contributes to diversity

Table 2.3 Continued

Fish Access and Habitat Connectivity
Original Conditions Spring and summer/fall Chinook salmon accessed this reach during all months of adult migration (March through December)
Disruptions • Dam on Lake Kokanee creates lowest fish barrier • Little Falls now major barrier because of low flows • Alluvial fans create fish barriers for coho and Chinook salmon (McTaggert and unnamed tributaries)
Effect to Fish <u>Abundance</u> • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no anadromous Chinook salmon <u>Productivity</u> • Limits anadromous Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity. <u>Spatial Structure</u> • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. <u>Diversity</u> • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure
<u>Ten-Year Actions</u> • Remove McTaggert Creek Diversion Dam, along with replacement of upstream culverts, to restore natural flow regime and habitat processes and to provide fish passage past culverts and diversion dam. • Replace or improve three culverts (McTaggert & Givens Creeks), along with McTaggert Creek diversion, to restore natural flow regime and habitat processes and to provide fish passage past culverts and diversion dam. • Provide full fish access to historical spawning and rearing habitat upstream/downstream of Cushman Project to restore of anadromous fish to the basin.

Table 2.3 Continued

Fish Access and Habitat Connectivity

Benefit to Fish

Abundance
- Opens suitable habitat beyond barriers for increased Chinook salmon production

Productivity
- Increases Chinook salmon utilization in lower stream reaches
- Increased nutrients provided from salmon carcasses from upstream areas improves stream productivity

Spatial Structure
- Removes barriers preventing upstream migration of adult salmon
- Reduces competition and risk to the population from environmental factors

Diversity
- Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed
- Diversity increases due to gain of spatial structure

Table 2.4. North Fork Skokomish River, Canyon Reach (RM 15.5 – RM 19.8): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Includes Little Falls (RM 15.6), Lake Kokanee (150 acres impounded by Cushman Dam No. 2 at RM 17.3), Big Falls (RM 18.3) , a short free-flowing stretch and lower Lake Cushman (RM 19.8). "Canyon Reach" begins just downstream of Little Falls and ends just upstream of Cushman Dam No.1. Over 50% of 4.3 mile reach flooded by reservoirs.

Sediment Supply, Transport, & Distribution
Original Conditions • Sediment efficiently routed through canyon • Reach composed of large rocks and cobbles. Most spawning size gravels transported through to lower reach.
Disruptions • Stored behind dam; sediments cannot move past (however, the original lake stored sediments as well) • Starved of smaller fine sediments • Larger cobbles are not moved due low flows
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Lose life history traits (timing), especially for spring Chinook
Recovery Actions Three- to Five-Year Actions • Assess, stabilize, abate, and monitor fine and coarse sediment sources • Reduce sediment from roads • Avoid timber harvest on steep slopes • Remove/repair logging roads • Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Optimal releases for sediment movement in the Mainstem would be a discharge down the North Fork which, when combined with the South Fork flows maintains as high a discharge as possible from the Main Stem without inducing flooding (estimated at about 5,000 cubic feet per second)

Table 2.4 Continued

Sediment Supply, Transport, & Distribution
Benefit to Fish Abundance • Increased chances of spawning over time increases the number of fish Productivity • Increased amount and quantity of spawning and rearing habitat Spatial Structure • Access to a greater number of types of habitat for adults and juveniles Diversity • Gain in life history traits (timing), especially for spring Chinook salmon

Large Woody Debris
Original Conditions • Wood jams likely present at falls and cascades • Wood transported to lower stream reaches and important for channel maintenance and development and floodplain processes
Disruptions • Upstream sources eliminated due to dams/reservoirs and timber harvests • Potential for logjams and wood transport severely limited
Effect to Fish Abundance • High mortality impact to juveniles Productivity • Reduced quantity and quality of spawning and rearing habitat • Pushes juveniles to less desirable habitats • Lowers carrying capacity of river • Redds more susceptible to bed scour • Increases competition for some species Spatial Structure • Loss of quantity and quality of pools that result in fewer habitat types • Loss of access to other habitats (floodplain connectivity) Diversity • Favors only a limited number of individuals and life stages
Recovery Actions Three- to Five-Year Actions • Assess feasibility of placing logs in the canyon reach for natural redistribution downstream within the reach to mitigate for loss of upstream LWD transport and supply

Table 2.4 Continued

Large Woody Debris
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Increased amount and quantity of spawning and rearing habitat • Provides juveniles with desirable habitats • Increases carrying capacity of river • Loss of quantity and quality of habitat • Reds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat units • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Hydrology
Original Conditions • High percentage of basin in rain on snow zone and heavily forested • Glacial stream • Original lake moderated peak flows • Natural flows provided efficient sediment transport through canyon • Peak flows likely ranged between 15,000 – 31,000 cfs
Disruptions • More than half this reach flooded by Lake Kokanee and Lake Cushman • Transport of LWD and sediment limited because of reduced flow and lower gradient • Loss of rearing and migration habitat due to low flows • Elimination of channel forming flows • Periodic, excessive non-ramped flows that flush eggs and strands fish • Natural hydrograph gone. Most of natural flow removed out of basin. Minimum flows of 30 cfs (1988) and 60 cfs (late 1990’s) • Majority of peak flows below 500cfs with occasional peaks from 1500 cfs to 3700 cfs

Table 2.4 Continued

Hydrology
Effect to Fish Abundance • Eliminates habitat thereby reducing the number of fish Productivity • Reduces the quality and quantity of habitat for spawning due to reduced flows Spatial Structure • Loss of access to habitat types • Habitat loss due to reduced flows Diversity • Favors only a limited number of individuals and life stages
Recovery Actions Ten Year+ Actions • Develop and implement a strategy of controlled or managed freshets to restore channel conveyance, to provide migration flows, increase spawning and rearing area, to enhance fish and wildlife and water quality, and slow the process of rising groundwater levels.
Benefit to Fish Abundance • Restores habitat for a greater number of fish Productivity • Restores the quality and quantity of habitat for spawning at original flow levels Spatial Structure • Regains access to habitat Diversity • Favors a greater number of individuals and life stages

Fluvial Geomorphology
Original Conditions • No channel migration zone present • Single thread channel, moderately steep made up of small falls (Big and Little Falls), cascades, chutes and pools • Large cobble and boulders dominate • Steep canyon walls
Disruptions • Channel geometry relatively unchanged • Cascades and small falls exist • Big Falls inundated by under upper end of Lake Kokanee

Table 2.4 Continued

Fluvial Geomorphology
Effect to Fish Abundance • Loss of juvenile rearing and adult migratory, holding and spawning habitats Productivity • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats Spatial Structure • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles. Diversity • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook
Recovery Actions Ten-Year Actions • Assess feasibility of placing logs in the canyon reach for natural redistribution downstream within the reach to mitigate for loss of upstream LWD transport and supply).
Benefit to Fish Abundance • Restores juvenile rearing and adult migratory, holding, and spawning habitats Productivity • Increases spawning and rearing habitat quality • Increased carrying capacity of rearing habitats Spatial Structure • Removes barriers that limit upstream distribution of spawners and juveniles Diversity • Increases diversity due to removal of migration barriers to available habitats in upstream reaches • Gain of life history traits, especially for spring Chinook

Riparian Function
Original Conditions • Steep hills and canyon walls with primarily coniferous forests • Low to moderate potential for LWD delivery due to low erosional potential and channel movement in the canyon
Disruptions • Below lake, logging has left second growth riparian forests, primarily conifer. • Some logging occurring adjacent to and within riparian forests

Table 2.4 Continued

Riparian Function

Effect to Fish

<u>Abundance</u>
- Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

<u>Productivity</u>
- Survival reduced due to water temperature increases
- Reduction in quality rearing habitat (pools) affects carrying capacity and productivity.
- Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity

<u>Spatial Structure</u>
- Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity

<u>Diversity</u>
- Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity
- Reductions in abundance and productivity over time reduce diversity.

Recovery Actions

<u>Three- to Five-Year Actions</u>
- Riparian corridor restoration/ enhancement to restore riparian forests for supporting future wood recruitment and maintenance of channel complexity and channel sinuosity

<u>Ten-Year Actions</u>
- Place conservation easements along the riparian corridor and reestablish riparian zone

Benefit to Fish

<u>Abundance</u>
- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

<u>Productivity</u>
- Survival rates increase due to cooler water temperature
- Increase in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity

<u>Spatial Structure</u>
- Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity

<u>Diversity</u>
- Diversity improves due to increase in the quality habitats that contribute to abundance and productivity.
- Improves abundance and productivity over time that contributes to diversity

Table 2.4 Continued

Fish Access and Habitat Connectivity
Original Conditions • Chinook salmon delayed at Little Falls (RM 15.6) and at Big Falls (~RM 18.3) • Snow melt provided passage flows for Chinook salmon at falls. • Primary spring Chinook salmon spawning areas upstream of canyon, both above and below original lake
Disruptions • Current Chinook salmon distribution ends at Little Falls (RM 15.6) due to upstream diversion causing low flows [August through October]. • Small numbers of coho and steelhead utilize the reach between Little Falls RM 15.6) and Lake Kokanee Dam (RM 17.4). • No fish passage beyond Lake Kokanee Dam (RM 17.4) • All Chinook salmon spawn below Little Falls. • Spawning habitat scarce in the short reach between Little Falls and Dam #2 (Lake Kokanee)
Effect to Fish <u>Abundance</u> • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon <u>Productivity</u> • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity <u>Spatial Structure</u> • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. <u>Diversity</u> • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure
Recovery Actions <u>Three to Five Year Actions</u> • Develop and implement habitat restoration strategy, primarily through mitigation associated with Cushman operations (Fish Habitat/Restoration Plan) to enhance aquatic habitat in the NF Skokomish and provide access to spawning habitat in Cushman and Kokanee tributaries.

Table 2.4 Continued

Fish Access and Habitat Connectivity
Benefit to Fish <u>Abundance</u> • Opens suitable habitat beyond barriers for increased Chinook salmon production <u>Productivity</u> • Increases Chinook salmon utilization in lower stream reaches • Increased nutrients provided from salmon carcasses from upstream areas improves stream productivity <u>Spatial Structure</u> • Removes barriers preventing upstream migration of adult salmon • Reduces competition and risk to the population from environmental factors <u>Diversity</u> • Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed • Diversity increases due to gain of spatial structure

Table 2.5. North Fork Skokomish River, Canyon Reach (Lower Cushman Dam) to Original Lake Outlet (RM19.8 – RM 23.8): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions • Moderate sediment supply. • Sediment load tempered by upstream lake • Channel erosion and migration provided sediment inputs into this reach.
Disruptions • Entire reach now inundated by Lake Cushman • Sediment supply eliminated • Sediment transport capacity eliminated
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Lose life history traits (timing), especially for spring Chinook
Recovery Actions Three to Five Year Actions • Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Optimal releases for sediment movement in the Main Stem would be a discharge down the North Fork which, when combined with the South Fork flows maintains as high a discharge as possible from the Main Stem without inducing flooding about 5,000 cubic feet per second. Ten-Year Actions • Investigate the feasibility and transport potential of placing sediment below Lake Kokanee (Dam #2) to mitigate for eliminated sediment supply to downstream reaches.

Table 2.5 Continued

Sediment Supply, Transport, & Distribution

Benefit To Fish

<u>Benefit of recovery actions would accrue to reaches of the North Fork and Skokomish River mainstem below the Cushman project.</u>

<u>Abundance</u>

- Increased chances of spawning over time increases the number of fish.

<u>Productivity</u>

- Increased amount and quantity of spawning and rearing habitat

<u>Spatial Structure</u>

- Access to a greater number of types of habitat for adults and juveniles

<u>Diversity</u>

- Gain in life history traits (timing), especially for spring Chinook salmon

Large Woody Debris

Original Conditions

High LWD loading in logjams, side channels and on exposed bars. Forested islands and likely beaver habitat in off channel areas such as side channels and forested wetlands.

Disruptions

- Upstream sources for reaches below the Cushman project eliminated due to dams/reservoirs and timber harvests
- Large, complex log jams eliminated
- Some recruitment into Lake Cushman from lake shores and upper NF Skokomish River, but no downstream transport mechanism

Effect to Fish

<u>Abundance</u>

- High mortality impact to juveniles

<u>Productivity</u>

- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

<u>Spatial Structure</u>

- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

<u>Diversity</u>

- Favors only a limited number of individuals and life stages

Recovery Actions

No LWD recovery actions since the entire reach is inundated.

Table 2.5 Continued

Large Woody Debris
Benefit to Fish N/A

Hydrology
Original Conditions • High percentage of basin in rain on snow zone and heavily forested • Glacial stream • Original lake moderated peak flows • Natural flows provided efficient sediment transport. • Bank erosion and channel migration provided woody debris input and created and maintained complex habitat. • Peak flows range between 12,000 - 29,000 cfs.
Disruptions • Loss of floodplain due to reservoir inundation • Elimination of mainstem, floodplain and lower tributary (Big Creek) spawning and rearing habitat due to reservoir inundation • Elimination of channel forming flows • Periodic, excessive non-ramped flows that flush eggs and strands fish • Natural hydrograph gone. Most of natural flow removed out of basin. Minimum flows of 30 cfs (1988) and 60 cfs (late 1990's).
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to reduced flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to reduced flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions <u>Ten Year Actions</u> • Develop and implement a strategy of controlled or managed freshets released downstream to restore channel conveyance, to provide sediment migration flows, fish migration flows, increase spawning and rearing area, to enhance fish and wildlife and water quality and slow the process of rising groundwater levels.

Table 2.5 Continued

Hydrology
Benefit to Fish • Benefit of recovery action would accrue to downstream reaches of the North Fork and to the Skokomish River mainstem. <u>Abundance</u> • Restores habitat for a greater number of fish <u>Productivity</u> • Restores the quality and quantity of habitat for spawning at original flow levels <u>Spatial Structure</u> • Regains access to habitat <u>Diversity</u> • Favors a greater number of individuals and life stages

Fluvial Geomorphology
Original Conditions • Recessional outwash floodplain likely contained complex habitat included forested island, forested wetlands, side channels and large log jams. • Coarse sediment provided Chinook salmon spawning habitat.
Disruptions • Due to reservoir inundation.
Effect to Fish <u>Abundance</u> • Loss of juvenile rearing and adult migratory, holding and spawning habitats <u>Productivity</u> • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats <u>Spatial Structure</u> • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles. <u>Diversity</u> • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook
Recovery Actions • No potential recovery of historic channel geomorphology and channel forming processes within this reach due to complete inundation.
Benefit to Fish • <u>N/A</u>

Table 2.5 Continued

Riparian Function
Original Conditions Old growth riparian forests with forested islands. Hardwoods and mixed forested in floodplain areas and areas of active channel migration.
Disruptions • Elimination of riparian function due to reservoir inundation of floodplain, riverine riparian forests and wetlands (including forested wetlands) • Elimination of LWD recruitment potential due to reservoir inundation
Effect to Fish <u>Abundance</u> • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Survival reduced due to water temperature increases • Reduction in quality rearing habitat (pools) affects carrying capacity and productivity • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity <u>Spatial Structure</u> • Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity <u>Diversity</u> • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity.
Recovery Actions <u>Three- to Five-Year Actions</u> • Riparian corridor restoration/ enhancement to restore riparian forests for supporting future wood recruitment and ecosystem benefits

Table 2.5 Continued

Riparian Function
Benefit to Fish Abundance • Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon Productivity • Survival rates increase due to cooler water temperature • Increase in quality rearing habitat (pools) affects carrying capacity and productivity • Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity Spatial Structure • Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity Diversity • Diversity improves due to increase in the quality habitats that contribute to abundance and productivity. • Improves abundance and productivity over time that contributes to diversity

Fish Access and Habitat Connectivity
Original Conditions Spring and summer/fall Chinook salmon can access this reach during all months of adult migration (March through December)
Disruptions • Elimination of all anadromous fish access due to Cushman Dams #1 and #2 • Dam on Lake Kokanee #2, creates lowest fish barrier.
Effect to Fish Abundance • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon Productivity • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity. Spatial Structure • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. Diversity • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure

Table 2.5 Continued

Fish Access and Habitat Connectivity

Recovery Actions

Three to Five+ Year Actions

- Develop and implement habitat restoration strategy, primarily through mitigation associated with Cushman operations (Fish Habitat/Restoration Plan) to enhance aquatic habitat in the NF Skokomish and provide access to spawning habitat in Cushman and Kokanee tributaries.

Benefit to Fish

Abundance

- Opens suitable habitat beyond barriers for increased Chinook salmon production

Productivity

- Increases Chinook salmon utilization in lower stream reaches
- Increased nutrients provided from salmon carcasses from upstream areas improves stream productivity

Spatial Structure

- Removes barriers preventing upstream migration of adult salmon
- Reduces competition and risk to the population from environmental factors

Diversity

- Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed
- Diversity increases due to gain of spatial structure

Table 2.6. North Fork Skokomish River, Original Lake (RM 23.8 – RM 25.0): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions • Sediment from upper watershed deposited and stored in lake and at inlet (river delta) • Sediment transport inhibited by lake processes
Disruptions • Inundation of lake deposits sediment higher upriver
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Lose life history traits (timing), especially for spring Chinook
Recovery Actions • No potential recovery of sediment processes within this reach due to complete inundation Three- to Five-Year Actions • Investigate the feasibility and transport potential of placing sediment below Lake Kokanee (Dam #2) to mitigate for eliminated sediment supply to downstream reaches. • Cushman Project operations should be modified to restore natural flows to the greatest extent possible and to mimic natural flows in timing and hydrograph shape to the NF Skokomish River. Optimal releases for sediment movement in the Main Stem would be a discharge down the North Fork which, when combined with the South Fork flows, maintains as high a discharge as possible from the Main Stem without inducing flooding about 5,000 cubic feet per second.

Table 2.6 Continued

Sediment Supply, Transport, & Distribution

Benefit to Fish

Benefit of recovery action would accrue to downstream reaches of the North Fork and to the Skokomish River mainstem.

Abundance
- Increased chances of spawning over time increases the number of fish

Productivity
- Increased amount and quantity of spawning and rearing habitat

Spatial Structure
- Access to a greater number of types of habitat for adults and juveniles

Diversity
- Gain in life history traits (timing), especially for spring Chinook salmon

Large Woody Debris

Original Conditions
- High woody debris loading likely at inlet and outlet of lake and along lakeshore
- Lake provided storage and recruitment of wood

Disruptions
- Large, complex logjams eliminated
- Some recruitment into Lake Cushman from lakeshores and upper NF Skokomish River, but no downstream transport mechanism.

Effect to Fish

Abundance
- High mortality impact to juveniles

Productivity
- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

Spatial Structure
- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

Diversity
- Favors only a limited number of individuals and life stages

Table 2.6 Continued

Large Woody Debris

Recovery Actions

- No potential recovery of large woody debris process within this reach due to complete inundation

Ten-Year Actions

- Assess feasibility of placing logs in the canyon reach for natural redistribution downstream to mitigate for loss of upstream LWD transport and supply

Benefit to Fish

Benefit of recovery action would accrue to downstream reaches of the North Fork and to the Skokomish River mainstem.

Abundance

- Reduced mortality impact to juveniles

Productivity

- Increased amount and quantity of spawning and rearing habitat
- Provides juveniles with desirable habitats
- Increases carrying capacity of river
- Loss of quantity and quality of habitat
- Reds less susceptible to bed scour
- Reduces competition for some species

Spatial Structure

- Restores the quantity and quality of pools that provide habitat units
- Gain access to other habitats (floodplain connectivity)

Diversity

- Favors a greater number of individuals and life stages

Table 2.6 Continued

Hydrology

Original Conditions

- Snowmelt, and rain peak flows
- Peak flows somewhat moderated due to lake
- Frequency of peak flows moderate
- Peak flows range between 12,000 - 29,000 cfs

Disruptions

- Small natural lake within a riverine system transformed into a large reservoir
- Elimination of natural hydrograph

Effect to Fish

<u>Abundance</u>

- Eliminates habitat thereby reducing the number of fish

<u>Productivity</u>

- Reduces the quality and quantity of habitat for spawning due to reduced flows

<u>Spatial Structure</u>

- Loss of access to habitat types
- Habitat loss due to reduced flows

<u>Diversity</u>

- Favors only a limited number of individuals and life stages

Recovery Actions

- No potential recovery of hydrology processes within this reach due to complete inundation

<u>Ten Year Actions</u>

- Develop and implement a strategy of controlled or managed freshets to restore channel conveyance, to provide sediment migration flows, fish migration flows, increase spawning and rearing area, to enhance fish and wildlife and water quality and slow the process of rising groundwater levels.

Benefit to Fish

<u>Benefit of recovery action would accrue to downstream reaches of the North Fork and to the Skokomish River mainstem.</u>

<u>Abundance</u>

- Restores habitat for a greater number of fish

<u>Productivity</u>

- Restores the quality and quantity of habitat for spawning at original flow levels

<u>Spatial Structure</u>

- Regains access to habitat

<u>Diversity</u>

- Favors a greater number of individuals and life stages

Table 2.6 Continued

Fluvial Geomorphology
Original Conditions • Original Lake provided depositional area of LWD and sediment. • LWD and sediment deposited at river delta (lake inlet)
Disruptions • Elimination of natural lake within the riverine system. • Loss of river delta complex, braided system, and floodplain due to inundation • Development of new river delta formation at head of Cushman reservoir. (Results in loss of migration, spawning and rearing habitat as well as nutrients)
Effect to Fish <u>Abundance</u> • Loss of juvenile rearing and adult migratory, holding and spawning habitats. <u>Productivity</u> • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats <u>Spatial Structure</u> • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles. <u>Diversity</u> • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook
Recovery Actions • No potential recovery of historic channel geomorphology and channel forming processes within this reach due to complete inundation <u>Ten-Year Actions</u> • In downstream reaches, construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat.
Benefit to Fish • <u>N/A</u>

Table 2.6 Continued

Riparian Function

Original Conditions

- Lakeside conifer forests and adjacent forested wetlands
- Riparian forest likely provided woody debris into the lake and shade along the shorelines

Disruptions

- Loss of riparian forests and forested wetlands adjacent to original lake due to inundation
- New delta area is no longer forested
- Extent of riparian corridor has decreased due increased frequency and intensity (washout)

Effect to Fish

Abundance

- Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity

- Survival reduced due to water temperature increases
- Reduction in quality rearing habitat (pools) affects carrying capacity and productivity.
- Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity.

Spatial Structure

- Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity

Diversity

- Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity
- Reductions in abundance and productivity over time reduce diversity.

Recovery Actions

Three- to Five-Year Actions

- Maintain existing riparian forests

Benefit to Fish

Abundance

- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity

- Survival rates increase due to cooler water temperature
- Increase in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity

Spatial Structure

- Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity

Diversity

- Diversity improves due to increase in the quality habitats that contribute to abundance and productivity
- Improves abundance and productivity over time that contributes to diversity

Table 2.6 Continued

Fish Access and Habitat Connectivity

Original Conditions

- Spring Chinook salmon, steelhead, coho, sockeye and bull trout had access to original lake and the NF Skokomish River above the lake.

Disruptions

- All anadromous fish access eliminated
- Original lake inundated by Lake Cushman

Effect to Fish

Abundance

- Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon

Productivity

- Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use
- Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivit

Spatial Structure

- Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity.
- Competition and risk to the population from environmental factors are increased when fish are not well distributed.

Diversity

- Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed.
- Diversity reduced due to loss of spatial structure

Recovery Actions

Three- to Five-Year Actions

- Develop and implement habitat restoration strategy, primarily through mitigation associated with Cushman operations (Fish Habitat/Restoration Plan) to enhance aquatic habitat in the NF Skokomish and provide access to spawning habitat in Cushman and Kokanee tributaries.
- Provide full fish access to historical spawning and rearing habitat in all of North Fork to fully restore anadromous fish to the basin

Table 2.6 Continued

Fish Access and Habitat Connectivity
Benefit to Fish Abundance • Opens suitable habitat beyond barriers for increased Chinook salmon production Productivity • Increases Chinook salmon utilization in lower stream reaches • Increased nutrients provided from salmon carcasses from upstream areas improves stream productivity Spatial Structure • Removes barriers preventing upstream migration of adult salmon • Reduces competition and risk to the population from environmental factors Diversity • Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed • Diversity increases due to gain of spatial structure

Table 2.7. North Fork Skokomish River, Original Lake Inlet to Headwaters (RM 25.0 – RM 38.3): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions • Moderate sediment load, original Lake Cushman captured upstream sediment
Disruptions • Increased sedimentation due to road building, logging, and recreational development • Inundation of lake deposits sediment higher upriver
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Lose life history traits (timing), especially for spring Chinook
Recovery Actions Three- to Five-Year Actions • Assess, stabilize, abate, and monitor fine and course sediment sources a. Reduce sediment from roads b. Avoid timber harvest on steep slopes • Remove/repair logging roads
Benefit to Fish Abundance • Increased chances of spawning over time increases the number of fish Productivity • Increased amount and quantity of spawning and rearing habitat Spatial Structure • Access to a greater number of types of habitat for adults and juveniles Diversity • Gain in life history traits (timing), especially for spring Chinook salmon

Table 2.7 Continued

Large Woody Debris

Original Conditions

- High LWD loading

Disruptions

- Loss of wood due to lake inundation and timber harvest; no wood travels downstream due to dam

Effect to Fish

Abundance

- High mortality impact to juveniles

Productivity

- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

Spatial Structure

- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

Diversity

- Favors only a limited number of individuals and life stages

Recovery Actions

Three- to Five-Year Actions

- Riparian corridor restoration/ enhancement to restore riparian forests for supporting future wood recruitment, juvenile rearing habitat, and ecosystem benefits.

