South Puget Sound Salmon Recovery Group

Chinook & Bull Trout Recovery Approach for the South Puget Sound Nearshore

Draft Version 1

For review purposes only

July 2004

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Prepared by the
South Puget Sound Salmon Recovery Group

For
The Shared Strategy for Puget Sound

Draft Version 1

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Introduction

This document is the nearshore complement to the Nisqually Chinook Salmon Recovery Plan.[1] Developed by the South Puget Sound Salmon Recovery Group (SPSSRG), it proposes a local strategy for delisting Nisqually Chinook and Bull trout. Shared Strategy for Puget Sound will integrate this plan into the overall Puget Sound ESU Chinook Recovery Plan due for release in June 2005.

There are seven chapters to the plan. The first two chapters present a broad profile of South Puget Sound as a region and the two focal species: Nisqually Chinook and bull trout. Chapter Three breaks new ground by presenting a natural processes-based conceptual model of how South Puget Sound works as an ecosystem consisting of habitats for Chinook and bull trout. The next two chapters examine the human-induced stressors that disrupt natural processes as well as their presence in nine South Puget Sound landscapes. Chapter Six outlines the science-based recommendations for general protection actions, recovery actions, and data needs necessary for managing habitat for salmon recovery. In balance with these actions are those governing hatchery and harvest practices. Chapter Seven represents the "human side" of the plan – how citizens, government, and salmon recovery organizations will harness the social, political, and economic institutions of our communities to implement the science-based recommendations covered in Chapter Six. Concluding the plan are two appendices that aid in understanding the South Puget Sound landscape and water quality issues.

The contents of this plan represent the best collective efforts of the members of the SPSSRG over a nine-month period. It also would not have been possible without their participation and contribution in ideas, funding, and text. I would like to thank the following people who participated on the following committees.

Management Oversight Committee

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[1] "Shallow water environments of Puget Sound estuarine and marine shoreline areas (in this document, we collectively refer to these areas as the *nearshore*) represent the aquatic boundary or interface between freshwater, air, land, and the open marine waters of Puget Sound. Estuaries include the deltatic portions of river mouths encompassing the upper extent of tidal influence (i.e., tidal freshwater or head of tide) to the outer extent of the delta. By definition this includes fjord systems such as the major inland passages of Puget Sound that technically comprise an estuarine complex. The nearshore includes upland and backshore areas that directly influence conditions along the shoreline and extends seaward to the deepest extent of the water column that encompasses the photic zone." PSNRP 2003.

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I extend my special thanks to those committee members contributing written materials and outlines. Scott Steltzner prepared material for Chapters One, Three, and Five, along with general editing and corrections for the document as a whole. Tom Kantz designed the conceptual models key to Chapter Three as well gave form to the landscape analysis in Appendix A and summarized in Chapter Five. Joanne Schuett-Hames researched all water quality related materials in the document and prepared Appendix B in its entirety. Doris Small prepared materials related to natural processes and the broad overview of South Puget Sound. Cindy Wilson, Margie Schirato, Scott Steltzner, Michelle Stevie, and Sayre Hodgson all contributed greatly in conducting nearshore assessments for the landscape analysis. Rich Eltrich provided summaries related to hatcheries and John Long provided text and analysis relating to Chinook harvest management. Each of these members contributed significant time and effort with their ideas as well.

The Washington Department of Fish and Wildlife, Shared Strategy for Puget Sound, the Squaxin Island Tribe, and the Puget Sound Action Team generously contributed the financial resources for consultant facilitation, project management, and writing services for this document.

John M. Kliem
June 30, 2004

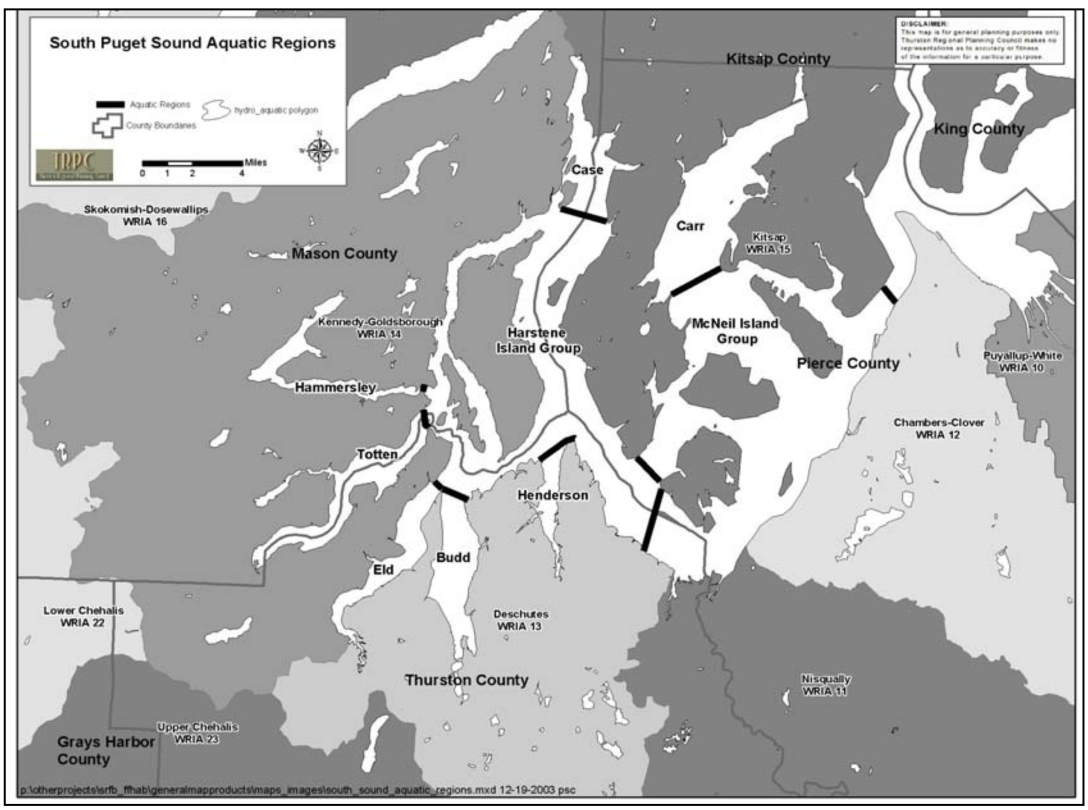
Overview of South Puget Sound

South Puget Sound geographically lies within the Puget Lowland physiographic province, a broad, low-lying region situated between the Cascade Range to the east and the Olympic Mountains to the west. The dominant physiographic feature of this area is the glacial plains cut by numerous streams and dissected by the inlets of Puget Sound.

The term South Puget Sound used in this report includes the marine waters and related nearshore located south of the Tacoma Narrows Bridge. It is the southern end of the larger Puget Sound fjord estuary complex, an area separated from central Puget Sound by a narrow, shallow sill associated with the Tacoma Narrows.

There are nine distinct South Puget Sound landscapes:

- Budd Inlet
- Case Inlet
- Hammersley Inlet & Oakland Bay
- Henderson Inlet
- Totten & Skookum Inlets
- Carr Inlet
- Eld Inlet
- Hartstene Island Group
- McNeil Island Group



The Nisqually River is the only major river system in the basin. Numerous streams drain into South Puget Sound that, when combined, rival the biological output of large

Puget Sound systems. The total surface area of marine waters in South Puget Sound is approximately 394 square kilometers. More than 50% of South Puget Sound is less than 36.6 meters deep and only a very small percentage is deeper than 100 meters.

Hydrographically, South Puget Sound is very different from the main basin of Puget Sound. Many of the larger scale physical and chemical processes found in greater Puget Sound are muted or accentuated in the smaller South Puget Sound subregion. This presents a unique set of conditions for physical, chemical, and biological interactions.

Numerous shallow, blind-end inlets divide South Puget Sound that causing poor circulation. As a result, water does not mix or dilute nutrient inputs to the same degree as the deeper, more tidally mixed areas such as the central Puget Sound basin, which has depths that often exceed 200 meters. The shallow nature of South Puget Sound, along with the slow flushing time, provides a greater amount of sandy habitat and makes many of the bays and inlets more productive then the rest of Puget Sound. Two consequences of such conditions are:

1. Different florae and faunae associated with the different sediment and benthos of South Puget Sound, and

2. An increased risk of pollutant concentration from land derived sediments in the South Puget Sound catchment area.

Llansó (1998) investigated these types of effects and found that the inlet ends of South Puget Sound had lower species diversity compared to the rest of Puget Sound. Furthermore, the species present appear to be associated with a combination of fine sediments and low DO.

Case Inlet and Carr Inlet are larger and deeper than other South Puget Sound inlets. The north/south positioning of these inlets cause prevailing winds to attenuate tidal flushing, which combined with relatively low freshwater input at their heads, results in poor mixing. Thus, these inlets tend to have episodic plankton blooms promoted by still water conditions that quickly exhaust nutrients. The other inlets and bays in South Puget Sound are quite shallow and branched, resulting in poor flushing and similar patterns of blooms. The hydrological, biological, and geomorphologic attributes of South Puget Sound make the region susceptible the potential for both the build up of anthropogenic nutrients and pollutants combined with stratification, resulting in oxygen depletion. Budd Inlet, in particular, has been under scrutiny because of persistent problems of low dissolved oxygen due to persistent stratification and the decay of phytoplankton blooms.

The intertidal region of South Puget Sound experiences twice-daily tide changes that expose large sand or mud flats, emergent salt marshes and beaches in estuaries, deltas and along shorelines. The mud and sand flats are typically devoid of emergent vegetation, but support eelgrass and benthic invertebrates that are essential food for higher order organisms. The emergent salt marsh has plants such as *Carex, Scirpus, Salicornia, Triglochin, and Distichlis,* among others. Salinity, substrate texture and the frequency and duration of floods govern these highly productive habitats. They also provide critical spawning habitat for many species of fish. Many shorelines have sandy beaches, often teeming with sand dollars. The flat, sandy areas of the nearshore are home to flounders, shrimp and worms, as well as seaweed beds that provide food and hiding places for millions of other creatures integral to the South Puget Sound food web. These distinct and highly productive intertidal zones provide critical habitat for many animal and fish species.

Freshwater

Five Watershed Resource Inventory Areas (WRIA) drain into South Puget Sound:

- WRIA 11 – Nisqually
- WRIA 12 – Chambers-Clover
- WRIA 13 – Deschutes
- WRIA 14 – Kennedy-Goldsborough
- WRIA 15 – Kitsap

Of these five WRIA, only the Nisqually, Deschutes, and Kennedy-Goldsborough WRIA drain exclusively into South Puget Sound. WRIA 15, Kitsap shares its drainage with Central Puget Sound north of the Tacoma Narrows and Hood Canal. WRIA 12, Chambers-Clover, also extends north of the Tacoma Narrows to Commencement Bay.

The following basin descriptions are extracts from the Limiting Factors Analysis prepared for each watershed. The descriptions for WRIA 12 and 15 include some areas outside of the South Puget Sound study area.

WRIA 11 – Nisqually

Water Resource Inventory Area (WRIA) 11 includes the Nisqually River which originates from the Nisqually Glacier on the southwest slopes of Mount Rainier (Figure 6) and three independent tributaries (McAllister Creek an unnamed creek and Red Salmon Creek) draining directly into Puget Sound. The Nisqually River flows northwesterly for approximately 72 miles before joining Puget Sound. The entire basin encompasses approximately 720 square miles and the principle drainage basin; the Nisqually River includes over 331 identified streams and 715 linear miles of river and stream channels (Williams 1975). The Nisqually River and its tributaries and the salmon stocks they support, are described in detail later in this report.

The salmonid resources of the Nisqually River Basin has been adversely impacted through a variety of land use practices. Commercial timber activities have increased sediment loads, reduced large woody debris input and recruitment potential, and altered precipitation run-off patterns. The conversion of pristine valley bottomlands and wetlands to agricultural purposes and now to rural residential and hobby farms has reduced the natural biological processes of these parcels necessary for the natural production of salmonids in the Nisqually River Basin. The Nisqually River estuary has lost approximately 30 percent of its historical intertidal and subtidal habitat. Of critical importance to the natural production of salmonids is the 54 percent loss in intertidal emergent marsh habitats. The mainstem Nisqually River is constrained by a system of revetments and levees in the lower 5.2 river miles, remnant flood control dikes in areas near McKenna and maintained dikes that protect the Yelm Diversion Canal between RM 21.8 to 26.4. These channel containment structures...inhibit lateral channel migration and have eliminated much of the spawning and rearing habitats that were once present. Additionally, there is some evidence that suggests off-channel rearing habitats have been reduced in the mainstem Nisqually River between 1965 and 1995. Currently, off-channel rearing habitats are virtually absent between river miles 10 and 25. (Kerwin 1999)

WRIA 12 – Chambers-Clover

WRIA 12 is located in central Pierce County and is roughly triangular in shape, bounded by Puget Sound on the west, and extends east to near the community of Graham. Point Defiance and the southwest shore of Commencement Bay serve as the WRIA's northern boundary. The City of DuPont near the Nisqually River Basin is located near the southern boundary. The WRIA covers approximately 180 square miles (Clothier, et al 2003).

WRIA 12 comprises the Chambers-Clover Creek Basin and the neighboring small drainages of Sequalitchew (including American Lake and Murray Creek) and Puget Creeks in Pierce County, Washington. It also encompasses several independent stream drainages, including unnamed creeks draining from the North Tacoma area directly into Puget Sound, and Crystal Springs Creek. Important lakes within WRIA 12 are Lake Louise, Owens Marsh, and Steilacoom, Gravelly, American, Spanaway, Waughop, Charlton, and Wapato Lakes (Clothier, et al 2003). WRIA 12 includes approximately the western half of the City of Tacoma, all of the Cities of Lakewood and University Place, and the Towns of Steilacoom, Dupont, Fircrest, and Ruston. It also includes the unincorporated communities of Parkland, Spanaway, Elk Plain, Frederickson, and Midland. McChord Air Force Base and part of Fort Lewis occupy a large portion of the central and southern part of the basin (Clothier, et al 2003) (See Figure 2).
The steady pace of urbanization in this watershed has led to declining fisheries resources in WRIA 12 for over a century, with the exception of hatchery-raised fall Chinook salmon. Many alterations have been made to the streams and overall watershed in WRIA 12, beginning as early as 1853 and accelerating in the late 1800s (Consoer and Townsend 1977). Trends in fisheries production/escapement appear to be linked to habitat conditions, such as stream flow, water quality, human harvest, and

natural predation. Human use and development have been major contributors to the current conditions. Impervious surfaces, runoff, pollution, and water consumption have taken their toll on WRIA 12 (Clothier, et al 2003). (Runge et al. 2003)

WRIA 13 – Deschutes

Located at the southern end of Puget Sound (Figure 1), Water Resource Inventory Area (WRIA) 13 is almost entirely within the bounds of Thurston County, with a small portion (the headwaters of the Deschutes River) in Lewis County. The drainages of the WRIA empty into three saltwater inlets that, in turn, define the major watersheds: Henderson Inlet to the East, centrally located Budd Inlet, and Eld Inlet to the West. The Deschutes River is the major hydrologic basin in WRIA 13, with a number of other smaller independent tributaries to salt water.

The Henderson Inlet watershed lies in the northeast section of WRIA 13 and has a total drainage area of about 29,275 acres (Thurston County 1989). The topography of the watershed is divided into three parts: the Dickerson Point peninsula, the Johnson Point peninsula, and the Woodland Creek Basin. The three areas drain surface water into Henderson Inlet. Most of the basin lies at an elevation of less than 200 feet above sea level. The inlet is about five miles long from Dickerson Point to the mouth of Woodland Creek, ranging from .25 to .75 miles wide, and covering 2.5 square miles in area. It has an average depth of 25 feet, and reaches its maximum depth of 60 feet near the mouth (Thurston County et al. 1995). The southern head of the inlet forms an estuary at the mouth of Woodland Creek and reveals large mudflats at low tide.

The Budd Inlet/Deschutes Watershed is comprised of 143 identified streams that provide over 256 linear miles of drainage. Total area of the watershed is 118,773 acres. The Deschutes River with its associated tributaries is the largest drainage system within the watershed. The 52 mile-long river drains approximately 166 square miles or about 84% of the total watershed. Other notable streams within the Budd Inlet drainage are Percival/Black Lake Ditch, Ellis, Moxlie/Indian , Adams, Mission and Schneider creeks.

The entire Eld Inlet watershed encompasses approximately 23,220 acres. The primary streams in the watershed are McLane Creek, it's tributaries, and Green Cove Creek. The McLane Creek drainage system incorporates a total of 7,360 acres. It begins in the Black Hills and flows northward, forming Delphi Valley and terminating at the estuary of Mud Bay. The Delphi Valley and surrounding Black Hills exhibit a wide variety of topographies. The highest point is 807 feet in the Black Hills north of Black Lake, while the lowest is Mud Bay at sea level. Cedar Flats and Swift Creeks are the major tributaries of McLane Creek that originate in the Black Hills, while Perkins Creek enters McLane from the Cooper Point peninsula side. Green Cove Creek originates at Grass Lake on the Cooper Point peninsula and runs 3.6 miles north along the eastern boundary of the watershed emptying into Green Cove midway up the peninsula. (Haring and Konovsky 1999)

WRIA 14 – Kennedy-Goldsborough

The Kennedy-Goldsborough Basin (WRIA 14) covers about 381 square miles of southwest Puget Sound. The area is drained by many small independent streams; no major river system is present. Streams generally flow north and east from rolling hills located between the inlets of southern Puget Sound and the Olympic Mountains to the north. One hundred thirty-nine independent streams, traversing approximately 240 linear miles have been identified. Inlets and mudflats deposited at stream confluences provide a variety of marine habitats. Slow tidal interchange within the long, enclosed water bodies of Eld Inlet and Mud Bay, Totten Inlet and Oyster Bay, Skookum Inlet, Hammersley Inlet and Oakland Bay, and upper Case Inlet and North Bay provides nutrient enriched waters at stream outlets. Streams are generally lowland types with headwaters originating from springs, surface water drainage, wetlands, beaver ponds, or small lakes. Upper watersheds are typically moderately to heavily forested with large acreages of second and third growth coniferous trees. Most streams originate in steep ravines, gradually transition to broad valley bottoms dominated by alder and brush, then flow through tide flats. Rural and urban development are usually associated with the lower portions of streams near salt water bays. (Kuttel, 2002)

WRIA 15 - Kitsap

East WRIA 15, straddling the boundary between Pierce and Kitsap counties (there is also an extremely minimal part of this watershed in the northeastern corner of Mason County). The watershed lies between the northern end of Case Inlet on the west and the Tacoma Narrows and Colvos Passage on the east, including several islands in the eastern portion of southern Puget Sound. The watershed contains approximately 101,000 acres (158 mi2) of land and 144 miles of shoreline. It is composed of two large peninsulas and many islands. The three largest islands are Fox, McNeil, and Anderson. There are a number of smaller islands, including, Raft, Herron, Cutts, Eagle, Gertrude, Tanglewood, and Ketron. It includes the incorporated City of Gig Harbor, as well as a number of unincorporated communities.

The estimated population of the Key Peninsula/Gig Harbor/Islands (KGI) watershed in 1990 was approximately 54,000. This population is expected to increase to 65,000 in 2000, to 78,000 in 2010, and to 87,000 in 2020 (PSRC 1995, as referenced in KGI DRAFT 1999). Estimated populations for the KGI subwatersheds in 1994 were (KGI DRAFT 1999):

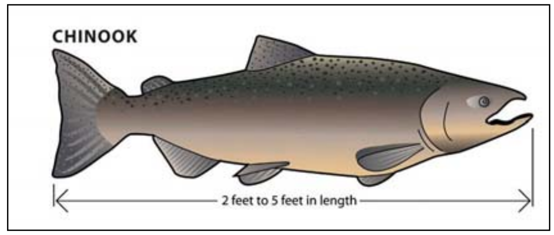
- Gig Harbor 22,000
- Burley/Minter 18,000
- Key Peninsula 9,000
- Rocky Bay 1,000
- Islands 3,700 (*Excludes McNeil Island prisoners*)

The largest population increases between 1990 and 2020 are expected in the Gig Harbor and Burley/Minter subwatersheds, which are both expected to double in population. (Haring 2000)

Chinook and Bull Trout Populations in South Puget Sound

1. Summary Profile of Listed Salmonids in the Puget Sound Nearshore

1A. Chinook (*Oncorhynchus tshawytscha*)



Ocean type (fall) Chinook typically migrate to sea during the first year of life, normally within three months of emergence. They spend the majority of their life in coastal waters and return to the natal stream in the fall a few days or weeks prior to spawning. In contrast, stream type (spring) Chinook rear for one or more years in fresh water prior to migrating to sea where they undertake extensive ocean migrations. They return to the natal stream in the spring or summer, several months prior to spawning (Healey 1998).

Although Chinook are generally considered to prefer deeper and faster spawning areas than other species in the genus *Oncorhynchus*, measurements recorded in the literature do not suggest that Chinook avoid shallow water and low flows. Their large body size may allow them to hold position in faster currents and displace larger spawning substrates than other Pacific salmon, hence the perceived preference for deeper and faster water. Chinook have been observed spawning in water ranging from ~ 2 inches (5 centimeters) to 15 feet (~ 4.6 meters) deep. They appear to select spawning sites with high subgravel flows. This preference may be related to the increased sensitivity of Chinook eggs to fluctuations in dissolved oxygen levels when compared to other species of Pacific salmon (Chinook produce the largest eggs, yielding a small surface-to-volume ratio) (Healey 1998).

Chinook fry appear to have more difficulty emerging from small substrate than large substrate. Most fry emergence occurs at night. Following emergence the fry move downstream, also principally at night. The fry may continue the downstream migration to the estuary, or take up residence in the stream for a few weeks to a year or more depending upon the life history strategy. Fry migrants typically range in size from 30 to 45 mm fork length. Fingerling migrants are larger, with a range of 50 to 120 mm fork length. While rearing in fresh water, Chinook feed primarily on larval and adult insects and zooplankton (Healey 1998).

Chinook fry feed in estuarine nearshore areas until they reach about 70 mm fork length, at which time they disperse to marine areas. Chinook rearing in estuarine areas are opportunistic feeders; they will consume a variety of prey ranging from chironomid larvae and zooplankton to mysids (opossum shrimps) and juvenile fish. Most fall Chinook do not migrate more than 1,000 km (about 620 miles) from their home stream during their ocean residence. Fish, particularly herring and sand lance, are the primary prey of Chinook during their ocean growth phase. However, invertebrates including euphausiids (krill), squid, and crab larvae are also important at times (Healey 1998).

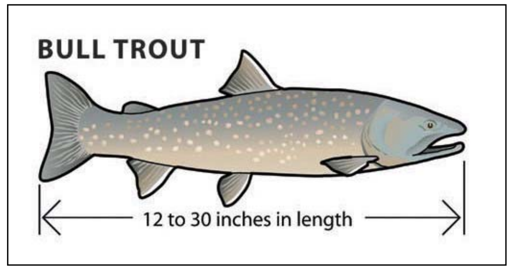
Nisqually Chinook Stock Profile

Stock Status:	The SaSI stock status is rated "Depressed" in 2002 due primarily to low stock productivity. The mean number of spawners for brood years 1988 through 1997 of 1,064 should have produced a mean number of recruits 5,062, even assuming low marine survival. However, the observed mean for these broods was only 3,815. In addition, the mean escapement is less than the recovery goal of 2,590.
Spawning Distribution:	Spawning occurs in the mainstem Nisqually from RM 15 to RM 40, Mashel River (RM 0.0 – RM 3.2), Ohop Creek (RM 0.0 – RM 6.2), Twenty-five Mile Creek (RM 0 – RM 0.6), Yelm Creek (RM 0.0 – RM 0.5), Horn Creek (RM 0.0 – RM 0.5), and Muck Creek (RM 0.0 – 0.7).
Spawning Timing:	Most spawning occurs from late September through October.
Genetic Analysis:	Chinook spawning in the mainstem Nisqually, Mashel River, and Ohop Creek were sampled in 1998, 1999, and 2000. Allele frequencies of the combined samples were similar to those of a few South Sound hatchery and wild populations. They were distinct from North Sound and other Washington Chinook. The extent of hatchery-origin fish in the genetic samples is currently unknown (Anne Marshall, WDFW, personal communication).
Stock Origin:	This is a mixed stock with composite production. The native Chinook stock may have been largely replaced by Soos Creek Hatchery (Green River) Chinook released into the Nisqually system and from Soos Creek Hatchery-origin strays from the Nisqually Tribe's Clear Creek and Kalama Creek hatcheries and the WDFW McAllister Creek Hatchery. Stock origin is difficult to determine because the life history and genetic composition of the native Nisqually stock may have resembled those of other South Sound Chinook stocks, including Green River and Puyallup (Anne Marshall, WDFW, personal communication). Current genetic and life history patterns could reflect native stock characteristics and/or extensive introgression with South Sound hatchery Chinook and so are not very informative (Puget Sound TRT 2001).

South Sound Tributaries Chinook Profile

Stock Status:	The evaluation of the South Sound Tributaries Chinook stock in the 1992 SASSI regarded all naturally spawning fish, including hatchery returns released or escaping above hatchery racks. These hatchery-origin adults, spawning in their basins of origin, were responsible for the large escapement numbers and the healthy rating for this stock in 1992. In SaSI 2002, the fall Chinook spawning aggregations observed in south Puget Sound independent tributaries are not rated. The Co-managers support this action with the following rationale: (1) The independent tributaries in South Puget Sound are not typical Chinook habitat because of relatively small stream size and low flows during the late summer/early fall spawning season. (2) The current low escapements (outside of streams that support on-station Chinook production programs) are likely the result of past hatchery plants or straying from either current South Sound hatchery production or viable South Sound natural populations. (3) Fall Chinook likely were not historically self-sustaining in these habitats and have little chance of perpetuating themselves through natural production. We do not regard fall Chinook spawning in generally small independent South Sound streams as being a distinct stock in the same sense that the term is used elsewhere in this inventory.
Spawning Distribution:	Most spawning takes place in McAllister Creek, Deschutes River, Percival Creek and other independent tributaries such as Woodland Creek, Mill Creek, Goldsborough Creek, Case Inlet streams, Carr Inlet streams, and East Kitsap streams.
Spawning Timing:	Spawning generally occurs from late September through October.
Genetic Analysis:	No genetic analysis has been done on South Sound Tribs Chinook.
Stock Origin:	South Sound tributaries are streams that we consider probably did not possess sustainable populations of Chinook historically. Present-day Chinook returns are due to the large releases from a number of South Sound hatcheries. Although locally returning Chinook are now used for broodstock at these hatcheries, their ancestry is largely Soos Creek Hatchery (Green River) Chinook.

1B. Bull trout (*Salvelinus confluentus*)



Bull trout reach sexual maturity at between four and seven years of age and are known to live as long as 12 years. They spawn in the fall after temperatures drop below 48 degrees Fahrenheit (8º C), in streams with cold, unpolluted water, clean gravels, and cobble substrate, and gentle stream slopes. Many spawning areas are associated with cold-water springs or areas where stream flow is influenced by groundwater. Bull trout eggs require a long incubation period compared to other salmon and trout (4-5 months), hatching in late winter or early spring. Fry remain in the stream bed for up to three weeks before emerging. Juvenile fish retain their fondness for the stream bottom and are often found at or near it.

Some bull trout may live near areas where they were hatched. Others migrate from streams to lakes, reservoirs, or saltwater a few weeks after emerging from the gravel.

The US Army Corps of Engineers published the following information in its draft 2004 document, "Bull Trout in the Nearshore."

> The only confirmed recent reference of bull trout from the South Puget Sound estuarine and nearshore waters is from Fresh et al. (1979). In 1978, from February 15 to July 20, a total of 47 species, 59,743 individual fish, and one bull trout were captured. This fish was caught by beach seine on April 17, 1978 at DeWolf Bight and examined for stomach contents, none present. Dewolf Bight is the only distinct point (presumed spit, external irregularity in the shoreline), approximately 1 km west from McAllister Creek, along the Nisqually Head or "west Delta" reach. Beaches in this area generally have gentle slopes and are predominately sand and mud. The bull trout capture date was the peak capture for chum salmon at Dewolf. This site had the second highest chum CPUE (136.6 day, 68.3 night) for all beach seine sites, highest was south Anderson Island (460.3 day, 92.8 night).
>
> Bull trout have also been captured in freshwater areas of the Nisqually, these fish presumably would have migrated from the nearby core area of the Puyallup River or other more northern areas. A single juvenile was collected during stream sampling in the lower reaches in the mid-1980's (WDFW 1998 in USFWS 2004). In the late 1990's, a single adult was observed at the Clear Creek Hatchery in mid-September. This fish was approximately 508 to 558 millimeters (20 to 22 inches) in size and presumed to be anadromous based on its "bright" coloration (J. Barr, Nisqually Tribe, pers. comm. 2003, in USFWS 2004).

Nisqually Bull Trout Stock Profile

Stock Status:	Bull trout/Dolly Varden in the Nisqually River have been identified as a distinct stock based on their geographic distribution. Habitat is available for all life history forms: anadromous, fluvial, adfluvial, and resident. The only information available is the collection of one juvenile bull trout/Dolly Varden by Nisqually tribal biologists while stream sampling in the mid-1980s. No bull trout/Dolly

Varden have been reported in the Nisqually tribal commercial fisheries. Spawn timing and locations are unknown.

Nisqually bull trout/Dolly Varden are native and are maintained by wild production. The stock status is Unknown. No data is available for this stock.

