2.11 STRAIT OF JUAN DE FUCA MARINE NEARSHORE ENVIRONMENT

2.11.1 Overview

The coastline of the area covered by this watershed plan (WRIA 18 and the Sequim Bay portion of WRIA 17) is approximately 79 miles in length (refer to Figures 1.1-1 and 1.1-2, the West and East WRIA 18 general maps depicting this coastline). This includes just the true marine (saltwater) coastline from the west side of the mouth of the Elwha River to the drainage divide on the northern coast of the Miller Peninsula that separates the Sequim Bay watershed from the coastal drainage flowing to the Strait from the Peninsula. It includes the inner and outer coastlines of all prominent spits and bays. But it does not include additional shoreline associated with the mouths and estuaries of all the WRIA 18 streams. The nearshore of WRIA 18 encompasses that marine coastline and the ecologically integrated estuaries. Figure 2.11-1 displays the Strait of Juan de Fuca marine nearshore environment.

There are a variety of more formal definitions of the nearshore. Some use specific numeric definitions of elevations above and below sea level or other reference elevations. Others use more qualitative, functional, or ecological methods. For purposes of this watershed plan, two definitions are particularly relevant:

- The North Olympic Peninsula Lead Entity (NOPLE) and the Hood Canal Coordinating Council (HCCC) have jointly adopted a Shared Nearshore Framework. That Framework defines nearshore as "the area adjoining the land and the sea, and the coupled ecological processes (geological, primary and secondary productivity, sediment, and hydraulic processes) that affect this area's ability to function in support of Pacific salmon". The Framework goes on to note, "[f]or the purposes of our shared nearshore framework, estuaries are considered part of the nearshore and are recognized as a vital connection to the watersheds." The Framework explains that NOPLE and HCCC use this qualitative definition in order to encompass (on the terrestrial side) integral "habitat that is tidally influenced, including tidal freshwater, brackish, and marine habitats". For the marine "boundary" they explain that the nearshore would extend at least to the lower limit of the photic zone (which they quantify as approximately –30' Mean Low Low Water (MLLW)), if not further outward "many miles offshore".
- The Puget Sound Nearshore Project is a major, long-term, joint project of the US Army Corps of Engineers and multiple tribal, state, and local governments, agencies, and organizations. The Project has adopted a somewhat different qualitative definition that defines nearshore as being "from the top of shoreline bluffs to the depth of offshore where light penetrating the Sound's water falls below a level supporting plant growth, and upstream in estuaries to the head of tidal influence. It includes bluffs, beaches, mudflats, kelp and eelgrass beds, salt marshes, gravel spits, and estuaries."

Given these two definitions, with significant potential differences along both the landward and waterward boundaries, as they would apply to WRIA 18, it may be important to consider reconciling the difference. Regardless, it is clear that both definitions fully incorporate everything from the uppermost limits of tidal influence (whether coastal or estuarine) and associated shoreline lands outward to at least the full depth of the photic zone. Consequently, this watershed plan can effectively operate with use of the second definition, even if it might be considered somewhat narrower in its geographic extent.

The NOPLE Strategy provides a detailed summary of the variety of ecological processes that it emphasizes as important to salmonids, including primary plant productivity, secondary productivity (of first-order consumers such as insects, plankton, and detritus consumers), the cycling flow of organic matter, nutrient cycling, sediment processes, and hydraulic processes.

2.11.2 Physical Environment

As defined above, WRIA 18's nearshore environment encompasses roughly 300 square miles of onshore and offshore land and water under a complex ownership of federal, tribal, state, and local governmental jurisdiction as well as significant private ownership. It is an integral part of the larger Strait of Juan de Fuca and Puget Sound Estuary ecosystem. As such, its physical condition is of great significance to the overall health of this larger ecosystem and the marine resources within the ecosystem.

As noted by Anne Shaffer, WDFW Area Marine Habitat Biologist (unpublished issue paper, November, 2001), this larger Puget Sound Estuary ecosystem (including the Strait of Georgia) sees more than 80% of its water move through the Strait of Juan de Fuca. Net water movement varies in relation to depth, with net movement of cold oceanic deep water being eastward, while net movement of fresher, warmer surface water is westward. Shaffer also notes that the Strait is a wind-dominated marine ecosystem, with currents changing dramatically within hours in response to regional and larger scale oceanic winds.