Benefit to Fish

Abundance

- Increased survival of juveniles

Productivity

- Increased amount and quantity of rearing habitat
- Provides juveniles with desirable habitats
- Increases carrying capacity of river
- Reduces competition for some species

Spatial Structure

- Gain access to other habitats (floodplain connectivity)

Diversity

- Favors a greater number of individuals and life stages

Table 2.7 Continued

Hydrology
Original Conditions • Flow intensity low, snowmelt, and rain peak flows. Peak flow frequency moderate to low. • Peak flows range between 8,000 - 27,000 cfs.
Disruptions • Climate change has increased flow intensity, shorter durations, higher frequencies, transition from snow-dominated to rain-dominated • Peak flow frequency is moderate
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to reduced flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to reduced flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions • No actions needed
Benefit to Fish <u>N/A</u>

Table 2.7 Continued

Fluvial Geomorphology

Original Conditions

- Lower reach (4 miles), low gradient side channels, floodplain connectivity, side channels and river delta into original lake.
- Single thread, steep to moderate gradient and low gradient at lower section with river delta, braided system, and floodplain development

Disruptions

- Loss of 3.5 miles of low gradient riverine and floodplain habitat replaced by reservoir
- Loss of river delta complex, braided system, and floodplain due to inundation
- Development of new river delta formation at head of reservoir with avulsion
- (Results in loss of spawning and rearing habitat and nutrients)

Effect to Fish

Abundance

- Loss of juvenile rearing and adult migratory, holding and spawning habitats

Productivity

- Spawning and rearing habitat quality reduced
- Reduced carrying capacity of rearing habitats

Spatial Structure

- Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles.

Diversity

- Reduces diversity due to migration barriers to available habitats in upstream reaches
- Loss of life history traits, especially for spring Chinook

Recovery Actions

Ten-Year Actions

- Construct engineered logjams and other habitat features at the lower end of the reach to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat.

Benefit to Fish

Abundance

- Restores juvenile rearing and adult migratory, holding, and spawning habitats

Productivity

- Increases spawning and rearing habitat quality
- Increased carrying capacity of rearing habitats

Spatial Structure

- Removes barriers that limit upstream distribution of spawners and juveniles

Diversity

- Increases diversity due to removal of migration barriers to available habitats in upstream reaches
- Gain of life history traits, especially for spring Chinook

Table 2.7 Continued

Riparian Function
Original Conditions • Old growth conifer forests in lower 4 miles of this reach that is now inundated • Included a forested floodplain with forested islands, side channels, and forested wetlands • Area upstream of lower gradient floodplain reach dominated primarily by large conifers
Disruptions • Loss of forested floodplains and islands due to inundation • New delta area at the upstream end of Lake Cushman is no longer forested • Recruitment potential reduced due to elimination of 4 miles of riverine habitat
Effect to Fish <u>Abundance</u> • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Survival reduced due to water temperature increases • Reduction in quality rearing habitat (pools) affects carrying capacity and productivity. • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity <u>Spatial Structure</u> • Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity <u>Diversity</u> • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity.
Recovery Actions <u>Three- to Five-Year Actions</u> • Develop and implement habitat restoration strategy, primarily through mitigation associated with Cushman operations (Fish Habitat/Restoration Plan) to enhance aquatic habitat in the NF Skokomish and provide access to spawning habitat in Cushman and Kokanee tributaries <u>Ten-Year Actions</u> • Place conservation easements along the riparian corridor and reestablish riparian zone

Table 2.7 Continued

Riparian Function
Benefit to Fish Abundance • Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon Productivity • Survival rates increase due to cooler water temperature • Increase in quality rearing habitat (pools) affects carrying capacity and productivity • Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity Spatial Structure • Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity Diversity • Diversity improves due to increase in the quality habitats that contribute to abundance and productivity

Fish Access and Habitat Connectivity
Original Conditions • Access at least upstream to Staircase Rapids near RM 30.0 • Potentially spring Chinook salmon and other salmon may have ascended past Staircase to RM 35.1 or even 38.3 (Brenkman 1998)
Disruptions All anadromous fish access eliminated by Cushman Project.
Effect to Fish Abundance • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon Productivity • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity. Spatial Structure • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. Diversity • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure

Table 2.7 Continued

Fish Access and Habitat Connectivity
Recovery Actions Three- to Five-Year Actions • Develop and implement plan to provide access to spawning habitat in Cushman and Kokanee tributaries.
Benefit to Fish Abundance • Opens suitable habitat beyond barriers for increased Chinook salmon production Productivity • Increases Chinook salmon utilization in lower stream reaches • Increased nutrients provided from salmon carcasses from upstream areas and improves stream productivity Spatial Structure • Removes barriers preventing upstream migration of adult salmon • Reduces competition and risk to the population from environmental factors Diversity • Regain of spring Chinook in the North Fork Skokomish will re-establish stock throughout the watershed • Diversity increases due to gain of spatial structure

South Fork Skokomish River and Vance Creek Implementation Actions

Extending for 27 miles, the South Fork drains an area of 128 square miles. There are three discernable sections to the South Fork. The first section runs from the confluence with North Fork to RM 3. The first three miles of the river runs through the broad Skokomish Valley at a low gradient. Within this section, extensive areas of the river have been restricted to channels or the shoreline has armoring or diking. During severe flooding, flows from the South Fork enter the North Fork via Richert Springs. Erosion occurs frequently along the stream bank for the first mile.

From RM 3.0 to 10.0, the river's gradient picks up, bordered by steep, rock wall canyons. The canyon walls are 400 feet deep in some places and 60 feet wide at its narrowest point. A series of cascades begins before RM 5 that continue to RM 7.

Once beyond the canyon, the South Fork meanders in a slightly broader valley from RM 10 to 23.5. The width of the valley widens and narrows at varying points. At RM 23.5, a falls prevent further fish passage. The next four miles of the South Fork cut through a very steep-sloped valley.

The USGS gauge located at RM 2.3 reports a mean discharge rate of 742 cfs for water years 1931-2005. The highest annual mean was 1,058 cfs in 1999 and the lowest annual mean was 423 cfs in 2001. The lowest daily mean of 57 cfs occurred on September 28, 2003 and the highest daily mean of 15,800 cfs occurred on January 15, 1961.

There are seven major tributaries to the South Fork:

- Vance Creek is the largest tributary with 10.3 miles of mainstem and another 33.9 miles of tributaries. The creek drains an area of 23.8 square miles. The gradient of the creek is moderate from its mouth at RM 0.8 of the South Fork to RM 4. The creek then climbs quickly in elevation, with an impassible falls at RM 7.1. Flows in the creek downstream of RM 2.5 are intermittent in late summer/ early fall. The lower sections of Vance Creek have farms and rural homes while the upper watershed is under USFS and private company ownership. Much of the timberlands have been extensively logged.

- Flat Creek enters the South Fork at around RM 8.7. This creek is approximately 1 mile in length. Rock Creek enters Flat Creek at RM 0.55 and is 4.8 miles long. Together, the two creeks drain an area of about 6.5 square miles. An impassible falls limits anadromous fish use to the first 0.1 miles of the system. A wetland exists downstream of the falls. This subbasin lies entirely within the Olympic National Forest, with some sections having experienced extensive logging.

- Brown Creek, a tributary joining the South Fork at RM 12.8, extends for 7.2 miles and drains 7.8 square miles. While Brown Creek begins at a low gradient, the surrounding topography steepens with impassible cataracts after RM 2. The subbasin is primarily in USFS ownership, which has seen significant harvesting in recent years. Springs are a primary hydrological source for the creek.
- The mouth of LeBar Creek joins the South Fork at RM 13.5. The creek extends 7.7 miles and the subbasin covers 9.8 square miles.
- Cedar Creek extends 2.9 miles from its mouth at RM 17.9. The subbasin drains approximately 5.6 square miles. A falls 0.25 from the mouth restricts anadromous fish passage.

Priority Protection Implementation Actions

Frissell et al. (2000) identified the South Fork Skokomish River (RM 13-21) as another Category 2, priority refugia with altered ecological integrity. Frissell et al. noted that this area contains patches of mature floodplain/riparian forest cover, floodplain wetland complexes, secondary and branched channels, and significant large woody debris accumulations. In addition to providing habitat for steelhead, bull trout, and coho, it is also an important contributing area to downstream Chinook and chum salmon habitat.

> Category 2: Priority refugia with altered ecological integrity.
>
> Category 2 areas are known to be somewhat altered from historic conditions, but at least some fish populations appear to be self-sustaining and resilient. These areas are not pristine, but frequently constitute the best of what salmon habitat remains within highly developed basins (Frissell et al. 2000).

Further upstream, Frissell et al. identified the South Fork Skokomish mainstem (RM 21-headwaters) as a Category 4 area. This is a relatively pristine area within the Olympic National Park.

> Category 4: Critical contributing areas.
>
> Category 4 areas have relatively high ecological integrity and an important hydrological influence on Category 1 or 2 segments that lie downstream. For various reasons, these areas do not contain viable salmon populations, but are of recognized importance to maintaining the integrity of downstream priority areas that do contain salmon habitat and populations (Frissell et al. 2000).

Vance Creek, despite being severely impacted by logging, road building, agriculture, and rural residential development, is slowly recovering. This basin, classified within a Category 2 protection status, supports populations of coho, fall chum, winter steelhead, sea run cutthroat, bull trout, and small numbers of naturally spawning fall Chinook salmon.

Table 2.8. South Fork Skokomish River, Confluence to Canyon Reach (RM 0.0 – RM 3.0): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions Sediment load high due to floodplain being the depositional reach. Stabilized by LWD jams and heavily forested riparian areas. Reach composed primarily of cobbles and gravels.
Disruptions Sediment load increased due to upstream hill slope and streambank erosion. Sediment transported to this depositional/floodplain reach. Streambed aggrading in lower reach near confluence of Vance Creek and the NF Skokomish River (the dips).
Effect to Fish <u>Abundance</u> • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish <u>Productivity</u> • Reduced amount and quantity of spawning and rearing habitat <u>Spatial Structure</u> • Loss of access to some types of habitat for adults and juveniles <u>Diversity</u> • Lose life history traits (timing), especially for spring Chinook
Recovery Actions <u>Three- to Five-Year Actions</u> • Maintain adequate forest cover (65%), age (late seral), and structure to facilitate properly functioning hydrology • Assess, stabilize, abate, and monitor fine and course sediment sources a. Reduce sediment from roads through decommissioning and maintenance b. Avoid timber harvest on steep slopes c. Remove/repair logging roads d. Monitor bed scour (multiple tributaries) and bed stability • Assess impacts and determine alternatives for improving excessive gravel conditions in South Fork Skokomish

Table 2.8 Continued

Sediment Supply, Transport, & Distribution
Benefit to Fish Abundance • Increased chances of spawning over time increases the number of fish Productivity • Increased amount and quantity of spawning and rearing habitat Spatial Structure • Access to a greater number of types of habitat for adults and juveniles Diversity • Gain in life history traits (timing), especially for spring Chinook salmon

Large Woody Debris
Original Conditions High LWD loading in log jams and forested islands due to upstream sources and adjacent riparian forests
Disruptions Reduced LWD recruitment potential from upstream sources and adjacent riparian forests. Some LWD in jams but primarily smaller jams with smaller pieces. Land clearing for homesteads, log drives and channel clearing removed most of the historical wood in the channel.
Effect to Fish Abundance • High mortality impact to juveniles Productivity • Reduced quantity and quality of spawning and rearing habitat • Pushes juveniles to less desirable habitats • Lowers carrying capacity of river • Redds more susceptible to bed scour • Increases competition for some species Spatial Structure • Loss of quantity and quality of pools that result in fewer habitat types • Loss of access to other habitats (floodplain connectivity) Diversity • Favors only a limited number of individuals and life stages

Table 2.8 Continued

Large Woody Debris
Recovery Actions Three- to Five-Year Actions • Construct engineered logjams, increase wood loading, and improve other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels and stable spawning habitat. • Maintain existing woody debris through education and enforcement • See Riparian Function section
Benefit to Fish Abundance • Reduced mortality impact to juveniles Productivity • Increased amount and quantity of spawning and rearing habitat • Provides juveniles with desirable habitats • Increases carrying capacity of river • Loss of quantity and quality of habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat units • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Table 2.8 Continued

Hydrology
Original Conditions Flows moderated due to heavily forested basin upstream. Flows still somewhat flashy due high percentage of basin in rain-on-snow zone.
Disruptions Flow intensity increased due to road network and basin harvesting. Erosion processes accelerated with depositional landforms eroded. Loss of NF hydrology increasing aggradation in vicinity of SF and NF Skokomish confluence and upstream above Vance Creek confluence (the dips).
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to reduced flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to reduced flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions • Protect intact habitat and forested conditions upstream
Benefit to Fish N/A

Table 2.8 Continued

Fluvial Geomorphology
Original Conditions Floodplain/channel migration zone in recessional outwash plane with high sediment load and abundant storage in bars and floodplain areas.
Disruptions Increase in sediment. Erosion processes accelerated with depositional landforms eroded. Aggradation due to upstream sediment sources, lateral bank/bar erosion, and loss of NF Skokomish hydrology. Confluence with NF Skokomish is now downstream an additional 1 mile due to aggradation of the SF Skokomish and the recent dike breach/avulsion of the lower NF Skokomish River into Richert Springs.
Effect to Fish <u>Abundance</u> • Loss of juvenile rearing and adult migratory, holding and spawning habitats <u>Productivity</u> • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats <u>Spatial Structure</u> • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles. <u>Diversity</u> • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook
Recovery Actions • Restore fluvial geomorphic functions • Remove levees, i.e. car body, anthropogenic bank stabilization • Setback levees, i.e. church levee, valley road dips) • Physically restore channel
Benefit to Fish N/A

Table 2.8 Continued

Riparian Function
Original Conditions Old growth riparian forest. Heavily forested floodplain and stable forested islands
Disruptions All original riparian forest removed. Remaining buffer is narrow and mixed younger conifer/hardwood reducing potential LWD delivery. Most forested wetlands converted to agriculture/residential development.
Effect to Fish <u>Abundance</u> • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Survival reduced due to water temperature increases • Reduction in quality rearing habitat (pools) affects carrying capacity and productivity. • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity <u>Spatial Structure</u> • Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity <u>Diversity</u> • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity.
Recovery Actions <u>Three- to Five-Year Actions</u> • Continue riparian enhancement, including conifer conversion • Plant and maintain riparian areas on both public and private properties; encourage forestry rather than conversion
Benefit to Fish <u>Abundance</u> • Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Survival rates increase due to cooler water temperature • Increase in quality rearing habitat (pools) affects carrying capacity and productivity • Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity <u>Spatial Structure</u> • Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity <u>Diversity</u> • Diversity improves due to increase in the quality habitats that contribute to abundance and productivity • Improves abundance and productivity over time that contributes to diversity

Table 2.8 Continued

Fish Access and Habitat Connectivity

Original Conditions

Perennial flow. Spring Chinook salmon move through from March through August, resting in deep pools upstream in the canyon before moving to the upper SF Skokomish to spawn.

Disruptions

Access affected by low stream flows and subsurface conditions in mid to late summer due to aggradation. Lower SF Skokomish has gone totally sub-surface the last 2 of 3 summers. Large reduction in rearing/spawning habitat and annual loss of juvenile salmonids.

Effect to Fish

Abundance

- Suitable habitat beyond barriers (dikes, aggraded dry riverbed) produces no Chinook salmon

Productivity

- Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use
- Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity.

Spatial Structure

- Barriers preventing upstream migration of adult salmon reduces distribution of fish to upper watershed.
- Competition and risk to the population from environmental factors are increased when fish are not well distributed.

Diversity

- Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed.
- Diversity reduced due to loss of spatial structure

Recovery Actions

- Restore fish passage through dry reach
- Restore access to isolated floodplain wetland habitats

Benefit to Fish

- Increased abundance, productivity, spatial distribution

Table 2.9. South Fork Skokomish River, Canyon Reach (RM 3.0 – RM 10.0): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions Sediment efficiently routed through canyon. Reach composed of large boulders and cobbles with spawning size gravels in some pool tailouts.
Disruptions Sediment load high due to upstream slope and streambank erosion. Sediment transported to floodplain reach in lower river. Some storage in bars in the floodplain reach near RM 7.5.
Effect to Fish Abundance • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish Productivity • Reduced amount and quantity of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Lose life history traits (timing), especially for spring Chinook
Recovery Actions • No actions planned
Benefit to Fish N/A

Table 2.9 Continued

Large Woody Debris

Original Conditions

High LWD loading in logjams and at upper end of cascades

Disruptions

Reduced recruitment potential from upstream sources due to riparian harvest in tributaries and SF Skokomish from Lebar Creek to top of Canyon (Homan Flats)

Effect to Fish

<u>Abundance</u>

- High mortality impact to juveniles

<u>Productivity</u>

- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

<u>Spatial Structure</u>

- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

<u>Diversity</u>

- Favors only a limited number of individuals and life stages

Recovery Actions

<u>Three- to Five-Year Actions</u>

- Restore habitat complexity and sinuosity by leaving existing wood in the system

<u>Ten-Year Actions</u>

- Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat.

Table 2.9 Continued

Large Woody Debris
Benefit to Fish <u>Abundance</u> • Reduced mortality impact to juveniles <u>Productivity</u> • Increased amount and quantity of spawning and rearing habitat • Provides juveniles with desirable habitats • Increases carrying capacity of river • Loss of quantity and quality of habitat • Reds less susceptible to bed scour • Reduces competition for some species <u>Spatial Structure</u> • Restores the quantity and quality of pools that provide habitat units • Gain access to other habitats (floodplain connectivity) <u>Diversity</u> • Favors a greater number of individuals and life stages

Hydrology
Original Conditions Flows moderated due to heavily forested basin upstream. Flows still somewhat flashy due to high percentage of basin in rain-on-snow zone and valley confinement.
Disruptions Flow intensity increased due to road network and basin harvesting. Erosion processes accelerated with depositional landforms eroded.
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to altered flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to altered flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions Upstream recovery actions to retain forest cover assist in restoring hydrologic conditions in this reach. No recovery actions planned within the reach.

Table 2.9 Continued

Hydrology
Benefit to Fish N/A

Fluvial Geomorphology
Original Conditions Crescent basalt geology. No channel migration zone or floodplain except in short section around RM 7.5. Steep canyon walls. Boulder and cobble dominate but areas of spawning size gravels in some pool tailouts.
Disruptions Erosion processes accelerated with depositional landforms eroded in the small floodplain reach around RM 7.5. Other areas likely have had little change.
Effect to Fish With few disruptions to fluvial geomorphology in this reach, there are minimal associated effects on fish.
Recovery Actions No actions needed
Benefit to Fish N/A

Riparian Function
Original Conditions Old growth forest within this reach. Much of the canyon walls are near vertical with few trees except at the top of the break in slope.
Disruptions Most riparian forest removed up to the break in slope above the canyon. Canyon walls not harvested but have sparse timber. Old growth riparian removed from floodplain reach around RM 7.5.
Effect to Fish • With little disruption to riparian function within this reach, there are minimal associated effects on fish.
Recovery Actions No actions needed
Benefit to Fish N/A

Table 2.9 Continued

Fish Access and Habitat Connectivity
Original Conditions Perennial flow. Spring Chinook salmon move through from March through August, resting in deep pools within this reach. Some evidence of difficult migration for spring Chinook salmon (WDF 1957).
Disruptions Access through canyon available but may be affected in late summer by low streamflow and subsurface conditions in the lower SF Skokomish and mainstem Skokomish Rivers.
Effect to Fish Abundance • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon Productivity • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity. Spatial Structure • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. Diversity • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure
Recovery Actions Recovery actions needed to improve fish access and habitat connectivity are within other reaches of the river (see Mainstem and North Fork in particular). No practical actions within this reach.
Benefit to Fish N/A

Table 2.10. South Fork Skokomish River, Canyon Mouth (Holman Flats) to Headwaters (RM 10.0 – RM 27.5): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions High sediment loads with some side channels and floodplain area for storage. In upper portion, reach composed of boulders and cobbles with spawning size gravels in some pool tailouts. Gravels are more abundant in lower part of reach with less boulder and cobble.
Disruptions Sediment load high due to hill slope and streambank erosion. Road failures and mass wasting in tributaries. Reduced sediment retention due to loss of in-channel wood. Reductions of riparian forest result in reduction of future wood recruitment and sediment storage.
Effect to Fish <u>Abundance</u> • Reduced chances of spawning over time reduces the number of fish • Limited ability to rear and grow reduces the number of fish <u>Productivity</u> • Reduced amount and quantity of spawning and rearing habitat <u>Spatial Structure</u> • Loss of access to some types of habitat for adults and juveniles <u>Diversity</u> • Lose life history traits (timing), especially for spring Chinook
Recovery Actions <u>Three- to Five-Year Actions</u> • Place conservation easements along the riparian corridor and reestablish riparian zone • Develop a feasibility plan to restore channel sinuosity and complexity • Road decommissioning to reduce risk of mass wasting, surface erosion and peak flows caused by the extensive road networks
Benefit to Fish <u>Abundance</u> • Increased spawning success over time increases the number of fish. <u>Productivity</u> • Increased amount and quality of spawning and rearing habitat <u>Spatial Structure</u> • Access to a greater number of types of habitat for adults and juveniles <u>Diversity</u> • Gain in potential life history pathways

Table 2.10 Continued

Large Woody Debris
Original Conditions High LWD loading in log jams, side channels and exposed bars
Disruptions Reduced recruitment potential from upstream sources due to riparian harvest in tributaries and SF Skokomish from Lebar Creek to top of Canyon (Holman Flats)
Effect to Fish <u>Abundance</u> • High mortality impact to juveniles <u>Productivity</u> • Reduced quantity and quality of spawning and rearing habitat • Pushes juveniles to less desirable habitats • Lowers carrying capacity of river • Redds more susceptible to bed scour • Increases competition for some species <u>Spatial Structure</u> • Loss of quantity and quality of pools that result in fewer habitat types • Loss of access to other habitats (floodplain connectivity) <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions <u>Three- to Five-Year Actions</u> • Continue riparian enhancement
Benefit to Fish <u>Abundance</u> • Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Increase in quality rearing habitat (pools) <u>Spatial Structure</u> • Improves the quality of habitats throughout the watershed where fish are distributed <u>Diversity</u> • Diversity improves due to increase in the quality habitats

Table 2.10 Continued

Hydrology
Original Conditions High percentage of basin in rain on snow zone but heavily forested so flow intensity moderated. Allowed for recharge.
Disruptions Recharge compromised. Flow intensity increased due to road network and basin harvesting. Erosional processes accelerated with depositional landforms eroded.
Effect to Fish <u>Abundance</u> • Eliminates habitat thereby reducing the number of fish <u>Productivity</u> • Reduces the quality and quantity of habitat for spawning due to reduced flows <u>Spatial Structure</u> • Loss of access to habitat types • Habitat loss due to reduced flows <u>Diversity</u> • Favors only a limited number of individuals and life stages
Recovery Actions <u>Three- to Five-Year Actions</u> • Place conservation easements along the riparian corridor and reestablish riparian zone • Road decommissioning to reduce risk of mass wasting, surface erosion and peak flows caused by the extensive road networks
Benefit to Fish <u>Abundance</u> • Increased spawning success over time increases the number of fish. <u>Productivity</u> • Increased amount and quality of spawning and rearing habitat <u>Spatial Structure</u> • Access to a greater number of types of habitat for adults and juveniles <u>Diversity</u> • Gain in potential life history pathways

Table 2.10 Continued

Fluvial Geomorphology
Original Conditions Crescent basalt geology. Small channel migration zone in some reaches with side channels. Boulder and cobble dominant in upper reaches but areas of spawning size gravels in lower gradient reaches and in area of high wood loading.
Disruptions Increase in sediment load from logging and road building activities primarily in the lower portion of the reach. Erosion processes accelerated with depositional landforms eroded, particularly in lower reach where riparian and upland forest was removed for proposed dam site.
Effect to Fish <u>Abundance</u> • Loss of juvenile rearing and adult migratory, holding and spawning habitats <u>Productivity</u> • Spawning and rearing habitat quality reduced • Reduced carrying capacity of rearing habitats <u>Spatial Structure</u> • Barriers (dry channels, low flow and dams) limit upstream distribution of spawners and juveniles. <u>Diversity</u> • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of life history traits, especially for spring Chinook
Recovery Actions With few disruptions to fluvial geomorphology in this reach, there are minimal associated effects on fish
Benefit to Fish N/A

Table 2.10 Continued

Riparian Function

Original Conditions

Old growth riparian forests with stable forested islands throughout the mainstem and tributary streams

Disruptions

Reduced recruitment potential in SF Skokomish River and tributaries due to streamside adjacent logging, particularly in reach below Lebar Creek including lower Lebar and Brown Creeks. SF Skokomish above Lebar Creek has old growth riparian forest but tributary riparian forests have been harvested where timber was accessible.

Effect to Fish

Abundance

- Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity

- Survival reduced due to water temperature increases
- Reduction in quality rearing habitat (pools) affects carrying capacity and productivity.
- Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity

Spatial Structure

- Affects the quality of habitats throughout the watershed where fish are distributed which in turn reduces abundance and productivity

Diversity

- Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity
- Reductions in abundance and productivity over time reduce diversity.

