

Stillaguamish Watershed Chinook Salmon Recovery Plan

*Prepared by:
Stillaguamish Implementation Review Committee (SIRC)*

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Front Cover Photos (foreground to background):

1. Fish passage project site visit by SIRC (Sean Edwards, Snohomish County SWM)
2. Riparian planting volunteers (Ann Boyce, Stilly-Snohomish Fisheries Enhancement Task Force)
3. Boulder Creek (Ted Parker, Snohomish County SWM)
4. Stillaguamish River Estuary (Washington State Department of Ecology)
5. Background – Higgins Ridge from Hazel Hole on North Fork Stillaguamish River (Snohomish County SWM)

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1. Introduction

Purpose

The Stillaguamish Chinook Salmon Recovery Plan is intended to provide guidance to local stakeholders in a collaborative effort to restore and protect Chinook salmon populations in the Stillaguamish River watershed – Water Resource Inventory Area (WRIA) 5. This Plan is one of fourteen local watershed plans being prepared for submittal to the Shared Strategy for Puget Sound. The Shared Strategy is compiling this information for a Puget Sound-wide salmon recovery plan, as required by the federal Endangered Species Act. Once the draft plan is submitted, it will undergo review by NOAA Fisheries in advance of a final plan being produced in mid-2005.

The overall goal of the Stillaguamish Watershed Chinook Salmon Recovery Plan is to help Chinook salmon populations recover to sustainable and harvestable levels.

The overall goal of the Stillaguamish Watershed Chinook Salmon Recovery Plan is to help Chinook salmon populations recover to sustainable and harvestable levels. This document recommends an integrated strategy for protecting and restoring Chinook salmon populations, including individual strategies for habitat management, harvest management, and hatchery management, as well as an initial 10-year recovery plan with specific actions for Chinook salmon habitat improvement. The Plan's recommendations include habitat projects to restore watershed processes that affect Chinook salmon populations, protection of existing habitat through regulatory and non-regulatory strategies, stewardship education and outreach, and a monitoring and adaptive management plan.

This watershed plan was prepared by the Stillaguamish Implementation Review Committee (SIRC), the local stakeholder group overseeing salmon recovery and watershed planning efforts in WRIA 5. This document is the result of ongoing work by fisheries experts and the 25 local organizations and citizens who participate on the SIRC and have agreed to the watershed goals and priorities in the document.

SIRC Mission and Objectives

The Stillaguamish Implementation Review Committee (SIRC) is a broad-based watershed stakeholder committee with 25 members representing local municipalities, tribes, state and federal government agencies, agricultural and forestry interests, flood control districts, environmental groups, and citizens.

The mission of the SIRC is “To restore and maintain a healthy, functioning Stillaguamish Watershed by providing a local forum in which agencies, organizations, communities, and the public can engage in a collaborative watershed-based process of decision making and coordination.”

The SIRC was established in 1990 to review implementation of the Stillaguamish Watershed Action Plan, which addressed water quality problems in the Stillaguamish Watershed. In the mid-1990s, with leadership from the Stillaguamish Tribe and Snohomish County, the SIRC began addressing salmon habitat restoration issues in the watershed. Since 1999, the SIRC has served as the local citizens committee for recommending prioritized lists of salmon habitat restoration projects to the Washington State Salmon Recovery Funding Board. In September 2000, a SIRC subcommittee called the Stillaguamish Technical Advisory Group (STAG) produced a document titled *Technical Assessment and Recommendations for Chinook Salmon Recovery in the Stillaguamish Watershed*. The SIRC is also the local forum for public input on Snohomish County’s long-term salmon conservation planning effort for the Stillaguamish Watershed.

The focus of the SIRC is on collaborative watershed-based decision-making and coordination. The SIRC will work to implement the approved Stillaguamish Watershed Chinook Salmon Recovery Plan and will address future issues at a watershed scale. This ongoing effort will include coordination among the watershed’s jurisdictions and stakeholders to secure commitments to this Plan and achieve the collective vision for Chinook salmon recovery in the Stillaguamish Watershed.

Relationship to Shared Strategy and Central Puget Sound ESU Efforts

The State of Washington has proposed a statewide salmon recovery plan that covers multiple species of salmonids and Evolutionarily Significant Units (ESUs), distinct population groups as established by NOAA Fisheries that can receive ESA coverage. The Puget Sound Chinook salmon ESU covers all Chinook salmon populations in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. The State’s plan includes sections for a regional response within the Central Puget Sound area as well as watershed-specific actions.

The Shared Strategy for Puget Sound is a collaborative initiative involving public and private stakeholders to share information and coordinate recovery planning across watersheds within the Central Puget Sound ESU region. The Shared Strategy effort relies on local watersheds to develop most of the technical information and public involvement effort for a Chinook salmon

recovery strategy. The Stillaguamish Watershed is one of fourteen watersheds that are working with the Shared Strategy to identify actions to recover salmon and obtain the commitments needed to achieve this goal. Individual watershed groups, such as the SIRC, are developing the technical and policy recommendations and will identify actions and commitments for habitat, harvest, and hatchery management to achieve local watershed goals.

The Stillaguamish Watershed will work with the Shared Strategy and the other watersheds and stakeholders throughout Puget Sound to integrate science and social policy into the regional recovery plan for Chinook salmon in the Central Puget Sound ESU. The watershed goal and recovery actions identified for the Stillaguamish Watershed will be coordinated with those from other watersheds to develop regional implementation scenarios. A regional consensus process will ensure that the final salmon recovery plan for Puget Sound ultimately reflects local needs and priorities, while meeting ESA requirements. The Shared Strategy is on schedule to deliver a regional recovery plan by June 2005.

Stillaguamish River Watershed Overview

The Stillaguamish River is the fifth largest tributary to Puget Sound. The Stillaguamish Watershed drains an area of approximately 700 square miles and includes more than 3,112 miles of river, stream, and marine shore habitat (Figure 1). Elevations in the watershed range from sea level to about 6,854 feet on Three Fingers Mountain. The river enters Puget Sound at Stanwood, 16 miles north of Everett in northwestern Snohomish County. The watershed drains into both Port Susan and Skagit Bay. It is also part of the Whidbey Basin, which includes Skagit Bay, Saratoga Passage, Port Susan, and Deception Pass.

The Stillaguamish Watershed can be divided into three general regions: the North Fork, South Fork, and Lower Mainstem. The two forks join in Arlington, 18 river miles from the mouth. Pilchuck, Deer, Boulder, and Canyon Creeks are the four largest tributaries to the Stillaguamish River system. The watershed includes land governed by Snohomish County and Skagit County, the cities of Arlington, Stanwood, and Granite Falls, and the Stillaguamish and Tulalip Tribes. Land use within the Stillaguamish Watershed is 76% forestry, 17% rural, 5% agriculture, and 2% urban (Snohomish County 1995). Federal, state, and private forest land uses occupy the majority of the watershed.

The local climate is typically maritime with cool, wet winters and mild summers. Rainfall is highly variable throughout the watershed, with average

annual rainfall ranging from 30 inches per year in the western lowlands of the watershed to 150 inches per year at higher elevations in the eastern portion of the watershed (Pess et al. 1999). Approximately 75% of the precipitation falls between October and March. Precipitation and streamflows are highest in late autumn and winter as a result of rainstorms and rapid snowmelt during warmer rainstorms (called rain-on-snow events). The lowest flows occur usually during the summer dry period from July through October.

Figure 1. Stillaguamish Watershed

Salmonid Species in the Stillaguamish Watershed

Chinook Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) inhabit the mainstem, North Fork and South Fork of the Stillaguamish River, as well as several of the watershed's larger tributaries (Pilchuck, Jim, Canyon, Squire, French, Deer, and Boulder Creeks) (Figure 2). Two populations of Chinook salmon are found in the Stillaguamish Watershed: North Fork summer Chinook salmon and South Fork fall Chinook salmon. These two populations are distinguished by temporal, and to a lesser degree, spatial differences in spawning. Juvenile Chinook salmon rear throughout the river system. Approximately 98-99% of Stillaguamish Chinook salmon are ocean-type that reside in freshwater habitat for one to five months before migrating to the estuary, while the remaining 1-2% are stream-type that rear for approximately one year in freshwater before migrating to the estuary (Griffith et al. 2003). While Stillaguamish-specific information regarding the types of habitat utilized by Chinook during their freshwater residence is lacking, it is likely that they rear in the margins and low velocity habitats of the mainstem and larger tributaries (Healy 1991).

North Fork (Summer) Chinook Salmon

North Fork Chinook salmon are the predominant Chinook salmon population within the Stillaguamish Watershed. The majority (80%) of the North Fork Chinook salmon spawn in the middle and upper sections of the North Fork Stillaguamish, with limited numbers of fish using the larger tributaries (Boulder, Squire, Deer, and French Creeks) for spawning (STAG 2000; Stillaguamish Tribe and WDFW, unpublished spawner survey data). North Fork Chinook salmon select spawning areas that are associated with tail outs, riffles, and bars in the deeper portions of the low flow channel area. These spawning locations are at high risk for impacts from late fall and winter flooding. North Fork Chinook salmon females typically lay 3,000 to 5,000 eggs in one or more nests (redds) (Stillaguamish Tribe, unpublished broodstock records). Redds are generally located in gravel 1 to 3 inches in diameter, and eggs are usually buried in gravel up to 10 inches deep. In the Stillaguamish River, Chinook salmon eggs should reach the eyed stage from mid-October to mid-November and should hatch in November. Emergence from the gravel usually occurs during December and January.

South Fork (Fall) Chinook Salmon

The few small populations of fall Chinook salmon in the Stillaguamish Watershed can be found in Jim Creek, Pilchuck Creek, and the lower portion of the South Fork Stillaguamish. Fall Chinook salmon are also infrequently found in French Creek and Canyon Creek. South Fork Chinook salmon tend

to enter the river later than North Fork Chinook salmon, with fish arriving on the spawning grounds during mid-September and completing their spawning by mid-October (STAG 2000). The South Fork Chinook population salmon is a genetically unique population from the North Fork Chinook salmon population. Within the Puget Sound genetic units, the South Fork population more closely aligns with the Snohomish and South Sound stocks (including Green River) (Marshall et al. 1995).

Bull Trout

Four local populations of bull trout (*Salvelinus confluentus*) exist in the Stillaguamish Watershed (USFWS 2004): the North Fork Stillaguamish River (including Boulder Creek and potentially Squire Creek); the South Fork Stillaguamish River; Canyon Creek; and Upper Deer Creek (including Higgins Creek). There are also resident freshwater populations of bull trout in the watershed. Stillaguamish bull trout populations are presumed to use nearshore marine areas in Skagit Bay, Port Susan, and Possession Sound. According to the latest information available, many bull trout migrate annually, leaving the estuaries during the warm summer and early fall months.

The U.S. Fish and Wildlife Service (USFWS) has listed the Puget Sound bull trout as Threatened under the federal Endangered Species Act. Since the range of Chinook salmon habitat in the Stillaguamish Watershed is also used by bull trout, it is believed that actions taken in this plan to recover Chinook salmon will also benefit bull trout populations in areas of overlap.

Other Salmonid Species¹

Coho Salmon

The SASSI identifies two distinct coho salmon (*Oncorhynchus kisutch*) populations: Stillaguamish and Deer Creek. The former is considered a mixture of native and non-native fish because of releases of hatchery coho salmon from the early 1950s to 1981. This population is classified by SASSI as depressed. The Deer Creek population is a native population. Its status is unknown. The Stillaguamish Tribe operates a coho salmon brood stock program with fish derived from naturally and hatchery spawned adults. Coho salmon return to the Stillaguamish River in September and October, and generally spawn from mid-November through January. They spawn in almost all accessible tributary streams in the Stillaguamish River system, preferring smaller streams with stable streamflow and gravel-sized substrate (Miller and Somers 1989). Coho salmon fry emerge in March and April, and spend a full year in the watershed before migrating as smolts to salt water (Miller and Somers 1989). Juvenile coho salmon rear throughout the watershed, preferring small streams, side channels, wetlands and beaver ponds. Between 1986 and 1989, the annual coho salmon smolt production estimates from the

¹ Stock information is taken from SASSI (1993), SaSI (1998) and WCC (1999) unless otherwise noted.

Stillaguamish watershed averaged 649,081 and ranged from a high of 826,297 (1986) to a low of 514,680 (1989) (Nelson et al. 1997).

Chum Salmon

The Stillaguamish chum salmon (*Oncorhynchus keta*) are geographically separated into two populations: North Fork and South Fork. Chum salmon enter the river from September through December. Spawning occurs from mid- to late October through December. Chum salmon prefer to spawn in side channels and in larger tributary streams. Chum salmon fry emerge in March through May and leave the freshwater system almost immediately (Miller and Somers 1989). Juvenile chum salmon may linger in the estuary for up to three months before migrating into Puget Sound.

Pink Salmon

Pink salmon (*Oncorhynchus gorbuscha*) in the Stillaguamish Watershed are geographically and temporally separated into two populations: North Fork and South Fork. The genetic distinctions between the two stocks are unknown. This species is believed to be native to the Stillaguamish. There is no record of hatchery introductions. Pink salmon are listed by SASSI as healthy. Pink salmon enter the river on odd-numbered years from early August through early October. They are also found in the river on even-numbered years in limited numbers. The spawning season for pink salmon begins in late August and peaks in mid-October. Spawning mainly occurs in the North Fork and the South Fork and in larger tributaries (especially Squire, Boulder, Jim, and Pilchuck). Other tributaries are also used for spawning when sufficient flow is present. Pink salmon fry emerge from the gravels in March and leave the river almost immediately.

Steelhead Trout

Four steelhead trout (*Oncorhynchus mykiss*) populations have been identified in the Stillaguamish Watershed, including one winter run and three summer runs. The winter run is healthy according to SASSI, while summer runs are critical or unknown. Juvenile steelhead trout rear between one and three years in freshwater before departing for Puget Sound (Miller and Somers 1989). The pools of small quiet streams and beaver ponds are important for the young fry, but as the fish grow in size they are able to use the higher energy stream environments. Spawning occurs mainly in the North Fork and South Fork. The primary spawning tributaries include Pilchuck, Boulder, Squire, Jim, and Canyon Creeks. Approximately 100,000 to 130,000 hatchery winter steelhead trout smolts and 80,000 hatchery summer steelhead trout smolts are annually released into the Stillaguamish River. Smolts migrate out of the river from March through late June.

Sockeye Salmon

There is a small population of river sockeye salmon (*Oncorhynchus nerka*) inhabiting the Stillaguamish Watershed. Whether they are strays from other watersheds or a genetically distinct population is not known. Sockeye salmon

are known to spawn in the upper North Fork, as well as several tributaries including Jim, Deer, Squire and Boulder Creeks. Sockeye salmon generally enter the river from July through September and spawn from August through October. Smolts migrate out of the river from March through June.

Sea-run Cutthroat Trout

Sea-run (*Oncorhynchus clarki clarki*) and resident populations of cutthroat trout are found throughout mainstem tributary habitats in the Stillaguamish Watershed, although there has been no systematic inventory of these populations. Resident cutthroat trout, along with rainbow trout and brook trout, have been stocked in many lakes in the watershed (USFS 1995). Sea-run cutthroat trout begin entering the Stillaguamish in late July. Spawning occurs in mid-February through mid-May. Sea-run cutthroat trout typically rear from two to four years in freshwater before migrating to salt water, where they spend about two to five months before returning to the watershed (Spence et al. 1996).

Figure 2. Chinook Salmon Distribution

Non-Stillaguamish Salmonid Populations

Salmonids originating from other watersheds (non-natal populations) are known to use the Stillaguamish nearshore for juvenile rearing and adult feeding and migration. It is assumed that salmonids from the neighboring Snohomish and Skagit watersheds use the Stillaguamish nearshore more heavily than salmonids from more distant watersheds. However, recent studies have shown that juvenile salmonids are distributed widely throughout the Puget Sound basin nearshore after they leave their natal watersheds (Brennan et al. 2004).

Focus on Chinook Salmon

Chinook salmon is the focal species for the Stillaguamish Watershed Salmon Recovery Plan. While the watershed stakeholders have a strong vision for broad ecosystem restoration, the determination that Chinook salmon should be a clear focus of this plan was based on the following factors:

- Chinook salmon are listed as Threatened under the federal Endangered Species Act (ESA).
- The habitat and ecosystem processes that must be restored and protected for Chinook salmon will benefit all other salmonids in the watershed.
- Chinook salmon recovery efforts over three decades have not resulted in achieving the former escapement goal of 2,000 (Ames and Phinney 1977).
- While bull trout are also listed as Threatened under the ESA, much is unknown about what specific measures should be taken to address bull trout habitat needs. The USFWS is developing a Puget Sound Recovery Plan for bull trout on a separate track from the regional Puget Sound Chinook salmon recovery process.

2. Current Status of Stillaguamish Chinook Salmon Populations

Independent Populations

Chinook Salmon

In March 1999, Stillaguamish Chinook salmon and other Puget Sound salmon populations were designated as Threatened under the federal Endangered Species Act. Substantial evidence has been accumulated to document the decline of Chinook salmon in the Stillaguamish River watershed (STAG 2000). Estimates of historic Chinook salmon populations within the watershed prior to extensive land use changes provide reference points to compare with current Chinook salmon population trends.

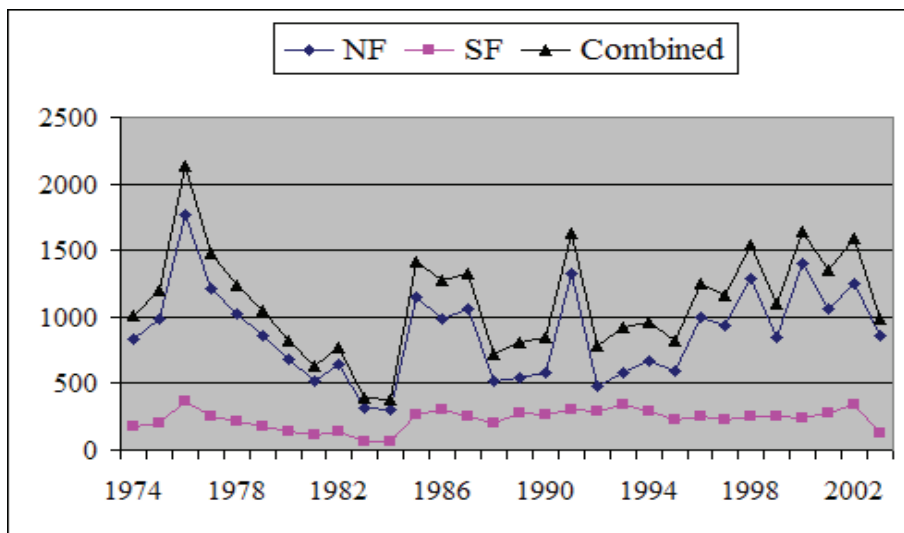
Historic levels of Stillaguamish Chinook salmon abundance are estimated by habitat modeling to be approximately 25,000 fish in the North Fork population and 21,000 fish in the South Fork population (Mobrand Biometrics 2004; Rawson et al. 2004). Habitat modeling indicates that current populations are at about 7% of historical levels² (Mobrand Biometrics 2004). The recent 8-year average (1996-2003) combined North and South Fork population adult escapement (fish that survive and return to their watershed of origin) is 1,326 fish (Abundance & Productivity Tables; Appendix C). The escapement goal of 2,000 fish for the watershed (Ames and Phinney 1977) has not been met since 1976. Figure 3 shows the pattern of Stillaguamish Chinook salmon escapement between 1974 and 2003. These numbers include adult Chinook salmon produced by the Stillaguamish hatchery supplementation program (described in more detail later in this document). Escapements since 1993 have shown limited improvement, likely in response to significant reductions in harvest shown in Figure 10 later in this chapter.



Habitat modeling indicates that current populations are at about 7% of historical levels

² Estimated current combined populations is 3,291; estimated historic combined populations is 46,153 (see Table 10).

Figure 3. Chinook Salmon Escapement (including hatchery fish) 1974-2003 (Abundance & Productivity Tables)



North Fork (Summer) Chinook Salmon

The North Fork Chinook salmon population has ranged from a high escapement of 1,768 fish in 1976 to a low escapement of 309 fish in 1984. The recent 8-year (1996-2003) average for North Fork Stillaguamish Chinook salmon escapement (including hatchery fish) is 1,080 fish. This average represents approximately 81% of the combined Stillaguamish natural Chinook salmon escapement (Abundance & Productivity Tables; Appendix C).

North Fork Stillaguamish Chinook salmon are an early timed (summer run) Chinook that are more closely aligned with Skagit River populations. This genetic relationship is supported by geologic information showing that the Sauk, a tributary of the Skagit, was connected to the North Fork Stillaguamish some 10,000 years ago (Marshall et al. 1995). "In addition to the genetic similarities, the age distribution and length-at-age of North Fork Stillaguamish Chinook are more similar to Chinook spawning in the lower portions of the Skagit River Basin than they are to Chinook in the South Fork Stillaguamish (Ruckelshaus et al. 2001)."

Eldridge and Killebrew (unpublished data) analyzed microsatellite DNA and found that although there had been significant introductions of Green River type hatchery Chinook salmon to the North Fork Stillaguamish between 1952 and 1974, "no legacy of Green River (hatchery) Chinook introductions was detected in the fishery, broodstock or on the spawning grounds in the years tested."

South Fork (Fall) Chinook Salmon

The South Fork population has ranged from a low escapement of 65 fish in 1984 to a high escapement of 345 fish in 1993. The recent 8-year (1996-2003) average for South Fork Stillaguamish Chinook salmon escapement

(including stray hatchery fish) is 246 fish. This average represents approximately 19% of the combined Stillaguamish natural Chinook salmon escapement (Abundance & Productivity Tables; Appendix C).

Analysis by Marshall et al. (1995) documented that the South Fork Stillaguamish Chinook salmon (fall run) population is more closely aligned with Snohomish Watershed Chinook salmon populations. This genetic connection is supported by geologic evidence that the South Fork Stillaguamish ran into the Pilchuck River area of the Snohomish Watershed in the recent geologic past. The genetic makeup of South Fork Chinook salmon is complicated by the outplanting of over 9 million fall Chinook salmon from outside the Stillaguamish Watershed during the 1957-74 time period (STAG 2000). The South Fork population has seen limited hatchery planting since 1976, with the Stillaguamish Tribe acclimating very limited numbers of North Fork summer Chinook salmon in the upper South Fork Stillaguamish above the Granite Falls fish ladder during 1991, 1993, and 1994 (STAG 2000). Based on recent spawning escapement numbers, a small number (<300) of naturally spawning, genetically discrete South Fork Chinook salmon appear to be self-sustaining at a low stable level within the current degraded environment. In addition, spawning surveys over the last several years have documented a number of stray Chinook salmon from outside the watershed (Rawson, personal communication).

Recently completed preliminary microsatellite DNA analysis for the South Fork population has indicated that the “South Fork population has a healthy effective population size and that although the data show (some) contribution from Green River hatchery Chinook, the population remains genetically differentiated from the large complex of populations that are mostly Green River derived. It is possible that the effective population size of the South Fork fish has been inflated by strays, perhaps of Green River origin” (Spidle, unpublished data; Appendix D). The question of the influence of straying into the South Fork Chinook salmon population may be resolved in the near future with the completion of genetic analysis of Green River hatchery and Snohomish River watershed DNA information.

Habitat Requirements of Chinook Salmon

Chinook salmon spend their earliest and latest life stages in freshwater river and stream habitats. While becoming sexually mature, Chinook salmon spend most of their adult lives feeding in saltwater, then return to the watersheds of their birth for reproduction. The freshwater requirements of Chinook salmon are reasonably well known, although many subtle and important details of the

freshwater life histories of specific populations in the Stillaguamish Watershed remain unknown.

Environmental conditions required during adult upstream migration include adequate water quality and suitable streamflow velocity, temperature, cover and depth for successful passage. Chinook salmon also require large, deep cold pools for holding prior to spawning. Pess and Benda (1994) documented a strong association between pool habitat and spawning location within the Stillaguamish Watershed. Areas of the river that have usable spawning habitat, but no pool habitat, have very limited spawning. Pess et al. (1999) documented a 38% loss of pool habitat in the North Fork Stillaguamish since 1950.

The amount of flow within a channel can determine whether Chinook salmon adults have access to areas within the river system traditionally used for spawning. Substrate composition, in-stream cover, water quality, water quantity, and habitat area are important requirements for salmon during spawning. Healey (1991) suggested that fry and smolt production could be more related to the amount of good spawning gravel area than to the number of spawners.

Flow, temperature, substrate condition, and redd depth appear to be important factors in incubation and emergence success. Important environmental factors during incubation include the level of fine sediment transported by the river and the frequency, duration, and magnitude of flood flows during incubation. Excessive sediment can smother fish eggs and flooding can destroy redds. Juvenile Chinook salmon are principally found in all mainstem areas, including side channels and larger tributaries. As Chinook salmon fry migrate, they may inhabit the river's edge, backwater and off-channel habitats, side channels, or banks with cover (Healey 1991).

Chinook salmon also require healthy estuary and marine shoreline habitat for juvenile and adult stages of their life cycle. The estuary and marine shoreline areas within the photic zone (i.e., the depth of water to which photosynthetically active light can penetrate – about 30 feet) together comprise what is referred to as the nearshore. Puget Sound nearshore and open water marine environments provide four main habitat functions critical to Chinook salmon survival: food production and foraging; refuge (from predation, winter storms, etc.); areas for physiological adjustment between freshwater and saltwater; and migratory corridors. Salmon and bull trout move through the entire nearshore and marine ecosystem in Puget Sound seeking opportunities to feed, take refuge from various threats, and transition between freshwater and marine environments with minimal stress. In addition to estuarine habitat directly connected to the main river channels, many nearshore areas include “pocket estuaries” that provide additional estuary rearing habitat for juvenile salmon (Beamer et al. 2003). Pocket estuaries

include tidal lagoons that are fed by small freshwater streams or seeps as well as the deltas of small Puget Sound tributary streams.

Factors Affecting Chinook Salmon Populations

Population and Land Use

Prior to European settlement, many Native American tribes utilized the Stillaguamish Valley, particularly from Barlow Pass to the river's mouth near Stanwood. Europeans first settled in the lower Stillaguamish basin in the early 1860s and began diking and draining the floodplain for agricultural uses (STAG 2000). Expanding population and land use practices have resulted in broad landscape alteration throughout the Stillaguamish Watershed. Removal of log jams in the river allowed access to upriver areas that were subsequently cleared and settled, giving rise to several small towns. Logging began in the lower watershed as early as 1863 and became more widespread as upriver navigation and access improved. By the turn of the 20th century, nearly all of the floodplain land on the mainstem had been cleared of trees and converted to agricultural lands. Most of the historic tidal-influenced salt marsh habitat was converted to agricultural uses through diking, ditching, and filling (Collins 1997).

Basin-wide land use within the Stillaguamish Watershed (Figure 4) is 76% forestry, 17% rural, 5% agriculture, and 2% urban (Snohomish County 1995). However, streamside land use within the hydrologically-connected areas utilized by anadromous fish (the anadromous zone) is comprised of 61% forestry, 22% rural, 15% agriculture, and 2% urban (Pess et al. 1999).

Figure 4. Future Land Use

Forestry

Forestry is the most geographically extensive land use in the Stillaguamish Watershed. Approximately 76% (530 square miles) of the 700-square mile watershed is either zoned for commercial forestry or is federal land managed for forest production and other uses (STAG 2000). Of the total forest land area within the watershed, approximately 150 square miles (28%) is private forest land, 110 square miles (21%) is state forest land, and 270 square miles (51%) is federal forest land.

Federal forest land primarily managed for timber production is designated as "Matrix". In the Stillaguamish Watershed there is a total of 11,377 acres in Matrix land (about 18 square miles), of which 11,198 acres is in the North Fork Stillaguamish River basin (French-Segelsen and Boulder Creek sub-basins) and 179 acres in the South Fork Stillaguamish River basin (Canyon Creek sub-basin). Some timber may also be harvested as a by-product of other forest management activities, such as thinning to promote late-successional forest conditions (Karen Chang 2005, personal communication. USDA Forest Service, Mt. Baker-Snoqualmie National Forest, Darrington Ranger District).

Forestry continues to be an important economic activity, but since the early 1990s the rate and extent of timber harvesting and forest road construction has declined from historic levels. This is due to a combination of factors, including changing regional and global market conditions, exhaustion of old growth timber supplies, and the implementation of state and federal environmental laws. Timber harvest on private, state, and federal forest land has been limited by the listing of Chinook salmon and bull trout, as well as other species including the northern spotted owl, marbled murrelet, and bald eagle, under the Endangered Species Act (Edwards 2003).

The scale of historic forest harvest activities and how forestry was historically practiced have contributed significantly to the decline in local salmon populations. Timber harvesting in riparian zones and on steep or unstable slopes, inappropriate forest road construction, and draining of forested wetlands have altered the delivery and rate of sediment and large woody debris transport, streamflow, temperature, and other important freshwater salmonid habitat conditions (Murphy 1995). Increased frequency and magnitude of high stream flows is due in part to the loss of forest cover from timber harvesting and the routing of surface runoff from forest roads into streams (Hartman et al. 1996). This has contributed to scouring upstream salmon spawning beds and smothering downstream spawning beds. Peak flows may also flush juvenile salmon out of normally slower moving portions of the river that are used for rearing habitat.

Extensive landslides and increased frequency and magnitude of high stream flows in the Stillaguamish Watershed are attributed in large part to past timber

harvesting and forest road management practices (STAG 2000; WCC 1999). Landslides and other forms of surface erosion that may be natural or induced by past forest practices or other land use activities have contributed to increased sediment loading in tributaries, main channels, and the mouth of the river. An analysis of 1,080 landslides within the Stillaguamish Watershed revealed that 74% were associated with clearcuts and roads (Collins 1997). Many of the landslides which originate in glacial sediments are deep-seated and a chronic source of turbidity and suspended sediments. Increased sediment loading has reduced the amount and quality of deep holding pools, spawning gravel, and rearing habitat. Accretion of sediment at the mouth of the river has created extensive sand flats that may expose returning spawners and outmigrating smolts to increased predation.

Each of these forestry-related impacts on salmon habitat have contributed, along with impacts from other land uses, to the decline of historic salmon populations in the Stillaguamish Watershed and continue to limit the productivity of existing populations.

Agriculture

Farming is the most prevalent land use in the lower floodplain of the Stillaguamish Watershed (STAG 2000). Many key river and stream habitats in the watershed are on or near agricultural lands. Riparian areas and wetlands along the mainstem and larger tributaries have historically been converted to agricultural lands and are actively farmed. Significant portions of the floodplain have been cleared, diked, and drained for agricultural uses. Historic tidal-influenced salt marsh habitat was converted to agricultural uses through diking, ditching, and filling. Many rural parcels dispersed throughout the watershed include small non-commercial farming operations. Agricultural land uses relate to Chinook salmon recovery in the context of flood control, drainage infrastructure, and riparian/wetland area management.

Clearing of mature riparian vegetation and degraded riparian areas throughout the floodplain has had detrimental effects on existing habitat. Reduced channel complexity and loss of riparian forest contributes to reduced streambank and instream habitat. Channelization of streams, loss of wetlands, and the construction of drainage ditches in floodplain areas for agriculture has increased the magnitude and severity of peak streamflows, as well as increasing the amount of nutrients, pesticides, and sediment into stream reaches used by Chinook salmon. Many potentially productive sloughs and side channels have been isolated from the main channel on or near farms. Dikes, levees, revetments, and tide gates installed to protect agricultural lands from floods and tidal influences limit Chinook salmon productivity by restricting meander and floodplain processes that maintain and create habitats. Culverts and other barriers on agricultural lands restrict fish passage. Estuarine habitat is constrained by cut-off sloughs, hardened banks, sediment deposition, and non-native invasive plants.

Urban/Rural Land Use

Conversion of existing forest and agricultural lands to rural residential and urban uses contributes to declining salmon populations in the watershed. Currently, Snohomish County has a human population of nearly 637,500 and is growing at an annual rate of 2.7%.³ The current population of the Stillaguamish Watershed is 58,441.⁴ Continued population growth will place increasing pressure on hydrologic function, water quality and habitat quality. As evidenced in other Puget Sound watersheds, conversion of agricultural and forest lands to rural residential and urban uses results in loss of floodplain functions, channel migration, and other wildlife habitats, as well as a transition from biologically-based water quality problems to point sources and non-point sources of pollution. Increases in impervious surfaces (e.g., structures, concrete, and asphalt) created by urban development reduce natural infiltration of precipitation and increase surface runoff (Spence et al. 1996). Such urbanization negatively affects hydrologic function and water quality through lawn fertilizer and pesticide inputs, pet waste, household and municipal sewage discharges, industrial sources, and contaminated runoff from roads. Development activities also result in stream channelization, bank hardening, and poor habitat quality that negatively impact salmonids (STAG 2000). The permanence of this type of conversion contributes to a wide range of impacts that goes far beyond impacts to salmon.

Environmental Policies and Regulations

A broad framework of federal, state, and local laws, plans, and policies are designed to limit the environmental impacts of land use and development activities in the Stillaguamish Watershed. A common objective of this regulatory framework is to protect freshwater habitat and water quality, which is intended to help salmon populations recover to sustainable and harvestable levels. The following regulatory programs are related to habitat protection:

Growth Management

The Washington State Growth Management Act (GMA) was adopted in 1990 [RCW 36.70A] to address population growth and urban sprawl in rapidly urbanizing areas of the state. The GMA requires certain counties and cities to prepare comprehensive plans that outline land use management policies and provide a framework for long-range growth planning. In addition to addressing growth, the Act requires counties and cities to adopt development regulations to designate and protect critical areas based on the “best available science” [RCW 36.70A.060(2)].

Snohomish County, Skagit County, and the cities of Arlington, Darrington, Granite Falls, and Stanwood are all subject to the provisions of the GMA.

³ As of April 2003, according to the Washington State Office of Financial Management (OFM) - <http://www.ofm.wa.gov/>

⁴ Estimate prepared by Tim Koss, Snohomish County Planning & Development Services, June 3, 2005.

Each of these local governments has prepared a comprehensive plan that projects future growth and ensures consistency of urban infrastructure (e.g., transportation, capital facilities, and utilities) through land use planning and zoning regulations. Local comprehensive plans aim to protect rural lands and critical areas including streams, wetlands, and wildlife habitat areas, reduce sprawl, and maintain productive agricultural, timber, and mineral resource lands. In addition, GMA requires inter-jurisdictional coordination in developing planning policies, which can be applicable to cross-jurisdiction watershed management and salmon habitat protection.

Snohomish County adopted Critical Areas Regulations (chapter 30.62 SCC) in 1995 to ensure designation and protection of the county's critical areas. Included in the designation of critical areas are wetlands, fish and wildlife habitat conservation areas (streams, threatened and endangered species habitats, etc), flood hazard areas, critical aquifer recharge areas, and geologically hazardous areas (erosion, landslide, seismic, and mine hazard areas).