Strong seasonal storms contribute pulses of both fresh water and sediment to the ecosystem, forming large lenses of very low salinity and very high turbidity within the nearshore zone. These lenses occur along the majority of the Strait's shoreline (including WRIA 18) and appear to occur primarily during winter and spring (Shaffer, 2001). Shaffer also notes that "due to deep oceanic water and strong wind and current mixing action, as well as seasonal strong contribution of riverine nutrients, the water of the main [Puget Sound/Strait of Juan de Fuca] basin is well-mixed, cold, and nutrient-rich throughout the year." Of importance to WRIA 18, Shaffer also notes that this general condition contrasts with shallow, enclosed embayments along the Strait (such as Port Angeles Harbor, Dungeness Bay, and Sequim Bay), which are seasonally strongly stratified and, in some instances, nutrient-limited.

The WRIA 18 Limiting Factors Analysis (Haring, 1999) describes that the nearshore and estuarine habitat of the Strait and WRIA 18 especially "have additional physical features which make them critical to marine and anadromous species. In particular, their abundant food supply, wide salinity gradients, and diverse habitats make them areas particularly valuable to anadromous fish for rearing, feeding, and osmoregulatory acclimatization during transition between freshwater and marine habitats."

Another key component of the physical nearshore environment is the movement of sediment through the ecosystem. The NOPLE Strategy (2001) summarizes these sediment processes as including "the erosion, transport, deposition, and storage of

Figure 2.11-1: Strait of Juan de Fuca Marine Nearshore

Photo prepared by Randy Johnson

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sediments. Maintenance of appropriate substrata for prey resource production was cited as important to young salmon. Longshore currents transport sediments from the source area of a drift cell, where sediments erode, to the terminus, where sediments are deposited. High-energy storm waves, particularly in winter, lower the beach profile by moving sediment to storage in offshore bars. Variations in wave direction, energy, and current as well as the physical interruption of sediment transport can alter sediment volume and composition. Activities that disrupt the equilibrium of the sediment budget in a drift cell or lower the beach profile through increased movement of sediment offshore can diminish habitat conditions for prey species."

The NOPLE Strategy (2001) describes the nearshore environment as "tremendously dynamic and complex, [providing] a wide array of functions for multiple plant and animal species, including Pacific salmon and their prey. Nearshore ecosystems produce, trap, cycle, and export energy; filter domestic wastes; retain and modulate freshwater runoff; buffer adjacent land areas from the force of marine waters; provide critical habitat for fish and wildlife migrations, feeding, refuge, and reproduction; and moderate extremes in air and water temperature.

Many sources have recognized the direct relationship between this generally dynamic, well-mixed and nutrient-rich nearshore environment and the productivity that can be found when the nearshore is healthy.

2.11.3 Biology

Marine Life--Vegetation

One of the most significant features of healthy nearshore environment is the productivity of its plantlife. Shaffer (1991) notes that vegetated habitats are found along approximately 60% of the Strait shoreline and consist of kelp and eelgrass beds, drift algae, and rocky/cobble shorelines with Laminarian cover. Kelp beds, which are found along at least 2/3 of that vegetated shoreline, or 40% of the entire Strait shoreline, are dominated by three species of algae: *Macrocystis integrifolia* (giant kelp), *Nereocystis luetkeana* (bull kelp), and *Pterygophora californica* (an understory kelp). The bulk of the remainder of the Strait's vegetated nearshore, roughly 20% of the total, consists of the vascular plant, eelgrass (*Zostera marina*).

Healthy nearshore vegetation plays many important roles in this ecosystem. In particular, it provides a primary food source for many key, first-order herbivorous organisms; it serves as critical physical structure providing shelter to many species; and it serves as host to a wide range of invertebrate and other marine organisms. The native nearshore vegetation also can play an important role in the physical nearshore processes, dampening tidal and current energy as well as influencing sediment migration and operating as a dominant plant community that prevents colonization by exotic vegetation.

The Puget Sound Nearshore Project newsletter (October, 2002) clearly describes the importance of this healthy vegetative community and explains how it "depends on slivers of sunlight penetrating the waters to provide life to eelgrass meadows where migrating salmon feed and hide from predators. When the nearshore is healthy, its flat, sandy areas are home to flounders, shrimp, and worms, as well as kelp and other algae that provide food and hiding places for millions of other creatures that are integral to the Sound's food web."

The NOPLE Strategy (2001) provides detailed summaries of the key vegetative habitats that constitute the overall nearshore/estuarine ecosystem, including eelgrass beds, kelp beds, flats/sand spits/beaches/backshore, tidal marshes and channels, banks/bluffs/cliffs, and marine riparian areas. This diversity of habitats is a direct expression of the importance the nearshore plays in overall watershed and marine processes.