2. Chinook and Bull Trout Use of the Nearshore Habitat

Hypothesis formed by the Puget Sound Technical Recovery Team and the Puget Sound Action Team are used to explain how various nearshore habitats in South Puget Sound support juvenile salmonids. Little information exists on adult salmonid use of Puget Sound marine waters; however, it is assumed that many of the habitats beneficial to juvenile salmonids are also beneficial to adults. In South Puget Sound, habitat types are distributed throughout a larger landscape mosaic whose patterns and interconnections provide productive and protective habitat units and edges that support multiple life history trajectories. Salmonid use of many different habitats over wide geographic regions and over different periods contributes to the long-term viability of a salmon population by reducing the reliance of the population on any single element of the nearshore and marine landscape.

Viable salmon populations use the nearshore landscapes in four basic ways during their life history:

- Feeding and growth (rearing)
- Refuge from predation and extreme events
- Physiological transition
- Migratory corridors

Ongoing data collection is beginning to show that the use of South Puget Sound for these purposes is not exclusive to Nisqually Chinook and bull trout. Seining research and genetic testing conducted by biologists from the Squaxin Island and Nisqually Tribes reveal that juvenile Chinook from river systems north of the Tacoma Narrows use South Puget Sound ecosystems.

Utilization of the nearshore by salmonids occurs within a landscape system summarized into four broad habitat types:

- Open exposed shores
- Protected shorelines
- Pocket estuaries
- River and stream estuaries and deltas

Each of these broad classes includes a number of embedded smaller scale habitat types such as mudflats, eelgrass, blind channels, etc. Specific salmon habitats can occur in more than one of the four landscape classes.

Open exposed shoreline habitat provides critical functions, including feeding and growth, refuge from predators, migratory corridors, and to a lesser degree physiological transition, for primarily larger juvenile salmon once they transition into the neretic zone. While important year round, the open exposed shorelines become more important later in the calendar year as juvenile salmon life history types move out of the protected areas.

Protected shoreline habitat provides critical functions, including feeding and growth, refuge from predators, migratory corridors, and physiological transition, and is very important for early fry migrants (e.g., pocket estuary fry, delta fry) and may also be important to mature juvenile salmon (e.g., parr migrants and yearlings). Protected shorelines are more important to all life history stages earlier in the year before the water temperatures increase. Protected shorelines often host large spawning aggregations of forage fish, and are very important for generating prey base for fry migrants and providing refuge from predators and extreme events. Protected shorelines can provide important support for large numbers of early fry migrants because many occurrences of protected shorelines are in close proximity to the natal river mouth estuaries for independent populations of Puget Sound Chinook.

Pocket estuaries are smaller lagoon-type systems near shorelines composed of habitats such as un-vegetated flats, salt marsh, and tidal channels. Pocket estuaries provide critical functions, including rearing (feeding and growth), refuge from predators and extreme events and opportunity for physiological transition, for juvenile salmon, primarily early fry migrants of very small size. Pocket estuaries differ from intertidal habitats in larger estuaries because (a) the finer scale habitats included in the pocket estuaries are more associated with lower wave energy regimes, and (b) the presence of surface and groundwater freshwater inputs that dilute salinity seasonally (usually winter and spring). In addition, there are different types of pocket estuaries such as lagoon-type systems with or without freshwater and small systems that may be perennial or ephemeral.

River and stream mouth estuaries and deltas provide critical functions, including rearing (feeding and growth) and refuge from predators and extreme events, for primarily early fry migrants (pocket estuary) and delta fry, and the opportunity for physiological transition and migratory corridors for larger juvenile salmon life history types (parr migrants and yearlings). River and stream mouth estuaries include natal estuaries and deltas.

3. Chinook and Bull Trout Management in South Puget Sound

The State of Washington and Treaty Tribes jointly co-manage Chinook and bull trout populations in Puget Sound. Together, these governments work cooperatively on developing management programs for habitat, hatcheries, and harvests, especially for Chinook populations.

3A. Habitat Management

The state and the Treaty Tribes collectively develop the tools needed for analyzing the loss and degradation of freshwater and nearshore habitats for salmonids. The Salmon Stock and Inventory (SaSI), first produced in 1992, classifies the status of wild stocks that helps to gauge the efficacy of restoration efforts. The Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) is a computerized information system to catalog details about habitat as well as map fish stock distribution and status.

3B. Hatchery Management

Puget Sound Chinook hatchery production and harvest is co-managed by WDFW and the Treaty Tribes. The Puget Sound Management Plan, written in 1977, provides a framework for co-managers to set Chinook production and harvest goals. There are currently two conservation programs in South Sound, the rest are dedicated to harvest. The goal of harvest programs is to provide for recreational, commercial and tribal fishing opportunity. The Nisqually River program is dedicated to both conservation and harvest. The long-term goal is to assist with restoration of naturally spawning populations of fall Chinook salmon in the Nisqually River and provide for tribal harvest in the river. The operation at Hupp Springs is also a conservation program that seeks to support the recovery of the White River spring Chinook salmon (Hatchery Reform recommendations, Feb. 2002).

There are currently 11 hatchery facilities operating in South Sound. The Nisqually Indian Tribe operates two facilities, the State of Washington and the Squaxin Tribe co-manage a facility, and the state operates eight more by itself through the Department of Fish and Wildlife. The table on the next page lists the facilities that support Chinook production, the number of fish released, and the receiving watershed.

Chinook Production in South Sound (from the "2003-04 Future Brood Document")

	Fall Chinook Released		Spring Chinook Released		
Production Facility	Sub-yearling	Yearling	Sub-yearling	Yearling	Watershed
Chambers Creek	100,000	70,000			Chambers
Lakewood	100,000	130,000			Chambers
Garrison Springs	850,000				Chambers
Clear Creek	3,500,000				Nisqually
Kalama Creek	600,000				Nisqually
Tumwater Falls	3,800,000				Deschutes
Percival Cove		200,000			Deschutes
Coulter Creek	Supports Tumwater Falls Production				
Minter Creek	1,800,000				Minter
Hupp Springs			200,000	85,000	Minter
Total Production	10,750,000	400,000	200,000	85,000	

Operational Guidance For Hatcheries in South Sound

Several documents provide operational guidance, direction, or program descriptions for hatcheries in South Sound. These include the Future Brood Document, the Co-Managers Salmonid Disease Control Policy and the Hatchery Genetic Management Plan.

Currently, hatchery programs in Washington State are undergoing an extensive operational review by the Hatchery Scientific Review Group (HSRG). The task of the HSRG is to assemble, organize, and apply the best available scientific information available to provide guidance and recommendations to the policy makers and technical staff who are responsible for implementing hatchery reforms.

Future Brood Document

The Future Brood Document (FBD) is a pre-season planning document for fish hatchery production in Washington State for the upcoming brood stock collection season. The FBD is coordinated between WDFW, the Northwest Indian Fisheries Commission (NWIFC), and Federal fish hatcheries. Hatchery production by volunteers, schools, and Regional Fisheries Enhancement Groups are represented by WDFW. Every Puget Sound hatchery program is listed in the document by facility location, species, race, brood year, stock and WRIA number. Each program lists the egg take goal, transfers that occur throughout the year and the planting goal. Dates, fish size and pounds produced are listed for each transfer and plant. This document is reviewed annually and the co-managers agree to production numbers. Changes to the FBD require submission of an FBD change form and approval by the co-managers.

Co-Managers Salmonid Disease Control Policy

This policy was developed between the Co-Managers in order to provide guidance and policy control of how hatcheries will operate to minimize the risk of importation, dissemination, and amplification of pathogens known to adversely affect salmonids.

The policy divides the state into eight egg health management zones and 14 fish health management zones. The Policy provides direction for the care of broodstock, egg collection, egg and fish transfers within and between health zones.

Hatchery Genetic Management Plans

Listing of Puget Sound Fall Chinook as threatened under the Endanger Species Act required all hatcheries in Puget Sound to develop a Hatchery Genetic Management Plan (HGMP). All Chinook programs in South Sound have an HGMP. The HGMP's describe, in a format prescribed by NOAA Fisheries, the operation of each artificial production program for salmon and steelhead in the Puget Sound region and the potential effects of each program on listed species. The HGMP's have been provided to NOAA Fisheries for consideration as significant measures under Section 4 (d) of the Endangered Species Act.

The following Chinook HGMP's are listed for South Sound facilities:

- Chambers Creek Fall Chinook Yearling Program (Lakewood and Chambers)
- Garrison Springs Fall Chinook Fingerling Program
- Tumwater Falls Fall Chinook Fingerling Program
- Tumwater Falls Fall Chinook Yearling Program (Percival Cove)
- White River Spring Chinook (Minter Creek and Hupp Springs)
- Minter Creek Fall Chinook Fingerling Program
- Nisqually River Fall Chinook Fingerling Program (Clear Creek and Kalama Creek)

Neither the Treaty Tribes nor the State of Washington has a hatchery program for bull trout in South Puget Sound.

3C. Harvest Management

Chinook

Harvest management of Chinook populations within Puget Sound is implemented through the Puget Sound Comprehensive Chinook Management Plan – Harvest Management Component (Puget Sound Indian Tribes and WDFW, March 2004). State and tribal technical staff meet periodically in-season to exchange information and data, achieve consensus on in-season management actions, and prepare post-season reports. Additional meetings and exchanges occur as needed to develop recommendations relative to the management units' harvest and conservation objectives, resolve differences in approach, and review monitoring program results. Data from the monitoring programs form the basis for development and refinement of forecasting and assessment efforts.

The Harvest Management Plan consists of management guidelines for planning annual harvest regimes as they affect Puget Sound Chinook for the 2004 - 2009 management years. The Plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, and considers the total harvest impacts of all fisheries on Puget Sound Chinook, including those in Alaska, British Columbia, and Oregon. The Plan's objectives can be stated succinctly as intent to:

> "Manage harvest of stronger salmon stocks to ensure that the incidental fishery-related mortality will not impede recovery of the productivity, abundance, and diversity of natural Puget Sound Chinook salmon populations to levels consistent with treaty-reserved fishing rights, and cultural and ecological values."

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

The co-managers and the Puget Sound Shared Strategy have adopted abundance and productivity goals for most Puget Sound Chinook populations, including Nisqually natural spawning Chinook. These goals represent best available information about the characteristics of recovered populations in Puget Sound. They are intended to guide all aspects of recovery planning, including components for management of harvest and hatchery production, and conservation and restoration of freshwater and marine habitat.
In order to achieve recovery, the Harvest Management Plan adopts fundamental objectives and guiding principles. The Plan will:

- Conserve the productivity, abundance, and diversity of the populations that make up the Puget Sound ESU.

- Manage risk: The development and implementation of the fishery mortality limits in this Plan incorporate measures to manage the risks, and compensate for the uncertainty associated with estimating current and future abundance and productivity of populations. In addition, the 'management error' associated with forecasting abundance and the impacts of a given harvest regime is built into simulating the long-term dynamics of individual populations. Furthermore, the plan commits the co-managers to ongoing monitoring, research, and analysis, to better quantify and determine the significance of risk factors, and to modify the plan as necessary to minimize such risks.

- Meet ESA jeopardy standards: The ESA standard, as interpreted by the NMFS, is that activities, such as harvest regulated by this plan, may be exempted from the prohibition of take, prescribed in Section 9, only if they do not "appreciably reduce the likelihood of survival and recovery" of the ESU (50 CFR 223 vol 65(1):173). This plan meets that standard, not just for the ESU as a whole, but in several respects sets a more rigorous standard for conserving the abundance, diversity, and productivity of each component population of natural Chinook within the ESU.

- Provide opportunity to harvest surplus production from other species and populations: This Plan provides for continued harvest of sockeye, pink, and coho salmon, as well as the abundant hatchery production of Chinook from Puget Sound and the Columbia River. This plan eliminates directed fisheries on depressed Puget Sound Chinook but permits incidental catch of these runs in fisheries aimed at other runs with harvestable surpluses. The level of incidental catch is constrained by specific conservative exploitation rate ceilings or other management objectives.

- Account for all sources of fishery-related mortality, whether landed or non-landed, incidental or directed, commercial or recreational, and occurring in the U.S. (including Alaska) or Canada, when assessing total exploitation rates.

- Follow the principles of the Puget Sound Salmon Management Plan (PSSMP), and other legal mandates pursuant to U.S. v. Washington (384 F. Supp. 312 (W.D. Wash. 1974), and U.S. v Oregon, in equitable sharing of harvest opportunity among tribes, and among treaty and non-treaty fishers.

- Achieve the guidelines on allocation of harvest benefits and conservation objectives that are defined in the 1999 Chinook Chapter of Annex IV to the Pacific Salmon Treaty.

- Protect Indian treaty rights: The exercise of fishing rights by individual tribes is limited to 'usual and accustomed' areas which were specifically described by sub-proceedings of U.S. v. Washington according to their historical use of salmon resources.

This plan is based on limits to the cumulative annual fishery-related mortality to each Puget Sound Chinook population. The limits are expressed either as an exploitation rate ceiling, which is the maximum fraction of the total abundance that can be subject to fishery-related mortality, or as a spawning escapement floor, which is the minimum abundance allowed to return to the natural spawning areas. In many cases, populations are aggregated into harvest management units because of the scale at which data that describe catch distribution are available. However, in every case, the fishery mortality limits apply to individual populations, and the effect of this plan on individual populations is the standard by which the guidelines were developed and will be the standard by which the plan's performance will be ultimately evaluated.

The development and implementation of the fishery mortality limits in this plan incorporate measures to manage the risks and compensate for the uncertainty associated with quantifying the abundance and productivity of populations, where the information is available for such assessment. In addition, the 'management error' associated with forecasting abundance, and estimating the impacts of a given harvest regime, is built into the simulation of the future dynamics of individual populations which is the basis for selecting exploitation rate objectives for some units. Furthermore, the plan commits the co-managers to ongoing monitoring, research and analysis, to better quantify and determine the significance of risk factors, and to modify the plan as necessary to minimize such risks.

Historic data regarding harvest numbers for naturally spawning and hatchery Nisqually Chinook, including the location of their capture, follow on the next two pages.

Bull trout

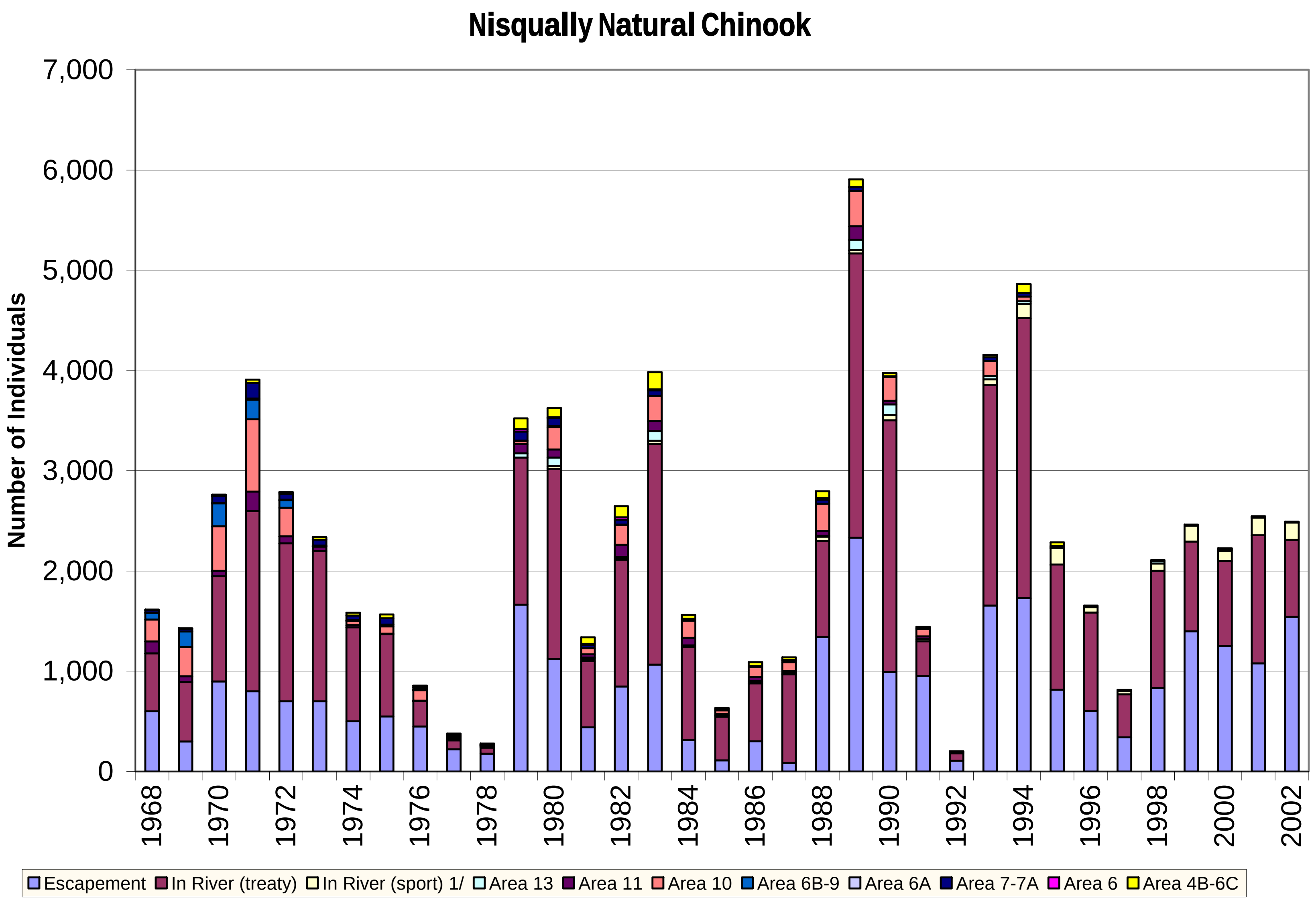
Bull trout are not known to utilize the freshwater habitats in South Puget Sound Tributaries to any great extent. There are very few, unverified reports of bull trout observations in this region. These reports are likely the result of misidentified fish, or strays from other systems. However, bull trout are known to be very dynamic, and could potentially utilize nearshore habitats in South Puget Sound.
There are no, directed bull trout fisheries, (treaty, non-treaty, commercial, or recreational) in South Puget Sound.

4. Recovery Planning for Chinook and Bull Trout

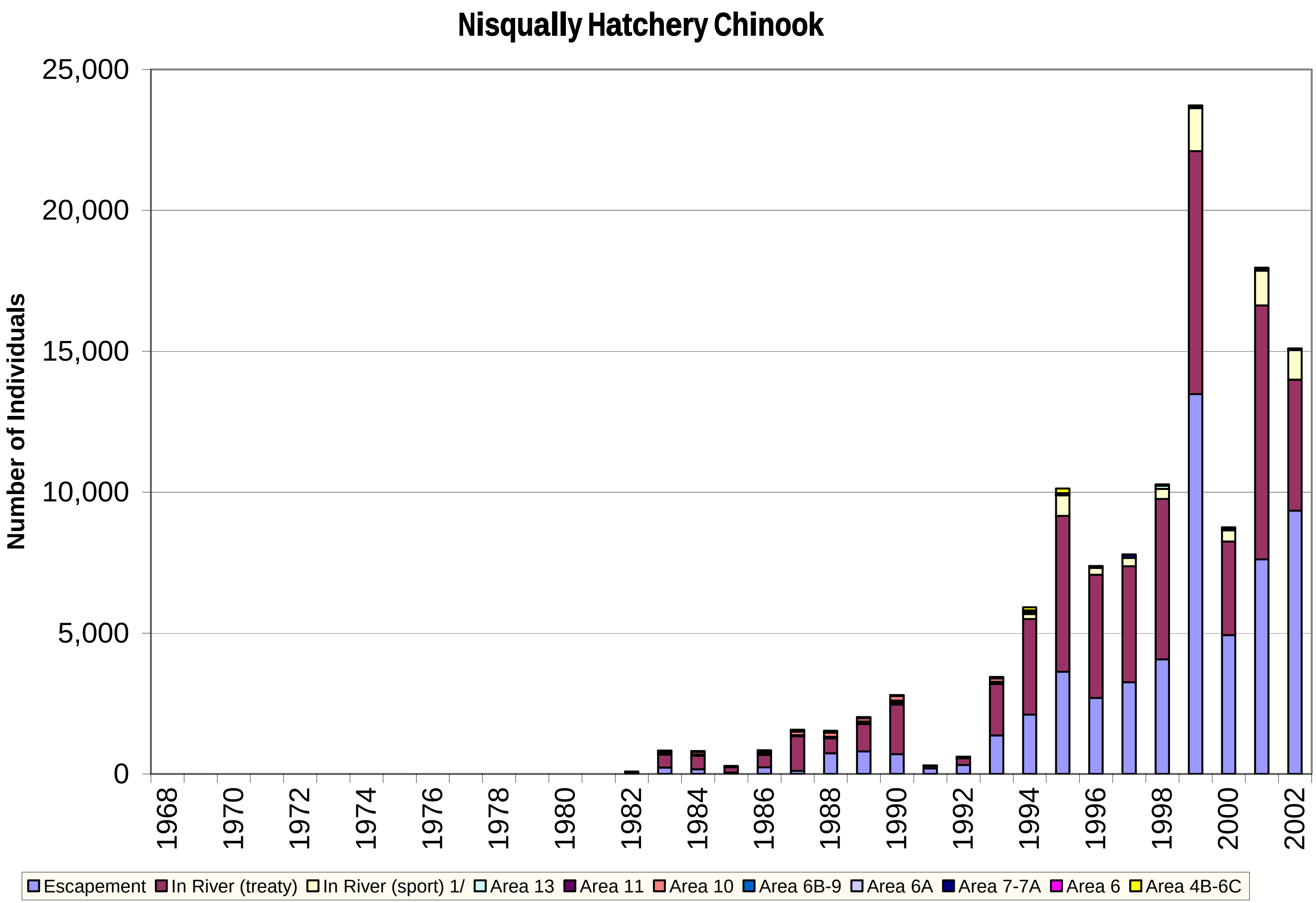
The NOAA National Marine Fisheries Service (NOAA Fisheries) and the US Fish and Wildlife Service (USFWS) listed Puget Sound Chinook salmon and coastal-Puget Sound bull trout as "threatened" species under the Endangered Species Act (ESA) in 1999. Listing under the ESA requires that NOAA Fisheries and USFWS prepare recovery plans for both species by geographic region. South Puget Sound is a subarea of the larger Puget Sound Evolutionary Significant Unit (ESU).

The State of Washington, however, determined that it would be in the state's best interest to assist NOAA Fisheries in its efforts to write a draft recovery plan for the Puget Sound ESU and four other ESU regions. Both federal agencies agreed to this participation and Shared Strategy for Puget Sound (Shared Strategy) has become the regional group responsible for coordinating a draft recovery plan for listed salmonids in the Puget Sound ESU.

Assisting Shared Strategy in the task of preparing a South Puget Sound Chapter to the larger Puget Sound ESU recovery plan is the South Puget Sound Salmon Recovery Group (SPSSRG). SPSSRG is an ad hoc local planning group comprised of representatives from Tribes, state agencies, local governments, and salmon recovery organizations with jurisdictional interest in the South Puget Sound nearshore.



Nisqually Natural Chinook
Number of Individuals
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Escapement
In River (treaty)
In River (sport) 1/
Area 13
Area 11
Area 10
Area 6B-9
Area 6A
Area 7-7A
Area 6
Area 4B-6C


Nisqually Hatchery Chinook
Number of Individuals
25,000
20,000
15,000
10,000
5,000
0
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Escapement
In River (treaty)
In River (sport) 1/
Area 13
Area 11
Area 10
Area 6B-9
Area 6A
Area 7-7A
Area 6
Area 4B-6C

The ESA requires that recovery plans contain

1. Objective, measurable goals for delisting
2. A comprehensive list of the actions necessary to achieve the delisting goals
3. An estimate of the cost and time required to carry out those actions.

In addition, NOAA Fisheries Recovery Planning Guidelines suggest that recovery plans include an assessment of the factors that led to population declines and/or which are impeding recovery. Finally, it is important that the plans include a comprehensive monitoring and evaluation program for gauging the effectiveness of recovery measures and overall progress toward recovery.

5. Viable Salmonid Population Projections

The recovery goal adopted by Shared Strategy for Nisqually Chinook is for wild populations to become self-sustaining at harvestable levels. Four interrelated parameters affect the potential outcome of this goal:

- Abundance There must be sufficient numbers of Chinook at various life stages to offset processes that affect population dynamics. These processes can include density effects, environmental variation, genetic processes, demographic stochasticity, ecological feedback, and catastrophes.

- Productivity The productivity of Chinook over its entire life cycle must ensure that the species is capable of consistently replacing itself. This factor is especially critical for Chinook during its freshwater productivity life-history stage.

- Spatial Distribution Chinook spatial structure depends fundamentally on habitat quality and its spatial configuration as well as the dynamics and dispersal characteristics of the species. A Chinook's ability to home to natal watersheds, natal tributaries within watersheds, and natal reaches within tributaries allows it to maintain a hierarchy of reproductive isolation. This spatial distribution engenders the unique "genetic stamp" for Nisqually Chinook.

- Diversity The ability of Chinook to survive within its unique its nearshore and freshwater habitat reflects varying traits, including anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology. Genetics dictate many of these traits while others are a combination of genetic and environmental factors. Any actions that affect the basic demographic and evolutionary processes for Chinook have the potential to alter its diversity. (McElhany et al. 2000)

Shared Strategy established planning ranges and targets that address the abundance and productivity parameters for Nisqually Chinook.[2] The planning range, as determined by several technical models, provides a broad estimate of the abundance needed for Nisqually Chinook to be viable over time. The wide range reflects variations in environmental conditions and uncertainty in historical information. The planning target provides a more specific measure within the range for evaluating the efficacy of recovery actions affecting habitat, harvest, and hatcheries. The target predicts the abundance and productivity of Chinook given a fully functioning estuary, improved freshwater conditions, restored access to blocked habitats, and poor ocean conditions.

The planning ranges and targets for Nisqually Chinook are:

Mean spawner abundance for 1996-2000	890
Planning range for abundance given a low-productivity rate of 1 recruit per spawner	13,000 – 17,000
Adult planning targets for abundance • Target given a low-productivity rate of 1 recruit per spawner • Target given a high-productivity rate of 3 recruits per spawner	 13,000 3,400
Juvenile planning targets for abundance • Target given a low-productivity rate of 1 recruit per spawner • Target given a high-productivity rate of 3 recruits per spawner	 1,000,000 730,000

Within the framework of the recovery planning process, the SPSSRG must identify actions and develop an appropriate implementation plan necessary for attaining the planning targets and ranges.

[2] Chinook Targets and Ranges, Version 5/8/02, Shared Strategy (http://www.sharedsalmonstrategy.org/goals.htm)

South Puget Sound Salmon Conceptual Model

If South Puget Sound is to have an ecosystem that supports Chinook and bull trout, there must be properly functioning nearshore habitats that serve their rearing, refuge, feeding, physiological transition, and migratory needs. The deterministic factors that influence properly functioning nearshore habitats are natural processes.

This is the fundamental hypothesis to the South Puget Sound Salmon Conceptual Model. The purpose of having such a model is to organize our thinking about how the nearshore ecosystem supports viable populations of Chinook and bull trout. It provides the context as to how the ecosystem should be functioning properly to support salmonids, and if not, why is it not functioning properly and which changes will be necessary. Ultimately, this points to which protection and recovery actions will be most effective in achieving the planning targets for Chinook and the delisting of bull trout. This approach borrows freely from the "Guidance for Protection and Restoration of the Nearshore Ecosystems of Puget Sound" (PSNERP 2003).

Nearshore Ecosystems

Nearshore ecosystems are communities of organisms and their physical and chemical environment interacting as an ecological unit. Ecosystems consist of three general features:

- Natural processes
- Structural components or habitats that are primarily created and maintained by natural processes
- Outputs or functions (such as Chinook and bull trout) that are supported by created habitats

The South Puget Sound nearshore ecosystem that serves Chinook and bull trout is dynamic, continuously changing system that naturally evolved over time as a result of the actions and interactions of different processes.

Nearshore Habitats

PSNERP defines habitat as "…the physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal." Furthermore, "…the importance or function of nearshore habitats to any biotic element…depends upon site-specific or local features of the habitat, quantity of habitat, and the landscape context of that habitat in the nearshore."

Although there has not been any formal adoption of a salmon-specific landscape classification system as yet, Fresh and Graeber has provided some classification guidance for habitat (Puget Sound Action Team 2004) that includes four broad categories and their use by salmonids. These are:

Open, Exposed Shorelines

Open exposed shoreline habitat provides critical functions, including feeding and growth, refuge from predators, migratory corridors, and to a lesser degree physiological transition, for primarily larger juvenile salmon once they transition into the neretic zone. While important year round, the open exposed shorelines become more important later in the calendar year as juvenile salmon life history types move out of the protected areas.

Protected Shorelines

Protected shoreline habitat provides critical functions, including feeding and growth, refuge from predators, migratory corridors, and physiological transition, and is very important for early fry migrants (e.g., pocket estuary fry, delta fry) and may also be important to mature juvenile salmon (e.g., parr migrants and yearlings).

Protected shorelines are more important to all life history stages earlier in the year before the water temperatures increase. Protected shorelines often host large spawning aggregations of forage fish, and are very important for generating prey base for fry migrants and providing refuge from predators and extreme events.

Protected shorelines can provide important support for large numbers of early fry migrants because many occurrences of protected shorelines are in close proximity to the natal river mouth estuaries for independent populations of Puget Sound Chinook.

Pocket Estuaries

Pocket estuaries provide critical functions, including rearing (feeding and growth), refuge from predators and extreme events and opportunity for physiological transition, for juvenile salmon, primarily early fry migrants of very small size.

River Mouth Estuaries and Deltas

River mouth estuaries and deltas provide critical functions, including rearing (feeding and growth) and refuge from predators and extreme events, for primarily early fry migrants (pocket estuary) and delta fry, and the opportunity for physiological transition and migratory corridors for larger juvenile salmon life history types (parr migrants and yearlings).