Streams, wetlands, and their buffers in the Stillaguamish Watershed are protected under the critical areas regulations. Riparian buffers identified in Snohomish County regulations include a 150-foot critical area and an additional 150-foot riparian management zone on both sides of a stream if an ESA-listed species is present. Wetland buffers range from 100 feet for a Category 1 wetland to 25 feet for a Category 4 wetland. The critical areas regulations require a project applicant to identify all critical areas affected by the proposed development activity and to mitigate impacts associated with the development. Snohomish County is in the process of updating its Critical Areas Regulations, including a Best Available Science analysis and updated code requirements. The County has considered the outcomes of the concurrent Chinook salmon recovery planning process in revising these regulations.

Shoreline Management

The Washington Shoreline Management Act (SMA) was adopted in 1972 "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines" [RCW 90.58]. The SMA establishes a balance of authority between local and state government. Cities and counties are the primary regulators of the Act. The Department of Ecology provides technical assistance and reviews local programs and permit decisions. Designated shorelines in Snohomish County include most streams and rivers over 20 cubic feet per second mean annual flow, lakes over 20 acres in size, marine shorelines, lands within 200 feet of the ordinary high water mark of these waterbodies, and their respective floodplains and associated wetlands. The County requires buffers and structural setbacks that range between 25 feet and 100 feet from the ordinary high water mark.

The Department of Ecology adopted new Shoreline Master Program (SMP) guidelines in 2003. These state rules are used by cities and counties as they update their plans to regulate development and use of shorelines. Amendments to the Shoreline Management Act were adopted in 2003 addressing integration with the Growth Management Act and the use of Best Available Science. These rules establish conditions for development in the floodplain. Snohomish County is scheduled to update its Shoreline Master Plan in 2005. The County is incorporating information from the local Chinook salmon recovery planning efforts into the restoration element of the Shoreline Master Plan update (Snohomish County Planning and Development Services, personal communication).

Forestry

In 2003, the SIRC completed an analysis of existing forestry policies and regulations as they apply to the Stillaguamish Watershed (Edwards 2003). This analysis was requested in recognition of the importance of forestry in the watershed. Below is a summary of the key forestry policies and regulations pertaining to Chinook salmon recovery in the Stillaguamish Watershed.

The Washington Forest Practices Act [RCW 76.09] regulates commercial forestry activities on all local government, state, and private forest lands. This is the most restrictive regulation of riparian areas on private forestry land in the U.S. (Forest Practices Draft HCP). The Forest Practices Act generally does not cover the removal of non-commercial sized trees or other vegetation, and includes a number of exemptions, including the removal of hazard trees and timber on parcels smaller than 2 acres. Local governments are preempted under state law from regulating commercial forest practices except in designated urban growth areas, lands platted after 1960, and on any other lands where the trees will be permanently removed. In these areas, local governments conduct the environmental review under SEPA and may condition these “conversion” type permits with their own local regulations (e.g., critical areas). Alternatively, with the approval of the Department of Natural Resources, local governments can adopt their own forest practices regulations provided they are at least as strong as the Forest Practices Act and the Forest Practices Rules [WAC 222].

The Timber, Fish and Wildlife (TFW) process to improve the regulation of forestry activities under the Forest Practices Act was initiated in 1986 and culminated in 1999 with the publication of the Forests and Fish Report. This report presented a comprehensive set of recommendations for improving the state’s forest practices rules. In 2000, the Forest Practices Rules were amended based on the Forests and Fish Report’s recommendations. These regulatory changes improved the standards and guidelines for riparian buffers and forest road maintenance. However, these rules only apply to large landowners (20 acres or more). The significance of this small landowner exemption is unknown because the total acreage involving such owners in the watershed has yet to be determined.

The Washington Department of Natural Resources Habitat Conservation Plan (HCP) was approved January 30, 1997, to protect state forest management activities from legal liabilities related to the Endangered Species Act. The HCP established standards and guidelines for state forest land management that the federal government (U.S. Fish and Wildlife Service and National Marine Fisheries Service) determined will adequately protect threatened and endangered species. The HCP includes a Riparian Conservation Strategy that limits timber harvesting and road building in riparian zones, unstable hillslopes, rain-on-snow zones⁵, and wetlands. This strategy is the primary mechanism by which the HCP limits forestry impacts on salmon habitat in the Stillaguamish Watershed.

Timber harvest on federal lands is subject to the Northwest Forest Plan. This plan, adopted jointly by the U.S. Forest Service and the Bureau of Land Management in 1994, established a comprehensive ecosystem management strategy for federal forest land in the Pacific Northwest. The plan created a network of old-growth forest and riparian reserves to protect critical habitat and watershed processes. A central part of the Northwest Forest Plan is the Aquatic Conservation Strategy, which provides guidance for the management of aquatic and riparian habitat. This strategy has four major components: Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration. The plan contains explicit standards and guidelines that must be used to evaluate whether proposed projects or management actions “meet” or “do not prevent attainment” of the Aquatic Conservation Strategy objectives.

Agriculture

Commercial and non-commercial farmers work within a complex regulatory framework of federal, state, and local environmental rules that protect salmon and aquatic habitat. Some of these rules specifically address agricultural operations and land use. The following is a brief summary of the different types of agriculture in the Stillaguamish Watershed and the existing environmental policies and regulations that specifically address these agricultural activities.

In the Stillaguamish Watershed, commercial farming operations generally include dairies, other livestock, field and row crops, and plant nurseries (Henri and Waller 2004). There is also some aquaculture activity in the watershed. Federal regulations, such as the Clean Water Act, Endangered Species Act, and National Environmental Protection Act, apply to these farming operations. The Washington State Growth Management Act and the Shoreline Management Act also apply to agricultural operations, with some exceptions. The Washington State Dairy Nutrient Management Act

⁵ The “rain on snow zone” is the area between 1,000 and 3,000 feet in elevation (also referred to as the “warm snow zone”) which receives frequent snow build-up that melts shortly thereafter. Forest management in this zone can be designed to improve or maintain desirable snowmelt hydrographs.

specifically addresses commercial dairy operations. Landowners with farm plans follow the rules and best management practices published in the Natural Resources Conservation Service Technical Guidelines.

Under the Clean Water Act, commercial farming operations that discharge to surface waters from their production or processing area may be required to obtain a permit for storm water or industrial point source discharges of pollutants through the National Pollutant Discharge Elimination System (NPDES). Discharges to ground water may trigger a state waste discharge permit from the Department of Ecology. In addition, dairies, livestock raising operations, feedlots, and poultry houses may be classified as Concentrated Animal Feeding Operations (CAFOs) or Animal Feeding Operations (AFOs), and may be required to obtain specific permits based on size and historical management. These NPDES, CAFO, AFO, or state permits set requirements to protect water quality, use best management practices, and maintain records (USEPA 2003). Permitted facilities are inspected periodically by the Department of Ecology and livestock facilities are inspected by the Department of Agriculture for compliance (Mena 2005).

The Washington State Dairy Nutrient Management Act of 1998 (RCW 90.64) specifically applies to all licensed dairy operations. This law requires licensed dairies to develop and implement dairy nutrient management plans to prevent nutrient pollution of surface and ground water. Conservation districts were responsible for approving the completion of dairy nutrient management plans by July 1, 2002 and for certifying implementation of those plans by December 31, 2003. These plans are required to meet Natural Resources Conservation Service technical standards. The Snohomish Conservation District has provided technical assistance to Snohomish County farmers to help them develop and implement these plans. Newly licensed dairies are required to have an approved plan implemented within two years of getting their license. Dairies are subject to compliance inspections by the Washington State Department of Agriculture at least once every two years. In the Stillaguamish Watershed, dairy nutrient management plans have been approved for all of the commercial dairies and only one of those plans has not been certified (Bartelheimer 2005).

The federal Clean Water Act and the state Water Pollution Control Act also prohibit the discharge of pollutants from non-point sources such as contaminated field runoff, or degradation from animal access. Non-point source water pollution is regulated based on Total Maximum Daily Load (TMDL) limits, which have recently been established for the Stillaguamish Watershed (DOE 2004). A water quality cleanup plan is currently being developed by the Department of Ecology to address the water quality issues identified in the Stillaguamish Watershed TMDL study.

Pesticide use including agriculture is regulated under federal and state pesticide regulations. The Washington State Department of Agriculture is the lead agency for proper pesticide management and carries out inspections to ensure pesticide use is consistent with federally approved label information (Mena 2005).

The Snohomish County Growth Management Plan includes Critical Area Regulations that apply to farm land, with some exemptions for agricultural activities. The Snohomish County code exempts most on-going commercial agricultural activities from permits including tilling and plowing, drainage and dike maintenance activities, and minor wetland filling. Some farm structures and single family dwellings are also exempt from shoreline permits. In floodplains, most new development activities, including structures, ditches, and dikes are required to obtain flood hazard permits. Maintenance of existing ditches and dikes also requires flood hazard permits (Middaugh 2005).

To preserve and enhance the local agricultural economy, Snohomish County has produced an Agriculture Action Plan that identifies over-regulation as “one of the largest obstacles to sustainable and successful agricultural activities” (Snohomish County 2005). To address this issue, Snohomish County is working with the farming community and state and federal regulatory agencies to simplify and streamline the permitting process for agricultural activities. Snohomish County is also participating in a pilot project whereby state and federal permits are issued at the county level. This effort is intended to help local farmers compete more effectively in local, regional, and international agricultural markets. The SIRC has not yet reviewed the Snohomish County Agriculture Action Plan to analyze the potential affect of plan’s recommendations on salmon recovery.

Instream Flows

Instream flows are defined as the stream flows needed to protect and preserve instream resources and values, such as fish, wildlife and recreation. Instream flows are most often described and established in a formal legal document, typically an adopted state rule. Once formalized in rule, instream flows are used to determine whether water is available for new out-of-stream uses and regulate those new uses, and to define the stream flows that need to be met in the stream. The Washington Department of Ecology is developing water-management rules to help determine how water in a basin could be allocated for future uses for people while maintaining enough water to protect important fish species.

Instream Habitat Management

The purpose of the Washington State Hydraulic Code [RCW 77.55] is to protect fish and shellfish and their associated habitat by regulating activities that affect the bed or flow of the state’s salt and fresh waters. The Washington Department of Fish and Wildlife (WDFW) has the authority to

enforce the Hydraulic Code for preserving, protecting, and perpetuating all fish and shellfish resources of the state. The law requires any construction activity that would affect the bed or flow of state waters to obtain a Hydraulic Project Approval (HPA) permit to ensure construction is done in a manner to prevent damage to fish and their habitat. HPA permits are issued by WDFW on a project-by-project basis.

Water Quality

The National Pollutant Discharge Elimination System (NPDES) is a permitting mechanism to carry out the objectives of the federal Clean Water Act to restore and maintain the chemical, physical, and biological integrity of the nation's waters. NPDES regulations are intended to manage discharges such as municipal, industrial wastewater, and stormwater sources. The Washington Department of Ecology is responsible for issuing NPDES permits for municipal stormwater discharges, as well as for construction and industrial-related discharges.

The Total Maximum Daily Load (TMDL) process is established by section 303(d) of the Clean Water Act. The TMDL process determines the amount of pollution loading a water body can receive and still remain healthy for its intended uses, such as industrial and agricultural uses, drinking, recreation, and fish habitat. States are required to identify sources of pollution in waters that fail to meet state water quality standards, and to develop Water Cleanup Plans to address those pollutants. The Department of Ecology is responsible for preparation of a list of impaired water bodies, referred to as the 303(d) list. A Water Cleanup Plan must be developed for each of these water bodies.

Stormwater Management

Snohomish County Code chapters 30.63A and 30.63B regulate clearing, grading, and other construction activities to minimize and/or mitigate impacts to waterbodies and natural resources from stormwater runoff. These regulations are intended to ensure that standards are met for water quantity and quality. The County does not currently use the Washington State Department of Ecology 2001 Stormwater Management Manual for Western Washington, but the County Code has been determined to be equivalent to the provisions included in the Department of Ecology's 1992 stormwater manual.

Noxious Weeds

The Washington State Noxious Weed Law [RCW 17.10] holds landowners, including counties and state land agencies, responsible for controlling weeds on their property. The Weed Law establishes State and County weed Boards who administer and enforce the weed laws. WAC 16-750 establishes the State Noxious Weed List fines and penalties. Federally owned lands are subject to the Federal Noxious Weed Act (Public Law 93-629). Education, coordination, and enforcement activities are carried out by the Washington State Noxious Weed Control Board, County Noxious Weed Control Boards, and the Washington State Department of Agriculture.

Habitat Limiting Factors

The habitat limiting factors for Chinook salmon populations in the Stillaguamish Watershed are grouped into six categories: riparian, estuarine, large wood, floodplain, sediment, and hydrology (STAG 2000). These limiting factors are described in detail below. Spence et al. (1996) provides additional context for understanding the effects of land use and land management activities on these habitat limiting factors. This section also includes several hypotheses for limiting factors in the nearshore and marine environment, as well as an overview of water quality issues in the watershed.

Spawning habitat is limited for Chinook salmon in the Stillaguamish Watershed due to poor gravel stability and high percentage of fine sediment levels resulting from extensive landslides and flooding in the watershed. Limited numbers of Chinook salmon are observed spawning below major landslides in the basin (Gold Basin on the South Fork and Steelhead Haven on the North Fork), presumably due to the impacts of fine sediment on these potential spawning areas (WDFW aerial spawner surveys, Stillaguamish Tribe unpublished data). While anecdotal evidence points to fine sediment limiting Chinook salmon spawning habitat in the Stillaguamish, a study is underway that will investigate the impacts of fine sediment on Chinook salmon habitat in the watershed.

Conversion of much of the floodplain to agricultural production, as well as forestry land uses throughout the watershed, have been a significant source of habitat loss and continuing degradation. The long-term absence of mature riparian vegetation throughout the floodplain has had detrimental effects on existing habitat. Losses of salt marsh and tidal channels from reclamation of tidelands, constricted channels, and cut-off sloughs have significantly reduced the quantity and quality of juvenile and adult salmonid habitat.

Riparian and upland clearing, ditching, and associated road construction have led to large changes in channel morphology, increased peak flows and stream temperatures, and have caused filling of holding pools, loss of wetlands, channel instability, and a reduction in large woody debris. These clearing-related activities have been the primary cause of reduced salmon egg-to-fry survival.

Riparian Areas

Riparian ecosystems perform a number of important functions that affect the quality and quantity of salmonid habitat. The presence (or absence) of woody riparian vegetation directly influences all life history stages of Chinook salmon. A properly functioning riparian forest provides shade, cover, and nutrient input/uptake; stabilizes stream banks; controls sediment; attenuates flooding; and contributes large woody debris and other forms of organic matter. Additionally, riparian vegetation provides a filter that reduces the transport of fine sediment to the stream. Riparian vegetation provides shade

and an insulating canopy that moderates water temperatures in both summer and winter. Other benefits include habitat for terrestrial wildlife and improvement to water quality. These functions are impaired as riparian forests are cleared or otherwise altered.

Historical Conditions

At the turn of the century, deciduous trees (primarily red alder, black cottonwood, and big leaf maple) dominated the lower Stillaguamish River floodplain, accounting for 63% of individual tree species. Riparian timber harvest between 1870 to 1910 removed most, if not all, of the large conifers on the mainstem, lower South Fork, and North Fork up to Rollins Creek (Collins 1997). A decade later, riparian forests in nearly all of Church Creek, much of Pilchuck Creek, lower portions of the North Fork tributaries, and the South Fork valley up to Granite Falls had been logged. By the 1940s, most riparian areas in the Stillaguamish Watershed had been logged, with the exception of upper and middle Deer Creek and uppermost Jim and Canyon Creeks. Other riparian lands throughout the watershed have been cleared and converted to agricultural and urban land uses.

Factors of Decline

Most of the impacts to riparian zones in the Stillaguamish Watershed have been caused by the following actions:

- Deforestation. Removal of riparian vegetation has resulted in increased water temperatures and erosion, as well as reduced instream cover and food supply.
- Roads and railroads. Roads and rail beds were constructed along riverbanks and included substantial bank hardening, fill, and vegetation removal. Poorly designed and maintained roads and associated culverts have substantially contributed to riparian degradation and large-scale landslides.
- Land use. Conversion of forested lands to agricultural and residential areas has reduced the ecological value of associated riparian areas.
- Dike, levee, and revetment installation. The installation of flood and erosion control structures has resulted in dramatic modifications to riparian areas and disconnection of off-channel habitats from the mainstem. Maintenance of these structures often includes vegetation removal⁶.
- Livestock grazing. Unrestricted access along riparian areas for livestock has led to trampling of native vegetation and significant degradation of riparian vegetation communities.
- Noxious weeds. The proliferation of invasive weed species has contributed to the suppression of native vegetation in riparian areas.

⁶ There is a risk of letting vegetation grow too big on dikes which may lead to failure. “Piping” occurs when roots get too big, the tree eventually dies, the roots rot, and a pipe is created that water can run through and weaken the dike.

Current Conditions

A considerable portion of the historically forested Stillaguamish riparian zone is composed of hydrologically immature vegetation due to forestry and agricultural land management practices. Almost all of the lower floodplain (area to the west of Interstate 5) is currently in agricultural use. Land cover data from 2001 show that just over half (52%) of the area within 300 feet of streams in the Stillaguamish Watershed is forested with hydrologically mature vegetation⁷, as shown in Table 1 (Purser et al. 2003).

Table 1. Forested Riparian Cover within Stillaguamish Subbasins (Purser et al. 2003)

Subbasin	Nearstream Forest Cover (%)	Subbasin	Nearstream Forest Cover (%)
Gold Basin	79	Upper Pilchuck Creek	55
Upper SF Stillaguamish	79	French-Segelsen	50
Upper NF Stillaguamish	77	Middle NF Stillaguamish	48
Upper Canyon Creek	77	Harvey Armstrong Creek	39
Stillaguamish Canyon	72	Lower NF Stillaguamish	38
Boulder River	70	Lower Pilchuck Creek	36
Deer Creek	67	Lower SF Stillaguamish	34
Robe Valley	64	Port Susan Drainages	34
Jim Creek	57	Church Creek	20
Lower Canyon Creek	56	Portage Creek	19
Squire Creek	55	Lower Stillaguamish	16

⁷ Hydrologically mature indicates a combined deciduous and evergreen forest cover that produces an amount of runoff similar to the same watershed under native (historical) vegetative conditions.

Figure 5. Stillaguamish Watershed Subbasins

Estuary/Nearshore

Estuaries, including marine nearshore areas, provide a physiological transition zone for juvenile salmonids to adjust to saltwater environments, an important forage location, and cover for predator avoidance. Chinook salmon use estuaries for rearing and smoltification. Growth during estuary residence is critical to marine survival for Chinook salmon. Smolts (2 to 6 inches long) congregate in estuaries on their way downstream toward the main part of Puget Sound, where they acclimate to salt water in the brackish water of the estuary. They also benefit from cover provided by overhanging and emergent vegetation and abundant food sources such as crustaceans and aquatic insects. Salt marsh blind tidal channels, tidally-influenced sloughs, eelgrass beds, pocket estuaries, and shallow shoreline areas are also important estuary habitat.

Stillaguamish Chinook enter Port Susan and Skagit Bay from late winter to late spring and are found in the estuary until late summer (Stillaguamish Tribe, unpublished beach seine data). Stream-type Chinook salmon enter the estuary in the late winter/early spring, along with fry migrants, and move to the delta front where they stay for a brief time. Some bypass the delta altogether and move offshore immediately (Healy 1991). Ocean-type Chinook salmon arrive in late winter/early spring and rear extensively in the estuary. They move slightly offshore in the late June/July timeframe until late summer/early fall (Beamer *et al.* 2003). The following life history types are exhibited by ocean-type Chinook salmon: fry migrants use pocket estuaries extensively, delta-fry migrants rear extensively in the delta, and parr migrants use the delta sparingly.

Historical Conditions

Prior to European settlement (circa 1860), there were approximately 4,439 acres of salt marsh habitat connected to the Stillaguamish Watershed. By 1886, as a result of dike building, only one-third of the original salt marsh remained. By 1968, only 15% of the original salt marsh remained, with an associated loss in blind tidal channels (Collins 1997)⁸. During the period from 1886 to 1968, approximately 863 acres of new salt marsh was created through accretion of sediment into Port Susan and Skagit Bay from the Stillaguamish River (Table 2). These newly accreted salt marsh areas do not have the same well-developed blind tidal channel system and do not provide the same habitat quality as the original lost salt marsh (Collins 1997).

⁸ There has been no additional new dike building since 1968.

Table 2. Estimates of Historic and Current Salt Marsh Habitat in the Stillaguamish River Delta (Collins 1997)

Site	Salt Marsh (in acres)				
	1870 (Pre Settlement)	1886	1968 Original	1968 New	1968 Total
South of Hatt Slough	487	94	0	99	99
Stillaguamish Delta	1,045	170	99	386	485
Leque Island	475	214	85	220	305
East of Douglas Slough	1,293	211	114	0	114
West of Douglas Slough	673	496	369	0	369
Camano Island	466	292	0	158	158
Total	4,439	1,477	667	863	1,530

In addition to the salt marsh estuarine habitat connected to the Stillaguamish River, nearshore areas in Port Susan and Skagit Bay historically included a number of “pocket estuaries” that provided additional estuary rearing habitat for juvenile salmon. Pocket estuaries include tidal lagoons that are fed by small freshwater streams or seeps as well as the deltas of small Puget Sound tributary streams. In Port Susan and Skagit Bay, pocket estuaries were located at a number of sites, including Kayak Point and Triangle Cove. Many of these pocket estuaries have been either lost or modified due to human land use and shoreline modifications. The loss of pocket estuary habitat throughout Puget Sound has likely had a significant impact on the fry migrant life history type of Chinook salmon.

Historically, the open shoreline areas of the marine nearshore also provided important habitat for juvenile and adult salmonids. These open marine shoreline areas historically included mature riparian forests, active feeder bluffs, and small Puget Sound tributary streams. The marine riparian forest was a significant source of large woody debris, organic detritus, insects, and shade. Marine riparian forests were some of the first areas harvested for timber because they were close to navigable waters for transportation of logs to saw mills. Eroding bluffs supplied as much as 90% of the sediments that formed the depositional beaches and spits along the shoreline. Fine sand and gravel beaches provide critical spawning habitat for sand lance and surf smelt. Pacific herring deposit their spawn on eelgrass. All three of these forage fish species are important prey for juvenile and adult salmonids. These forage fish are also key links in the food chain between plankton and larger predators, including salmonids. Eelgrass also requires fine sand and gravel substrate for growth. Salmon and many other organisms use eelgrass beds as juvenile nursery areas and as refuge from predation. Eelgrass is also eaten by invertebrates, which are in turn prey for juvenile salmon. The small Puget Sound tributary streams supplied freshwater, organic debris, and sediment to the nearshore. Some of the Puget Sound tributary streams were also accessible for spawning, rearing, and foraging by salmonids. These small stream mouths are biologically productive areas within the nearshore and serve as pocket estuaries.

Factors of Decline

Many factors have contributed to the loss of estuarine and nearshore habitat, including:

- Construction of dikes and the associated loss of salt marsh habitat and blind tidal channels;
- Installation of tide-gates, flood-gates, pump-stations, weirs, and culverts;
- Construction of road, railroad, and utility crossings in the estuary;
- Loss of complex distributary channels, which has created a bottleneck and increased exposure to predation for juvenile and adult salmon at the mouth of Hatt Slough;
- Increased sediment deposition in the estuary due to upstream land uses;
- Draining and filling of wetlands, including pocket estuaries;
- Marine shore residential development and construction of bulkheads and groins;
- Removal of large woody debris and log jams;
- Development and deforestation of estuary and marine riparian areas; and
- Colonization of estuarine habitat by the non-native invasive cord grass *Spartina spp.*
- Water quality degradation, including high temperature and low dissolved oxygen;

During the past decade much has been learned about Puget Sound nearshore habitat conditions and how they influence the recovery of natal and non-natal salmonid populations. However, the relative importance of open shoreline nearshore areas is still not clear. Research on the use of the nearshore environment by Stillaguamish Chinook salmon populations is being conducted by the Stillaguamish Tribe Natural Resources Department and preliminary results have been reported (Stillaguamish Tribe 2005).

Current Conditions

The Stillaguamish Watershed includes 22 miles of marine shoreline. Approximately 75% of this shoreline has been armored.⁹ Much of the Stillaguamish estuary has been converted to agricultural uses. Estuarine habitat in the watershed is constrained by cut-off sloughs, hardened banks, sediment deposition, and non-native invasive plants. Accretion of sediment into Port Susan has increased the size of the sand and mud flats at the mouth of the Stillaguamish River; presently there are more than 7,800 acres of unvegetated sand and mud flats (Stillaguamish Tribe, unpublished data).

⁹ The percent shoreline modification was derived from the Washington State ShoreZone Inventory (DNR 2001) using an approach recommended by the Washington State Department of Natural Resources, Nearshore Habitat Program staff.

The Stanwood wastewater treatment plant is located in the estuary and releases its effluent into the old Stillaguamish channel immediately south of Stanwood. Discharges will be released on a coordinated schedule with the tides, as agreed to by the Department of Ecology, allowing effluent to drain into the open waters of Port Susan and South Skagit Bay.

Compared to other watersheds in central Puget Sound, second growth forests in the nearshore area of the Stillaguamish watershed now provide relatively good marine riparian vegetation. However, much of this second growth forest has been cleared to provide unobstructed views of the Puget Sound. Large woody debris within the nearshore is also probably much less than what was there historically.

Many of the historical feeder bluffs are still intact, but attempts to stabilize some feeder bluffs using bulkheads at the toe of the slope to protect beach front and bluff top residential properties have probably reduced the rate and amount of sediment supplied to the beaches. Although depositional beaches and sand spits within the Stillaguamish open marine shore area have been developed for residential and recreational uses, recent forage fish spawning habitat surveys indicate that sand lance, surf smelt, and Pacific herring continue to spawn along the shoreline between McKees Beach and Warm Beach (WDFW 2004).

The mouths and potential spawning areas within the lower reaches of many of the Puget Sound tributary streams have been confined by culverts, ditches, and bank armoring. As a result of these stream channel modifications, the complexity and accessibility of these streams has been reduced significantly. Nevertheless, the nearshore areas around these stream mouths are biologically productive.

Large Woody Debris

Large woody debris is an important component of riparian and instream habitat. It provides cover, habitat complexity, and a source of food for aquatic insects, which are themselves sources of prey for salmon. Cover is an important element in rearing habitat used by Chinook salmon. Cover is defined as depth, large substrate, overhanging vegetation, undercut banks, woody debris, floating debris, and aquatic vegetation. In the Pacific Northwest, an important factor in complexity is large woody debris (LWD). LWD is generally meant to describe fallen riparian wood pieces that exhibit both large size (often >50 feet in length or >24 inches in diameter) and are found in complex wood jams. Once they are instream, these wood pieces are the basis for essential channel complexity and side channel formation. LWD creates both micro- and macro-habitat features, and is an important component throughout the drainage network from headwater streams to estuaries.

Historical Conditions

Giant rafts of logs are described in the history of Puget Sound settlements and were once present in the lower Stillaguamish River. Six log raft jams were located in a 16 km stretch of the mainstem prior to the turn of the 20th century (Collins 1997). Settlers and the Army Corps of Engineers removed all of the log raft jams to improve navigation and to allow for the settlement of upstream areas. Giant snags were also systematically removed from the lower mainstem for navigation purposes. By 1900, over one thousand snags and leaning riparian trees were removed, mainly downstream of Hatt Slough in the Old Mainstem. The removal of the giant log rafts may have contributed to destabilization of the heads of floodplain sloughs, a decrease in the frequency and magnitude of overbank flooding, downcutting of the mainstem channel, and an increase in the amount of sediment reaching Port Susan (Collins 1997).

Factors of Decline

Changes in the amount of LWD available for recruitment have been caused primarily by the following factors:

- Deforestation. Historic removal of riparian vegetation reduced the supply of wood to the river.
- Conversion of forested lands to agricultural and residential areas.
- Dike, levee, and revetment installation.
- LWD removal. Historically (and to a lesser extent today) it was a common practice to remove woody debris and snags from rivers in order to improve navigation routes and floodwater conveyance, allow livestock grazing, or to protect structures such as trestles and bridges.

Current Conditions

Instream wood has been documented in the Lower Stillaguamish and from the confluence of the North Fork and South Fork Stillaguamish up to Squire Creek and to Granite Falls. Wood counts per mile are well below properly functioning conditions (80 pieces per mile, according to NMFS 1996). Current counts average approximately 1 piece per mile in several of the river reaches sampled. Table 3 presents LWD distribution data by subbasin.

Table 3. Large Wood Counts in 5 Subbasins (Haas et al. 2003)

Subbasin	Main Channel Length Surveyed (miles) ¹⁰	Pieces of LWD per mile
Lower Stillaguamish	21.5	0.8
Lower SF Stillaguamish	16.2	1.3
Lower NF Stillaguamish	14.9	1.1
Middle NF Stillaguamish	9.5	0.8
French-Segelsen	7.2	8.3

¹⁰ Survey data from the Lower Stillaguamish Includes Koch Slough and Hatt Slough but not the Old Stillaguamish Channel

Floodplain

Unconstrained floodplains provide some of the most productive habitats for anadromous salmonids (Sommer et al. 2001). Off-channel habitats in the floodplains of larger rivers are important refuge habitats for salmonids, reducing competition and providing refuge during high winter flood events. Floodplains are also a source of nutrients and organic matter for the food web. These areas filter floodwaters and provide depositional areas for fine sediment. Fragmentation of floodplain habitat and the resulting isolation of populations impact the long-term viability of salmonids (Wissmar and Timm 2003).

Stream and river channels and floodplains can be degraded and simplified by human actions that modify the landscape. This occurs directly through earth-moving projects or indirectly by land uses that alter natural processes that shape the stream channels and floodplains. Such changes can result in reduced pool depth and frequency, loss of side channels and sloughs, restricted channel migration, and reduced floodplain connectivity. These changes reduce the amount and/or quality of salmonid habitat (Regetz 2003).

Bank erosion has been a natural part of the evolution of river valleys for millions of years. Development in the floodplain has led to the need for bank protection. Flood control practices contribute to increases in streamflow velocity and energy that can lead to more destructive and costly bank failures.

Historical Conditions

The draining and filling of side channels along with hardening of stream banks has significantly reduced the quantity and quality of salmonid rearing habitat and biological productivity in the Stillaguamish Watershed. Two-thirds of this damage to floodplain habitat occurred between 1870 and 1886 (Collins 1997).

Additional alterations to the floodplain occurred between 1930 and the present, with the loss of more than one-third of the channel area occurring between 1933 and 1991. These alterations decreased the area that could potentially receive floodwaters, increasing the cumulative potential for catastrophic floods downstream. In addition, United States Army Corps of Engineers' records from 1955 to 1965 show over 33 miles of rip-rap placed within the watershed, with the majority of it placed on the mainstem of the Stillaguamish (Collins 1997).

Factors of Decline

The loss and degradation of in-channel and off-channel rearing habitat can be linked to processes that have been altered on a watershed scale, as well as processes and functions that operate in close proximity to rearing habitat. Several primary factors have led to the loss of floodplain connectivity, including the following:

- Channelization or straightening of streams
- Bank protection or armoring (e.g., rip-rap)
- Levee and dike construction
- Removal of snags, LWD, and gravel
- Railroad and road construction

Current Conditions

The floodplain has been disconnected from the river largely as a result of the construction of levees, dikes, and other flood control structures and bank modifications. Table 4 indicates the total miles of modified (hardened) banks in mainstem subbasins.

Table 4. Riverbank Modifications (Haas et al. 2003)

Subbasin	Bank Length (miles)	Miles of Modified Bank	% Modified Bank
Lower Stillaguamish	42	22.26	53%
Lower NF Stillaguamish	29.2	4.7	16%
Middle NF Stillaguamish	19.3	2.5	13%
French-Segelsen	12.4	1.7	14%
Lower SF Stillaguamish	31.9	4.5	14%

Sediment

Sediment transported from upland areas and from within the channel determines the nature and quality of salmonid habitat in streams, rivers, and estuaries. Landslides, bank erosion, earthflows, slumps, and creeps are major contributors of natural sediment delivery to streams. The development and persistence of channel features used for spawning and rearing depends on the composition and rate that sediment is delivered (Spence et al. 1996).

In freshwater habitat, the quality (gravel size and fine sediment composition) and stability of spawning habitat are key factors affecting Chinook salmon production. In general, fine sediment concentrations above 12% in the substrate reduce the amount and quality of salmonid spawning and rearing habitats and specifically impact embryo survival and emergence success in Chinook salmon. Levels at or below 11% are often encountered in relatively pristine habitats (Peterson et al. 1992).

Historical Conditions

During 1997, a landslide inventory was completed for the Stillaguamish Watershed (Perkins and Collins 1997). The inventory documented 1,080 landslides within the watershed between the early 1940s and the early 1990s, of which 851 delivered sediment to stream channels. Seventy-four percent of the 1,080 landslides were associated directly or indirectly with human disturbance, most commonly clearcuts (52%) or road construction (22%).

Factors of Decline

The following factors contribute to excessive sediment deposition in the Stillaguamish Watershed:

- Timber harvest, forest road construction and maintenance
- Landslides – natural and/or triggered by timber harvest

Current Conditions

Surveys of fine sediment in tributaries found that the Lower and Middle North Fork Stillaguamish River, Lower Canyon Creek, and South Fork Stillaguamish drainages exceeded fine sediment criteria (SWM 2002). Comprehensive data on precise sediment conditions in Chinook salmon production areas has not been collected downstream of these tributaries and priority sources of sediment impacts have not been identified.

Efforts are underway to address human-caused landslide activity by reducing harvest and road building on steep unstable slopes, as regulated by the DNR HCP and the 1997 Forest and Fish Rules. The two large deep-seated glacial landslides in the watershed (Gold Basin in the Lower South Fork, and Steelhead Haven in the Lower North Fork) are two of the largest contributors of sediment to the river. Impacts of these landslides extend downstream to the estuary. As a result, the Stillaguamish Flood Control District is frequently dealing with maintenance issues from the amount of fine sediment in the system.

Forest road density is an important indicator of watershed health. Forested areas with over two miles of road per square mile may not have properly functioning sediment and water delivery to lower watersheds (NMFS 1996).¹¹ Table 5 illustrates the extent of forest road networks that are underlain by unstable geology and built on greater than 30% slopes. The combination of unstable geology and steep slopes present an increased risk of sediment routing to streams and rivers.

¹¹ There are 1,876 total miles of roads contained in 13 subbasins dominated by forestry land uses: Upper North Fork Stillaguamish, Deer Creek, Upper Canyon Creek, Robe Valley, French-Segelsen, Jim Creek, Upper South Fork Stillaguamish, Gold Basin, Middle North Fork Stillaguamish, Boulder River, Upper Pilchuck Creek, Squire Creek, Lower Canyon Creek.. The average road density of these watersheds is 2.9 mi/mi².