Recovery Actions

Three- to Five-Year Actions

- Continue riparian enhancement
- Relocate campsites away from the river (Laney Campground)

Benefit to Fish

Abundance

- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon

Productivity

- Survival rates increase due to cooler water temperature
- Increase in quality rearing habitat (pools) affects carrying capacity and productivity
- Changes in food web support (nutrients, detritus, invertebrates) that likely leads to greater productivity

Spatial Structure

- Improves the quality of habitats throughout the watershed where fish are distributed that increases abundance and productivity

Diversity

- Diversity improves due to increase in the quality habitats that contribute to abundance and productivity
- Improves abundance and productivity over time that contributes to diversity

Table 2.10 Continued

Fish Access and Habitat Connectivity
Original Conditions Perennial flow. Spring Chinook salmon access up to above Church Creek confluence at ~ RM 23
Disruptions Access is still available but may be affected in late summer by low streamflow and subsurface conditions in the lower SF Skokomish and mainstem Skokomish Rivers.
Effect to Fish <u>Abundance</u> • Suitable habitat beyond barriers (dams, dikes, aggraded dry riverbed) produces no Chinook salmon <u>Productivity</u> • Limits Chinook salmon utilization to lower stream reaches where habitat has been degraded from past land use • Loss of nutrients provided from salmon carcasses to upstream areas reduces stream productivity. <u>Spatial Structure</u> • Barriers preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. <u>Diversity</u> • Loss of spring Chinook in the North Fork Skokomish is thought to be partially responsible for the loss of spring Chinook throughout the watershed. • Diversity reduced due to loss of spatial structure
Recovery Actions No actions needed within this reach
Benefit to Fish N/A

Table 2.11. Vance Creek, Confluence to 800 Bridge (RM 0.0 – 3.6): Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution
Original Conditions Sediment load high due to the floodplain being the depositional reach. Stabilized by large woody debris accumulations and heavily forested riparian areas.
Disruptions Alluvial fan at bottom of canyon (transition) has broadened and lateral movement of channel is causing increased bank erosion. Aggradation occurring reach-wide. Cobble and boulder dominant in channel in the transition reach with smaller grained material on the bars. Sediment highly embedded and high in silts, sands, cobbles, and boulders.
Effect to Fish Abundance • Reduced spawning success over time reduces the number of fish. • Limited ability to rear and grow reduces the number of fish. Productivity • Reduced amount and quality of spawning and rearing habitat Spatial Structure • Loss of access to some types of habitat for adults and juveniles Diversity • Loss of potential life history traits
Recovery Actions Three- to Five-Year Actions • Place conservation easements along the riparian corridor and reestablish riparian zone. • Develop a feasibility plan to restore channel sinuosity and complexity. • Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels, and stable spawning habitat. • Road decommissioning to reduce risk of mass wasting, surface erosion and peak flows caused by the extensive road networks

Table 2.11 Continued

Sediment Supply, Transport, & Distribution

Benefit to Fish

Abundance

- Increased spawning success over time increases the number of fish.

Productivity

- Increased amount and quality of spawning and rearing habitat

Spatial Structure

- Access to a greater number of types of habitat for adults and juveniles

Diversity

- Gain in potential life history pathways.

Large Woody Debris

Original Conditions

High large woody debris loading. Old growth conifer forest. Forested wetlands, including beaver impoundments provided shade large woody debris, recruitment/storage, nutrient input/retention, rearing habitat, flow moderation, and storage.

Disruptions

Recruitment potential greatly reduced due to loss of riparian forests and in-channel wood removal. In-channel woody debris greatly reduced and mostly smaller pieces and jams. Beaver influence greatly reduced to nonexistent. Single logs and log jams continually cut and removed by landowners.

Effect to Fish

Abundance

- High mortality impact to juveniles

Productivity

- Reduced quantity and quality of spawning and rearing habitat
- Pushes juveniles to less desirable habitats
- Lowers carrying capacity of river
- Redds more susceptible to bed scour
- Increases competition for some species

Spatial Structure

- Loss of quantity and quality of pools that result in fewer habitat types
- Loss of access to other habitats (floodplain connectivity)

Diversity

- Loss of potential life history traits

Table 2.11 Continued

Large Woody Debris
Recovery Actions Three- to Five-Year Actions • Plant and maintain riparian areas on both public and private properties; encourage forestry rather than conversion • Place conservation easements along the riparian corridor and reestablish riparian zone • Develop a feasibility plan to restore natural riverine processes and functions • Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels and stable spawning habitat.
Benefit to Fish Abundance • Reduced mortality impact to juveniles • Increased carrying capacity of river Productivity • Provides juveniles with desirable habitats • Increased amount and quality of spawning and rearing habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Table 2.11 Continued

Hydrology
Original Conditions Flows moderated by a heavily forested basin and by in-channel roughness. Beaver dams in side channels and tributary streams assisted in retaining flows in summer and moderated peak flows. Summer flows low but stable.
Disruptions Peak flows higher. Higher density and shorter duration flows due to basin harvesting and high road density. Loss of recharge capability that result in lower summer flows. Erosion processes accelerated with depositional landforms easily eroded.
Effect to Fish Abundance • Eliminates habitat thereby reducing the number of fish Productivity • Reduces the quality and quantity of habitat for spawning due to reduced flows Spatial Structure • Loss of access to habitat • Habitat loss due to reduced flows Diversity • Loss of potential life history traits.
Recovery Actions Ten-Year Actions • Place conservation easements along the riparian corridor and reestablish riparian zone • Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, sidechannels, and stable spawning habitat. • Continue decommissioning of high risk roads on private and federal forest land and maintain mature forests
Benefit to Fish Abundance • Reduced mortality impact to juveniles • Increases carrying capacity of river Productivity • Provides juveniles with desirable habitats • Increased amount and quality of spawning and rearing habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Table 2.11 Continued

Fluvial Geomorphology
Original Conditions Floodplain/channel migration zone in the recessional outwash plain. High sediment load but abundant storage in bars and floodplain.
Disruptions Increase in sediment load of all particle sizes due to debris flows and lateral bank erosion. Large deposits of smaller sediments in depositional areas are highly erodible. Suspected influence in lower Vance Creek from the aggradation on the mainstem and lower South Fork Skokomish caused by reduced flows out of the North Fork Skokomish
Effect to Fish <u>Abundance</u> • Loss of juvenile rearing and adult migratory, holding and spawning habitat <u>Productivity</u> • Spawning and rearing habitat quality and quantity reduced • Reduced carrying capacity of rearing habitats <u>Spatial Structure</u> • Barriers (dry channels, low flow) limit distribution of spawners and juveniles. <u>Diversity</u> • Reduces diversity due to migration barriers to available habitats in upstream reaches • Loss of potential life history traits
Recovery Actions <u>Three- to Five-Year Actions</u> • Develop a feasibility plan to restore natural riverine processes and functions and restore perennial flow to Vance Creek • Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels and stable spawning habitat. • Continue decommissioning of high risk roads on private and federal forest land and maintain mature forests and reduce overall road network

Table 2.11 Continued

Fluvial Geomorphology
Benefit to Fish Abundance • Reduced mortality impact to juveniles • Increases carrying capacity of river Productivity • Provides juveniles with desirable habitats • Increased amount and quality of spawning and rearing habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat • Gain access to other habitats (floodplain connectivity) Diversity • Favors a greater number of individuals and life stages

Riparian Function
Original Conditions Old growth conifer riparian forests and forested wetlands with beaver influences. Stable forested islands.
Disruptions All original riparian forest removed. Riparian buffer is narrow and mostly mixed with conifers and hardwoods. Most forested wetlands were converted to agricultural lands or residential land uses by draining and ditching, or through timber production. Loss of shade increasing temperatures, loss of rearing habitat, flow moderation, and storage. Beaver ponds removed reducing habitat and flow moderation and storage.
Effect to Fish Abundance • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon Productivity • Survival reduced due to water temperature increases • Reduction in quality rearing habitat affects carrying capacity and productivity. • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity. Spatial Structure • Affects the quality and quantity of habitats reducing abundance and productivity Diversity • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity. • Loss of potential life history traits

Table 2.11 Continued

Riparian Function
Recovery Actions Three- to Five-Year Actions • Continue riparian enhancement and protection efforts • Work with landowners to place conservation easements along the stream and riparian corridor • Encourage forestry and salmon friendly agricultural practices rather than conversion
Benefit to Fish Abundance • Improves quality and quantity of habitat capable of supporting juvenile and adult salmon Productivity • Survival increases due to cooler water temperatures • Increase in quality rearing habitat affects carrying capacity and productivity. Spatial Structure • Improves the quality and quantity of habitat increasing abundance and productivity. Diversity • Diversity improves due to increase in quality habitats that contribute to abundance and productivity • Improves abundance and productive over time that contributes to diversity

Table 2.11 Continued

Fish Access and Habitat Connectivity

Original Conditions

Access through the reach maintained due to perennial flow

Disruptions

Falls is still upper extent of anadromy, but this reach can be barrier due to low flow and or subsurface flows for early returning fish and for movement of juvenile's salmonids. Upper one-half of reach (800 Bridge to 2nd Valley Bridge goes sub-surface every summer for at least the last 15 years.

Effect to Fish

Abundance

- Low flow and subsurface flow reduces abundance by prohibiting successful spawning and migration.

Productivity

- Limits Chinook productivity to accessible reaches only
- Chinook production currently only occurs during abnormally wet summers and falls.
- Loss of nutrients provided from salmon carcasses reduces stream productivity

Spatial Structure

- Barriers' preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity.
- Competition and risk to the population from environmental factors are increased when fish are not well distributed.

Diversity

- Diversity reduced due to loss of spatial structure
- Loss of potential life history traits
- Spring Chinook historically may have used Vance Creek for spawning and/or rearing

Recovery Actions

Ten-Year Actions

- Develop a feasibility plan to restore natural riverine processes and functions
- Construct engineered logjams and other habitat features to aid in creating and maintaining channel sinuosity and channel complexity and to restore important fish habitat features such as pools, side channels and stable spawning habitat.
- Continue decommissioning of high risk roads on private and federal forest land and maintain mature forests

Table 2.11 Continued

Fish Access and Habitat Connectivity
Benefit to Fish Abundance • Habitat utilized by Chinook salmon increases abundance over time Productivity • Increased nutrients provided from salmon carcasses improves stream productivity. Spatial Structure • Removes barriers preventing upstream migration of adult salmon • Increases Chinook salmon distribution • Reduces competition and risk to the population from environmental factors Diversity • Favors a greater number of individuals and life stages • Diversity increases do to gain of spatial structure

Table 2.12. <u>Vance Creek, 800 Bridge to Headwaters (RM 3.6 – RM 10.3)</u>: Original Conditions, Disruptions, Effect to Fish, Recovery Actions, and Benefit to Fish

Sediment Supply, Transport, & Distribution

Original Conditions

High sediment load (efficient transport in upper reaches)

Disruptions

Sediment load high due to hill slope (roads and mass wasting) and stream bank erosion. Accelerated sediment loading beyond capacity of stream to move. In tributaries, loss of sediment retention due to loss of wood in channel and loss of future wood recruitment.

Affect to Fish

<u>Abundance</u>

- Reduced success of spawning over time reduces the number of fish.
- Limited habitat reduces the number of fish.

<u>Productivity</u>

- Reduced quantity and quality of spawning and rearing habitat

<u>Spatial Structure</u>

- Loss of access to some types of habitat for adults and juveniles

<u>Diversity</u>

- Loss of potential life history traits

Recovery Actions

<u>Three- to Five-Year Actions</u>

- Assess, stabilize, abate, and monitor fine and course sediment sources
- Reduce sediment from roads
- Avoid timber harvest on steep slopes
- Remove/repair logging roads
- Monitor bed scour and bed stability

Table 2.12 Continued

Sediment Supply, Transport, & Distribution
Benefit to Fish Abundance • Increased spawning success over time increases the number of fish. Productivity • Increased amount and quality of spawning and rearing habitat • Minimizing sediment inputs in this reach assists in maintaining productive fish habitat downstream. Spatial Structure • Access to a greater number of types of habitat for adults and juveniles Diversity • Favors a greater number of individuals and life stages • Diversity increases due to gain of spatial structure

Large Woody Debris
Original Conditions High large woody debris loading. Old growth conifer forest.
Disruptions Loss of woody debris recruitment due to stream adjacent harvest and numerous debris flows
Effect to Fish Abundance • High mortality impact to juveniles Productivity • Reduced quantity and quality of spawning and rearing habitats • Reduced wood recruitment to downstream segment affecting productivity in that segment • Lowers carrying capacity of river Spatial Structure • Loss of quantity and quality of pools that result in fewer habitat types Diversity • Loss of potential life history traits
Recovery Actions Three- to Five-Year Actions • Riparian corridor protection /enhancement to restore riparian forests for supporting future wood recruitment and maintenance of channel complexity and downstream channel sinuosity • Protect intact habitat

Table 2.12 Continued

Large Woody Debris

Benefit to Fish

Abundance
- Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon
- Increases carrying capacity of river

Productivity
- Increased amount and quality of spawning and rearing habitat
- Increases carrying capacity of river

Spatial Structure
- Restores the quantity and quality of pool that provide habitat

Diversity
- Favors a greater number of individuals and life stages
- Diversity increases due to gain of spatial structure

Hydrology

Original Conditions

Much of the area is in rain or snow zone approximately 1,500' to 3,500' in elevation.

Disruptions

Peak flows higher. Higher intensity and shorter duration flows due to basin harvesting and high road density. The result is a loss of recharge and lower summer flows. Erosion processes accelerated with depositional landforms eroded.

Effect to Fish

Abundance
- Eliminates habitat thereby reducing the number of fish

Productivity
- Reduces the quality and quantity of habitat for spawning due to reduced flows and peak flows

Spatial Structure
- Loss of access to habitat types
- Habitat loss due to reduced flows

Diversity
- Loss of potential life history traits

Recovery Actions

Ten-Year Actions
- Continue decommissioning of high risk roads on private and federal forest land
- Reduce overall road network
- Maintain mature forests particularly within the rain on snow zone

Table 2.12 Continued

Hydrology
Benefit to Fish Abundance • Reduced mortality impact to juveniles • Increases carrying capacity of river Productivity • Provides juveniles with desirable habitats • Increased amount and quality of spawning and rearing habitat • Redds less susceptible to bed scour • Reduces competition for some species Spatial Structure • Restores the quantity and quality of pools that provide habitat Diversity • Favors a greater number of individuals and life stages • Diversity increases due to gain of spatial structure

Fluvial Geomorphology
Original Conditions V-shaped canyon in Crescent basalt geology. Glacial material plastered on valley walls and highly unstable. Single thread channel, moderate to steep gradient. Boulder and cobble dominant with some gravels and sands in lower gradients and behind logjams.
Disruptions Increase in sediment load of all particle sizes due to debris flows. Large deposits of smaller sediments in depositional areas that are highly erodible.
Effect to Fish Abundance • Loss of juvenile rearing and adult migratory, holding and spawning habitats Productivity • Spawning and rearing habitat quality and quantity reduced Spatial Structure • Aggraded channels with low or subsurface flow limit upstream distribution of Chinook salmon. Diversity • Loss of potential life history traits

Table 2.12 Continued

Fluvial Geomorphology
Recovery Actions Three- to Five-Year Actions • Continue decommissioning of high risk roads on private and federal forest land • Reduce overall road network • Maintain mature forests particularly within the rain on snow zone • Riparian corridor protection /enhancement to restore riparian forests for supporting future wood recruitment and maintenance of channel complexity and downstream channel sinuosity
Benefit to Fish Abundance • Reduced mortality impact to juveniles • Increases carrying capacity of river Productivity • Provides juveniles with desirable habitats • Increased amount and quality of spawning and rearing habitat • Redds less susceptible to bed scour • Reduces competition for some species. Spatial Structure • Restores the quantity and quality of pools that provide habitat Diversity • Favors a greater number of individuals and life stages • Diversity increases due to gain of spatial structure

Table 2.12 Continued

Riparian Function
Original Conditions Old growth conifer forests
Disruptions Original riparian forest removed in the lower portion of this segment affecting current wood levels and future recruitment potential. Loss of recruitment potential from tributary streams due to harvesting and debris flows.
Effect to Fish <u>Abundance</u> • Affects quality and quantity of riverine habitat capable of supporting juvenile and adult salmon <u>Productivity</u> • Reduction in quality rearing habitat affects carrying capacity and productivity. • Changes in food web support (nutrients, detritus, invertebrates) likely reduces productivity <u>Spatial Structure</u> • Affects the quality and quantity of habitats reducing abundance and productivity <u>Diversity</u> • Diversity affected due to the reduction or loss of quality habitats that affect abundance and productivity • Reductions in abundance and productivity over time reduce diversity. • Loss of potential life history traits
Recovery Actions <u>Three- to Five-Year Actions</u> • Riparian corridor protection /enhancement to restore riparian forests for supporting future wood recruitment and maintenance of channel complexity and downstream channel sinuosity • Protect intact habitat
Benefit to Fish <u>Abundance</u> • Improves quality and quantity of riverine habitat capable of supporting juvenile and adult salmon • Increases carrying capacity of river <u>Productivity</u> • Increased amount and quality of spawning and rearing habitat <u>Spatial Structure</u> • Restores the quantity and quality of pool that provide habitat <u>Diversity</u> • Favors a greater number of individuals and life stages • Diversity increases do to gain of spatial structure

Table 2.12 Continued

Fish Access and Habitat Connectivity
Original Conditions Anadromy ends at a falls about 30' high at approximately RM 7.0.
Disruptions Falls is still upper extent of anadromy, but lower reaches can be barriers due to low flow or subsurface flows for early returning fish and for movement of juvenile salmonids.
Effect to Fish <u>Abundance</u> • Chinook habitat is marginal within this segment but Chinook can penetrate to the fall if the lower segment is flowing. • Low flow and subsurface flow reduces abundance by prohibiting successful spawning and migration. <u>Productivity</u> • Limits Chinook productivity to accessible reaches only • Chinook production currently only occurs during abnormally wet summers and falls. • Loss of nutrients provided from salmon carcasses reduces stream productivity <u>Spatial Structure</u> • Barriers' preventing upstream migration of adult salmon forces distribution into lower stream reaches affecting their abundance and productivity. • Competition and risk to the population from environmental factors are increased when fish are not well distributed. <u>Diversity</u> • Diversity reduced due to loss of spatial structure • Loss of potential life history traits • Spring Chinook historically may have used Vance Creek for spawning and/or rearing
Recovery Actions <u>Ten-Year Actions</u> • Focus for fish access is primarily in lower segment of this reach. • Continue decommissioning of high risk roads on private and federal forest land • Reduce overall road network • Maintain mature forests particularly within the rain on snow zone • Develop a feasibility plan to restore natural riverine processes and functions with the focus in the lower reach

Table 2.12 Continued

Fish Access and Habitat Connectivity
Benefit to Fish Abundance • Habitat utilized by Chinook salmon increases abundance over time Productivity • Increased nutrients provided from salmon carcasses improves stream productivity. Spatial Structure • Removes barriers preventing upstream migration of adult salmon • Increases Chinook salmon distribution • Reduces competition and risk to the population from environmental factors Diversity • Favors a greater number of individuals and life stages • Diversity increases due to gain of spatial structure

Chapter Three
Harvest Management Recovery Strategy

The Role of Harvest in Recovery

Recovery of Chinook salmon in the Skokomish River will rely primarily on habitat protection and restoration to rebuild the abundance and productivity of natural Chinook salmon stocks. In the interim, as described in the next chapter, hatchery returns to the two local facilities will continue to contribute to natural spawning.

> <u>Vision for Skokomish Salmon Recovery</u>
>
> In the Skokomish Watershed, the co-managers will develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.
>
> <u>Goals for Skokomish Salmon Recovery</u>
>
> 2. Provide for abundant, productive, and diverse self-sustaining Chinook salmon throughout its historical distribution in the watershed. The plan seeks to accomplish this goal by:
>   f. Attaining abundances that are similar to those that occurred before extensive modification of the watershed in the last century;
>   g. Expanding the abundance and distribution of naturally producing fall (later-retuning) Chinook salmon in the South Fork;
>   h. Reestablishing a self-sustaining, natural population of early-returning Chinook salmon in the North Fork;
>   i. Attaining productivities that assure a low risk of extinction of the populations; and
>   j. Attaining productivities that assure sustainable harvest.
>
> 2. Provide significant contributions to reintroduce extirpated species and the recovery of other important species at risk and other key species that interact to support healthy salmonid ecosystems.
>
> 3. Secure and enhance natural production of other salmonids.
>
> 4. Assure that the economic, cultural, social, and aesthetic benefits derived from the Skokomish ecosystem will be sustained in perpetuity.

The primary objectives of harvest management are (1) to ensure that a sufficient number of Chinook salmon escape to adequately seed available habitat in the mainstem, South Fork and North Fork Skokomish, and (2) to provide broodstock for the next generation of hatchery production. Achieving these objectives will assure that harvest does not impede recovery.

Natural Chinook salmon production is dependent on the number of spawners and their fecundity, the fitness of their offspring, and the multi-dimensional aspects of freshwater and estuarine habitat quantity and quality that determine the survival of eggs, alevins, rearing juveniles, and smolts. Marine productivity and habitat conditions in estuaries and the nearshore and coastal zones used by outmigrant juvenile and subadult Chinook also have a significant effect on survival. Habitat quality and quantity, therefore, exert strong influences on the number of juveniles produced and the number of Chinook surviving to adult.

Harvest management affects Chinook production principally by its influence on escapement. However, the types of fishing gear involved and the local intensity of commercial and recreational harvest in all fisheries that Skokomish Chinook encounter in Canada, Washington coastal ocean areas, Puget Sound, or Hood

Canal, may have subtle but significant effects on the age and size of adults that escape, and on the breadth of their migration and spawn timing.

If harvest is properly constrained, the number of escaping adults can optimize natural production under existing habitat quality and capacity. Careful monitoring of habitat conditions and natural Chinook production can enable adjustment of harvest management goals and strategic objectives as habitat conditions change, presumably for the better.

General Legal Framework and Guiding Principles for Chinook Harvest Management

The primary legal structure for managing harvest policy affecting Skokomish Chinook salmon largely rests with three closely intertwined processes: the Pacific Salmon Treaty, the Pacific Fisheries Management Council, and the co-management of harvest in inland waters as provided by *US v. Washington* (see Appendix C.). 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 (see Appendix C).

The guiding principles that provide for both recovery and harvest opportunities for the Puget Sound Chinook ESU and for Skokomish Chinook are described in the Puget Sound Harvest Management Plan (see Appendix C).

Skokomish Chinook salmon represent an essential component of the Puget Sound ESU. Because of uncertainty about the potential for the mid-Hood Canal rivers (the Hamma Hamma, Duckabush, and Dosewallips Rivers) to support an independent Chinook salmon population and the critically depressed status of returns to those systems (Ruckelshaus et al. 2006), protection and recovery of natural Chinook salmon production in the Skokomish system is vitally important to maintaining the diversity of the ESU.

Population Status

Skokomish River Chinook salmon are described as a Category 2 population, because indigenous stocks have been extirpated or substantially reduced and current natural production is comprised primarily of hatchery-origin fish. Genetic analyses suggest that the 'historical genetic characteristics of the early and late-returning populations were replaced or substantially altered by Green River-origin fish' (Ruckelshaus et al. 2006), which were used to found the Skokomish hatchery program. Genetic analyses have not identified the presence of a native fall Chinook salmon component in the existing population.

Spawning escapement to natural areas has remained relatively stable over the past ten years (1997 – 2006), and has met, or exceeded, the escapement goal of 1,650 Chinook four times during that period (Figure 3.1, also see Table 1.2 in Chapter 1). The hatchery program has contributed to the persistence of natural spawners. First-generation hatchery-origin adults have contributed 20 to 80 percent, and averaged 60 percent, of natural escapement in recent years (WDFW and PSIT 2007). Escapement to George Adams Hatchery has increased dramatically over the last ten years, and has averaged 11,900 in the last five years (Figure 3.1, also see Table 1.2 in Chapter 1). Despite apparently stable escapement, it appears that natural Chinook productivity remains chronically depressed.

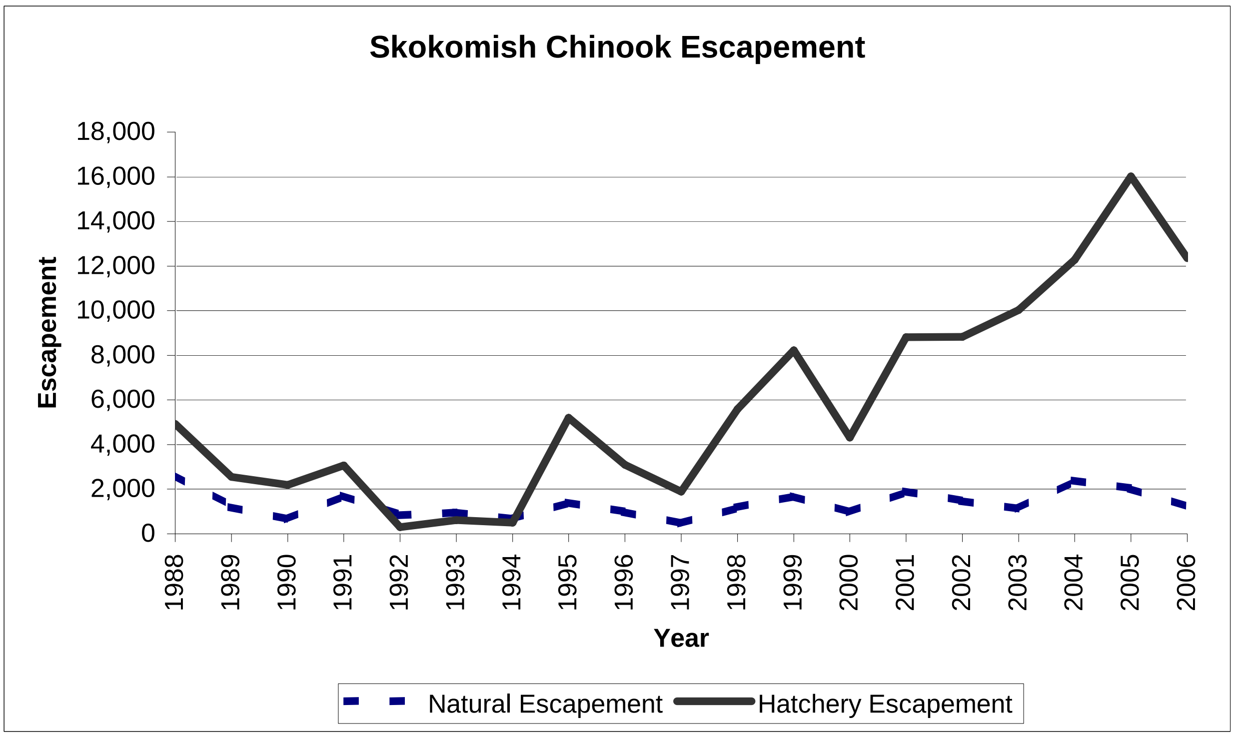


Figure 3.1. Chinook escapement in the Skokomish River and to George Adams Hatchery

Harvest Distribution

Commercial and recreational fisheries harvest Skokomish Chinook salmon in the coastal waters of Alaska, British Columbia, and Washington as well as in Puget Sound. Coded-wire tagged adults from the George Adams Hatchery recovered from all these fisheries suggest that Alaska fishers account for about two percent, and British Columbia accounts for about 40% of the total harvest of Skokomish Chinook salmon. Washington coastal troll and Puget Sound net fisheries (including those in Hood Canal and the Skokomish River) account for 26% of the harvest and Washington recreational fisheries account for 32% of the catch (PSC Chinook Technical Committee 2007 – see Appendix C for detail). These data show that a substantial portion of the harvest occurs outside of the immediate jurisdiction of the Washington co-managers.