Marine Life--Fisheries

In addition to vegetation, marine life along the nearshore of WRIA 18, as well as throughout the Olympic Peninsula, consists of a wealth of animal life. Of particular importance to this plan are the nearshore features and the various vertebrate and invertebrate species that are integral to the lives of anadromous fish and commercial/recreational shellfish resources.

Anadromous Fish

For salmonids, the nearshore and estuarine environment serves many essential functions. As noted in the NOPLE strategy (2001), the nearshore has:

> *"been termed the life support system for juvenile Pacific salmon feeding, rearing, and migrating. Juvenile chum (Oncorhynchus keta) and chinook (O. tshawytscha) salmon in particular are recognized as being fundamentally dependent on nearshore ecosystems. This fact is of heightened significance given that ESA-listed Hood Canal/Eastern Strait of Juan de Fuca summer chum salmon and Puget Sound chinook salmon occur throughout many of our nearshore ecosystems. Chinook and chum stocks, in the western Strait of Juan de Fuca, while not currently listed by ESA, are considered to be at critical or depressed levels. However, the importance of the nearshore is not restricted to chum and chinook salmon alone. All salmon species must migrate through the nearshore, both as juveniles heading to sea and as adults returning to spawn. Hence, the nearshore within the salmon recovery jurisdiction of HCCC and NOPLE supports multiple species and stocks of Pacific salmon that originate not only from watersheds within the Hood Canal-Straits-Pacific single geographic unit, but also from outside this area. We also know that the nearshore within this geographic unit supports the life history of forage (bait) fish species such as surf smelt (Hypomesus pretiosus), sand lance (Ammodytes hexapterus), and herring (Clupea harengus) that are critical prey for Pacific salmon. In addition, numerous other marine fish species are presently under consideration for ESA listing.*
>
> *Historically, the paradigm was that juvenile salmon could be found in nearshore environments during what has commonly been called the "fish window" from approximately April through September. Recent evidence from nearshore beach seining surveys suggests, however, that juvenile salmon can be found within the matrix of nearshore habitats (e.g., eelgrass beds, mudflats, marshes, and channels) year-round. Thus, the nearshore is*

> *increasingly recognized as a critical, year-round component of Pacific salmon life histories. Furthermore, restoration work in a specific watershed may be wasted if the estuary for that watershed is disconnected or dysfunctional."*

Shaffer (2001) clarifies that the forage fish "depend on quiet embayments, sandy, undisturbed, shaded beaches, and eelgrass beds for spawning. Kelp beds provide critical refuge and foraging habitat for juveniles and adults of all three [listed--pink, chum & coho] species." And she goes on to emphasize that "these [forage] fish are critical food fish for salmonids, and will dictate their migration, and survival".

Shaffer also explains that "pink, chum, Chinook, and coho depend on nearshore areas. Juvenile fish require nearshore healthy wetlands along lower rivers as they transition from fresh water to marine water, and eelgrass and kelp beds during their outward migration after they reach marine waters. Adult Chinook and coho will also use kelp beds extensively as feeding and staging areas before heading into natal streams to spawn."

Forage Fish

Figure 2.11-2 presents locations of forage fish their spawning areas along the WRIA 18 Strait of Juan de Fuca shoreline. Based on local knowledge, the map was prepared for the Clallam County Marine Resources Committee.

Shellfish

The nearshore is home to diverse and extensive shellfish populations. In WRIA 18, the most important of these shellfish resources include: Dungeness crab, geoduck clams, and through a recent reintroduction program, the native Olympia oyster. Pacific oysters are also farmed, particularly in the Dungeness Bay area.

Other Invertebrates

Also found in the nearshore habitat are sea stars, sea cucumbers, anemones, and numerous other examples of invertebrates.