Each of these broad classes includes a number of embedded smaller scale habitat types such as mudflats, eelgrass, blind channels, etc. Specific salmon habitats can occur in more than one of the four landscape classes. Appendix A contains an inventory of these habitat types in South Puget Sound, as well as an assessment of their condition.

Natural Processes

Natural processes are the essential building blocks that create habitats that form the ecosystems that support Chinook and bull trout.

The PSNERP Nearshore Science Team (2003) explained that:

> Ecosystem processes operate at naturally varying rates, frequencies, durations, and magnitudes that are controlled or constrained by various anthropogenic and natural factors. For example, climate landform, bathymetry, and geologic setting of an area constrain or control how biota, water, water, sediment, and organic matter are moved in the system. Processes also operate at various spatial and temporal scales and they can include such things as changes in chemical composition (e.g., nutrient transformations), biomass (e.g., production and consumption) and movement of material (e.g., sediment transport). For example, sediment can be transported over spatial scales of 1 to 100's of kilometers. In an estuary, sediments originate from the watershed, are transported downstream by river flow, and then moved episodically (eroded and deposited) by bi-directional water movements (tides and river flow) through the estuarine gradient. The sediment composition on a beach typically depends upon upland sources of material deposited directly on the beach, movements of material along the beach, and wind and wave action, which are a function of large-scale climate events.

Applying this approach to South Puget Sound, the SPSSRG analyzed the ecosystem and habitat niches of Chinook and bull trout to discern the key natural processes that contribute to their formation. The result of thinking reveals the following list of natural processes:

<u>Tidal exchange (Simmenstad 2000)</u>

- Frequency and duration of tidal flooding is one critical determinant of emergent vegetation composition; salinity (degree of mixing of freshwater with salt water) is another important factor.
- Exposure to wave and current energy directly influences whether an environment will be accretionary or erosive, which are important determinants of marsh progradation, for instance.
- The drainage area and tidal prism of tidal marshes are the primary controls on the complexity of a dendritic tidal channel system.
- Hydrologic connections affect the input of plant and animal recruits, and the accumulation and residence time of detritus.

<u>Sedimentation</u> (Simmenstad 2000)

- Sediment accretion and erosion often involves distant sediment sources, mechanisms of sediment transport and delivery, and the processes of deposition and resuspension/erosion.

- Sediment accretion can be critical to the natural maintenance and "health" of a marsh, both from the standpoint of maintaining the marsh surface relative to sediment compaction and sea level rise as well as the supply of nutrients for marsh plant production.

<u>Nutrient Input (Simmenstad 2000)</u>

- Nutrient delivery by river and tidal hydrology mediates nutrient-limited plant growth.

- Nutrients are transformed and regenerated by below-ground soil processes regulated in part by the extent of anaerobic microbiota and porewater exchange, thus varying extensively between vegetated and unvegetated (e.g., mudflat) habitats at different tidal elevations.

- Trapping of detrital organic matter and incorporation into nutrient cycling pathways is directly linked to autochthonous and allochthonous sources and rates of supply, as well as features such as low energy side-channels and sloughs, which promote trapping.

<u>Large Woody Debris Function in Spit Formation (Simmenstad 2000)</u>

- Disturbance of estuarine habitats by hydrological (strong tides and freshwater flow) and physical (e.g., large woody debris scouring) forces maintains a diverse matrix of habitats at different successional stages and topography.

- Deposition of large woody debris is also presumed to enhance cover and refuge for juvenile salmon, but this remains to be validated.

<u>Organic Matter Composition (Simmenstad 2000)</u>

- Detritus is trapped and retained differentially by different plant communities.

- The residence time of detritus, and thus the rate and opportunity for decomposition, is to some degree determined by geomorphic features such as dendritic tidal channels and other geomorphic/ topographic features.

<u>Food Web (Simmenstad 2000)</u>

- The spatial distribution of primary production across the landscape affects not only the rates, sources, and pathways of organic matter (detritus) but also physical refuge for juvenile salmon in the case of emergent and other macrophytic vegetation.

- Temporal diversification provides diverse sources of organic matter to the detritus pool that sustain secondary production over time. (Thom 1987).

- Nutrient cycling is tied to primary production not only as a source of nutrients but also it regulates nutrient cycling to some degree by affecting (through the extent of plant–root processes) anaerobic–aerobic geochemistry in soils.

<u>Freshwater Input</u> (Simmenstad 2000)

- Physiological adaptation zones at the transition between areas of no salinity and increasing levels of salinity are critical for juvenile salmon; this is especially the case for juvenile chinook that appear to require extended periods (e.g., often weeks).

<u>Prey Species Input</u> (Simmenstad 2000)

- Sites of concentrated production of preferred prey appear in specific habitats, substrates, vegetation, and tidal elevations and vary over space and time, driven in part by the same processes that affect salmon distribution (e.g., juvenile salmon).

- Prey trapping can occur by hydrodynamic action and is a prominent feature of the tidal–freshwater and brackish regions of estuaries where current reversals occur (e.g., Tschaplinski 1982, 1987)

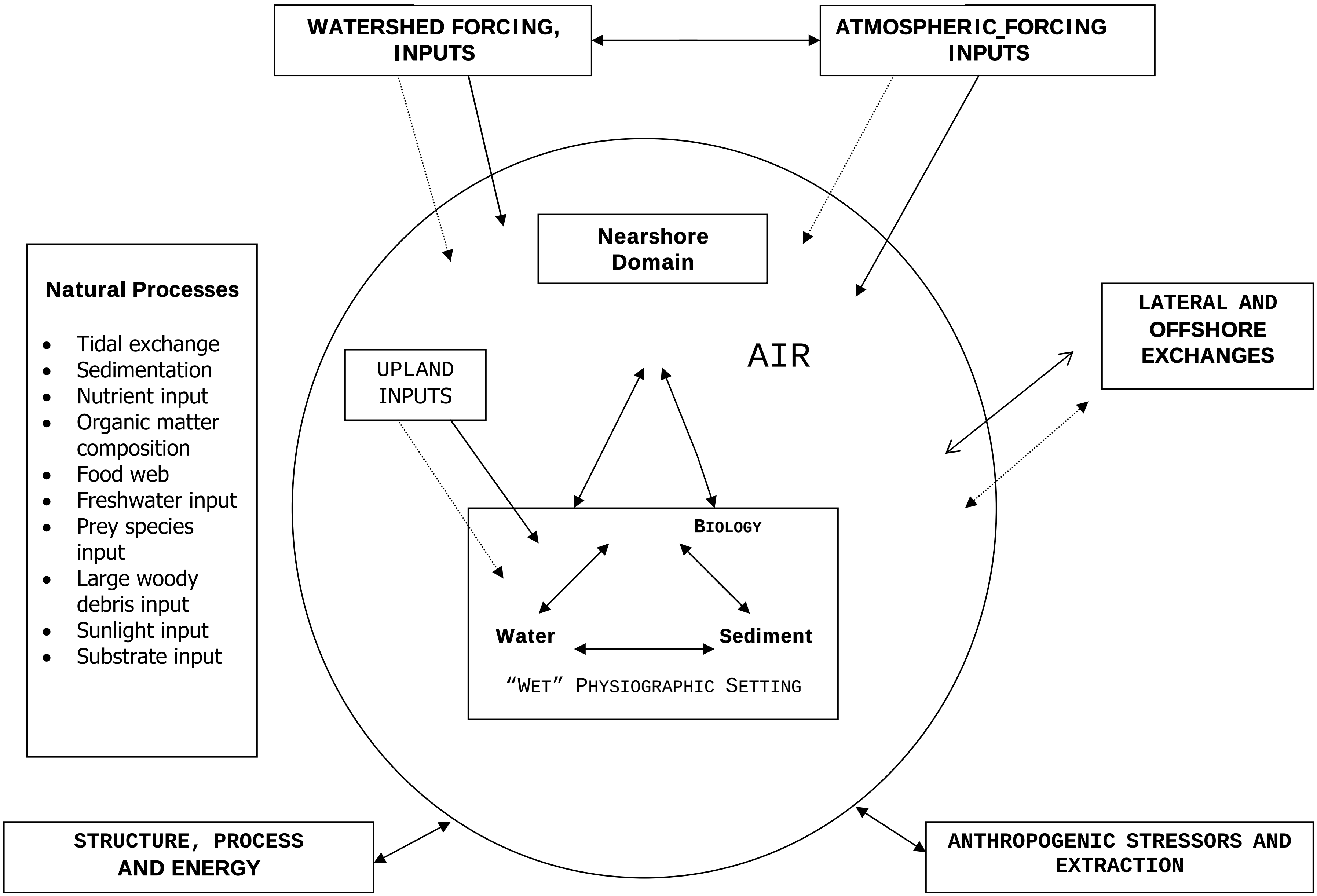
- Prey organisms are exported from some habitats and supply food resources to larger invertebrates and small fishes, which are in turn preyed upon by larger nektonic organisms foraging in adjacent habitats and other regions of the estuary (Kneib 1997); salmon can fill several roles in this relay.

<u>Sunlight Input</u> (Fresh, K.L. 2001)

- In parts of Puget Sound, shoreline development has resulted in the loss of eelgrass (*Zostera marina L*.) (Thom and Hallum 1990). One source of eelgrass loss is overwater structures, which cover the surface of the water, potentially affecting the submarine light environment and reducing eelgrass cover. Reductions in the amount of light reaching eelgrass can affect plant density, vigor, and size (both length and width), and, in the worst case, eliminate seagrass from beneath a structure (Dennison 1987; Zimmerman and others 1991; Abal and others 1994; Zimmerman and others 1995).

The Puget Sound Nearshore Ecosystem Restoration Projects Nearshore Science Team developed a conceptual model of the Puget Sound nearshore that has been adopted for use in South Puget Sound. The purpose of the model is to help guide thinking about how natural processes function in south Puget Sound and how these processes are influenced, positively or negatively, to affect salmonid habitat.

South Puget Sound



Human-Induced Stressors

In South Puget Sound, human activities have dramatically disrupted the function of many natural processes. These disruptions, termed "human-based stressors," change habitat, and ultimately, the ecosystem that Chinook and bull trout have adapted to through evolutionary development. On a temporal scale, many of these human-induced stressors have been sudden, creating significant impacts that have lead to declines in the viability of both species.

Thus, the focal point of recovery efforts is to restore those natural processes that have experienced degradation through human activities. Doing this requires two steps. The first is to identify human-based stressors, which is the purpose of this chapter. The second step involves identifying the location of human-based stressors within the nine South Puget Sound landscape regions, which is the focus of the next chapter.

The SPSSRG identified twelve major human-induced stressors on natural processes specific to South Puget Sound. These are:

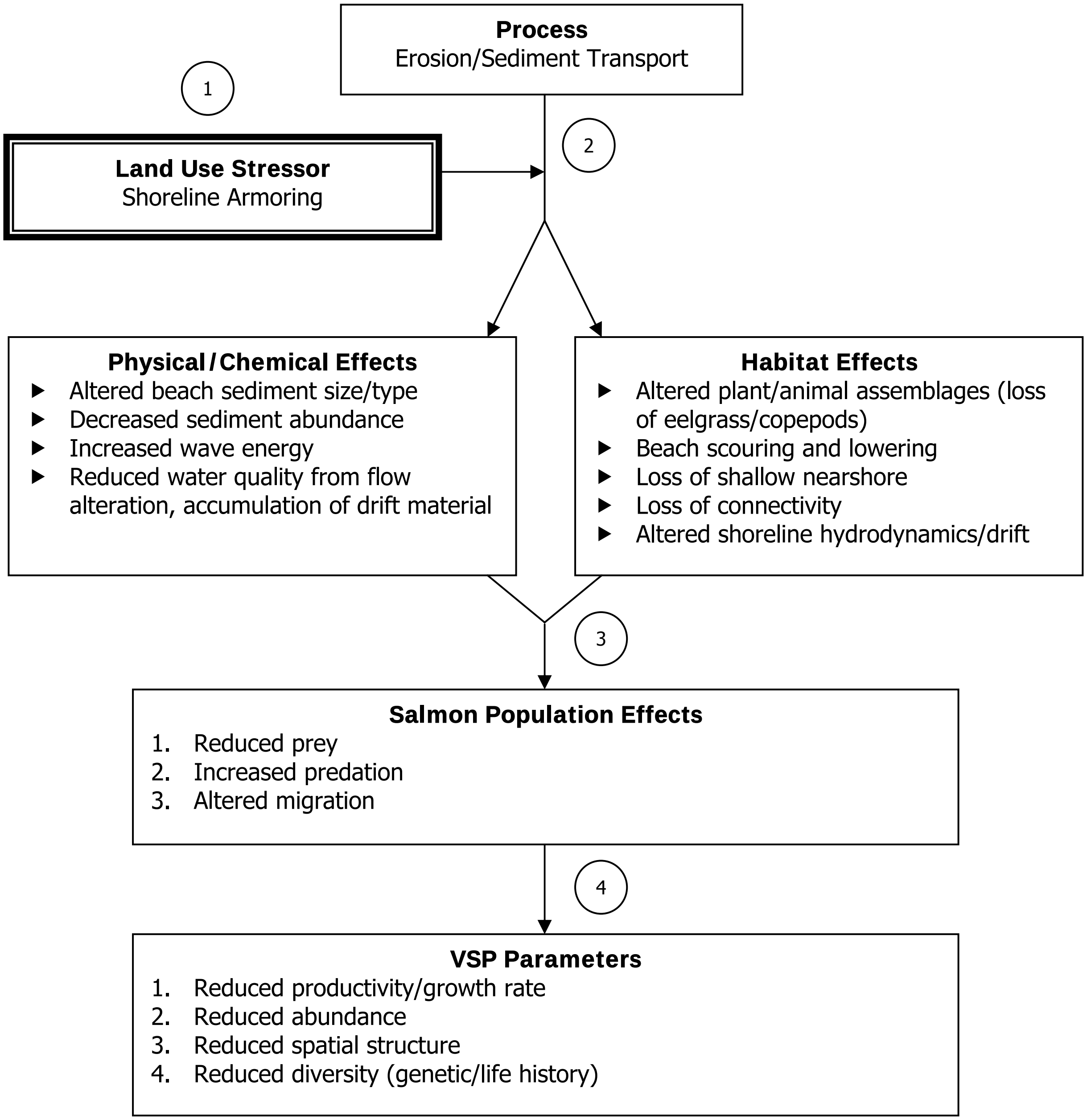
- Shoreline armoring
- Overwater structures
- Ramps
- Stormwater/Wastewater
- Landfill below the high high water line
- Riparian loss
- Wetland and estuarine modification
- Input of toxic components
- Predation
- Boat traffic
- Invasive species
- Shellfish aquaculture

While this list is not exhaustive of all human-induced stressors, it does reflect those with the most significant impact on natural processes and the greatest prevalence throughout all of South Puget Sound.

To understand how these stressors affect Chinook and bull trout, the SPSSRG developed a series of conceptual models. These models are a graphic representation of the hypotheses regarding how stressors alter both the physical and chemical makeup of the environment and the creation of habitat. Each model also explores the resulting effect on Chinook and bull trout populations, which it then relates to viable salmon population parameters that influence planning targets specific for Chinook.

Each of the following pages presents a conceptual model for each human-induced stressor.

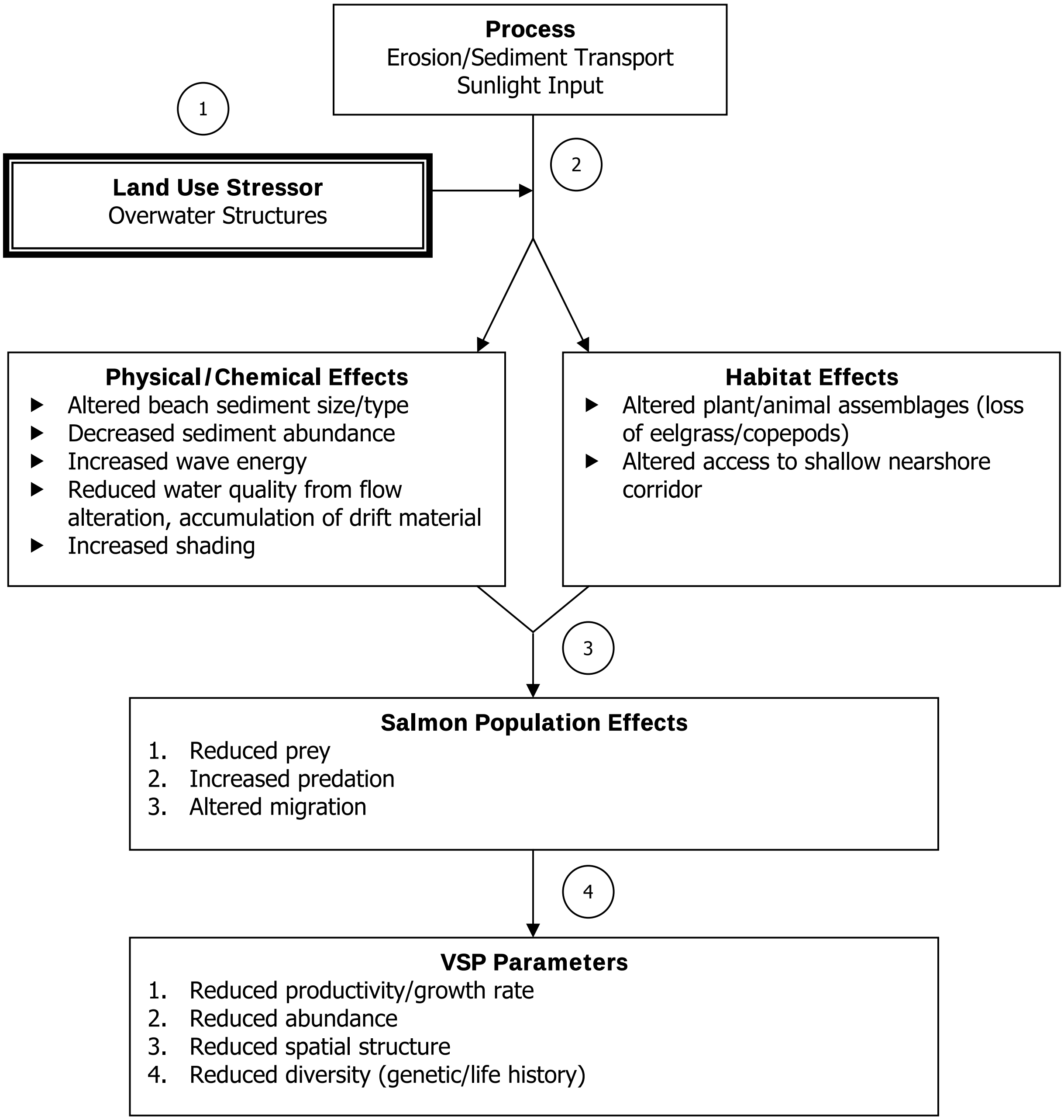
Shoreline Armoring



Hypothesis:

1. Shoreline Armoring impacts nearshore Erosion/Sediment Transport processes
2. Erosion/Sediment Transport processes have Physical/Chemical and Habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on Salmon Populations
4. Changes in Salmon Populations result in changes in the Viable Salmonid Population parameters (Productivity/Growth Rate, Abundance, Spatial Structure, Genetic/Life History Diversity)

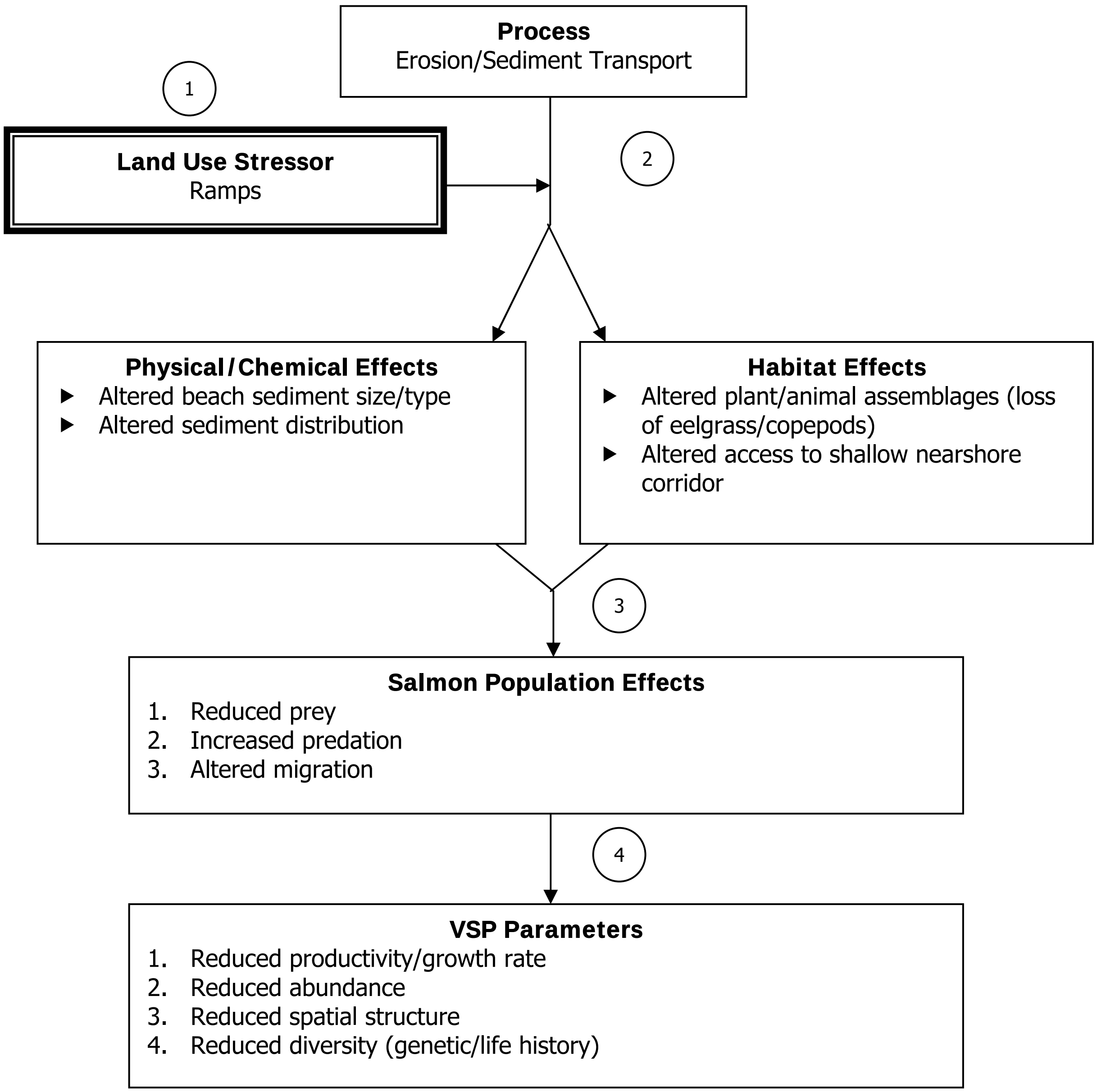
Overwater Structures



Hypothesis:

1. Overwater Structures impact nearshore Erosion/Sediment Transport and Sunlight Input processes
2. Erosion/Sediment Transport and Sunlight Input processes have Physical/Chemical and Habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on Salmon Populations
4. Changes in Salmon Populations result in changes in the Viable Salmonid Population parameters (Productivity/Growth Rate, Abundance, Spatial Structure, Genetic/Life History Diversity)

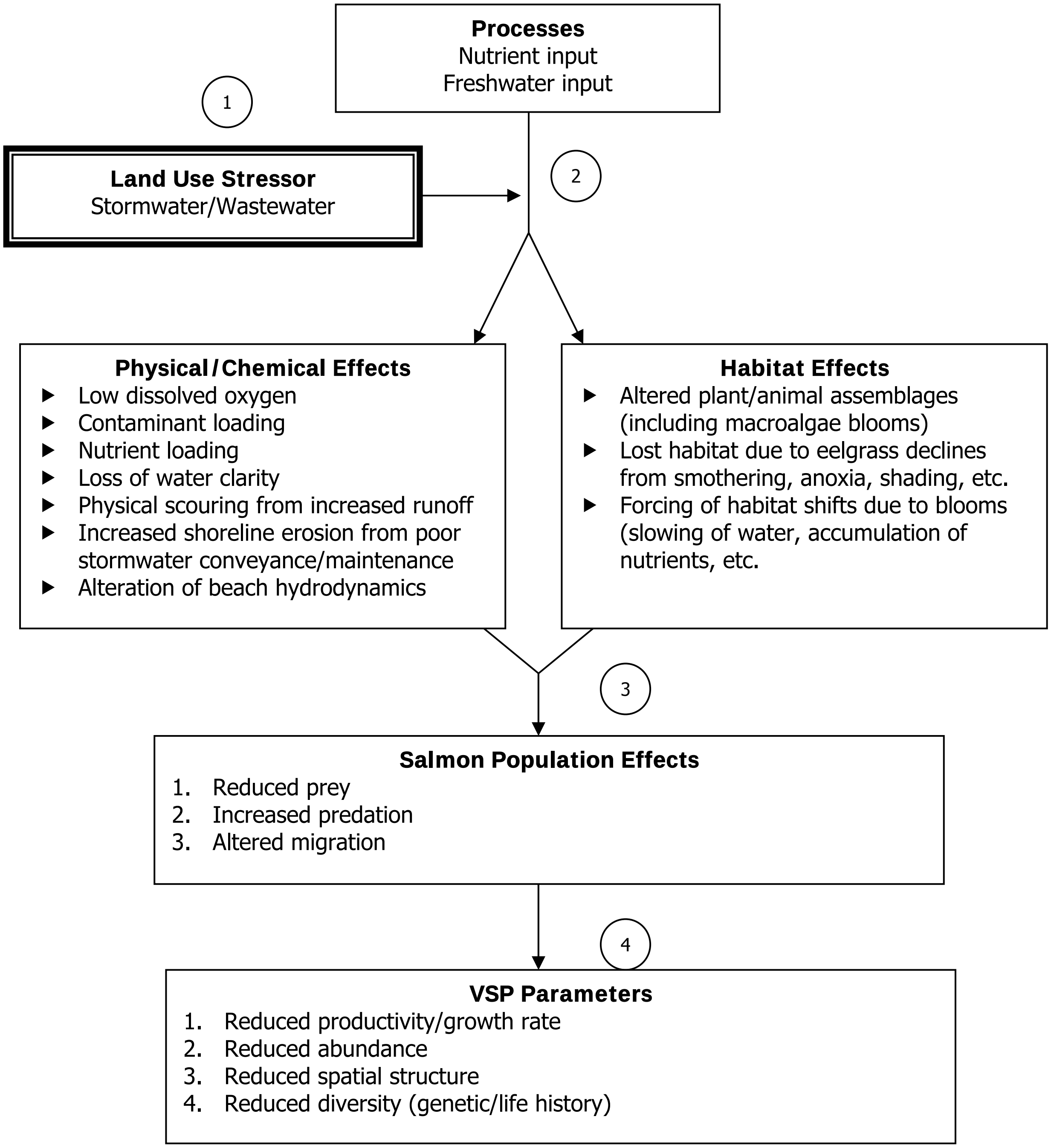
Ramps



Hypothesis:

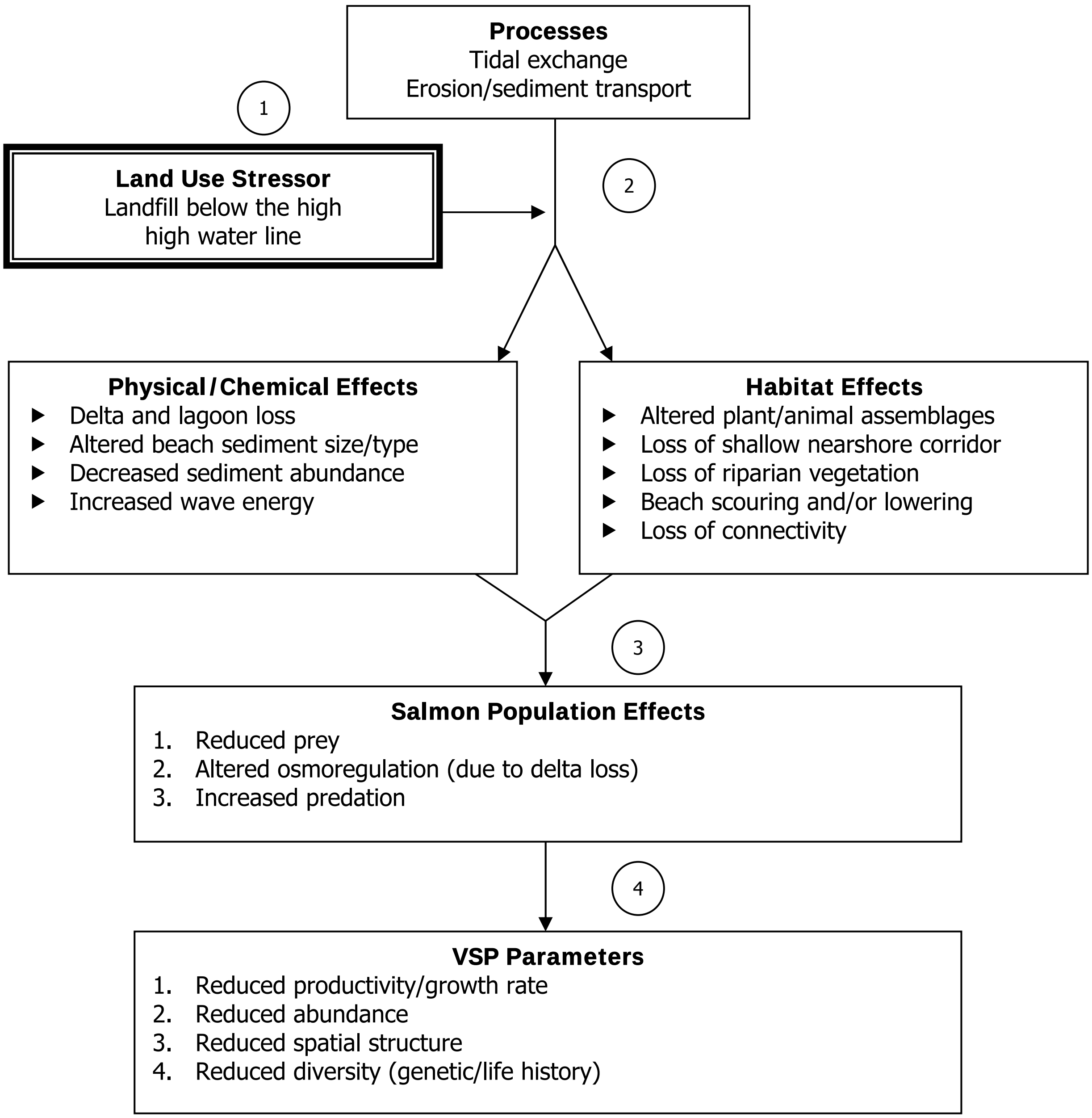
1. Ramps impact nearshore Erosion/Sediment Transport processes
2. Erosion/Sediment Transport processes have Physical/Chemical and Habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on Salmon Populations
4. Changes in Salmon Populations result in changes in the Viable Salmonid Population parameters (Productivity/Growth Rate, Abundance, Spatial Structure, Genetic/Life History Diversity)