Harvest Management Goal

The harvest management goal for Skokomish Chinook is to provide substantial and stable commercial, recreational, ceremonial, and subsistence harvest opportunity. Provision of harvest opportunity will, however, be subject to constraints that assure sustainability, conservation and recovery of the Skokomish Chinook populations.

Objectives for Harvest Management

The principal objective of harvest management will be to assure that escapement is sufficient to seed the available habitat at its capacity, as determined by productivity, through all the freshwater life stages. As habitat quality improves, or when additional suitable areas are made accessible, the harvest and escapement objectives will be adjusted to provide the necessary spawning escapement. Production potential is related to not only the quality and quantity of spawning habitat, but also that of rearing habitat along the mainstem and in the estuarine delta and nearshore areas.

Current and future harvest management will require balancing of harvest and conservation objectives. The current hatchery program provides harvest opportunity that partially mitigates for the loss of natural Chinook production and also contributes to natural escapement. A goal of this Recovery Plan is to restore the ability of naturally-produced Chinook to provide economic, social and cultural benefits once provided by Skokomish Chinook salmon. The listing of the Puget Sound Chinook ESU mandates that harvest meet the conservation standards of the ESA, so that it does not significantly reduce the probability of survival and recovery of the ESU.

Harvest Management Strategic Objectives

- Strategy 1: Manage harvest of Skokomish Chinook as a composite stock with natural-origin and hatchery-origin components, to constrain the rate of harvest in Washington fisheries to provide suitable levels and distribution of spawning escapement.

- Strategy 2: Adjust the harvest management strategy and actions in response to improved knowledge of current natural Chinook productivity or improved habitat conditions

Strategic Objective 1: Manage harvest of Skokomish Chinook as a composite stock

Skokomish Chinook salmon are a composite stock, with natural-origin and hatchery-origin components, both of which are made up of genetically and phenotypically similar fish. Both components contribute to natural reproduction, though the majority of spawning adults are of hatchery origin in some years. Sampling of adults on the spawning grounds, to detect adipose fin marks and coded-wire tags, indicates that on average about 60% of recent escapements are first generation hatchery fish (WDFW and PSIT 2007). Annual estimates of the hatchery contribution to natural escapements have ranged from about 20% to 80%. Current harvest objectives recognize that the majority of returning adults home to the hatchery, but management actions are primarily intended to assure that enough Chinook salmon spawn naturally to optimize production within the constraints of current habitat capacity.

The Puget Sound Chinook Harvest Management Plan (HMP) constrains pre-terminal fisheries in Washington such that their exploitation rate on Skokomish Chinook does not exceed a specific ceiling rate determined by the status of the population. Terminal-area fisheries are managed to achieve specified levels of natural escapement in accordance with current habitat capacity, and sufficient hatchery escapement to perpetuate enhancement programs in the Skokomish River.

Strategic Objective 2: Adjust the harvest management strategy or actions in response to improved knowledge of current natural Chinook productivity or improved habitat conditions

Harvest management objectives are established with the intent of ensuring that the resulting level of spawning escapement is consistent with the capacity of natural habitat and the productivity of the Chinook population. The current harvest objective is based on imperfect knowledge of current capacity and productivity. The co-managers will collect the data required to accurately estimate current productivity, and to detect change in productivity in response to habitat restoration actions.

The co-managers will continue to collect data and perform technical analyses that quantify abundance, productivity, distribution, and diversity. In practice this will involve estimating (1) spawner escapement, (2) the number of juvenile Chinook (smolts) emigrating from the river and the number of returning adults that were produced by natural spawners from each generation, and, (3) the distribution and timing of spawning and distribution of juvenile production in the Skokomish watershed. Quantifying the relationships between spawners and juvenile production or adult recruits provide direct measures of habitat capacity (i.e., the number of spawning adults required to optimize natural production) and productivity (i.e., the number of smolts and/or adult recruits produced per spawner). This information will guide the adjustment of harvest management exploitation rates and escapement thresholds.

In the short-term (i.e., in the next 5 to 10 years), it is unlikely that natural Chinook production will, by itself, support the production and harvest objectives. It is expected that Chinook hatchery programs will continue to provide the majority of harvestable surplus and hatchery-origin adults will contribute to natural production of the composite Chinook stock. An accurate estimate of current productivity and habitat capacity may result in an adjustment of the escapement goal, and potentially, an adjustment to the harvest exploitation rate ceiling or terminal-area harvest strategy.

The current Chinook stock will continue to adapt to habitat conditions in the Skokomish River. In the longer term (i.e., within twenty years), it is likely that habitat conditions will improve as a result of diverse habitat restoration activities envisioned by this plan.

Monitoring information may show that habitat has recovered to the point of being capable of sustaining productive natural Chinook production that is less dependent of the support now provided by the hatchery program. As habitat conditions improve, this will contribute to Skokomish Chinook productivity (and capacity, distribution and diversity). As continued monitoring indicates increased natural productivity, the co-managers will consider appropriate criteria and time frames for adjustment of the harvest management strategy and adjustment of escapement objectives. It is expected that the natural spawning escapement goal will increase and/or that harvest opportunity will take full advantage of recovering Chinook populations.

Harvest management will continue to be integrated with hatchery management. Local adaptation could be promoted by enhancing the fitness of hatchery-origin fish that contribute to natural spawning, by integrating wild Chinook into the hatchery broodstock, altering hatchery practices, and by reducing the extent to which first generation hatchery returns interbreed with natural origin adults. Harvest management may also assist local adaptation of natural-origin Chinook by focusing harvest on hatchery returns.

Harvest Implementation Actions

Actions to implement the goals and strategic objectives for harvest management are as follows:

<u>Implementation Action 1</u>: Manage harvest of Skokomish Chinook as a composite stock

In the twenty-year scope of this plan, Skokomish Chinook will continue to be managed as a composite stock under exploitation rate ceilings imposed on pre-terminal fisheries in Washington, and a terminal harvest strategy designed to achieve the appropriate level of natural escapement, and returns sufficient to perpetuate the hatchery programs. Now, and as recovery proceeds, harvest management also will promote conserving the spatial distribution and diversity of natural spawners by distributing the terminal area harvest impact across the migration timing of Chinook salmon in terminal marine areas and in the Skokomish River. Potential selective effects of fisheries, that may affect the size, sex ratio, or age distribution of escaping adults, are believed to be adequately controlled under the current harvest regime.

The current harvest management regime will remain in effect under the current HMP through at least 2009 (see Harvest Recovery Actions for Skokomish Chinook in Appendix C). This approach has resulted in natural escapements consistently more than 1,200 Chinook, and returns to the George Adams Hatchery more than sufficient to meet its broodstock requirements. In addition, assuming that recent survival rates will continue, escapement will be sufficient to provide additional adults for transport into the upper South Fork, under the proposed supplementation program (see Chapter 4 Hatchery Management).

An updated Puget Sound Chinook HMP will be developed by the co-managers and NOAA-Fisheries and implemented beginning with the 2010 season. Any changes or modifications to the harvest management of Skokomish Chinook will be described in the revised HMP.

<u>Implementation Action 2</u>: Adjust the harvest management strategy or actions in response to improved knowledge of current natural Chinook productivity or improved habitat conditions

Over the next five to ten years, the co-managers will advance technical analyses of the natural productivity of Skokomish Chinook salmon. Three approaches will be followed:

- Cohort reconstruction, using escapement estimates, catch data, and coded-wire tag (CWT) recoveries and mark sampling from fisheries and escapement, will be compiled over successive brood years to develop a spawner – adult recruit function that quantifies the current capacity of habitat. The Co-managers have recently initiated an effort to compile all available data needed for cohort reconstruction.

- Smolt emigration studies will be initiated to measure juvenile production from the South Fork. Comparing estimates of total smolt production to escapement will provide useful insight into freshwater survival, the functionality of spawning and rearing habitat in the lower and upper reaches of the South Fork, and a reevaluation of the current habitat capacity estimates.

- Modeling of Chinook salmon production potential using habitat-based models (e.g., the Ecosystem Diagnosis and Treatment model or similar methodology) or Population Viability Analysis models (e.g., SimSalmon, VRAP, or others) will be refined to provide independent assessments of current productivity and habitat capacity. These technical analyses may lead to adjustment of current harvest and escapement objectives to be in alignment with the best available estimates of natural Chinook productivity and habitat capacity.

The current natural escapement goal of 1,650 Chinook is the average of estimated escapements from 1965 through1976 (WDF 1977). At present, this is the best available estimate of optimum escapement (i.e. the level that will achieve maximum sustainable yield (MSY or MSH). A more accurate assessment of productivity and capacity is essential to better define the range of escapement that will optimize production under current conditions that determine freshwater and marine survival. As mandated by the current Puget Sound Chinook HMP, the intent is to consistently achieve or exceed the estimate of current optimum (MSY) escapement, under average environmental conditions, to take full advantage of favorable survival conditions as they occur.

If current natural productivity can be estimated accurately, using cohort reconstruction or habitat-based models to derive a spawner-recruit function, estimates of suitable spawning escapement (e.g., equivalent to MSH) and habitat capacity can also be derived. This information will be applied to adjusting the current, nominal escapement goal of 1,650 Chinook.

<u>Implementation Action 3</u>: As habitat restoration improves conditions for Chinook spawning and rearing, further adjust harvest objectives to increase the proportion of natural-origin spawners, or otherwise maximize local adaptation of the composite stock.

Habitat conditions and Chinook productivity are expected to improve over the long term. It may be possible to test productivity experimentally, by providing a range of escapement over a period of years, and carefully monitoring smolt production and adult recruitment, to detect an increase in productivity.

The natural productivity and capacity of Skokomish Chinook will be affected by habitat restoration actions and harvest will need to be adaptively managed and integrated with these efforts. Over the long term, (i.e., the next 20 years) habitat restoration and protection efforts are expected to bring about an increase in Chinook salmon production and productivity, to an extent that natural production becomes more independently sustainable.

The spawning and rearing capacity of the North Fork will be assessed under the enhanced-flow regime established by the City of Tacoma Cushman Project operating license. It is anticipated that the North Fork will eventually support a re-introduced early-timed Chinook salmon population in addition to the current fall stock. The harvest management regime for this population will be developed by Co-manager agreement.

Supplementation of natural spawning in the upper South Fork will also involve estimating habitat capacity to determine how many adults to transport. The recent survival rates for fingerling chinook released from the George Adams Hatchery have produced returns substantially higher than the broodstock requirement, so strategies are evolving to harvest more of this surplus. It is expected that the surplus will also meet the short –term needs of the South Fork supplementation project.

As the potential for natural production improves, the harvest management strategies and objectives will evolve to increase the proportion of natural-origin Chinook that spawn naturally, thereby mitigating the potential genetic influence on wild fitness associated with interbreeding of hatchery- and natural-origin adults, and fostering continued adaptation of the composite stock to the unique conditions in the Skokomish system.

Mark-selective fisheries (MSF) may provide increased harvest opportunity and are a potentially useful tool for managing the composition of natural escapement. As more of the Chinook production in Hood Canal hatcheries is mass marked (see Chapter 4), mark-selective fisheries can be used in pre-terminal areas to target the harvest of hatchery-origin (i.e., marked) Chinook while protecting (releasing) natural-origin (i.e., unmarked) Chinook. It is important to understand the potential effect of pre-terminal MSF on the magnitude and composition of the Skokomish Chinook terminal run, especially in the context of meeting co-manager objectives for pre-terminal and terminal harvest. Terminal area MSF (i.e., those in Hood Canal and the Skokomish River) may also be considered to focus recreational fishery harvest and commercial net harvest on hatchery-origin returns.

Chapter Four
Hatchery Management Recovery Strategy

The Role of Hatcheries in Recovery

The role for hatcheries in salmon recovery for the Skokomish River Watershed is based on the premise that artificial production of salmon can provide important short-term and long-term benefits to threatened salmon populations, the ecosystem, and the peoples who rely on them. In this way, hatcheries serve as a critical substitute for degraded natural processes that will take time to recover as habitat restoration takes place while minimizing the risks to threatened Chinook salmon.

> Vision for Skokomish Salmon Recovery
>
> In the Skokomish Watershed, the co-managers will develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.
>
> Goals for Skokomish Salmon Recovery
>
> 3. Provide for abundant, productive, and diverse self-sustaining Chinook salmon throughout its historical distribution in the watershed. The plan seeks to accomplish this goal by:
>   k. Attaining abundances that are similar to those that occurred before extensive modification of the watershed in the last century;
>   l. Expanding the abundance and distribution of naturally producing fall (later-retuning) Chinook salmon in the South Fork;
>   m. Reestablishing a self-sustaining, natural population of early-returning Chinook salmon in the North Fork;
>   n. Attaining productivities that assure a low risk of extinction of the populations; and
>   o. Attaining productivities that assure sustainable harvest.
>
> 2. Provide significant contributions to reintroduce extirpated species and the recovery of other important species at risk and other key species that interact to support healthy salmonid ecosystems.
>
> 3. Secure and enhance natural production of other salmonids.
>
> 4. Assure that the economic, cultural, social, and aesthetic benefits derived from the Skokomish ecosystem will be sustained in perpetuity.

Figure 4.1 illustrates the relationship between hatchery and habitat strategies in the Skokomish River and what people of the watershed desire for themselves and future generations. Hatcheries offer the possibilities of maintaining or increasing abundance of salmon, reintroducing stocks or species, and expanding the distribution of existing ones. Salmon can respond quickly to these actions but the results may not be sustainable without continued hatchery production. In contrast, habitat recovery can restore ecosystem processes that form and sustain naturally reproducing salmon and salmon populations, but the results may take much longer. Using hatcheries and habitat recovery in unison can be and, in the present case, is a more efficient and successful approach to achieving the short- and long-term goals for the watershed than using either one alone.

Habitat restoration is the cornerstone to Chinook salmon recovery, but rehabilitating degraded natural processes that create and sustain critical habitat may take 50 to 100 years or more to attain. In fact, it may prove impossible to restore the Skokomish Watershed completely to the pre-1850 condition that supported historic runs. Consequently, hatcheries have played and will continue to play an essential role in managing and protecting the resources of this watershed.

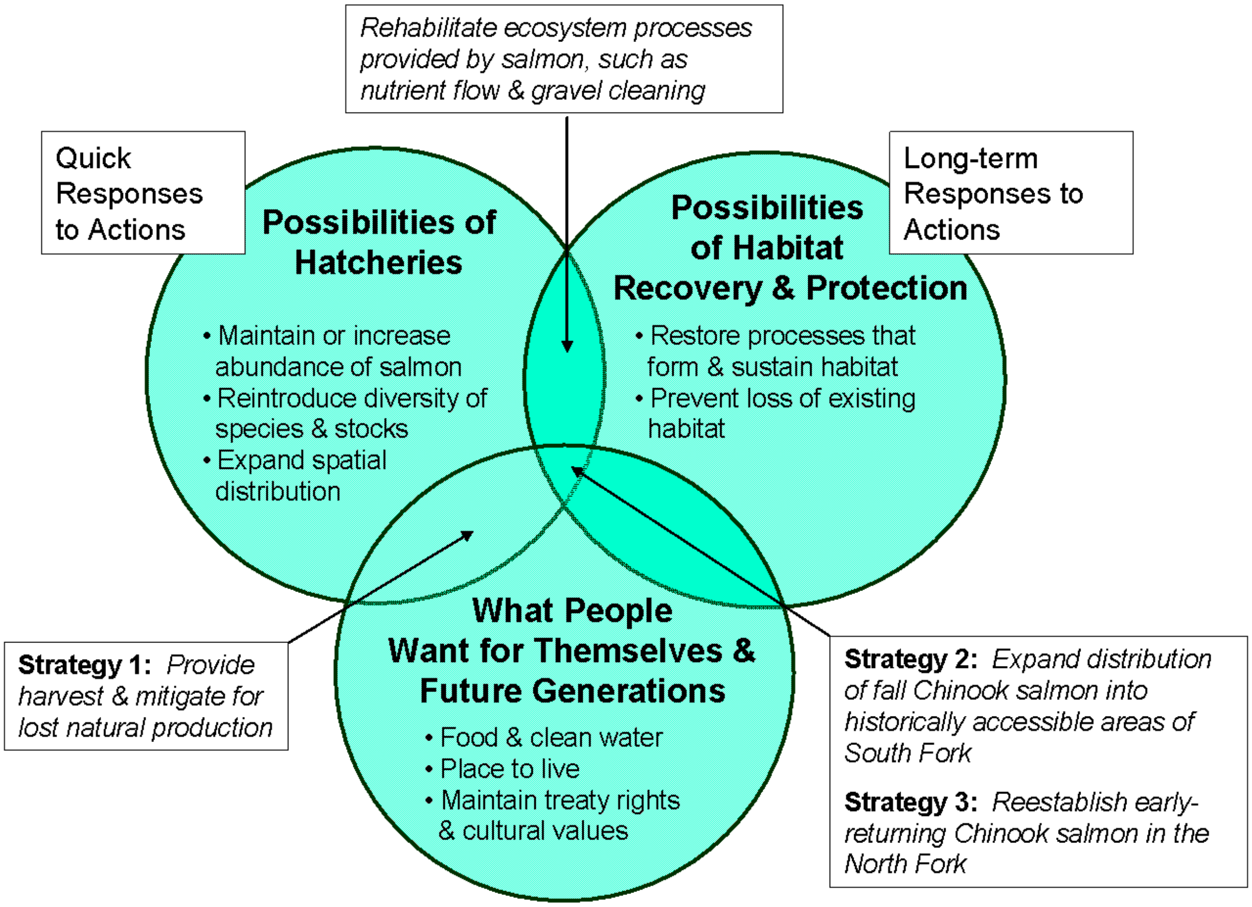


Figure 4.1. Relationship of hatchery and habitat goals and public policy for recovery of Skokomish River Chinook salmon populations

Hatchery Strategic Objectives

As shown in Figure 4.1, there are three hatchery strategic objectives for achieving the goals for Chinook salmon recovery within the Skokomish Watershed:

<u>Strategic Objective 1</u>: Continue to provide for harvest and escapement and mitigate for lost natural production

Hatcheries perpetuate Chinook salmon as a species until ecosystem repairs are possible and they provide the necessary abundance to make harvest possible. In this regard, hatcheries are particularly important in meeting tribal treaty obligations. The 1974 landmark court case *United States v. Washington* established that without salmon the fishing rights reserved by the Tribes in treaties with the United States government cannot be met and that hatchery fish must be included in meeting the treaty rights. Hatchery and harvest management is now the shared responsibility of the co-managers: the State of Washington and the Skokomish Indian Tribe and other Point No Point Treaty tribes. In the Skokomish Watershed, there has been a conscious trade-off to partially compensate for the dramatic loss of habitat and natural production, especially on the North Fork Skokomish, by using artificial propagation to provide fish for harvest. This is reflected in Figure 4.2.

The operating premise of Strategy 1 is that with appropriate management, the George Adams and Hoodsport hatchery production can be used to maintain harvest and support and expand natural production in Skokomish River while partially mitigating for lost production due to habitat degradation and minimizing the potential risks associated with artificial production and harvest.

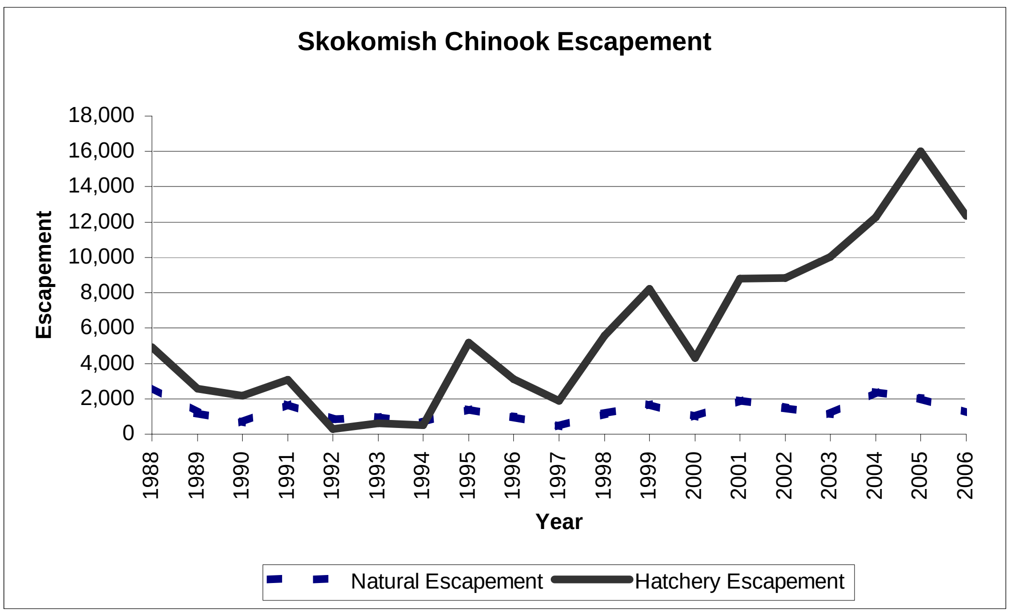


Figure 4.2. Hatchery and wild Chinook escapement in the Skokomish River

<u>Strategic Objective 2</u>: Expand the distribution of fall Chinook salmon in the South Fork

Current management of Skokomish River Chinook salmon tries to allow for escapement of 1650 adults into the river to spawn. These fish are comprised of natural origin (i.e. hatched in the wild) and hatchery-origin fish, although the proportions vary. In the South Fork, spawning is limited in most years to the area downstream of Vance Creek because gravel aggradation and low stream flows have effectively blocked passage to spawning and rearing areas upstream. The objective of this strategy is to move adult fall Chinook salmon into the areas upstream of this blockage. This includes areas of spawning habitat 10-15 miles upstream of the canyon section that has not consistently been used since the indigenous spring Chinook salmon were extirpated from the drainage. Although it is not known yet how much expansion might boost abundance of returning natural origin Chinook salmon, the operating hypothesis is that it will provide immediate improvement in spatial distribution, help increase diversity, and increase the number of natural-origin juveniles.

Strategic Objective 3: Reestablish early-returning Chinook salmon to the Skokomish River (with initial focus on the North Fork)

The historical population of Chinook salmon in the North Fork had an early-returning life history and may have had annual returns of adults in the range of 30,000-60,000 fish (Lichatowich 1992). The combined effects of blocked fish passage and loss of stream flows, caused by dam construction and flow diversion in service of hydroelectric operations, extirpated it from the watershed.. Although there is limited spawning in a few miles of the lower North Fork, recent changes in the legal constraints that had stymied opportunities to reestablish Chinook salmon in the North Fork may now allow for increased stream flows and passage of Chinook salmon upstream of the dams.

Reestablishing an early-returning Chinook salmon to this fork of the river would increase the diversity, abundance, and spatial structure of the Chinook salmon in the watershed, the region, and the ESU, but the challenges are large and may take some time to overcome. They include implementing the necessary stream flows, passage, and habitat restoration activities; identifying an appropriate genetic strategy for an early-returning life history, such as potential donor stocks or selecting for earlier returns; revising harvest management; and providing adequate hatchery facilities to raise the fish. The implementation of this strategy will occur in three phases as described below under Implementation Action 3.

Benefits and Risks of Hatchery Strategies

The three strategies identified above should provide both immediate short-term and long-term benefits to salmon and the people who depend on them. There are present-day concerns, however, that past hatchery practices have jeopardized the fitness of naturally spawning populations. For example, Green River hatchery stock imported as mitigation for lost natural production has interbred with the small numbers of indigenous Skokomish River Chinook that survived the dams, habitat destruction, and harvest to such an extent that the native gene pool is no longer distinguishable, resulting in a significant loss of diversity and possibly of fitness. Other concerns about hatchery fish focus on the potential of disease amplification, predation, and increased competition with wild populations. Such issues could affect the results of recovery activities to reestablish and rebuild natural populations in this watershed.

Experience has shown that these risks cannot be eliminated, but they can be controlled and therefore we should use existing tools and advances in hatchery science to maximize the benefits possible by hatcheries while minimizing the potential risks. Even before the co-managers began developing this recovery plan, they reviewed all of their hatchery programs internally for consistency with the Endangered Species Act, participated in an independent review of hatcheries by the Hatchery Scientific Review Group (HSRG), and developed hatchery and genetic management plans (HGMPs) to minimize risk to natural populations and comply with Section 4(d) of ESA. For further discussion, see Appendix D.

Hatchery Implementation Actions

Continuing current hatchery programs, along with introducing two new initiatives, will implement the strategic objectives for hatcheries in the Skokomish River Watershed. The following discussion examines each of these actions in context to their appropriate strategic objectives.

<u>Implementation Action 1</u>: Continue operation of existing hatchery programs

Continuing hatchery operations as they currently exist is important for attaining the strategic objective of providing harvest and escapement through natural spawning using the George Adams fall Chinook salmon stock. This action is crucial for implementing *Strategic Objective 1*.

Funding is currently available for Implementation Action 1.

The Washington Department of Fish and Wildlife raises or supports the release of nearly 7 million fall Chinook salmon in or near the Skokomish River Watershed to provide for harvest and escapement for natural spawning (Table 4.1). This production program consists of three hatcheries that manage hatchery and natural spawning populations as a composite population. This approach, known as an *integrated production strategy*, allows artificially propagated fish to spawn in the wild to become reproductively integrated into the natural population and natural-origin fish to be included in the broodstock. Under the best possible conditions, an integrated strategy uses a larger proportion of natural-origin fish as broodstock than the proportion of hatchery-origin fish spawning in the wild. In the Skokomish River Watershed, however, analyses indicate that this will not be possible until habitat restoration has progressed to the point where it significantly boosts the productivity and abundance of natural-origin fish.