Human Impacts

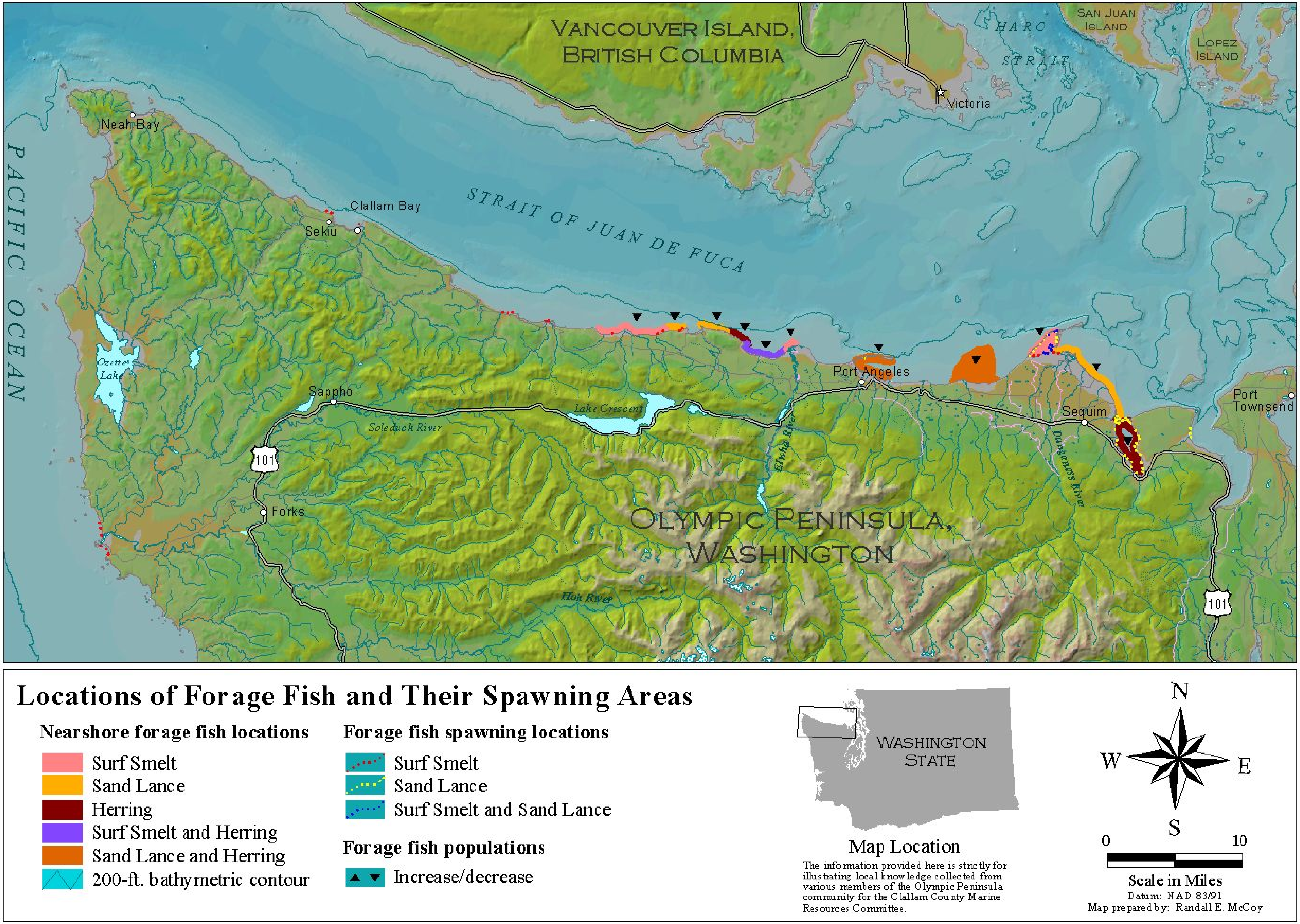
Extensive loss and impairment of nearshore and estuarine habitat has occurred within WRIA 18 and throughout the Puget Sound Estuary/Strait of Juan de Fuca region. These impacts are described in several documents, including Shaffer (2001), Haring (1999), the NOPLE Strategy (2001), and the introductory materials being produced by the Puget Sound Nearshore Project (Project). The Project's newsletter quantifies the human impact throughout the Sound, noting that:

- Human development has modified one-third of the Puget Sound shoreline;
- Inter-tidal marsh habitat has declined 75% since the 1800s;
- Nine of the 10 species listed as endangered or threatened within the Puget Sound region inhabit the nearshore (Hood Canal Summer Chum, Puget Sound Chinook, Puget Sound Bull Trout, Bald Eagle, Marbled Murrelet, Aleutian Canada Goose, Humpback Whale, Stellers Sea Lion, and *Howelia aquatilis;* excluding only the Spotted Owl)

- Three additional Puget Sound salmon species have been listed as in danger of becoming extinct according to the ESA; and
- Resident orca whale populations have declined significantly from 97 in 1996 to 78 in 2001.