Table 5. Forest Roads Data by Subbasin (DNR 2002)

Subbasin Information			Miles of Forest Roads with Unstable Geology and Steep Slopes > 30% ¹²				% Of all Roads at Risk
Road Density (mi/mi ²)	Area (mi ²)	Name	Federal Lands	Private	State DNR	Total	
3.2	54.3	Upper North Fork Stillaguamish	35.65	6.72	5.43	47.80	28%
2.6	67.9	Deer Creek	4.04	8.67	2.77	15.49	9%
1.8	38.8	Upper Canyon Creek	11.95	0.44	0	12.39	18%
3.98	24.3	Robe Valley	7.24	3.69	0.12	11.06	11%
3.06	29.6	French-Segelsen	5.55	0.41	1.19	7.15	8%
3.92	47.0	Jim Creek	3.90	2.79	0.29	6.98	4%
1.5	54.8	Upper South Fork Stillaguamish	6.37	0.09	0	6.46	8%
1.74	29.3	Gold Basin	6.27	0.04	0	6.31	12%
3.45	35.8	Middle North Fork Stillaguamish	0	1.98	3.77	5.75	5%
4.43	24.4	Lower Canyon Creek	0	2.64	.01	2.65	2%
.56	25.8	Boulder River	0.07	0.28	1.74	2.09	14%
4.08	46.0	Upper Pilchuck Creek	0	0.80	0.97	1.77	1%
1.22	26.1	Squire Creek	0.48	0.03	0	0.52	2%
	478.1	Totals	81.46	28.31	14.55	124.33	

In 2001, the Stillaguamish Tribe received a Washington Salmon Recovery Funding Board grant to develop a landslide hazard zonation map, to be used by resource managers as a decision-making tool for future land use activities in the Stillaguamish Watershed. Using the 1997 landslide inventory described above as a means to determine why and where landslide activity occurred previously, a GIS tool has been developed showing zones of high potential landslide risk for any future land use activity. This landslide hazard tool provides us with answers to three critical questions: 1) which areas have a high potential for landslide activity based on past land uses, 2) if a landslide occurs will it reach fish bearing waters, and 3) if it reaches fish bearing waters, what will the impacts be at all channel reaches downstream. The ultimate goal of this GIS tool is to reduce human-induced landslide activity in the watershed.

Both the data in Table 5 and the recent hazard zonation study point out areas of concern for timber harvest and road building, but field verification is necessary to confirm unstable areas.

¹² Slope-stability maps for the Puget Lowland of Western Washington often use 15% slope as a stability threshold based on a consideration of the mechanics of failure and shear strength of a silt-clay bed (Dunne and Leopold 1978). Table 5 shows only forest roads that are underlain by unstable geology and are traversing greater than 30% slopes. Abandoned roads pose an additional threat in certain locations (e.g. road sections with culverts). Site-specific analysis is always necessary to determine the specific stability of a particular roadbed or its contribution to sediment regimes in a watershed.

Hydrology

Natural hydrologic processes are critical in creating and maintaining suitable habitat conditions. Hydrologic integrity is strongly correlated with upper watershed forest cover.

Instream flow is important for the upstream migration, holding, and spawning requirements for Chinook salmon adults. Juvenile incubation, emergence, and rearing requirements related to flow are fundamental for the continued survival and natural production of this species.

The stability of Chinook salmon spawning habitat is equally important. During high flow events, spawning gravel can be moved downstream (a process known as scour). The North Fork Stillaguamish River has shown a trend of increasing peak flows (Figures 6 and 7), both in frequency and magnitude, resulting in increased Chinook salmon mortality (Collins 1997; Beamer and Pess 1999). Changes in peak flow frequencies have been attributed to land use practices such as clear-cut harvesting, loss of wetland function, road construction, and rural development.

Figure 6. NF Stillaguamish peak flows summary 1920-2001 (Collins 1997, Snohomish County 2002)

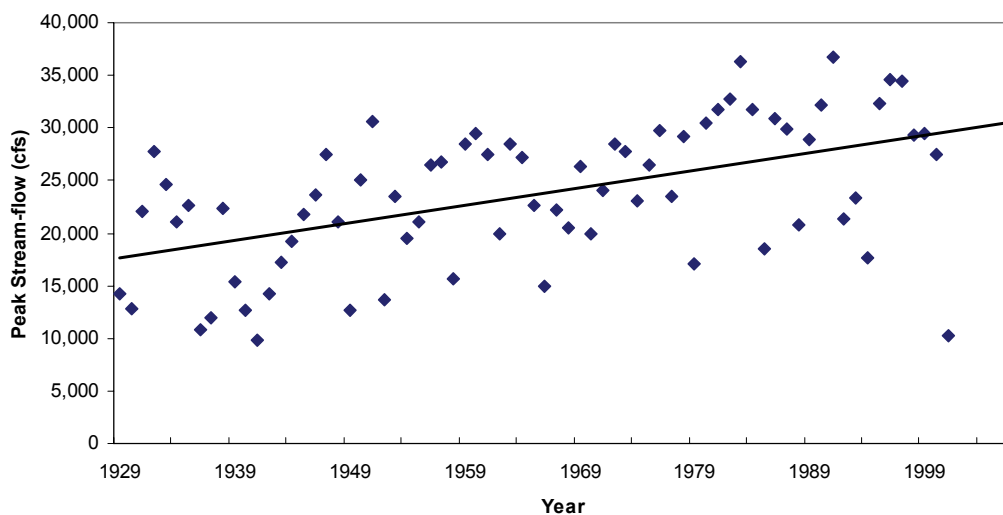
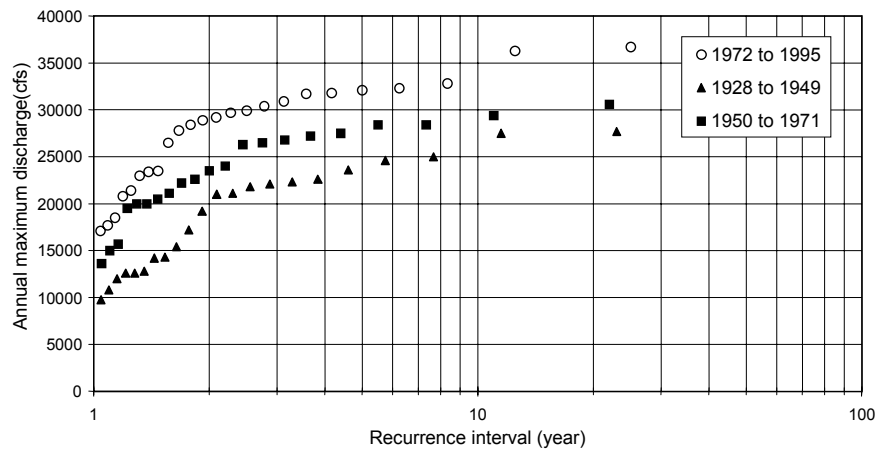
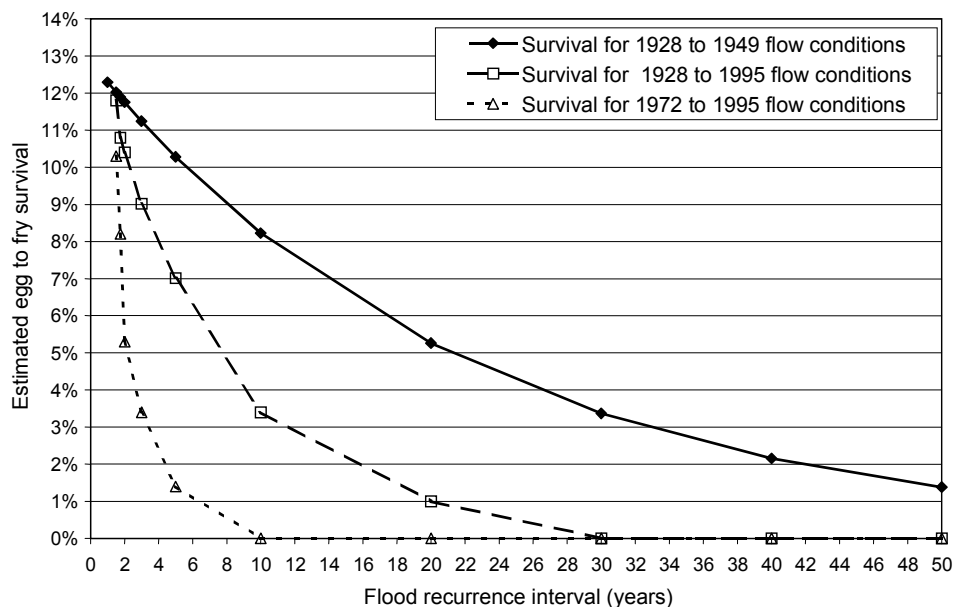


Figure 7. North Fork Stillaguamish flood recurrence interval (Beamer and Pess 1999)



Beamer and Pess (1999) concluded that peak flows can constrain adult Chinook salmon production even in years when flooding is not severe. Egg to fry survival is sensitive to changes in peak flow (Figure 8). The historic twenty-year flood event (1929-1949) has now become the two-year event (1972-1995). “This means that (currently) every broodyear of spawning Chinook has a 50% chance, rather than a (historic) 10% chance, of being exposed to (peak) flow events that correspond to egg to fry survival rates where the (Chinook) stock does not replace itself (Beamer and Pess 1999; Appendix E). Even without any kind of harvest, Stillaguamish Chinook salmon would have made the escapement goal only 3 out of the last 17 years (PMFC 1997).

Figure 8 Estimated egg to fry survival v. flood recurrence interval for the North Fork Stillaguamish (Beamer and Pess 1999)



Historical Conditions

Records have shown increasing peak flows in the North Fork Stillaguamish over time (Figure 6). Ten of the largest eleven annual peak flows on record occurred between 1980 and 1995 (Pess et al. 1999). Urbanization (Klein 1979; Booth and Jackson 1997) and agricultural activities (Hornbeck et al. 1970) have been shown to increase the magnitude and severity of peak flows (Wissmar and Timm 2003).

Factors of Decline

The factors of decline that have degraded hydrologic function in the Stillaguamish Watershed include the following:

- Deforestation. Clearing of mature forest vegetation and conversion of these lands to other land uses that do not support forest cover.
- Industrial Forestry. This land use may not support large blocks of hydrologically mature forest cover on a sub-basin scale and may contain forest stands ranging in age from seedling to mature. Clearing of mature forest vegetation over large areas of the watershed and construction and retention of roads in upland forest areas has reduced natural infiltration, thereby increasing runoff rates and peak flows.
- Filling and draining of wetlands and side channels has modified peak flows in tributaries.
- Construction of dikes, levees, revetments, and bulkheads on the mainstem and larger tributaries has reduced or eliminated floodplain connectivity and flood storage capacity.

- Surface water withdrawals and groundwater withdrawals in areas of direct hydrologic continuity, and policies that have allowed over-allocation of water resources.

Current Conditions

The amount of rainfall that is absorbed into the ground and eventually influences stream flow levels depends on the presence of vegetation. GIS analysis of land cover showed that approximately 53% of the entire Stillaguamish Watershed is hydrologically mature forest, within a range of 14% to nearly 85% on a subbasin scale (Table 6).

Table 6. Forested Cover within Stillaguamish Subbasins (Purser et al. 2003)

Subbasin	% Young Forest (0-27 years)	% Mature Evergreen Forest (>100 yrs old)	%Total Hydrologically Mature Forest
Gold Basin	12	51	85
Upper Canyon Creek	12	43	82
Boulder River	11	49	75
Deer Creek	20	28	75
Upper SF Stillaguamish	16	40	72
Upper NF Stillaguamish	23	27	70
Robe Valley	24	27	66
Stillaguamish Canyon	22	15	65
French-Segelsen	25	25	64
Jim Creek	24	18	60
Upper Pilchuck Creek	27	14	60
Squire Creek	20	32	56
Middle NF Stillaguamish	32	14	56
Lower Canyon Creek	29	15	51
Lower NF Stillaguamish	31	8	45
Harvey Armstrong Creek	29	7	40
Lower Pilchuck Creek	39	3	38
Lower SF Stillaguamish	30	7	34
Port Susan Drainages	37	4	31
Church Creek	31	1	19
Portage Creek	30	1	17
Lower Stillaguamish	28	1	14

Potential low instream flow in certain subbasins was identified as contributing to limiting Chinook salmon production. While the list is not complete, the following subbasins have been identified as having low instream flow:

- Stillaguamish River – lower mainstem
- Jorgenson Slough/Church Creek
- Pilchuck Creek
- NF Stillaguamish River - from Oso to Whitehorse

Water Quality

In addition to sufficient habitat, water quality is critical in protecting the various life stages of salmonids. There is research documenting non-lethal, but highly detrimental, effects on fish from chemical contamination of water (Baldwin et al. 2003). Water quality standards address human health and direct fish mortality, but not declines in fish abundance and productivity.

Human population growth in the Stillaguamish Watershed has led to increasing demands for more roads, wastewater treatment, and commercial activities. The most common water quality issues in the Stillaguamish include runoff from commercial and non-commercial farms, failing septic systems, land clearing and construction, road surface runoff, and over-allocation of water resources. Land use conversion, urbanization, and lack of or ineffective water quality best management practices (BMPs) have contributed to considerable non-point source pollution in the watershed (STAG 2000).

The Stillaguamish River has experienced a deterioration of water quality, in terms of both conventional and microbiological standards. Water quality monitoring in the watershed by Snohomish County, the Tulalip and Stillaguamish Tribes, and Washington Department of Ecology has found problem areas in the mainstem, North Fork, and South Fork Stillaguamish, and smaller tributaries. Snohomish County has conducted numerous investigations for nutrients, heavy metals, bacteria, and other toxicants, mainly in the lower portions of the river. The Stillaguamish Tribe's monitoring efforts include recording water temperature, dissolved oxygen, turbidity, alkalinity, hardness, total suspended solids, pH, conductivity, and bacteria.

The Washington Department of Ecology is in the process of developing Total Maximum Daily Load (TMDL) cleanup plans for water bodies that do not meet state water quality standards. A TMDL establishes limits on pollutants that can be discharged to an individual waterbody and still allow state standards to be met. Ecology is developing TMDLs for the watershed that address the following water quality problems: temperature, fecal coliform bacteria, pH, and dissolved oxygen.

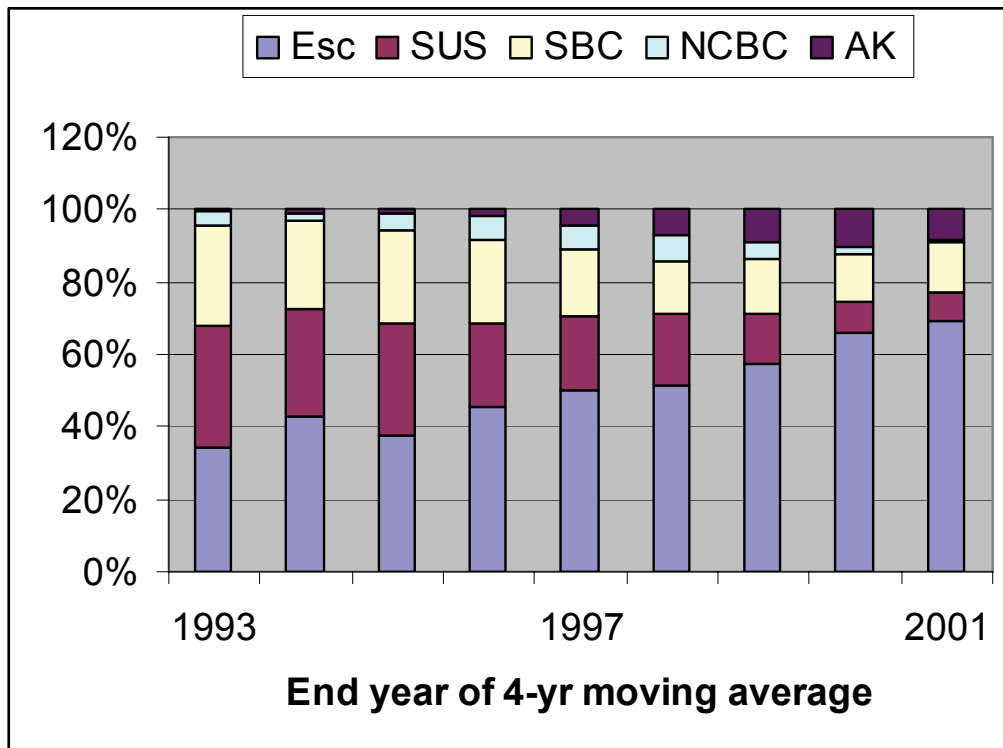
Harvest

Chinook salmon from the Stillaguamish Watershed are vulnerable to harvest in recreational and commercial fisheries throughout their adult range, from Alaska to Puget Sound. Canadian and Puget Sound fisheries have accounted for most (approximately 80%) of the historic and current harvest on Stillaguamish Chinook salmon populations, with Washington coastal and Alaskan fisheries accounting for harvest of the remaining portion (Figure 9). The Stillaguamish Tribe has not had a directed Chinook salmon fishery in the Stillaguamish River since 1982, the Tulalip Tribes have not had a directed fishery in Area 8A since 1984, and non-Indian commercial and sport fisheries

directed at Stillaguamish Chinook salmon have been closed since the mid-1980s. Currently, fisheries are closed in most areas and during times when significant numbers of Stillaguamish Chinook salmon are present, or they are managed under regulations, such as gear restrictions or unmarked fish release requirements, that minimize the harvest of wild fish.

Under the Treaty of Point Elliott (1855) as interpreted by the federal district court (1974) and affirmed by the United States Supreme Court (1979), the State of Washington, through its Department of Fish and Wildlife, and the treaty tribes, through their tribal governments, share equal authority and responsibility for management of the salmon resource. This authority and responsibility includes assessment of stock status, setting of stock management objectives, development of fishery and enhancement plans to meet objectives, and implementation of plans through regulations and enforcement. Through custom, and with some legal basis, certain tribes are the principal managers of the salmon resource within certain river systems. For the Stillaguamish River, this is the Stillaguamish Tribe and the Tulalip Tribes. Thus, the co-managers for salmon stocks originating in the Stillaguamish Watershed are the treaty tribes and the State of Washington.

Figure 9. Four-year moving average percentage distribution of total fishing mortalities among fisheries and escapement for Stillaguamish Chinook, 1993-2001¹³. (Pooling and averaging of data in Pacific Salmon Commission, Chinook Technical Committee, Report TCCHINOOK04-4 Table G.22)

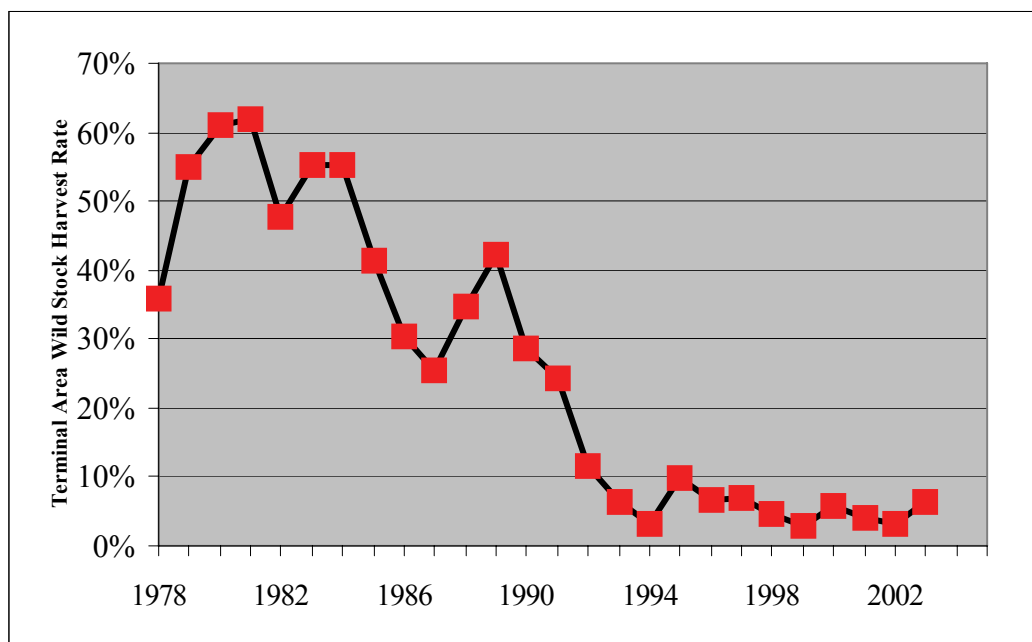


Due to high harvest rates and ongoing watershed disturbances, many Puget Sound Chinook salmon populations, including Stillaguamish Chinook salmon, exhibited declines in abundance and were ultimately listed as Threatened under the ESA in 1999. Given the ESA listing, all fisheries targeting wild Chinook salmon were prohibited in Washington's marine and fresh waters.

Fishery restrictions in local net and sport fisheries (terminal area fisheries) over the years have been effective, as shown by the decline in terminal area harvest rates (Figure 10). Each year since 1993, less than 10% of Stillaguamish Chinook salmon returning to the Port Susan / Port Gardner / Stillaguamish River area have been harvested, and all of this has been incidental to fisheries directed at other species or hatchery Chinook salmon.

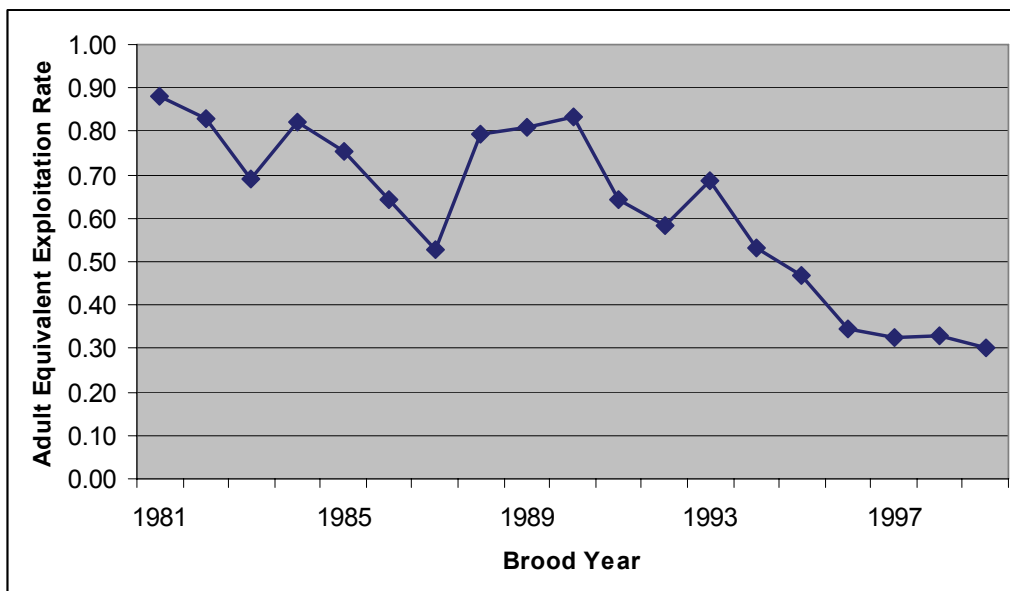
¹³ ESC=escapement, SUS=United States below the 49th parallel, SBC=southern British Columbia, NCBC=northern British Columbia, AK=Alaska

Figure 10. Trend in terminal area wild stock harvest rate for Stillaguamish Chinook salmon, 1978-2003 (from Tulalip Tribes terminal area run reconstruction database).



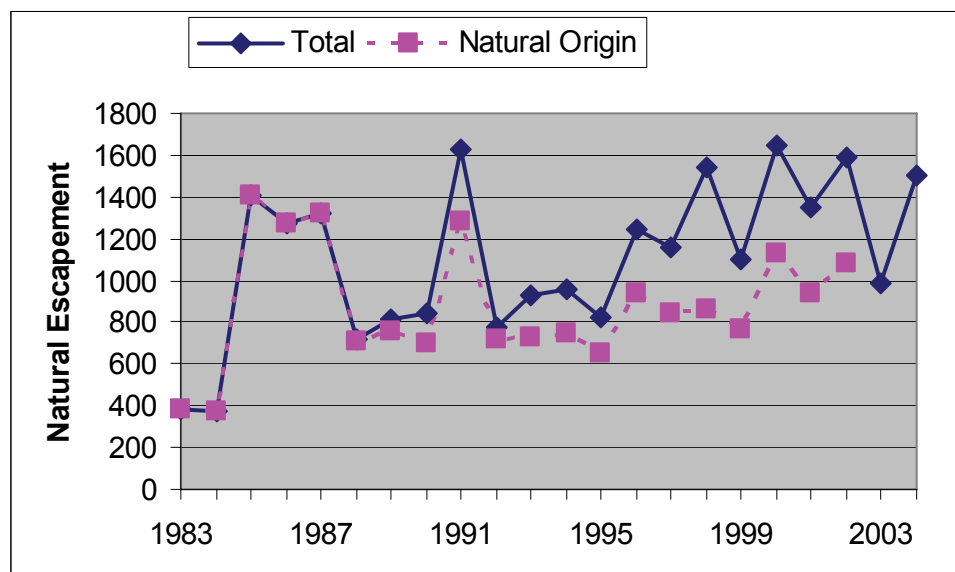
The decline in terminal area harvest rates has been accompanied by a reduction in pre-terminal fishery impacts on both sides of the US/Canada border. Under the 1999 annex of the Pacific Salmon Treaty, impacts to Stillaguamish and other Chinook salmon stocks are limited, and Canadian fisheries have not been fishing up to the maximum levels allowed under this agreement. The net result of changes in the management of harvest of Stillaguamish Chinook in all areas over the past two decades has been a reduction in overall exploitation rates from approximately 80% to 30% (Figure 11). Under the current harvest management plan, exploitation rates should be reduced further, to approximately 25%.

Figure 11. Adult equivalent exploitation rates on North Fork Stillaguamish Chinook salmon, brood years 1981-1999. (from Puget Sound Technical Recovery Team Abundance and Productivity Tables).



These greatly reduced exploitation rates have resulted in increasing escapements, although the proportional increase in spawning escapement has not been as large as the proportional decrease in exploitation rates (Figure 12). In recent years especially, the spawning escapement numbers have not responded to continually declining exploitation rates. This suggests that the system may have reached a limit in habitat capacity or productivity such that it will not respond to further harvest rate reductions.

Figure 12. Stillaguamish Chinook salmon spawning escapements 1983-2004. (Spawning escapement estimates from Washington Department of Fish and Wildlife; natural origin escapement fraction from Stillaguamish Tribe).



In addition to fishing mortality from all sources of incidental and directed harvest, there is known poaching of Chinook salmon in the Stillaguamish Watershed. Poaching refers to illegal harvest that is unreported. Determining total poaching impacts on Chinook salmon and its significance is difficult to quantify. Co-manager biological staff annually discover snagging gear (i.e., heavy hooks, weights, and line), nets, and/or other illegal fishing equipment in the Stillaguamish Watershed during field sampling activities, and annually encounter Chinook salmon bearing scars from unsuccessful poaching incidents. Although state and tribal enforcement efforts in the watershed have been increased in response to these observations, staffing and funding are still inadequate to reduce this problem to acceptably low levels.

Hatchery

Since 1952, hatchery programs have been developed in the watershed for the purpose of enhancing fishing opportunities and mitigating habitat loss with out-of-basin hatchery plants stopped in 1977 (STAG 2000). During 1986, concerns over high harvest rates and degrading freshwater habitat conditions resulted in the development of a natural stock restoration program by the Stillaguamish Tribe. By utilizing existing wild Chinook salmon from the North Fork Stillaguamish and providing a stable hatchery environment, additional Chinook salmon smolts could be released each spring to supplement the limited natural outmigration.

The current tribal natural stock restoration program contributes an estimated one-third of the returning adults to the spawning habitat of the North Fork

Stillaguamish River (Abundance & Productivity Tables; Appendix C). NOAA Fisheries (formerly NMFS) has determined that the Stillaguamish Chinook Salmon Natural Stock Restoration Program is one of the six essential hatchery programs within the Puget Sound necessary for Chinook salmon recovery. Based on NOAA Fisheries' assessment of population decline and habitat degradation, the North Fork Stillaguamish Chinook salmon would likely further decline and become extinct without the intervention of the natural stock restoration program (NMFS 1999).

The hatchery program uses both returning natural and hatchery Chinook salmon adults that are captured in the North Fork Stillaguamish using small mesh seines to provide the necessary brood stock for the natural stock restoration program. Adults are spawned during August and September. Chinook salmon spawning, incubation and early rearing occur at the Stillaguamish Tribe's Harvey Creek Hatchery while final rearing, coded wire tagging and release occur at the WDFW Whitehorse Springs Hatchery located in the area of the North Fork Stillaguamish where natural Chinook salmon spawn and rear. The Tribe's North Fork summer Chinook salmon restoration hatchery program is succeeding at maintaining genetic diversity. No legacy of Green River (hatchery) Chinook salmon introductions have been detected in tested samples (Eldridge and Killebrew, unpublished data; Appendix F).

The rearing and release of salmonids from hatcheries can have potential impacts to wild Chinook salmon populations. Hatchery-produced fish may lack genetic vigor (Busack and Currens 1995), transfer disease to wild fish (Busack and Currens 1995; ISAB 2002), and compete for food resources and space (Nickelson et al. 1986; Hawkins 1998). Genetic impacts to wild/natural spawning Chinook salmon populations from hatchery operations may include altering of the genetic population structure, decline in long-term fitness, and other impacts not reflected in population abundance (Busack and Currens 1995). Furthermore, increasing hatchery production theoretically makes more fish available for harvest, resulting in increased harvest pressure on wild salmon.

A number of actions have been implemented to reduce the risk of impacts to both wild and hatchery fish within the Stillaguamish Watershed. These include incorporating wild Chinook in the broodstock at a level that insures genetic integration of the two groups, marking all Chinook salmon released from the hatchery to minimize the masking effect, and ensuring an effective breeding population size by implementing 5 x 5 matrix spawning and final acclimation and release from a large gravel pond with controlled predation exposure (STAG 2000). Genetic analysis by Willy Eldridge of the Northwest Indian Fisheries Commission and preliminary risk/ benefit analysis by Michael Ford of NOAA Fisheries have indicated that the natural stock restoration program is minimizing impacts to natural spawning population of Chinook salmon.

In addition, Brannon et al. (2004) noted in the American Fisheries Society's journal *Fisheries* that "recent studies are quieting some of the concerns that have been raised about the fitness of hatchery fish and the risks associated with their use. These studies suggest that artificially propagated fish (of similar quality and genetic background) can perform comparable to their wild conspecifics and suggest that they can also contribute to the wild population (Brannon et al. 2004)."

Other Factors Affecting Chinook Salmon Populations

Estuarine/Ocean Productivity Conditions

A considerable amount of research has documented cyclical changes in ocean conditions, which have significant impacts on the marine survival of salmon (Mantua et al. 1997). Changes in marine currents and flows affect ocean temperatures, which in turn can affect productivity and salmon survival (Pearcy 1992). Although marine survival levels for Chinook salmon fluctuate widely, decadal shifts in marine conditions may have led to reductions in overall marine survival for Puget Sound Chinook salmon. Decadal changes in primary productivity may be connected to the decline of forage and bottom-dwelling fish species in Puget Sound over the last 20 years. In addition to productivity changes, the effects of estuarine and oceanic shifts in temperature, salinity, and current direction must be taken into consideration when developing and evaluating habitat, harvest, and hatchery recovery plans.

Predation on Chinook Salmon

Outmigrant predator/prey studies by Hawkins (1998) on the Lewis River found that both hatchery and wild salmonid smolts impact rearing juvenile fall Chinook salmon through predation. Wild steelhead, cutthroat, and coho smolts had higher predation rates than their hatchery counterparts. However, there was a greater impact on juvenile fall Chinook salmon by hatchery smolts as a result of their larger numbers at release.

There are three major mammalian predators of salmon in Puget Sound and coastal Washington: California sea lions, harbor seals, and Orca whales. Other non-marine mammalian predators include northern river otter, domestic dog, and black bear. Bird predation contributes to loss of salmon at all life stages. The Stillaguamish Tribe's North Fork Chinook salmon broodstock program has collected hundreds of adult Chinook salmon in the river since 1986. These fish show no significant scarring, which would be evidence of seal and sea lion predation (Pat Stevenson, personal communication, 2005). There is insufficient data to gauge the magnitude of bird and mammalian predation on Stillaguamish salmon populations; however, it is not likely worse than under historical conditions (NMFS website; Ruggerone and Goetz 2004).

Non-Native Species

Introduction of non-native aquatic nuisance species into the marine and freshwaters of Washington threatens the ecological integrity of the State's water resources, as well as economic, social, and public health conditions. Because they have few natural controls in their new habitat, these nuisance species spread rapidly, destroying native plant and animal habitat. *Spartina spp.* has demonstrated direct impacts to estuarine habitat (Dethier and Hacker 2004). The transition of inter-tidal acreage to *Spartina spp.*-dominated salt marsh at and above mean ordinary high water results in exclusion of species typically found in the inter-tidal region such as eelgrass, Dungeness crabs, clams, juvenile fish, shorebird, and waterfowl. The proliferation of *Spartina spp.* also results in the trapping of up to 6 inches of sediments annually. There are extensive populations of *Spartina spp.* in Port Susan and South Skagit Bay, which may pose a considerable threat to juvenile Chinook salmon populations.

Climatic Shifts

Climatologists have documented a number of cyclical changes that occur in surface temperatures and precipitation levels, which affect streamflows and water temperature in the Pacific Northwest (Climate Impacts Group 2004). Changes in climate and consequent shifts in weather and streamflow can have a dramatic effect on Chinook salmon survival during the freshwater phase of their life cycle. During warmer periods less snow pack develops, and what is available melts more quickly, increasing flooding potential. In summer, when air temperatures are higher, decreased snow pack and precipitation lead to lower streamflows with higher water temperatures. Flooding during the winter and spring impacts egg and fry survival, while lower flows in the summer impact the amount of water available for adult migration and spawning.

3. Planning Targets for Chinook Salmon Recovery

Planning Targets for Independent Populations

The Puget Sound Technical Recovery Team (TRT) and the Shared Strategy for Puget Sound have developed recovery planning ranges and targets (interim recovery goals) for the 22 individual Chinook salmon populations in Puget Sound. These ranges and targets provide a common measurement for recovery that can be used by habitat, hatchery, and harvest managers to guide recovery strategies within the individual watersheds and at the regional level. These targets are approximately 80% of historic salmon production.

The TRT planning range provides a broad estimate of the abundance needed for an individual Chinook salmon population to be viable over time. There are interacting factors controlling population dynamics and viability. Uncertainty inherent to this target definition includes the quality and quantity of available data and the inability to predict environmental conditions that will affect individual populations in the future. The planning target is a specific measure within a range to help evaluate recovery actions in habitat, harvest, and hatcheries. The target predicts the abundance of a Chinook salmon population based on a fully functioning estuary, improved freshwater conditions, restored access to blocked habitats, and poor ocean conditions. More measures of population viability are described in the next section.