Stormwater/Wastewater



Hypothesis:
1. Stormwater/Wastewater impacts nearshore Nutrient and Freshwater Input processes
2. Nutrient and Freshwater Input processes have Physical/Chemical and Habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on Salmon Populations
4. Changes in Salmon Populations result in changes in the Viable Salmonid Population parameters (Productivity/Growth Rate, Abundance, Spatial Structure, Genetic/Life History Diversity)

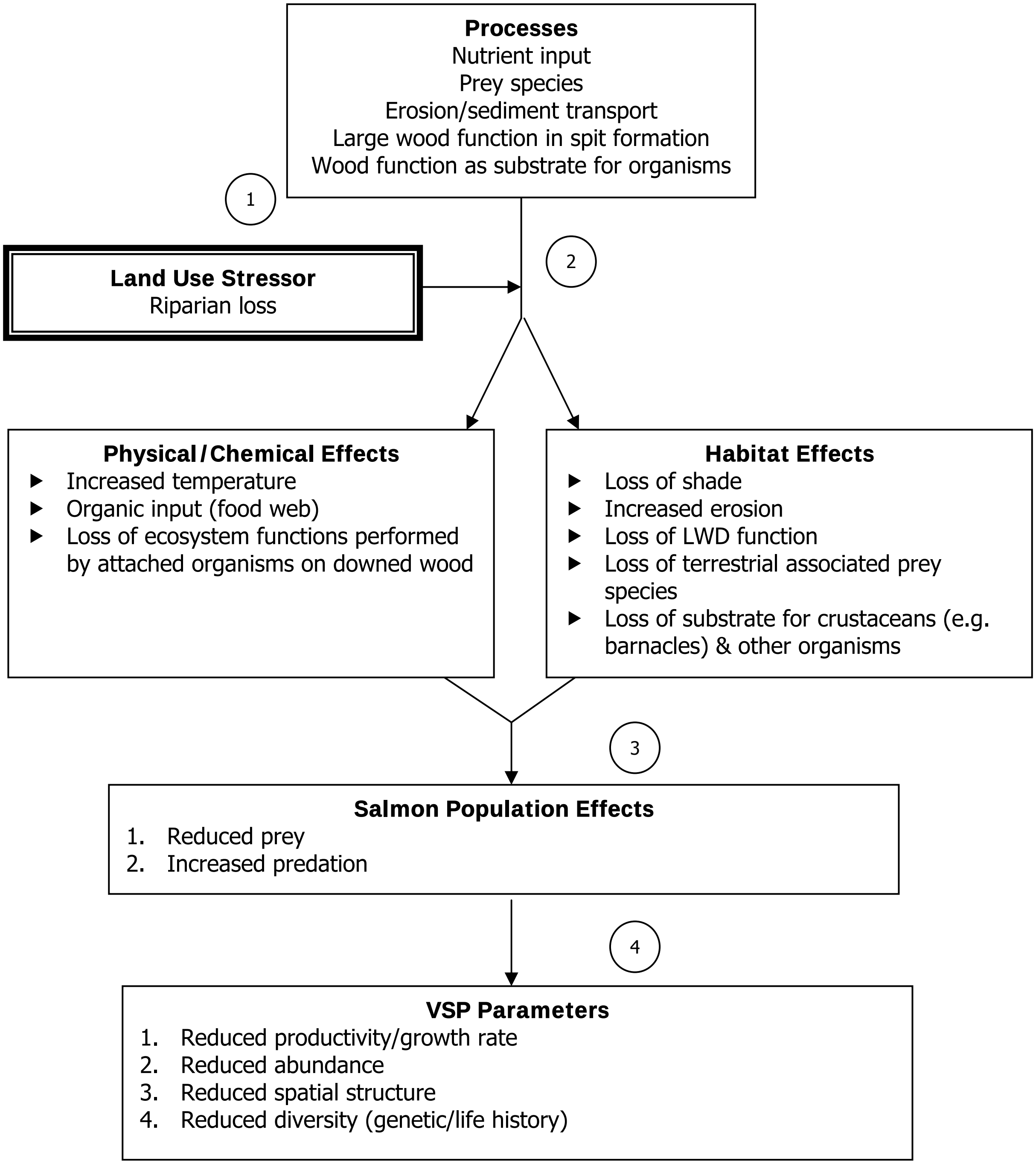
Landfill Below the High High Water Line



Hypothesis:

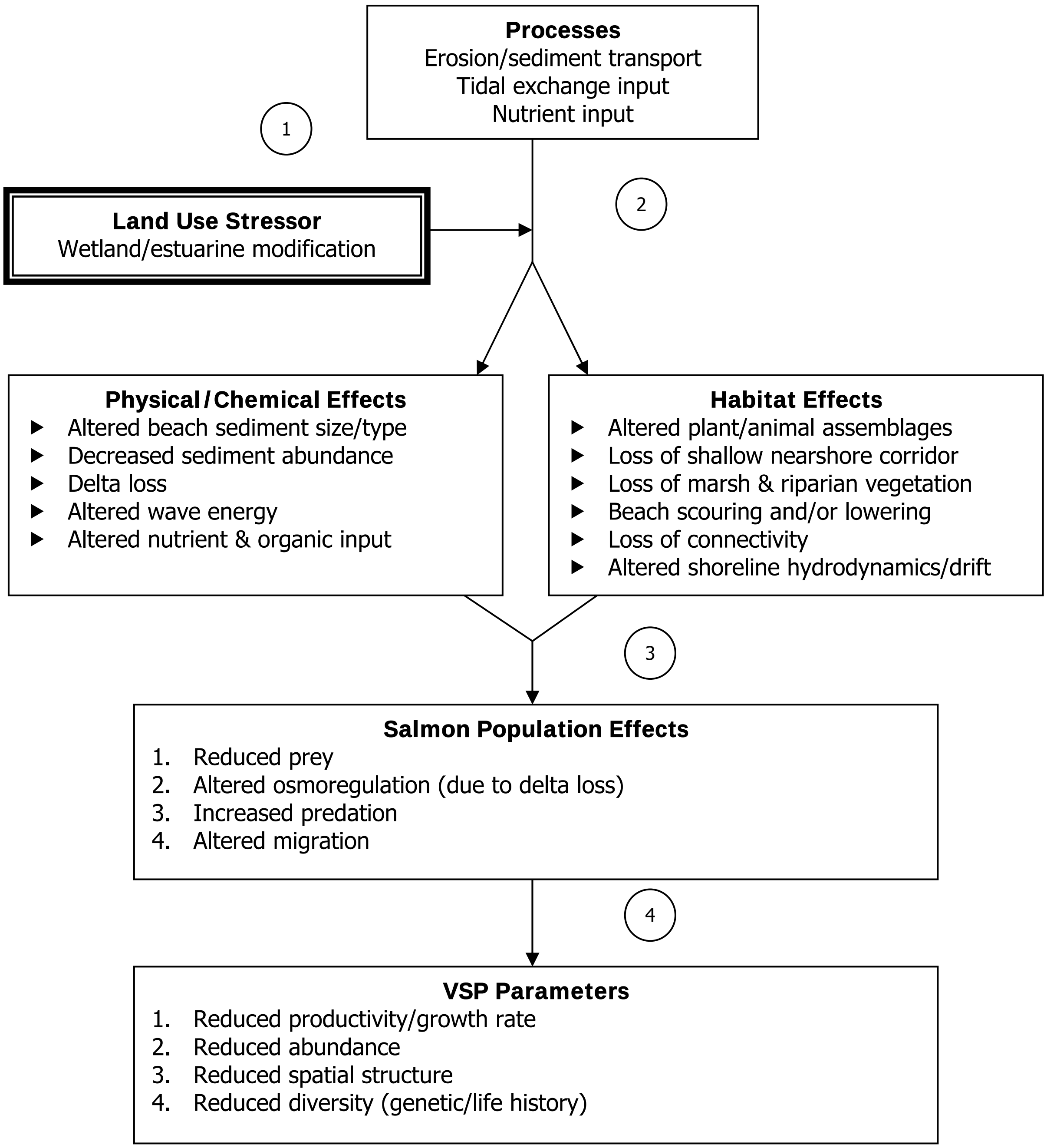
1. Landfill impacts nearshore Tidal Exchange and Erosion/Sediment Transport processes
2. Tidal Exchange and Erosion/Sediment Transport processes have physical/chemical and habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on salmon populations
4. Changes in salmon populations result in changes in the VSP parameters

Riparian Loss



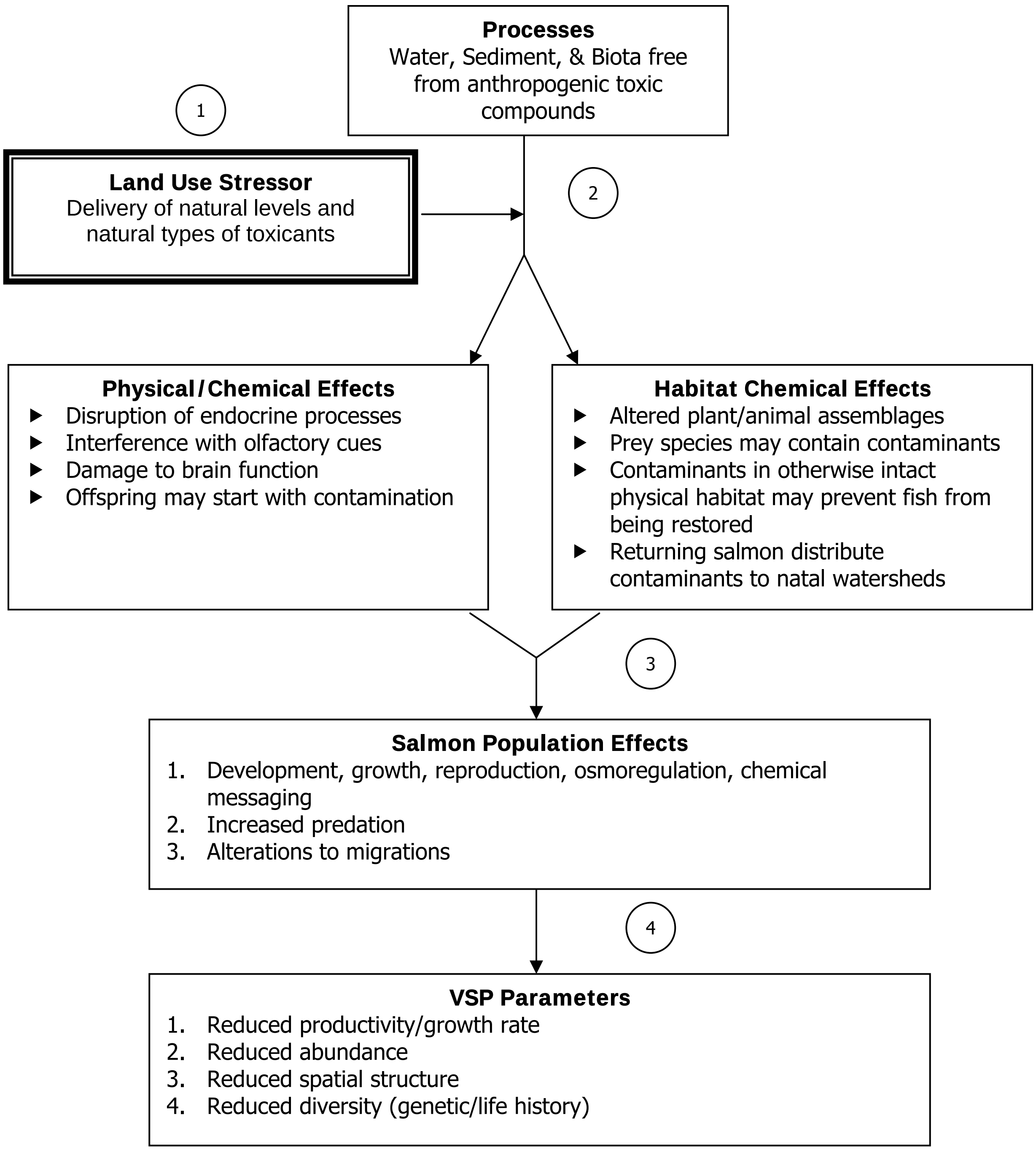
Hypothesis:
1. Riparian loss impacts nearshore nutrient input, erosion/sediment transport, and large wood processes
2. Nutrient input, erosion/sediment transport, and large wood processes have physical/chemical and habitat effects on the nearshore environment
3. Nearshore physical/chemical and habitat conditions have an effect on salmon populations
4. Changes in salmon populations result in changes in the viable salmonid population parameters

Wetland and Estuarine Modification



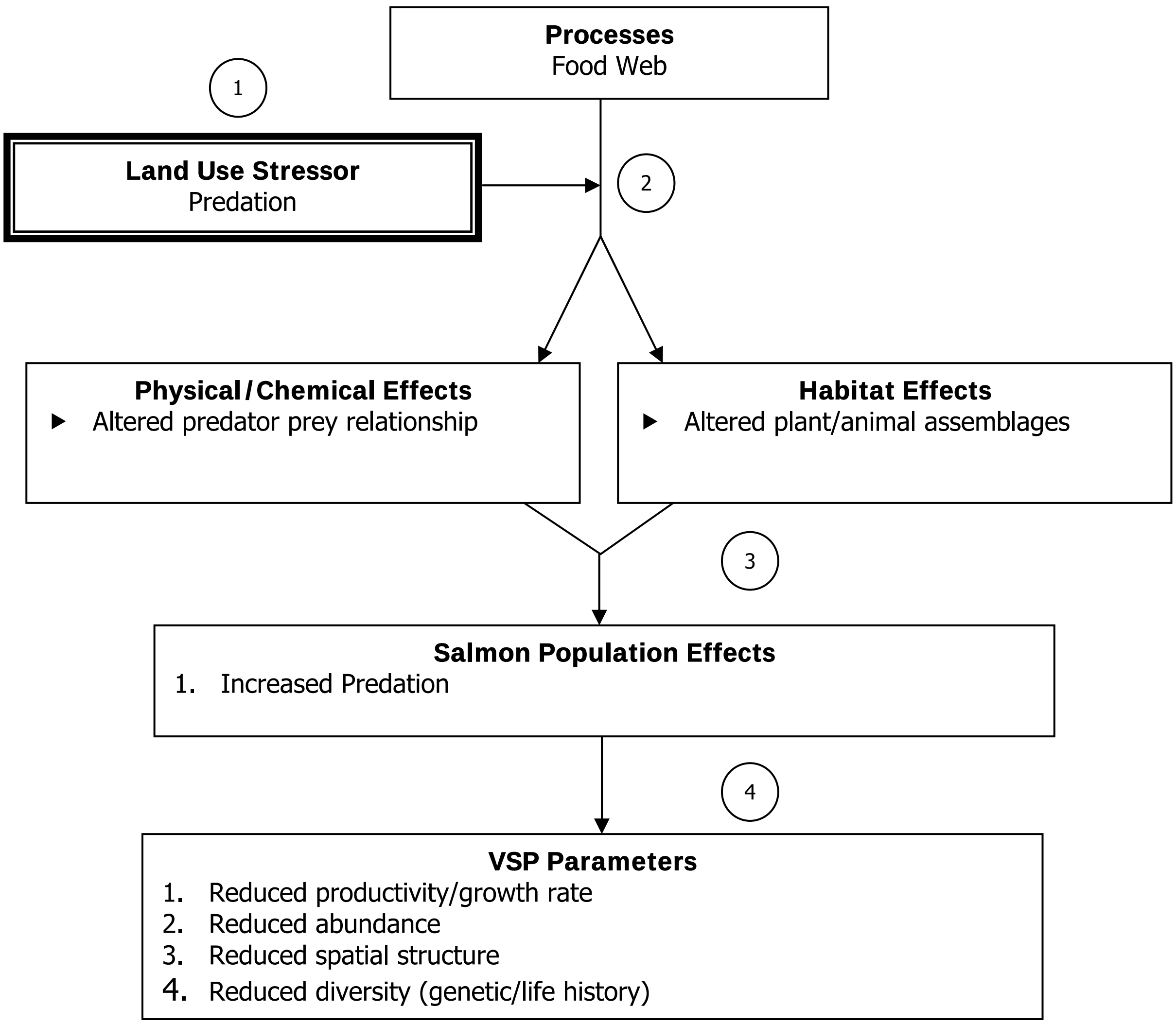
Hypothesis:
1. Wetland/estuarine modification impacts nearshore Tidal Exchange and Erosion/Sediment Transport processes
2. Erosion/Sediment Transport, Tidal Exchange and Nutrient Input processes have physical/chemical and habitat effects on the nearshore environment
3. Nearshore Physical/Chemical and Habitat conditions have an effect on salmon populations
4. Changes in salmon populations result in changes in the VSP parameters

Input of Toxic Components



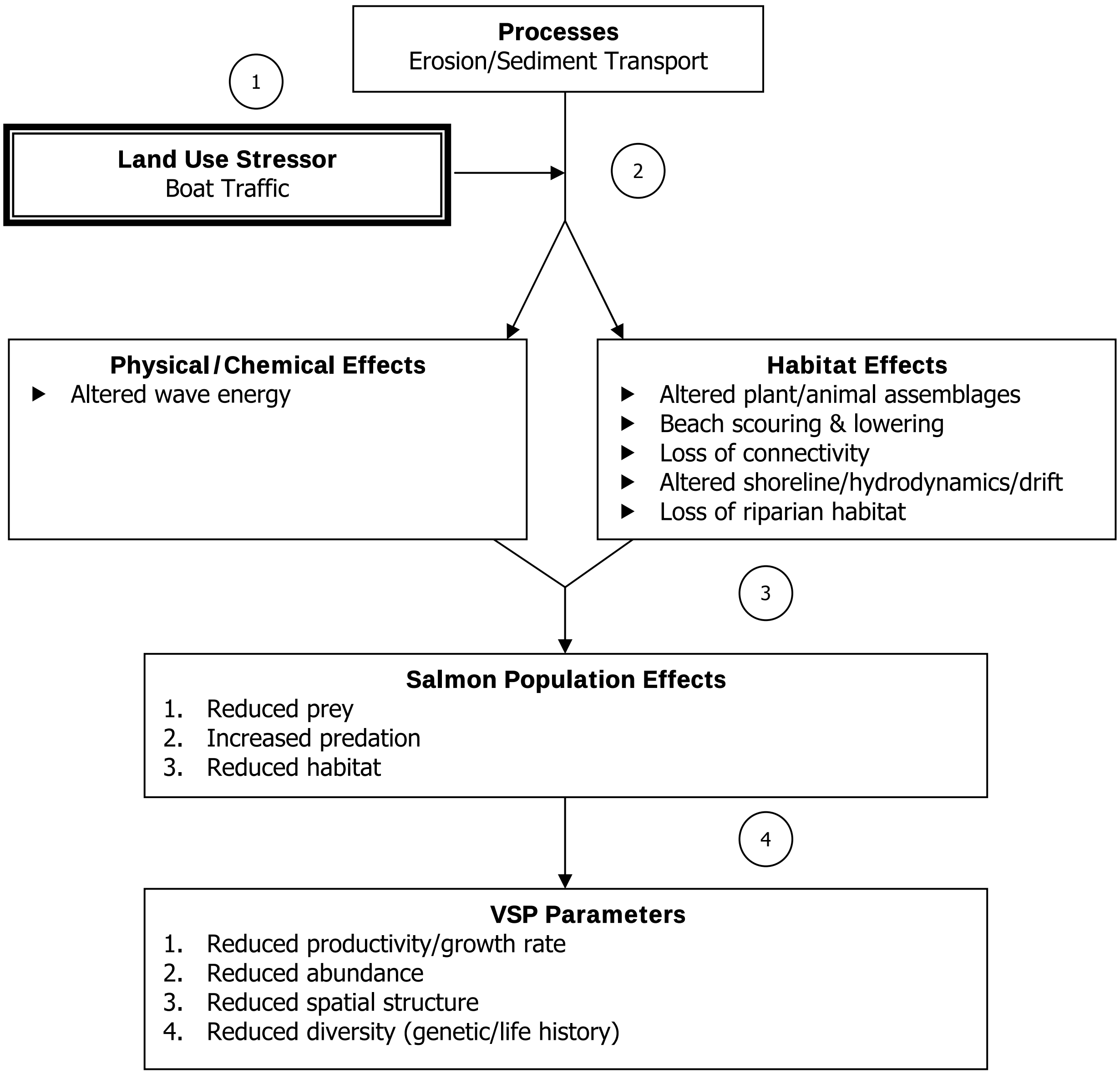
Hypothesis:
1. Anthropogenic toxic inputs contaminate the marine and nearshore water, biota, and sediments
2. Historic conditions provided clean water, sediment, and biota free of human-made toxic components
3. Toxic components can cause effects on salmonid processes
4. Changes in salmon populations result in changes in the VSP parameters

Predation



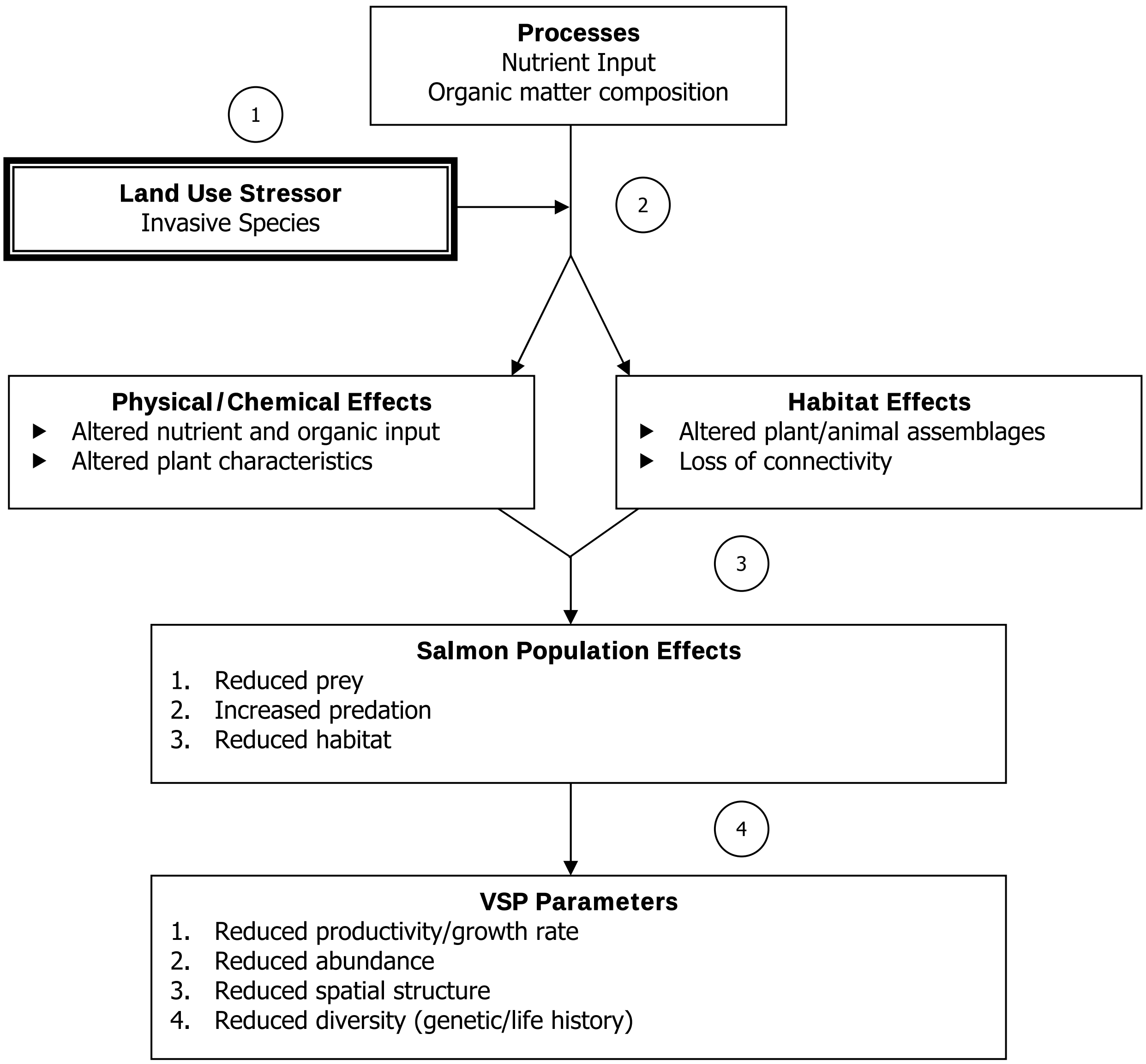
Hypothesis:
Increased predation on salmon has a negative effect on the food web leading to alterations in the biological features, including changes in the relationships between predators and their salmon prey. The resulting increase in predation leads to reduced salmon population, abundance, and spatial diversity.

Boat Traffic



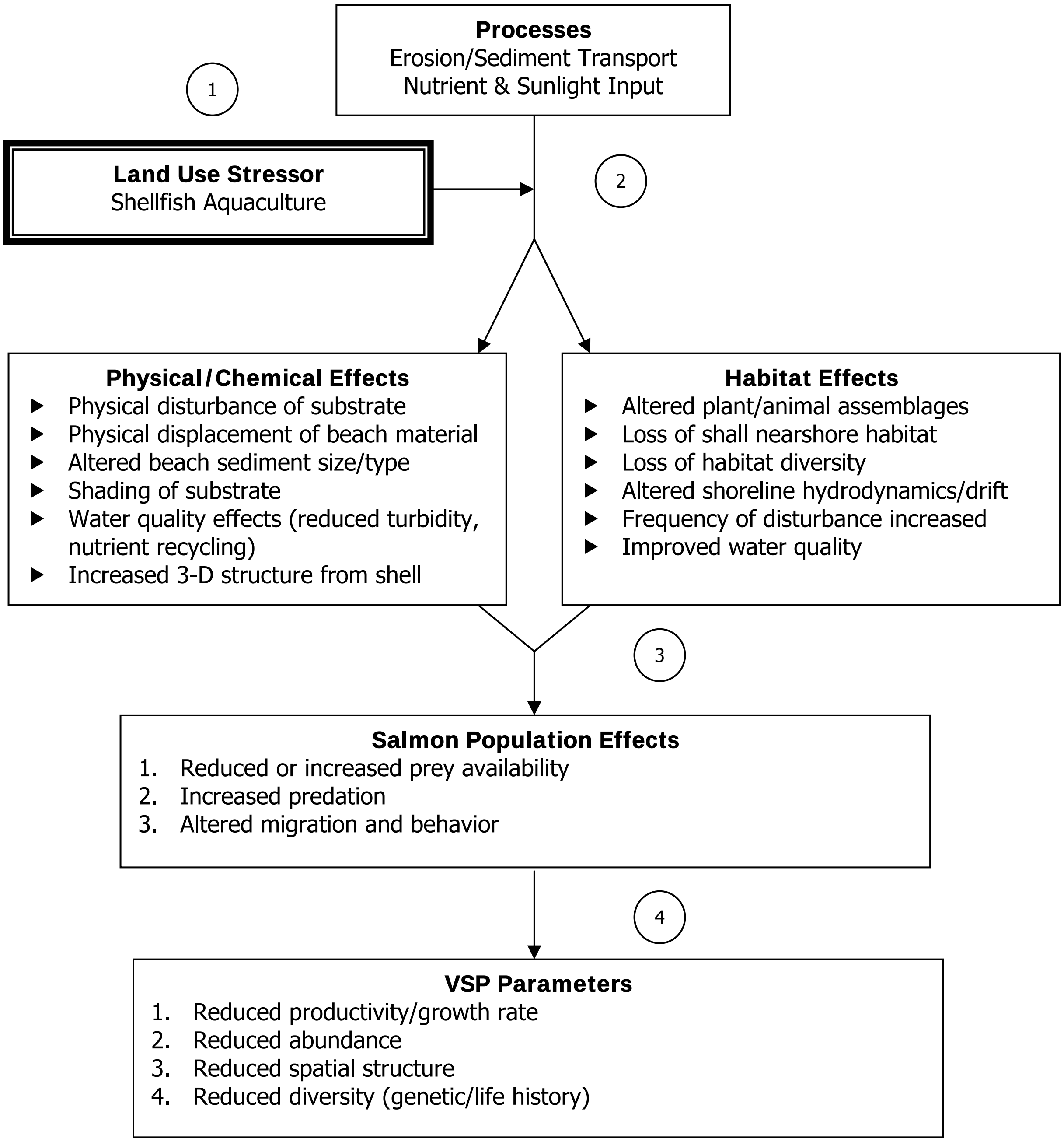
Hypothesis:
Wakes from vessels have a negative effect on erosion which leads to alterations in the physical and biological habitat features, including changes in the plant and animal communities, loss of habitat, and loss of connectivity. The resulting increase in competition for prey resources, increased predation, and reduced habitat leads to reduced salmon population productivity, abundance, and life history diversity.