Shaffer (2001) summarizes impacts as being from bulkheading (and associated loss of marine riparian habitat), point and non-point source pollution and associated nutrient loading within embayments, diking and armoring of lower river reaches and deltas, overwater structures, and occasional oilspill impacts. She provides a detailed list of human impacts in the Strait and Hood Canal:

- Altering of lower rivers and tidal deltas, including diking, armoring, and damming along [WRIA 18] rivers has resulted in extensive loss of estuarine habitat and function, including loss of estuarine wetland, eelgrass, and clam habitat.
- Armoring of shorelines (bulkheading) can dramatically change the sediment transport and drift cells along shorelines, which in turn results in changes in shoreline habitat and loss of critical baitfish [forage fish] habitat. [In WRIA 18] bulkheading is associated with…the old railroad bed, municipal water lines (Elwha line to Port Angeles), and urban centers of Port Angeles and Port Townsend [WRIA 17], as well as along rural residential areas…. It has gone largely undocumented, and is resulting in large scale changes, including loss of critical habitat, along these areas.
- Non-point source pollution from poor septic stewardship and agricultural runoff has been documented to cause ecosystem shifts, including loss of eelgrass beds…. Kelp, as well as zooplankton and larval fish that depend on them, are documented to be extremely sensitive to petroleum products. Harmful macroalgae blooms are theorized to cause habitat shifts and decline in both eelgrass beds and recreational shellfish resources in Dungeness Bay. For example, ulvoid mats appear to be on the increase, but to date, cause and impact are undocumented. Stormwater runoff from lawns [and other sources] introduces nutrients and pollutants to the nearshore, and [it is] increasing.
- Fill of intertidal areas has occurred extensively throughout [WRIA 18]. Fill was often placed at river and creek mouths and along spits—all areas critical for forage fish and salmonid migration, as well as being important shellfish habitat.
- Over- and in-water structures are a significant feature [in WRIA 18]. Most prominent examples of nearshore impediment [in WRIA 18] include the Rayonier pier [and other structures throughout the inner shore of Port Angeles Harbor].
- Industrial use of embayments, such as Port Angeles Harbor, alters habitat through physical modification of the nearshore, and pollution of marine nearshore waters, sediments, and resources.
- The [nearshore is] vulnerable to large oil spills [originating in the Strait] due to heavy shipping traffic [and it has] experienced at least two such events in the last twenty years.
- Commercial, tribal, and recreational fishing may have impacts on nearshore habitats. For example, in some areas, urchin fishing may affect distribution and composition of Strait kelp forests.



Locations of Forage Fish and Their Spawning Areas

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- Non-native species. For example, recent work has indicated an increase in the non-native overstory kelp, *Sargassum muticum*. Spartina invasion is a concern for many embayments.

The WRIA 18 Limiting Factors Analysis (Haring, 1999) describes in great detail the specific human impacts that have occurred, giving emphasis to the impacts of shoreline armoring, eutrophication and loss of intertidal/nearshore vegetated habitat, susceptibility to point and nonpoint pollution of water quality, and oil spill risks.

Monitoring/Data Gaps

Monitoring

There is no comprehensive monitoring program in place for the WRIA 18 nearshore or any significant portion of it. Site-specific monitoring of some parameters, such as water quality variables, has occurred in conjunction with specific activities such as recreational/ commercial shellfish harvest (especially Dungeness and Sequim bays) and with particular restoration projects such as at the Rayonier Mill site. There have also been some analyses of tidal and longshore current processes conducted in conjunction with Elwha River restoration planning, investigation of Dungeness Bay water quality problems, and Sequim Bay aspects associated with restoration of the Jimmycomelately watershed and estuary.

An extensive survey of forage fish status and distribution is currently being conducted under the auspices of the Clallam County Marine Resources Committee, in consultation with WDNR.

Data gaps

Haring (1999) notes the following data gaps:

- Much of the marine shoreline of WRIA 18 has been altered. Further study would be beneficial to identify the likely effects of removal of shoreline armoring (particularly to the west of Morse Creek and from the base of Ediz Hook to the Elwha River).
- Eelgrass and kelp habitats have been documented as very important to salmonids. Eelgrass habitat is being replaced by Ulva (spp), which appears to provide little salmonid habitat benefit. Wilson (1993) and several TAG participants recommend a comprehensive regular assessment of eelgrass and Ulva presence—(Wilson 1993) recommends every 3 years, particularly in Dungeness Bay to Washington Harbor where increasing Ulva presence is documented. This study should look not only at the conversion area, but also the local conditions that appear to favor conversion to Ulva.

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