The planning targets and current spawner equilibrium abundance for the Stillaguamish Chinook salmon populations are shown in Table 7. The effects of incidental harvest or hatchery operations are not shown. It is important to recognize that these numbers represent a specific point along a population performance curve, and that the planning target (or current condition) is a specific curve, not any one number of fish. Movement along this curve is influenced by human-caused and other mortality. Equilibrium abundance is the point where spawning salmon have maximized their use of identified habitat conditions and are just replacing themselves in the next generation. Equilibrium abundance is used to compare current populations to those that may result from recovery efforts or in future scenarios.



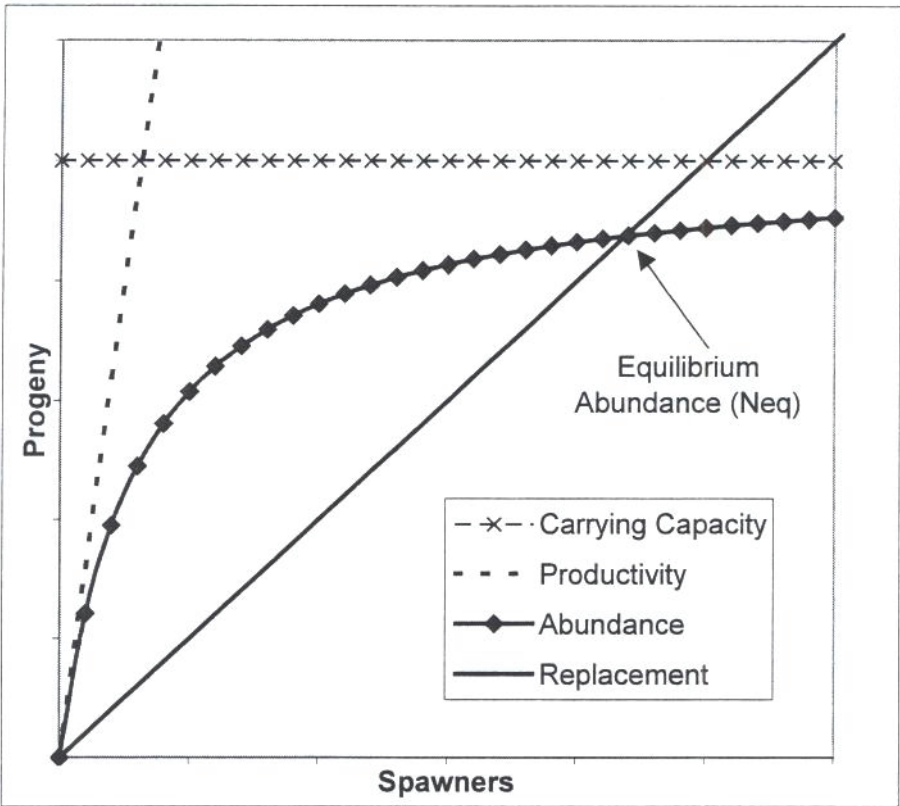
Planning targets provide a common measurement for recovery that can be used by habitat, hatchery, and harvest managers to guide recovery actions.

Table 7. Chinook Salmon Adult Abundance Planning Targets and Current Conditions

Chinook Population	Scenario	Equilibrium Abundance
South Fork	Current	861
	Target	15,387
North Fork	Current	2,430
	Target	17,795

Figure 13 illustrates a conceptual population performance curve for one population (from Beverton and Holt 1957). This figure is intended to illustrate the conceptual relationship between the number of progeny or recruits (fish in the next generation) that are produced by current spawning fish. This ratio of spawners to progeny is the productivity of the population. Current and historical conditions would each be represented by a separate curve. Actual population performance curves for Stillaguamish Chinook salmon, showing historic, current, and anticipated population performance resulting from the recovery plan actions, are in Chapter 5.

Figure 13. Salmon Population Performance Relationship



Viable Salmon Populations

A viable salmon population (VSP) refers to a population with a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (NMFS 2000). A viable salmon population has four components, or VSP parameters, that are used to determine relative health. Geographic distribution is assumed to be a key factor in maintaining variation and genetic diversity, and underlies each of the following VSP parameters:

- Abundance
- Productivity
- Diversity
- Spatial Structure

Abundance

Abundance is the number of individuals in the independent Chinook salmon population at a given life stage or time. Abundance is generally measured in terms of population size. Genetic risks of low abundance include inbreeding depression, mutation accumulation, and the overall loss of genetic diversity. When there are higher levels of environmental variability, a higher population size is required to maintain the population at a higher level (NMFS 2000). A population should be large enough to survive normal environmental variation, or human caused impacts.

Productivity

Productivity, or growth rate, represents the population's potential for increasing or maintaining its abundance over time. Productivity and population growth rate provide information on how well a population is performing in the habitats it occupies during its life cycle. Sufficient freshwater productivity is essential to maintain the overall abundance of Chinook salmon during periods of poor ocean conditions. The productivity of a population at low abundance, or inherent productivity, is often used to compare population viability between current and future populations. A continuously negative productivity value may lead a population toward extinction (a population is consistently failing to replace itself) (NMFS 2000).

Diversity

Diversity represents the variety of life histories, sizes, and other characteristics expressed by individuals within a population and refers to differences in genetic and behavioral traits. Diversity helps protect a salmon population from short-term environmental changes. Higher levels of genetic variability (diversity) allows a species to adapt to the special environmental conditions

within its specific habitat areas, and to use a wider array of environments than they could without this diversity. Genetic diversity also provides the raw material for surviving long-term environmental change (NMFS 2000).

Spatial Structure

Spatial structure represents how the abundance at any life stage is distributed among available or potentially available habitats. Spatial structure is important because structural changes in the population may impact the population's evolution and its ability to adapt to habitat changes. Spatial structure can be assessed by looking at life history variations, distribution and type of habitat patches, spatial distribution of abundance, migration corridors, and access to unique habitat areas (NMFS 2000).

Ecosystem Diagnosis and Treatment

Ecosystem Diagnosis and Treatment (EDT) is a habitat modeling tool for rating the quality, quantity, and diversity of habitat within and along a stream, relative to the needs of a focal species such as Chinook salmon. The EDT methodology includes a conceptual framework for decision-making and a set of modeling tools that organize environmental information and rate the habitat elements in regard to the focal species. In effect, it describes how the fish would rate conditions in a stream based on our scientific understanding of their needs. EDT has been used extensively in the Pacific Northwest for a number of years in a variety of settings. In the Stillaguamish Watershed, EDT was used to model the anticipated results of several Chinook salmon recovery scenarios.

Biological performance, a central feature of the EDT framework, is defined in terms of three elements - life history diversity, productivity, and capacity¹⁴ (and therefore abundance). These elements of performance are characteristics of the ecosystem that describe persistence, abundance, and distribution potential of a population.

The EDT analytical model is the tool used to analyze environmental information and draw conclusions about the ecosystem. The model incorporates an environmental attributes database and a set of mathematical algorithms that compute productivity and capacity parameters for the diagnostic species. Existing and potential conditions are compared to identify the factors or functions that are preventing the realization of population

¹⁴ Capacity represents the upper limit that the river system can support, given available (or assumed) habitat conditions.

objectives. The diagnosis can be qualitative or quantitative, depending on the type and quality of the information used to describe the ecosystem.

The EDT output is a clear statement about the present conditions of the watershed as related to the diagnostic species. The EDT model is used to estimate the Chinook salmon population response to alternative scenarios. It also provides a practical, science-based approach for developing working hypotheses as a basis for moving forward with watershed protection and restoration activities.

Figure 14. EDT Reaches

Properly Functioning Conditions

The ultimate habitat recovery goal is to maintain and restore natural ecosystem conditions that sustain salmonid productivity. To achieve this goal for Chinook salmon, individual habitat parameters should at least meet the quantitative measurement known as “properly functioning conditions” (NMFS 1996). Maintenance and recovery of the four VSP parameters necessary for a healthy salmon population depend at least on the achievement of properly functioning habitat conditions, similar in complexity and area to what was found in the watershed historically. In order to achieve properly functioning conditions, the following goals must be met:

- Maintain and restore natural watershed processes;
- Maintain a well-dispersed and well-connected network of high quality habitat that addresses the needs of all life history stages; and
- Develop, evaluate, and adapt land management activities using monitoring and assessment in order to achieve the objectives listed above.

Properly functioning conditions have been analyzed using the EDT model for the Stillaguamish Watershed¹⁵. These results are shown in Chapter 5. The estimated Chinook salmon populations levels associated with properly functioning conditions are robust and generally achieve the Shared Strategy population target levels. These results are important since they allow the overall Shared Strategy target to be translated into long-term properly functioning conditions habitat condition performance targets for each of the six habitat limiting factors categories. Habitat restoration actions, both short-term (10 years) and long-term (50 years), to achieve properly functioning conditions are described in Chapter 5.

Riparian

The Stillaguamish Technical Advisory Group (STAG)¹⁶ defined properly functioning conditions for the Stillaguamish riparian zones as 80% of stream shorelines (contiguous area within the channel migration zone) having a riparian buffer width equal to or greater than one Site Potential Tree Height¹⁷

¹⁵ Recent EDT modeling of properly functioning conditions assumed a pre-1870 estuarine condition and did not account for harvest impacts, loss of genetic fitness due to hatchery operations, and potential degradation of habitat. As additional EDT modeling is completed, more specific and optimal habitat restoration and protection strategies may be identified.

¹⁶ The STAG is made up of scientists from several agencies throughout the watershed, including the Stillaguamish and Tulalip Tribes, Snohomish County, WDFW, USFS, the City of Arlington, and the Snohomish Conservation District.

¹⁷ Site Potential Tree Height is over 200 feet for trees in the Stillaguamish Watershed (Pollock and Kennard 1998). 200' SPTH applies to most riparian areas within the Chinook anadromous zone.

on fish bearing waters to ensure properly functioning riparian habitats (NMFS 1996; STAG 2000).

Approximately 8,000 acres of riparian area would need to be planted, restored, maintained and protected to achieve properly functioning conditions in the nine subbasins that contribute to the majority of Chinook salmon productivity within the Stillaguamish Watershed.¹⁸ This calculation is based on analysis of 2001 land cover (Purser et al. 2003). Areas upstream of these nine subbasins exhibit more riparian function.

Estuary/Nearshore

The Stillaguamish Technical Advisory Group (STAG) recommends that at least 80% of historic estuarine and nearshore habitat must be accessible and usable for properly functioning conditions (NMFS 1996; STAG 2000). Based on research by Collins (1997), approximately 2,020 acres of estuarine area would have to be restored to achieve this 80% target for properly functioning conditions.

Large Woody Debris

The STAG recommends that 80 pieces (24-inch by 50-foot) of large woody debris (LWD) per mile be added and/or maintained on the mainstem Stillaguamish River and tributaries to ensure properly functioning instream wood conditions (NMFS 1996; STAG 2000). Based on instream data gathered during 2002 from the North Fork and South Fork Stillaguamish, an additional 3,700 pieces of LWD would be needed to achieve the properly functioning conditions standard in the 40+ miles of these reaches. This is equivalent to approximately 62 engineered log-jams similar to those that have been built on the North Fork Stillaguamish, with additional single pieces throughout the system.

Floodplain

The STAG recommends that no more than 10% of streambanks in any reach¹⁹ be hardened to ensure adequate floodplain and off-channel connectivity (NMFS 1996; STAG 2000). The existing amount of hardened bank in Chinook-bearing reaches throughout the Stillaguamish Watershed is shown in Table 4. The gap between current conditions and achieving this properly functioning conditions target in the North and South Fork Stillaguamish is 4.1 miles of existing hardened bank. The total mileage of hardened bank in the North and South Forks of the Stillaguamish from Table 4 is 13.4 miles, while

¹⁸ These key subbasins are: Lower Stillaguamish, Lower Pilchuck, Lower South Fork, Lower North Fork, Middle North Fork, Boulder River, French-Segelsen, Squire Creek and Upper North Fork. Other subbasins may contribute to overall ecosystem health or downstream Chinook salmon habitat but do not have significant Chinook salmon spawning habitat within them.

¹⁹ Stream reaches identified for use in EDT analysis (Haas et al. 2003).

the total mileage of bank length in these areas is 92.8 miles. 10% hardened banks to achieve properly functioning conditions in the North and South Forks would be a total of 9.3 miles. The gap between properly functioning conditions and existing conditions is therefore 4.1 miles of hardened banks to be removed.

The lower Stillaguamish mainstem is extremely important for both populations of Chinook salmon and is a candidate for floodplain restoration projects. Hardened streambanks in the lower Stillaguamish present a major impediment to Chinook salmon productivity improvements. Achieving properly functioning conditions in the lower Stillaguamish would require removal of 18 miles of hardened streambanks.

Sediment

The STAG has defined properly functioning conditions as less than 12% concentrations of fine sediment (<6.35mm) in spawning areas (Bjornn and Reiser 1991; NMFS 1996; STAG 2000). The 2004 Stillaguamish Lead Entity Strategy (Waller and Stevenson 2004) identified over 124 miles of potentially unstable forest roads on federal, state and private land. At least two large deep-seated landslides and numerous unstable banks (Haas et al. 2003) are also known to be contributing to sediment conditions. It is unknown to what degree the attenuation of these sources will lead to properly functioning conditions.

Hydrology

The STAG recommends that the cumulative subbasin total of hydrologically mature forest be 80% of total forest cover (Nichols 1990). In the 14 subbasins dominated by forestry land use, 35,596 acres of immature forest would need to mature to achieve the properly functioning conditions target (Purser et al. 2003).²⁰ This assumes no net loss in existing mature forest cover. This assumption may be overly conservative given current land use pressures and forest management trends toward marketing smaller logs to processing plants. Additional actions to achieve properly functioning conditions include improving wetland function and reducing bank armoring and channelization in the lower watershed.

Instream flow levels should be set at an optimum level to ensure recovery goals and actions within this recovery plan are achieved. To determine optimal flows for rearing, spawning and holding, representatives from the Washington Department of Ecology, Washington Department of Fish & Wildlife, Tulalip and Stillaguamish Tribes negotiated instream flow levels based on an Instream Flow Incremental Methodology (IFIM) study. With the

²⁰ Subbasins dominated by forestry land use are: Upper Pilchuck, Upper South Fork, Gold Basin, Robe Valley, Upper Canyon Creek, Lower Canyon Creek, Jim Creek, Upper North Fork, Boulder River, French-Segelsen, Squire Creek, Deer Creek, Middle North Fork, and Stillaguamish Canyon.

study results, a determination can be made on how much flow would provide optimum habitat for the priority species/life stage during a particular time of the year. For example, flows will be set in the river from late August to October to provide optimum habitat for Chinook spawning in the North Fork Stillaguamish.

4. Watershed Vision for Salmon Recovery

Guiding Principles for the Stillaguamish Watershed Chinook Salmon Recovery Plan

The SIRC adopted the following guiding principles for the Stillaguamish Watershed Chinook Salmon Recovery Plan in August, 2002:

- **Integration:** The plan shall address water quality and salmon recovery issues in an integrated manner, consistent with the intent of the 1990 Watershed Action Plan and the origins of the SIRC.
- **Fairness:** The plan shall promote fair treatment and shared burden of cost for rural, urban, business, private, local, state, federal and tribal constituencies.
- **Science:** The plan shall use the best available science to make technical determinations. Existing watershed plans and analyses should be used as the core basis of this planning information. At the request of the SIRC, the Stillaguamish Technical Advisory Group will evaluate disagreements on best available science.
- **Scope:** Chinook salmon recovery shall be the primary emphasis of the plan within a broad ecosystem restoration context designed to enhance the watershed for all native freshwater and marine aquatic fisheries.
- **Evaluation:** Recovery shall be measured by criteria that are broadly accessible and that promote sustainability as well as fish population targets or water quality standards.
- **Community:** Recommended planning actions shall integrate scientific principles with community, social and economic values including but not limited to the protection and preservation of agriculture and rural quality of life. Community resources, such as volunteers, landowners and local knowledge, should be a part of plan implementation.
- **Landownership:** All landowners holding farm, forestry, recreation and residence properties may request fair compensation for the use of their land in restoration.
- **Regulation:** The plan shall seek to support actions that improve enforcement of current growth management and environmental



Habitat, harvest, and hatchery management are expected to work together to bring about recovery of the two Stillaguamish Chinook salmon populations.

regulations and make them more effective rather than proposing new regulations. Non-regulatory efforts that promote salmon recovery are necessary elements of the plan.

- **Commitment:** Actions shall be backed by financial and work plan commitments of implementing organizations and shall be designed to have measurable results.
- **Education:** Communication of problems, proposed actions and results to all ages of the public shall be defined as part of plan implementation in order to facilitate public comment and plan development.
- **Cooperation:** The plan shall recognize the individual efforts of agencies and organizations and promote cooperation among them.
- **Balance:** The plan shall balance long-term goals while recognizing the need for short-term actions.

Watershed Goal

The purpose of listing the Puget Sound Chinook salmon as Threatened under the ESA is to restore a self-supporting population that does not require legal intervention to maintain its existence (NMFS 2000). Within the Stillaguamish Watershed, the primary goal is to restore healthy, viable populations of Chinook salmon to a level where natural population production is healthy enough to support recreational and commercial fisheries. The relative health and viability of the population will be judged by its VSP parameters: abundance, productivity, population structure, and diversity (NMFS 2000). These factors are essential to a viable salmon population and depend on properly functioning habitat.

The SIRC has chosen to focus their efforts at this time on the implementation of a 10-year strategy aimed at moving toward recovery of Chinook salmon populations in the Stillaguamish Watershed. This strategy includes specific habitat, harvest, and hatchery management actions, as well as policy and regulatory commitments and conditions. The benefits of individual habitat management actions have been modeled using EDT to generate estimated Chinook salmon population gains that will result in achieving 30% of the TRT planning targets. Details of the 10-year action plan are included in Chapter 5. Implementation of these actions over the next decade will allow for ongoing planning, monitoring, and adaptive management to achieve long-term recovery of the species.

Beyond the initial 10-year recovery strategy and implementation of its recommended actions, an adaptive management approach will be used to determine the necessary actions to achieve long-term Chinook salmon recovery objectives. The health and viability of the Stillaguamish Chinook salmon populations will be judged by the Viable Salmonid Population (VSP)

parameters and ongoing progress toward reaching the TRT planning targets. Necessary long-term strategies and actions for habitat, harvest, and hatchery management will be adopted as appropriate.

In support of the guiding principles above, the 10-year watershed goal chosen by the SIRC in April 2004 is based on a number of planning assumptions:

- The SIRC promotes restoration of natural ecosystem processes and properly functioning conditions in the watershed with local stakeholders participating in natural resources decision-making.
- The 10-year goal will move the watershed toward properly functioning conditions and the Shared Strategy planning target for Chinook salmon while recognizing the extended time period recovery will require.
- An ambitious approach will be taken to build on current momentum and minimize reliance on uncertain future implementation.
- Proposed watershed actions are designed to be reasonably achievable by local organizations within the 10-year period.
- Significant funding from regional, state and federal sources will be requested to complete projects. Without this external funding, the goal will not be achieved.
- The SIRC will analyze opportunities for policy and regulatory coordination, especially in the areas of local and forest land use policies, and identify regulatory gaps related to habitat and watershed protection that will need to be addressed for consistency and effectiveness of ongoing watershed restoration projects.

Habitat Strategy

Habitat improvement is a major component of Chinook salmon recovery in the Stillaguamish Watershed. Habitat recovery requires an understanding of the relationships between land use practices, watershed-scale processes, habitat conditions, and Chinook salmon requirements. Protection, restoration, and re-connection of habitat and watershed functions, as well as more effective regulatory enforcement, further data collection, and research, are necessary elements in addressing habitat problems throughout the watershed.

Habitat linkages and restoration of lost habitat and related watershed functions will play a major role in the recovery of Chinook salmon populations. Table 8 demonstrates some of the linkages between habitat-forming processes, land use, resulting habitat conditions, and response by Chinook salmon in the Stillaguamish watershed.

Table 8. Habitat Linkages

Habitat-forming processes	Affected by land use	Resulting habitat conditions	Chinook salmon population response
Delivery of water	Removal of 35-40% of the historical forest cover, 15-20% permanently ²¹	Increases peakflows that blow out large woody debris, erode banks; eroded banks and upland areas contribute greatly increased sediment loads that fill pools, intrude redds, further simplify habitat ²² .	Reduced habitat diversity and complexity leads to reduced survival of juveniles; reduced egg survival, survival to emergence; reduced adult holding capacity; potential pre-spawning mortality from increase temperatures.
	Construction of dikes, levees, revetments; cutting off side-channels, sloughs, blind tidal channels ²³	Increases portion of channel network/habitat that is exposed to high-energy flows; directly reduces edge, side-channel, slough, and blind tidal channel habitat critical for juvenile rearing ²⁴	This has the most dramatic effect on the currently configured Chinook salmon populations in the Stillaguamish. These land use actions directly reduce critical juvenile rearing habitat causing estuarine density-dependent mortality and reducing fitness of emigrating smolts contributing to low ocean survival rates ²⁵ .
	Filling or isolating beaver ponds, riverine and palustrine wetlands ²⁶	Reduces floodplain detention and retention storage increases flood magnitudes, particularly in lower river, and increases flow velocities that blow out large woody debris, erode banks ²⁷	Reductions in habitat diversity and complexity caused by high magnitude and high velocity stormflows reduce density-dependent survival of juvenile Chinook salmon ²⁸ ; evidence is gathering for juvenile Chinook salmon use of freshwater off-channel habitat which these land use actions directly reduce.
Delivery of wood	Removal of 35-40% of the historical forest cover in the whole watershed and likewise in the	Removal of riparian forests prevents new woody debris from recruiting, reduces habitat diversity and complexity, reduces	Reductions in physical habitat diversity and complexity caused by high magnitude and high velocity stormflows reduce density-dependent survival

²¹ See Pollock and Kennard (1998), Purser et al. (2003) and Simmonds et al. (2004)

²² See Lisle and Eads (1991), Rhodes and Purser (1998), and Collins (1997)

²³ See Bortleson et al. (1980)

²⁴ See COE (2000) and STAG (2000)

²⁵ See Collins (1997) and Collins and Sheikh (2003)

²⁶ See Pess et al. (1999)

²⁷ See Crance (1988)

²⁸ See STAG (2000)

Habitat-forming processes	Affected by land use	Resulting habitat conditions	Chinook salmon population response
	riparian area, 15-20% permanently	channel roughness leading to increased streamflow velocities; contributes to high stream temperatures ²⁹	of juvenile Chinook salmon; contributes to potential for density-independent adult pre-spawning mortality from high stream temperatures. ³⁰
	Removal of in-channel wood by streamside landowners, "poachers," and government agencies	Reduces habitat diversity and complexity, reduces channel roughness leading to increased streamflow velocities	Reductions in physical habitat diversity and complexity resultant from high magnitude and high velocity stormflows reduce density-dependent survival of juvenile Chinook salmon.
Delivery of sediment	Removal of 35-40% of the historical forest cover in the whole watershed and likewise in the riparian area, 15-20% permanently	Eroded banks and upland areas contribute greatly to increased sediment loads that fill pools, intrude redds, further simplify habitat	Increases direct density-independent mortality in redds and reduces density-dependent survival of juveniles; reduces adult holding capacity ³¹ .
	Extensive (lots of road miles all over the basin) and intensive (high density of road miles in specific basins) roading ³²	Has contributed to increased frequency of landslides and increased delivery of fine sediment directly from unpaved and/or poorly drained road surfaces; increases the potential for intrusion of fines into redds; fills pools.	Suffocates or entombs eggs and juveniles (source of density-independent mortality) ³³ ; pool filling reduces density-dependent survival of juveniles and leads to reduced adult holding capacity

Unconstrained floodplain reaches are highly productive habitats for anadromous salmonids (Stanford and Ward 1992). In addition, off-channel areas adjacent to floodplains have been shown to be important rearing habitats for salmonids during high winter flood events (Tschaplinski and Hartman 1983). Fragmentation of habitat and the resulting isolation of populations affects the long-term viability of salmonids. In addressing habitat fragmentation and connectivity for the Northern Spotted Owl, Thomas et al.

²⁹ See Spence et al. (1996)

³⁰ See Healy in Groot and Margolis (1991)

³¹ See Reeves et al. (1989)

³² Roading is defined as the construction of road surfaces, cut banks, fill slopes, drainage facilities and the maintenance thereof. There acute dramatic changes from construction and chronic multi-parameter effects from the maintenance of road systems in watersheds. See Spence et al. (1996), Collins (1997), and Sharma and Hilborn (2001).

³³ See Bjornn and Reiser (1991)

(1990) outlined several general principles that are equally applicable to salmon recovery planning (Spence et al. 1996):

- Large blocks of habitat are preferable to small blocks.
- Blocks of habitat that are close together are superior to those that are far apart.
- Contiguous blocks are preferable to fragmented habitats.
- Corridors linking habitats function better when they resemble the preferred habitat of the target species.

Thus, the first objective of this habitat strategy is to prevent further fragmentation of aquatic habitat. The second objective is to improve the connectivity between isolated habitat patches. The third objective is to protect and restore areas surrounding critical salmon habitat from further degradation, allowing for the expansion of existing refugia such as:

- Preferred spawning areas
- Off-channel floodplain habitat
- Estuary and marine shoreline habitat
- Complex sloughs and undisturbed blind tidal channels
- Natural riverbanks

Harvest Strategy

To ensure that Washington based commercial and recreational fisheries do not impede Chinook salmon rebuilding and recovery, the co-managers adopted the Puget Sound Harvest Management Plan (Puget Sound Indian Tribes and Washington Department of Fish and Wildlife 2004). Consistent with the overall goals of the Stillaguamish Watershed Chinook Salmon Recovery Plan, harvest of Chinook salmon will occur in a manner that will have a high probability of not impeding the capability of the North Fork and South Fork Stillaguamish Chinook salmon populations to rebuild to levels that will support directed harvest and other benefits.

The following general principles guide the details of the harvest strategy:

- Harvest management alone cannot rebuild Stillaguamish Chinook salmon populations. Harvest management must work together with habitat and hatchery management to support a viable recovery plan.
- Development of an appropriate harvest management plan will require increased knowledge of the production function. One principal goal of the monitoring and adaptive management plan will be to assure the collection

of appropriate information to monitor, and revise if necessary, the production function.

- All sources of fishery-related mortality count equally in assessing the exploitation rate. These include pre-terminal fisheries directed at Chinook salmon such as those in Canada and in the ocean off of Washington state, pre-terminal fisheries with incidental mortality of Chinook salmon such as the north Puget Sound sockeye fishery, recreational fisheries directed at Chinook salmon such as the Puget Sound winter blackmouth fishery, hook-and-release mortality in selective recreational fisheries, and incidental harvest of Stillaguamish Chinook salmon in terminal fisheries directed at hatchery stocks. All mortality will be assessed in terms of adult equivalent mortality – as the reduction in the number of adult fish (or biomass of eggs in the new model) that would reach the spawning grounds in the absence of fishing³⁴.

Harvest Management Plan

The harvest management guidelines for Stillaguamish Chinook salmon include an exploitation rate objective and a critical escapement threshold. The exploitation rate objective is the maximum fraction of the production from any brood year that is allowed to be removed by all sources of fishery-related mortality, including direct take, incidental take, and non-landed mortality. The exploitation rate is expressed as an adult equivalent rate, in which the mortality of immature Chinook salmon is discounted relative to their potential survival to maturity.

Analysis specific to North Fork Stillaguamish Chinook salmon was completed to develop the exploitation rate objective to reflect, to the extent possible, the current productivity of the stock. Brood year recruitment (i.e., number of recruits per spawner) was estimated, for brood years 1986 through 1993, by reconstructing the total abundance of natural origin Chinook salmon that were harvested or otherwise killed by fisheries, or escaped to spawn. The resulting brood year recruitment rates were partitioned into freshwater and marine survival rates. The future abundance (i.e. catch and escapement) of the stock was simulated for 25 years, using a simple population dynamics model, under total fishery exploitation rates that ranged from 5 percent to 60 percent. In the model, production from each year's escapement was subjected to randomly selected levels of freshwater and marine survival, and randomly selected levels of management error. Each model run (i.e. for each level of exploitation rate) was replicated one thousand times, and the set of projected population abundances analyzed to determine the probability of achieving the management objectives. The simulation for North Fork Stillaguamish

³⁴ A formula for adult-equivalent exploitation rate is $(R-E)/R$, where R is the total number of fish (or biomass of eggs in the new model) that would have returned to spawn naturally in the absence of fishing and E is actual number (or biomass of eggs) that did spawn naturally given the fishing pattern.

Chinook salmon, across a range of exploitation rates (Table 9), indicated that total exploitation rates below 0.35 met the recovery criteria.

Table 9. Summary of results of 1,000 runs of the simulation model at each exploitation rate.

Exploitation Rate	Probability of Falling Below Critical	Probability of Recovery	Median Escapement Ratio	Median Escapement
0.00	1%	96%	2.75	3,597
0.05	1%	96%	2.81	3,377
0.10	1%	96%	2.76	3,165
0.15	2%	95%	2.66	2,964
0.20	2%	95%	2.56	2,758
0.25	3%	93%	2.57	2,418
0.30	4%	92%	2.48	2,210
0.35	6%	92%	2.46	1,920
0.40	7%	91%	2.29	1,686
0.45	11%	87%	2.14	1,444
0.50	17%	80%	1.92	1,180
0.60	41%	52%	1.04	648
0.70	73%	12%	0.27	259
0.80	94%	0%	0.02	55

The fishery management objective for the 2000 management year was to realize an exploitation rate that, if imposed consistently over a future time interval:

- Would not increase the probability that the stock abundance would fall below the critical escapement threshold, after 25 years, by more than five percentage points higher than were no fishing mortality to occur; and
- Would result in at least an 80% of greater probability of the stock recovering (i.e. escapement exceeding the current level) after 25 years.

Stock recovery, for this analysis, was defined as the average spawning escapement for the final three years in the simulation period exceeding the average for the first three years in the simulation period (Rawson 2000).

At the present time, there is very little information concerning the productivity of the South Fork Chinook salmon population other than the fact that the average abundance of this stock has been approximately 50% of the North Fork Chinook salmon population based on relative escapement. Incorporating this lower estimate of abundance, and assuming the same productivity (i.e. recruitment rates), the simulation model predicted that exploitation rates below 35% met the first management objective. The probability of rebuilding

at this exploitation rate was 96%. This analysis indicates that a target exploitation rate of 0.35 would also be appropriate for the South Fork Chinook salmon population.

The Washington co-managers have set an exploitation rate guideline of 0.25, as estimated by the FRAM simulation model, for the Stillaguamish Chinook salmon management unit. According to the simulation model, this level of exploitation results in a 4% risk of the management unit falling below the critical escapement threshold of 500, and affords a 92% probability of recovery (i.e., that spawning escapement will exceed the current average level).

The low abundance threshold for North Fork Chinook salmon is 500 natural-origin spawners. Reconstruction of the total brood abundance of adult Stillaguamish Chinook salmon suggests that escapements of 500 (+/- 50) can result in recruitment rates ranging from two to five adults per spawner (Rawson 2000). The genetic integrity of the stock may be at risk and compensatory mortality factors may affect the stock when annual escapement falls below this threshold to 200 (NMFS Biological Opinion 2000). The critical threshold for South Fork Chinook salmon is undetermined pending further analysis of data. However, recent preliminary DNA analysis indicates a critical population threshold at 100 spawners per year (Spidle, unpublished data; Appendix G).

The low abundance threshold for the Stillaguamish management unit is based on the 1996-2002 average fraction of the natural escapement for the years 1996-2002 in the North Fork. This average was .813 (range: .770 - .852). Thus a management unit escapement of $500/.813 = 615$ would, on average, include 500 North Fork fish. The range of management unit escapement thresholds computed this way is 586 to 649. Based on this, we have selected a low abundance threshold of 650 for the Stillaguamish management unit. Whenever spawning escapement is projected to be below this level, fisheries will be managed to either achieve the critical exploitation rate ceiling, or exceed the low abundance threshold.

Long-Term Harvest Management Plan

The co-managers will continue to collect and evaluate the information necessary to develop a long-term harvest management plan for Stillaguamish Chinook salmon. This plan will be based on updated assessments of the productivity and capacity of the Stillaguamish system. The basis of the plan will be production functions for each population relating recruitment biomass to the biomass of natural spawners or fertilized eggs on the spawning grounds. The long-term harvest management plan will be designed to provide long-term maximum sustainable harvest from the entire management unit under the constraint that the viability and diversity of the production of each stock will not be jeopardized. This program may use information collected as part of

regular monitoring, but it may also include special monitoring or assessment in addition to the monitoring program.

Hatchery Strategy

North Fork Stillaguamish

The Stillaguamish Chinook Salmon Natural Stock Restoration Program is a state-of-the-art program designed to protect and help restore naturally spawning Chinook salmon from the North Fork Stillaguamish. By removing adult Chinook salmon that would naturally spawn in unstable, degraded habitat and providing the progeny of those fish with a stable environment within the hatchery, additional survival benefits are obtained for a given group of eggs and sperm. The release of hatchery-reared smolts provides additional adults back to the watershed to buffer the decline of natural spawners due to the poor habitat conditions and the low productivity of the natural environment.

The objectives of the hatchery program are:

- To insure the short-term preservation and long-term restoration of native Stillaguamish River Chinook salmon populations to levels that will sustain fisheries, non-consumptive fish benefits, and other related cultural and ecological values; and
- To provide technical information through the US/Canada Indicator Stock Program on harvest rates and locations, migration timing, and productivity for north Puget Sound summer/fall natural Chinook salmon populations.

The initial intent of the program is to help preserve the listed population by releasing up to 220,000 sub-yearling North Fork Stillaguamish-origin summer Chinook salmon each year (STAG 2000). Specific performance standards for the Stillaguamish program are: 1) initially maintain and then increase the total abundance of the composite natural/hatchery summer Chinook salmon population; 2) as habitat improves, increase the ratio of natural origin spawners vs. hatchery origin spawners on the spawning grounds; 3) produce adult hatchery fish that are similar to natural-origin fish in morphological and life history traits; and 4) maintain the genetic diversity of the population (HGMP 2000).

The hatchery program initially began adipose clipping and coded wire tagging all of the fish released from the program. In 1997, due to conservation concerns, the decision was made to drop the adipose clip, but continue to coded wire tag the fish. This decision was based on anticipated selective hatchery harvest fisheries and the regional implementation of 100% electronic sampling for all Chinook salmon fisheries. Failure by Canada and Alaska to implement 100% electronic sampling, combined with the importance of the

Stillaguamish indicator stock, and improvements in escapement have resulted in returning to adipose clipping and coded wire tagging all natural stock restoration fish released by the hatchery.