Invasive Species



Hypothesis:
Invasive species have a negative effect on nutrient input and plant composition leading to alterations in the biological features, including changes in nutrients and plant characteristics. The resulting increase in competition for prey resources, increased predation, and reduced habitat leads to reduced salmon population productivity, abundance, and life history diversity.

Shellfish Aquaculture



Hypothesis:
Shellfish aquaculture in South Sound alters plant and animal assemblages and results in the loss of shallow nearshore habitat and habitat diversity important to salmon resources. These impacts may be potentially positive or negative depending on the type of aquaculture practice. We hypothesize that shellfish aquaculture reduces productivity, abundance, spatial structure, and diversity of salmon populations.

Landscape Analysis of the South Puget Sound Nearshore

The SPSSRG conducted a landscape analysis of South Puget Sound to evaluate the functionality of its natural processes and habitat as well as the presence of human-induced stressors. To this end, the analysis divided South Puget Sound into nine distinct regions:

- Budd Inlet
- Carr Inlet
- Case Inlet
- Eld Inlet
- Hammersley Inlet and Oakland Bay
- Hartstene Island Group
- Henderson Inlet
- McNeil Island Group
- Totten and Skookum Inlets

The map on the next page delineates these nine landscape regions.

This division of South Puget Sound has precedent; it is the same division used by the State of Washington and the Treaty Tribes for harvest planning and management. It also reflects a very natural division of the South Puget Sound ecosystem into distinct geographic units that display their own unique characteristics. Assessment Units divide landscape regions into smaller segments that generally mirror the drift cells as delineated by the Washington State Department of Ecology.

The analysis relied on a combination of existing and original habitat assessments. The majority of the South Puget Sound shoreline was assessed recently as part of ongoing salmon recovery efforts. Information from these much more detailed reports has been summarized for inclusion in this document. For areas not covered by an existing report, an experienced habitat biologist familiar with the area used professional judgment to identify the landscape stressors affecting natural processes.

For regions within Pierce County, the main source material was the "Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment (2003)." Tom Kantz, Pierce County, interpreted data from this assessment for integration into this report except for the portion of Pierce County located in Case Inlet that was interpreted by Scott Steltzner, Squaxin Island Indian Tribe. Original data collection was necessary for that portion of the McNeil Island group along the shoreline from the Nisqually Delta to the Tacoma Narrows Bridge, including Ketron Island. Sayre Hodgson of the Nisqually Tribe was responsible for this work.

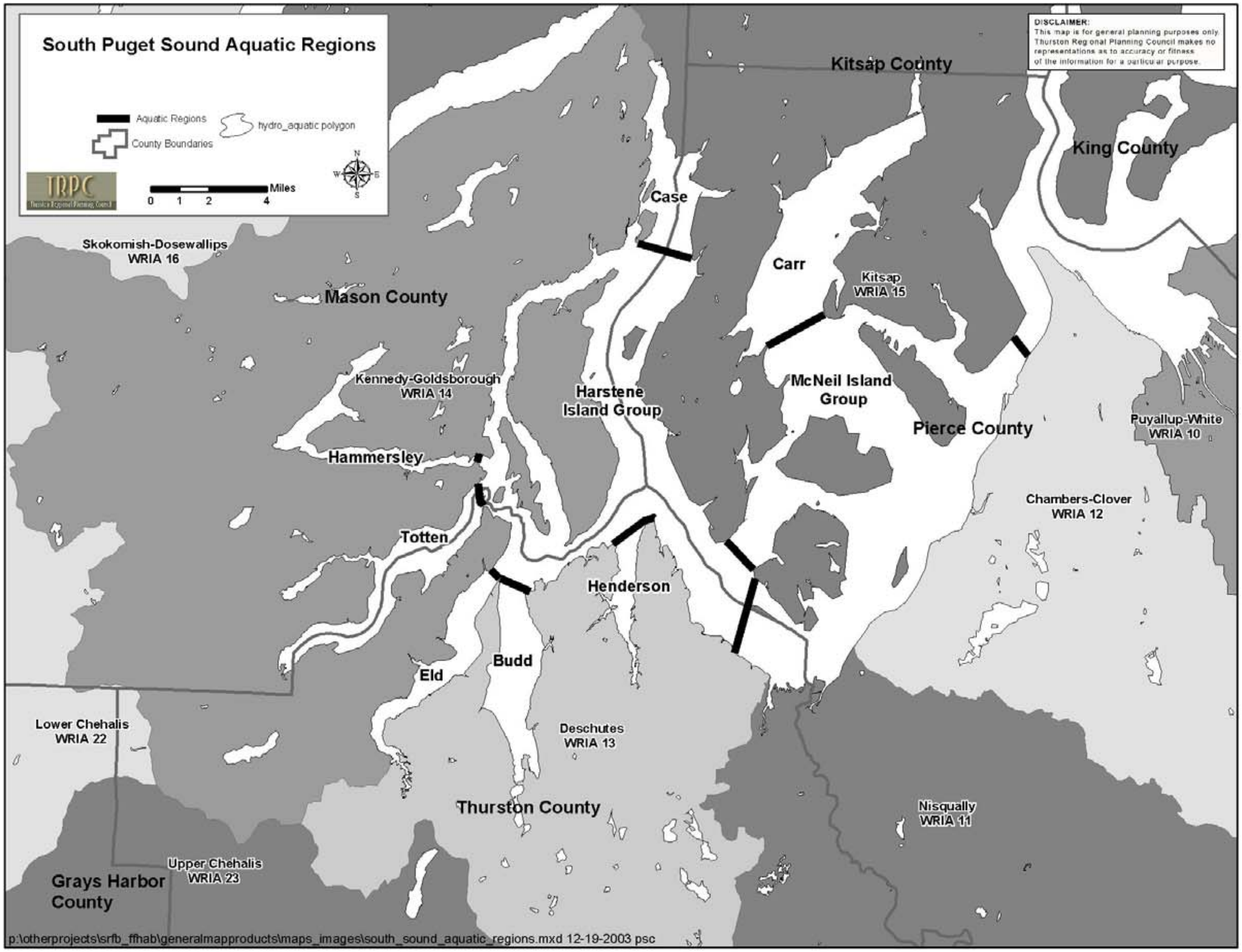
For areas not covered by an existing report, an experienced habitat biologist familiar with the area used professional judgment to identify the landscape stressors affecting natural processes. Original data collection was necessary for that portion of the McNeil Island group along the shoreline from the Nisqually Delta to the Tacoma Narrows Bridge, including Ketron Island. Sayre Hodgson of the Nisqually Tribe was responsible for this work.

For the landscape regions within Mason County, the main source material was the "Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment (2002)" and the "Greater Mason County Nearshore Habitat Assessment (draft, 2004)" which was interpreted by Scott Steltzner and Michelle Stevie, Squaxin Island Indian Tribe. This team also was responsible for preparing and interpreting original nearshore assessments for all of Totten and Skookum Inlets as well as the eastern shoreline of Dana Passage from Boston Harbor to Dickenson Point, as well as the Hartstene Island group shoreline from Budd Inlet to Henderson Inlet.

Original data collection and interpretation also proved necessary for the Thurston County shoreline. Cindy Wilson of Thurston County and Margie Schirato of Washington State Department of Fish and Wildlife was responsible for this effort, except for those areas as noted above.

Joanne Schuett-Hames, Washington Department of Ecology, examined and interpreted existing data relating to water quality conditions for the nine landscape regions.

The landscape analysis, coupled with the conceptual model and discussion regarding human-induced stressors, served as a foundation for developing general protection and recovery actions. It was also essential for identifying significant data needs. The pages following the map of landscape regions are a summary of Appendix A. This summary is a quick guide to determine stressors, and ultimately actions that will eliminate, reduce, or mitigate impacts on natural processes for specific regions in South Puget Sound. Detailed project recommendations are located in Chapter Six of this document.


South Puget Sound Aquatic Regions
Aquatic Regions
hydro_aquatic polygon
County Boundaries
TRPC
Miles
0 1 2 4
DISCLAIMER:
This map is for general planning purposes only. Thurston Regional Planning Council makes no representations as to accuracy or fitness of the information for a particular purpose.
Kitsap County
King County
Case
Carr
Kitsap WRIA 15
Skokomish-Dosewallips WRIA 16
Mason County
Kennedy-Goldsborough WRIA 14
Harstene Island Group
McNeil Island Group
Pierce County
Puyallup-White WRIA 10
Hammersley
Totten
Chambers-Clover WRIA 12
Henderson
Budd
Eld
Lower Chehalis WRIA 22
Deschutes WRIA 13
Thurston County
Nisqually WRIA 11
Upper Chehalis WRIA 23
Grays Harbor County
p:\otherprojects\srfb_ffhab\generalmapproducts\maps_images\south_sound_aquatic_regions.mxd 12-19-2003 psc

Landscape Region / Assessment Unit	Intact Areas*	Shoreline Armoring	Overwater Structures	Ramps	Stormwater/ Wastewater	Landfill Below HHWL	Riparian Loss	Wetland & Estuarine Mod.	Input of Toxic Components	Predation	Boat Traffic	Invasive Species	Shellfish Aquaculture
Budd Inlet													
Doffelmeyer to Gull Harbor-North End	●	●					●	●					
South Budd Inlet	●	●	●	●	●	●	●	●	●		●		
Deschutes River-fish trap to Butler Cove		●	●		●	●	●	●	●		●		
Butler Cove to Big Tykle Cove		●	●		●		●				●		
Big Tykle Cove to Cooper Point		●	●		●		●				●		
Carr Inlet													
Green Point and Horsehead Bay		●	●				●						
Horsehead Bay to Raft Island, including Cutts Island	●	●	●				●						
Allen Point to Burley Lagoon		●											
Burley Lagoon		●	●				●						
Purdy Spit to entrance of Van Geldern Cove		●	●				●						
Case Inlet													
North Spit of Dutcher Cove to Mason County Line	●	●					●						
County Line to Power Line Crossing	●	●			●		●						
Eastern Power Line Crossing to Western Power Line Crossing	●				●	●							
Western Power Line Crossing to Fair Harbor	●	●					●	●					
Fair Harbor to Southern Tip of Stretch Island, Including Reach Island		●	●		●		●						

*Please see "Notes" at the end of this chapter for a discussion on the definition of "intact."

Landscape Region / Assessment Unit	Intact Areas	Shoreline Armoring	Overwater Structures	Ramps	Stormwater/ Wastewater	Landfill Below HHWL	Riparian Loss	Wetland & Estuarine Mod.	Input of Toxic Components	Predation	Boat Traffic	Invasive Species	Shellfish Aquaculture
Eld Inlet													
Cooper Point to Green Cove (North end)		●			●		●	●					●
Green Cove to North End of Mud Bay	●	●			●		●	●					●
Mud Bay-South end of Eld Inlet		●	●		●		●	●					●
North of Mud Bay to Cove/Point (unnamed)		●			●		●	●					●
North side of Unnamed Cove to North side of Youngs Cove	●	●			●		●	●					●
Youngs Cove to Flapjack Point		●			●		●	●					●
Flapjack Point to Frye Cove	●	●			●		●	●					●
Frye Cove to Sanderson Harbor	●	●			●		●	●					●
Hammersley Inlet & Oakland Bay													
Hungerford Point to Libby Point	●						●						
Libby Point to Munson Point	●	●					●						
Munson Point to Bayshore	●				●			●					●
Bayshore to Eagle Point		●	●		●		●	●					
Eagle Point to Skookum Point	●	●					●	●					
Skookum Point to Arcadia	●	●			●								
Hartstene Island Group													
Devils Head to North Entrance of Taylor Bay	●	●											
North Entrance of Taylor Bay to North Entrance of Whiteman Cove		●						●					
North Entrance of Whiteman Cove to Herron, Including Herron Island	●	●						●					
Herron to North Spit of Dutcher Cove	●	●					●						

Landscape Region / Assessment Unit	Intact Areas	Shoreline Armoring	Overwater Structures	Ramps	Stormwater/ Wastewater	Landfill Below HHWL	Riparian Loss	Wetland & Estuarine Mod.	Input of Toxic Components	Predation	Boat Traffic	Invasive Species	Shellfish Aquaculture
Hartstene Island Group (Continued)													
Stretch Island Bridge to Walkers Landing	●	●				●	●						
Walkers Landing to Hungerford Point	●	●				●	●						
Steamboat Island to Hunter Point		●					●						
Hunter Point to Sanderson Harbor		●			●		●	●					●
Dofflemyer Point to East Entrance of Little Fishtrap	●	●	●				●						
East Entrance of Little Fishtrap to Henderson Inlet	●	●											
Johnson Point to Baird Cove		●	●		●		●						
Baird Cove to Mill Bight	●	●	●		●		●						
Mill Bight to Dog Fish Bight		●					●						
Dog Fish Bight to Sandy Point		●				●		●					
Sandy Point to Butterball Cove	●	●			●			●					
Butterball Cove to DeWolf Bight	●	●											
DeWolf Bight to Hogum Bay	●	●					●						
Hogum Bay to Mc Neill Island Group (122 degrees 45') (Meridian Road)	●	●											●
Hartstene Island- Dougall Point to Fudge Point, Including McMicken Island	●	●					●						
Hartstene Island- McMicken Island to Brisco Point	●	●					●						
Hartstene Island - Brisco Point to Salmon Point		●					●	●					●
Hartstene Island- Salmon Point to Northwest Point of Hartstene Island	●	●					●						●
Northwest Point of Hartstene Island to Dougall Point	●	●					●						
Squaxin and Hope Islands	●		●										

Landscape Region / Assessment Unit	Intact Areas	Shoreline Armoring	Overwater Structures	Ramps	Stormwater/ Wastewater	Landfill Below HHWL	Riparian Loss	Wetland & Estuarine Mod.	Input of Toxic Components	Predation	Boat Traffic	Invasive Species	Shellfish Aquaculture
Henderson Inlet													
Johnson Point to Woodland Creek	●	●	●				●	●					
South Henderson Inlet	●		●		●			●					
Woodard Bay to Henderson Inlet Line	●	●	●				●	●					
McNeil Island Group													
Harstene Island Line (122 degrees 45”) to Nisqually Head/Luhr Beach	●	●											●
Nisqually Head/Luhr Beach to Mouth of Little McCallister													
Nisqually estuary to Gordon Point (near Steilacoom)	●	●				●		●					
Ketron Island	●												
Gordon Point (near Steilacoom) to the tip of Days Island		●				●		●					
Days Island to Tacoma Narrow Bridge		●				●							
Tacoma Narrows Bridge to Point Fosdick (EMU 3)													
Point Fosdick to Wollochet Bay (EMU 4)		●	●				●	●					
North Shore of Hales Passage to Green Point (EMU 5)		●	●				●	●					
Van Geldern Cove to Pitt Passage, including Pitt Island (EMU 9)		●	●				●	●					
Pitt Passage to Devil’s Head (EMU 10)		●	●				●	●					
Fox Island shoreline (EMU 13)		●	●				●	●					
Anderson Island shoreline (EMU 14)		●	●				●	●					
McNeil Island shoreline (EMU 15)		●	●				●	●					

Landscape Region / Assessment Unit	Intact Areas	Shoreline Armoring	Overwater Structures	Ramps	Stormwater/ Wastewater	Landfill Below HHWL	Riparian Loss	Wetland & Estuarine Mod.	Input of Toxic Components	Predation	Boat Traffic	Invasive Species	Shellfish Aquaculture
Totten and Skookum Inlet													
Arcadia to Windy Point		●					●						●
Windy Point to Barron Point (mouth of Skookum Inlet)	●						●						●
Little Skookum Inlet	●							●					●
Wildcat Harbor to Hurley Cove		●					●						●
Hurley Cove to County Line	●												●
County Line to West Side of Burns Cove	●							●					●
West Side of Burns Cove to Hudson Cove		●					●						●
Hudson Cove to East Entrance of Gallagher Cove		●					●						●
East Entrance of Gallagher Cove to Steamboat Island		●					●						●

Notes:

The definitions for the term “intact” as used in this document are:

1. “Intact areas are areas where the shoreline and riparian vegetation are in a natural condition (i.e. absent of shoreline impacts such as bulkheads, shoreline armoring, overwater structures, or major loss of riparian vegetation). These areas may still be impacted by impaired habitat forming processes in the area, such as impaired water quality of sediment supply.”

2. “Areas assessed as intact in the KGI, Hammersley, and Oakland Bay, and the Greater Mason County Nearshore Salmonid Habitat Assessments were rated by a mathematical model as having high quality habitat that has been relatively unaffected by human induced stressors.”

General Protection Actions, Recovery Actions, & Data Needs

1. Habitat

The Habitat Committee of the South Puget Sound Salmon Recovery Group identified a series of general protection and recovery actions necessary for achieving the viable salmonid population projections for Nisqually Chinook as well as providing properly function conditions for bull trout and other salmonids relying on nearshore habitat.

Protection actions seek to preserve natural processes that create habitat or protect specific nearshore areas where habitat appears intact. Recovery actions attempt to overcome the disruption stressors cause to natural processes.

1A. Protection Actions for Natural Processes

The first and foremost protection strategy is to stop throughout South Puget Sound the continued degradation of natural process that create habitat. All development must undergo careful evaluation as to its impact on natural processes in the nearshore and ensure that there will be no net loss of properly functioning conditions. This may require mitigation on a drift cell or landscape basis.

Actions designed to protect key natural processes in South Puget Sound before stressors degrade them follow below.

Protection of Freshwater Input

- Protect the connectivity of tributaries to nearshore areas. Frequently, small tributaries are tightlined or filled as part of land development before flowing into marine waters. In order to allow for infiltration, nutrient and substrate contribution as well as maintenance of hydrologic regimes these areas should be restored, protected and preserved.

Protection of Tidal Exchange

- Maintain the connectivity of mouths of tributaries, estuaries, and wetlands to nearshore habitats.

- Ensure that overwater structures at tidal coves and wetlands have appropriate-sized openings to protect tidal flow. Such actions protect water quality and fish access as well as maintain the tidal prism (range between high and low tide). All development should ensure there is not net loss of the total acreage of available intertidal ecosystem.

Protection of Prey Species Input

- Identify and protect potential forage fish (herring, smelt, and sand lance) spawning areas. The Department of Fish and Wildlife have mapped these areas for South Puget Sound.
- Require riparian buffers along forage fish-spawning beaches - Research has shown that the eggs of herring, sand lance and surf smelt, important food sources for salmon, survive at higher percentages when they are on beaches shaded by riparian plants. There are a number of guidance materials available for maintaining views and access while retaining vegetation along the shoreline.

Protection of Nutrient Input

- Prohibit new sources and direct discharge facilities that contribute pollutants and excessive artificial nutrients.

Protection of Large Wood Function in Spit Formation

- Prohibit new structures at dams or weirs that inhibit the passage of wood.

Protection of Food Web

- Model hatchery interactions, adjust stocking rates, and collect data. Start on a local scale and update existing South Puget Sound trophic level modeling.

Protection of Sunlight Input

- Allow sunlight input by requiring specific grating/materials for docks and other overwater structures.

Protection of Erosion/Sediment Transport

- Ensure that there is no net less of erosion/sediment transport in each drift cell.
- Maintain the top slope of bluffs with native vegetation.
- Prevent the placement of structures on feeder bluffs that provide substrate inputs. Prevent further blocking of feeder bluffs by structures that do not pass substrate.

1B. Protection of Intact Habitats

Secondly, management actions should particularly focus on protecting sections of nearshore habitat identified in the South Puget Sound nearshore assessment as "intact." Natural processes need protection within these areas so that future human actions do not degrade these habitats. Intact nearshore areas include:

<u>Budd Inlet</u>

- Priest Point Park
- Ellis cove
- North end of Gull Harbor

<u>Carr Inlet</u>

- Cutts Island

<u>Case Inlet</u>

- Head of Rocky Bay
- Eel grass beds off Victor
- Entire northwest portion of the area that lies from the Eastern Power Line to the Western Power Line Crossing
- Sherwood Creek estuary
- Sand Spit south of Sherwood Creek

<u>Eld Inlet</u>

- The Evergreen State College property
- Young's Cove internally
- Frye Cove County Park
- Frye Cove internally

<u>Hammersley Inlet and Oakland Bay</u>

- West of Cape Horn to Libby Point
- Church Point
- North of Munson Point
- Upper Chapman Cove
- Upper Oakland Bay
- Eagle Point
- Mill Creek Estuary

<u>Hartstene Island Group</u>

- Small cove between Devils Head and Taylor Bay
- Small lagoon on southwest Herron Island
- Head of Dutcher Cove
- Inlets north of Walkers Landing
- West side of mainland marshes between Walkers Landing to Hungerford Point

- Little Fish Trap
- Big Fish Trap
- Mill Bight and the northern shoreline between Baird Cove and Mill Bight
- The Big Slough Area between Sandy Point to Butterball Cove
- Tolmie State Park
- Portions of Butterball Cove
- Portions of Hogum Bay
- McMicken Island
- Shoreline South of Dougall Point
- Portions of shoreline from Wilson Point to Brisco Point
- Lagoon on Hartstene Island north of the bridge
- Western Jarrell Cove
- Squaxin Island
- Hope Island

Henderson Inlet

- Area south of Swayne Road in southern Henderson Inlet
- Woodward Bay internally

McNeil Island Group

- Portions of Hogum Bay
- Some areas within the Nisqually Estuary

Totten and Little Skookum Inlets

- Feeder bluffs between Windy Point and Barron Point
- Port Blakely Timber Company Recreation Area
- Kennedy Creek estuary and associated salt marsh
- The western shoreline between the County Line to the West Side of Burns Cove

1C. Recovery Actions Addressing Human-Induced Stressors

Human-induced stressors have disrupted natural processes throughout South Puget Sound. Recovery of these natural processes will be critical to restoring the functionality of habitat for Chinook, bull trout, and other salmonids. To this effect, the SPSSRG recommended a series of general actions to address human-induced stressors.

Recovery Actions for Shoreline Armoring

- Removing armoring from publicly owned sites – City, County and State Parks often contain waterfront recreation areas with unnecessary armoring. Removal of these structures and restoring native vegetation can account for actual restoration of processes because of their relatively large size and provide perfect example sites for education purposes.

- Identify and remove bulkheads not needed for protecting structures

- Avoid the necessity of shoreline armoring by requiring setbacks and buffers

- When feasible, require the use of soft shore protection measures to protect shorelines - Much of the bulkheading that has occurred in South Puget Sound is unnecessary, and in many cases has actually increased shoreline erosion. When bulkeading is required, soft shore alternatives that mimic natural processes, using gravel, sand, logs and root masses, should be used.

- Institute a No Net Gain in armoring per drift cell – Local governments updating shoreline master programs and GMA critical areas ordinances can adopt a standard to protect existing shoreline function by placing moratoria on new armoring or collecting a resource impact fee for each armoring permit to help defray the cost of bulkhead removal and other nearshore restoration projects.

- Remove or modify shoreline armoring that is blocking the passage of materiel from feeder bluffs.

Recovery Actions for Overwater Structures

- Formalize design criteria in Overwater Structures white paper – The Aquatic Habitat Guidelines Project developed a white paper with useful design criteria to prevent and minimize damage to nearshore environments. These criteria should be formally adopted in a public rule-making process for WDFW's Hydraulic Project Approval permit program, Corps of Engineers' Section 10 permits and other appropriate permits.

- Design overwater structures to let light through, to allow survival of subtidal/ intertidal vegetation.

- Remove old homes, floats, debris, old piling, anchors, and derelict vessels.

- Minimize the number of docks by encouraging community facilities.

Recovery Actions for Ramps

- Minimize the number of ramps by encouraging community facilities.

- Provide incentives to residential property owners to give up individual ramps and marine railways.

- Identify and remove boat ramps that cloak sediment transport.

Recovery Actions for Stormwater/Wastewater

- ~~Consider a No Discharge Zone for South Puget Sound – Recreational boats are currently allowed to discharge sewage into the open waters of Puget Sound. This contributes to nutrient loading. A no discharge zone designation is a common~~

~~provision of the Clean Water Act that to date has not been exercised in Puget Sound. As mentioned earlier, the long residence time of water in South Puget Sound may warrant employing this provision~~. REMOVE - SWARTOUT

- Retrofit stormwater systems using Low Impact Development practices – Many urban areas could be retrofitted using LID principles to improve water retention, treatment and infiltration to the water table, especially as part of ongoing redevelopment projects.

- Retrofit wastewater treatment plants for reclaimed water re-use – Wastewater that is currently being discharged into south Puget Sound can be treated to higher standards and used for irrigation, fire suppression, and wildlife habitat enhancement similar to Yelm's State of the Art system.

- Promote land use practices that prevent stormwater flows- Development reduces the natural storage and buffering capacity of watersheds, resulting in greater stormwater runoff and a range of negative impacts to aquatic habitats. Where feasible, stormwater runoff should be prevented by preserving native land cover and natural drainage systems (forests, soils, wetlands, shorelines, stream corridors) and limiting the area and connectivity of impervious surfaces.

- Implement Comprehensive Stormwater Programs - Element SW 1.2 of the *2000 Puget Sound Water Quality Management Plan* calls on all cities and counties to adopt comprehensive stormwater programs to manage stormwater runoff.

- Include Nutrient Removal in On-Site Sewage System Design - Nutrient loadings to south Puget Sound are a significant water quality concern (see for example, WDOE 2002 at http://www.ecy.wa.gov/pubs/0203021.pdf). Nutrient sources include discharges from sewage treatment systems. In the Puget Sound region, on-site sewage systems are designed to meet bacteria standards to protect public health, but do little to remove nutrients. Systems installed in shoreline and riparian areas of south Puget Sound should be designed to reduce nitrogen concentrations as well.

- Improve Monitoring and Maintenance of On-Site Sewage Systems - In order for sewage systems to function effectively they must be properly sited, designed, installed, operated, monitored and maintained. Element OS-2 of the *2000 Puget Sound Water Quality Management Plan* calls on local health jurisdictions to adopt programs that provide for regular monitoring/maintenance of on-site systems and follow-up action to ensure that malfunctioning and failing systems are repaired or replaced. The plan further calls on local health jurisdictions to identify areas of special concern and use risk-based approaches to provide enhanced oversight in marine shoreline areas and other sensitive environments.

- Promote or Require Wastewater Reuse - Municipalities and other dischargers should explore opportunities to recycle and reuse treated wastewater to reduce nutrient loadings to marine waters and to supplement and replenish limited freshwater supplies.

- Prohibit New Wastewater Discharges to Puget Sound - Water quality studies indicate that wastewater discharges are contributing to the eutrophication of marine waters in south Sound. Element P-2.1 of the *2000 Puget Sound Water Quality Management Plan* calls on Ecology to pursue alternatives to marine wastewater discharges "whenever such alternatives are feasible, economically achievable and environmentally preferable. . . . Alternatives to be considered shall include, but not necessarily be limited to, the following: land application, reuse, additional treatment and the use of constructed wetlands."

- Reduce Nutrient Loadings from Permitted Wastewater Facilities - State and federal law and the *2000 Puget Sound Water Quality Management Plan* call on Ecology to set water quality and sediment standards, to implement anti-degradation requirements, to incorporate conditions from Total Maximum Daily Load studies, and to issue NPDES permits to meet and implement these requirements. Increased nitrogen loadings and related problems with dissolved oxygen have been identified in many areas of south Puget Sound.

- Systematically reduce human-caused nutrient sources. Ecology marine monitoring data and studies have found the South Sound waters are susceptible to low dissolved oxygen conditions that can be caused by increased nutrients. A focused effort, South Puget Sound wide is needed to prevent human-associated nutrients from entering the South Sound.

- Implement a comprehensive street sweeping program to reduce the amount of pollution in water runoff - Roads, highways and bridges are sources of pollution such as sediment, heavy metals, oil, grease and debris. A significant amount of these pollutants are carried to Puget Sound by storm water when it rains. New technology in street sweeping equipment considerably reduces the amount of pollution found in runoff water.

<u>Recovery Actions for Landfill Below the High High Water Line</u>

- Prohibit any new fill for any use or structure

- Remove fill and structures below the high high water line

<u>Recovery Actions for Riparian Loss</u>

- Require native plantings along shoreline as a permit condition – Most bulkheads, overwater structures and other appurtenances require a local building permit and several state or federal use permits. These permits should require the planting of native vegetation, even for renewal permits, so that a marine riparian area can eventually re-establish. There are a number of guidance materials available for maintaining views and access while retaining native vegetation along the shoreline.

- Establish building setbacks that are protective of shoreline forests and other natural habitats, or allow the restoration of these habitats. Shoreline forests and other natural habitats provide important functions such as inputs of salmonid prey species and wood. Encroachment into these natural areas and forests leads to extensive physical/chemical, and habitat effects and impacts on salmonid populations.

- Require riparian buffers along the nearshore as a permit condition - The importance of riparian buffers for salmon and trout in freshwater systems has long been recognized. Placing buffers along the marine nearshore would serve a similar purpose.

- Increase public ownership along the shoreline to protect riparian habitat.

- Designate shorelines as open space areas.

Recovery Actions for Wetland and Estuarine Modification

- Encourage dike and tide gate removal, and improve agricultural practices on marine and estuarine marshes. In the past, substantial loss of estuarine and tidally influenced wetlands was due to the diking and hydrologic isolation of the wetlands, primarily for agricultural purposes. Dike removal and restrictions on agricultural use of estuarine wetlands (fencing of cattle, etc.) would restore important estuarine functions. This can be accomplished through incentives and buy-back programs, some of which currently exist at the federal level, such as the Conservation Reserve Program and the Wetland Reserve Program through the Natural Resources Conservation Service. Similar state and local programs could also be created and targeted toward wetland/estuarine restoration.