Table 4.1. Current hatchery production of fall Chinook salmon in the Skokomish River watershed under Strategy 1

Production facility	Number of Fall Chinook		Watershed of release
	Fingerling	Yearling	
George Adams	3,800,000		Skokomish River
Hoodsport	2,800,000	120,000	Finch Creek
Rick's Pond		120,000	Skokomish River
Total Production	6,600,000	240,000	

Two hatchery facilities in the Skokomish River Watershed and one on Finch Creek in southwest Hood Canal that focus on fall Chinook salmon production are: George Adams, Rick's Pond, and Hoodsport.

George Adams Hatchery. The Washington Department of Fish and Wildlife owns and operates the George Adams Hatchery located at RM 1.0 on Purdy Creek. The facility was constructed in 1960 and enlarged to its current size in 1977. The physical layout spans 31 acres and relies on raceways and rearing and release ponds for production. The facility produces around 3.8 million Chinook fingerlings annually by collecting and spawning returning George Adams brood stock, a derivative of Green River fall Chinook salmon that were introduced into the watershed, incubating the eggs, and then releasing them into Purdy Creek (George Adams Fall Chinook HGMP). The hatchery also provides Chinook eggs for Rick's Pond on the Skokomish River (see below). In addition, George Adams Hatchery currently rears and releases 300,000 coho yearlings and supports chum production at McKernan (also in Skokomish River Watershed) and Hoodsport hatcheries.

Rick's Pond Fall Chinook Salmon Program. Rick's Pond is a dirt-bottom rearing and release pond owned and managed by Long Live the Kings (LLTK), a private nonprofit organization. The pond is located near the mouth of an unnamed tributary at RM 2.9 on the Skokomish River mainstem. The facility has been raising yearlings since 1996 and annually releases approximately 120,000 Chinook yearlings. George Adams Hatchery provides Chinook fry to Rick's Pond and to LLTK Lilliwaup Hatchery and Chinook reared at LLTK Lilliwaup Hatchery are transferred to Rick's Pond for final rearing and release. Timings of the release are done to minimize impacts to naturally spawned Chinook salmon juveniles (Rick's Pond HGMP). The rearing and release of Chinook fingerlings (instead of yearlings) at Rick's Pond is being discussed by the Co-managers and may be implemented beginning with brood year 2008.

***Hoodsport (Finch Creek) Hatchery*.** The Hoodsport Hatchery is at the mouth of Finch Creek, approximately five miles north of the Skokomish Estuary. This Washington Department of Fish and Wildlife facility covers slightly over 4 acres and contains a hatchery building with an incubation room and 17 raceways of different sizes. The program has been rearing fall Chinook salmon fingerlings since 1953 and Chinook yearlings since 1995.

The Washington Department of Fish and Wildlife operates the Hoodsport Hatchery as an integrated harvest program. It releases 2.8 million fingerling and 120,000 yearling Chinook salmon to provide for increased harvest opportunities. The timing of releases after April 1 is done to minimize predation or competition with ESA-listed Hood Canal summer chum salmon. The broodstock origin is mixed (Hoodsport Fall Chinook Yearling HGMP 2002 and Hoodsport Fall Chinook Fingerling HGMP 2002). It is possible to operate the Hoodsport program to meet the expected standards of an isolated harvest program.

Other Hatcheries. Three other hatchery facilities—McKernan Hatchery, Enetai Hatchery, and Sund Rock Net Pens—once produced Chinook salmon but no longer do so. However, both McKernan Hatchery and Enetai Hatchery continue to raise and release other species of salmon (see Appendix D). McKernan Hatchery is a satellite facility to George Adams Hatchery and is located two miles west of George Adams Hatchery on Weaver Creek, a tributary of the Skokomish River. It currently produces no Chinook salmon for Hood Canal, although it occasionally holds Chinook salmon for release in South Puget Sound. Enetai Hatchery is operated by the Skokomish Tribe on Enetai Creek, just north of the Skokomish River. The Sund Rock Net Pens no longer exists but was a satellite facility to the Hoodsport Hatchery that was located along the shoreline of Hood Canal approximately two miles north of the Hoodsport Hatchery.

Implementation Action 2: South Fork supplementation program

The purpose of this program is to expand the distribution, diversity, and abundance of natural spawners in the South Fork of the Skokomish River. Until recently, natural spawning has occurred from river mile 1 to 5 in the South Fork. WDFW has surveyed this area for spawners since the 1960's. In recent years, however, spawning has been limited to the area downstream of Vance Creek because gravel aggradation and low summer stream flows have effectively blocked passage to spawning and rearing areas upstream. In addition to the lower five miles, usable spawning habitat exists upstream of the canyon section 10-15 miles upstream where the river valley broadens out and the gradient is not as steep. This area has probably not been used since the indigenous spring

Chinook salmon were extirpated from the drainage, although only a few surveys exist for this area. Spring flows from the South Fork would allow juveniles to migrate downstream and out of the river.

New funding will be needed for Implementation Action 2 and comprehensive cost estimates have not yet been developed.

The operating principle for this program is to keep it as simple as is possible in approach, yet remain effective in achieving its desired outcome. The following major points outline the proposed program:

1. Returning Skokomish fall Chinook salmon would be captured in the lower Skokomish River and/or at George Adams Hatchery, transported upstream of the blockage, and released in pools.

2. The first priority is to use adults because that approach is the least expensive alternative, it would have minimal potential for hatchery domestication effects that can occur during traditional hatchery rearing of juveniles, and it allows the co-managers to control the percentage of hatchery salmon that move into the river[11].

3. The number of adults transported will be based on assessments of the spawning and/or rearing capacity in the South Fork and adult availability.

4. Natural production of the transported fish would be monitored by trapping out-migrating juveniles in a screw trap in conjunction with a study of steelhead in the South Fork being conducted by the National Marine Fisheries Service and the co-managers.

5. The program could begin in fall 2008. As indicated in Figure 4.1, the program could continue (short term) until a productive naturally-spawning population is distributed throughout the South Fork (long term). This should happen naturally as flows increase in the lower river.

Implementation Action 3: Early-returning Chinook Reestablishment Program (with initial focus on the North Fork)

The purpose of this program is to reestablish early-returning Chinook salmon to the North Fork of the Skokomish River. Historically, the North Fork was a major producer of spring Chinook salmon in Hood Canal with annual returns of adults in the range of 30,000-60,000 fish (Lichatowich 1992). These fish were extirpated from the watershed by the combined affects of dams constructed for hydroelectric operations and loss of stream flows caused by these operations.

[11] Identified by external marks (adipose-clipped fins) and/or coded-wire tags.

Increased flows and passage upstream of the barrier dams are now a possibility for the first time since this population was extirpated (see Chapter 5, Hydropower Management Recovery Strategy).

Reestablishing an early-returning Chinook population in the North Fork will not only increase the diversity, productivity, abundance, and spatial distribution of Chinook in the Skokomish River, but it has important implications for the entire Puget Sound ESU. The recovery criteria adopted by the co-managers and the federal government for this species calls for two recovered populations in Hood Canal. Only two populations occur in Hood Canal, the hatchery supported Skokomish fall Chinook salmon population and the Mid-Hood Canal population, which is an aggregation of natural spawners in the Dosewallips, Duckabush, and Hamma Hamma rivers (Ruckelshaus et al. 2006).

Consequently, restoring the passage, habitat, and Chinook population to the North Fork will significantly increase the likelihood of salmon recovery for the whole Puget Sound.

New funding will be needed for Implementation Action 3 and comprehensive cost estimates have not yet been made.

This program has significant challenges to overcome once passage and flows are available (see Chapter 2, Habitat Management Restoration Strategy). The immediate strategy is to identify the issues and prioritize actions so that the program can begin as soon as possible. A preliminary list is in Table 4.2. Although some aspects may begin in the next 2-5 years, it will probably take 5-10 years for full implementation of the action.

Table 4.2. Technical issues to be resolved in the establishment of early Chinook salmon hatchery program in the Skokomish River

Issue	Planning Phase
Identifying a brood stock strategy to reestablish early-returning Chinook. Main two options are • Using an existing spring Chinook stock, such as Minter Creek White River stock • Artificially selecting for early return timing using existing George Adams stock	Phase 1 (1-5 years)
Identifying appropriate hatchery facilities	Phase 1
Determining the appropriate size of the program over time based on assessment of Chinook capacity in North Fork.	Phase 1 & 2
Implementing release strategies to minimize possible negative interactions with other species or hatchery programs in the estuary	Phase 2 (5-10 years)
Interactions with native and non-native species in the North Fork, including the resident population of Chinook salmon in Lake Cushman and bull trout	Phase 1 & 2
Marking and monitoring strategies	Phase 1
Potential changes in harvest regulations • To protect reestablishing early-returning Chinook • To protect other species as North Fork Chinook become available for harvest.	 Phase 2 Phase 3 (10-20 years)
Identify funding sources	Phase 1 & 2

Chapter Five
Hydropower Management Recovery Strategy

The Role of Hydropower Management in Recovery

The approach for managing hydropower in the Skokomish Watershed is based on the hypothesis that mitigating the impacts of Cushman Dam operations will provide significant short- and long-term benefits to recovering threatened Chinook salmon stocks and the ecosystem.

The Cushman Project with its withdrawal of water from the North Fork of the Skokomish River and construction of barrier dams has had the single largest land use impact on natural processes in the watershed as described in Chapter 2. The subsequent disruptions caused by the dewatering of the North Fork and blocking upstream salmonid access have contributed to the threatened status of Chinook salmon in the Skokomish watershed and other Hood Canal systems, as well as eliminating early runs of spring Chinook salmon and diminishing treaty rights. Mitigating the effects of dam operations will deliver significant benefit to Chinook by increasing spatial structure, abundance, productivity, and diversity. These improvements would over time lead to less reliance on hatcheries and increased opportunities for harvest.

<u>Vision for Skokomish Salmon Recovery</u>

In the Skokomish Watershed, the co-managers will develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.

<u>Goals for Skokomish Salmon Recovery</u>

1. Provide for abundant, productive, and diverse self-sustaining Chinook salmon throughout its historical distribution in the watershed. The plan seeks to accomplish this goal by:
   - p. Attaining abundances that are similar to those that occurred before extensive modification of the watershed in the last century;
   - q. Expanding the abundance and distribution of naturally producing fall (later-retuning) Chinook salmon in the South Fork;
   - r. Reestablishing a self-sustaining, natural population of early-returning Chinook salmon in the North Fork;
   - s. Attaining productivities that assure a low risk of extinction of the populations; and
   - t. Attaining productivities that assure sustainable harvest.
2. Provide significant contributions to reintroduce extirpated species and the recovery of other important species at risk and other key species that interact to support healthy salmonid ecosystems.
3. Secure and enhance natural production of other salmonids.
4. Assure that the economic, cultural, social, and aesthetic benefits derived from the Skokomish ecosystem will be sustained in perpetuity.

Hydropower Strategic Objectives

There are six hydropower management strategic objectives for achieving Chinook salmon recovery in the Skokomish Watershed:

Strategic Objective 1: Restore and manage river flows to create habitat and repair natural processes

The diversion of flow has produced a variety of effects on fish and habitat in the Skokomish River. The most obvious has been a reduction in available fish habitat within the North Fork (spatial structure). The current flow regime cannot support fish passage above the Lower Falls at RM 15.6, which is approximately 1.5 miles above McTaggert Creek. In all, diversions have reduced the average annual North Fork Skokomish River flow below dam No. 2 by over 96% (Stetson 1996). This reduced spatial structure impacts Chinook salmon abundance, diversity, and productivity.

Furthermore, reduced flows on the North Fork Skokomish have significantly altered attributes of the river downstream. The reduction in flows has created changes to the North Fork and mainstem Skokomish River channel due to disruptions in sediment transport and distribution, exacerbating aggradation in the mainstem and south fork of the Skokomish River. This effect also is noted in the estuary; Jay & Simenstad (1996) attributed the steepened face at the edge of the delta to insufficient sediment supply. In both the river and the estuary, this situation has created a chain reaction whereby fish access, biological processes, channel complexity, tidal prism, fluvial geomorphology, and riparian function have been seriously disrupted.

Returning flows in the North Fork Skokomish River will be an essential element to restoring habitat that will support and sustain Chinook salmon.

Strategic Objective 2: Provide fish passage at the Kokanee and Cushman dams

Chinook salmon were capable of passing beyond Big Falls now submerged in Lake Kokanee (Stewart and Quinn, year?). Anthropological and scientific research clearly point to fish use above this area (NAA 1997. Construction of Cushman Dams No. 1 and No. 2 created two impassable fish barriers that removed 26 miles of potential anadromous fish habitat. Even if current water levels in Lake Cushman are maintained, another 8 miles of free-flowing habitat is available upstream of the dams.

By providing fish passage over the two dams, Chinook salmon will benefit from increased spatial structure. The expectation is that this measure will allow for greater productivity and eventual abundance. Furthermore, diversity will improve through the reestablishment of spring Chinook salmon runs.

<u>Strategic Objective 3</u>: Develop habitat projects to compensate habitat losses

The construction of the Lake Kokanee and Lake Cushman dams resulted in the inundation of the original Lake Cushman and 18.1 miles of free-flowing river, reducing the quantity of spawning and rearing habitat available to Chinook salmon. Given that the total stream mileage flooded exceeds the total stream mileage that still exists (approximately 8 miles), the Cushman project removed a majority of the anadromous fish habitat available in the North Fork Skokomish River. In addition, reduced flows have decreased available habitat for Chinook spawning and rearing in other areas of the watershed and estuary as well, as described in Chapter 2 (Habitat)

To compensate for this loss of habitat, remaining areas of habitat within the watershed need to be improved and expanded. Efforts should be focused on tributaries and side channels to enhance Chinook salmon productivity.

<u>Strategic Objective 4</u>: Provide fish stocking and supplementation to reestablish Chinook salmon stocks

The construction of the Cushman dams and the diversion of flows resulted in substantial loss of Chinook salmon abundance and diversity. Fish stocking and supplementation is necessary to augment existing runs, reestablish spring Chinook salmon, satisfy treaty fishing rights, and meet recreational fishing demands. Chapter 4 describes this strategy in additional detail.

<u>Strategic Objective 5</u>: Restore channel capacity of the mainstem Skokomish River

The disruption of sediment supply, transport, and distribution due to flow withdrawals has exacerbated aggradation of gravel in the mainstem Skokomish River. Because current and future river bed changing flood flows may never reach original flow volumes, artificial lowering of the channel bed elevation may be necessary to achieve normal channel capacity and will be considered as an action complementary to increasing flood flows. Studies by Stetson (1996) suggest that 13,000 cfs is a reasonable target for bankfull flows of the mainstem channel capacity. Channel capacity restoration will need to be carefully designed in congruence with the US Army Corps of Engineers General Investigation (see Chapter 2 for description).

<u>Strategic Objective 6</u>: Support the Hood Canal Dissolved Oxygen Program (HCDOP) to develop and implement study plans to identify the potential causes and solutions of the water quality problems

The steady deterioration of dissolved oxygen (DO) levels in Hood Canal has become acute since the 1990s. Researchers hypothesize that a variety of factors may contribute to this problem, including the changes in freshwater input to Hood Canal in terms of timing, location and quantity.

Freshwater input into Hood Canal waters has changed dramatically in timing and location since diversion of the North Fork Skokomish River into the reservoirs of Lake Cushman and Lake Kokanee. Exacerbating the situation are flow releases timed for power production (highest in winter) and storage of water in the reservoir for flood protection (winter) or recreation (summer). The predominant flow (over 95%) is diverted through the penstocks directly into Hood Canal near Potlatch bypassing the historic route that replenishes the mainstem Skokomish River and the estuary. While these changes pre-date the observed increase in frequency of low dissolved oxygen events, oceanographic measurements clearly indicate that low dissolved oxygen has been a feature of Hood Canal since at least the 1950s. Development of the HCDOP model of Hood Canal oceanographic conditions may detect the relative level of importance of the various contributing factors to low dissolved conditions.

While the effects of low dissolved oxygen levels may prove less for mobile fish species such as salmon, negative impacts on the marine ecosystem, including disruption of food webs that support salmonids in marine waters, may directly affect Chinook salmon productivity. Consequently, it is important for the Chinook salmon recovery effort to support the Hood Canal Dissolved Oxygen Program study to determine potential impacts and needed recovery actions.

Hydropower Implementation Actions

Implementing the strategic objectives is a series of specific actions that mitigate hydropower operations that create a deleterious effect on Chinook salmon. These implementation actions are consistent with the conditions developed by the Department of the Interior pursuant to Section 4(e) of the Federal Power Act in the re-licensing of the Cushman Project. With the exception of implementation action 10, the actions originate from the Department of Interior and are part of the license requirements under Section 4(e) of the Federal Power Act.

<u>Implementation Action 1</u>: Establish minimum base flow

Operate the Cushman Project to provide optimal amount of habitat for Chinook salmon spawning and rearing for juveniles and adults. Pre-project mean monthly flow in September is estimated at 245 cfs (Stetson 1996).

<u>Implementation Action 2</u>: Provide for annual outmigration flows

Increase flows from the dam to assist the outmigration of juvenile Chinook salmon. Historically, flows during the April-May outmigration period were approximately 100-130% of the average annual flow. A flow of 310 cfs between April 1 and May 31 provides 120% of a minimum base flow of 240 cfs.

<u>Implementation Action 3</u>: Provide for attraction flows

Increase flows from the dam to provide attraction flows for spawning Chinook salmon. Attraction flows of a minimum of 300 cfs for at least two consecutive days per week are needed between September 15 and November 23.

<u>Implementation Action 4</u>: Limit ramping rates

Rapid streamflow changes can result in the stranding of juvenile Chinook salmon. The following seasonal ramping rates will avoid stranding:

- From February 16 to June 15, limit ramping to 2 inches per hour from one hour after sunset to one hour before sunrise with no ramping during the rest of the day
- From June 16 to October 31, limit ramping to 1 inch per hour for all hours of the day
- From November 1 to February 15, limit ramping to 2 inches per hour for all hours of the day

<u>Implementation Action 5</u>: Provide for fish passage past Dams No. 1 and 2

Overcoming the impassable barriers created by Dams No. 1 and 2 requires ensuring upstream and downstream passage for Chinook and other salmon species. Fish passage measures to provide for the safe, timely, and effective upstream and downstream passage of anadromous species, and consistent with any fish passage regulations or guidelines promulgated by NMFS and/or WDFW are required.

<u>Implementation Action 6</u>: Develop annual habitat projects

To compensate substantial habitat losses caused by the inundation of the North Fork Skokomish River, it will be necessary to implement habitat projects, such as those identified in Chapter 2 of this plan.

<u>Implementation Action 7</u>: Fish stocking and supplementation

Because of the number of years it will take for habitat improvements to render their desired effects, additional stocking and supplementation of Chinook salmon is necessary to meet treaty obligations and recreational fishing demands. This action also provides the opportunity to increase life history diversity for Chinook salmon by reestablishing early-season runs in the North Fork and South Fork Skokomish Rivers (see Chapter 4 of this plan).

<u>Implementation Action 8</u>: Removal of the McTaggert Creek diversion dam

Removal of the McTaggert Creek diversion dam will help restore flows that support salmonids using this tributary of the North Fork Skokomish River. Additional work needed includes restoration of riparian habitat and removal of barrier culverts.

<u>Implementation Action 9</u>: Develop a plan to mitigate effects of disrupted sediment transport in the mainstem Skokomish River

Restoration of the capacity of the mainstem Skokomish River (target 13,000 cfs) will enhance spawning and rearing. It will likely involve release of controlled freshets, along with structural projects in the lower watershed to increase capacity by lowering the channel bed elevation. The project will target the area from the upstream reservation boundary to the Highway 106 Bridge. The anticipated approach for this project focuses on restoring channel capacity by lowering the channel bed elevation. Development and implementation of a plan to address the mainstem sediment transport will require coordination and cooperation of Tacoma Power, Skokomish Indian Tribe, federal, state and local government, as well as the local community.

<u>Implementation Action 10</u>: Support efforts of the Hood Canal Dissolved Oxygen Program to identify and develop corrective actions to improve water quality in marine waters.

The Hood Canal Dissolved Oxygen Program is developing models of marine circulation to identify and study changes in freshwater input to the Canal related to dissolved oxygen issues. Assessment of the potential contribution of the increased freshwater discharge at Potlatch related to power plant operation, as well as the reduced freshwater discharge of the mainstem Skokomish River, are necessary to fully understand the potential impacts of hydropower operation on Chinook salmon.

Chapter Six
Integration of Habitat, Hatchery, Harvest & Hydropower Strategies

Challenges of Integrating
Habitat, Harvest, Hatchery and Hydropower Strategies

Integration is the coordinated combination of actions among all the different management sectors (habitat, harvest, hatcheries, and hydroelectric) that together work to achieve the goal of recovering self-sustaining, harvestable salmon runs. Because many actions in these sectors fundamentally require tradeoffs between what people want and what salmon need, "H-integration" involves balancing biological effectiveness in moving towards salmon recovery (e.g. the greatest sustainable improvements in the shortest amount of time) and fairness in providing competing benefits for people. The most biologically effective combination of activities is unlikely to be successful, for example, because it may require costs to communities that are perceived as unfair and therefore are not politically sustainable. These actions would likely not get implemented and consequently are not useful for restoration. Likewise, trying to please everyone may be ineffective and costly in recovering salmon (Figure 6.1).

Sequencing, Duration, Location

Practically, integrating the different actions in habitat, hatchery managements, and fishery management means implementing the actions at the best time, in the appropriate sequence, in appropriate locations, and at the necessary levels to be most effective. Figure 6.2 on the next page illustrates likely sequences, durations, and magnitudes of actions and their predicted effects for Skokomish River Chinook salmon.

The most important step is beginning the habitat restoration strategy and activities that will increase the productivity of naturally spawning Chinook salmon. To protect the investments in habitat restoration, habitat protection likewise needs to increase. Likewise, while hatchery Strategy 1 provides for harvest and some natural spawning, hatchery Strategy 2 can provide short-term, immediate means of increasing spatial structure, diversity, and numbers of naturally spawning fish, but ultimately terminating the program depends on major modifications to the habitat forming processes of the South Fork that allow natural passage. Hatchery Strategy 3, reestablishing early-returning Chinook salmon to the Skokomish River, depend not only gaining adequate flows and passage in the watershed but also on a choice of an appropriate strategy for the brood stock and enough time for local adaptation to occur.

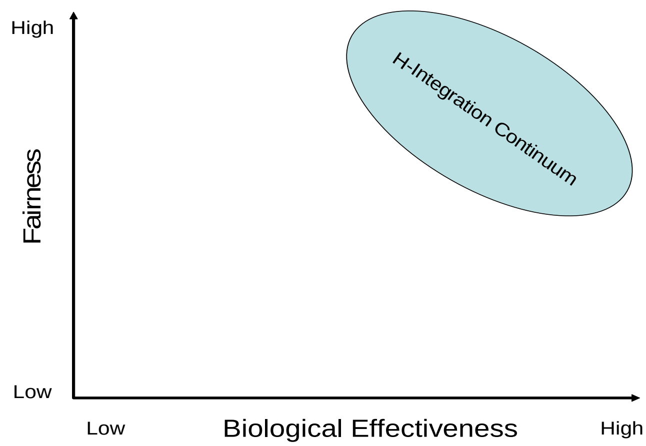


Figure 6.1. Achieving integration of actions in different management sectors (habitat, fisheries, hatcheries, and hydroelectric power) is a balance between fairness and the continuum of biological effectiveness in achieving salmon recovery goals.

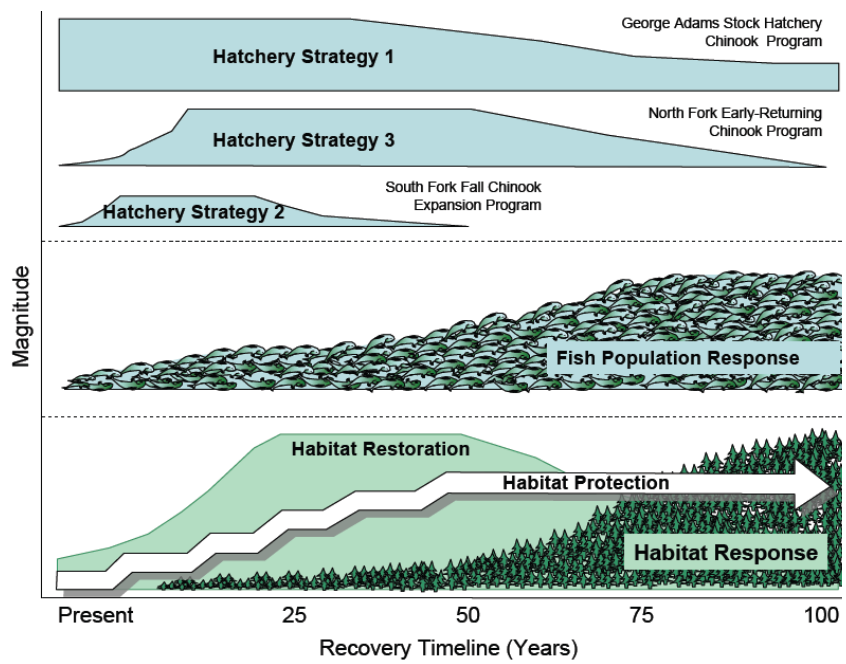


Figure 6.2. Conceptual illustration of sequencing of hatchery strategies in the Skokomish River in relation to habitat restoration and protection actions and the response of the fish populations. The height of the strategies and fish and habitat responses over time indicates the expected magnitude.

Using or developing the appropriate scientific tools to help inform these choices is also an important part of the sequencing. For example, as natural production increases in response to habitat and hatchery strategies, harvest management will need to have adequate tools and data to continue to provide for harvest while protecting natural-origin fish.

Next Steps in Integration

As indicated above, integration involves four key steps

1. Using the best available information and analyses to understand and predict the combined effects of the individual H-sector actions on VSP characteristics of the population. This begins with comparing the effects of the actions for their directionality (+ or -), magnitude, time lag, and persistence.
2. Choosing actions that are complementary in their effects and are properly sequenced
3. Implementing the actions
4. Utilize monitoring and adaptive management to address probabilities and uncertainties (see Chapter 7)

Recovery planning for Skokomish Chinook salmon has focused on qualitative analyses of these steps and this has provided the general direction and priorities for integration in this recovery plan. Quantitative analyses provide an additional way of refining these analyses and testing for unexpected results that may not be apparent in qualitative analyses. Quantitative analyses require gathering appropriate data and selecting or developing appropriate models for the analysis and this is just beginning for Skokomish Chinook salmon.