“The Stillaguamish coded wire tag group is one of the best Chinook tag groups we have in Puget Sound for estimating exploitation rates because a large portion of the North Fork Stillaguamish is actually sampled for coded-wire tags. In many other systems no, or very few, in-river tag recoveries are included in the exploitation rate analysis (Rawson, personal communication).”

The benefits of the program include reducing the risk of extinction to the wild Chinook salmon population by increasing the total (hatchery plus wild) abundance of the population and increasing the numbers of natural origin recruits back to the spawning grounds. Based on the NOAA Fisheries and co-managers assessment of population declines and habitat degradation, the Stillaguamish Chinook salmon populations would likely further decline and go extinct without the intervention of the natural stock restoration program (NMFS 1999).

The current program size was the result of a number of factors. The first was a concern about the long-term ability of the natural population to survive given the high 1980s harvest rates and poor freshwater conditions. Another factor was the risk associated with taking too many fish into the hatchery and having something go wrong. The number of adult broodstock needed to release enough coded wire-tagged fish to provide statistical power to the indicator stock program was also considered.

Recently completed EDT modeling supports the hypothesis for the current hatchery natural stock restoration program. Modeling results indicate that "without the hatchery supplementation, escapement declines (in the North Fork) to less than 100 fish after about 30 years. With the hatchery program, escapement varies due to harvest, flow and marine survival variability (within the model), but does not decline. The model suggests that the hatchery program is providing a conservation benefit by keeping total spawning abundance above 500 fish" (Mobrand Biometrics 2005; Appendices H and I).

The following EDT model run graphs of North Fork Stillaguamish Chinook salmon escapement (Figures 15 and 16) are the result of inputting known 1983-1998 data for peak flow events, harvest rates, estimated low marine survival, and the extreme low escapements. The first model run was done without a hatchery program being operated. The second model run included the operation of the existing natural stock restoration program. Both model runs include random variability, within the defined parameter limits. The blue portion of the graphs represent wild/natural spawners and the red color represents adult returns from the natural stock restoration hatchery program.

Figure 15 North Fork Stillaguamish Chinook Salmon Escapement with No Hatchery Program

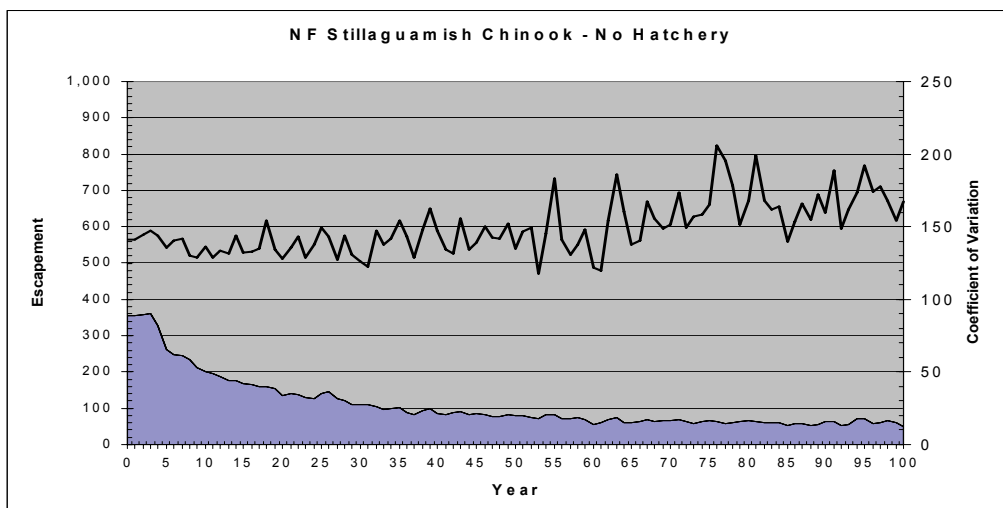
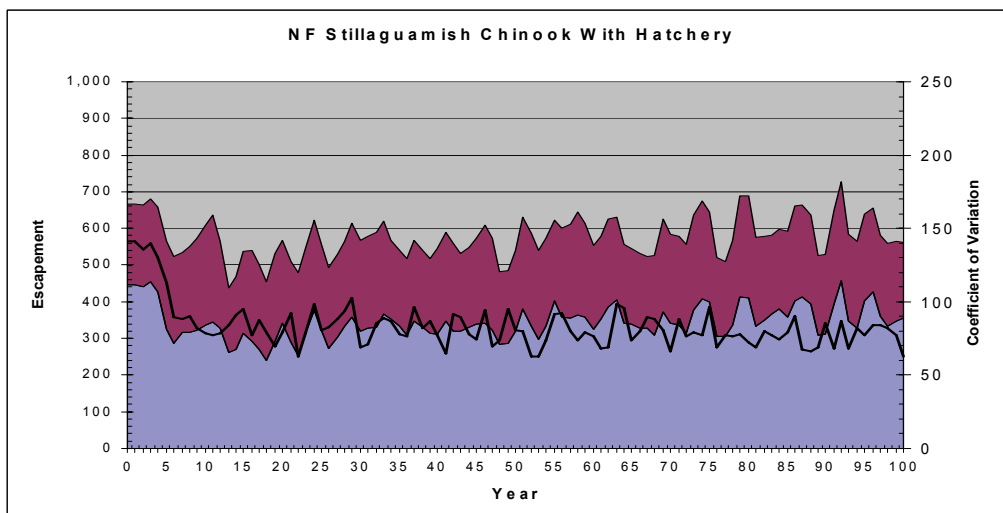


Figure 16 North Fork Stillaguamish Chinook Salmon Escapement with Hatchery Program



The Hatchery Scientific Review Group has developed a habitat, harvest and hatchery management tool, the “All H Analyzer” (AHA model) (www.hatcheryreform.org). Preliminary model runs of the North Fork Natural Stock Restoration Program suggests that the current program size minimizes hatchery impacts such as fitness loss to the natural population. The program results in having the correct ratio of hatchery-origin spawners (HOS) to natural-origin spawners (NOS) in both the broodstock and on the spawning grounds to fully integrate the hatchery restoration program with the naturally spawning population.

The goal for the natural stock restoration program is to see four consecutive years of natural origin escapements over 700 into the North Fork

Stillaguamish and its tributaries. The 700 NOS target was based on setting an escapement number above the 500 NOS minimum escapement low abundance threshold included in the 2004 Puget Sound Harvest Management Plan. That 500 NOS harvest management target was set based on several studies that indicated that annual escapements below 500 NOS's would pose a risk for the population (Allendorf et al. 1997; McElhany et al. 2000; HSRG 2005). The co-managers chose a number above 500 to allow for some protection/buffer in the event that the population went into steep decline with suspension of the natural stock restoration program.

The adaptive management plan for the natural stock restoration program is to monitor the spawning escapement numbers and geographic distribution of those fish within the watershed. Should the natural origin spawning escapement fall below 500 fish for four consecutive years, the co-managers will evaluate either restarting the natural stock restoration program (if it has been de-activated) or expanding the scope of the existing program to preserve the genetic diversity of the population.

Hatchery management has evolved significantly over the last twenty years to reduce disease risk and improve genetic fitness. The 1999 listing of Puget Sound Chinook salmon has focused attention on the effects of hatchery programs on natural populations, in particular as they may affect the genetic fitness and survival of natural populations. In cooperation with Washington Department of Fish and Wildlife (WDFW) and NOAA Fisheries, the Stillaguamish Tribe has developed a Hatchery Genetic Management Plan (HGMP) for the Harvey Creek Hatchery program. The HGMP comprehensively describes the short- and long-term operating and monitoring procedures that ensure the program is consistent with recovery goals for the North Fork Stillaguamish population and the Puget Sound Evolutionarily Significant Unit (ESU).

The HGMP and associated monitoring and evaluation plans provide a management framework for the program, such that genetic and ecological risks associated with artificial production and supplementation can be researched and evaluated. This information can then be used to modify the program to reduce or eliminate the risks. The HGMP may or may not call for immediate changes in hatchery practices or production objectives. NOAA Fisheries is expected to review the co-managers' Hatchery Management Plan, of which the HGMP is an integral part, with respect to conservation criteria established by the ESA's 4(d) rule.

Although the review of all Puget Sound HGMP's is still in process and no final authorization by NOAA Fisheries has been issued, the preliminary review of the Stillaguamish Chinook Natural Stock Restoration Program by Tim Tynan of NOAA Fisheries noted the following: "From a review of estimated natural recruit per spawner and Stillaguamish hatchery Chinook

contribution data, the program clearly is helping to sustain the listed population in the midst of severe freshwater habitat degradation resulting from surrounding land use practices. Protocols applied through the program appear adequate to minimize the risk of genetic change and loss of genetic diversity and fitness within the propagated populations, and among regional Chinook populations” (Tynan 2000).

In addition to the review of the HGMP by NOAA Fisheries, an independent science panel of fisheries experts, the HSRG panel, also reviewed the Chinook salmon natural stock restoration program. Their evaluation includes the following observations: “This program is consistent with short-term and long-term goals. The program appears to be reducing the risk of demographic extinction of summer Chinook salmon in the North Fork Stillaguamish River. The demographic benefits of this program outweigh the risks. The program has a high likelihood of achieving its goals, particularly if pre-spawning mortality and disease transmission can be controlled, and potentially reduced, at the Harvey Creek Hatchery. This is a valuable program that has the potential to provide very important long-term conservation benefits (HSRG 2002).”

In the HSRG’s upcoming report to Congress, the panel made the following statements: “It is clear that the co-managers in the Stillaguamish/Snohomish region fully understand and subscribe to the principles and concepts developed in the Hatchery Reform Project. Goals are clearly articulated, credible progress has been made (or will soon be made) to implement reforms and the infrastructure necessary to track progress and assure success over time is evolving. In the near-term, the greatest value is likely to be produced from investment in those regions where the co-managers are most prepared to implement hatchery reform. The co-managers in those regions – most notably the Stillaguamish/Snohomish, but also Hood Canal, Eastern Straits, and North Coast regions – have demonstrated a firm understanding of the process of hatchery reform and have made the decisions to implement change (HSRG 2005).”

Michael Ford (NOAA) and Kip Killebrew (Stillaguamish Tribe) completed the preliminary 1999 draft Benefit Risk/Assessment Tool for the Stillaguamish Natural Chinook Restoration Program. That assessment utilized watershed specific data, broodstock information, escapement /spawner ground surveys, and coded wire tag information from the Tribe’s Hatchery Genetic Management Plan to complete the assessment. In addition to this assessment, a preliminary analysis of North Fork microsatellite DNA data by Willy Eldridge of the Northwest Indian Fisheries Commission has further documented that the Tribe’s restoration hatchery program is succeeding at maintaining genetic diversity (Eldridge and Killebrew, unpublished data; Appendix F).

The co-managers will utilize recently created models to evaluate ecological interactions and the corresponding risk assessment and minimization (Busack et al. 2005). In addition, the program's potential impacts of domestication and inbreeding depression will be evaluated using new modeling being developed by NWIFC and WDFW. These factors and the associated risks can then be evaluated against the risk of extinction modeling efforts underway by Greene (personal communication, 2005) and Mobrand Biometrics (2005; Appendix I).

South Fork Stillaguamish

The SIRC believes that the limiting factors contributing to poor freshwater survival in the North Fork Stillaguamish are also affecting freshwater survival in the South Fork Stillaguamish. Therefore, the survival data and models outlined in the North Fork Stillaguamish section of this chapter are applicable and appropriate for the South Fork Stillaguamish as well.

The Hatchery Scientific Review Group has recently completed a technical white paper "When Do You Start A Conservation Hatchery Program?" that provides guidance based on a population's effective size as to when that population is at risk. A review of that document and recently completed DNA analysis on the South Fork Chinook salmon population has indicated that "the SF Stillaguamish fall run of Chinook is not at genetic risk requiring immediate remediation in a new hatchery program. A restoration program should be considered when the long term (1986-present) harmonic mean run size drops to 180 fish per year, which would equate to an escapement of 100 adults per year each year from 2005-2011 (Spidle, unpublished data; Appendix G)."

"The Chinook salmon from the South Fork Stillaguamish River have a healthy effective population size, at the least, as evidenced by microsatellite data. It is possible that the effective population size of the population has been inflated by strays, perhaps of Green River (hatchery) origin. The South Fork population remains genetically differentiated from the complex of Green River derived populations (Spidle, unpublished data; Appendix D)"

Integrated Strategy

The Stillaguamish Watershed Chinook Salmon Recovery Plan includes habitat management, harvest management, and hatchery management actions. The plan discusses how the actions in each area are expected to affect the four VSP parameters of the two Chinook salmon populations in the Stillaguamish system, following the technical guidance for developing salmon recovery plans (Puget Sound Technical Recovery Team and Shared Strategy Staff Group 2003).

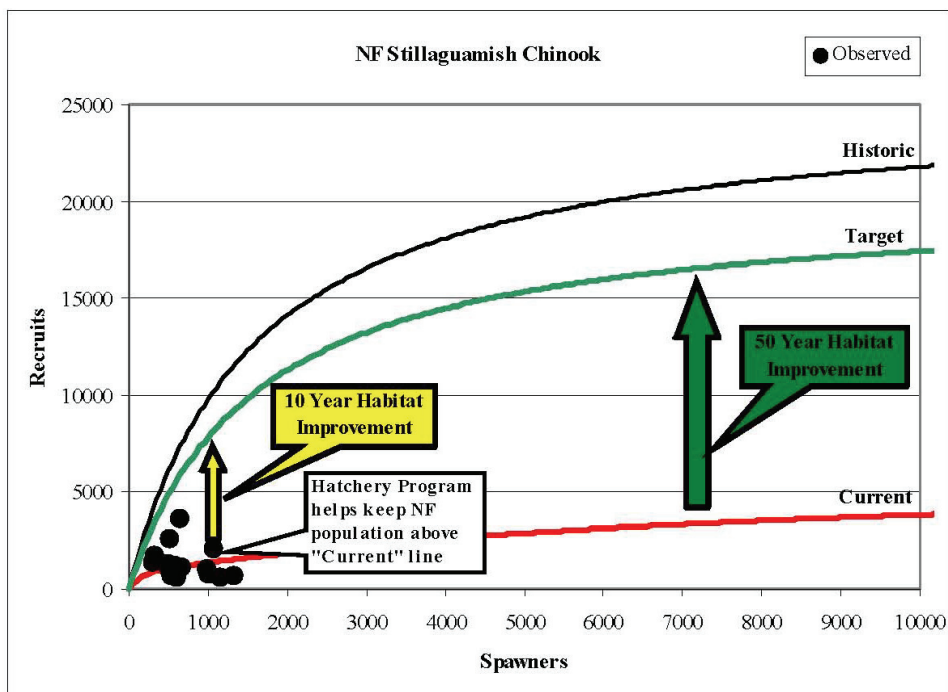
An essential part of this plan is a demonstration of how the actions in habitat, harvest, and hatchery management are expected to work together to bring

about recovery of the populations. Although the benefits of harvest management (i.e., increased escapement) are realized almost immediately, significant increases in habitat productivity will take decades to occur. The best evaluation of whether habitat protection and restoration efforts are successful or not in the Stillaguamish Watershed will be if increases in Chinook salmon population productivity occurs over time. The planning targets for Stillaguamish Chinook salmon populations reflect a condition of restored habitat and a range of harvest scenarios. As long as habitat conditions are restored to planning target levels, that habitat, along with harvest management, will provide VSP consistent with recovered populations.

In the Stillaguamish Watershed, the inter-relationship between habitat, harvest, and hatchery management can be examined by looking at the effects of various recovery actions on the populations under different scenarios. The current status and recovery targets for the two Stillaguamish Chinook salmon populations can be expressed graphically in terms of spawner-recruit curves from the output of Ecosystem Diagnosis and Treatment (EDT) modeling (Figure 17). This figure shows the current status, recovery target, and historic population numbers for the North Fork Stillaguamish Chinook population.

As demonstrated in the spawner-recruit curve, there is an upper limit on the number of fish the system can produce under any particular scenario. This upper limit is based on habitat condition limitations. It follows, then, that the way to increase the upper limit is to improve habitat conditions.

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



The integration of the habitat, harvest, and hatchery recovery components of the plan are driven by the monitoring status of the two Stillaguamish Chinook salmon populations. Consistent negative changes over time in the trends in abundance of the two populations will initially trigger short-term adaptive management modifications to the hatchery and harvest management plans. These two components of the plan can be modified the most quickly and will potentially show a more immediate population response, in comparison to changing habitat restoration activities. It is imperative that immediate measures are taken in order to maintain effective population size. Habitat restoration measures are likewise important, but can take longer to become effective.

Adaptive harvest management triggers have been established for declining escapements so that should the total (both North Fork and South Fork) Stillaguamish Chinook salmon escapement drop below the critical threshold of 650 fish, fisheries will be managed to either achieve the critical exploitation rate ceiling, or exceed the low abundance threshold. The short-term strategy is to harvest at less than the maximum sustainable harvest rate so as not to impede recovery.

In addition to these harvest management triggers, the hatchery program adaptive management plan is set up to respond to steadily declining trends, over several years, in North Fork Chinook salmon escapement to below 500

natural origin spawners. Recently completed DNA analysis of the South Fork Chinook salmon population has indicated that “ the South Fork Stillaguamish fall run of Chinook is not at genetic risk requiring immediate remediation in a new hatchery program. A restoration program should be considered when the long term (1986-present) harmonic mean run size drops to 180 fish per year, which would equate to an escapement of 100 adults per year for each year from 2005-2011 (Spidle, unpublished data; Appendix G). Should either of the populations decline to these levels, the co-managers would develop plans to either activate or expand natural stock restoration programs to provide enough natural origin hatchery releases to maintain the population above the critical threshold based on current survival estimates. In addition, to meet HSRG guidelines on broodstock mining and to avoid the founder effect and inbreeding depression concerns, no more than 25% of the run will be used for broodstock annually. The exception to this target would be a catastrophic decline in the population that endangered its immediate survival, in which case genetics specialists would be consulted to determine the appropriate broodstocking level.

While further reductions in harvest rates and increasing the output of hatchery natural restoration smolts is expected to bring the population above the critical low abundance threshold in the short-term, additional habitat restoration activities will need to be implemented to improve the productivity of naturally spawning fish. The currently proposed recovery plan relies in a significant way on the improvement of habitat conditions to improve productivity, capacity and equilibrium abundance. Productivity, or recruits per spawner, is determined primarily by freshwater, estuarine, and marine survival related to habitat conditions. Adaptive management of habitat restoration and protection is driven by the assessment of which component(s) of the freshwater and estuarine habitats are not meeting plan goals and objectives for implementation or effectiveness or are indicative of unsupported assumptions or hypotheses about watershed, riparian, in-channel, or estuarine function in the Stillaguamish Watershed. Ecological conditions can be re-assessed regularly by using Ecosystem Diagnosis and Treatment (EDT) modeling with new effectiveness assumptions and new actions in new recovery scenarios.

The recovery trigger/goal for modifying the North Fork hatchery natural stock restoration program is to see four consecutive years of increasing natural origin escapements over 700 into the North Fork Stillaguamish and its tributaries. The 700 NOS target was based on setting an escapement number above the 500 NOS minimum escapement low abundance threshold included in the 2004 Puget Sound Harvest Management Plan. That 500 NOS harvest management target was set based on several studies that indicated that annual escapements below 500 NOS's would pose a risk for the population (Allendorf et al. 1997; McElhany et al. 2000; HSRG 2005). The co-managers chose a number above 500 to allow for some protection/buffer in the event

that the population went into steep decline with suspension of the natural stock restoration program.

Habitat improvements and constrained harvest levels should allow the population to recover to self-sustaining levels that support directed harvest in most years. If the Chinook salmon populations show a positive response to habitat recovery efforts, the co-managers will determine the future need and size of Chinook hatchery programs to meet other management objectives such as the U.S./Canada Indicator Stock Study and interim harvest goals.

As the populations recover, the long-term integrated strategy is to continue to monitor abundance and spatial distributions through spawner ground surveys, and productivity through operation of the smolt trap to ensure that all components of the population are improving.

5. Habitat Restoration Strategy

10-Year Habitat Restoration Projects

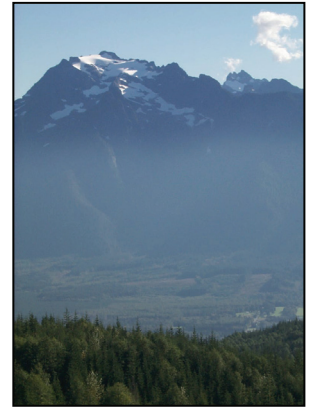
As described in Chapter 4, the SIRC has chosen to pursue an ambitious ten-year recovery strategy in the Stillaguamish Watershed that will result in a projected increase in Chinook salmon populations to 30% of the TRT planning target. Recognizing that there are many uncertainties associated with a strategy over a ten-year time period, such as political, economic, and social support for this strategy, poaching impacts, and natural climatic occurrences, the SIRC agreed to a prioritized list of habitat projects that will benefit Chinook salmon populations throughout the Stillaguamish Watershed. Factors such as feasibility, landowner willingness, permitting, engineering and coordination were considered in developing habitat project lists.

Over 50 projects have been completed in the Stillaguamish Watershed since 1998 to manage and restore Chinook salmon habitat and watershed functions. These have included riparian enhancements, engineered log jams, road decommissioning, landslide hazard mapping, bank stabilization, erosion and sediment control, wetland buffer restoration, and conservation easements.

The Stillaguamish Lead Entity Strategy (Waller and Stevenson 2004) was prepared in 2004 to guide and prioritize future voluntary actions and projects in the watershed for funding by the Washington state Salmon Recovery Funding Board. The Lead Entity Strategy organized habitat restoration projects into six main categories (riparian, estuary, large woody debris, floodplain, sediment, and hydrology), corresponding to the limiting factors for Chinook salmon populations in the Stillaguamish Watershed.

The ten-year habitat restoration strategy adopted by the SIRC reflects the categories and geographic priorities identified in the Lead Entity Strategy. Addressing all habitat categories and watershed processes is essential for salmon recovery efforts to be successful. The habitat management and restoration actions proposed by the Stillaguamish Watershed Chinook Salmon Recovery Plan follow the geographically-based criteria described below for each limiting factor.

The SIRC has prioritized locations within the Stillaguamish Watershed where management or restoration projects would assist in returning properly



The SIRC has chosen to pursue an ambitious ten-year recovery strategy that will increase Stillaguamish Chinook salmon populations to 30% of the TRT planning target.

functioning conditions. Projects are ranked by criteria linked to the overall watershed strategy for Chinook salmon recovery. Priorities for restoration projects focus on key reaches where Chinook salmon are currently productive, including spawning grounds, migration corridors and rearing areas. Some projects will be implemented first in order for subsequent projects to be effective (e.g. reduce upstream sediment sources before creating downstream spawning habitat). However, individual projects identified by the community, such as the Steelhead Haven landslide, are prioritized if they have the potential to address multiple limiting factors.

The SIRC recognizes that some individual habitat restoration actions can have potential liabilities. Impacts on adjacent or downstream properties should be analyzed and addressed in project design and monitored during project implementation. Adjacent property owners and other stakeholders should be informed during feasibility and design phases to ensure broad-based community support and appropriate project design.

Riparian

Riparian Project Types

Potential actions for protecting, restoring, and enhancing ecological functions of the riparian zone include measures listed below:

Overall habitat enhancement:

- Planting native vegetation in the riparian corridor, especially in locations where poor riparian conditions are present
- Streambank stabilization using native plants
- Exclusion of livestock
- Removal and control of noxious weeds
- Pest control measures

Restoring hydrologic processes:

- Inventory and evaluation of existing levees, dikes, roads, and railroads for potential removal, relocation, or vegetation enhancement

Preservation actions:

- Protection of existing riparian corridors with fee-simple or conservation easement acquisition
- Maintenance of existing vegetation communities in the riparian corridor

Riparian Geographic Criteria

Riparian restoration project sites will be selected using one or more of the following criteria:

- Areas where Chinook salmon use is highest or adjacent to these areas
- Potential to restore basic riparian function:

- ♦ reduction in water temperature
- ♦ large wood recruitment
- ♦ bank stabilization
- ♦ cover and nutrients for salmon
- In areas lacking properly functioning riparian forest cover located in upper watersheds that will contribute to the greatest area of downstream conditions for Chinook salmon.
- Predominantly in rural, urban, and agricultural land uses and private ownership.³⁵

Riparian priority areas in the Stillaguamish Watershed are shown on Figure 18.

Approved Riparian Projects

The SIRC approved the following riparian restoration actions, including riparian planting, maintenance, thinning, fencing, and weed control. Projects are listed in the order that they may be implemented, according to the geographic priorities described above.

1. ■ Restore 135 acres in Upper North Fork, Squire Creek, French-Selgelsen subbasin
- Restore 65 acres in Lower South Fork Stillaguamish
2. ■ Restore 65 acres in Middle North Fork Stillaguamish
- Restore 35 acres in Lower South Fork Stillaguamish
3. ■ Restore 65 acres in Middle North Fork Stillaguamish
- Restore 35 acres in Lower South Fork Stillaguamish

Riparian buffers in the upper watershed regulated under the USFS Northwest Forest Plan, the DNR Habitat Conservation Plan, and the Forests and Fish Rules will provide a large percentage of the 8,000 acres needed for properly functioning conditions in the Stillaguamish Watershed. Other portions of the riparian zone throughout the Stillaguamish Watershed are in public ownership under the jurisdiction of Snohomish County, WDFW, the cities of Arlington, Stanwood, Granite Falls, and Darrington, and the Stillaguamish and Tulalip Tribes. SIRC stakeholders have worked with numerous private landowners to install and maintain voluntary buffers of varying widths. Private landowners can also enroll in programs such as the Conservation Reserve Enhancement Program (CREP) to be compensated for taking land out of production to maintain riparian buffers.

³⁵ Effective riparian restoration and management on state, federal and private industrial forestlands is a critical component of salmon recovery in the Stillaguamish. However, this criterion recognizes that most opportunities for community sponsored riparian restoration will not focus on state, federal and private industrial forestlands. Riparian policy and project implementation in these areas are administered according to established forest policies in federal and state laws as well as adopted habitat conservation plans such as the Forests and Fish HCP (see Edwards 2003).

Estuary/Nearshore

Estuary/Nearshore Project Types

Potential actions for restoration and enhancement of lost or degraded estuarine and nearshore habitat areas include measures listed below.

Overall habitat enhancement:

- Restoration or enhancement of blind tidal channels and salt marsh habitats through dike removal and/or setback (Hood 2004)
- Restoration of pocket estuaries
- Shoreline restoration to remove bulkheads and enhance native vegetation
- Construction of log-jams to enhance tidal channel formation in the river delta
- Removal of noxious weeds in the estuarine environment

Restoring hydrologic processes and improving water quality:

- Removal of existing levees, dikes and revetments, where appropriate
- Dike setbacks to restore tidal processes and re-establish cut-off sloughs
- Tide gate retrofits
- Reduction of pollutants entering the estuary

Preservation actions include the following:

- Protection of functioning estuary, pocket estuary, and marine shoreline habitats
- Purchase of fee-simple or conservation easements on estuary and marine shoreline property

Estuary/Nearshore Geographic Criteria

Restoration project sites in estuaries and the nearshore will be selected using one or more of the following criteria:

- Transition zones from fresh water to salt water, migratory corridors, opportunities to escape predators, and foraging opportunities for Chinook salmon
- Adjacent to areas subject to frequent tidal or seasonal flooding
- Shoreline areas that border Chinook salmon migration routes
- Evidence of historic blind tidal channel or salt marsh habitat
- Exhibit sustainable project development attributes:
 - ◆ large parcels
 - ◆ parcels with less development and utility infrastructure
 - ◆ transportation or flood control structures
 - ◆ parcels with marginal economic use that may improve through habitat restoration

Estuary priority areas in the Stillaguamish Watershed are shown on Figure 18.

Approved Estuary/Nearshore Projects

The SIRC approved the following estuarine actions, including estuary restoration through dike setback and channel reconfiguration, estuary creation by placing large wood in tidal areas, and increasing blind tidal and distributary channels for Chinook salmon. Projects are listed in the order that they may be implemented, according to the geographic priorities described above.

1. ▪ Restore 115 acres of salt marsh estuarine habitat including 18 acres of blind tidal channel habitat at Leque Island
2. ▪ Restore 80 acres of salt marsh estuarine habitat at The Nature Conservancy property
3. ▪ Attempt to create 120 acres of salt marsh estuarine habitat by placing 10 engineered log jams on the mud/sand flats (experimental pilot project: to be monitored by adaptive management process)

Potential Estuary/Nearshore Projects

Restoration and protection of nearshore pocket estuary sites in Port Susan is needed for the recovery of Stillaguamish Chinook salmon and bull trout populations. However, there are only a few potential pocket estuary restoration sites in WRIA 5. Most of the significant pocket estuary restoration opportunities are located within the Lower Skagit River basin (WRIA 4), Island County (WRIA 6), and the Snohomish River basin (WRIA 7). Therefore, it is recommended that in addition to pursuing nearshore and pocket estuary restoration in WRIA 5, the SIRC and TAG coordinate with WRIs 4, 6 and 7 to promote and support nearshore and pocket estuary protection and restoration actions throughout Whidbey Basin and especially in Port Susan and Skagit Bay. This coordination could include the following SIRC and TAG actions:

- Review and understand the Port Susan and Skagit Bay nearshore elements of the WRIA 6 and WRIA 7 salmon conservation plans;
- Explore opportunities to support protection and restoration nearshore projects in WRIs 4, 6 and 7;
- Support studies that improve scientific knowledge of the Whidbey Basin nearshore habitat conditions and how they influence the recovery of natal and non-natal salmonid populations; and
- Support public education, outreach, and technical assistance that addresses the need for Port Susan and Skagit Bay nearshore habitat protection and restoration.

Large Woody Debris (LWD)

Large Woody Debris Project Types

Habitat enhancement:

- Placement of engineered log-jams and or individual wood pieces in mainstem rivers to enhance instream habitat
- Use of large wood revetments or smaller structures to stabilize streambanks or attenuate landslides
- Enhancement of riparian features in locations where poor riparian conditions are present

Preservation actions:

- Purchase of fee simple or conservation easements to protect existing riparian function
- Retention of mature forest characteristics in floodplain and stream corridors

Large Woody Debris Geographic Criteria

Large woody debris project sites will be selected using one or more of the following criteria:

- Areas where Chinook salmon use is highest or adjacent to these areas
- Promote effective restoration of Chinook salmon habitat upstream of the confluence of the North and South Fork Stillaguamish Rivers.³⁶:
 - ◆ side channel connections
 - ◆ pool development
 - ◆ in-channel cover
- Sites where placement of large wood will also work to prevent chronic landslides.
- Reaches where instream refugia are needed.
- Reaches where placing LWD will not jeopardize personal safety of residents or cause damage to private property.

Large woody debris priority areas in the watershed are shown on Figure 20.

Approved Large Woody Debris Projects

The SIRC approved the following large woody debris actions, including large wood placement in stream channels to increase pools, roughness, flow variability, scour, and habitat types for Chinook salmon. Projects are listed in the order that they may be implemented, according to the geographic priorities described above.

³⁶ Areas upstream of the confluence present more favorable floodplain connectivity and instream conditions that make large wood placement more likely to produce habitat benefits. While the Lower Stillaguamish floodplain lacks significant wood, it has more hardened banks that decrease the effectiveness of wood placement.

1.
 - 5 engineered log jams (ELJs) in Lower South Fork-Upper (SF 3)
 - 10 ELJs in French Segelsen and Middle North Fork (NF 7 & 4)
 - 2 ELJs at North Meander
 - 2 ELJs at Smokes Farm
2.
 - 6 ELJs in Lower South Fork (SF 2)
 - 9 ELJs in Lower North Fork (NF 2 & 3)
 - 2 ELJs in North Fork (NF 3 & 5)
3.
 - 9 ELJs in Lower North Fork (NF 2 & 3)
 - 6 ELJs In Lower South Fork (SF 3)

Floodplain

Floodplain Project Types

The natural dynamics of a watershed are dependent on a natural rate of stream meandering for recruitment of large woody debris (LWD), sediment management for spawning gravels, and side channel habitat development. These dynamics are necessary at a certain level for natural watershed processes to be restored. Actions that may be utilized to improve floodplain conditions include:

- Restoration of fish access to abandoned side channels and sloughs
- Re-connection of floodplains and forested wetlands to main river channels
- Dike setback and excavation to achieve either of the above

Floodplain Geographic Criteria

Floodplain restoration project sites will be selected using one or more of the following criteria:

- Provide peak flow refugia and juvenile rearing and adult holding capacity at a normal range of stream flows
- Promote instream connectivity between existing intact floodplain habitats
- Restore floodplain functions directly downstream of key spawning areas to improve conditions for all juveniles and particularly stream-type Chinook salmon
- Provide flood storage and mitigate peak flows consistent with the Stillaguamish River Comprehensive Flood Hazard Management Plan
- Identified by willing landowners where hardened banks may be removed
- Owned by existing public entities or conservation organizations
- Low risk to life or property
- Marginal economic uses that may increase through restoration
- Threatened by development

Floodplain priority areas in the watershed are shown on Figure 19.

Approved Floodplain Projects

The SIRC approved the following floodplain restoration actions including dike setbacks, channel re-configuration, and creation of off-channel habitat. Projects are listed in the order that they may be implemented, according to the geographic priorities described above.

1. ▪ Restore 10 acres of new side channel at North Meander and Smokes Farm
2. ▪ Restore 14 acres of new side channel in Lower and Middle North Fork Stillaguamish
3. ▪ Restore 6 acres of new side channel in Lower South Fork Stillaguamish
4. ▪ Remove 4.1 miles of bank armoring in North and South Fork Stillaguamish

The SIRC will look for additional opportunities to include removal of hardened bank throughout the watershed in other types of projects, such as those addressing flood hazard management. If bank stabilization is preventing available side channel flood relief and juvenile Chinook flood refuge, and other approaches are acceptable to the current landowners, bank armoring removal is recommended. Future outreach and stewardship efforts will inform landowners of the importance of removing bank armoring throughout the watershed. Information on alternative methods of bank stabilization should also be provided to landowners.

Sediment

Sediment Project Types

Restoration of natural sediment regimes must address sediment sources where mass wasting or land use activities route fine sediment directly to streams. Potential actions to restore natural sediment regimes include the following:

- Engineered slope stabilization to reduce direct inputs from chronic and deep-seated landslides that are active near main river channels
- Targeted road decommissioning and treatment
- Wetland restoration to stabilize small tributary sediment regimes
- Plant riparian vegetation and add LWD to protect and stabilize streambanks

Sediment Geographic Criteria

Sediment project sites will be selected using one or more of the following criteria:

- Where sediment routing has been documented from landslides or road networks

- In areas identified by landslide hazard zoning maps
- In subbasins with road densities greater than 2 miles of road per square mile in conjunction with greater than 5% of the total road network on unstable geology and traversing steep slopes

Sediment priority areas in the watershed are shown on Figure 20.