- Increase funding for estuarine restoration and monitoring – Most funding sources for restoration are capped at $5 million or less and require enormous resources on the part of local partnerships to find match. Restoring natural processes generally occurs at a larger geographic scale than structural restoration projects and may contain elements that are experimental until implemented and monitored. These funding sources also limit the amount of the grant that can be spent on monitoring and adaptive management, so little is known as to the success of these projects. Increasing state and federal appropriations for restoration at larger scales and actively investing in effectiveness monitoring would improve restoration effectiveness.

- Remove shoreline armor and bulkheads around the mouths of tributaries.

- Remove blockages to small tributaries, such as culverts, fill, and structures.

Recovery Actions for Input of Toxic Components

- Public education re Best Management Practices (BMPs) for preventing entry of toxic contaminants into nearshore and marine waters. For many years the ocean and inland marine waters were generally considered safe from harm by human actions. This is no longer the case; South Puget Sound nearshore and marine waters now have extensive contamination that can cause a broad suite of negative effects to salmonid populations.

- Ban the use of PBDEs - PBDEs (polybrominated diphenyl ethers) are persistent, bio-accumulating toxics used as flame-retardants in mattresses, carpets, etc. They have a structure similar to PCBs (polychlorinated biphenols), appear to behave similarly, and they are increasing in the environment in North America.

- Clean up Puget Sound toxic sediments, including South and Central Puget Sound. The removal of sediments is preferable to capping.

- Pesticides – Educate the public about the problems related to pesticide use and provide stream buffers to help filter water before it reaches streams.

- Prevent oil spills through local and regional planning and implementation efforts.

Recovery Actions for Predation:

- Reduce or eliminate man-made predator buffets.

Recovery Actions for Boat Traffic:

- Restrict vessel speed and/or redirect vessel routes - Many inlets and passages in South Puget Sound offer narrow and shallow openings for marine traffic. The wake from passing boats and ships passing through these constrictions can cause shoreline erosion and damage to the near-shore marine environment. Much of this impact can be avoided by selectively controlling speeds and vessel routes located near sensitive areas.

- Require specific anchoring practices and docking design.

Recovery Actions for Invasive Species:

- Require that ballast water in commercial ships be exchanged or treated before release in South Puget Sound - Before a voyage commercial ships must take in water (ballast) for stability. Once a ship arrives at its destination port this water is released. A common method of non-native species introduction is by being carried in this ballast water. By requiring the dumping or treatment of ship ballast water exotic species would be prevented from introduction.

- Remove from riparian areas invasive terrestrial non-native vegetation, such as scotch broom.

Recovery Actions for Shellfish Aquaculture:

- Identify Shellfish Aquaculture Impacts and Improve Management Practices - The production and harvest of shellfish involves a variety of techniques that can negatively affect the nearshore environment. Practices should continue to be developed to avoid and mitigate potential negative impacts. One document that sets a solid framework for this work is the Pacific Coast Shellfish Growers Association's *Environmental Codes of Practice for the Pacific Coast Shellfish Industry*, adopted in 2002 to minimize an array of impacts associated with the most common industry practices.

Application of Recovery Actions to each Landscape Region and Assessment Unit

Coupling the recommended actions above with the landscape analysis from the prior chapter provides a broad recovery strategy for each landscape region and assessment unit.

For example, to make nearshore habitat fully functional for Chinook and bull trout within the Assessment Unit "Doffelmeyer to Gull Harbor-North End" in Budd Inlet, the landscape analysis reveals that shoreline armoring, riparian loss, and wetland/estuarine modification are the key stressors to address. Therefore, the general recovery actions necessary for this assessment unit would include those listed above for shoreline armoring, riparian loss, and wetland/estuarine medication.

1D. Habitat Data Needs

Salmon recovery planning is at its infancy and there remains a significant need to learn more about the natural processes, stressors, and potential recovery actions appropriate to South Puget Sound's uniqueness. The South Puget Sound Salmon Recovery Group's Habitat Technical Committee identified a series of data needs critical for guiding future actions directed at protection and recovery of nearshore habitat. As important as this data is, its absence should not impede progress towards implementing protective and recovery actions through appropriate management actions.

Data Needs for Natural Processes

Prey Species Input

- Study how climate change will affect forage fish population variations and health.

Wood Function as Substrate for Organisms

- Study the importance of cover for juvenile salmonids in the marine nearshore - In freshwater, juvenile salmon and trout are known to use cover, such as vegetation, to conceal themselves from predators as well as to escape unfavorable conditions such as direct sunlight. It is unknown if cover performs a similar function in the marine nearshore.

- Study water quality functions and ecosystem roles of organisms on inter-tidal downed wood. Downed wood along inter-tidal zones is colonized by living organisms such as barnacles and mussels. These may provide important ecosystem functions such as water filtration. Extensive loss of shoreline forests and clearing of inter-tidal downed wood in some parts of South Sound have removed this natural substrate and associated processes. A study of the organisms' functions will provide useful knowledge for informing shoreline protection and shoreline and water quality restoration efforts.

- Determine the historical level of woody debris within the South Puget Sound nearshore then set goals and identify methods for increasing its presence.

Nutrient Input

- Identify sources of pollutants and excessive artificial nutrient. Prohibit new sources and direct discharge facilities. Correct and remove old sources and facilities that are currently contributing pollutants to nearshore habitats, such as culverts, stormwater, and non-point pollution, and agriculture run-off.

Organic Matter Composition

- Study timing of organic matter delivery as input for food web models – The seasonal nature of plant growth and decay has a large influence on the life cycles of organisms in the detritus-based food web important for juvenile salmon. Peaks in this production and transfer of energy may not be in synch with the timing of juvenile wild salmon recruitment to the nearshore.

- Research the association of organic matter composition with habitat and the importance of organic matter composition within South Puget Sound.

Food Web

- Research possible changes that may have occurred over time in the food web of South Sound. This understanding of how the food web in the South Sound ecosystem functions and may change under differing conditions is of fundamental importance to long-term salmon protection. One aspect of this is how the addition of nutrients from human-created sources changes phytoplankton communities, and how possible changes to plankton communities affects dissolved oxygen, how changed dissolved oxygen may affect fish species, etc.

Erosion/Sediment Transport

- Study the appropriate use of supplementing beach, especially location, timing, and type of material used.

Data Needs for Human-Induced Stressors

Overwater Structures

- What is the relative impact on water quality of septic discharges from houseboats and live-aboard vessels? Is it greater in some areas than in others?

Ramps

- Research new technologies for launching vessels.

Stormwater/Wastewater

- A Phase II dissolved oxygen study is necessary to enable South Sound to be viewed as an integrated system instead of individual locations. Washington Department of Ecology has completed a Phase I dissolved oxygen study which initiated development of coupled, three-dimensional hydrodynamic and water quality models of South Sound. This study and initial modeling has confirmed the South Sound's sensitivity to increased nutrients and susceptibility to low dissolved oxygen conditions related to nutrient additions.

- Study the function of tributary mouths in the nearshore.

- Inventory all stormwater/wastewater outlets throughout South Puget Sound.

Riparian Loss

- Evaluate the ecological use of wildlife species along the nearshore.

Input of Toxic Components

- Evaluate South Sound wastewater for the presence of pharmaceuticals and study the effects to South Sound fish from pharmaceuticals that are present. Pharmaceuticals such as estrogens are believed to affect fish hormone systems and fitness characteristics. Although pharmaceuticals are very likely to be present in the South Sound, there have been no studies to determine which ones are present, or how they affect local fish.

Predation

- Fishery-independent stock assessments – The status of many stocks of marine fish, including salmonids is not well known because most stock assessments are made using fishery catch data. Studies specifically designed to characterize the entire fish community are better at informing food web models and understanding shifts in abundance of predators and prey that may be affecting salmon.

- Study the effect of hatchery fish, birds, marine mammals, and harvest management.

Boat Traffic

- A study is needed of the contaminant levels and effects on biota (e.g., smelt spawn) from polycyclic aromatic hydrocarbons (PAHs) resulting from intensive boating recreation. Once in South Sound, the PAHs may stay due to low flushing rates. Intensive boating recreation throughout the summer may be adding unknown and potentially substantial amounts of PAHs to South Sound waters

Invasive Species

- Conduct an inventory of spartina in the South Puget Sound nearshore.

- Conduct a comprehensive survey of introduced marine species in South Puget Sound and determine their impact on salmonids - Introduced marine species have the potential to disrupt the ecosystem by altering the natural community and threatening native species. It is essential that introduced species in South Puget Sound be identified and the extent of colonization known before plans can be made to contain or eradicate nuisance species.

Shellfish Aquaculture

- Aquaculture regulations/best management practices to provide protection of habitat and biota. South Sound nearshore and marine areas are utilized extensively for diverse types of aquaculture. Due to the broad scale, and in some cases intensive use of the landscape areas for aquaculture, clear guidance protective of the South Sound marine ecosystem and its salmonids is necessary.

- Determine the percent of aquaculture cover within South Puget Sound at the varying tide levels.

- Study the effects of shellfish aquaculture on salmon in South Puget Sound - The shallow waters and protected bays of Puget Sound are ideal for growing shellfish. Puget Sound ranks as either the number one or number two region for raising cultured oysters, clams and mussels. It is unknown what effect shellfish aquaculture has upon the habitat of South Puget Sound salmon.

- Develop alternative aquaculture practices to allow removal of dikes.

2. Hatcheries

2A. Regional Approach to Hatchery Reform

The Hatchery Scientific Review Group (HSRG) has established a regional approach for integrating hatchery programs into salmon recovery strategies for Chinook in Puget Sound.

> "...Hatchery programs must be viewed as tools that can be managed as part of an integrated strategy to meet watershed or regional resource goals, in concert with actions affecting habitat, harvest rates, water allocation and other factors."

To this effect, the HSRG identified six key Puget Sound-wide actions how hatcheries affect the environment and fishery resources (HSRG April 2004). A summary of these actions follows below.

Hatchery programs must clearly define their purpose and the type of program they intend to operate.

The two primary purposes for hatcheries are to help conserve naturally spawning populations and provide fish for harvest. Some hatcheries do both, as well as retain other purposes, such as scientific research, education, and providing cultural benefits.

Furthermore, hatcheries need to be clear about the genetic management goals for the broodstock and naturally spawning populations. All programs need to identify their broodstock goal as either genetically integrated or segregated relative to naturally spawning populations; no individual hatchery program can be both or intermediate without imposing significant genetic risks to naturally spawning populations.

Hatchery programs need to operate within a regional and ecosystem context.

Hatcheries cannot operate in a vacuum; they must consider the programs of other hatcheries operating simultaneously in the same watershed and region to minimize adverse interactions between salmonid stocks.

Furthermore, hatcheries also need to consider both their receiving habitat as well as the naturally spawning and hatchery-propagated fish that depend on the existing habitat.

Assessment of the biological significance and viability of salmonid populations provides an important benchmark for developing both long- and short-term goals and management strategies for a particular population or stock.

In integrated hatchery programs that maintain hatchery broodstock genetically similar naturally spawning populations, the combined population of hatchery and wild fish share similar characteristics for biological significance and viability.

In segregated hatchery programs, biological significance reflects only on the composition of the hatchery population and viability links to the performance of hatchery stock in both the hatchery and natural environments.

Hatchery operations need to consider their impact on harvest and the conservation of propagated stock.

Hatchery operations can affect the short and long-term survival and behavior of the stock that is the target of hatchery propagation. This can happen due to broodstock choice and collection, spawning, incubation and rearing protocols. The hatchery environment used for rearing can also be a concern. Such operations potentially affect achieving harvest goals as well as goals for biological significance and viability of the target stock. This is true whether the target stock represents only the hatchery stock as in segregated programs or represents a component of the natural stock, as in integrated programs.

Hatchery fish can affect harvest and the conservation of other stocks and species.

It is critical for hatcheries to alleviate the adverse impacts that release factors can cause to other stocks and species through genetic or ecological interactions. The presence of hatchery fish may also alter fishing patterns and thereby affect harvest rates on naturally produced stocks.

Manage hatchery programs to ensure accountability and success.

To meet conservation, harvest, and other goals while minimizing adverse impacts on natural-origin salmonids within watersheds or regions, hatchery programs need to be accountable for decisions and actions related to their management and operations.

Success is dependent on an accurate and timely management information system that can measure benefits, evaluate actions, and provide information for hatchery management and operations.

2B. South Puget Sound Hatchery Recommendations

Hatcheries in South Puget Sound have a dual role in salmon management. First, selected facilities work to conserve and enhance threatened or depressed stocks, Nisqually fall Chinook being the most noteworthy. Secondly, South Puget Sound hatcheries provide harvest opportunities for recreational, commercial, and tribal fishers.

The HSRG reviewed each hatchery program in the South Puget Sound region and made specific recommendations relating to their management. A summary of these recommendations are as follows:

- Close McAllister Hatchery (completed)
- Close Fox Island Net Pens (completed)
- Eliminate Agate Pass coho program at Coulter Creek
- Eliminate Coulter Creek Chinook releases (completed)
- Eliminate pink production at Minter Creek
- Reduce coho production at Minter creek
- Reduce coho production at Squaxin/South Sound Net Pens (completed)
- Adjust Chinook broodstock returning time at Minter Creek
- Evaluate and monitor each hatchery stocks through coded-wire tagging and mass-marking
- Provide for improved predator control measures to ensure accurate pond inventory at release
- Purchase of fish counters for evaluation and monitoring of juveniles released from hatcheries
- Purchase of equipment to improve operational effectiveness, such as fish pumps

2C. Data Needs for Hatcheries

Fisheries managers originally designated this region a harvest management zone as part of their post-Boldt Decision efforts to provide adequate fishing opportunities for the Puyallup, Nisqually, and Squaxin Island tribes, all of which have "usual and accustomed" fishing areas here. Several hatcheries in this region are old Washington Department of Wildlife trout facilities not suited to salmon production. The Department manages these facilities for interbasin stock transfers. At its height, this region was releasing up to ten million smolts per year, approximately ten percent of the total releases in Puget Sound and coastal Washington. Despite increased production, returns have declined. The HSRG strongly recommend an analysis of the carrying capacity of the Sound and that hatchery managers cap or decrease production in this region until more certainty is established.

3. Harvests

Harvest policy remains the purview of the co-managers, the State of Washington, the Squaxin Island Tribe, the Nisqually Tribe, and the Puyallup Tribe. Although the co-managers set harvest limits on a government-to-government level, the impacts of habitat and hatchery actions play a key role in this process. Harvest policy will continue to integrate habitat and hatchery conditions when modeling projected harvest numbers for Chinook.

There is no sport or commercial fishery for bull trout.

Management Actions for Implementing General Protection Actions, Recovery Actions, & Data Needs

Up to this point, this report presents recommendations as to which intact habitats in South Puget Sound need protection, how to recover those habitats affected by disrupted natural processes, and what data gaps still exist that require further study.

Management actions harness the social, economic, and political forces necessary for implementing these recommendations. Management Actions consist of:

- Development plans, policies, and regulations of counties, cities, tribes, state, and federal government
- Public and private restoration and conservation projects (can include mandatory, voluntary, and incentive-based programs)
- Educational efforts and other public outreach efforts

This chapter first focuses on identifying existing management actions available to governments and salmon recovery organizations for implementing protection and recovery actions.[3] It then analyzes the adequacy of these existing tools, identifies gaps, and proposes changes that will ensure better implementation. The third section of this chapter focuses on a five-year management action plan with costs.

1A. Survey of Existing Management Actions for Protection and Recovery

The tables on the following page are a survey of existing management actions available to government and salmon recovery organizations with jurisdictional interest or focus within the South Puget Sound nearshore. Tables 7-1 and 7-2 examine management actions that achieve protection-based actions. Tables 7-3 through 7-5 examine those management actions that address recovery-based actions.

In relation to mitigating the impacts of new development, the regulatory authority of state agencies and local governments provides significant opportunities for implementing the protection and recovery actions for South Puget Sound recommended in Chapter Six. This will strengthen as local governments integrate the findings of this plan when updating their plans, ordinances, and best available science citations.

The purview of salmon recovery organizations, given adequate funding, is capable of addressing many protection actions (especially acquisition of land or development rights) as well as voluntary remedial projects with private and public landowners.

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[3] "Governments" in the context of this report includes the State of Washington; the Squaxin Island and Nisqually Tribes; Pierce, Thurston, and Mason Counties; and the municipalities and special use districts within each of the aforementioned counties. "Salmon recovery organizations" include a wide range of nonprofit entities, such as the Regional Fisheries Enhancement Groups, land trusts, etc.

Table 7-1 General management action tools available to state agencies for implementing protection-based actions.

Protection Actions	Shoreline Management Act	Growth Management Act	Puget Sound Action Team Plan	Water Pollution Control Act	Water Rights	Aquatic Use Authority	Forest Practices Act/Forest & Fish	State Environmental Policy Act	Hydraulic Permit Approval	Aquaculture	Harvest	Hatchery
Freshwater Input	1,2,3	2,3	2	1,3	1			3	3			3
Tidal Exchange	1,2	2,3	2	1		4		3	3		3	3
Prey Species Input									3			
Wood Function as Substrate for Organisms	2	2,3	2				4		3			
Nutrient Input	2	2,3	2	1,2							3	3
Large Wood Function in Spit Formation	2	2,3	2				4		3			
Organic Matter Composition	2	2	2									
Food Web	2	2	2									
Sunlight Input	2	2	2			4	4		3			
Erosion/Sediment Transport	1,2	2,3	2	1		1,4	4	1,3	3		4	
Shoreline Forests	1			1			1					

Key: 1 - WDOE 3 - WDFW 2 - PSAT 4- WDNR

Table 7-2 General management action tools available to local governments for implementing protection-based actions.

Protection Actions	Shoreline Management Plan	Critical Area Ordinances	State Environment Policy Act	On-site Sewage, sewers	Land use regulations	Floodplain Regulations	Stormwater	Non-point Pollution Ordinance	Drinking & reclaimed water, exempt wells
Freshwater Input	1,2,3,4	1,2,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,4	1,3
Tidal Exchange	1,2,3,4	1,2,3,4	1,2,3,4		3	3	3		
Prey Species Input	1,2,3,4	1,2,3,4	1,2,3,4	1	3	1,3	3	1	
Wood Function as Substrate for Organisms	1,2,3,4	1,2	1,2,3,4		1,3	1,3	3		
Nutrient Input	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	3	3	1,2,3,4	1,2,4	3
Large Wood Function in Spit Formation	1,2,3,4	1,2,3,4	1,2,3,4		3	3	3		
Organic Matter Composition	2	2	1,2,3,4	3	3	1,3			
Food Web	1,2,4	1,2,3,4	1,2,3,4	3	3	3			
Sunlight Input	1,2,3,4	1,2,3,4	1,2,3,4		3	3			
Erosion/Sediment Transport	1,2,3,4	1,2,3,4	1,2,3,4			1,2,3,4	1,2,3,4		

Key 1 - Thurston County 2 - Mason County 3 - City of Olympia 4 – Pierce County

Table 7 – 3 General management action tools available to state agencies for implementing recovery-based actions.

Recovery Actions	Shoreline Management Act	Puget Sound Action Plan	State Water Pollution Control Act	Aquaculture	Aquatic Use Authorizations	Weed Control/Invasives	State Environmental Policy Act	Hydraulic Permit Approval	Forest Practices Act/Fish & Forest	Biosolids	Toxics	Growth Management Act	Enforcement	Harvest - finfish & shellfish	Hatcheries
Shoreline Armoring	1,2,4	2	1		4		1,2,3	3				1,2,3 4,7			
Overwater Structures	1,2,4	2	1		4		1,2,3	3				4,7			
Ramps	1,2,4	2	1		4		1,3	3				4,7			
Stormwater/Wastewater	1,4	2	1		4		1,3			1		2,3,4 7			3
Landfill Below HHW Line	1,2,4		1		4		1,3	3				2,4,7			
Riparian Loss	1,2	2	1				1,3	1,3	3,4			2,3,4 ,7			
Wetland Estuarine Modification	1,2,4	2	1		4	1,4	1,2,3	3				3,7			
Input of Toxic Components	1	2	1			1						7			
Predation	1		1					3				7			3
Boat Traffic	1		1									7			3
Invasive Species	1	2	1		4	4,6						7			3
Shellfish Aquaculture	1,4	2	1	3,4	4,5							4,7		3	3
Net Pen Aquaculture	1,4		1	1,3,4	4							4,7		4	3

Key: 1 - WDOE 2 - PSAT 3 - WDFW 4- WDNR 5 - WDOH 6 - WDA 7 - DCTED

Table 7 – 4 General management action tools available to local governments for implementing recovery-based actions.

Preventative Regulations for Recovery Actions	Shoreline Management Plans	Critical Areas Ordinance	State Environmental Policy Act	On-site sewage disposal, sewers	Land use regulatins, floodplain laws	Stormwater	Non-Point Pollution Ordinance	Drinking water, reclaimed water, exempt wells	Boating Ordinance
Shoreline Armoring	1,2,3,4	1,2,3,4	1,2,3,4		1,2,3,4				
Overwater Structures	1,2,3,4	1,2,4	1,2,3,4		1,3				
Ramps	1,2,3,4	1,2,4	1,2,3,4		1,3				
Stormwater/Wastewater			1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,3	3	
Landfill Below HHW Line	1,2,3,4	1,2,4	1,2,3,4		1,3,4				
Riparian Loss	1,2,3,4	1,2,3,4	1,2,3,4		1,3,4	1,3			
Wetland Estuarine Modification	2,3	1,2,3,4	1,2,3,4		1,3,4				
Input of Toxic Components	2,3	1,2,3,4	1,2,3,4	1,2,3,4	1,3	1,2,3,4	1,3	3	
Predation	2,3	1,2,3,4	1,2,3,4		1,3				
Boat Traffic			1,2,3,4		1,3				1,2,3
Invasive Species	1,2,3,4	1,2,3	1,2,3,4		1,3				
Shellfish Aquaculture	1,2,4	1,2,4	1,2,3,4						
Net Pen Aquaculture	1,2,4	2	1,2,3,4						

Key 1 - Thurston County 2 - Mason County 3 - City of Olympia 4 - Pierce County

Table 7-5 General management action tools available to salmon recovery organizations for implementing recovery-based actions.

Recovery Actions	Salmon Recovery Funding Board (Lead Entities)	Regional Fisheries Enhancement Groups	Tribes	Site-Based Non-Governmental Organizations	Conservation Districts	Other Project Funding Sources	Watershed Councils	Nisqually National Wildlife Refuge	Public Parks & Trails	Non-site based educational groups	Land Trusts
Shoreline Armoring	●		●	●	●	●			●		●
Overwater Structures			●		●	●			●		
Ramps			●		●	●			●		
Stormwater/Wastewater			●	●	●	●	●				
Landfill Below HHW Line			●			●			●		●
Riparian Loss	●	●	●		●	●	●	●	●	●	●
Wetland Estuarine Modification	●	●	●	●	●	●	●	●	●	●	●
Input of Toxic Components			●	●	●	●	●		●		
Predation	●		●								
Boat Traffic			●						●		
Invasive Species	●		●		●	●	●		●		●
Shellfish Aquaculture			●		●	●			●		
Net Pen Aquaculture			●						●		

1B. Further Recovery Management Actions for Protection and Recovery

Despite the gamut of existing management actions available for implementing Chinook and bull trout recovery in South Puget Sound, more effort is necessary to ensure their full delisting. The SPSSRG identified six prioritized strategic directions that aim at intrinsically changing how we think about salmon recovery and the way we utilize existing resources to that end.

Social Change

Salmon recovery depends on a dramatic shift in community attitudes, and social change begins when society accepts a long-term view of the world that abandons the pursuit of short-term gain over long-term benefit. Bringing this change about requires

- Education and marketing efforts that nurture and celebrate wild salmon as an essential part of our community's culture – now and in the future
- Engaging local businesses, social groups, and religious organizations to become first supportive, then actively involved in salmon recovery efforts
- Translating public support into the necessary political will necessary for implementing the hard actions and delivering the level of resources demanded of salmon recovery
- Facilitating human development in a way that places more emphasis on protection through good design – acknowledging that people and salmon can live together successfully
- Teaching people about intact habitat by increasing their access opportunities to these areas

Regional Leadership

Salmon recovery in South Puget Sound will not be possible without cooperative leadership from government – the state, tribes, and local governments – and salmon recovery organizations. Progressive steps in this direction include:

- Forming a regional management body responsible for formulating and coordinating an ongoing regional approach to salmon recovery in South Puget Sound that sets and implements regional priorities and measures their short- and long-term success
- Establishing a permanent South Puget Sound science advisory team responsible for increasing the knowledge base of salmon recovery and making recommendations for further protection and recovery actions

Setting Financial Priorities

Salmon recovery is not possible without the commitment of financial resources to implement protection and recovery actions. Programmatically, state and local governments feel they have the necessary tools to bring new development in conformance with salmon recovery. However, the basic impetus missing behind these plans, policies, and law is the necessary funding to apply them in a thorough and deliberate manner. Personnel for adequate development review and enforcement are two key components to salmon recovery, but current funding resources fall far short of their needed levels given current budgetary constraints for environmental programs. More funding must go to these basic regulatory programs.

Furthermore, dealing with existing development is more problematic. Some of the worst impacts to salmon today emanate from established public and private developments that no longer meet current standards. Many private landowners lack the resources or the willingness to alter their properties to mitigate their impact to salmonids. State, tribal, and local governments have aging infrastructure that impact salmon, but the replacement or mitigation price exceeds local financial resources. Voluntary and publicly funded remedial efforts are the only approaches to fixing these problems. Current funding levels are inadequate and inconsistent to address this problem. Again, more dedicated funding in a steady stream is essential.

The community must also expedite its efforts aimed at acquiring land or development rights for properties adjacent to the nearshore that are important for salmonid habitat.

Support Innovation

Implementing salmon recovery in South Puget Sound demands new, innovative approaches. Governments and salmon recovery organizations must be prepared to take risks – biologically and politically – to facilitate success. Stepping up to the plate in this fashion, however, assumes that government and salmon recovery organizations be prepared to assume the public liability when such efforts fail.

Regulatory Effectiveness

Despite the availability of a wide-range of regulatory management actions available to state and local government, there remains plenty of room to use these tools more effectively on behalf of salmon recovery. Major points in this arena are:

- It is critical for permit review processes to focus on the cumulative impacts of projects. This is especially critical when evaluating a project’s affect on natural processes; disruption of sediment transport is an excellent example.

- The review and permitting of development in the nearshore environment needs better coordination. Too many agencies with jurisdiction in the nearshore make it difficult for project proponents and reviewers alike to address salmon recovery mitigation adequately and comprehensively. A "one-agency" permitting or a clearinghouse approach is essential to long-term salmon recovery.

- A comprehensive regulatory approach to salmon recovery depends on strong interjurisdictional planning. Each level of government can no longer work in a vacuum thinking of its own jurisdictional interest for salmon recovery in South Puget Sound. Cooperation and integration of governmental regulatory efforts needs to be seamless to ensure there are no gaps that impact salmon when managing growth.

- Stronger and more effective enforcement is the glue that holds regulatory effectiveness together. This is more than a financial priority – it encompasses social change and regional leadership issues as well. Enforcement also entails the permit follow-through that many governments fail to do because of the lack of time and staff. State, tribal, and local governments need more funding and resources to develop and implement enforcement programs.

<u>Protection through Land Use Planning</u>

Communities need new approaches to managing growth. Through growth management programs, communities are beginning to explore the application of new tools that benefit salmon:

- Encourage open space with incentive programs and eliminate minimum lot size requirements for participating in them.

- Provide financial incentives to developers for low impact development.

- Prevent high-density development along shorelines outside of urban growth areas.

- Establish shoreline breaks in both urban and rural areas to protect habitat.

- Integrate salmon recovery efforts into Shoreline Management Plans and ordinances.

- Create salmon-friendly development standards for application by local governments throughout South Puget Sound.

1C. Five-Year Management Goals

The eventual recovery and maintenance of Chinook and bull trout populations in South Puget Sound is likely to be an effort that will take several generations. Reversing over 100 years of development impacts will be a slow and expensive process indeed. While government and salmon recovery organizations have completed many of the first steps towards salmon recovery, more effort is necessary, even if it is still organizational in nature. The SPSSRG proposes the following Five-Year Management Goals as essential for building the strong foundation necessary for ensuring salmon recovery is successful.