An important use of these analyses will be to set the framework for adaptive management (Chapter 7). For example, Table 6.1 shows how results from the analyses can be organized. The major actions from one time period (e.g., current) have expected outcomes at other time periods (e.g., 5, 10, and 20 years), which in turn suggest whether actions need to change at those time periods. The expected outcomes also become the triggers for adaptive management. For example, if the expected outcome does not occur at 5 years, it makes sense to ask why. Were these the right actions? Were they implemented? Was the monitoring inadequate to detect the response? Did something else unexpected happen in the watershed to explain the results? Does the model need to be refined? Answering these questions then leads to refining the sequence, location, timing, and duration of the next set of restoration actions.

Chapter Seven
Adaptive Management

A Strategy for Managing Uncertainty

Adaptive management of salmon recovery for Skokomish Chinook will be part of the larger adaptive management effort being developed for the Puget Sound Chinook ESU.

Adaptive Management is defined as monitoring or assessing the progress toward meeting objectives and incorporating what is learned into future management plans.

Monitoring is the measure of success of any management prescription or restoration. Well- designed monitoring should (1) indicate whether the restoration measures were designed and implemented properly, (2) determine whether the restoration results met the objectives, and (3) give us new insights into ecosystem structure and function (Kershner 1997).

Will habitat, harvest, hatchery, and hydroelectric strategies recover Chinook salmon in the Skokomish River? The answer hinges on many things that are still uncertain. For example, do we understand the physical and biological processes operating in the watershed that limit salmon recovery well enough to make effective choices? Will there be enough funds to implement the most effective actions? Will the goals, objectives, and strategies outlined in the recovery plan be successfully implemented? Will agencies with regulatory authorities use them to protect existing watershed functions so that recovery actions can provide net improvements?

Adaptive management is a tool for managing uncertainty. It refers to an explicit process of making decisions based on the best available information, implementing them, learning from the results of the implementation, and adjusting the decisions as necessary to achieve a goal. This process can be seen as a management cycle involving four keys steps (Figure 7.1).

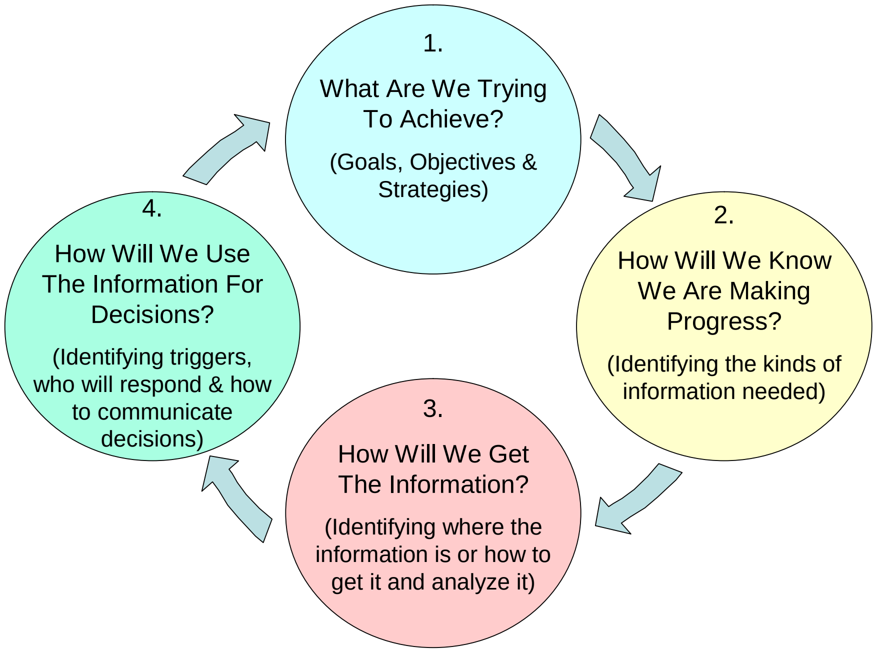


Figure 7.1. The adaptive management cycle (adapted from the Ecosystem Management Initiative Evaluation Cycle, University of Michigan)

These steps are 1) defining participants; 2) develop goals and objectives;
3) developing a framework for how you would know if you are making progress;
4) preparing and implementing a plan to get the important information; and
5) deciding how to use the information.

An important characteristic of this cycle is that improvements can and should occur in all the steps of the evaluation cycle over time. This allows us to begin taking actions without waiting for a perfect monitoring or decision making system, because through the evaluation process monitoring, analyses, and strategic decision making are examined for how they can be refined and improved.

This chapter outlines a framework for all the steps even though not all are fully developed.

The following steps provide a template for sound protection and restoration monitoring.

<u>Step 1</u>. Define participants

Watershed scale protection and restoration involves multiple specialists, Tribal and agency personnel, and non-agency partners. Taking an interdisciplinary approach and utilizing multiple agencies will help integrate the four H's. All agencies and personnel should actively participate in setting objectives, study design, and analysis.

<u>Step 2</u>. Develop goals and objectives

Establish clear goals and objectives – The objectives define the strategy or project's purpose and determine the type and extent of restoration/protection. Objectives need to be measurable, quantifiable, and repeated over time. It's important to define the temporal and spatial scale so monitoring objectives can be identified and prioritized. When the temporal and spatial scales are clearly defined the study design and sampling protocols can be developed.

<u>Step 3</u>. How will we know if we are making progress?

Design monitoring to detect change – Utilize standard principles for conducting environmental field studies. Information should be collected on physical, biological, or chemical characteristics before treatment, before changing management strategies, or changing flow regimes so changes resulting from the restoration/protection can be documented.

We will know if we are making progress in the Skokomish River if we know that recovery actions are being implemented and if we see expected changes in the status of the population, habitat, or ecosystem processes. Chapters 2-5 identify recovery actions for each of the management sectors and Chapter 6 outlines a way of organizing the expected, combined effects of all the actions.

Three kinds of information are needed for Step 3:

1) Baseline Information, existing conditions throughout the watershed or restoration project area. A clear picture of existing limiting factors such as fish abundance and distribution, road density, stream crossings, fish barriers, GIS mapping, and stream channel geometry to compare with post project conditions and monitoring for trends over time.

2) Implementation monitoring benchmarks, and

3) Effectiveness monitoring and indicators of expected changes in the status of the population and the status of limiting factors affecting the population. Implementation benchmarks are actions with measurable

objectives for determining whether the action was successful or not. Indicators of change in status are biological measures of the characteristics of the population (such as measures of abundance, productivity, spatial distribution, and diversity) and characteristics of the habitat (such as stream flows, pool frequency, large woody debris, etc.) or other limiting factors (such as predation, over-harvest, or competition from exotic organisms) that allow us to make inferences about the effectiveness of the actions.

Tables 7.1 and 7.2 show implementation benchmarks and indicators for monitoring status and effectiveness of recovery actions.

<u>Step 4</u>. How will we get the information?

Assess the effectiveness and report results – Report monitoring results. Utilize photographs, bar/line graphs to compare before/after treatments. Monitoring reports can build support for restoration by showing a positive change to environmental conditions.

The Skokomish Tribe, other Point No Point Treaty Tribes, and Washington Department of Fish and Wildlife currently collect much of the information needed on the status and trends of the fall Chinook population, although this will need to be expanded and refined to address many of the recovery strategies. Likewise, the Skokomish Tribe and others collect some of the information needed for elements of the habitat strategies. This monitoring will also need to be expanded. The details will be developed in statistically sound monitoring plans and implementation of the monitoring plans will depend on securing funding. Table 7.2 describes some of the key elements of the monitoring strategy.

<u>Step 5</u>. How will the information be used for making decisions?

Adapt Goals and Objectives from new information – Utilize the information collected from monitoring to modify management practices. Monitoring is the key to evaluate and modify management practices and developing new approaches or goals for watershed restoration. It's important to document success or failure of a particular project or strategy so mangers can determine if the design, implementation, environmental conditions, or good/poor planning produced the outcome.

Many different groups ranging from individual landowners, county and state regulator agencies, the Skokomish Tribe, other Tribes, Tacoma Power, and federal land and natural resource agencies, may make decisions that affect Chinook salmon in the Skokomish River watershed. Influencing these decisions can be challenging because of the variety of legal and political processes involved. A key for salmon recovery, however, is identifying implementation triggers. Triggers are the key elements of the implementation that need to occur to meet the implementation benchmark or they may be levels of status and effectiveness that would indicate the need to reevaluate a strategy. Tables 7.1 include preliminary triggers for the different recovery strategies for Skokomish Chinook salmon. These will be revised with new information.

Table 7.1. Implementation benchmarks and triggers for adaptive management.

Strategy	Ecological Processes	Implementation Benchmark	Triggers
1. Restore and monitor habitat-forming flow regimes and channel geometry	• Sediment supply, transport & distribution • Fluvial Geomorphology • Habitat Connectivity	a. Bankfull flows in North Fork of 1000 cfs, increasing to 1500 cfs b. Bankfull flows in mainstem increasing to 13,000 cfs	• Fish and flow oversight committee established by 2008 • Sediment transport and distribution • Creation of rearing tributaries • Flow monitoring in place by 2010
		a. Channel geometry construction planned and designed toward channel geomorphology (sinuosity, gradient, bankfull width, sediment budget, etc.) and overbank flows b. Mechanical restoration of channel geomorphology to facilitate sediment transport and distribution	• Assessment of alternatives for restoring channel geometry in the South Fork and Vance Creek completed by 2010 • Design channel restoration projects
		a. 75% of engineered logjams and remedial large woody debris placement implemented by 2020	• Assessment of high priority locations for LWD placement completed by 2010
2. Establish & implement a road map for consensual agreement on restoration of floodplain and channel functions	• Channel Complexity • Fluvial Geomorphology	a. Federal and local partners meet funding requirements to implement General Investigation	• Funding requirements met annually for next 5 fiscal years
		a. Skokomish River Basin Ecosystem Restoration & Flood Damage Reduction General Investigation identifies common agreement on approaches by 2010	• Tribe and county participate • Landowners input solicited and participate with property access • Design alternatives reached by consensus by 2010

Table 7.1 Continued

Strategy	Ecological Processes	Implementation Benchmark	Triggers
2. Establish & implement a road map for consensual agreement on restoration of floodplain and channel functions	• Channel Complexity • Fluvial Geomorphology	a. Final NEPA approved by 2012 for the Skokomish River Basin Ecosystem Restoration & Flood Damage Reduction General Investigation	• Final NEPA approved by 2012
3. Complete existing high priority projects for restoration of the Skokomish estuary and develop & implement priorities for other identified nearshore and estuary projects in Hood Canal	• Sediment supply, transport & distribution	a. Highest priority dikes, levees and fill removed from Skokomish Estuary by 2015	• Remove dikes and fill on Nalley Slough by 2007 • Remove dikes and fill on Nalley Island by 2009 • Remove or breach lower river road levees below Tribal Center by 2015
		a. Design Implementation Plan with priorities for Hood Canal salmon nearshore restoration and conservation by 2008	• Consensus Plan outlined by stakeholders with a research and adaptive management component by 2008 • Implementation Plan is being used to guide nearshore actions by 2009
4. Protect high quality habitat	• Loss of essential habitat and capacity	a. Identify areas of high quality habitat and areas with potential to be high quality habitat	• Assess conservation trajectory each five years • Ensure less than 10% loss of identified areas supporting habitat functions by 2020

Table 7.1 Continued

Strategy	Ecological Processes	Implementation Benchmark	Triggers
5. Restore floodplain connectivity	• Channel Complexity • Fluvial Geomorphology • Habitat connectivity	a. Identify confined reaches of the mainstem channel b. Plan channel restoration actions geared toward channel geomorphology (sinuosity, gradient, bankfull width, sediment budget, etc.) and bankfull flows	• Develop a hydrological model considering the geomorphology of the Skokomish River valley for analyzing alternatives by 2012 • Skokomish River Basin Ecosystem Restoration & Flood Damage Reduction General Investigation identifies common agreement on approaches within next 5 years (see Strategy 2).
6. Restore channel forming processes	• Channel complexity • Fluvial geomorphology • Habitat connectivity	a. Bankfull flows in North Fork b. Extended bankfull flows in channel mainstem c. Mechanical restoration of channel geomorphology to facilitate sediment transport and distribution	• 1000 cfs at recurrence interval of 1.5 years • Obtain a bankfull flow of 13,000 cfs in mainstem • Design of channel restoration projects
7. Restore fish access to upstream areas	• Habitat connectivity	a. Chinook salmon have access to NF Skokomish River above Lake Kokanee and Cushman dam by 2020	• Agree to and implement flow and passage agreements by 2020
		a. Chinook salmon accessing above Cushman Project demonstrate productivity by 2028	• Document successful spawning and juvenile production by 2020
		a. Chinook salmon have access to McTaggert Creek by 2020	• Remove McTaggert Creek diversion dam and replace culverts to allow passage by 2020
		a. Chinook salmon have access to SF Skokomish by 2020.	• Agree to and implement Chinook haul operation into SF by 2008

Table 7.1 Continued

Strategy	Ecological Processes	Implementation Benchmark	Triggers
8. Decommission roads, maintain and stabilize remaining road network in the upper watersheds	• Sediment supply, transport & distribution	a. All moderate and high risk roads decommissioned, stabilized or upgraded to prevent sediment delivery by 2015.	• WDOE and USFS agreement. • GDRC Habitat Conservation Plan MUDD (maintenance, upgrade, dormant, decommission) program.
9. Develop appropriately in the watershed to reduce habitat impacts to salmon	• Sediment supply, transport & distribution • Fluvial geomorphology	a. Maintain less than 8% impervious surface within the watershed and subbasins. b. See also Strategy 2	• Establish a plan with the county, private timber companies, and federal government to encourage forestry and limit conversion of forest lands to development by 2015. • Establish a community outreach and education program by 2012 • Implement a plan to protect intact riparian habitat through voluntary landowner agreements or conservation agreements by 2018 • Develop and begin implementing a storm water management plan that minimizes impact of stormwater flows and contaminants on salmon by 2012 • Relocate Laney Campgrounds away from River by 2012
10. Work to understand the implications of regional climate change on salmon recovery and develop strategies to address potential habitat and flow effects	• Fluvial geomorphology • Sediment supply, transport and distribution	a. Develop strategies to address potential impacts of climate change to Skokomish watershed and habitat by 2010	• Integrate strategies to address potential impacts of climate change into the recovery actions of this recovery plan by 2012

Table 7.1 Continued

Strategy	Ecological Processes	Implementation Benchmark	Triggers
11. Manage harvest of Skokomish Chinook salmon as a composite stock to achieve specific objectives for harvest rates that allow recovery.	• Abundance • Productivity • Diversity • Spatial distribution	a. Achieve annual total escapement of 3650 fish, including 1650 spawners in the river and 2000 hatchery brood stock	• Pre-season forecast of the Fishery Regulation Assessment Model (FRAM) is less than 1200 natural spawners • Pre-season forecast for hatchery brood stock is less than 1000
12. Refine harvest management based on research and technical analyses of productivity	• Abundance • Productivity • Diversity • Spatial distribution	a. Estimate preliminary Skokomish Chinook stock-recruit relationship and productivity by 2010 b. Estimate Skokomish Chinook stock-recruit relationship and productivity by 2017	• Complete preliminary cohort analysis and run reconstruction analysis by 2008 • Complete cohort analysis and run reconstruction analysis by 2015
13. Use hatcheries to provide for both harvest and natural escapement.	• Abundance • Productivity • Diversity • Spatial distribution	a. Produce 7 million juvenile fall Chinook salmon annually for release (See Table 1, Chapter 4) b. Marking, CWTs for monitoring & evaluation	• Collect 4,000 brood stock annually • Evaluate hatchery and genetic management plans every 5 years to ensure that they are being revised to minimize genetic, ecological, and demographic risks (see Appendix C)
14. Expand distribution of Chinook salmon in the South Fork	• Spatial distribution • Abundance	a. Increase production of natural origin juvenile fall Chinook from areas of the South Fork that are currently not accessible by 2010.	Determine no. needed, capture and transport adult fall Chinook salmon above blockage in South Fork and upstream of canyon reach by 2008

Table 7.1 Continued

Strategy	Ecological Processes	Implementation Benchmark	Triggers
15. Reestablish an early-returning Chinook salmon to the North Fork	• Diversity • Spatial distribution • Abundance	a. Establish natural production of juvenile Chinook salmon from the North Fork by 2024	• Implement Strategies 1 & 7 in Chapter 2 and Implementation Action 3 in Chapter 4 • Identify appropriate facilities and brood stock strategies by 2012 • Identify juvenile and adult monitoring strategy by 2024
16. Integrate habitat, harvest, hatchery & hydroelectric recovery strategies	• All the above	a. Produce an analysis of the expected combined effects of habitat, hydroelectric, harvest, and hatchery strategies to guide adaptive management by 2008	• Develop or choose appropriate model(s) for the analysis by 2008.

Table 7.2. Effectiveness and status and trends monitoring for Skokomish River Chinook salmon

Monitoring Elements					
Strategy	**Indicator**	**Tool**	**Frequency**	**Location(s)**	**Responsibility**
1. Restore and monitor habitat forming flow regimes and channel geometry	• Substrate movement and bar formation • Channel restoration and geometry designs completed	• Photographs, including aerial • Stream gauges • Painted substrate • Transects	• Continuous	• To be recommended by oversight technical committee (see Strategy #1 in Chapter 2)	To be recommended by oversight technical committee (see Strategy #1 in Chapter 2)
2. Establish and implement a road map for consensual agreement on restoration of floodplain and channel functions	• Funding, local and state • Participation • Design agreement • NEPA approval	• Capital Improvement Program • Regular local sponsor and Corps meetings • Formal agreement • Final documentation	• Annual funding • Regular meetings at least quarterly • One time •	• N/A	• Tribal, County, State, and Federal Governments • Landowners
3. Complete existing high priority projects for restoration of the Skokomish estuary and develop & implement priorities for other identified nearshore and estuary projects in Hood Canal	• Fill removed • Acres restored • Completed Nearshore Implementation Plan	• Construction monitoring • Project Effectiveness Monitoring • Lead Entity Process	• At time of construction • Annually • Continuous	• Estuary	• Tacoma Power and Skokomish Tribe • Lead Entity and Skokomish Tribe and other Point No Point Treaty Tribes

Table 7.2 Continued

Monitoring Elements					
Strategy	**Indicator**	**Tool**	**Frequency**	**Location(s)**	**Responsibility**
4. Protect high quality habitat	• Acres protected & acres lost • Types of habitat protected and lost	• Project and regulatory program tracking • Change in land use/land cover	• Continuous project and program tracking • Five year change analysis	• Watershed	• Lead Entity for projects • Mason County and Tribe
5. Restore floodplain connectivity	• Flows observed on the floodplain • Deposition of fined grained sand and silt on floodplain • Substrate movement and bar formation	• Field observations • Painted substrate	• Bankfull flow and greater frequency	• Confined sections that are restored mechanically	To be recommended by oversight technical committee (see Strategy #1 in Chapter 2)
6. Restore channel forming processes	• Lower Cushman releases mimic Staircase annual hydrograph at bankfull flows • Bankfull flows extend to the mainstem from release at Lower Cushman • Designs completed	• Stream gauge • Cushman butterfly valve	• Continuous	• North Fork • Mainstem	To be recommended by oversight technical committee (see Strategy #1 in Chapter 2)

Table 7.2 Continued

Monitoring Elements					
Strategy	**Indicator**	**Tool**	**Frequency**	**Location(s)**	**Responsibility**
7. Restore fish access	• Presence/ absence or numbers of fish • Presence of redds • Production of juveniles	• Trap, haul and count • Spawning surveys • Juvenile trapping and marking	• Seasonal • Continuous	• According to passage agreement and fish committee	• To be determined, but including Tacoma Power and Skokomish Tribe
8. Decommission roads, maintain and stabilize remaining road network in the upper watersheds	• Road inventory baseline (USFS, GDRC) • Miles and distribution of high risk roads • Road performance and maintenance trends.	• Road surveys and assessments	• Continuous • 5 year intervals	• USFS and private lands, (primarily GDRC) in SF Skokomish, NF Skokomish and Vance subbasins	• USFS • GDRC • SWAT (Skokomish watershed action team.
9. Develop appropriately in the watershed to reduce habitat impacts to salmon	• Percent impervious surface within watershed and subbasins	• Aerial photographs • GIS analysis of impervious surface • Monitoring development permit compliance and enforcement	• Every five years	• Mainstem • Major sub-basins	• To be determined

Table 7.2 Continued

	Monitoring Elements				
Strategy	**Indicator**	**Tool**	**Frequency**	**Location(s)**	**Responsibility**
10. Work to understand the implications of regional climate change on salmon recovery and develop strategies to address potential habitat and flow effects	• Understanding by plan authors of range of potential impacts associated with climate change	• Study session • Development of potential strategies for Skokomish watershed	• Annual	• NA	• WDFW • Skokomish Tribe • HCCC • Local, federal, state and other governments
11. Manage harvest of Skokomish Chinook salmon as a composite stock to achieve specific objectives for harvest rates that allow recovery.	• Number of natural origin recruit (NOR) adults in escapement • Number of hatchery origin recruit (HOR) adults in escapement • Numbers and exploitation rate of HORs and NORs harvested	• Spawner surveys • Catch monitoring • Coded-wire tagging, marking and sampling	• Annual	• Skokomish River, Hood Canal and pre-terminal intercepting fishery areas	• WDFW, Skokomish Tribe • PNPT Tribes
12. Refine harvest management based on research and technical analyses of productivity	• Number of NOR smolts • Exploitation rates • Stock/recruit relationship	• Juvenile trapping • Snorkel surveys • Models	• For each new HGMP or every 5 years, as needed	• Skokomish River	• WDFW, Skokomish Tribe, • PNPT Tribes

Table 7.2 Continued

	Monitoring Elements				
Strategy	**Indicator**	**Tool**	**Frequency**	**Location(s)**	**Responsibility**
13. Continue using hatcheries to provide for both harvest and natural escapement.	• Number of brood stock • Fertilization rates • Egg-to-smolt survival • Disease incidence • Growth rates	• Hatchery records • Mass marking • Coded-wire tagging	• Annual	• All hatchery facilities	• WDFW, Skokomish Tribe, Point No Point Tribes, Long Live the Kings
14. Expand distribution of Chinook salmon in the South Fork	• Number of NOR smolts produced • Number of NOR and HOR adults (see #7)	• Juvenile trapping • Spawner surveys & mark/tag sampling	• Annual	• South Fork	• WDFW, Skokomish Tribe
15. Reestablish an early-returning Chinook salmon to the Skokomish	• Number of NOR smolts produced • Number of NOR and HOR adults (see #7) • Run and spawning timing	• Juvenile trapping • Spawner surveys & mark/tag sampling	• Annual	• North Fork (initial focus)	• WDFW, Skokomish Tribe
16. Integrate habitat, harvest, hatchery & hydroelectric recovery strategies	• All of the above	• All of the above	• All of the above	• All of the above	• All of the above

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Appendix A
Overview of the Skokomish Watershed

The Skokomish Watershed, located in the northwest corner of Mason County, Washington, is the largest watershed draining into Hood Canal. With its headwaters in the southeast corner of the Olympic Mountains, the Skokomish Watershed covers approximately 240 square miles. The main physical features of the Skokomish Watershed include:

- The largest estuary in Hood Canal;
- The Mainstem Skokomish River (9.0 miles);
- The North Fork Skokomish River (a continuation of the Mainstem that adds 33.3 miles);
- Two hydroelectric dams and reservoirs; Lake Cushman is 4,000 acres and Lake Kokanee is 70 acres in area);
- The South Fork Skokomish River (27.5 miles);
- 270 miles of tributaries, with Vance Creek (11.0 miles) being the largest and most important; and
- Approximately 55 miles of accessible habitat for anadromous fish.

Rainfall levels in the Skokomish Watershed range from 75 inches per year at the mouth to about 230 inches per year in the Olympic Mountains at 6,000-foot elevation (Phillips 1968). Runoff from the higher elevation snowpack feeds the North and South Forks through the spring and early summer months. Flooding frequently occurs during the winter when weather systems bring alternating warm and cold fronts that melt the snowpack.

Forestry on public and private lands dominates the steeper topography and headwaters on the South Fork and up to RM 28 on the North Fork. Logging is the primary land use in the South Fork Skokomish River; the US Forest Service manages approximately 80% of the South Fork Skokomish River subbasin and another 13% is under Simpson Timber Company ownership. Approximately 60% of this area has been harvested since the 1920's. The Olympic National Park lies upriver of Lake Cushman on the North Fork Skokomish and in the upper most headwaters of the South Fork Skokomish.

Farms and rural residences are prevalent in the lower gradient valleys and the shorelines of Lake Cushman. Most agriculture consists of cattle and other livestock production, hay, Christmas tree production, and limited vegetable farming. Mason County zones this area for rural residential (5-, 10-, and 20-acre minimum parcel size), and agriculture forestry resource land.

Flood control structures and diking improvements are also common in these areas as well. Highway 101 spans the river at RM 5.3. The Skokomish Indian Reservation spans approximately 5,000 acres on the uplands from the mouth.

In addition to salmon habitat, the Skokomish Watershed has a rich biota. The estuary is an important shellfish area and the lower valley is key habitat for elk, deer, beaver, and waterfowl.

Appendix B
Background Information for Habitat Recovery Strategy

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. Past and current planning efforts related to Skokomish Chinook recovery planning include:

The Summer Chum Salmon Conservation Initiative (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, particularly related to the Skokomish estuary habitat.

The Hood Canal Summer Chum Salmon Recovery Plan (HCCC 2005) builds on the aforementioned Summer Chum Salmon Conservation Initiative, focusing on habitat protection and restoration.