Approved Sediment Projects

The SIRC approved the following sediment actions including forest road treatment and decommissioning, and landslide remediation to improve embeddedness, turbidity and fine sediment. Projects are listed in the order that they may be implemented, according to the geographic priorities described above.

1.
 - Landslide remediation at Steelhead Haven - Lower North Fork
 - Landslide remediation at Gold Basin - Lower South Fork
 - Treat 48 miles of roads in Upper North Fork (federal, state, and private)
 - Treat 5 miles of roads in the French-Segelsen subbasin (federal only)
 - Treat 11 miles of roads in Deer Creek subbasin (state, private)
 - Treat 6 miles of roads in Middle North Fork (state, private)
 - Treat 12 miles of roads in the Upper Canyon Creek subbasin (federal)
 - Treat 7 miles of roads in the Robe Valley subbasin (federal)
 - Treat 4 miles of roads in the Robe Valley subbasin (state, private)
 - Treat 3 miles of roads in the Lower Canyon Creek subbasin (state, private)

Forest road treatment options range from storm-proofing to total road obliteration, where the entire road prism is removed. Sediment reduction and transport of water to natural channels is the primary objective. Many forest roads were built by old standards and are brought up to current standards. In most cases, culverts are replaced, upgraded, or removed, side-cast material is pulled back, and ditches are maintained to carry water to the next natural channel. Installation of numerous cross drains is another solution to sediment and water problems. At a minimum, removing culverts can save roads from being completely washed out in the absence of ongoing maintenance. Responsible agencies have standards for different types of road decommissioning projects, which may include re-vegetation, based on existing conditions. The SIRC supports coordination among the appropriate agencies and stakeholders to ensure the success of these road treatment and decommissioning projects.

Hydrology

Hydrology Project Types

The following actions have the potential for improving hydrological conditions in the Stillaguamish Watershed:

- Restoration of floodplains, including wetlands, to increase infiltration, slow runoff, and reduce downstream peak flow impacts
- Development of plans in forested regions that target the reduction of road density and de-commissioning of under-utilized forest roads
- Improve the age class and cumulative acres of forested land cover
- Identification of optimum instream flow levels and actions to reduce water consumption throughout the watershed.

Hydrology Geographic Criteria

Hydrology project sites will be selected using one or more of the following criteria:

- Floodplain and wetland restoration in higher elevation watersheds upstream of Chinook salmon spawning areas impacted by peak flows
- Forest protection strategies in the rain-on-snow zone (1000–3000 feet elevation)

Hydrology priority areas in the watershed are shown on Figure 19.

10-Year Habitat Project Costs

A summary of habitat projects, with estimated cost information, included in the SIRC's approved 10-year strategy, is shown in Table 10.

Table 10. SIRC 10-Year Watershed Goal: Habitat Project Costs

Project Type	Units	Quantity	Cost/Unit	Total Costs
Riparian	Acres Planted	400	\$7,500	\$3,000,000
Estuary	Acres Restored	195	\$20,000	\$3,900,000
	Acres Created	120	\$6,700	\$804,000
Large Wood	Engineered Log Jams	51	\$67,000	\$3,417,000
Floodplain	Acres Restored	30.0	\$100,000	\$3,000,000
	Armoring Removed	4.1	\$250,000	\$1,025,000
Sediment	Landslide Treatments	2	\$2,250,000	\$4,500,000
	Forest Road Treatment (miles)	106	\$30,000	\$3,180,000
Acquisition	Acres Acquired	1445	\$6,000	\$8,670,000
Subtotal				\$31,496,000
+40% Contingency & Inflation				\$12,598,400
Total				\$44,094,400

These costs can include acquisition or compensation if necessary, depending on the wants of the public or private landowner. As stated earlier, most salmon recovery funding at this time comes from the Washington State Salmon Recovery Funding Board. The CREP program pays farmers for cropland taken out of production while a buffer is planted to restore the riparian zone. Many of the landowners in the Stillaguamish valley value the forests, streams and wildlife and want to participate in the restoration process voluntarily, but compensation will be considered when appropriate.

Figure 18. Riparian and Estuary Priority Areas.

Figure 19. Floodplain and Hydrology Priority Areas

Figure 20. Large Wood and Sediment Priority Areas.

Anticipated Results

Table 11 presents EDT model results for current conditions, the SIRC watershed goal, properly functioning conditions, the Shared Strategy target, and historical conditions (Mobrand Biometrics 2004).

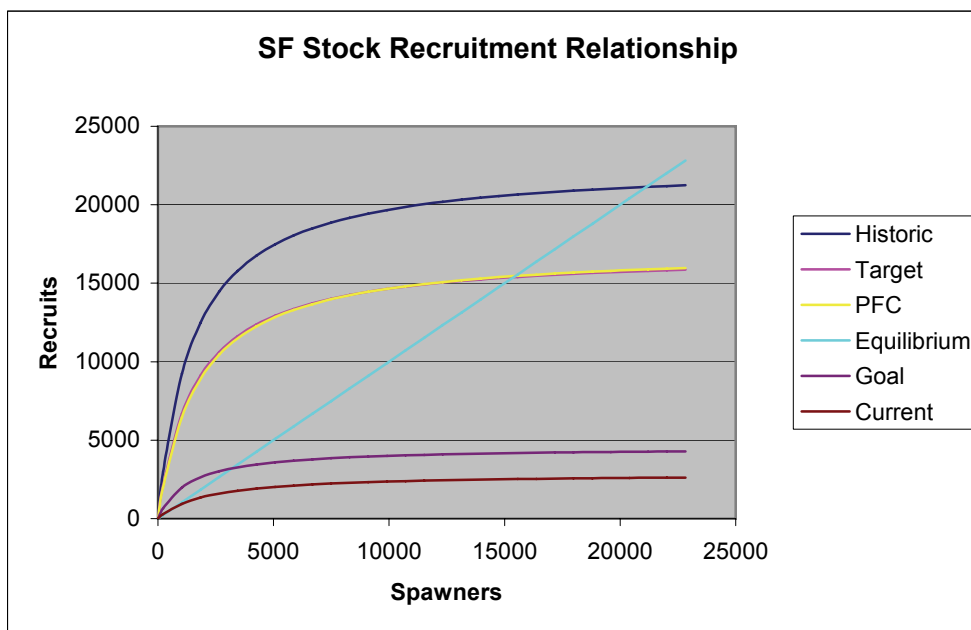
Table 11. Chinook salmon population performance for a range of habitat conditions (Mobrand Biometrics 2004)

Scenario	Chinook Population	Life History Diversity	Intrinsic Productivity	Capacity	Equilibrium Abundance
Current	South Fork	45%	1.4	3,028	861
10-Year Goal	South Fork	79%	3.4	4,543	3,196
PFC	South Fork	100%	10.0	17,170	15,460
Target	South Fork	100%	10.7	16,973	15,387
Historical	South Fork	100%	15.1	22,638	21,141
Current	North Fork	58%	2.7	3,839	2,430
10-Year Goal	North Fork	86%	5.4	7,316	5,950
PFC	North Fork	100%	10.6	19,297	17,482
Target	North Fork	100%	11.9	19,435	17,795
Historical	North Fork	100%	15.6	26,725	25,012

Figures 21 and 22 graphically represent the expected results of the 10-year strategy on the two Chinook salmon populations in the Stillaguamish Watershed (Mobrand Biometrics 2004).

The short-term (10-year) goal for South Fork Stillaguamish Chinook salmon is an equilibrium abundance of 3,196 spawners. Assuming that the South Fork population has been self-sustaining under the current degraded habitat conditions and harvest management guidelines, this population should respond in a positive manner to the implementation of the proposed habitat improvements. The population should show an increase in both abundance and productivity as the fish take advantage of a broader range of habitat conditions. As the population increases, a response in the distribution of spawners over a larger geographic range and time period should be anticipated. This assumption has been documented with the transfer of west coast Chinook salmon to the Great Lakes region and New Zealand (Quinn et al. 2000).

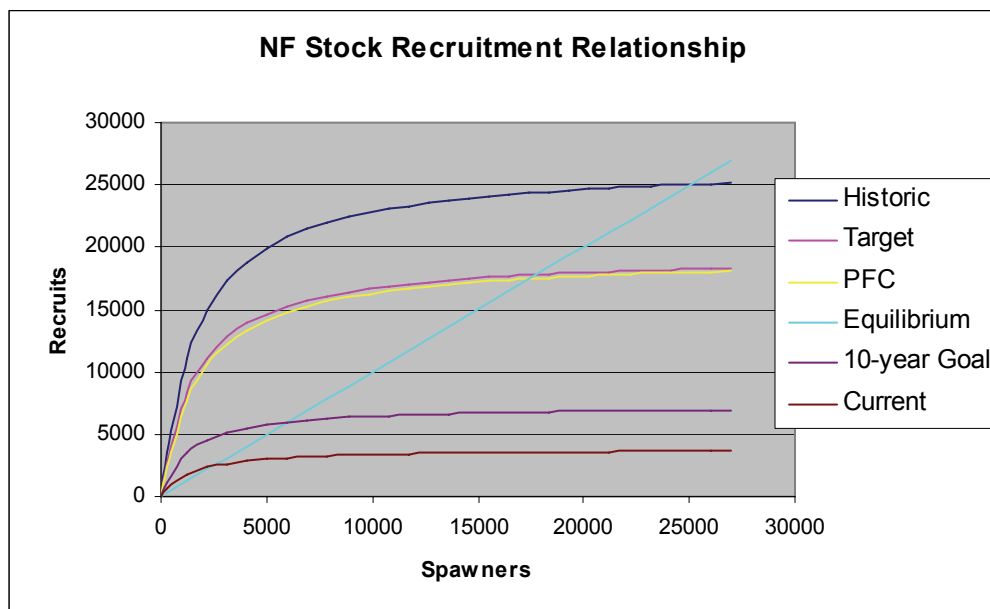
Figure 21. South Fork Population Performance



The long-term (11-50 years) goal for South Fork Stillaguamish Chinook salmon is an equilibrium abundance of 15,387 spawners. That equilibrium abundance will be achieved through the implementation of additional habitat restoration plans. If the co-managers determine that the South Fork population is not self-sustaining or does not respond positively to the habitat restoration activities, a natural stock hatchery restoration program would be considered under an adaptive management scenario.

The short-term (10-year) goal for North Fork Stillaguamish Chinook salmon is an equilibrium abundance of 5,950 spawners. This population should respond in a positive manner to the implementation of the proposed habitat improvements in the North Fork Stillaguamish. The population should show an increase in both abundance and productivity as the fish take advantage of a broader range of habitat conditions.

Figure 22. North Fork Population Performance



The long-term population planning target for North Fork Chinook salmon is an equilibrium abundance of 17,795. These fish will be distributed throughout the known historic range of usage for both the mainstem North Fork and its tributaries with a population productivity (11.9) sufficient to support terminal area fisheries in most years.

Long-Term Habitat Restoration Projects

Following the implementation of restoration projects outlined in the SIRC's approved 10-year strategy, the watershed will reach approximately 30% of properly functioning conditions and the Chinook salmon population target. In years 11-50, the restoration actions shown in Table 12, if fully implemented, should result in reaching both the properly functioning conditions and population targets for the watershed. All restoration efforts are contingent upon protecting existing habitat using a combined enforcement and incentive program, and assume natural oceanographic conditions and predictable harvest and natural predation levels.

Table 12. Habitat project costs, years 11-50

Project Type	Units	Quantity	Cost/Unit	Total Costs
Riparian	Acres Planted	7600	\$7500	\$57,000,000
Estuary	Acres Restored	1,055	\$20,000	\$21,100,000
	Acres Created	650	\$6,700	\$4,355,000
Large Wood	Engineered Log Jams	11	\$67,000	\$737,000
Floodplain	Acres Restored	120	\$100,000	\$12,000,000
	Armoring Removed	18	\$250,000	\$4,500,000
Sediment	Landslide Treatments	8	\$2,250,000	\$18,000,000
	Forest Road Treatment	424	\$30,000	\$12,720,000
Acquisition	Acres Acquired	5780	\$6,000	\$34,680,000
Subtotal				\$165,092,000
+40% Contingency and Inflation				\$66,036,800
Cost for Years 11-50				\$231,128,800
Cost for Years 1-10 (from Table 10)				\$44,094,400
SIRC 50 Year Plan Total Costs				\$275,223,200

Stakeholders for Implementation

A wide variety of Stillaguamish Watershed stakeholders are capable of implementing the habitat projects described above. These agencies and organizations were influential in the development of the project concepts through the SIRC and will be involved in implementation of project actions, as well as overseeing progress toward the overall goals of this plan. Implementing the habitat project actions identified in this chapter will require commitments from a number of stakeholder organizations. In many cases, meeting these commitments will require certain conditions such as funding from federal or state sources, willing landowner support, permitting, technical assistance, or a formal public review process. These commitments and conditions will evolve over time with ongoing analysis and coordination related to on-the-ground project actions. Assumed capabilities and past project implementation experience of habitat restoration project stakeholders are shown below (subject to refinement):

- Snohomish County – All project types
- Stillaguamish Tribe – All project types
- Tulalip Tribe – All project types

- Washington Department of Fish and Wildlife – Estuarine wetland restoration, fish passage improvements, riparian fencing, re-vegetation, off-channel rearing, technical assistance
- Stillaguamish Flood Control District – Estuarine, floodplain, riparian
- Snohomish Conservation District – Forest road treatment, riparian, floodplain, best management practices
- U.S. Forest Service – Forest road treatment and hydrology
- Washington Department of Natural Resources – Forest road treatment and hydrology
- Adopt-A-Stream - Riparian
- Stilly-Snohomish Fisheries Enhancement Task Force – Riparian, floodplain, side channels, LWD, estuarine projects
- Stillaguamish Tribe Banksavers - Riparian
- Ducks Unlimited – Estuarine
- The Nature Conservancy – Estuarine
- City of Arlington – Hydrology, riparian, floodplain
- Department of Ecology – TMDLs, water quality issues
- Private landowners – All project types

6. Habitat Protection Strategy

Existing Habitat Protection Actions

The following is a brief description of the jurisdictions or agencies in the Stillaguamish Watershed that have adopted regulatory or programmatic actions to protect those habitat functions necessary to recover sustainable populations of Chinook salmon. Table 13 is a summary of the various jurisdictions' and agencies' existing habitat protection actions, as linked to the six limiting factors for Chinook salmon in the Stillaguamish Watershed.

City of Arlington

- GMA Comprehensive Plan (developing 10-year update in 2005)
- Critical Areas Regulations
- Land use codes

City of Stanwood

- GMA Comprehensive Plan (developing 10-year update in 2005)
- Critical Areas Regulations
- Land use codes

Snohomish County

- GMA Comprehensive Plan (developing 10-year update in 2005)
- Critical Areas Regulations (under revision in 2005)
- Shoreline Master Plan (scheduled for update in 2005)
- Land use codes

Skagit County

- GMA Comprehensive Plan (developing 10-year update in 2005)
- Critical Areas Regulations
- Shoreline Master Plan
- Land use codes

Washington Department of Ecology

- Developing TMDL water quality plans
- Instream flow rule setting
- Wetlands protection regulations



Without protecting existing habitat functions, restoration activities cannot reverse the decline in Chinook salmon populations.

Washington Department of Fish and Wildlife

- Hydraulic Project Approval permits
- Enforcement officers

Washington Department of Natural Resources

- Habitat Conservation Plan (for state managed lands)
- Forest and Fish Rules (for private forestry)

U.S. Forest Service

- Northwest Forest Plan

Table 13. Relationship of Chinook salmon habitat protection to limiting factors

Jurisdiction/ Agency	Riparian	Estuary	Large Woody Debris	Floodplain	Sediment	Hydrology
City of Arlington	✓			✓	✓	✓
City of Stanwood		✓		✓		
Snohomish County	✓	✓		✓		✓
Skagit County	✓			✓		
WA State Department of Ecology		✓		✓	✓	✓
WA Department of Fish and Wildlife		✓	✓			✓
WA Department of Natural Resources	✓		✓	✓	✓	✓
US Forest Service	✓		✓	✓	✓	✓

Habitat Protection Tools

Protecting existing, functioning habitat in the Stillaguamish Watershed is absolutely necessary to ensure recovery of Chinook salmon populations. The current and future status of Chinook salmon in the watershed depends on protecting the remaining places where good habitat functions still exist. High quality habitat increases salmon population productivity which, in turn, helps maintain adequate numbers. Without protecting existing habitat functions, restoration activities cannot reverse the decline in Chinook salmon

populations. In addition, protection of existing habitat is cost-effective and provides a degree of certainty to achieving salmon recovery objectives.

Protection can be achieved with a variety of tools that provide different levels of certainty for specific habitat attributes and long-term benefits to the environment. It is important to utilize a variety of protection strategies to meet the overall needs of the watershed, as well as to match site-specific conditions. The SIRC has emphasized its desire for a comprehensive approach that balances protection of Chinook salmon habitat with preservation of private property rights. This balance can be achieved through use of a variety of regulatory tools and incentive-based voluntary actions. According to stakeholder interests and landowner needs, a mix of both regulatory and non-regulatory tools should be used in achieving salmon recovery objectives in the Stillaguamish Watershed.

The goal of the strategies described in this section is to protect existing salmon habitat throughout the Stillaguamish Watershed to ensure no net loss and to prevent further degradation. There are a number of policy, regulatory, and programmatic approaches that may be utilized for protection of salmon habitat to achieve recovery objectives. The following are potential mechanisms that would be beneficial to salmon recovery efforts in the Stillaguamish Watershed. Each of these is addressed in more detail below.

- Non-regulatory and programmatic actions, such as incentive-based approaches
- Integration of salmon recovery goals and objectives with local comprehensive plans and land use policies
- Compliance and enforcement of existing regulations
- Revisions to existing regulations or adoption of additional regulatory requirements as necessary

Incentives and Non-Regulatory Approaches

Incentives such as financial, public relations, social, or cultural rewards can be used to encourage positive actions that contribute to salmon recovery and watershed protection efforts. Incentives are often less expensive than investments in costly capital facilities, and provide watershed stakeholders with recognition for their good stewardship. Recovery of listed salmon species and removal from the ESA list will reduce landowner costs through expedited permit processes and by no longer requiring preparation of project-related biological assessments.

The following are some potential incentives and other innovative approaches that may be utilized to achieve salmon recovery and watershed protection objectives:

- Develop or continue programs that allow tax reductions for protection and restoration of riparian and forested areas. Examples of eligible activities may include setting aside buffers larger than those required by critical areas regulations, and enhancing degraded riparian buffers or open space parcels.
- Promote recognition programs for local farmers and other landowners to encourage active stewardship and participation in salmon recovery efforts.
- Provide financial incentives and technical assistance for ecologically sensitive alternatives to bank armoring. Snohomish County's Cooperative Bank Stabilization Program provides technical assistance and some material costs. Landowners are responsible for project permitting and construction.
- Promote streamlined permitting processes for restoration projects and for rural residential landowners who plan to develop or re-develop their lots if they agree to engage in voluntary stewardship activities.
- Use transfer or purchase of development rights programs to protect forest cover and minimize development of impervious surfaces. These programs allow willing rural landowners to sell unused development rights to property owners in urban areas, helping to preserve rural land uses and densities, as well as retain agricultural and forest lands in the watershed. Snohomish County and the City of Arlington have a transfer of development rights pilot program.
- Encourage implementation of recovery actions by qualifying implementing agencies for state and federal grant and loan programs.
- Develop incentives to reduce or minimize impervious surfaces through the use of low impact development techniques to reduce stormwater runoff.
- Offer reduction in stormwater fees for those landowners who build and maintain stormwater drainage systems that exceed minimum regulatory requirements.
- Develop incentives to promote water conservation throughout the watershed.
- Create other innovative programs to provide regulatory flexibility and encourage stewardship by individual land owners.

Comprehensive Plans and Policies

Comprehensive plans and policies provide a broad framework that can be used in developing and implementing salmon recovery plans. Planning policies related to salmon habitat include those for natural resources, protection of environmentally sensitive areas and open space, agriculture, and to an extent, transportation. However, as related to protection of salmon habitat, potential conflicts may be found between comprehensive plan policies. For example, preservation of sensitive fish habitat may conflict with designated land uses or densities, agricultural uses, economic development initiatives, or siting of essential public facilities.

Local governments should review and revise their comprehensive plans and policies to incorporate the objectives of salmon recovery planning. Revision of these policies may prioritize salmon habitat protection through conserving resource lands and open space areas, minimizing land use patterns that encourage urban sprawl, and maintaining economic development that supports processing and marketing the capacity of local natural resource production.

Following are some additional recommendations regarding comprehensive plans and policies related to salmon habitat protection:

- Revise existing policies and incorporate new policies to specifically address protection of salmon habitat.
- Incorporate higher levels of salmon habitat protection (such as livestock or vegetation management guidelines) into applicable policies.
- Adopt county or city comprehensive plan goals that integrate salmon recovery objectives with critical areas protection, forest cover retention, habitat connectivity, stormwater management, open space planning, and parks and recreation.
- All cities, counties, state and federal agencies, tribes, and other stakeholder organizations in the Stillaguamish Watershed should adopt policies and objectives to protect and restore salmon habitat and watershed processes. Specific actions supporting these policies and objectives may include:
 - ◆ Support low-density/low impact land uses in rural areas outside of urban growth areas;
 - ◆ Protect and restore appropriate riparian areas;
 - ◆ Maintain and restore natural streambank conditions;
 - ◆ Protect and restore natural watershed functions in the floodplain and channel migration zone;
 - ◆ Retain large woody debris in streams to support salmon habitat and restore natural watershed processes;
 - ◆ Eliminate existing fish passage barriers such as culverts and tide gates and prevent the creation of new barriers;
 - ◆ Achieve no net loss of wetland functions and values, and restore degraded wetlands where possible;
 - ◆ Avoid cumulative adverse impacts to streams, riparian corridors, and wetlands throughout the watershed; and
 - ◆ Address salmon habitat protection in management plans for natural areas and open spaces.

Land Use Recommendations

Agriculture

Working with these landowners is a critical piece of a comprehensive salmon recovery effort in the watershed. The SIRC has developed a cooperative and collaborative approach to involve Stillaguamish farmers in watershed issues, including salmon habitat protection and restoration. Ongoing efforts to work with this important community should include the following:

- Support policies and programs that contribute to profitable and sustainable agriculture.
- Retain the infrastructure necessary to support sustainable agricultural land potential.
- Avoid subdividing of agricultural land.
- Purchase conservation easements where appropriate from willing sellers.
- Install vegetated riparian buffers, utilizing funding from the Conservation Reserve Enhancement Program, discretionary funds, local cost-share programs, and other sources.
- Provide technical assistance, incentives, cost sharing, and recognition to help implement on-the-ground projects (e.g. removing/replacing culverts or other fish passage barriers; restoring stream banks to natural conditions; livestock fencing).
- Identify the needs and differences between the regulated commercial agricultural community and non-regulated hobby farmers.

Forestry

Approximately three-quarters of the Stillaguamish Watershed is in forestry land uses. The following are recommendations for salmon habitat protection on forestlands under various ownership, including federal and state lands, large commercial lands, and private rural forestlands:

- Protect intact forest lands and minimize forest cover loss.
- Maintain viable forest lands through sustainable forestry.
- Support land use policies that keep forest lands in forestry production.
- Discourage conversion of forest lands to residential development.
- Encourage development of forest stewardship plans, transfer/purchase of development rights, and acquisition to protect and restore forest cover.
- Acquire forested parcels providing high benefit to salmon habitat through fee or easement or acquiring harvest rights.
- Provide education and technical assistance to small forestry operations and private rural forest landowners.

- Utilize monitoring results in an adaptive management process to develop and refine recommended actions.

Rural Residential and Urban Land Use

Rural residential areas make up a large percentage of the Stillaguamish Watershed. These lands are outside of Urban Growth Area (UGA) boundaries and areas zoned for commercial or industrial use. Urban areas in the watershed include the cities of Arlington, Stanwood, and Granite Falls and their associated UGAs, as well as a portion of the Darrington UGA. State and local laws require the protection of existing environmental functions in both urban and rural areas. Focusing growth in existing urban areas will protect remaining habitat in the rural areas of the watershed. Retention of rural land uses is critical to achieving salmon recovery objectives.

Rural residential and urban development can result in decreased forest cover and increased impervious areas, including roads, parking lots, roofs, and driveways. These activities contribute to reduced natural infiltration and evapotranspiration and increased stormwater runoff, which cumulatively lead to degraded hydrologic functions, sediment transport processes, and in-stream habitats. The following are recommendations for rural residential and urban land uses to protect salmon habitat and watershed processes:

- Avoid expansion of Urban Growth Area Boundaries adjacent to critical Chinook salmon habitat areas.
- Avoid creation of high-density residential developments or commercial centers outside established urban growth areas.
- Focus growth and development where infrastructure already exists.
- Protect existing wetlands, riparian areas, forest cover and other habitat areas where possible.
- Encourage higher densities and cluster development in urban areas and away from riparian corridors and wetlands to allow for maximum build-out of developable lands and to maintain maximum forest cover.
- Enforce clearing and grading and tree retention regulations for new development and site alterations.
- Minimize new impervious surfaces and implement low impact development practices to maintain hydrologic function.
- Develop urban forestry programs to retain existing trees, encourage planting, and engage volunteers.
- Provide education and technical assistance to landowners on natural yard care and gardening practices.
- Utilize monitoring results in an adaptive management process to develop and refine recommended actions.

Roads and Utilities

Siting roads and utility corridors across streams, wetlands, riparian and wetland buffers can degrade salmon habitat and restrict fish passage. The following are recommendations to reduce the impacts of these activities on salmon habitat:

- Avoid or minimize effects of existing and future roads on critical areas.
- Apply best available science in construction and maintenance of roads and utilities that minimizes riparian, floodplain, and water quality impacts.
- Develop road mitigation practices consistent with salmon recovery goals.
- Identify alternative siting or designs that reduce impacts to critical areas.
- Limit expansion of urban infrastructure beyond urban growth areas.
- Site new infrastructure away from riparian areas, channel migration zones, and marine shorelines.
- Prevent new barriers to anadromous fish passage.

Regulatory and Programmatic Actions

A variety of regulatory and programmatic tools may be applied for protection of salmon habitat and watershed processes. These include local Growth Management Act land use regulations and programs, as well as other state and federal regulations such as the Shoreline Management Act, Department of Natural Resources' Habitat Conservation Plan (HCP), Clean Water Act, Fish and Forest Rules, and the Northwest Forest Plan. Environmental regulations should be used wherever applicable to provide the necessary levels of protection, but should also be flexible to adjust to local environmental conditions and functions based on the best available science. The following are regulatory and programmatic tools that can be utilized to protect the Chinook salmon habitat and reduce the impacts of the habitat limiting factors in the Stillaguamish Watershed.

Riparian

- Include all riparian zones around streams as fish and wildlife habitat conservation areas in critical areas regulations.
- Avoid clearing and development in riparian buffer areas, except for projects that will restore natural processes and native vegetation, through critical areas regulations.
- Maintain sufficient buffers along fish-bearing streams based on site-specific biological assessments or best available science when local regulations are not available.
- Protect wetlands and their functions and values that support salmon habitat and other watershed processes through critical areas regulations.
- Avoid, minimize, restore, and mitigate for impacts to wetlands.

Large Woody Debris

- Prohibit removal, relocation, or modification of large woody debris in aquatic habitats and adjacent banks.
- Remove or re-locate large woody debris posing an imminent threat to infrastructure and essential facilities. Place wood back into the system at a location where it will not pose an immediate hazard and where the lack of large woody debris has been identified as a problem.
- Install large woody debris in a manner that does not prevent navigation.

Floodplain

- Discourage new development in the floodplain through critical areas regulations or flood hazard management regulations.
- Identify channel migration zones as critical areas because they are important fish and wildlife conservation areas.
- Only allow development where these activities will not increase flood elevations, decrease storage capacity, prevent restoration of historical floodways, or restrict natural erosion and accretion processes.
- Inform those wishing to build in these areas of the value of natural floodplains and channel migration zones for salmon habitat and the potential hazards of development.
- Where development is allowed in the floodplain, encourage restoration and enhancement of floodplain processes and habitat where feasible.
- Prohibit new dikes, levees, tide gates, floodgates, pump stations, culverts, dams, water diversions, and other floodplain alterations unless these activities will not impair floodplain processes, restrict adult or juvenile habitat access or escape, or it has been demonstrated that no feasible alternative exists.
- Incorporate large woody debris or other habitat enhancements into flood control and bank stabilization measures to protect and enhance salmon habitat.
- Consider setbacks and the use of bioengineering techniques where it is not feasible to decommission existing flood control facilities.
- Locate new development away from shoreline areas wherever feasible to reduce the need for future bank stabilization measures.
- Allow bank stabilization of natural shorelines with equivalent mitigation only after demonstrating a threat to existing residential or commercial structures or public facilities.
- Require bioengineering techniques that incorporate vegetation and woody debris when there is no feasible alternative but to stabilize banks or repair existing dikes or levees. These techniques have lower long-term maintenance costs and provide a more suitable environment for salmon than riprap or other bank hardening structures.

- Where shorelines have been modified, encourage re-development activities to include salmon habitat improvements through methods such as bioengineering and construction of setback dikes and levees.
- Use the Washington State Department of Fish and Wildlife Integrated Streambank Protection Guidelines as guidance for shoreline modifications.

Sediment

- Identify and map landslide hazard areas for protection through critical areas regulations.
- Prohibit clearing and grading activities and building of new roads in landslide hazard areas except where necessary for public health and safety.
- Stabilize human-caused slope failures or landslides only to the extent necessary to prevent damage to people, property, and salmon habitat. Bioengineering methods and materials should be used where feasible.
- Adopt clearing and grading ordinances to limit impacts of sedimentation and to encourage development and retention of mature conifer forests, especially in riparian zones and headwater areas.
- Require effective erosion and sedimentation controls, such as silt fences, hydroseeding, and slope stabilization.
- Develop seasonal rules that reduce risk during high precipitation periods.

Hydrology

- Protect and restore hydrologic processes, groundwater recharge and natural storage areas.
- Promote natural infiltration wherever feasible.
- Adopt grading ordinances that protect natural drainage swales that provide measurable storage during storm events.
- Develop and/or adopt a stormwater design manual, equivalent to the Washington State Department of Ecology's Stormwater Management Manual for Western Washington (Washington State Department of Ecology 2001). This manual should include standards for development activities during both the construction and post-construction phases, including management of stormwater runoff and maintenance of stormwater management facilities.
- Develop stormwater comprehensive plans that inventory and prioritize retrofitting or replacement of stormwater management facilities as needed.
- Minimize impervious surfaces to reduce stormwater flows and pollution.
- Use low impact development techniques to manage stormwater from new development or re-development activities wherever feasible.
- Protect and restore wetlands.

Water Quality

- Identify water quality problem areas and existing pollutant sources.
- Reduce or eliminate pollution sources that affect salmon (i.e., dissolved oxygen, turbidity, suspended solids, and heavy metals).
- Participate in regional and local water quality monitoring efforts through TMDL, NPDES, and wellhead protection programs.
- Protect and restore wetlands.

Noxious Weeds

- Implement a comprehensive Integrated Pest Management program to eradicate noxious weeds through removal, technical assistance, education, outreach, and volunteer programs.
- Develop a process that assures land management activities and restoration projects include a noxious weed control component.

Mitigation

- Mitigation for impacts to salmon habitat and wetlands should be directed to watershed restoration and protection efforts.
- Consider the potential for mitigation banking to preserve functioning habitat in the watershed.
- Develop an application and qualification process for SIRC stakeholders to access mitigation funds resulting from regulatory violations.

Acquisition

To achieve adequate habitat protection, the existing inventory of sensitive riparian habitats used by Chinook salmon can be refined using assessments and new information. This updated inventory can be used for the development of a priority list for acquisition. Priorities for habitat protection should focus on habitat linkages and ecosystem connectivity. Critical habitats can be acquired by willing landowners using fee simple or conservation easements.

Compliance and Enforcement

Compliance and enforcement of existing regulations is essential to prevent continuing habitat degradation and to ensure long-term salmon recovery and watershed protection objectives. All federal, state, local, and tribal governments and other stakeholder organizations in the Stillaguamish Watershed should ensure that compliance with existing regulations is enforced to the maximum extent practicable. This should include inter-jurisdictional cooperation to meet regulatory goals and additional emphasis on enforcement. Lack of enforcement personnel and funding is a significant contributor to current poor habitat conditions. Local jurisdictions must have the capacity to enforce regulations in order to prevent further degradation and loss of

Chinook salmon habitat. Existing local government zoning, critical areas, and other development regulations should be enforced to:

- Protect riparian areas and wetlands
- Prevent resource extraction or development in streams and wetlands
- Prevent increases in sediment transport and increased stream temperatures
- Prevent increase in stormwater flow frequency and transport

Priorities for regulatory enforcement should include areas that have high restoration potential and areas that maintain habitat linkages.

Another enforcement issue is poaching of threatened salmon including Chinook salmon at over 30 public access sites on the Stillaguamish River. Both the Stillaguamish Tribe and WDFW have a limited number of enforcement officers to catch all violators and often have to rely on citizen reports. Illegal nets are confiscated on a regular basis during peak fishing time. A combination of more enforcement officers, stiff fines for violations, and citizen education will be essential to solve this problem.

Potential opportunities for improved compliance and enforcement of existing regulations include:

- Provide adequate funding for technical assistance, field inspection, and enforcement staff (e.g., ongoing code compliance, erosion control inspection).
- Increase coordination and consistency between agencies for development review issues related to protection of salmon habitat and aquatic resources.
- Provide additional training as necessary for permit review, inspection, monitoring, and enforcement staff in the latest best management practices.
- Maintain a 24-hour phone line, web address, and other mechanisms to report violations related to Chinook salmon.
- Consider adequacy of mitigation requirements and penalties for code violations. Significant impacts to existing conditions must be mitigated or compensated for.
- Adopt common scientific performance measures to track effectiveness of enforcement activities over time.
- Review results of violations reporting in an adaptive management process triggered by data gathered during monitoring activities indicating failure to meet desired targets.
- Utilize monitoring results in the development of recommended actions.
- Establish an annual review of the various adaptive management processes.
- Disqualify those stakeholders for state and federal grant and loan programs who do not follow or meet their commitments to this Plan.

7. Stewardship Education and Outreach Strategy

Introduction and Background

Stewardship education and outreach are essential elements of the Stillaguamish Watershed Chinook Salmon Recovery Plan because many of the proposed actions require the support of the general public and the involvement of landowners who are willing to protect and restore salmon habitat on their private property. Regulatory actions alone cannot adequately protect and restore salmon or the freshwater and marine habitat conditions that are required for salmon recovery. Therefore, it is necessary to actively work with the general public and private property owners to identify and implement locally acceptable actions that will produce measurable results for Chinook salmon recovery in the Stillaguamish Watershed.