- Cooperative Planning

  1. The SPSSRG intends to expand its salmon recovery efforts to include all South Puget Sound salmonids in both the nearshore and freshwater environments. This will allow refinement of current recovery efforts into a comprehensive approach. Estimated cost: $100,000

  2. The formation of a Sound Puget Sound Advisory Science Team will continue to direct science-based analysis and recommendations for salmon recovery based on an adaptive management approach. Estimate cost over the five-year period: $250,000

  3. Establishing a regional forum for cooperative, interjurisdictional salmon recovery planning. Estimated cost over the five-year period: $500,000

- Regulatory Improvements

  1. Integration of South Puget Sound salmon recovery protection and recovery actions for the nearshore into state, tribal, and local government plans, policies, and development regulations. For local governments, this may include incorporating this document into Shoreline Management and Comprehensive Land Use Plans and regulations, adoption by reference for substantive authority under SEPA (WAC 197-11-660), and adopted as a citation for best available science pertaining to fish and wildlife habitat conservation areas. Estimated cost for four jurisdictions: $400,000

  2. South Puget Sound state, tribal, and local governments will develop a strategic plan for improving project review and enforcement activities, including an analysis of proposed funding mechanisms. Estimated cost: $100,000

- Acquisition Activities

  1. Governments, salmon recovery organizations, and land trusts will develop a strategic plan for acquisition and management of land or development rights for intact or nearly intact nearshore habitat supporting salmonids. Estimated cost: $100,000

  2. Governments, salmon recovery organizations, and land trusts may need interim acquisition funding for intact or nearly intact nearshore habitat supporting salmonids under immediate development threat. Estimated cost for five-year period to acquire 50 acres: $3,000,000

- Restoration Activities

  Restoration efforts aimed at repairing disrupted natural processes that create habitat for salmon needs to continue at a funded level corresponding to the capacity of South Puget Sound salmon recovery organization to do the work. The goal is to do the equivalent of two miles of major nearshore reconstruction annually (such as the replacement of shoreline armoring with soft erosion control alternatives) and five miles of minor nearshore reconstruction. Estimated cost for the five-year period: $99,000,000

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Budd Inlet

Budd Inlet Water Quality Overview

- CWA 1998 Section 303(d) listings: dissolved oxygen, pH, sediment bioassay, and extensive chemical contamination. (Additional toxics listings are proposed for the 2002/2004 list.)
- Statification: Strong and persistent (BUD002), and moderate and infrequent (BUD005) (Newton et al. 2002).
- Dissolved Oxygen: very low, <3.0 mg/l (stations BUD002 & BUD005), (based on Ecology marine monitoring data).
- Ammonium-N: very high (stations BUD002 & BUD005), (based on Newton et al. 2002).
- Nitrite: highest concentration in Puget Sound found in inner Budd Inlet (BUD002), and high concentration also found at station BUD005; high nitrite can be an indicator of eutrophication (Newton et al. 2002).
- Sensitive to eutrophication (Newton et al. 2002).
- Sensitivity to added nutrients: very high (station BUD002), and not high (station BUD005) (based on Newton et al. 2002).
- Fecal Coliform Bacteria: Inner Budd Inlet appeared to have chronically high and persistent fecal coliform bacteria counts (>14 organisms per 100 mL) (Newton et al. 2002).
- Utilizing five indicators of water quality concern (strong stratification, low DO, limiting nutrients, high fecal coliform bacteria concentrations, and high ammonium concentrations) Budd Inlet was within the highest concern category for the state's marine stations during 1998 to 2000 (Newton et al. 2002).
- PCBs: detected in sediment study (Dutch et al. 2003).

Primary Stressors: Nutrients, toxics, dissolved oxygen, stratification

Dofflemyer to Gull Harbor-North End

- Burfoot park
- Low bank, intense residential development south of Boston Harbor area
- Sand beach
- Impacted riparian area
- Some upland agricultural uses
- Feeder bluffs
- Some armoring
- Documented surf smelt spawning area (4)
- Entire Inlet documented as Important Faunal Area (4)
- Documented as Critical Faunal Area along shoreline (4)

- Substrate mixed fine materials (4)
- Historial algal community (4)

Primary Stressors:	Wetland/Estuary Modification, Shoreline Armoring, Riparian Loss
Intact Areas:	Burfoot Park
Reference:	Cindy Wilson. Thurston County. 2004

Gull Harbor to Priest Point (Ellis Cove south end)

- Gull Harbor -New acquisition area for Capital Land Trust
- Gull Harbor provides side channel habitat
- Good riparian habitat
- Priest Point well preserved-owned by City of Olympia
- Shellfish Harvest Prohibited area
- Some upland agricultural uses
- Feeder bluffs
- Documented surf smelt spawning area (4)
- Historial algal community north of breakwater(4)
- Entire Inlet documented as Important Faunal Area (4)
- Documented as Critical Faunal Area along shoreline (4)
- Substrate mixed fine materials (4)
- Some armoring
- North Priest Point substrate sand (4)
- Possible Hazardous Materials site (8)

Primary Stressors:	Shoreline Armoring, Riparian Loss Wetland/Estuary Modification
Intact Areas:	Priest Point Park, Ellis Cove, North End of Gull Harbor
Reference:	Cindy Wilson. Thurston County. 2004

South Budd Inlet

- Cascade pole Hazardous waste clean-up site
- Port property-Industrial use
- Constriction between Budd Inlet and Capital Lake, causes loss of estuarine habitat
- Ship canal dredging
- Fish trap
- Roads and bridge crossings in Budd Inlet
- Shellfish Harvest Prohibited area

- Intensive residential development on eastern shoreline. Low bank, no riparian habitat
- Extensive armoring, highly modified shoreline
- Indian Moxlie creek enters eastern basin of inlet
- Deschutes River enters western basin of inlet
- Historical loss of delta and mudflats during construction of downtown Olympia
- Documented surf smelt spawning area (4)
- Entire Inlet documented as Important Faunal Area (4)
- Documented as Critical Faunal Area along shoreline (4)
- Primarily mudflat substrate, limited estuarine habitat remaining
- Lott discharge
- Stormwater discharge
- Haz-mat sites (8)
- Marinas (1) (8)

Primary Stressors: Wetland/Estuary Modification, Shoreline Armoring, Riparian Loss, Toxic Materials, Stormwater and Waste Water, Boat Traffic, Overwater Structures, Ramps, Landfill

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

Deschutes River-fish trap to Butler Cove

- Potential Haz-Mat sites (8)
- Shellfish Harvest Prohibited area
- Industrial uses-upland and water based
- Tightlined streams with loss of nearshore habitat
- Fill in estuarine areas
- Steep slopes-erosion impacts
- Unstable slopes
- Minimal riparian habitat
- Marina
- Documented surf smelt spawning area (4)

Primary stressors: Toxic Materials, Stormwater and Waste Water, Riparian Loss Shoreline Armoring, Boat Traffic, Overwater Structures, Wetland/Estuary Modification, Toxic Materials, Landfill

Intact areas:

Reference: Cindy Wilson. Thurston County. 2004

Butler Cove to Big Tykle Cove

- Shellfish Harvest Prohibited area
- Upland land uses residential and golf course
- Some loss of riparian habitat with single family development
- Some docks and launch areas
- Some unstable slopes (4)
- Docks and armoring
- Documented surf smelt spawning area (4)

Primary stressors: Shoreline Armoring, Riparian Loss, Boat Traffic, Overwater Structures, Stormwater and Waste Water

Intact areas:

Reference: Cindy Wilson. Thurston County. 2004

Big Tykle Cove to Cooper Point

- Shellfish Harvest Prohibited area
- Docks and armoring
- Documented surf smelt spawning area (4)
- Signifcant armoring and docks

Primary stressors: Shoreline Armoring, Riparian Loss, Boat Traffic, Overwater Structures, Stormwater and Waste Water

Intact areas:

Reference: Cindy Wilson. Thurston County. 2004

Carr Inlet

Carr Inlet Water Quality Overview

- CWA 1998 Section 303(d) listings: dissolved oxygen and fecal coliform. (Additional listings proposed for the 2002/2004 303(d) list include pH, and for the waters of concern list include total PCBs in tissue, and six toxic sediment contaminants.)
- Stratification: rated moderate and infrequent (station CRR001), (Newton et al. 2002).
- Dissolved Oxygen: low, <5.0 mg/l (station CRR001); good. >5.0 mg/l (station BML001), (based on Ecology marine monitoring data).
- Ammonium-N: not high (station CRR001), (based on Newton et al. 2002).
- Nitrite: high ~~concentration~~ (station CRR001); high nitrite can be an indicator of eutrophication (Newton et al. 2002).
- Sensitive to eutrophication (Newton et al. 2002).
- Sensitivity to added nutrients: very high (station CRR001), (based on Newton et al. 2002).
- PCBs: detected in sediment study (Dutch et al. 2003).

Primary Stressors: Nutrients, toxics. dissolved oxygen

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Green Point and Horsehead Bay

- Active feeder bluffs from Green Point to mouth of Horsehead Bay
- Documented forage fish spawning areas in Horsehead Bay.
- Most of the upper shoreline a mix of sand and gravel that may be suitable for forage fish spawning.
- Most shorelines in this area have been substantially impacted by hardened shoreline, multiple docks, and lack of riparian vegetation.
- Little or no eelgrass from Green Point to the mouth of Horsehead Bay. Extensive eelgrass beds at the mouth of Horsehead Bay, but little eelgrass within the bay.

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Horsehead Bay to Raft Island, including Cutts Island

- Most of the upper shoreline is a mix of sand and gravel that may be suitable for forage fish spawning.
- Extensive eelgrass beds, especially north of Horsehead Bay to Raft Island, and around Allen Point.
- Most shorelines in this area (except Cutts Island) have been substantially impacted by hardened shoreline, multiple docks, and lack of riparian vegetation.
- Multiple dilapidated structures and bulkheads have been identified that are non-functioning or provide little value in protecting structures.
- Cutts Island has extensive eelgrass beds, active feeder bluffs, and overhanging trees that provide LWD.

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Allen Point to Burley Lagoon

- Most of the upper shoreline is a mix of sand and gravel that may be suitable for forage fish spawning.
- Documented surf smelt spawning in some areas
- Extensive eelgrass from Allen Point to Burley Lagoon
- Extensive shoreline hardening throughout area
- Many areas with good riparian condition

Primary Stressors: Shoreline Armoring

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Burley Lagoon

- Northern part of Burley Lagoon has undisturbed shoreline habitat with a wooded riparian zone, extensive marsh, and a tidal channel.
- Southern part of the lagoon is impacted by extensive shoreline armoring.
- The east shoreline at the entrance to Burley Lagoon has few positive habitat attributes (riparian buffer, fine-grained substrate, eelgrass, etc.) and is impacted by beach armoring and overwater structures.

- Water quality issues in Burley Lagoon

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Purdy Spit to entrance of Van Geldern Cove

- Area includes a wide variety of shoreline habitats, including open shoreline, inlets, spits, and lagoons
- Extensive shoreline armoring of Purdy Spit, but also extensive eelgrass along the length of the Purdy Spit
- Extensive eelgrass along entire open shoreline from Purdy Spit to entrance of Van Geldern Cove
- Documented forage fish spawning in some areas. Most of the open shoreline substrate appears suitable for forage fish spawning
- Some areas have extensive shoreline armoring and modification, including clearing of native vegetation
- Those areas with active feeder bluffs that are not suitable for shoreline development may retain more natural habitat features, including intact riparian conditions and LWD input.
- Minter Bay has relatively intact riparian vegetation and little shoreline armoring
- Glen Cove contains active feeder bluffs, extensive shoreline armoring, and areas of moderately good riparian condition

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Case Inlet

Case Inlet Water Quality Overview

- CWA 1998 Section 303(d) listings: pH, fecal coliform. (Additional listings proposed for the 2002/2004 303(d) list include dissolved oxygen and bis2-ethylhexyl phthalate, and for the waters of concern list include three toxic sediment contaminants.)
- Stratification: rated moderate and infrequent (station CSE002; Newton et al. 2002).
- Dissolved Oxygen: low, <5.0 mg/l (station CSE002), (based on Ecology marine monitoring data).
- Ammonium-N: high (station CSE002), (based on Newton et al. 2002).
- Nitrite: high (station CSE001 & CSE002); high nitrite can be an indicator of eutrophication (Newton et al. 2002).
- Eutrophication: sensitive (Newton et al. 2002).
- Sensitivity to added nutrients: very high (station CSE002), (based on Newton et al. 2002).

Primary Stressors: Nutrients, dissolved oxygen, toxics, pH

North Spit of Dutcher Cove to Mason County Line

- The unit primarily consists of Vaughn Bay and Rocky Bay. (2)
- Documented forage fish spawning near the entrances to both bays as well as within Rocky Bay. (5)
- Small active feeder bluffs are located within Rocky Bay. (2)
- The shoreline has been substantially impacted by shoreline hardening, multiple over water structures and a lack of riparian vegetation. (1, 2)
- Eelgrass is present between Dutcher Cove and Vaughn Bay, on the north side of Vaughn and Rocky bays and just offshore of both bays. (2)
- The heads of both bays have a higher habitat quality rating than the mouths and center. (2)
- The waters between Stretch Island and Key Peninsula are listed as impaired due to toxics. (7)
- Rocky Bay is listed as an impaired water body due to fecal coliform. (7)

Primary Stressors: Shoreline Armoring, Riparian Loss.

Intact Areas: Head of Rocky Bay.

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

County Line to Power Line Crossing

- Documented forage fish spawning along the entire unit. (5)
- The entire unit has a moderate amount of feeder bluffs. (3)
- Most shorelines, especially on the south end, have been impacted by shoreline hardening including the removal of much of the riparian vegetation. (1, 3)
- Extensive eelgrass beds are found offshore of Victor. (3)
- Shellfish aquaculture occurs throughout the unit. (3)
- The southern portion of the unit has been rated a priority restoration area. (3)
- The waters off of Rocky Point are listed as an impaired water body due to fecal coliform. (7)

Primary Stressors:	Shoreline Armoring, Riparian Loss. Stormwater & Wastewater.
Intact Areas:	Eelgrass beds off Victor.
Reference:	Greater Mason County Nearshore Habitat Assessment draft, 2004

Eastern Power Line Crossing to Western Power Line Crossing.

- This unit consists of the relatively intact mudflats and salt water marshes that make up the head of Case Inlet. (3)
- The riparian vegetation is largely intact. (3)
- Fill has been placed near the mouth of Coulter Creek partially chanalizing the creek. (3)
- Most of the unit has been rated as a priority conservation site. (3)
- The head and western side of this unit are listed as an impaired water body due to fecal coliform. (7)

Primary Stressors:	Landfill Below High Water Line, Stormwater & Wastewater.
Intact Areas:	The entire northwest portion of the unit.
Reference:	Greater Mason County Nearshore Habitat Assessment. Draft 2004

Western Power Line Crossing to Fair Harbor

- Documented forage fish spawning on all shorelines except inside of the lagoons. (5)
- Extensive shoreline armoring exists from Allyn to Sherwood Creek and from Fair Harbor to the sand spit. (3)

- Eelgrass beds are found off the mouth of Sherwood Creek. (3)
- Priority conservation areas include a creek mouth and sand spit providing high quality habitat. (3)
- Areas listed for priority restoration include the armored shoreline north of Sherwood Creek, the thin riparian zone south of Sherwood Creek and the estuary to the unnamed creek south of Sherwood Creek where a road has bisected the salt marsh. (3)

Primary Stressors: Shoreline Armoring, Riparian Loss, Wetland/Estuary Modification

Intact Areas: Sherwood Creek estuary, sand spit south of Sherwood Creek

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

Fair Harbor to Southern Tip of Stretch Island, Including Reach Island

- Documented forage fish spawning on all of Reach Island, the northeast side of Stretch Island and the shoreline between the two islands. (5)
- Active feeder bluffs are located on most of Stretch Island. (3)
- Almost all of the shoreline, except for a portion of eastern Stretch Island, has been substantially impacted by shoreline hardening. (1, 3)
- Eelgrass beds are present between Reach Island and the mainland and along the western shore of Stretch Island. (3)
- Areas identified for restoration include the shoreline north of the bridge to Stretch Island and the southwest shore of Stretch Island. (3)

Primary Stressors: Shoreline Armoring, Riparian Loss, Over Water Structures, Stormwater & Wastewater.

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

Eld Inlet

Eld Inlet Water Quality Overview

- CWA 1998 Section 303(d) listings: none. *(Additional listings proposed for the 2002/2004 waters of concern list include dissolved oxygen and pH.)*
- Stratification: rated moderate and infrequent (stations ELD001, ELD002), (Newton et al. 2002).
- Dissolved Oxygen: low, <5.0 mg/l (ELD001), good, >5.0 mg/l (ELD 002), (based on Ecology marine monitoring data).
- Ammonium-N: high (station ELD002), not high (station ELD001), (based on Newton et al. 2002).
- Sensitivity to added nutrients: not high (stations ELD001 & ELD002), (based on Newton et al. 2002).
- PCBs: detected in sediment study (Dutch et al. 2003).

Primary Stressors: Nutrients, dissolved oxygen

Cooper Point to Green Cove (North end)

- Shellfish Harvest Permitted area (8)
- 90% armoring (1) (8)
- Frequent dock and floats
- Upland residential and removal of riparian habitat (1) (8)
- Green Cove subject of Basin Plan
- Lots of floats and debris on beach
- Geoduck tubes and shellfish culture areas
- Unstable bluff areas
- Gravel/cobble substrate
- Water system on beach
- Documented surf smelt spawning area (4)
- Critcal species: Surf smelt (4)
- Important species Western Grebe
- Drift Cell northerly

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

Green Cove to North End of Mud Bay

- With the exception of the Evergreen State College (TESC) property, nearly all of shoreline is armored and the riparian area removed.
- Shellfish Harvest Permitted area (8)
- Docks and armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Green Cove subject of Basin Plan
- Extensive presence of sand dollars on eastern shoreline
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags,stakes, mesh and boxes on beach.
- Documented surf smelt spawning area (4)
- Critcal species: Pacific oyster and Surf smelt (4)
- Varying bluff areas, high and low bank
- Substrate gravel/cobble moving to silts as you move south

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture

Intact Areas: Most of The Evergreen State College property

Reference: Cindy Wilson. Thurston County. 2004

Mud Bay-South end of Eld Inlet

- Shellfish Harvest Permitted area (8)
- Docks and less armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags,stakes, mesh and boxes on beach.
- Estuarine wetlands-Category 1
- Drift cell NAD
- Public road and Highway 101 crossings of estuary and wetlands
- Historic agriculture use of estuary area
- Substrate silts and mud
- Primarily low bank

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture, Overwater Structures

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

North of Mud Bay to Cove / Point (unnamed)

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags, stakes, mesh and boxes on beach.
- Drift Cell to North
- Tightlining or blocking of almost every tributary stream to Eld Inlet
- Critical Species: Surf Smelt and Pacific Oyster

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

North side of Unnamed Cove to North side of Youngs Cove

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring outside of Park property (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags, stakes, mesh and boxes on beach.
- Drift Cell divergent zone
- Substrate cobble to large rock
- Critical Species: Surf Smelt

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas: Youngs Cove Internal

Reference: Cindy Wilson. Thurston County. 2004

Youngs Cove to Flapjack Point

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags, stakes, mesh and boxes on beach.

- Drift Cell to north
- Substrate cobble to large rock
- Critical Species: Surf Smelt

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

Flapjack Point to Frye Cove

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Extensive shellfish culture operations. Including Geoduck, oysters, clams in bags,stakes, mesh and boxes on beach.
- Drift Cell to North
- Substrate cobble to large rock

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas: Frye Cove County Park

Reference: Cindy Wilson. Thurston County. 2004

Frye Cove to Sanderson Harbor

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Frequent overwater stairways and homes at edge of shoreline.
- Substrate cobble to large rock
- Critical Species: Surf Smelt

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas: Frye Cove County Park, Frye Cove internal

Reference: Cindy Wilson. Thurston County. 2004

Hammersley Inlet and Oakland Bay

Hammersley Inlet/Oakland Bay Water Quality Overview

- CWA 1998 Section 303(d) listings: fecal coliform. (Listings proposed for the 2002/2004 waters of concern list include dissolved oxygen and pH.)
- Statification: strong and intermittent (station OAK004; Newton et al. 2002).
- Dissolved Oxygen: good, >5.0 mg/l (station OAK004), (based on Ecology marine monitoring data).
- Ammonium-N: high (station OAK004), (based on Newton et al. 2002).
- Fecal Coliform Bacteria: two times, from 1998 to 2000, Oakland Bay had extremely high (>100 organisms per 100 mL) fecal coliform bacteria counts (Newton et al. 2002).
- Sensitivity to added nutrients: very high (station OAK004), (based on Newton et al. 2002).
- PCBs: detected in sediment study (Dutch et al. 2003).

Primary Stressors: Nutrients, dissolved oxygen, stratification

Hungerford Point to Libby Point

- Documented forage fish spawning at Cape Horn. (5)
- Active feeder bluffs are located along the entire unit. (4)
- The entire shoreline provides valuable high quality habitat to migrating juvenile salmon. (6)
- Rated with high riparian overhang. (6)
- There has been little modification of the shoreline. (1, 6)
- Cape Horn, the creek mouths and the active feeder bluffs have been rated as priority conservation sites due to exceptional habitat. (6)

Primary Stressors: Riparian Loss

Intact Areas: West of Cape Horn to Libby Point

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Libby Point to Munson Point

- Less than 50% of shore has riparian overhang. (6)
- Almost the entire shoreline is residential resulting in extensive shoreline armoring along the entire length of the unit. (6, 4)
- Church Point provides a small high quality habitat refuge between relatively degraded shorelines. (6)

- Juvenile salmon out-migrating from the high quality areas on either end of the unit must use this degraded habitat as a migration corridor. (6)

Primary Stressors: Shoreline Armoring, Riparian Loss

Intact Areas: Church Point

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Munson Point to Bayshore

- Complex unit with long sandy beaches, estuaries, coves and salt marshes that provide quality habitat. (6, 4)
- Riparian overhang rated as high. (6)
- Some shoreline modification has occurred south of Chapman Cove; the rest of the shorelines are primarily unmodified. (6)
- Intensive shellfish aquaculture in upper Oakland Bay and Chapman Cove. (1, 6)
- The mouth of John's creek has been chanalized bypassing its estuary. (6)
- The dendritic channels in upper Oakland Bay, the upper of intertidal salt marsh of Chapman Cove and the sandy beach north of Munson Point have been rated as priority conservation areas. (6)
- The head of Oakland Bay is listed as an impaired water body due to fecal coliform. (7)

Primary Stressors: Shellfish Aquaculture, Wetland/Estuary Modification, Stormwater & Wastwater.

Intact Areas: North of Munson point, Upper Chapman Cove, Upper Oakland Bay.

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Bayshore to Eagle Point

- An industrial and urbanized waterfront characterizes this shoreline. (1, 6, 4)
- The city of Shelton is located in the southern portion of the unit while state Hwy 3 runs along the rest of the shoreline. (1, 6)
- Riparian overhang is rated as fair to good from Bayshore to Shelton and poor from Shelton to Eagle Point. The riparian corridor along Hwy 3 is rated as having good overhang but is considered too shallow to allow proper functioning. (6)
- Most of the shoreline in this area, except near Bayshore, has been heavily modified by shoreline hardening. (1, 6)
- All of the streams mouths in this unit have been chanalized through the deltas. (6)

- Almost the entire unit has been rated as a priority restoration area. (6)
- Shelton Harbor is listed as an impaired water body due to fecal coliform. (7)
- Extensive floating log storage exists west of Eagle Point. (1, 6)

Primary Stressors: Shoreline Armoring, Over Water Structures, Riparian Loss, Wetland/Estuary Modification, Storm Water & Waste Water

Intact Areas:

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Eagle Point to Skookum Point

- Eagle point has been rated a priority conservation site due to its high quality habitat. (6)
- The rest of the unit is residential resulting in a generally low percentage of riparian overhang. (6)
- Most of the unit has been intensely impacted by shoreline armoring and dikes. (1, 6)
- The mouths of the tributaries have been rated as priority restoration areas due to diking, bulkheading, and riparian loss. (6)

Primary Stressors: Shoreline Armoring, Riparian Loss, Wetland & Estuary Modification

Intact Areas: Eagle Point

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Skookum Point to Arcadia

- Active feeder bluffs along the central portion of the unit. (4)
- Riparian overhang is generally rated as high. (6)
- There is little shoreline modification. (1, 6)
- The tributary mouths and feeder bluffs have been rated as priority conservation sites. (6)
- The marine waters off of Mill Creek are listed as an impaired water body due fecal coliform. (7)

Primary Stressors: Shoreline Armoring, Storm Water & Waste Water

Intact Areas: Mill Creek Estuary

Reference: Oakland Bay and Hammersley Inlet Nearshore Habitat Assessment. 2002

Hartstene Island Group

Hartstene Island Group Water Quality Overview

- CWA 1998 Section 303(d) listings: Dissolved oxygen, fecal coliform, pH. (Additional listings proposed for the 2002/2004 303(d) list include bis(2-ethylhexyl)phthalate (sediment) and total PCBs (tissue), and for the waters of concern list include three toxics sediment parameters.)
- Stratification: ratings of moderate and infrequent (CSE001, NSQ002), and weak and infrequent (DNA001) (Newton et al. 2002).
- Dissolved Oxygen: very low, <3.0 mg/l (station NSQ002), low, <5.0 mg/l (station DNA001), good, >5.0 mg/l (station CSE001), excellent, >6.0 mg/l (station PCK001), (based on Ecology marine monitoring data).
- Ammonium-N: high (stations DNA001 & CSE001), not high (station NSQ002), (based on Newton et al. 2002).
- Nitrite: high (stations DNA001 & NSQ002); high nitrite can be an indicator of eutrophication (Newton et al. 2002).
- Sensitivity to added nutrients: not high (stations NSQ002, DNA001, & CSE001), (based on Newton et al. 2002).

Primary Stressors: Nutrients, dissolved oxygen, toxics. stratification

Devils Head to North Entrance of Taylor Bay

- Documented forage fish spawning on the southern end of the unit. Most of the shoreline except for Taylor Bay appears suitable for forage fish spawning. (2, 5)
- Active feeder bluffs are found along the entire unit. (2)
- Hardened shoreline on north end of Taylor Bay. (1, 2)
- Most areas retain good riparian condition. (2)

Primary Stressors: Shoreline Armoring

Intact Areas: Small cove between Devils Head and Taylor Bay

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

North Entrance of Taylor Bay to North Entrance of Whiteman Cove

- Documented forage fish spawning in the center and north ends of the unit. Most of the shoreline except for inside Whiteman Cove appears suitable for forage fish spawning. (2, 5)
- Active feeder bluffs along the entire unit. (2)
- Hardened shoreline exists across the entrance to Whiteman Cove. (1, 2)

- Most areas retain good riparian conditions. (2)
- Culverts, tide gates, and sheet pilings block the entrance to potential high quality habitat within Whiteman Cove. (2)

Primary Stressors: Shoreline Armoring, Wetland/Estuarine Modification

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003)

North Entrance of Whiteman Cove to Herron, Including Herron Island

- Documented forage fish spawning in the southern end of the unit. Most of the shoreline appears suitable for forage fish spawning. (2, 5)
- Active feeder bluffs are located in the southern and central part of the unit as well as along a small section of southwest Herron Island. (2)
- Much of the shoreline in the north part of the unit near Herron, as well as most of Herron Island, has been impacted by shoreline hardening. (1, 2)
- The habitat quality of the small lagoon on the southwest of Herron Island was rated as high. (2)
- The tidal connection to a lagoon behind Camp Gallagher has been severed, removing potential high quality habitat. (2)

Primary Stressors: Shoreline Armoring, Wetland/Estuarine Modification

Intact Areas: The small lagoon on southwest Herron Island

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Herron to North Spit of Dutcher Cove

- Most of the shoreline appears to be suitable for forage fish spawning. (2)
- Active feeder bluffs are located inside Dutcher Cove. (2)
- Shoreline armoring has substantially impacted the entire unit except for Dutcher Cove. (2)
- Generally, the unit has a low percentage of overhanging riparian. (3)
- The relative habitat quality of Dutcher Cove was rated as high. (2)

Primary Stressors: Shoreline Armoring, Riparian Loss

Intact Areas: Head of Dutcher Cove

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Stretch Island Bridge to Walkers Landing

- Documented forage fish spawning on all shorelines except inside of McLane Cove. (5)
- Active feeder bluffs from the Stretch Island Bridge to the entrance of McLane Cove. (3)
- There is little shoreline hardening except at the north entrance to McLane Cove. (1, 3)
- The riparian zone is relatively intact except for the shoreline along Walkers Landing. (3)
- The shoreline north of Stadium, the western shore of McLane Cove and the small group of inlets north of Walkers Landing have been categorized as conservation areas due to intact feeder bluffs and stream mouths.
- The shoreline around Walkers Landing has been designated a priority restoration area due to extensive development. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss, Landfill
Intact Areas:	Inlets North of Walkers Landing
Reference:	Greater Mason County Nearshore Habitat Assessment. Draft 2004

Walkers Landing to Hungerford Point

- Documented forage fish spawning on most of the shorelines of this unit. (5)
- Active feeder bluffs are present south of Walkers Landing as well as in the southern half of the unit. (3)
- Most of the shoreline, except for some back bays, has been substantially altered by shoreline hardening. (1, 3)
- Much of the shoreline has been impacted by the loss of riparian vegetation. (3)
- The shoreline adjacent to Walkers Landing has been recommended as a priority restoration area due to the loss of feeder bluffs and the riparian zone as well as shoreline hardening and the filling of portions of the marsh. (3)
- The mainland marshes from Graham Point to the south have been recommended as priority conservation areas. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss, Landfill
Intact Areas:	West side mainland marshes
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Steamboat Island to Hunter Point

- Documented forage fish spawning along western sand bar of Steamboat Island, Carlyon Beach and Hunter Point. (5)
- Active feeder bluffs on Steamboat Island. (4)
- Almost 100% of the shoreline of Steamboat Island and Carlyon beach has been impacted by shoreline hardening. A large portion of the eastern half of the unit has experienced no shoreline hardening. (1,4)
- The western two-thirds of the unit have been impacted by the loss of riparian vegetation. (4)
- The shore along Carlyon Beach is a recommended priority restoration area. (4)

Primary Stressors: Shoreline Armoring, Riparian Loss.

Intact Areas:

Reference: Appendix Z. Greater Mason County Nearshore Habitat Assessment. Draft 2004

Hunter Point to Sanderson Harbor

- Shellfish Harvest Permitted area (8)
- Docks and 100% armoring (1) (8)
- Upland residential and removal of riparian habitat (1) (8)
- Drift Cell to the North
- Frequent overwater stairways and homes at edge of shoreline.
- Substrate cobble to large rock
- Critical Species: Surf Smelt

Primary Stressors: Shoreline Armoring, Riparian Loss, Stormwater & Wastewater, Wetland/Estuary Loss, Shellfish Aquaculture,

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

Dofflemyer Point to East Entrance of Little Fishtrap

- Documented forage fish spawning along all open shorelines. (5)
- Active feeder bluffs are located in the eastern half of the unit. (4)
- The western half of this unit has been substantially impacted by shoreline armoring and loss of riparian vegetation. (4)
- A marina, and associated over water structures, exists at Boston Harbor. (4)
- Little fish trap provides high quality habitat for rearing and migration. (4)

Primary Stressors: Shoreline Armoring, Riparian Loss, Over Water Structures.