The Salmon Habitat Recovery Strategy for the Hood Canal and Eastern Strait of Juan de Fuca (Hood Canal Coordinating Council 2005) is the result of five years of local collaboration, with periodic updates based on emerging scientific and technical information. The Hood Canal Coordinating Council 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. 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.

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 Historic Versus Contemporary Nearshore Habitat Assessment (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 geodatabase of restoration project opportunities in the nearshore environment (Correa 2003 and HCCC 2005)

Watershed Planning Efforts: WRIA 16 planning unit (including the northern portion of WRIA 14 that drains into Hood Canal) continue to develop and implement a watershed plan to plan and manage water resources and to protect or enhance fish habitat for WRIA 16, including Skokomish watershed. The Planning Units is 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).

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.

In addition to planning efforts, many habitat recovery protection and restoration activities have been planned, funded and implemented. The following is a partial list of funded or completed projects:

Habitat Protection Activities Completed or Funded:

1. U.S. Forest Service (USFS) Watershed Analysis completed in 1995
2. Army Corps of Engineers Early Action Study in 1995
3. South Fork Skokomish Watershed Analysis (USFS 1995)

4. Skokomish River Comprehensive Flood Hazard Management Plan by Mason County (KCM) in April 1996

5. Washington State DNR and Simpson Timber Company Watershed Analysis 1997

6. 905(b) Army Corps of Engineers Reconnaissance Study in 2000

7. Washington Conservation Commission WRIA 16 Limiting Factors Analysis for riverine and nearshore (Correa 2003)

8. WRIA 16 Salmonid Refugia Report 2003 (SRFB contract#00-1829)

9. Designated as a Key Watershed by US Forest Service (high priority anadromous salmon restoration)

10. Ecosystem Diagnosis and Treatment on-going for summer chum in estuary/nearshore

11. Skokomish River Reach Assessments, including Corp General Investigation (partially funded by SRFB contract #04-1712), and including BOR Geomorphic Mapping

12. Skokomish Mainstem

    a. Skokomish Salmon Recovery Team (SRFB contract #99-1652)

    b. Skokomish River Acquisition (SRFB contract #01-1387)
    c. Bourgalt Acquisition of 165 acres
    d. Richert Springs Protection (SRFB contracts #05-1603 and 06-2283)

13. Skokomish North Fork

    a. 9887 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)

    b. 3920 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)

14. Skokomish South Fork

    a. 83,587 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)

    b. 9,523 meters of road designated for conversion to trail in 2003 USFS A&TM Plan (but not funded)

15. Vance Creek

   a. 6,336 meters of road designated for decommissioning in 2003 USFS A&TM Plan (but not funded)

   b. No road designated for conversion to trail in 2003 USFS A&TM Plan

Habitat Restoration Activities Completed or Funded:

1. Skokomish Mainstem and Estuary

   a. Skokomish River North Channel Oxbow and Plan (SRFB contract #99-1679 and 99-1689)

   b. Bourgalt/North Channel Reconnection (SRFB contract #00-1081)

   c. Nalley Slough Tide Gate and Levee Removal (Phase 1 – SRFB contract #01-1302)

   d. Nalley Island Levee Removal (Phase 2 – SRFB contract #02-1560)

   e. Nalley Slough Reconnection

   f. Skabob Creek Bridge on Reservation Road

   g. Skabob Creek Culvert Replacement with Bridge on SR106

   h. Skokomish River Road culvert replacements with flat car railroad bridges (1999).

   i. Skokomish River Road and East Bourgault Road Fill Removal Projects (2007 USFWS grant award).

   j. Purdy Creek Bridge Replacement Study for SR101and planned replacement in 2008-2009.

   k. Lower Valley BMPs and Conservation Reserve Enhancement Program

2. Skokomish North Fork

   a. 4660 meters of USFS roads decommissioned

3. Skokomish South Fork

   a. 133,167 meters of USFS roads decommissioned (including LeBar Creek – SRFB contract #01-1426 and Brown Creek – SRFB contract #05-1611)

   b. Brown's Creek USFS Campground relocation

   c. Rearing ponds constructed within floodplain and anadromous zone of South Fork, LeBar Creek, and Brown Creek in "bathtub" area (1994-5)

   d. Riparian plantings and conifer release in anadromous zone of South Fork, LeBar Creek, and Brown Creek in "bathtub" area (1994-5)

   e. South Fork Skokomish LWD Enhancement (SRFB contract #06-2302)

   f. Nutrient Enhancement Program by US Forest Service

4. Vance Creek

   a. 42,347 meters of USFS roads decommissioned

   b. Riparian plantings in lower mainstem

Appendix C
Background Information for Harvest Management Recovery Strategy

General Legal Framework for Harvest Management

The primary legal structure for managing harvest policy affecting Skokomish Chinook salmon largely rests with three closely intertwined processes: the Pacific Salmon Treaty, the Pacific Fisheries Management Council, and the co-management of harvest defined by *US v. Washington*.

Pacific Salmon Treaty

The United States and Canada signed the Pacific Salmon Treaty to address the management of salmon stocks that originate in one country and are intercepted in the other. The goal of the treaty is to equitably share the available harvest between the two countries while ensuring conservation of the species by setting fishing limits. The Pacific Salmon Commission is the legal body that oversees implementation of the treaty. It is also responsible for making periodic updates (known as an "annex") to specific provisions of the treaty, the latest of which concluded in 1999 and is in effect until 2009. This update to the treaty modified provisions defining limits to fisheries designed to be consistent with recovery of declining Chinook salmon stocks. To this end, the 1999 annex established two abundance-based management regimes, Aggregate Abundance-Based Management (AABM) and Individual Stock Based Management (ISBM), defining harvest limits for fisheries operating in specific geographic regions of the United States and Canada. The treaty relies on the Pacific Fisheries Management Council, US states, and tribes to implement fishery regimes in the United States that are consistent with these limits.[12]

Analysis of coded-wire tag recoveries indicate that in the 2000 to 2004 period an average of 40% of total fishing mortality of Skokomish Chinook occurred in fisheries in British Columbia (CTC 2007). The Chinook Technical Committee Report on Canadian AABM Fisheries[13] indicates that George Adams stock (Skokomish Chinook) "...shows little change in the proportion of the run taken in

[12] Pacific Salmon Commission 2003/2004 Nineteenth Annual Report, page 94
[13] Report of the Joint Chinook Technical Committee Workgroup on the October 19, 2005 Assignment Given to the Chinook Technical Committee by the Pacific Salmon Commission Regarding the Conduct of Canadian AABM Fisheries. Report TCCHIMOOK (06)-1. Pacific Salmon Commission, July 29, 2006.

2002-2003 compared to the base period or other time periods"[14]. For the years 2000 through 2004, Table B.1 shows the proportion of harvest mortality of George Adams Hatchery Chinook in Alaska, Canada, and U.S. fisheries.

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Table C.1. Distribution of harvest mortality of George Adams Hatchery Chinook, 2001- 2004 [15]

Fishing Area	2000	2001	2002	2003	2004
Alaska	0.7%	1.7%	3.1%	1.9%	1.6%
Canada	55.3%	33.8%	38.5%	31.4%	41.8%
Washington Troll	5.7%	13.1%	7.7%	11.9%	12.9%
Washington Net	0.5%	19.7%	19.2%	16.9%	22.7%
Washington Sport	37.8%	31.7%	31.5%	37.9%	21.0%

Pacific Fisheries Management Council

The Pacific Fisheries Management Council (PFMC) is the federal body that coordinates and oversees ocean fisheries in US waters off the coasts of California, Oregon, and Washington. The goal of the PFMC is to manage the fisheries within its jurisdiction to ensure a sustainable harvest and that it is shared among different fishing groups including commercial, recreational, and tribal fishers.

The PFMC Salmon Fishery Management Plan is the guiding document for the PFMC when establishing harvest regimes specific to Puget Sound Chinook salmon in ocean areas off Washington and Oregon. The plan does this by setting objectives and specific regulations for conservation, habitat and production, and harvest. These objectives are then applied to four management areas, but only those fisheries that operate north of Cape Falcon have significant impact on Puget Sound Chinook. The North of Cape Falcon area runs from 3 to 200 miles offshore from Cape Falcon, OR to the US-Canadian border.

Each year state and tribal fishery managers work together before the start of the fishing season to forecast the abundance of wild and hatchery Chinook populations coastwide. These forecasts are based on recent abundance and survival trends for each population or management unit[16]. These forecasts are used by fishery managers and citizen advisors working with the Council to develop commercial and recreational fishery options for public review. Forecasted abundance and harvest scenarios are input to a sophisticated

[14] 1979-1982: - the PST base period.
[15] Puget Sound Chinook Harvest Final EIS, National Marine Fisheries Service, 2004, Appendix B, page 9
[16] http://wdfw.wa.gov/factshts/harvest.htm

computer simulation model (FRAM) which estimates the resulting escapement and exploitation rate for each stock under each scenario.

The PFMC considers the coastal fishing regime options, and solicits public comment, before recommending a set of regulations to the U.S. Secretary of Commerce for final approval. Its goal is to optimize fishing opportunities that achieve escapement goals for all stocks and that meet the conservation guidelines for listed stocks required by the Endangered Species Act.

Co-Management of Inland Waters

The North of Cape Falcon process also develops a harvest regime for fisheries in Puget Sound (i.e. including U.S. waters in the Strait of Juan de Fuca, Strait of Georgia, Rosario Strait, and Hood Canal), and considers the impact of fisheries outside of the effective management jurisdiction of the Washington co-managers in the Pacific Ocean (PFMC), British Columbia and Alaska on Chinook stock that originate in the southern U.S.

The State of Washington and tribal nations with fishing rights reserved through treaties have the responsibility to set annual harvest regimes for the inland waters of Puget Sound. Pursuant to the 1974 *US v Washington* Federal court decision, co-management of fisheries has been implemented through the framework established in the 1985 Puget Sound Salmon Management Plan (PSSMP).

> "The PSSMP is the framework for planning and managing harvest so that treaty rights will be upheld and equitable sharing of harvest opportunity and benefits are realized. The fishing rights of individual tribes are geographically limited to 'usual and accustomed' areas that were specifically described by sub-proceedings of U.S. v. Washington. Allocation of the non-Indian share of harvest among commercial and recreational users is decided by the policy of the Washington Department of Fish and Wildlife."[17]

Following the listing of Puget Sound Chinook in 1999, the State of Washington, and the treaty tribes have jointly developed the Comprehensive Management Plan for Puget Sound Chinook. The National Marine Fisheries Service approved the most recent version of the harvest management component of this plan in 2005 as achieving the conservation standards of the ESA. The harvest component regulates commercial, recreational, ceremonial, and subsistence fishing with the objective to:

> *Ensure that fishery-related mortality will not impede rebuilding of*

[17] Puget Sound Chinook Harvest Management Plan, p. 5

natural Puget Sound Chinook salmon populations, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty -reserved fishing rights.

Guiding Principles for Puget Sound Chinook

The guiding principles in the comprehensive management plan that provide for both recovery and harvest opportunities for Puget Sound Chinook in general are to:

- Conserve the productivity, abundance, and diversity of the Puget Sound ESU populations
- Develop and implement fishery mortality limits that manage the risks and compensate for the uncertainty associated with estimating the current and future abundance and productivity of populations
- Meet and even exceed the ESA jeopardy standards for conserving the abundance, diversity, and productivity of natural Chinook
- Provide opportunity to harvest surplus production from other species and hatchery populations while eliminating directed fisheries on depressed Puget Sound Chinook
- Account for all fishery-related mortality when assessing total exploitation rates, whether that be landed or non-landed, incidental or directed, commercial or recreational, and US or Canadian waters.
- Adhere to the principles of the Puget Sound Salmon Management Plan and other legal mandates pursuant to *US v. Washington* and *US v. Oregon* to ensure equitable sharing of harvest opportunities among tribes, and among treaty and non-treaty fishers.
- Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Annex IV to the Pacific Salmon Treaty.
- Ensure exercise of Indian treaty rights within their “usual and accustomed” areas according to their historical use of salmon resources.

The basic implementation concept behind the plan is to focus harvest opportunities on species other than Chinook, or direct them toward strong hatchery Chinook runs from Puget Sound. Through this approach, the only anticipated harvest-related mortality to natural Puget Sound Chinook will be from incidental catch during the harvest of other stocks or species. By allowing most returning natural Chinook to “pass through” the fisheries, escapement levels will increase toward, the goal of stock rebuilding, and possibly allow higher exploitation rates in the future. However, an increase in recovered habitat is necessary to create any substantial net gain from increased numbers of natural spawners.

Guiding Principles for Skokomish Chinook

Since Skokomish Chinook are harvested or killed incidentally in fisheries in British Columbia and the Washington Coast, harvest conservation objectives established under the Pacific Salmon Treaty, and those adhered to by the Pacific Fisheries Management Council have immediate relevance to annual management planning. However, it is the Comprehensive Chinook Management Plan prepared by the co-managers that provides the guiding principles and objectives for harvest that contribute to recovery of Skokomish Chinook.

The guiding principles underlying the present harvest management regime for Skokomish fall Chinook in the Comprehensive Chinook Management Plan are:

1. Full recovery of natural productivity in the Skokomish River cannot occur under the current hydroelectric operating regime and degraded habitat status;

2. The harvest management regime seeks to provide adequate seeding of existing spawning and rearing habitat, and to promote diversity and spatial distribution. The current escapement goal (i.e, the number of spawners that will provide maximum sustainable yield) is 1,650. The Management Plan specifies harvest conservation measures in years of low abundance that will provide at least 800 natural spawners.

3. Until the natural productivity of the Skokomish River is restored, the hatchery program will continue to supplement natural escapement. Ultimately, as natural production increases, there will be reduced reliance on hatchery support for Skokomish stock and fisheries

4. Continue current hatchery production to partially mitigate the effects of habitat loss, and provide fishing opportunity and meaningful exercise of treaty rights to members of the Skokomish Indian Tribe. The George Adams Hatchery program is mandated as partial mitigation for the impacts from operation of the City of Tacoma’s hydroelectric facility

5. Hatchery and natural-origin spawners are genetically indistinguishable due to management practices over many years with associated natural spawning and interbreeding.

6. Managing fisheries in southern U.S. waters, particularly those in Hood Canal terminal areas, to achieve stated objectives for Skokomish Chinook will be consistent with and complementary to achievement of objectives for recovery of the mid-Hood Canal Chinook population in the Duckabush, Dosewallips, and Hamma Hamma rivers.

Harvest Management Actions Contributing to Recovery

To this end, the co-managers will implement the following harvest management actions that contribute to and are consistent with recovery:

- Manage both wild and hatchery Skokomish fall Chinook as a composite population.

- Manage southern U.S, fisheries to:

    - Meet the nominal escapement goal for the Skokomish River of 3,650 fish. This goal reflects a need for 1,650 natural spawners[18] and 2,000 adults required for broodstock to perpetuate current hatchery production.[19] The natural escapement goal represents the best-available estimate of MSH escapement.

    - Achieve a natural escapement of at least 1,200 if the recruit abundance is insufficient for the full escapement goal to be met.

    - Ensure natural escapement greater than the low abundance threshold escapement defined as 1,300 fish – an aggregate of 800 natural spawners and 500 adults returning to the hatchery. The low abundance threshold for natural escapement is approximately 50% of the current escapement goal (MSH). If escapement is projected to fall below that level, additional harvest conservation measures are implemented.

    - Ensure that the exploitation rate in pre-terminal southern US fisheries does not exceed the ceiling level of 15%, estimated using the Fishery Regulation Assessment Model (FRAM). If natural escapement is projected to be less than 800, and/or hatchery escapement less than 500, the exploitation rate ceiling is reduced to 12% for pre-terminal southern U.S. (SUS) fisheries.

[18] Hood Canal Salmon Management Plan, 1985
[19] See 1996 Production Evaluation MOU, PNPTC-WDFW-USFWS; 2002 Framework Plan, WDFW-PNPTT

Annual Fisheries Planning Process

The annual harvest management planning process for Skokomish Chinook involves the following steps:

1) The abundance of Chinook returning to Hood Canal (i.e. the 'terminal run size') is forecasted, based on recent average abundance and survival of hatchery releases. Forecasted Hood Canal Chinook abundance is apportioned to each of the two natural populations (Skokomish and Mid-Hood Canal), other natural Hood Canal Chinook (e.g., in 12C and 12D), and two hatchery production units (George Adams and Hoodsport).

2) The forecasted abundance of all Chinook populations (including stocks from British Columbia, Puget Sound, the Columbia River) and the prior year's fisheries regime is input to the FRAM simulation model to make an initial assessment of the status (i.e. estimated escapement) of all Puget Sound populations, particularly those potentially in critical status. Status is determined with reference to the Upper Management Threshold (UMT) and Low Abundance Threshold (LAT) established for each population in the Puget Sound Harvest Management Plan.

3) The status (i.e., projected escapement) of a population relative to its LAT determines the operative exploitation rate ceiling, and guides development of pre-terminal and terminal harvest regimes. Application to Skokomish Chinook is as follows:

    a) if the forecast escapement exceeds the LAT, pre-terminal southern U.S. fisheries are shaped so their aggregate exploitation rate will not exceed 15%; terminal area fisheries are then shaped to meet the 3,650 escapement goal (1650 natural and 2000 hatchery); However, if model runs indicate that natural escapement may not exceed 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 to achieve those goals; and, .

    b) if the forecasted natural escapement is less than 800 Chinook, and/or hatchery escapement is forecasted to be less than 500 Chinook, the management unit is considered to be in critical status, and pre-terminal fisheries in southern U.S. areas will be further shaped to not exceed the Critical Exploitation Rate Ceiling of 12% (Puget Sound Tribes and WDFW 2004). In response to a critical status, terminal and extreme terminal harvest management actions would also be undertaken to increase escapement to greater than the LAT, if possible.

4) As the PFMC / North of Falcon fisheries planning proceeds, several options for shaping Washington coastal and Puget Sound fisheries are evaluated using FRAM simulations, to assess their effect on escapement and exploitation rates for all populations or management units. This process considers various management controls such as the timing and locations of the various fisheries from the ocean to the terminal areas.

5) This planning process results in an annual fishing regime defining fishing regulations and/or catch targets or quotas for all treaty Indian and non-Indian fisheries. With this regime in place, objectives for Skokomish Chinook and all other Puget Sound Chinook populations are expected to be achieved, as stated in the harvest plan.

Harvest Adaptive Management

Adaptive management has been a part of fisheries planning and implementation for a long time. Most 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 and inseason assessment. The Point No Point Treaty Tribes and WDFW have for many years prepared annual reports that update catch and escapement information and provide run forecasts for all salmon management units of Hood Canal, including mid Hood Canal Chinook (e.g., PNPTC and WDFW 2004, 2005, 2006). Beginning in 2001, the Co-managers have been producing post-season reports on the performance of annual management of Chinook salmon fisheries; 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. With the increased focus on rebuilding natural production, harvest adaptive management will 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 (see Chapter 7 – Monitoring, Assessment, and Adaptive Management – in the Puget Sound Chinook Harvest Management Plan). Recognizing this need, Table B.2 includes some general adaptive management needs, but focuses on summarizing assessments, tasks, tools, monitoring, and funding to be used in adaptive management of harvest for Skokomish Chinook.

Table C.2. Harvest adaptive management assessments and associated monitoring required, time frames and funding status.

Assessment or Task	Rationale	Monitoring & Tools Required	Time Frame for Implementation & Results	Funding	Funding Availability
Coordinate harvest adaptive management 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.
Integration harvest with habitat and hatchery adaptive management	Adaptive management must be integrated to succeed (see Chapter 6 & 7).	Some monitoring applies to all management sectors, e.g., escapements, run sizes, productivity.	Continuing. Short & long term.	To be determined in course of completing adaptive manage-ment plans.	To be determined in course of completing adaptive management plans.
Estimate Chinook escapement returns to the Skokomish 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 and Skokomish Tribe	Currently available.
Estimate harvests of Skokomish 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 Tribes.	Current funding available but more needed.

Table C.2. Continued.

Assessment	Rationale	Monitoring & Tools Required	Time Frame for Implementation & Results	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 Tribes.	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 C.2. Continued.

Assessment	Rationale	Monitoring & Tools Required	Time Frame for Implementation & Results	Funding	Funding Availability
Skokomish 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 Skokomish watershed. Cohort analysis and new run reconstruction using Skokomish data	Continuing tagging and sampling, and Skokomish cohort analysis & new run reconstruction.	WDFW and Tribes	Coded wire tagging and sampling covered. Additional funding needed for cohort analysis and new run reconstruction.
Improve estimates of Skokomish Chinook exploitation rates.	Provides check on meeting harvest management objectives.	Requires cohort analysis and new run reconstruction.	Long term.	WDFW and Tribes.	To be determined
Estimate a Skokomish Chinook rebuilding exploitation rate (RER).	To improve management of harvest risk.	Requires cohort analysis and new run reconstruction in short term (using Skokomish data)	Long and short term.	WDFW and Tribes.	Currently not available for Skokomish data analysis.
Assess distribution of Skokomish 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	WDFW and Skokomish Tribe.	Same as immediately above.

Table C.2. Continued.

Assessment	Rationale	Monitoring & Tools Required	Time Frame for Implementation & Results	Funding	Funding Availability
Assess genetic, demographic and ecological characteristics of the Skokomish 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. characteristics) and assess harvest management responses.	Spawner surveys (for escapement estimates, escapement distribution, NOR/HOR ratios, genetic profiles, biol. character.), juvenile trapping (for hatchery & wild emigrant estimates, genetic profiles, life hist. info. & biol. character.), seining & snorkeling surveys for juvenile distribution and habitat use, including estuaries and nearshore.	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 seining 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 Tribes	Currently available.
Prepare for 2009 PST annex negotiations with Canadians.	Canada's exploitation rates on Skokomish Chinook are relatively high.	Estimation of Skokomish RER. 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.

Appendix D
Background Information for Hatchery Recovery Strategy

Overview of Hatchery Management Planning

Co-management Framework

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 *United States v Washington* 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, Table 2),

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, Table 2),

3. Comprehensive regional management plans (CRMP) to coordinate co-manager activities and priorities,

4. Exchange of technical information and analyses through coordinated information systems, and

5. Dispute resolution.

ESA Planning

Under Section 4(d) of the Endangered Species Act (ESA), the National Marine Fisheries Service is to issue regulations that are necessary to conserve protected species. This usually includes a prohibition on activities that "take" (e.g., kill, injure, harass, or otherwise harm) listed species. Activities that include “take” can be permitted in special circumstances, however, if conducted as part of a federally approved conservation plan or resource management plan (RMP) that prevents jeopardy to the species. Supporting the RMP are hatchery and genetic management plans (HGMPs) for each hatchery program that describe the details of the operation.

The Co-managers have completed HGMPs for all programs and submitted RMPs for ESA protected Chinook salmon, summer chum salmon, and non-Chinook species not listed under ESA (WDFW and PSTT 2004, PSTT and WDFW 2004). 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 Chinook 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.

Finally, in addition to the planning necessary to comply with prohibitions against harming listed species under ESA, the development of watershed recovery plans provides an opportunity to complete or revise many of the objectives envisioned by comprehensive regional management plans (CRMPs) under the

United States v *Washington* with the perspective of recovering self-sustaining natural populations that support harvest.

Hatchery Reform Planning

The hatchery reform project began at the behest of Washington State's congressional representatives in 1999 to assist in a comprehensive 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). An independent panel of scientists called the Hatchery Scientific Review Group (HSRG) reviewed hatchery programs within all the regions of Puget Sound and the Coast and made specific recommendations. The HSRG summarized its findings and recommendations to the co-managers for several regions including Hood Canal in March 2004 (HSRG 2004) and these have been the basis for implementing many operational changes in hatchery programs and for research to resolve unanswered problems. The HSRG reports annually to Congress on progress in hatchery reform.

Other Hatchery Programs in the Skokomish River Watershed

Brief descriptions of current and proposed Chinook salmon programs are in Chapter 4. The HGMP for each program provides more detail regarding the goals, strategies, operations, and facilities.[20] The co-managers have developed recovery program HGMPs in conjunction with the development of recovery plans.

Current Production of Other Species

Hatchery programs in the Skokomish River do not operate independently of programs for other species. Hatchery operations in the Skokomish River Watershed also produce coho salmon (*O. kisutch*), fall chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), and steelhead (O. mykiss). The annual hatchery production goals of these species, excepting steelhead, are shown in Table D.1. These programs often share facilities and released fish can, and often do, interact in the wild.

[20] Available at http://wdfw.wa.gov/hat/hgmp/#pugetsound

Table D.1. Hatchery production of non-Chinook species of salmon in the Skokomish River

Production Facility	Species			Release Location	Purpose
	Coho	Fall chum	Pink		
George Adams	300,000			Skokomish R.	Harvest
McKernan		10,000,000		Skokomish R.	Harvest
Enetai		2,500,000		Enetai Cr.	Harvest
Hoodsport		12,000,000	500,000	Finch Cr.	Harvest

Washington State's long-term Hood Canal hatchery steelhead program was discontinued after 2004. A large-scale test of steelhead supplementation of local populations in Hood Canal was initiated beginning in 2007 (Berejikian et al. 2006). The supplementation program includes the collection of embryos from redds constructed by natural steelhead in the South Fork Skokomish River and the rearing and release of 34,500 age-1 and/or age-2 smolts and 400 adults (age-3 and/or age-4).

Future Production of Other Species

The Cushman Hydroelectric project had major impacts on fish species in the Skokomish River and to the Skokomish Tribe that depended on the river. The U.S. Department of Interior's section 4(e) conditions for the adequate protection and utilization of the Skokomish Indian Reservation provide for artificial production and release of fish, as well as fish passage, instream flows, and other conditions. For the purposes of this plan, we assume that the 4(e) artificial production conditions will be implemented and that 50,000 Chinook fingerlings, 20,000 steelhead, 50,000 coho, 10 million sockeye eggs/fry, and 110,000 sockeye smolts will be produced. Technical issues to be resolved are similar to the one identified in Table 4.2 of Chapter 4 for early-timed Chinook salmon although no schedule has been set for implementation.