In response to the need for a well-defined, results-oriented effort to promote public awareness and support for salmon recovery, this stewardship education and outreach strategy achieves the following:

- Explains the stewardship approach recommended by the SIRC for organizing public education and outreach efforts for salmon recovery;
- Defines the SIRC's public education and outreach goals;
- Identifies important target audiences;
- Prioritizes specific topics for public education and outreach;
- Describes existing and recommended stewardship activities; and
- Recommends base funding for core stewardship activities.

Stewardship Approach for Public Education and Outreach

To effectively raise public awareness and engage citizens in Chinook salmon recovery, education and outreach activities must be guided by clear goals and a conceptual model that defines the mechanisms by which such activities will generate useful results. Opinion research among Snohomish County residents shows that the concepts of “stewardship” and “personal responsibility”



The greatest impact, in terms of both public engagement and action, occur with a combination of information, educational activities, and technical assistance.

resonate with local residents and they are strong motivators for action (Ward and Ransley 2004). The SIRC therefore supports a “stewardship approach” for organizing public education and outreach activities.

The SIRC recognizes the importance of understanding the types of results that can be expected from different types of stewardship education and outreach activities. Wide-reaching activities, such as newsletters and brochures, are useful for reaching large audiences and have a relatively low per capita cost, but generally do not produce significant measurable results in terms of behavioral change or action. At the other end of the spectrum, direct technical assistance to individual landowners is generally more effective at promoting specific actions, such as the adoption of best management practices (BMPs) and landowner participation in salmon habitat protection and restoration projects. Direct personal contact has a higher per capita cost, but the measurable results in terms of salmon habitat protection and restoration are much greater. The greatest impact, in terms of both public engagement and action, occur with a combination of information, educational activities, and technical assistance. This conceptual model simply explains what many stewardship practitioners already know to be true and provides clear justification for investments in those stewardship activities that produce results.

Public Education and Outreach Goals

Following this stewardship approach, Chinook salmon recovery education and outreach activities in the Stillaguamish Watershed should be conducted to achieve the following goals:

1. Increase public awareness, engagement, and support for Chinook salmon recovery.
2. Promote the adoption of BMPs by the general public and targeted audiences.
3. Encourage civic involvement and policy awareness.
4. Mobilize citizens to participate in restoration and protection of Chinook salmon habitat.
5. Recognize model demonstration projects and reward good stewardship practices.
6. Develop a long-term strategy to provide training and technical assistance to targeted audiences for BMP implementation.
7. Emphasize activities that promote measurable actions by landowners and residents.

Stewardship Audiences

The SIRC recognizes that the activities of the following stakeholder groups in the Stillaguamish Watershed can directly impact salmon habitat in either positive or negative ways. Therefore they are important target audiences for stewardship education and outreach:

- Industrial and non-industrial forestland owners;
- Livestock and crop farmers, including owners of plant nurseries and tree farms;
- Business and residential landowners with freshwater and marine shorelines and wetlands;
- Other rural residential landowners;
- Developers and real estate professionals;
- Construction companies;
- Excavation and land clearing companies;
- Gravel mining companies;
- Earth moving and land clearing equipment rental companies;
- On-site septic system builders;
- Public and private utilities;
- Small non-commercial farmers; and
- Recreational water users.

Stewardship education and outreach activities should be tailored to directly engage these stakeholder groups in salmon recovery. To do this successfully, stewardship education and outreach practitioners will need to identify barriers that might inhibit and motivating factors that might encourage these groups to adopt BMPs. This will require time and effort to develop an understanding of barriers and motivating factors. Local stewardship practitioners should work cooperatively to conduct this important research and development effort.

A large percentage of forestland in the Stillaguamish Watershed is owned and managed by the USDA Forest Service and the Washington State Department of Natural Resources. These public agencies are currently engaged in salmon recovery efforts and are therefore not addressed in this stewardship education and outreach strategy. Information on efforts to ensure sustained and future involvement of these agencies is included in the previous chapter.

Personal priorities and motivating factors differ between those who depend on the land for their livelihood, such as farmers, forest landowners, and business owners, and those who use the land to foster a particular lifestyle. The former are often concerned with or need technical assistance with shoreline regulations, land use regulations, and financial incentive programs. Livestock

and crop farmers in particular are also motivated by water availability for livestock and crops, meeting land needs of livestock and crops, and excess shade created by riparian buffers. Outreach specialists and technical service providers should be prepared to address these issues when approaching landowners about Chinook salmon recovery efforts. Priorities and concerns of residential landowners with shorelines or wetlands and non-commercial small farmers include shoreline regulations, land use options, and freedom to landscape their land as suits their lifestyle. Recreational water users are most concerned about water access, water quality, and safety.

Stewardship education and outreach practitioners should consider the different priorities and motivating factors of each stakeholder group and tailor education, outreach, and technical assistance accordingly. In the Stillaguamish Watershed, the highest level of success has generally been achieved through person-to-person contacts and compromise. Developing trust and social acquaintance with stakeholder groups and individuals is usually necessary before they will engage in salmon habitat protection and restoration activities. Through direct personal contact with stakeholder groups, educators have an opportunity to learn from citizens and landowners valuable information about the current and recent historic conditions of the community and the land. This local knowledge should be respected and utilized in the organization of local stewardship activities.

The general population should not be overlooked in its relationship to Chinook salmon recovery. Each individual in the watershed has some influence on the quality and quantity of water, which is intimately linked with salmon success. Ward and Ransley (2004) found that more than 50% of Snohomish County residents may be willing to engage in reducing their personal impact on streams and rivers. Stewardship practitioners should take advantage of these positive attitudes by providing people with information that they can use in their daily lives to affect change. This includes providing information about opportunities for members of the general population to become actively involved in policy-making processes.

Stewardship Education and Outreach Topics

The following topics should be addressed through stewardship education and outreach for Chinook salmon recovery. Promoting public awareness and knowledge of these topics is the first step toward encouraging human behaviors that are beneficial to salmon.

Function of shoreline, wetland, and nearshore habitats

Shoreline, wetland, and nearshore habitats support complex ecosystems of which salmonids are a key part. These habitats are formed and maintained by complex physical and chemical inputs and processes. Educators should be able to provide clear explanations of how each of these habitats functions at a landscape level, and consequently explain how protection and restoration of these habitats are essential to successful Chinook salmon recovery. The function and importance of riparian vegetation should be emphasized.

Salmon ecology and habitat requirements

In order to appreciate the need for habitat protection and restoration, people must understand the complex life cycle and habitat requirements of Chinook salmon as well as historic habitat conditions. Therefore, educators should use a complete life-cycle approach when providing information about Chinook salmon, from birth and spawning in fresh water to adulthood in the open oceans to transitional periods in estuarine environments.

Noxious weeds and invasive species

The power of invasive species to disrupt properly functioning ecosystems is immense. Educators should be able to identify and provide information about invasive species of concern in the Stillaguamish Watershed (e.g. Japanese knotweed and hybrids, reed canary grass, etc.) and how to deal with them appropriately.

Water quality issues

Because clean water is essential Chinook salmon recovery as well as human health, water quality should be addressed in public education and outreach programs. Appropriate issues include, but are not limited to: stream water quality, aquifer recharge and stream flow, marine water quality, chemical pollutants, and septic systems. The cumulative water quality impacts of factors such as pet waste, vehicle pollution, failing septic systems, litter, and household waste must not be overlooked.

Best management practices

Technical service providers and outreach specialists should be prepared to offer information on land use practices that are the most beneficial and the least detrimental to both the environment and the landowner. The majority of residents want to do the right thing and stewardship practitioners need to be equipped to help them do so.

Policy affecting landowners

In order for landowners to make informed decisions about how they use their property, they must be aware of their impact on the watershed and they must understand government laws and policies affecting their land. Technical assistance providers should therefore be able to offer educational information and relevant contacts for policies such as shoreline regulations, critical area regulations, the Endangered Species Act, and permitting processes.

Stewardship Activities

Existing Stewardship Activities

Several governmental and non-governmental organizations in the Stillaguamish Watershed have existing stewardship education and outreach efforts (Table 14). Each of these organizations has programs that focus on salmon recovery as one of their primary objectives.

Table 14. Existing Stewardship Education and Outreach Efforts

Activity	Agency	Target Audiences
Carcass distributions	SSFETF	fishing groups, students, home school groups
Festival participation (information booths)	CA, SCSWM, SCD, SSFETF, ST	volunteers, property owners, general public, legislators, partners, potential partners
Field trips	SCSWM, SSFETF, ST	general public, volunteers, partners, potential partners, legislators
Invasive plant control	SCD, SCSWM, SSFETF, ST	volunteers, property owners, general public information, legislators, partners, potential partners
Mailings	CA, SCD, SCSWM, SSFETF, ST	members, volunteers, property owners, general public, local businesses
Native plant salvages	SCD, SCSWM, SSFETF, ST	property owners, volunteers
Native seed collections	ST	volunteers
Native vegetation plantings	SCSWM, SCD, SCSWM, SSFETF, ST	volunteers, property owners, general public, local businesses
Newsletters	CA, PSAT, SCD, SCSWM, ST, SSFETF	volunteers, property owners, general public, local businesses
Phone consultations	CA, SCD, SCSWM, SSFETF, ST	property owners, volunteers, general public
Salmon surveys	SSFETF, ST	volunteers, fishing groups
School presentations	SCSWM, SSFETF, ST	students, teachers, (friends and families of students)
Site visits	CA, SCD, SCSWM,	property owners, legislators

Activity	Agency	Target Audiences
	SSFETF, ST	
Trash removal	SSFETF, ST	property owners, volunteers, general public, local businesses
Volunteer opportunities	SCD, SCSWM, SSFETF, WSUE	volunteers, other agencies, general public, local businesses
Website	PSAT, SCD, SCSWM, ST, SSFETF	volunteers, partners and potential partners, general public, local businesses, property owners,
Workshops	CA, PSAT, SCSWM, SSFETF, WSUE	volunteers, agency staff, legislators

CA=City of Arlington

PSAT=Puget Sound Action Team

SCD=Snohomish Conservation District

SCSWM=Snohomish County Surface Water Management

SSFETF=Stillaguamish Snohomish Fisheries Enhancement Task Force

ST=Stillaguamish Tribe

WSUE=WA State University Extension

Outreach specialists can provide information on the topics described above to targeted audiences and the general public through broadcast activities such as outreach booths, newsletters and other written materials, the media, the Internet, classes and workshops. More specialized future events and technical services can be offered through these broadcast activities. These activities are useful for raising public awareness.

Examples of activities targeted toward interested audiences include but are not limited to restoration events such as native vegetation plantings, native plant salvages, salmon carcass distributions, youth education, watershed tours, policy and habitat workshops. These endeavors attract the landowners most likely to engage in active salmon recovery efforts, whether in the form of habitat improvement projects on their land or civic engagement.

Finally, outreach efforts and technical assistance should be offered to all landowners. Watershed stewards can fulfill this role by getting to know local landowners and their issues of concern. The SIRC recognizes that there is much to be gained from the knowledge that many landowners have to offer based on their experiences living in the watershed. While this process takes time and patience it is a worthwhile investment because the restoration of properly functioning habitats and sustainable salmon populations is a long-term project. In many cases, mutually beneficial actions can be identified and implemented that meet the needs of both landowners and Chinook salmon.

Providing technical assistance will be necessary to ensure the success of on-the-ground watershed projects and restoration activities. Technical resources will assist project sponsors in working with diverse landowners and watershed

residents to access funding and customize restoration and stewardship efforts to Chinook salmon habitat needs and unique site-specific circumstances.

Recommended Stewardship Activities

The following stewardship education and outreach activities will support public involvement in salmon recovery actions and build public awareness and support for the recovery of local salmon populations:

1. The SIRC should continue to serve as the local clearinghouse and coordinator of available technical resources to reduce duplication of effort and competition for limited stewardship funds.
2. Continue to provide governmental and non-governmental assistance to landowners, stakeholder, and other residents to:
 - a. Build awareness of Chinook salmon recovery and watershed protection efforts;
 - b. Help create a stewardship ethic among watershed residents;
 - c. Assist landowners with on-the-ground projects to benefit Chinook salmon habitat and natural watershed processes; and
 - d. Focus stewardship activities on Chinook salmon recovery plan priorities.
3. Integrate Chinook salmon recovery outreach objectives with other water resource management efforts, such as instream flow protection, water quality clean up, flood hazard management, and marine resource conservation.
4. Provide technical assistance to small forest landowners to support protection of existing forest cover, restoration of degraded forest areas, implementation of timber harvest and forest road management BMPs, and retention of forest land for timber production.
5. Provide technical assistance to agricultural landowners to support protection of intact riparian areas and forest cover, restoration of degraded riparian areas and forest cover, removal or improvement of culverts and other fish passage barriers, establishment of off-channel habitat, and promotion of alternatives to bank hardening.
6. Provide technical assistance to upland as well as freshwater and marine shoreline landowners to promote forest protection and restoration incentive programs, low impact development techniques, bioengineering alternatives, native plant use, and watershed stewardship.
7. Provide technical assistance to landowners to prevent and/or clean up point and non-point source water pollution.
8. Develop a strategy to educate elected officials and policy makers on the SIRC's adaptive management process and provide adequate lead time to seek the support necessary to implement the identified actions.
9. Coordinate ongoing hands-on watershed restoration efforts such as volunteer planting, animal exclusion through fencing, native plant salvage events, and bioengineering projects.

10. Sponsor presentations, open houses, and workshops to involve watershed residents in the Chinook salmon recovery process. Potential venues include community and neighborhood presentations, youth education, evening seminars, watershed tours and site visits. Present to existing groups at their regularly scheduled meetings whenever possible.
11. Educate residents about the multiple benefits of watershed restoration activities, such as flood hazard management, drinking water protection, and water quality enhancement.
12. Provide advanced educational opportunities to build knowledge base and skills of interested community members to act as stewards on behalf of salmon recovery through their own efforts or in conjunction with existing educational or programmatic activities.
13. Develop and distribute educational materials related to salmon conservation, including written materials, media, websites, and workshops.
14. Maintain a watershed library and website containing general watershed information, salmon recovery plan summaries and updates, SIRC meeting agendas and meeting summaries, and watershed event information, as well as a mechanism for the public to comment and submit salmon and watershed-related inquiries.
15. Install interpretive signs throughout the watershed identifying rivers and creeks, as well as highlighting restoration projects or acquisition sites. These signs would emphasize the importance of Chinook salmon habitat in the watershed, collaborative salmon recovery and watershed protection efforts, and site-specific restoration activities.

Funding for Stewardship

Existing programs that have base funding are generally more successful in implementing long-term strategies. While it is possible to obtain grants and other special funds to support education and outreach activities, long-term base funding is needed to sustain the results-oriented stewardship approach called for in this strategy. Like maintenance programs of all sorts, stewardship education and outreach programs need to be on-going. Effective stewardship education and outreach programs have three basic levels of activity: broad dissemination of general information, transferal of specific knowledge to targeted audiences, and direct technical assistance to individuals with action projects. For a program to be effective, all three levels need to be continuously available to citizens. This means core program elements should receive base funding and should not be dependent on grant funding. Once base program elements are funded, grants should be used for special, short-term initiatives.

8. Monitoring and Adaptive Management Strategy

Introduction and Purpose

This Plan lists many actions designed to improve the quality, quantity, diversity, and complexity of habitat for Chinook salmon in the Stillaguamish Watershed. The Plan also calls for investment in conservation programs, projects, and other actions designed to protect high-quality habitat and to prevent degraded habitat from becoming worse or lost altogether. Hatchery and harvest strategies developed by the co-managers are also part of the Plan. Monitoring and adaptive management provides a mechanism to evaluate our progress at the sub-basin, basin, and Chinook salmon population scales and adjust our direction if necessary as we implement the Plan.

Monitoring is the systematic, measurable observation of watershed, habitat, and population characteristics; project and program implementation and effectiveness; and process studies designed to test the assumptions on which the Plan is based. Monitoring is a critical element of the recovery effort because it allows us to evaluate progress toward desired results. Adaptive management is the formal use of monitoring results, combined with preset criteria that serve as “triggers” to evaluate and revise, if necessary, project and program designs, implementation schedules, overall action strategies, and our assumptions and expectations about the desired results of our actions.

The following is a “bare bones” list of items to be monitored in order to know whether the Plan is being effectively implemented. It relies on existing monitoring efforts and other monitoring actions that have a high likelihood of being performed on a regular basis in the future. These monitoring actions include field inventory using explicit, quantitative protocols; basin-scale land cover analysis; data collected in hatchery and harvest operations; and, either directly or by reference, monitoring of Chinook salmon recovery actions and programs carried out by local, state and federal agencies. The monitoring elements are prioritized based on importance to our near-term and long-term understanding of Chinook salmon population performance and habitat quality.

Although this Monitoring and Adaptive Management Strategy is specifically designed to monitor and evaluate this Plan, the SIRC recognizes that many stakeholders have their own methods of monitoring the progress of their



Monitoring and adaptive management provides a mechanism to evaluate our progress at the sub-basin, basin, and Chinook salmon population scales and adjust our direction if necessary as we implement the Plan.

respective salmon recovery activities. Some stakeholders have already established baseline conditions using indicators, such as the NOAA Fisheries Matrix of Pathways and Indicators, and they are implementing monitoring and adaptive management plans developed in consultation with regulatory authorities. The SIRC welcomes stakeholders to share the results of any relevant monitoring conducted outside of the framework of this Monitoring and Adaptive Management Strategy.

Monitoring Elements

This Monitoring and Adaptive Management Strategy is focused on unambiguous, quantifiable measures. As such it requires the use of standard measurement methods and techniques. Comparisons and triggers are carefully defined to provide clear indicators of whether and when adaptive actions are necessary. This strategy focuses on the following types of monitoring elements, or measures:

1. Specific Chinook salmon population and habitat conservation actions called for in this Plan (Implementation Monitoring);
2. Conservation actions that must be effective, rather than just accomplished (Direct Effectiveness Monitoring);
3. Conservation actions that are effective in a timeframe consistent with the Plan's stated goals, objectives, and targets (Cumulative Effectiveness Monitoring); and
4. Key assumptions that form the basis for undertaking actions and expecting specific responses (Validation Monitoring).

Implementation Monitoring

The purpose of implementation monitoring is to determine whether we did what we said we were going to do. If we did do what we said we were going to do, then adaptive action is not required. If we did not, then some kind of adaptive action may be necessary. This section defines the implementation monitoring framework for specific elements of the harvest, hatchery, and habitat strategies.

Table 15. Habitat Restoration Implementation Monitoring

Project	Indicator	Comparison	Trigger
Riparian restoration	Acres of riparian vegetation planted	Annualized progress toward target acres	Two consecutive years not meeting targets
Floodplain connectivity	Side-channel acres reconnected	Pro-rated five year total acres	Performance does not meet pro-rated five year total acres
Treat landslides	Landslides treated	1 landslide treatment constructed by 2009 and 1 more by 2014	No permits by end of 2008
Reduce sediment from roads	Miles unpaved forest roads on potentially unstable slopes restored or treated	Annualized progress toward target miles	Two consecutive years not meeting targets
Increase large woody debris (LWD)	Engineered log jams installed	Annualized progress toward target numbers, locations	Third year totals do not meet target; seven year totals do not meet target
Estuary restoration	1. Leque Island and The Nature Conservancy (TNC) properties restored to tidal influence 2. River delta log jams installed	1. 115 acres of Leque Island and 80 acres of TNC property restored to tidal influence 2. 10 log jams installed in river delta	1. No tidal influence restored to either Leque Island or TNC property by 2010 2. No log jams installed by 2010

Table 16. Habitat Protection Implementation Monitoring

Protection Element	Indicator	Comparison	Trigger
Critical Areas Regulations (CAR)	CAR updated	Current CAR	Update not complete on time
Comprehensive Growth Management Plan (Comp. Plan)	Comp. Plan updated	Current Comp. Plan	Update not complete on time
Shoreline Management Plan (SMP)	SMP updated	Current SMP	Update not complete on time
Hydraulic Code	1. # projects constructed without required Hydraulic Project Approval (HPA) permit 2. % hardened bank in EDT reach under HPAs	1. No unpermitted projects 2. NMFS (1996) hardened bank criteria	1. 2 in a calendar year 2. > 10% in EDT reach
Temperature Total Maximum Daily Load (TMDL)	TMDL water quality cleanup plan completed	No TMDL water quality cleanup plan	TMDL water quality cleanup plan not approved by DOE by 2007
Habitat designated for conservancy	Acres of habitat conserved	Annualized progress toward target	2 consecutive years of not meeting annualized target

Table 17. Harvest Strategy Implementation Monitoring

Harvest Element	Indicator	Comparison	Trigger
Non-incidental harvest	% of fish harvested	Maximum annual target	Two consecutive years of exceeding target %
Incidental harvest	% of fish harvested	Maximum annual target	Two consecutive years of exceeding target %
Canada harvest	% of fish harvested	Maximum annual target	Two consecutive years of exceeding target %

Table 18. Hatchery Strategy Implementation Monitoring

Hatchery Element	Indicator	Comparison	Trigger
Selection of program fish	Portion/geographic distribution of population selected for program	Targeted distribution in time/space of program fish	Less than 80% of run time or geography selected for program
Smolt release	Number and size of smolts released	Minimum number of Chinook smolts released	Two consecutive years of not meeting minimum smolt release numbers

Effectiveness Monitoring

The purpose of effectiveness monitoring is to determine whether projects and other elements of the Plan are effective at what they were designed to accomplish. It also addresses cumulative effectiveness of the overall recovery plan and whether it is having the desired or planned affect on Chinook salmon productivity. This section defines the direct and cumulative effectiveness monitoring framework of specific elements of the harvest, hatchery, and habitat strategies as well as the Plan as a whole.

Table 19. Habitat Restoration Effectiveness Monitoring

Project	Indicator	Comparison	Trigger
Riparian restoration	Acres of conversion from bare ground, grass land cover to shrubs/small trees (use periodic land cover analysis every 3-5 years)	Pro-rated progress toward riparian restoration acre targets in Plan	Two consecutive periods of not meeting pro-rated progress toward riparian restoration acre targets in Plan
Floodplain connectivity	1. Do project side channels remain reconnected? (% connection maintained) 2. Are reconnected side channels used by juvenile Chinook salmon? (juvenile density in summer, winter)	1. % reconnected channel area that is wetted and contains > 8 ppm DO in August 2. Published juvenile density values (Stillaguamish Tribe, Washington Trout, NOAA Fisheries)	1. Less than 50% of new side-channel remains connected five years after construction 2. Less than 50% of published juvenile density in side-channel after 5 years
Treat landslides	Is sediment reduced from landslide treatments? (% fines in spawnable gravel downstream from landslide treatments)	Stillaguamish fine sediment criteria (STAG 2000)	Does not meet Stillaguamish fine sediment criteria within 2 years after construction
Reduce sediment from roads	Is sediment reduced from road treatments? (% fines in spawnable gravel downstream from road treatments)	Stillaguamish fine sediment criteria (STAG 2000)	Road-derived fine sediment does not meet standard by 2009
Increase large woody debris (LWD)	Are log jams increasing habitat diversity (% pool area [primary and backwater], pool frequency)?	Pool area and frequency criteria in Chinook salmon habitat	<5% increase in pool area in 5 years

Project	Indicator	Comparison	Trigger
Estuary restoration	Acres of salt marsh habitat restored or created	Annualized progress for the following projects: 1. Leque Island 2. TNC property 3. River delta log jams	Salt marsh habitat restored or created by 2010: 1. Leque Island 60 acres 2. TNC property 40 acres 3. River delta log jams 60 acres
Cumulative effectiveness	Chinook salmon productivity	Annualized progress toward productivity target	Productivity by 2009 does not meet annualized progress toward productivity target

Table 20. Habitat Protection Effectiveness Monitoring

Protection Element	Indicator	Comparison	Trigger
Critical Area Regulations (CAR)	1. Nearstream Total Impervious Area (TIA) acres (see Purser et al. 2003) 2. Wetland acres	1. Spence et al.(1996) 2. No net loss of wetland acres	1. >3% increase in TIA in 5 years 2. >3% net loss of wetland acres in 5 years
Comprehensive Growth Management Plan (Comp. Plan)	1. Nearstream acres in forest land cover types (see Purser et al. 2003) 2. Wetland acres	1. Spence et al. (1996) 2. No net loss of wetland acres	1. >3% loss of forest land cover in 5 years 2. >3% net loss of wetland acres in 5 years
Shoreline Management Plan (SMP)	Bank hardening length in priority reaches	Spence et al., 1996; NMFS, 1996	>3% increase in 5 years
Forest Practices Regulations, DNR HCP, and Northwest Forest Plan	1. % hydrologically mature forest in subbasin (see Purser et al. 2003) 2. Road density 3. Miles of road on potentially unstable slopes	1. Nichols (1990) 2. NMFS (1996) 3. Baseline miles of road on potentially unstable slopes (see Table 5)	1. > or = 10% of historically forested portion of sub-basin < 20 years old 2. > 2.0 road miles / sq. mi. in any basin 3. any new roads built on potentially unstable slopes
Hydraulic Code	Feet of hardened bank allowed in Chinook salmon reaches	Current amount of hardened bank (see Haas et al. 2003)	Net increase in hardened bank
Temperature Total Maximum Daily Load (TMDL)	Stream temperature (7-day running average high)	TMDL numerical objective	5-year, 10-year milestones not met
Habitat designated for conservancy	% forest land cover; wetland	No net loss	>3% loss in 5 years

Table 21. Harvest Strategy Effectiveness Monitoring

Harvest Element	Indicator	Comparison	Trigger
Spawning escapement	Adult escapement	Annualized progress toward target	Two consecutive years of not meeting annualize progress toward target
Canada harvest	Canada harvest	Agreed upon limit to Canadian harvest	Two consecutive years of not meeting annualize progress toward target

Table 22. Hatchery Strategy Effectiveness Monitoring

Hatchery Element	Indicator	Comparison	Trigger
Manage hatchery for high return of program fish	Ratio of adults spawned to returning hatchery spawners	Ratio of hatchery spawners to natural spawners	< 2.0 returning adults per hatchery spawner
Manage hatchery for high smolt survival	Egg to release survival (%) of hatchery fish	Natural-origin egg to release survival	< 70% survival
Manage program smolts to emulate natural smolts	Size distribution and outmigration timing of hatchery and natural juveniles	No statistically significant difference between hatchery and natural juveniles	Statistically significant difference in size distribution or outmigration timing
Manage program adult fish to emulate natural adult fish	Age and sex composition, time and area of spawning of returning hatchery and natural adults	No statistically significant difference between hatchery and natural adults	Statistically significant difference in age or sex composition or time of spawning or area of spawning between hatchery-origin and natural-origin adults

Validation Monitoring

- Validation monitoring tests our assumptions about what our actions will achieve, the time-frame for achievement, and whether a particular method or strategy is adequate for achieving target conditions. Specifically for this Plan, validation monitoring is a tool we can use to test our hypotheses about watershed processes and Chinook salmon population performance. Significant differences between what we think happens and what actually happens trigger adaptive management.

Table 23. Habitat Restoration Validation Monitoring

Project/Hypothesis	Indicator	Comparison	Trigger
Riparian restoration (voluntary approach can achieve targets)	Acres replanted by subbasin	Plan targets for riparian restoration acres by subbasin	Two consecutive years of not meeting annualized targets
Floodplain connectivity (reconnected side channels increase Chinook salmon rearing habitat and smolt escapement)	1. % backwater pool 2. Juvenile Chinook salmon use of upstream side-channels 3. Smolt escapement	1. % pool target 2. Juvenile density target 3. Smolt escapement target	1. No increase in pool area 2. Low level of use by juvenile Chinook salmon 3. Low # of natural smolts 3 years in a row
Treat landslides (landslides are the major sources of redd-intruding sediment)	Sediment from roads; fines in redds	Stillaguamish fine sediment criteria (STAG 2000)	Fine sediment criteria not met in downstream redds within 5 years after treatment
Reduce sediment from roads (landslides and/or road-derived sediment are the largest sources of redd-intruding sediment)	Sediment from landslides; fines in redds	Stillaguamish fine sediment criteria (STAG 2000)	Fine sediment criteria not met in downstream redds within 5 years after treatment
Increase large woody debris (log jams improve habitat diversity and complexity for juvenile Chinook salmon)	1. % pool area in EDT reach 2. Juvenile density in and around log jams	1. % pool area in EDT reach before restoration 2. Juvenile density before restoration	1. No net increase in pool area % in reach; 2. No use for Chinook salmon juvenile rearing
Estuary restoration (restoration or creation of salt marsh habitat improves habitat diversity and complexity for juvenile Chinook salmon)	Juvenile density in restored or created salt marsh	Juvenile density in existing salt marsh	Less than 50% of published juvenile density within 3 years of restoration

Table 24. Habitat Protection Validation Monitoring

Protection Element/Hypothesis	Indicator	Comparison	Trigger
Critical Area Regulations (CAR) protect riparian buffers	% forest cover	2001 land cover	Loss of mature evergreen and medium evergreen forest cover in nearstream
Shoreline Management Plan (SMP) protects against modifications to banks in Chinook salmon habitat	% hydromodification	2002 data from SC	Increase in % modification
Forest Practices Regulations, DNR HCP, and Northwest Forest Plan protect riparian buffers	% forest cover	2001 land cover	Loss of mature evergreen and medium evergreen forest cover in nearstream

Table 25. Harvest Strategy Validation Monitoring

Harvest Element/Hypothesis	Indicator	Comparison	Trigger
Harvest of ESA-listed fish (e.g., blackmouth fishery; assumption is that there are fish surplus to recovery)	1. Harvest % 2. Adult escapement	1. Harvest ceiling % 2. Adult escapement for South Fork and North Fork populations	1. Two consecutive years of exceeding harvest ceiling 2. Two consecutive years of not meeting adult escapement targets

Table 26. Hatchery Strategy Validation Monitoring

Hatchery Element/Hypothesis	Indicator	Comparison	Trigger
Conservation hatchery program will increase composite North Fork Chinook salmon population above critical threshold	Relative productivity of natural spawners versus hatchery spawners	Productivity of natural spawners compared to hatchery spawners	Conservation hatchery does not increase composite North Fork population for 3 consecutive years and hatchery fish do not return with >2.0 natural spawner to hatchery spawner survival rate
Conservation hatchery program can produce Chinook salmon that are not significantly different genetically from the naturally spawning population	Periodic DNA monitoring of the hatchery component and naturally spawning component of the North Fork population	Genetic composition of hatchery component compared to naturally spawning component	Genetic composition of hatchery component changes significantly from naturally spawning component within 4 years

Administration

Implementation of this Monitoring and Adaptive Management Strategy, will require the following conditions:

- 1. Commitment to fund and implement monitoring and evaluation actions;
- 2. Timely reporting of monitoring results;
- 3. Regular and timely evaluation of whether criteria are met; and
- 4. Commitment to change what we said we will do if it is found to be infeasible, ineffective, or if the underlying assumptions of the action cannot be validated.

Monitoring responsibilities, priorities, and adaptive management responses for the habitat, harvest, and hatchery strategies are summarized in the following tables. The Stillaguamish Technical Advisory Group (TAG) will review all monitoring results annually in March. The TAG will determine the particular barriers to success related to inadequate progress on implementation of the Plan, ineffectiveness of actions, or invalid assumptions. The TAG will present its findings and recommendations to the SIRC in April. The SIRC will determine appropriate management response and take action accordingly.