Intact Areas: Little fish trap.

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

East Entrance of Little Fishtrap to Henderson Inlet

- Documented forage fish spawning along all open shorelines. (5)
- Active feeder bluffs are located throughout the unit. (4)
- Shoreline armoring exists at the entrances to Big and Little Fishtrap coves as well as along Dickenson Point. (1, 4)
- Big Fishtrap cove is recommended as a priority conservation area. (4)
- This unit provides generally good habitat for rearing and migration. (4)

Primary Stressors: Shoreline Armoring.

Intact Areas: Big fish trap.

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

Johnson Point to Baird Cove

- Low quality Gravel substrate in Baird Cove (4)
- Sand substrate in Ponsin Cove (4)
- Bulkheading north of Baird Cove –20% (4)
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Many pocket estuaries and inlets
- Zittels Marina at mouth of Baird Cove
- Feeder Bluffs

Primary Stressors: Overwater Structures, Shoreline Armoring, Riparian Loss, Stormwater & Wastwater.

Intact Areas:

Reference: Cindy Wilson. Thurston County. 2004

Baird Cove to Mill Bight

- High quality sand in Mill bight (4)
- Some armoring (20%)

- Signifcant Beach feeding processes near Mill Bight that lessen as shoreline moves north
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Mill Bight in Shellfish Harvest prohibited area
- Mill Bight contains estuarine wetland habitat
- Many pocket estuaries and inlets
- Puget Marina

Primary Stressors:	Overwater Structures, Shoreline Armoring, Riparian Loss, Stormwater & Wastwater.
Intact Areas:	Mill Bight and northern shoreline area
Reference:	Cindy Wilson. Thurston County. 2004

Mill Bight to Dog Fish Bight

- Substantial armoring of shoreline- 60% (4)
- Significant beach feeding processes potential and where not bulkheaded (4) (1)
- Feeder bluffs (4) (1)
- 1980 mapping shows beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Permitted Area (1)

Primary Stressors:	Shoreline Armoring, Riparian Loss
Intact Areas:	
Reference:	Cindy Wilson. Thurston County. 2004

Dog Fish Bight to Sandy Point

- 100% bulkhead modified (4)
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Permitted Area (1)

Primary Stressors:	Shoreline Armoring, Landfill, Wetland & Estuary Modification
Intact Areas:	
Reference:	Cindy Wilson. Thurston County. 2004

Sandy Point to Butterball Cove

- Tidal Aquatic Bed wetlands (8)
- High quality Sand in Big Slough Area and Sandy Point North (4)
- Big Slough/Tolmie State Park-No bulkheads (4)
- 75% of shoreline bulkheaded and/or modified (4)
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Conditional area up to Big Slough(1)
- Shellfish Harvest Permitted area north of Big Slough (1)
- 1998 303d Listed Waters (8)

Primary Stressors:	Shoreline Armoring, Wetland & Estuary Loss, Stormwater & Wastwater
Intact Areas:	Big slough area
Reference:	Cindy Wilson. Thurston County. 2004

Butterball Cove to DeWolf Bight

- Tidal Aquatic Bed wetlands (8)
- Estuary loss to boat basin (1)
- High density population-Beachcrest (1) (8)
- Unstable slopes (4)
- Feeder Bluffs (4)
- 10% bulkhead modification, primarily at mouth of Butterball Cove (4)
- Butterball Cove- Mud substrate (4)
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Conditional area (1)

Primary Stressors:	Shoreline Armoring
Intact Areas:	Tolmie State Park, Portions of Butterball Cove
Reference:	Cindy Wilson. Thurston County. 2004

DeWolf Bight to Hogum Bay

- Historical Estuary Area (8)
- Tidal Aquatic Bed wetlands (8)
- High density population-Beachcrest (1)
- Feeder bluffs (10) (8)
- No structure modifications (4)
- 1980 beach substrate and algal community (4)
- Nisqually Reach Shellfish Protection district (1)

- Shellfish Harvest Conditional area (1)

Primary Stressors: Shoreline Armoring, Riparian Loss

Intact Areas: Portions of Hogum Bay

Reference: Cindy Wilson. Thurston County. 2004

Hogum Bay to Mc Neill Island Group (122 degrees 45') (Meridian Road)

- Historical Estuary area (8)
- Tidal Aquatic Bed wetlands (8)
- Modified slopes (4)
- Entire area is critical to birds (4)
- Mud silt/clay substrate (4)
- Bulkhead, launch and dock area –Public (1) (4)
- 50% modified by bulkhead (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Conditional area (1)
- 1998 303d Listed Waters (8)

Primary Stressors: Shoreline Armoring, Shellfish Aquaculture

Intact Areas: Portions of Hogam Bay

Reference: Cindy Wilson. Thurston County. 2004

Hartstene Island- Dougall Point to Fudge Point, Including McMicken Island

- Documented forage fish spawning at Dougall Point and the eastern two-thirds of McMicken Island. (5)
- The feeder bluffs present along the entire unit are rated as exceptional in the north one-third of the unit. (3)
- The shorelines of Dougall Point have been substantially impacted by shoreline hardening. The lagoon has been recommended as a priority restoration site due to loss of the riparian corridor, shoreline hardening and a road built on the spit. (3)
- Eelgrass beds are present off Dougall Point. (3)
- The shoreline north of Fudge Point has been impacted by riparian loss and shoreline hardening. (3)
- The shoreline south of Dougall Point has been recommended as a priority conservation area due to the exceptional sediment supply and intact riparian corridor. (3)
- McMicken Island, protected as a state park, provides high quality habitat. (3)

Primary Stressors: Shoreline Armoring, Riparian Loss

Intact Areas:	McMiken Isaland and the shoreline south of Dougall Point
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Hartstene Island- McMicken Island to Brisco Point

- Documented forage fish spawning on the southern two-thirds of the unit. (5)
- Active feeder bluffs are located along the entire unit. (3)
- There is extensive shoreline armoring between Fudge Point and Wilson Point. (1, 3)
- The shoreline north of Wilson Point retains good riparian conditions. (3)
- The shoreline from just north of Brisco Point to Wilson Point has been categorized as a priority conservation site due to intact riparian zone, exceptional feeder bluffs and the large woody debris potential. (3)
- The tip of Brisco Point has been impacted by shoreline hardening and the removal of riparian vegetation. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss
Intact Areas:	Portions of the Shoreline from Wilson Point to Brisco Point
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Hartstene Island - Brisco Point to Salmon Point

- Documented forage fish spawning in the southern half of the unit. (5)
- Active feeder bluffs are found along the entire unit. (3)
- Extensive shoreline hardening exists in the north and center portions of the unit. (1, 3)
- The southern two-thirds of the unit have been impacted by shoreline hardening, riparian loss and shellfish aquaculture. (3)
- The shoreline adjacent to the southern end of Hartstene road has been recommended for priority restoration as a result of alterations to the mouth of the salmon bearing stream and residential development. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss, Wetland & Estuary Modification, Shellfish Aquaculture.
Intact Areas:	
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Hartstene Island- Salmon Point to Northwest Point of Hartstene Island

- Documented forage fish spawning along the entire shoreline of this unit. (5)
- The northern two-thirds of the unit posses feeder bluffs rated as "moderate". (3)
- The shorelines of the northern half of the unit have been impacted by shoreline armoring. (1, 3)
- Areas identified for conservation include the stream deltas in the very southern portion of the unit as well as the lagoon and associated mudflat located just north of the Hartstene Island Bridge. (3)
- The shoreline from north of the bridge to the end of the unit has been recommended for restoration aimed at expanding an area of excellent habitat. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss, Shellfish Aquaculture
Intact Areas:	Lagoon north of the bridge
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Northwest Point of Hartstene Island to Dougall Point

- Documented forage fish spawning along the entire shoreline except for the inside of Jarrell Cove. (5)
- Feeder bluffs from Jarrell Cove to the small cove west of Dougall Point. (3)
- The shorelines of the small cove west of Dougall Point have been substantially affected by shoreline hardening and riparian removal. (1, 3)
- The stream/delta corridor along the western part of the unit has been identified for conservation. (3)
- Jarrell Cove and the shoreline extending to northeast corner of Hartstene Island have been recommended as priority conservation sites. (3)
- Areas identified for restoration include the bluff west of Jarrell Cove, the hardened shorelines in Jarrell Cove and the shore adjacent to the Hartstene Point Marina. (3)

Primary Stressors:	Shoreline Armoring, Riparian Loss
Intact Areas:	Western Jarrell Cove
Reference:	Greater Mason County Nearshore Habitat Assessment Draft 2004

Squaxin and Hope Islands

- Documented forage fish spawning on most beaches of both islands. (5)
- Feeder bluffs on portions of Squaxin Island. (3)
- There is little modification to the shoreline of either island. Both provide high quality habitat to migrating juvenile salmonids. (3, 4)
- Coho netpens are located in Peale Passage. (4)
- Derelict vessels on Squaxin Island. (4)
- Squaxin Island is in a protected status as an Indian reservation while Hope Island is a State Park. (4)

Primary Stressors: Overwater structures.

Intact Area: Almost the entire shoreline of both Islands is intact.

Reference: Greater Mason County Nearshore Habitat Assessment. Draft 2004

Henderson Inlet

Henderson Inlet Water Quality Overview

- CWA 1998 Section 303(d) listings: dissolved oxygen, fecal coliform. (Listings proposed for the 2002/2004 waters of concern list include pH and four toxic sediment contaminants.)
- Stratification: *data not available.*
- Dissolved Oxygen: excellent, >6.0 mg/l (station HND001), (based on Ecology marine monitoring data).
- Ammonium-N: no data (i.e., none reported in Newton et al. 2002).

Primary Stressors: Nutrients (assumed), toxics, dissolved oxygen

Johnson Point to Woodland Creek

- Documented Smelt spawning area
- Many pocket coves and inlets (1) (4) (8)
- 100% of Johnson Point itself is bulkheaded
- Significant armoring >60% to Swayne Road
- Mudflats primarily south of Swayne road
- Oyster and clam potential
- Shellfish Harvest Permitted, Conditional and Prohibited area-North to south

Primary Stressors: Shoreline Armoring, Riparian Loss, Wetland & Estuary Loss, Overwater Structures,

Intact Areas: South of Swayne Road in southern Henderson relatively undisturbed riparian area

Reference: Cindy Wilson. Thurston County. 2004

South Henderson Inlet

- Harmony Farms-Capital Land Trust
- Woodland Creek wetlands/tidal area publicly owned
- Generally undeveloped with good riparian habitat
- Road crossings and culverts impacting side channels, streams and tidally influenced wetland areas.
- Some riparian loss due to residential and agricultural uses
- Primarily mud flats and estuarine Category I wetlands
- Some isolated bulkheads, several docks and a launch on the western shore of Henderson
- Shellfish Harvest Prohibited area
- Mouth of Woodland Creek impacted by culverted road crossing

Primary Stressors: Wetland & Estuary Loss, Overwater Structures, Stormwater & Wastewater

Intact Areas: Riparian areas generally intact.

Reference: Cindy Wilson. Thurston County. 2004

Woodard Bay to Henderson Inlet Line

- Primarily mud flats and estuarine wetlands in Woodard Bay
- Significant armoring and riparian habitat removal
- Significant Bat habitat in Woodard Bay Preserve
- Historical log yard, long term impacts?
- Significant Seal pupping area at Woodard Bay
- 1980 Sand substrate
- Feeder bluffs present where not armored

Primary Stressors: Shoreline Armoring, Riparian Loss, Wetland & Estuary Loss, Overwater Structures,

Intact Areas: Woodard Bay Internal

Reference: Cindy Wilson. Thurston County. 2004

McNeil Island Group

McNeil Island Group Water Quality Overview

- CWA 1998 Section 303(d) listings: fecal coliform. (Additional listings proposed for the 2002/2004 303(d) list include three toxic sediment contaminants, and total PCBs in tissue, and for the waters of concern list includes pH, and 15 toxic sediment contaminants.)
- Stratification: rated moderate and infrequent (station GOR001), (Newton et al. 2002).
- Dissolved Oxygen: good, >5.0 mg/l (stations GOR001 & NSQ001); excellent, >6.0 mg/l (station STL001), (based on Ecology marine monitoring data).
- Ammonium-N: not high (station GOR001), (based on Newton et al. 2002).
- Sensitivity to added nutrients: not high (station GOR001), (based on Newton et al. 2002).
- PCBs: detected in sediment study (Dutch et al. 2003).

Primary Stressors: Toxics

Harstene Island Line (122 degrees 45") to Nisqually Head/Luhr Beach

- Historical Estuary area (8)
- Tidal Aquatic Bed wetlands (8)
- Modified slopes (4)
- Entire area is critical to birds (4)
- Mud silt/clay substrate (4)
- Bulkhead, launch and dock area –Public (1) (4)
- 50% modified by bulkhead (4)
- Nisqually Reach Shellfish Protection district (1)
- Shellfish Harvest Conditional area (1)

Primary Stressors: Shellfish Aquaculture, Shoreline Armoring.

Intact Areas: Portions of Hogam Bay

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Nisqually Head/Luhr Beach to Mouth of Little McAllister

- Adjacent Nisqually wildlife refuge
- I-5 crossing at mouth of creek
- Intensive land use at mouth
- High bluff area
- Some SFR and riparian clearing

- Little to no armoring
- Estuarine wetlands at mouth and on adjacent delta/refuge
- Woody debris

Primary Stressors:

Intact Areas:

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Nisqually estuary to Gordon Point (near Steilacoom)

- The Burlington Northern railroad line runs along this entire shoreline. The shoreline is highly armored and composed mainly of boulders and fill used to stabilize the rail line. Shoreline vegetation along the rail line has been removed, and in some areas the rail line isolates the shore from feeder bluffs. Near the Nisqually estuary, the rail line is farther from the shore and has less of an impact.
- Except for the rail line, this segment of shoreline is primarily forested, owned by Fort Lewis, and undeveloped, except for some houses and a marina near Gordon Point, and a gravel pit operation (with overwater structures) near Tatsolo Point.
- Below the rail line, and in areas where the rail line is set back farther from the sound, the substrate is composed mostly of sand or gravel and sand (WDNR 2001)
- About half of this shoreline is absent of eelgrass, and half has patchy eelgrass present (an area near the mouth of Sequalitchew Creek, and from Tatsolo Point to Gordon Point) (WDNR 2001)
- Nisqually estuary: this estuary provides some intact habitat (mudflats and estuarine emergent marsh) but the estuary has also been confined and modified by dikes and Interstate 5. See the Nisqually Chinook Recovery Plan (Nisqually Chinook Recovery Team 2001) for information on actions needed in the Nisqually estuary.
- Sequalitchew Creek outlet: estuary is divided and confined by the large culvert that passes under railroad. This limits the quantity and quality of available estuary habitat
- The rail line blocks or highly constricts numerous small streams that drain directly into Puget Sound along this shoreline. This impedes fish passage and reduces the quantity and quality of pocket estuary habitat along the shoreline.
- Ft. Lewis diverts water from Sequalitchew Lake, and releases it and effluent from the Solo Point wastewater treatment plant near Tatsolo Point. This limits the quantity, quality, accessibility of available estuary habitat.

Primary Stressor: Shoreline Armoring Landfill, Wetland/estuarine Modification

Intact Areas: Some parts of the Nisqually estuary are intact

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Ketron Island

- No shoreline modifications (WDNR Shorezone)
- Sandy beach on west shoreline, sand and gravel beach on east shoreline (WDNR Shorezone)
- Eelgrass is patch on west side of island and absent on east side (WDNR Shorezone)
- No documented forage fish spawning areas
- Some docks and removal of vegetation on the northern part of the island
- Feeder bluffs are present and not blocked by any structures
- Healthy marine riparian vegetation in most areas of the island

Primary Stressor: None.

Intact Areas: Southern two-thirds of Ketron Island.

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Gordon Point (near Steilacoom) to the tip of Day Island

- The railroad line parallels the water along this entire shoreline, often very close to the water. The rail line is associated with shoreline hardening (boulders and fill used to stabilize the track) and loss of riparian vegetation. In some areas the railroad isolates the shore from feeder bluffs.
- This shoreline has patches with no development directly next to the shore (except for the railroad) but also many areas such as Steilacoom, Sunset beach, and Day Island with houses or other development close to the shore and associated with shoreline hardening, docks and other overwater structures, and removal of vegetation
- Documented sand lance spawning and surf smelt spawning on shoreline directly south of Chambers Creek outlet and about 1.5 miles north of Chambers Creek (WDFW, 2003)
- Most of this shoreline is absent of eelgrass, but there is some patchy eelgrass south of Day Island. There are some stretches of patchy floating bull kelp north of Chambers Creek (WDNR 2001)
- Substrate along this shoreline is composed of mostly sand or gravel and sand beaches (WDNR 2001)
- Chambers Creek outlet: estuary is modified by shoreline hardening, industrial development, and removal of riparian vegetation. The railroad bridge crossing confines the creek outlet, reducing quantity and quality of estuary habitat. Marina at mouth of Chambers Creek has overwater structures. There is a sewage treatment plant outlet here also.

- Steilacoom Creek outlet: railroad crosses outlet over a bridge, leaving this pocket estuary somewhat intact but also somewhat impacted by bank hardening and confinement.
- Extensive gravel pit operation just north of Chambers Creek has removed shoreline vegetation, modified the shoreline and removed feeder bluffs. The operation has some overwater and in-water structures

Primary Stressor: Shoreline Armoring, Landfill, Wetland/Estuarine Modification

Intact Areas:

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Day Island to Tacoma Narrow Bridge

- Railroad parallels close to the shore along this section Riparian vegetation has been removed, the shoreline has been armored with boulders and fill to stabilize the track, and in some areas the track isolates feeder bluffs from the main shore. There are a few areas where the track is farther from the shore, allowing for healthier vegetation and a more natural beach substrate and slope.
- Some stretches of this shoreline are absent of development (other than the railroad track and housing built well upslope), while other areas have houses built very close to the shore, docks, and loss of riparian vegetation and shoreline armoring.
- Documented sand lance spawning spawning on shoreline less than one mile north of Day Island (WDFW, 2003)
- Titlow Lagoon: 2 lagoon ponds, outflow is a constrained culvert through RR track, which impairs connectivity and fish access
- This shoreline is absent of eelgrass except for some patchy eelgrass between Day Island and the Tacoma Narrows bridge. Most of this shoreline has patchy or continuous floating bull kelp (WDNR 2001).
- Most of this shoreline is composed of gravel and sand beaches (WDNR 2001)
- The marina on the northeast side of Day Island has overwater structures

Primary Stressor: Shoreline Armoring, Landfill,

Intact Areas:

Reference: Sayre Hodgson. Nisqually Indian Tribe. 2004

Tacoma Narrows Bridge to Point Fosdick (EMU 3)

- Consists of high-bank, open shoreline with numerous active feeder bluffs
- Densely wooded riparian buffer is present throughout most of the area and contributes LWD to the shoreline

- There is very little shoreline development, although houses cover much of the landscape inland from the tops of the bluffs
- Upper shoreline appears to be suitable for forage fish spawning, and sand lance spawning has been documented
- Kelp beds widespread in the mostly gravel, cobble, or boulder shallow subtidal zone
- Eelgrass present only near Point Fosdick

Primary Stressors:

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed
Nearshore Salmon Habitat Assessment. 2003

Point Fosdick to Wollochet Bay (EMU 4)

- The open shoreline has a low bank, and is heavily developed with extensive bulkheading
- Very little native vegetation has been left intact
- Within Wollochet Bay, the shoreline is heavily developed, including extensive bulkheading, docks and overwater structures
- Some eelgrass at the mouth of the bay
- Within the bay, the upper beach is primarily sand and potentially suitable habitat for forage fish spawning
- Head of the bay is a relatively large estuary with extensive marsh edge and large mudflat exposed at low tide. Relatively less development has occurred here and the shoreline is in a mostly natural state.

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

North Shore of Hales Passage to Green Point (EMU 5)

- Most of the shoreline is open (with exception of Shaws Cove)
- Most of the shoreline is developed and bulkheaded
- Many bulkheads appear to provide little functional value
- Active feeder bluffs in a few locations
- Eelgrass occurs in only a few locations

- Most of the upper shoreline appears to be suitable for forage fish spawning, although only sand lance have been known to spawn in this area

Primary Stressors:	Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification
Intact Areas:	
Reference:	Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Van Geldern Cove to Pitt Passage, including Pitt Island (EMU 9)

- Van Geldern Cove has marsh and eelgrass habitat, but also has areas of extensive bulkheading and numerous piers and docks.
- Mayo Cove has marsh and eelgrass habitat, but also has areas of extensive bulkheading and numerous piers and floating docks.
- Penrose State Park within Mayo Cove has densely wooded riparian buffer, active feeder bluffs, and patches of eelgrass.
- South Head includes natural undisturbed shoreline with active feeder bluffs and LWD input.
- Pitt Passage has largely undeveloped shoreline with active feeder bluffs, LWD inputs and abundant eelgrass, and substrate appears suitable for forage fish spawning. Other areas have extensive bulkheading with little forested riparian habitat.
- Forage fish spawning areas documented in short reaches at the entrance to Van Geldern Cove and in Mayo Cove.

Primary Stressors:	Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification
Intact Areas:	
Reference:	Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Pitt Passage to Devil's Head (EMU 10)

- Most areas appear suitable for forage fish spawning, while documented surf smelt and sand lance spawning exists primarily south of Filucy Bay
- Within Filucy Bay has been greatly impacted by the level of shoreline development including extensive residential development, and shoreline hardening. There are also a number of private docks, small floats as well as a marina.

- The north cove of Filucy Bay has a marsh fringe and a shallow tidal channel, is bordered by densely wooded riparian buffer.
- Filucy Bay also contains several derelict structures and bulkheads that apparently serve no function
- Habitat along the open shorelines of Pitts Passage and south of Filucy Bay are relatively intact with multiple feeder bluffs and wooded riparian buffer.
- Eelgrass is present along Pitt Passage, but not in Filucy Bay or the open shorelines south of Filucy Bay.

Primary Stressors:	Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification
Intact Areas:	
Reference:	Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Fox Island shoreline (EMU 13)

- The northern shoreline has extensive development, including shoreline hardening, and the adjoining upland areas have been cleared and developed, with only small pockets of wooded habitat remaining near the shoreline.
- The shoreline of Tanglewood Island is mostly undisturbed, except for the northern tip which has extensive shoreline modification associated with the lighthouse station
- The southern shoreline is high bank, particularly around Gibson Point, and tends to have somewhat less shoreline development that the northern shoreline
- Most of the upper beach substrate along Fox Island appears suitable for forage fish spawning.
- Dense eelgrass beds occur along some reaches of the southern shoreline

Primary Stressors:	Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification
Intact Areas:	
Reference:	Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Anderson Island shoreline (EMU 14)

- Open shorelines generally provide moderate habitat quality, but some shorelines have been degraded by shoreline armoring and other shoreline development

- Higher quality habitats are associated with protected inlets and lagoons, although much of the habitat has been degraded by shoreline hardening, overwater structures, and removal of much of the forested buffer.
- Highest quality habitat is in Carlson Bay and the head of Oro Bay
- In Oro Bay, the culvert under Ekenstem-Johnson Road is a partial blockage to juvenile salmonids to an extensive marsh upstream of the road
- A dike blocks tidal exchange and fish access to an extensive wetland and marsh at the head of East Oro Bay
- Potentially suitable forage fish spawning habitat is found in much of the open shoreline
- Eelgrass is found in only a few locations along the northern, southern, and eastern shorelines

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

McNeil Island shoreline (EMU 15)

- The shoreline has been left in a mostly natural state, but some areas have been extensively modified
- Along the southeast shoreline at the site of the main correctional facility there exists a ferry terminal, small pier, boat ramp, a bulkhead, and extensive riprap
- Still Harbor has experienced moderate shoreline alteration including shore sections of bulkhead
- Four small creeks have been impounded, which restricts flow and fish access, and greatly impacts the establishment of marsh habitat
- As extensive marsh exists on the eastern shoreline
- Most of the eelgrass is concentrated along the west shoreline of the island in Pitt Passage
- In many locations around the island there appears to be suitable forage fish spawning habitat

Primary Stressors: Shoreline Armoring, Overwater Structures, Riparian Loss, Wetland/Estuary Modification

Intact Areas:

Reference: Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment. 2003

Totten and Little Skookum Inlets

Totten & Little Skookum Inlets Water Quality Overview

- CWA 1998 Section 303(d) listings: none. (Listings proposed for the 2002/2004 waters of concern list include dissolved oxygen, pH, and four toxic sediment contaminants.)
- Stratification: rated moderate and infrequent (stations TOT001, TOT002; Newton et al. 2002).
- Dissolved Oxygen: good, >5.0 mg/l (station TOT001), (based on Ecology marine monitoring data).
- Ammonium-N: high (station TOT002), not high (station TOT001) (based on Newton et al. 2002).
- Sensitivity to added nutrients: high (stations TOT001 & TOT002), (based on Newton et al. 2002).

Primary Stressors: Nutrients

Arcadia to Windy Point

- Most of the shoreline has documented forage fish spawning. (5)
- Shoreline armoring impacts the north portion of the unit. (1, 4)
- There has been a moderate amount of removal of the riparian buffer in the center of unit. Much of the rest of the shoreline retains good riparian buffers. (4)

Primary Stressors: Shoreline Armoring, Riparian Loss, Shellfish Aquaculture

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004

Windy Point to Barron Point (mouth of Skookum Inlet)

- Documented forage fish spawning along all shorelines. (5)
- Active feeder bluffs are located throughout the unit. (4)
- The south portion of the unit has little riparian buffers. (4)

Primary Stressors: Riparian Loss, Shellfish Aquaculture

Intact Areas: Feeder Bluffs

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004

Little Skookum Inlet

- Moderate feeder bluffs located on the south end of unit. (4)
- Several shellfish operations are located throughout the inlet. (1, 4)
- The shoreline riparian is generally intact. (4)
- Western end of inlet is diked off. (4)
- There is extensive WDNR land holdings located on the western end of the inlet. (4)
- Little Skookum Inlet posses some of the most unmodified habitat in South Puget Sound. (4)

Primary Stressors: Wetland/Estuary Modification , Shellfish Aquaculture

Intact Areas: Port Blakely timber company recreation area

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004

Wildcat Harbor to Hurley Cove

- Documented forage fish spawning along the whole unit. (5)
- Some feeder bluffs are located on the southern end. (4)
- Little to no riparian vegetation on north end of unit. (4)
- Extensive shoreline armoring on Kamilche point. (1, 4)
- Shellfish aquaculture located on southern end of unit. (4)

Primary Stressors: Shoreline Armoring, Riparian Loss, Shellfish Aquaculture

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004

Hurley Cove to County Line

- Documented forage fish spawning on northeast portion of the unit. (5)
- Feeder bluffs located in Bowman Cove. (4)
- Riparian vegetation is generally intact throughout the unit. (4)
- Shellfish aquaculture in southern and center of the unit. (4)

- Extensive mudflats and salt marsh at southern end of unit provide excellent habitat. Some land ownership by WDNR between Hwy 101 and county line. (1, 4)

Primary Stressors:	Shellfish Aquaculture
Intact Areas:	Kennedy Creek estuary and associated salt marsh
Reference:	Greater Mason County Nearshore Habitat Assessment, Draft 2004

County Line to West Side of Burns Cove

- Documented forage fish spawning on Burns Point. (5)
- Limited feeder bluffs west of Burns Point. (1,4)
- Oyster Bay Road cuts off a small amount of marsh habitat (4).
- The shoreline is generally intact with minimal shoreline hardening and removal of riparian vegetation. (1,4)

Primary Stressors:	Wetland/estuary modification, shellfish Aquaculture
Intact Areas:	The western part of the shoreline of this unit is relatively intact
Reference:	Greater Mason County Nearshore Habitat Assessment, Draft 2004

West Side of Burns Cove to Hudson Cove

- Documented forage fish spawning throughout the unit . (5)
- Active feeder bluffs in the center of the unit. (4)
- Approximately half of the riparian overhang has been removed from the unit (1,4)
- The spit across from Deepwater Point is almost entirely residential to the high water line resulting in shoreline armoring and removal of riparian vegetation. (1,4)
- Shoreline armoring has occurred on the south end of the unit. (4)

Primary Stressors:	Shoreline Armoring, Riparian Loss, Shellfish Aquaculture
Intact Areas:	None
Reference:	Greater Mason County Nearshore Habitat Assessment, Draft 2004

Hudson Cove to East Entrance of Gallagher Cove

- Documented forage fish spawning throughout the entire unit. (5)
- Active feeder bluffs throughout the unit. (4)
- The shoreline is almost completely natural. (4)
- Emergent marsh is present in Gallagher Cove . (4)
- Shoreline armoring and riparian loss in Gallagher Cove. (4)

Primary Stressors: Shellfish Aquaculture, Shoreline Armoring, Riparian Loss

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004

East Entrance of Gallagher Cove to Steamboat Island

- Documented forage fish spawning in most of the unit. (5)
- Area is developed with approximately 50 % of the riparian vegetation removed. (4)
- Almost no shoreline armoring in the unit in the southern end while the northern end has substantial armoring. (1,4)
- Moderate feeder bluffs located along the North end of the unit. (4)
- Central part of unit has sand spit with emergent marsh. (4)
- The north portion of this unit has been rated an impaired water body due to temperature. (7)

Primary Stressors: Riparian Loss, Shellfish Aquaculture, Shoreline Armoring

Intact Areas:

Reference: Greater Mason County Nearshore Habitat Assessment, Draft 2004.