Hatchery Management Actions Contributing to Recovery

Guidelines, Evaluations, and Adaptive Management

As affirmed in the Co-managers' RMP and the HGMPs, hatchery programs in the Skokomish River follow a number of guidelines, policies and permit requirements in order to operate. The intent of these rules is to limit adverse effects on cultured fish, wild fish, and the environment. 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, summer chum, and bull trout), maintaining stock integrity and genetic diversity, maximizing survival and controlling fish pathogens, and ensuring compliance with state and federal water quality standards. Some of the manuals and guidelines used by WDFW or the tribes are listed in Table D.2.

The co-managers regularly evaluate the risks and benefits of hatchery programs as part of their effort to adaptively manage and improve hatcheries. Tools used to evaluate hatchery programs are continually being improved. Some of the most current ones are listed in Table D.3. Tables D.4 and D.5 describe the relationship between the tools, HGMPs, and monitoring in more detail.

Table D.2. Guidelines and manuals used for hatchery operations.

Guidelines	Explanation
Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington (Hershberger and Iwamoto 1981)	Defines practices that promote maintenance of genetic variability in propagated salmon.
Spawning Guidelines for Washington Department of Fisheries Hatcheries (Seidel 1983)	Defines spawning criteria to be used to maintain genetic variability within the hatchery populations
Stock Transfer Guidelines (WDF 1991)	Guidance in determining allowable stocks for release for each hatchery
Fish Health Policy of the Co-managers of Washington State (NWIFC and WDFW 2006)	Designates zones limiting the transfer of eggs and fish in Puget Sound thereby limiting spread of fish pathogens between watersheds
National Pollutant Discharge Elimination System Permit Requirement	Sets allowable discharge criteria for hatchery effluent and defines acceptable practices to ensure the quality of receiving waters and ecosystems

Table D.3. Models used for evaluating hatchery actions for salmon recovery.

Model	**Description**
AHA	All-“H”-Analyzer—Uses a Beaverton-Holt spawner-recruit model, assumptions about habitat capacity and productivity, hatchery production information, and a genetic model for loss of fitness in hatchery fish to predict the relative numbers of fish returning to the wild, the hatchery, and harvest.
BRAP	Benefit Risk Assessment Procedure—a qualitative model for assessing genetic and ecological impacts of hatchery fish on wild populations.
EDT population	Ecosystem Diagnosis and Treatment model—This version incorporates harvest and hatchery information into the well-used original model, which used information about the habitat quality of stream reaches to predict the impacts of habitat actions on salmon abundance, productivity, and diversity.
RAMP models	Easy to use quantitative models of genetic impacts
• FITFISH	Models loss of fitness from domestication
• TUFTO-HINDAR	Models genetic effective population size with one or more interacting populations to assess risk of losing genetic diversity through genetic drift
• PCD-RISK	Bioenergetic model of the impacts of predation and competition between hatchery and natural fish in freshwater.
Managing for Success	This is database which is still under development by the co-managers, tracks the implementation of hatchery reform recommendations arising from the assessments using the models above and the recommendations of independent reviews, such as the HSRG.

Table D.4. Tools and processes used to assess hatchery operations and their consistency with the co-managers' General Principles (from WDFW and PSTT 2004).

General Principles	Concerns Addressed	HGMP	Benefit-Risk Assessment Procedure	Section 7 consultation	HSRG Review
• 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

Table D.5. Hatchery adaptive management assessments and associated monitoring required, time frames and funding status.

Assessment	Rationale/ Direction	Monitoring Required	Time Frame: Implementation/ Results	Funding	Funding Availability
Integration of hatchery, habitat and harvest actions	Sequencing, timing, and location of habitat, hatchery and fishery management actions so that they work together to be most efficient.	Some monitoring applies to all Hs; e.g., escapement numbers and distribution, runsizes and productivity. “Managing for Success” database will be useful for tracking implementation of integration.	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.	Production depends on effective hatchery operations.	Brood stock 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	Currently available.
Numbers and kinds of adults returning to river	Detect major changes & trends and evaluate hatchery program effectiveness.	Spawner surveys to estimate HORs and NORs.	Continuing. Short & long term.	Co-managers, LLTK	Currently available.
Skokomish Chinook cohort analysis and new run reconstruction.	Estimates run sizes for complete picture of hatchery effectiveness. Looks at major changes & trends.	Coded wire tagging, marking, and sampling. Actual cohort analysis and run reconstruction in future.	Continuing. Long term.	Co-managers	Coded wire tagging, marking and sampling covered. Additional funding for future analysis.

Table D.5 Continued

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 history info. & biol. character.), seining & snorkeling surveys for juvenile distribution and habitat use, including estuaries and nearshore.	Continuing current programs need to initiate new programs. Short and long term.	Co-managers	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.	Co-managers	All cover spawner surveys and some juvenile trapping. Funding needed for additional trapping, and other surveys.
Distribution of Chinook throughout watershed.	To determine extent of distribution and signal the need for new actions.	Spawner surveys, juvenile trapping in tributaries, seining & snorkel surveys, including estuaries.	Same as immediately above	Co-managers	Same as immediately above.
Progress toward recovery goals – productivity & abundance.	From cohort analysis and run reconstruction (see above).	Coded wire tagging, marking, and sampling.	Continuing. Long term.	Co-managers	Currently available.

Recent Actions

There have been numerous hatchery management actions implemented in Hood Canal since the listing of Puget Sound Chinook under the ESA in 1999. Those actions to help achieve Chinook salmon recovery goals include:

- Implementing measures for hatchery Chinook and non-Chinook programs to minimize negative affects on natural Chinook populations, such as reducing potential ecological interactions in freshwater and estuarine areas by controlling size, time, and location of release;
- Discontinuing the importation of non-local hatchery Chinook stocks in 1991 and thereby allowing for local adaptation and increase in diversity;
- Reducing or eliminating some hatchery programs, such as the termination of yearling releases from saltwater net pens to reduce potential straying and spawning by hatchery Chinook in natural spawning areas;
- Improving monitoring, assessment and adaptive management programs to meet hatchery objectives and standards and ultimately the recovery goals; and
- Coordinating management actions among the management entities.

Actions for George Adams Hatchery Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the George Adams Hatchery for this program.
- WDFW will limit, as the management intent, annual production of fall Chinook salmon for on-station release at George Adams Hatchery to a total, maximum of 3,800,000 fingerlings or sub-yearlings. Limiting juvenile production to current (proposed) levels will help retain potential future options for the recovery of the listed Chinook salmon ESU.
- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to fall Chinook salmon sub-yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns. Except for the designated Chinook production utilized for double-index tagging and chinook rebuilding efforts in the Skokomish River using supplementation techniques, all George Adams hatchery origin fish will be visibly marked by removal of the adipose fin. This objective was phased in for Chinook and fully implemented with the 2007 brood year production. For the 2005 brood year50% of the total production was adipose fin marked. Adipose fin marking was increased to

75% of total production with the 2006 brood leading, as stated, to 100% of total production in the 2007 brood year.

- WDFW will apply coded-wire tags to a portion of the sub-yearling fall Chinook salmon production at George Adams Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.
- The co-managers will monitor Chinook salmon escapement to the Skokomish River to estimate the number of hatchery-origin and natural-origin Chinook escaping to the river each year. This monitoring will allow for assessment of the status of the natural population.

Currently, some Chinook production is coded-wire tagged at George Adams Hatchery and it 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, adipose fin-clipping of Chinook fingerling production increased beginning with brood year 2005, as described above, to allow additional monitoring and evaluation of the hatchery program.

Actions at Rick's Pond Fall Chinook Salmon Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the George Adams Hatchery for this program.

WDFW will limit, as the management intent, annual production of fall Chinook for on-station release at Rick's Pond to a total of 120,000 yearlings. Limiting juvenile production to current levels will help retain potential future options for the recovery of the listed Chinook salmon ESU. The rearing and release of Chinook fingerlings (instead of yearlings) at Rick's Pond is being discussed by the Co-managers and may be implemented beginning with brood year 2008.

WDFW and the Tribes have agreed to adipose-clip 100% of the fall Chinook salmon released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will apply coded-wire tags to a portion of the yearling fall Chinook salmon production at Rick's Pond to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.

- The co-managers will monitor Chinook salmon escapement to the Skokomish River sites to estimate the number of hatchery-origin and natural-origin Chinook escaping to the river each year. This monitoring will allow for assessment of the status of the natural population.

Actions for Hoodsport Hatchery Fall Chinook Salmon Program

- WDFW will continue to use gametes procured from fall Chinook salmon adults volunteering to the Hoodsport Hatchery for this program. The intent is to collect localized hatchery-origin broodstock at this location.

- WDFW will limit, as the management intent, annual production of fall Chinook salmon for on-station release at Hoodsport Hatchery to a total, maximum of 2,800,000 fingerlings or sub-yearlings and 120,000 yearlings. Limiting juvenile production to current levels will help retain potential future options for the recovery of the listed Chinook salmon ESU.

- WDFW will, as a management intent, agree on an identifiable mark with the tribes and apply it to 100% of the fall Chinook salmon sub- yearlings and yearlings released through the hatchery program each year to allow monitoring and evaluation of the hatchery program fish releases and adult returns.

- WDFW will apply coded-wire tags to a portion of the sub-yearling and yearling fall Chinook salmon production at Hoodsport Hatchery to allow for evaluation of fishery contribution and survival rates, and of straying levels to other Puget Sound watersheds.

- Currently, some Chinook production at Hoodsport Hatchery 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 and the Tribes have agreed to mass mark Chinook fingerling and yearling production and all Chinook have been adipose-clipped beginning with brood year 2004. In addition, each year there will be combined adipose fin-clipping and coded-wire tagging for 200,000 subyearling Chinook and 100,000 yearling Chinook.

The guidelines listed above for Chinook hatchery programs also apply to non-Chinook hatchery programs. For example, 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 ESA listed Chinook and ESA listed 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 and Hood Canal marine areas. 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).

Appendix E
Background Information for Hydropower Recovery Strategy

Description of the Cushman Hydropower Project

Tacoma Public Utilities, a division of the City Tacoma, owns and operates the Cushman Hydropower Project. The project consists of two dams on the North Fork Skokomish River, a dam and diversion channel on McTaggert Creek, and two power generating facilities.

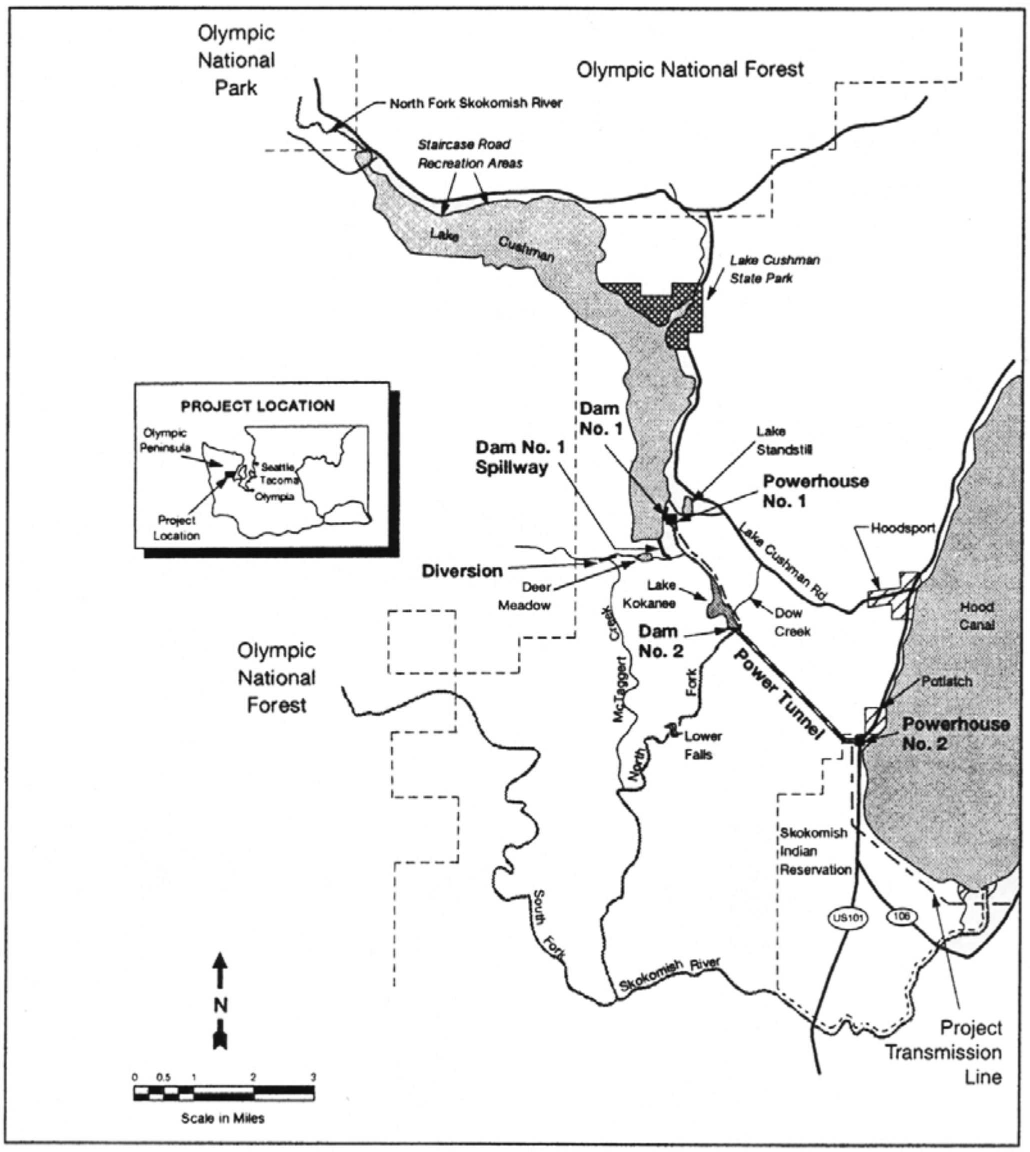

Figure E.1. Cushman Hydropower Project

The following information is from *Relicensing of the Cushman Hydroelectric Project (FERC No. 460), Skokomish River, WA*, a Biological Opinion prepared by the National Marine Fisheries Service (NOAA Fisheries) on the Federal Energy Regulatory Commission's (FERC) proposed license for the operation of the Cushman Hydroelectric Project (FERC No. 460).

Cushman Dam No. 1 is a 260 ft-high concrete arch dam constructed in 1926. The dam impounds Lake Cushman, a 9.6 mile-long storage reservoir of nearly 4,000 surface acres. Powerhouse No. 1, located about 600 ft downstream from Dam No. 1, has an installed generating capacity of about 50 MW.

Cushman Dam No. 2, about 2 miles downstream from Dam No. 1, was completed in 1930. It is a 230 ft-high concrete arch dam that impounds Lake Kokanee. The power intake from Dam No. 2 diverts water from the North Fork Skokomish River into a 17 ft-diameter pressure tunnel that extends 2.5 miles to a steel surge tank. From here, three 12 ft-diameter 1,350 foot-long steel penstocks connect to Powerhouse No. 2 located on the Skokomish Indian Reservation along the shore of Hood Canal at Potlatch. Powerhouse No. 2 has a generating capacity of 81 MW.

A third dam located on upper McTaggert Creek diverts flow into a channel that feeds Deer Lake, which in turn feeds a tributary that flows into the North Fork Skokomish River upstream of Kokanee Dam. This re-routing of flow from McTaggert Creek was done to increase the power generating capacity of Powerhouse No. 2. Because McTaggert Creek joins the North Fork of the Skokomish at RM 13.5, this diversion of flow into Powerhouse No. 2 further contributes to reduced flows in the North Fork Skokomish River.

In 1924, the former Federal Power Commission, now the Federal Energy Regulatory Commission (FERC), issued Tacoma Public Utilities a 50-year minor part license to flood 8.8 acres of Federal land. The Cushman Hydropower Project is and has been otherwise unlicensed. The minor part license was silent on issues such as natural resource protection and mitigation, as it was on the dams, powerhouses, and other project components. The minor part license expired in 1974 and Tacoma Power filed an application for a new major project license that included the entire Project works. The Project operated from 1974 to 1998 under annual licenses, which contained no environmental measures. In 1998, FERC issued a final license order, but all environmental mitigation and enhancement measures in the new license were stayed pending judicial review.

In 2006, the D.C. Circuit Court of Appeals remanded the license back to FERC and ordered FERC to include the Department of Interior's Section 4(e) conditions in the license. Today, the license, and all environmental measures, remains stayed pending further action by FERC.

Tacoma began the release of 30 cfs in 1988 per agreement with WDOE and increased this amount to 60 cfs in 1999 voluntarily.

1998 Licensing Requirements

Relicensing of the Cushman Hydroelectric Project (FERC No. 460), Skokomish River, WA

Article 401:	Erosion control plan for dike removal at Nalley Ranch
Article 402:	Erosion control plan for removal of diversion dam at McTaggert Creek
Article 403:	Plan to enhance mainstream channel conveyance capacity
Article 404:	Plan for studying the effectiveness of maintaining mainstem channel conveyance using up to 25,000 acre-feet of water for flushing flows First five years and Remaining 35 years
Article 405:	Maintain minimum reservoir elevations in Lake Cushman
Article 406:	Plan for monitoring reservoir elevations and streamflows
Article 407:	Release minimum flow of 240 cfs, or inflow, whichever is less, to lower North Fork Skokomish River
Article 410:	Water quality enhancement plan
Article 411:	Plan for ramping rates
Article 412:	Plan for fish habitat enhancement
Article 413:	Fish habitat and population monitoring plan
Articles 414, 415, & 419:	Downstream and upstream passage
Article 416:	Monitoring fish passage facilities
Article 417:	Fish restoration plan
Article 418:	False attraction at Potlatch powerhouse
Article 422:	Estuarine enhancement plan
Article 423:	Threatened and endangered species protection plan
Article 425:	Recreational Resources Plan

Revised 4(e) conditions (to address Dept. of Interior's objective of also protecting the reservation):

1. Minimum flow must exceed 240 cfs

2. Requires flow increase to 310 cfs between April 1 and May 31 to provide out-migration flows.

3. Requires flow increases to 300 cfs for two consecutive days each week between September 15 and November 23 to provide attraction flows. (All of the above flows are subject to adjustment upward based on adaptive management and conditions resulting from conditions #10 and #11.)

4. Control down ramping of flows so the rate of flow change agrees with the agency recommended ramping rates (rates developed by WDFW).

5. Provide telemetered stream gages. Includes the existing gages and new gages on the South Fork and Vance Ck.

6. Provide upstream and downstream fish passage at both projects as recommended by NMFS.

7. Fund fish habitat development projects by providing $56,000 per year (in 1996 dollars).

8. Provide for fish stocking and supplementation at the following levels:
   - 100,000 yearling Chinook at 10 smolts per pound
   - 20,000 steelhead smolts at 6 smolts per pound
   - 50,000 coho smolts at 15 smolts per pound
   - 10 million sockeye eggs/fry at 2000 per pound
   - 100,000 sockeye smolts at 12 smolts per pound

9. Remove McTaggert Creek diversion dam

10. Monitor, adaptively manage and report on flow regime effectiveness. Adjust minimum flow and transport flows, as channel capacity changes will allow.

11. Implement a mainstem sediment transport plan that includes:
    - Restoring bank-full capacity of 13,000 cfs at the SR106 bridge by lowering the channel bed elevation and maintaining it at that level for the life of the license (recommends gravel removal).
    - Releasing flows within seven years at the following levels: (These flows can be reduced to protect the recreational pool level in the reservoirs between Memorial Day and Labor Day and as necessary to prevent out of bank flooding between the Reservation Boundary and SR106 bridge.)
      - o December to March 1500 cfs
      - o April to August 700 cfs
      - o September to November 2950 cfs

    - Achieve the following channel capacity targets: Mainstem – 13,000 cfs and North Fork – 2950 cfs.

Water Quality of Hood Canal Marine Waters

The unique attributes of Hood Canal contribute to the potential for water quality problems. While low dissolved oxygen (DO) levels were observed for decades, chronic levels have been below 3 parts per million (ppm) for longer duration and fish kills from episodic events of low DO appear to have increased in frequency since the 1990's. When dissolved oxygen is below 3 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. Fish kills, fishing closures and the appearance of bacterial mats that thrive in anaerobic conditions along subtidal canal depths have spurred increased efforts to understand the underlying causes (natural or man-made) which may contribute to this water quality problem.

While the effects of low dissolved oxygen are thought to be reduced for mobile fish species such as salmon, the effects of prolonged water quality impacts on the marine ecosystem, including food webs supporting salmonids in marine waters, are yet to be fully understood. The vicinity of the Skokomish River delta is affected by both chronic low DO and episodic DO. The delta region itself may be sufficiently shallow to avoid the direct impacts, but the Potlatch area appears to be particularly prone to episodic low DO events (and fish kills) from late summer/fall southerly winds that push the surface layer northwards, resulting in upwelling of deeper (high salinity and low oxygen) waters. Chronic low DO affects much of the lower Canal, with Lynch Cove as the most impacted area and the Great Bend within the affected region.

Local groups, university researchers and county, state and federal entities joined forces in 2003 as the Hood Canal Dissolved Oxygen Program (HCDOP) to develop and implement study plans to identify the potential causes and solutions of the water quality problems. The program launched a comprehensive three year study to include water quality monitoring, modeling of watersheds and marine circulation, freshwater and groundwater input monitoring, nutrient input monitoring, assessment of the properties of ocean waters, and study of Hood Canal biological communities. This information will be used to evaluate potential corrective actions. Updated information on the studies can be found at the HCDOP website http://www.hoodcanal.washington.edu/.

The HCDOP identifies three major factors that create conditions that lead to low oxygen levels in the Canal:

- Slow water circulation (flushing with marine waters from Puget Sound or ocean waters)

- Strong stratification of marine waters (i.e. distinct layers maintained with different water characteristics)
- High productivity

Increasing any or a combination of these factors could lead to the events that we are now witnessing. Changes in these factors can be from natural causes (e.g. climate) or from man-made sources, and possibly both. For example, higher productivity in marine waters could be a result of climate changes, e.g. sunlight, and/or increased nutrient input, e.g. from inadequate wastewater treatment.

Major hypotheses for the causes of the increase in low dissolved oxygen events include changes in

- Ocean input (e.g. oxygen content, salinity or density, nutrients, timing or amount)
- Phytoplankton production (e.g. change in growth conditions such as sunlight amount, nutrient input)
- Production of organic matter (e.g. natural sources or man-made sources)
- Freshwater input or timing (e.g. drought or man-made influence)
- Climate (e.g. wind speed or direction, drought, rainfall variations)

Hypotheses related to changes in river input are of particular interest to the Skokomish Chinook salmon recovery effort. Freshwater input changed dramatically in timing and location beginning when the North Fork Skokomish River filled the Cushman hydroelectric project reservoirs of Lake Cushman and Lake Kokanee in 1926 and 1930, respectively. These events were coupled with flow releases timed for power production (highest in winter) and storage of water in the reservoir for flood protection (winter) or recreation (summer). Also, beginning in 1930, the predominant flow (over 95%) was diverted at the lower dam (impounding Kokanee Lake) through penstocks to a powerhouse on the Hood Canal shoreline near Potlatch, then directly into marine waters. This diversion bypassed the historic lower North Fork route of river flow that replenished the mainstem Skokomish River and the estuary outlet. Thus, at the penstocks/powerhouse flow release site, artificial regional marine circulation anomalies from the discharge have quite possibly affected the conditions creating low dissolved oxygen events in the lower Canal. Fish kills in recent years have been observed most frequently in the Potlatch vicinity. Although many factors are likely in play, study of the potential effect of river input changes is warranted. While these changes pre-date the recent observed increased frequency of low dissolved oxygen events, the oceanographic measurements clearly indicate that low dissolved oxygen has been a feature of Hood Canal since at least the 1950s.

Recovery of the water quality of Hood Canal is a vital component of the salmon recovery effort for the Skokomish River population. We support the continued scientific research and modeling efforts to determine potential corrective actions related to Skokomish River and this recovery plan. In the interim, we endorse the early action items devised by HCDOP, e.g. promoting low impact development, effective stormwater and wastewater management, as part of the effort to restore the Hood Canal ecosystem.

Appendix F
Glossary

Term	Explanation
Active adaptive management	Managers design practices so as to discriminate between alternatives, and thus reveal the "best" management action. This sometimes involves testing practices that differ from "normal", to determine how indicators will respond over a range of conditions.
CRMP	Comprehensive Regional Management Plans—a management plan developed by the co-managers that describes the management objectives, strategies, and coordination for a watershed or region.
EIS	Environmental Impact Statement—a report on the environmental impacts of a federal action called for under the National Environmental Policy Act.
Equilibrium brood document	Describes the desired functions and standard mode of hatchery operations, including facilities, species cultured, brood stock source, hatchery practices (fish transfer, brood stock collection, rearing, and release), production goals (number, size, and timing of fish to be released), and contingency plans.
Equilibrium brood program	The program described in the equilibrium brood document
Future Brood Document	Annual describes the actual details or variations from the equilibrium brood document (e.g. production goals or fish transfers) from year to year.
HGMP	Hatchery and Genetic Management Plans—a description of hatchery goals, history, operations, and facilities necessary for Section 4(d) compliance under the Endangered Species Act.

Term	Explanation
HOR	Hatchery-origin recruit; a fish whose parents were spawned in the hatchery and who was incubated or raised in a man-made environment.
HSRG	Hatchery Scientific Review Group—a group of scientists formed as part of the Hatchery Reform Act to review hatcheries.
NEPA	National Environmental Policy Act directs federal agencies to assess the environmental impacts of their decisions, funding, and regulations.
NOR	Natural-origin recruit; a fish whose parents spawned in the wild and who hatched from eggs incubated in a natural environment.
Passive adaptive management	Managers control uncertainty by selecting the "best" management option, assuming that the model on which the predictions are based is correct.
PSTT	Puget Sound Treaty Tribes.
PNPTT	Point No Point Treaty Tribes.
RMP	Resource Management Plan—a harvest or hatchery plan prepared for federal approval as a conservation plan.
4(d)	A section of the Endangered Species Act that directs the federal government to issue regulations that are necessary and advisable for the conservation of a species and that also exempts programs from the regulations if they are carried out as part of a federally approved conservation plan.
"Take"	To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct on a species protected by the Endangered Species Act.