The lead agencies indicated in the monitoring responsibility and priority tables below are coded as follows:

CLC	Cascade Land Conservancy
SC	Snohomish County
ST	Stillaguamish Tribe
DOE	Washington State Department of Ecology
WDFW	Washington State Department of Fish and Wildlife
DNR	Washington State Department of Natural Resources
FS	United States Forest Service

Table 27. Habitat Restoration Monitoring Responsibilities and Priorities

Monitoring Element	Lead Agency	Reporting Frequency	Evaluation Frequency	Priority (1 – 3)
Riparian Restoration				
Acres of riparian vegetation planted	ST	Annually	Annually	3
Acres of conversion from bare ground, grass land cover to shrubs/small trees	SC	Every 3-5 years	Every 3-5 years	3
Acres replanted by subbasin	SC	Every 3-5 years	Every 3-5 years	3
Floodplain Connectivity				
Side-channel acres/miles reconnected	SC	Annually	Five years	3
1. % side-channel connection maintained 2. Juvenile density in summer and winter	SC/ST	Annually	Annually	3
1. % backwater pool 2. Juvenile Chinook salmon use of upstream side-channels; smolt escapement	SC/ST	Annually	Annually	3
Treat Landslides				
Landslides treated	ST	Annually	Five years	2
% fines in spawnable gravel downstream from landslide treatments	ST/SC	Annually	Annually	2
Sediment from landslides, other sources; fines in redds	ST/SC	Annually	Annually	2
Reduce Sediment from Roads				
Miles unpaved forest roads on potentially unstable slopes restored or treated	DNR/FS	Annually	Annually	2
% fines in spawnable gravel downstream from road treatments	ST/SC	Annually	Annually	2
Sediment from landslides, other sources; fines in redds	ST/SC	Annually	Annually	2
Increase Large Woody Debris				
Engineered log jams installed	SC	Annually	3-4 years	2
% pool area (primary and backwater), pool frequency	SC	Annually	Annually	2
juvenile Chinook density in and around log jams	ST	Annually	Annually	2
Estuary Restoration				
1. Leque Island and The Nature Conservancy (TNC) properties restored to tidal influence 2. River delta log jams installed	ST	Annually	Five years	1
Acres of salt marsh habitat restored or created	ST	Annually	Five years	1
Juvenile density in restored or created salt marsh	ST	Annually	Five years	1

Table 28. Habitat Protection Monitoring Responsibilities and Priorities

Monitoring Element	Lead Agency	Reporting Frequency	Evaluation Frequency	Priority (1 – 3)
Critical Areas Regulations (CAR)				
CAR updated	SC	Annually	Legal due date	1
1. Nearstream Total Impervious Area (TIA) acres 2. Wetland acres	SC	Every 3-5 years	Every 3-5 years	1
% forest cover	SC	Every 3-5 years	Every 3-5 years	1
Comprehensive Growth Management Plan (Comp. Plan)				
Comp. Plan updated	SC	Annually	Legal due date	1
1. Nearstream acres in forest land cover types 2. Wetland acres	SC	Every 3-5 years	Every 3-5 years	1
<i>No validation monitoring</i>				
Shoreline Management Plan (SMP)				
SMP updated	SC	Annually	Legal due date	1
Bank hardening length in priority reaches	SC	Annually	Annually	1
% hydromodification	SC	Annually	Annually	1
Forest Practices Regulations, DNR HCP, and Northwest Forest Plan				
<i>No implementation monitoring</i>				
1. % hydrologically mature forest in subbasin 2. Road density 3. Miles of road on potentially unstable slopes	SC	Every 3-5 years	Every 3-5 years	1
% forest cover	SC	Every 3-5 years	Every 3-5 years	1
Hydraulic Code				
1. # projects constructed without required Hydraulic Project Approval (HPA) permit 2. % hardened bank in EDT reach, under HPAs	WDFW	Annually	Annually	1
Feet of hardened bank allowed in Chinook salmon reaches	SC	Annually	Annually	1
<i>No validation monitoring</i>				
Temperature Total Maximum Daily Load (TMDL)				
TMDL water quality cleanup plan completed	DOE	Annually	Legal due date	1
Stream temperature (7-day running average high)	DOE	Annually	Five years	1
<i>No validation monitoring</i>				
Habitat designated for conservancy				
Acres of habitat conserved	CLC	Annually	Annually	2
% forest land cover; wetland	SC	Every 3- 5 years	Every 3-5 years	2
<i>No validation monitoring</i>				

Table 29. Harvest Monitoring Responsibilities and Priorities

Monitoring Element	Lead Agency	Reporting Frequency	Evaluation Frequency	Priority (1 – 3)
Non-incident % or number of fish harvested	ST	Annually	Annually	1
Incidental % or number of fish harvested	ST	Annually	Annually	1
Canada % or number of fish harvested	ST	Annually	Annually	1
Harvest %; adult escapement	ST	Annually	Annually	1

Table 30. Hatchery Monitoring Responsibilities and Priorities

Monitoring Element	Lead Agency	Reporting Frequency	Evaluation Frequency	Priority (1 – 3)
Portion/geographic distribution of population selected for conservation hatchery program	ST	Annually	Annually	1
Number and size of smolts released	ST	Annually	Annually	1
Egg to release survival (%) of hatchery fish	ST	Annually	Annually	1
Size distribution, outmigration timing of hatchery and natural juveniles	ST	Annually	Annually	1
Age and sex composition, time and area of spawning of returning hatchery and natural adults	ST	Annually	Annually	1
Relative productivity of natural spawners versus hatchery fish	ST	Annually	Annually	1
Periodic DNA monitoring of the hatchery component and naturally spawning component of the North Fork population	ST	Annually	Annually	1

Table 31. Implementation Adaptive Management Responses

Monitoring Element	Trigger	Barriers to Success	Determine Cause	Potential Responses
Habitat Restoration Implementation	Projects not implemented	Inadequate SRFB funding; lack of staff commitment, project sponsors; inability to obtain permits; no willing landowners	Review funding, agency resources; review permit requirements; outreach to landowners	Seek other sources of funding; encourage prioritization of project development and implementation; seek ways to improve permitting; improve outreach to recruit sponsors and willing landowners
Habitat Protection Implementation	Protective measures not implemented or updated	Lack of agency cooperation; internal obstacles for implementing agencies; work programming does not prioritize protection	Review current protection policies to determine adequacy; review work priorities	Propose policy revisions and prioritization of habitat protection; work directly with elected officials, agency directors
Harvest Strategy Implementation	Recovery Exploitation Rate (RER) exceeded or minimum escapement not reached	Poor pre-season estimate of run size; Inaccurate preseason fishery impact assessments; Failure to adhere to RER or minimum escapement guideline	Review preseason forecast methodology and impact assessment models (postseason reports); harvest north of US/Canada border too high to be compensated in US fisheries	Modify preseason forecast input data or methodology; recalibrate impact assessment model Reduce fishery impacts to adhere to RER or minimum escapement guideline; renegotiate US Canada treaty
Hatchery Strategy Implementation	Program goals not met	Work programming; poor escapement	Review program fish selection methods; review escapement parameters	Revise program operations to align with program objectives

Table 32. Effectiveness Adaptive Management Responses

Monitoring Element	Trigger	Barriers to Success	Determine Cause	Potential Responses
Habitat Restoration Effectiveness	Restoration targets not met	Poor implementation (pace, methods, etc.); inadequate juvenile production; assumptions invalid	Review project designs, locations; review construction methods; review, revise validation monitoring, test new hypotheses	Focus on projects that are known to be successful; try new designs, locations, methods; revise monitoring strategy
Habitat Protection Effectiveness	Degradation of riparian forest, wetlands, banks, forest cover, stream temperature	Poor administration and/or lack of enforcement of protective measures	Review protection and enforcement policies	Propose revisions to protection policies, new enforcement policies, new standards and/or codes; connect administration and enforcement to current conditions, desired future conditions
Harvest Strategy Effectiveness	Escapement trend not reflective of population productivity trend	Recovery Exploitation Rate (RER) not appropriate for population productivity	Review input data and methodology for derivation of RER and minimum escapement	Revise computation of RER and minimum escapement
Hatchery Strategy Effectiveness	Low survival of hatchery fish and/or natural fish	Poor selection of program fish; problems with hatchery operations; natural fish production limiting program production	Review program fish selection methods, hatchery methods, escapement parameters, habitat availability	Revise program operations to align with program objectives

Table 33. Validation Adaptive Management Responses

Monitoring Element	Trigger	Barriers to Success	Determine Cause	Potential Responses
Habitat Restoration Validation	Assumptions/hypotheses not valid	Continued use of ineffective ideas, data, technology, methods	Review hypotheses, assumptions and develop new hypotheses	Revise Plan to incorporate new hypotheses and revise Monitoring Strategy to test new hypotheses
Habitat Protection Validation	Assumptions/hypotheses not valid	Continued use of ineffective ideas, data, technology, methods	Review hypotheses, assumptions and develop new hypotheses	Revise Plan to incorporate new hypotheses and revise Monitoring Strategy to test new hypotheses
Harvest Strategy Validation	Assumptions/hypotheses not valid	Continued use of ineffective ideas, data, technology, methods	Review hypotheses, assumptions and develop new hypotheses	Revise Plan to incorporate new hypotheses and revise Monitoring Strategy to test new hypotheses
Hatchery Strategy Validation	Assumptions/hypotheses not valid	Continued use of ineffective ideas, data, technology, methods	Review hypotheses, assumptions and develop new hypotheses	Revise Plan to incorporate new hypotheses and revise Monitoring Strategy to test new hypotheses

Funding for Monitoring

The proposed Monitoring and Adaptive management Strategy includes measurable actions, indicators, comparison criteria, evaluation trigger points, and management responses. It also provides a supporting framework for re-focusing our efforts, if necessary, based on the results of our evaluation process. This Monitoring and Adaptive Management Strategy should also serve as an explicit platform for obtaining political and financial support for actions that are proven to be successful for Chinook salmon recovery in the Stillaguamish Watershed. Much of the work called for in this Monitoring and Adaptive Management Strategy is currently funded and underway. However, much of the current funding is short-term and its continuation is uncertain. Therefore continuation of the currently funded monitoring and evaluation work is also uncertain. Long-term funding is an essential condition for implementing this Monitoring and Adaptive Management Strategy.

9. Long-Term Planning Issues

Commitments and Conditions

The Stillaguamish Watershed Chinook Salmon Recovery Plan is a voluntary plan. All participating jurisdictions and stakeholders have the option to adopt the whole Plan, endorse specific recommendations, or not support the Plan. At this time, all of the jurisdictions and stakeholder organizations participating in the SIRC are working together to restore salmon. The SIRC will ask for letters or resolutions from participating jurisdictions and stakeholder organizations to describe their level of commitment to the Plan's recommendations and to Chinook salmon recovery in the Stillaguamish Watershed.

Many different entities have authority over the factors that contribute to the decline of Stillaguamish Chinook salmon. The State of Washington and the Washington State Treaty Tribes are co-managers of salmon harvest and operate most salmon hatcheries. A host of other agencies, including the United State Forest Service (USFS), Washington Department of Natural Resources (WADNR), counties, cities, and private landowners have jurisdiction in areas that influence habitat conditions.

The policy and regulatory issues described above are complex and will require a significant amount of coordination with the appropriate local, state, and federal government agencies. The SIRC is committed to an aggressive approach to Chinook salmon recovery and will continue building relationships with individual agencies and other stakeholders as necessary to develop policy and regulatory commitments. There is concern among the SIRC that ongoing local land uses may continue to degrade salmon habitat and watershed processes while voluntary restoration actions are making progress to recover Chinook salmon populations. As a result, the SIRC will look for state and regional leadership on regulatory matters, including:

- Implementation of local land use policies and zoning regulations that protect critical areas and other watershed functions that support sensitive fish habitat
- Enforcement of forest management regulations and improved forest management practices on private, state, and federal lands
- Review and modification of the U.S. Army Corps of Engineers riparian maintenance policy



The SIRC is committed to an aggressive approach to Chinook salmon recovery and will continue building relationships with individual agencies and other stakeholders as necessary to develop policy and regulatory commitments.

- Streamlined permitting from state and federal agencies for implementation of voluntary restoration actions
- Poaching enforcement and penalties in the Stillaguamish Watershed, Puget Sound, and in the Pacific Ocean

Economic Analysis

A generalized economic impact analysis of the Stillaguamish Watershed Chinook Salmon Recovery Plan has not been conducted. A general economic impact analysis for salmon recovery would be most reliable when done on a larger-than-watershed scale (for example, a Puget Sound-wide analysis). Economic data is more available and accurate at the regional level, in addition to the fact that secondary economic impacts are not usually captured at the local (i.e. Stillaguamish) level. For a Stillaguamish-specific economic analysis to be accurate, these secondary effects would have to be measured.

Significantly larger Chinook salmon populations could potentially bring positive economic benefit to Snohomish County and the surrounding region. However, the projected increase in Chinook salmon populations is not significant in the initial 10-year timeframe of this Plan. Whether or not these additional fish would be available for harvest would be a matter of policy, not economics, at that time. Even assuming that policy did allow their harvest, the economic significance for commercial or sport fishing would be small, due to the small population size. Over a longer time horizon of 100 years, Chinook salmon populations might regain sufficient robustness to withstand significant harvest and create a significant economic benefit. However, economic projections over such a long time period are not reliable.

The attractive natural environment is a factor which draws many people to live in the Pacific Northwest region. According to state projections, the population of Snohomish County is expected to grow from its current level of 639,400 to 930,000 by the year 2025 (an increase of 45% in twenty years)³⁷. While this population increase will bring new businesses and jobs to the region, it will also have an associated infrastructure cost to support these new inhabitants, as well as an environmental impact cost which could actually have a negative impact on Chinook salmon population recovery.

Some localized economic analyses of land protection measures associated with salmon recovery programs have been completed in the region, which detail micro- and macro-economic impacts to farming communities and enterprises³⁸. A regional economic analysis of Skagit County's proposed riparian protection program in 2003 showed reduced agricultural production

³⁷ Snohomish County Planning and Development Services.
<http://www1.co.snohomish.wa.us/Departments/PDS/>

³⁸ It should be noted that these were not comprehensive studies of all salmon recovery efforts.

as a result of the program, accompanied by a decline in farm proprietor and labor income, as well as a decrease in farm-related jobs. No significant benefit to the salmon fishing industry resulted from the program (Skagit County 2003). An economic analysis of farm buffers in the Stillaguamish Watershed showed that while buffers can have a negative impact on the farm enterprise, this is not always the case. The net impact depended highly on the type of farm, its size, and the availability of buffer cost share programs (Resource Consulting 2004).

Funding

The Shared Strategy has created a task force to develop a preliminary salmon recovery financing strategy. This committee will assess current and potential sources of salmon funds, and identify different scenarios for funding recovery actions. They will solicit input and feedback from watershed planners and stakeholders, and present their recommendations for regional funding strategies to the Shared Strategy's Development Committee.

The task force has identified a set of key assumptions about salmon recovery funding:

- The financing strategy will result in increased funding of salmon recovery in the Puget Sound region, will be developed in consultation with other regions, and will use funding strategies that benefit the entire state whenever possible.
- The financing strategy will result in greater dependability in the level of funding and sources available for salmon recovery needs for the first ten years of implementing the recovery plan.
- The financing strategy will result in greater efficiency in the awarding of capital funding, with less money spent on competition for funding and more on on-the-ground results.
- The financing strategy will depend primarily on more effective use of existing funding sources and compliance with state, federal, and local regulatory programs.
- The financing strategy will address capital and key operating costs for habitat, hatcheries, and harvest management.
- The financing strategy will reward leadership, commitment, and results.
- The financing strategy will support a tangible set of achievements at the local, regional, and/or statewide scale in the first ten years of plan implementation.

The regional financing strategy will identify sources of salmon funding, the conditions for accessing those funds, and the dependability of those funding sources. The task force will work to identify funding gaps and strategies to

raise the necessary funds to fill those gaps. Initial cost estimates identified for salmon recovery in the Stillaguamish Watershed will be combined with estimates from the other Puget Sound watersheds to identify the total estimated costs related to recovery actions for the first ten years of plan implementation. The task force will identify mechanisms for matching funding needs with adequate funding sources, as well as identifying potential new funding sources. Lastly, the financing strategy will evaluate the commitments necessary to implement the regional financing strategy, and ways to develop those commitments.

Research and Data Gaps

A significant amount of research has been completed in the Stillaguamish Watershed. A list of key past research accomplishments is included in Appendix B. This research includes studies on riparian and habitat conditions in the watershed; the effects of land use on salmonid habitat and water quality; limiting factors for salmon habitat; technical assessment and recommendations for Chinook salmon recovery; and several subbasin assessments. This information is being applied through modeling and on-the-ground actions.

Current gaps in available information may limit the effectiveness of a comprehensive Chinook salmon recovery strategy. A comprehensive limiting factors analysis has been completed for the Stillaguamish Watershed outlining a prioritized list of data and information gaps. Below is a sample of data gaps and corresponding research that could fill these gaps as funding allows.

Population Estimation

- South Fork Chinook salmon spawner surveys

Estuary/Nearshore

- Analyze juvenile Chinook salmon use of estuarine and lower river habitat (type of habitat used and timing) – *in progress*
- Undertake a baseline study of nearshore habitat conditions and usage by juvenile Chinook salmon – *in progress*
- Evaluate effectiveness of salt marsh habitat restoration
- Encourage co-managers and federal agencies to evaluate extent of predation on Stillaguamish Chinook salmon populations

Large Woody Debris

- Survey LWD in Chinook salmon production reaches which have not yet been surveyed (lower Armstrong Creek, Pilchuck Creek, Jim Creek, Deer Creek). Starting in 2005, re-survey those reaches surveyed since 2000.
- Co-monitor pools and juvenile usage of wood structures.

Floodplain

- Identify high quality habitat and willing landowners for future restoration activities.

Sediment

- Monitor and develop a sediment budget focused on fine sediment which impacts Chinook salmon redds.

Hydrology

- Establish the effect of instream flows and water rights withdrawals on summer low flow conditions.
- Model effect of wetland degradation and forest cutting on base-, mean, and peak-flows and stages.
- Assess proportion of hydrologic change due to natural vs. anthropogenic causes

Water Quality

- Evaluate temperature impacts in the lower river on Chinook salmon survival and fecundity

Noxious Weeds

- Evaluate the effects of *Spartina spp.* on salt marsh habitat functions for juvenile Chinook salmon
- Evaluate the effects of knotweed on riparian habitat functions for Chinook salmon

As this information becomes available, it should be incorporated into the management activities of those agencies regulating habitat and land use in the watershed.

Policy and Regulatory Issues

In addition to individual project actions to protect and restore Chinook salmon habitat, a number of policy and regulatory issues exist that will need to be addressed in order to pursue a comprehensive Chinook salmon recovery strategy. In the past, the SIRC has chosen primarily to focus on compliance and enforcement of existing regulations related to salmon habitat and watershed processes. However, in order to achieve an effective overall Chinook salmon recovery strategy, the SIRC will identify areas for regulatory coordination and may identify specific policy and regulatory gaps. Policies and regulations would be analyzed in the context of how they help or hinder watershed processes and Chinook salmon conservation.

Land Use Regulations

Chinook salmon habitat restoration will not be effective if environmental degradation continues due to population growth and urban/suburban development. Land use policies and regulations that affect fish habitat and watershed processes include those related to growth management; protection of critical areas, including streams, wetlands, and geological hazard areas (steep slopes, landslide-prone areas); development in the floodplain; and protection of channel migration zones. The SIRC should conduct an evaluation of how effective all existing local land use regulatory programs are on protecting salmon habitat and make recommendations to the relevant jurisdictions to improve those policies and regulations found to be deficient for protecting salmon habitat and watershed functions.

Adequate refinement and enforcement of existing local land use regulations must reflect growth management policies designed to protect habitat. Growth management allows cities such as Arlington and Stanwood to expand within their urban growth areas, as well as expand their urban growth boundaries. Population increases are expected in the Arlington and Stanwood Urban Growth Areas, as well as a small commercial expansion in the vicinity of Darrington to increase employment opportunities in that community. Despite the intent of GMA, new commercial development and conversion of agricultural lands to rural residential land use can continue to impact sensitive habitat areas and conflict with watershed-based planning and restoration efforts. The conversion of existing forest and agricultural lands to rural residential and urban uses is a significant future concern.

Uncertainty related to local development regulations will present a challenge to salmon recovery efforts. As required by the Washington state Growth Management Act, counties and cities are required to update their Critical Areas Ordinances by December 2005 and update their Shoreline Management Master Programs by 2012. These updates provide an opportunity to coordinate local government policies and regulations with salmon recovery objectives. The protections offered by these regulations include stream and wetland buffers that are essential to preserving Chinook salmon habitat. The SIRC is monitoring development of the Snohomish County 10-Year GMA Comprehensive Plan Update, Critical Areas Regulations and Shoreline Master Plan updates, and will review and provide input during the appropriate comment periods. The SIRC has encouraged Snohomish County Planning and Development Services to consider the contents of the Stillaguamish Watershed Chinook Salmon Recovery Plan in drafting these new County policies and regulations.

Other regulatory and non-regulatory tools, including wetland preservation, sensitive area acquisition, site design, development guidelines, assessment, and monitoring should be utilized to support natural habitats and manage growth impacts. A landscape-level watershed planning approach will be

important in order to minimize and mitigate the effects of increasing urbanization throughout the watershed. Local government comprehensive plans and development regulations should consider these additional tools:

- Designate zoning classifications that meet natural landscape attributes and limit impervious surfaces by sub-basin
- Encourage natural floodplain processes and prohibit incompatible floodplain land uses such as bank hardening

Nearshore/Marine Environment

The goal of the nearshore component of a Chinook salmon recovery plan is to develop actions and planning area commitments to protect and restore those places of significance to salmon in the nearshore and marine areas of Puget Sound. The nearshore-marine system still has functioning habitats and processes that are critical to protect and restore. An integrated approach to harvest, hatchery, and habitat management in the nearshore-marine environments will be essential to addressing cumulative effects on salmonid populations.

The complexity of the use of the nearshore-marine environment by all Puget Sound Chinook salmon populations, combined with lack of sufficient information on these populations, limit the present ability to make quantitative nearshore-specific predictions relative to the VSP parameters in the timeframe of the Shared Strategy process. The Puget Sound Technical Recovery Team (TRT) will define the biological basis for nearshore-marine recovery related to Puget Sound Chinook salmon populations, and the USFWS Puget Sound/Olympic Peninsula Recovery Unit Team (RUT) will define the biological basis for nearshore-marine recovery related to bull trout populations. A separate regional nearshore-marine chapter of a recovery plan will be developed by the Puget Sound Action Team for the Shared Strategy to incorporate initiatives like the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), as well as technical and implementation issues best addressed at the regional scale.

Given the growth pressures in the region and developing understanding of the nearshore habitats and processes, the focus of short-term efforts will be to protect existing processes and habitats, and to ensure future opportunities for restoration and protection. Quantitative habitat expectations will be set for nearshore-marine contributions at the regional scale as the watershed-level information is compiled across Puget Sound. The Shared Strategy salmon recovery plan will incorporate more technically robust long-term strategies under development by NOAA Fisheries, PSNERP, and The Nature Conservancy as understanding of what actions are required and how those actions directly benefit fish populations improves.

Viability of Fisheries, Agriculture, and Forestry

Fishing, farming, and forestry are economically and socially important in the Stillaguamish Watershed. The ongoing viability of these natural resource industries is vital to Chinook salmon recovery as well as to the regional economy. The SIRC has strong support from the natural resource sector as a result of ongoing recognition of the benefits and value of local agriculture, forestry, and fisheries in the Stillaguamish Watershed.

Many key stream and river habitats in the Stillaguamish Watershed are on or near agricultural and forest lands. The potential impacts from agriculture and forestry to Chinook salmon habitat can be reduced by stewardship activities initiated by willing landowners. Recognizing that protection, restoration, and management of riparian areas and wetlands within the floodplain are important to salmon recovery, incentives must be in place to allow farmers and foresters to participate in Chinook salmon habitat restoration and protection. Without these incentives, farm and forest owners may consider selling and converting their lands to residential and commercial uses. The permanence of change resulting from this type of land use conversion has significant long-term impacts that conflict with the goals of salmon recovery and ecosystem restoration. The SIRC will continue to develop collaborative and coordinated approaches to watershed protection and restoration that include the interests of local farmers and foresters throughout the watershed.

The fishing economy is critical to the Tribal and non-Tribal community of the Stillaguamish Watershed. Tribal and non-Tribal fisheries have been severely impacted by reductions in fish populations. Voluntary reductions in harvest activities have reduced the impact from direct take of Chinook salmon. The SIRC feels the resource industries in the Stillaguamish Watershed need to continue to be viable and are essential to meaningful salmon recovery efforts.

Floodplains

While floodplains provide both important habitat features and components of hydrologic function critical for salmon, they are also the location of some economically and socially valuable land uses in the watershed. The ability for upstream floodplain storage to reduce flood impacts downstream is important to the Stillaguamish community and the SIRC. Therefore, restoring floodplain connectivity is also viewed by the SIRC as an opportunity to reduce the impact of floods downstream on human infrastructure. To secure future enhancement of floodplain function, the SIRC will support efforts to maintain agricultural uses of the floodplain, as well as implementation of restoration projects and agricultural Best Management Practices wherever applicable to reduce the negative impacts of agriculture in the floodplain.

The Stillaguamish River Comprehensive Flood Hazard Management Plan (Flood Plan) considers the impacts of flooding on aquatic habitats. One of the

plan's goals states "To the maximum extent possible, allow and encourage natural floodplain processes." Approximately 9,530 acres of mainstem floodplain is used for agriculture due to the rich soils provided by floodplain processes. The Flood Plan also states "Encouraging retention of low-density uses on large parcels (such as farmland) is key to preventing future flood damages from occurring." The zoning of this area is designated as "Ag-10", allowing for the potential construction of up to 800 new homes in the floodplain. Approximately 1,540 additional acres are zoned as "Rural Residential", with the potential for up to 130 new homes to be constructed in other parts of the floodplain. The total number of new homes that could potentially be built in the floodplain is almost twice the number of existing homes in the floodplain.

The hypothesis is that the largest threat to restoring floodplain connectivity in the Stillaguamish is the conversion of existing agricultural lands to rural residential uses. Due to poor economic conditions associated with farming, the current land use trend is splitting of large agricultural lands by retiring farmers into the smallest parcels allowed by county zoning. These parcels would then be developed for rural residential uses. While agricultural uses and some seasonal combined uses are compatible with floodplain function, rural residential uses and the resulting roads and infrastructure may be incompatible with both floodplain function and existing agricultural uses.

The role of sediments in relationship to floodplain function is widely misunderstood. Residents of the floodplain regularly refer to historic dredging of the river and comment on recent build-up of sediments causing increases in flood damage. Contrary to local opinion and surprisingly to some local residents, the stream bottom in some sections of the lower river is actually lower (degraded) than it was historically. The relationship between sediments and flooding is described in Section 3.4.2 of the Flood Plan. This section describes the movement of sediments through the river system and identifies locations where the river channel is aggrading and degrading. The plan includes a description of the various flood planning efforts that have occurred over the decades. The most beneficial of these planning efforts in relation to salmon recovery is the U.S. Army Corps of Engineers' Stillaguamish River Ecosystem Restoration Final Feasibility Report and Environmental Assessment (2000). This study identified locations in the floodplain and estuary that, if restored, would provide aquatic habitat and functions beneficial to downstream habitats, and, if implemented, also provide some flood relief.

The Flood Plan states that flood control activities from 1930 to the present have resulted in the loss of more than one-third of the mainstem channel area (Collins 1997). Section 6.2.2 states that gravel removal from the river bed may contribute to the disconnection of side-channel slough from the main channel, or disconnection of the floodplain from the main channel by

deepening the channel. Section 6.2.3 prioritizes alternatives encouraging natural floodplain processes, such as re-establishing natural storage area or conveyance channels.

Current floodplain projects in the watershed include complete removal of flood control structures to allow for restoration of natural processes (Smokes Farm), and other projects that take more of an engineered maintenance approach (North Meander) due to funding and modeling constraints. It has long been the position of the SIRC to restore natural floodplain functions whenever possible, but if necessary to gain the support of individual SIRC members, alternatives will be considered. The SIRC recognizes that the various floodplain restoration actions are attempting to correct impacts that have occurred over the past 125 years. The SIRC also recognizes that it may be decades before floodplain lands are available for dike setback or removal. In the short-term, specific floodplain projects may have a narrow focus for the benefit of salmon recovery, while social and economic conditions develop over the long-term for consideration of other potential alternatives.

The SIRC may explore opportunities to remove hardened banks and restore floodplain habitats in the lower mainstem Stillaguamish River and other reaches with significant bank armoring. The lower mainstem reach of the river historically had abundant side channels and higher incidence of channel migration, but is now heavily modified. Restoration of this and other floodplain reaches would require negotiation with riparian landowners.

Other alternatives that are in the discussion stages include the intentional flooding of farmland for wetland banking. The Transfer of Development Rights program is funded and being developed at Snohomish County with support of the council and executive. FEMA is aware that there is a need for better flood elevation information on the Stillaguamish. The SIRC members can also continue to work with individual landowners as we have done with the Smokes farm, North Meander and old Channel projects.

To provide for a greater level of certainty, the SIRC will organize a subcommittee to develop a comprehensive floodplain function strategy. This subcommittee will conduct an analysis of those regulatory agencies impacting floodplain function, including Snohomish County, the Cities of Arlington and Stanwood, and the Washington State Departments of Ecology and Natural Resources. Subcommittee representatives from those agencies will meet with other relevant stakeholders, including the Stillaguamish Flood Control District, Stillaguamish and Tulalip Tribes, agricultural representatives, land trust agencies, and other interested parties.

Forest Lands

Current use of forest lands has three relevant considerations for salmon recovery planning. First, cumulative timber harvest activities in steep

headwaters have and continue to cause channel widening and significant sediment loads in tributaries of the North and South Fork Stillaguamish River. Second, improper forest road construction has been a significant contributor to cumulative sediment loads and impacts to hydrology. Third, the management of riparian zones in headwater streams is key to maintaining the integrity of the hydrologic regime and instream stability.

In the future, timber harvest, forest road building and forest practices on steep slopes and riparian areas need to be conducted with full consideration of habitat conditions. Because forestry is such an extensive land use in the Stillaguamish Watershed, it is important for local salmon recovery efforts to account for how the existing regulatory framework for the forestry sector contributes to the protection and restoration of salmon habitat. Recent changes to the Washington State forest practice rules are encouraging. However, these rules must be implemented and monitored if the changes are to be effective. The SIRC recognizes the longevity of timber production, coupled with market and regulatory uncertainty, adversely impacts the economic viability of forest land ownership and that conversion to urban development may result in more significant impacts over time. The permanence of change resulting from this type of land use conversion has significant long-term impacts that conflict with the goals of salmon recovery and ecosystem restoration. Incentives should be established to encourage and enable continued private forest land participation in the protection and restoration of salmon habitat.

The sustainability of timber harvest is tied to both the hydrological function as well as sustainable economics in the watershed. Excessive harvest in the short-term will not leave enough timber to harvest in the future. Protecting the watershed function and sustainable forestry can be mutually beneficial if the right balance between timber harvest and watershed function is achieved.

The SIRC should coordinate with the appropriate state and federal agencies to encourage the following policies that support Chinook salmon recovery in the Stillaguamish Watershed:

- Improved forest management protection of riparian habitat
- Forest road BMPs and some hydrologic restoration
- Increase in forest harvest rotation intervals leading to more mature forest
- Maintain forest cover of 80% at subbasin scale

Changes in forest practices would provide multiple benefits throughout the watershed. In addition to improving salmon habitat, retention and creation of mature forest would reduce flooding in the lower reaches of the watershed.

The Snohomish County General Policy Plan contains sections on forestry (GPP Goal LU-8). Forestry goals and policies in the County GPP do not include a goal or policy to conduct forest practices in a manner that are

consistent with the Stillaguamish Watershed Chinook Salmon Recovery Plan. Forestry policies that would be consistent with the direction of this Plan would include encouraging growth and retention of mature forests, limiting erosion from forest road construction, encouraging efforts to limit the impact of landslides on sedimentation, and making efforts to control peak water runoff from clear cut logging operations. The SIRC encourages revisions to the General Policy Plan to include forestry policies that are consistent with meeting habitat protection and salmon recovery objectives.

The SIRC recognizes that the Forest and Fish Agreement has changed the way forestry is conducted in Washington State and that it is contributing to the recovery of Chinook salmon in the Stillaguamish Watershed. However, the SIRC also recognizes that existing science also indicates a need for additional habitat improvements that go beyond the requirements of the Forest and Fish Agreement. Because of this, the SIRC encourages the exploration of incentives that would enable forest land owners to take the additional steps that are needed to restore salmon habitat and watershed processes.

Instream Flows

State instream flow regulations seek to ensure perennial rivers and streams of the state have base flows necessary to provide for preservation of wildlife, fish, scenic, aesthetic, navigational, and other environmental values, while also providing water for future human needs. The Washington Department of Ecology is currently in the process of establishing an instream flow rule for the Stillaguamish, with input from watershed stakeholders. While providing sufficient reserves for future rural development, the proposed Stillaguamish water management rule will set instream flows needed in streams at specific locations and times to protect fish spawning and rearing, among other objectives.

The Department of Ecology anticipates setting instream flows at the following points in the Stillaguamish Watershed:

- Stillaguamish River at Silvana
- NF Stillaguamish River at Arlington
- NF Stillaguamish River at Whitman Road
- SF Stillaguamish River at Arlington
- SF Stillaguamish River at Granite Falls
- Pilchuck Creek
- Jim Creek
- Squire Creek
- Canyon Creek

It is recognized by all interests that there is a limited amount of water available during the low flow periods between July and October. It is unknown at this time to what extent diversions or water withdrawals cause or contribute to the low flow problems in the watershed. The proposed instream flows will protect against future diversions or junior water rights exacerbating low flow problems. The Department of Ecology, along with Snohomish County, the City of Arlington, and the Stillaguamish Tribe, is implementing a stream monitoring program in the watershed to collect basic data and to implement the future instream resource protection program.

During the spring of 2005 the Stillaguamish Tribe, Snohomish County, and Northwest Hydraulics initiated a Stillaguamish Instream Flow Assessment Pilot Project funded by the Shared Strategy for Puget Sound. The pilot study will use a geographically-focused approach to target discrete subbasins within the Stillaguamish Watershed where human actions are likely to be affecting flow regimes, both now and in the future. The pilot study looks to relate these human-induced flow changes to impact on salmonids by the use of Ecosystem Diagnosis and Treatment (EDT) and possibly SHIRAZ modeling, coupled with HSPF hydrologic modeling. The overall approach incorporates two contrasting, but very representative and transferable, case studies. Pilchuck Creek is a large Chinook salmon-bearing stream assumed to be affected primarily by water withdrawals, Church Creek is a smaller coho salmon-bearing stream affected primarily by current and future land use changes. The project will conclude by Fall 2005, with management recommendations to the watershed concerning human activities that potentially impact low flows. If successful, the pilot approach would be applied throughout the Puget Sound and beyond.

Water Quality

The Stillaguamish community has worked hard for 15 years to clean up the watershed for all citizens. Initiatives to protect and restore water quality were the foundation of the SIRC. Efforts continue to develop cleanup plans for impaired waterbodies and to address failing septic systems. Some water quality issues, such as improvements in sediment and temperature, are closely linked to salmon recovery. It is an objective of the SIRC that parallel efforts continue on water quality initiatives while salmon recovery work progresses.

Compliance with federal and state water quality laws has significant implications for salmon recovery. Snohomish County and other jurisdictions within the Stillaguamish Watershed must ensure compliance with regulations such as the Clean Water Act. The goals of the Act are to achieve and maintain “swimmable and fishable” waters. Municipalities and other entities subject to National Pollutant Discharge Elimination System (NPDES) permits are required to set standards for pollution, establish stringent conditions for development activities, and enforce violations.

The SIRC and its member agencies and individuals are working with the Department of Ecology, which is the state agency with responsibility for maintaining and protecting surface and groundwater quality, in developing implementation plans for two Total Maximum Daily Load (TMDL) projects. These projects address current water quality problems in the Stillaguamish where the waters do not meet state water quality standards for dissolved oxygen, fecal coliform bacteria, pH and temperature. The implementation plans will include strategies and activities needed to make water quality improvements; identification of responsible agencies and funding needs; and a timetable to bring about water quality improvements by the year 2009.

The Stanwood wastewater treatment plant is currently close to meeting its obligations to upgrade, operate and test their system to meet the Department of Ecology's NPDES requirements. The upgraded wastewater treatment plant should reduce the potential release of excessive fecal coliform and dissolved oxygen demands. These water quality improvements will benefit juvenile salmonids that utilize the old Stillaguamish channel and estuary locations which may have formerly been impacted by effluent discharges from the treatment plant.

Snohomish County and cities that have not adopted Ecology's Stormwater Manual for Western Washington should develop a stormwater program that is equivalent to this manual in ensuring that development projects are designed with the goal of infiltrating most of their stormwater. Infiltration addresses both the negative quality (i.e., carrying fecal coliform bacteria) and quantity (i.e., increasing peak flows and scouring as impervious areas increase) aspects of stormwater in urbanizing areas. Local stormwater management regulations should include provisions to:

- Retrofit/re-design infrastructure to decrease sediment and flow effects
- Provide incentives for low impact development design techniques (e.g., reduced impervious surfaces and increased stormwater infiltration)

Treaty Tribes and the Salmon Culture

The Stillaguamish and Tulalip Tribes have a deep cultural and economic stake in viable salmon populations. Rights to fish for salmon are protected by federal treaty and have been verified by subsequent court decisions. Because populations are so depressed, the Tribes have not had a directed Chinook salmon fishery in the watershed for over two decades. It cannot be overstated how critical the cultural survival of the Tribes is dependent on the survival of salmon. For centuries, the Tribes have followed and depended on the migration of the salmon for subsistence, ceremonial and, eventually, economic livelihood. The Boldt decision upheld the Tribes' right to harvest salmon in their usual and accustomed areas, and began the discussion of co-management with the State of Washington over habitat protection. The Tribes will

continue to be a key partner for salmon recovery and one with a special stake in its success.

Closing

Meeting all of the goals identified in this Stillaguamish Watershed Chinook Salmon Recovery Plan will be the responsibility of the people living in the Stillaguamish Watershed over the next 100 years. In addition to those contained in this plan, the SIRC will continue to make recommendations for additional actions to benefit Chinook salmon, watershed residents, and the overall Stillaguamish River ecosystem.

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