3. STRAIT OF JUAN DE FUCA ECOSYSTEM: MARINE SHORELINES

Clallam County marine shorelines are buffeted directly by wind and waves entering the Strait of Juan de Fuca from the Pacific Ocean. The shoreline is shaped by seasonal shifts in weather along with cycles of ocean temperature and long term climate change. The underlying geology of the Olympic Peninsula also affects the shape and character of the shoreline through erosion, landslides, sediment movement and beach formation.

The protected coves, bays and river mouths along the Strait of Juan de Fuca have been the sites for human settlements for thousands of years. More recently, the weather and spectacular views of wildlife have attracted development along exposed bluffs and beaches. What happens along the marine shoreline—through natural or human-generated activities—affects the people who live along the shorelines as well as resource-based businesses and the many species that depend on the nearshore for food, cover from predators migrating to the ocean.

The Strait of Juan de Fuca provides habitat and migration corridors for many species of Puget Sound and Fraser River salmon, marine mammals and thousands of migratory birds, including many State-identified "priority species" (Table 3-1). The nearshore ecosystem supports aquatic plants and animals that feed the upper levels of the food web.

Table 3-1. Priority wildlife species mapped along the Clallam County, Strait of Juan de Fuca shorelines (Sources: WDFW, WDNR)

Terrestrial Species	Aquatic Species
Bald eagle	Sand lance
Common loon	Surf smelt
Harlequin duck	Pacific herring
Taylor's checkerspot butterfly	Coho salmon
Wood duck	Chum salmon (fall and summer)
Band-tailed pigeon	Pink salmon
	Sockeye salmon
	Chinook salmon (fall and spring)
	Steelhead (summer and winter)
	Cutthroat trout

Terrestrial Species	Aquatic Species
	Rainbow trout
	Dolly Varden/Bull Trout
	Harbor seal
	Gray whale

This chapter provides an overview of the ecosystem processes at work along the shorelines of the Strait of Juan de Fuca, how structures, docks and other modifications affect long term shoreline processes and the baseline condition of Clallam County's marine shorelines. Additionally this chapter contains a brief discussion about projected changes to sea levels along the Puget Sound/Strait of Juan de Fuca marine shorelines.

3.1 *Overview of Marine Shoreline Ecosystem Processes*

Although the focus of this report and of the Shoreline Master Program update in general is on conditions within the jurisdiction of the Shoreline Management Act, the shoreline guidelines require Clallam County to look beyond the jurisdictional boundaries of the Act and assess the processes that shape and influence shoreline ecological functions. Knowing how these processes work can help determine which management strategies are appropriate for the marine shorelines in Clallam County.

3.1.1 Processes Affecting Marine Shorelines

The Strait of Juan de Fuca shoreline consists of several different shore types including bluff-backed beaches, barrier beaches (including spits), rocky platforms, stream deltas, inlets and embayments associated with protected lagoons and salt marshes. These features, which formed as a result of the County's unique geographic and oceanographic setting, are continually evolving and changing in response to dynamic physical processes such as sediment erosion and deposition, landslides and bluff retreat (Shipman 2004; Johannessen and MacLennan 2007).

The process of bluff erosion begins when sediment grains, blocks or slabs detach from the bluff face and slide down the slope. The eroded material deposited at the base or toe of the slope protects the bluff from wave attack for a while, but is gradually washed away by wind and wave action. Eventually, waves undercut the bluff toe, which destabilizes the slope making it more susceptible to failure (Johannessen and MacLennan 2007). Bluff toe erosion can occur rapidly during wet weather periods, storm surges or during extraordinary high tides. Evidence of marine or wave-induced bluff erosion is visible all along the Strait of Juan de Fuca (Figure 3-1).

Landslides are an extreme form of bluff erosion generally triggered by forces acting on the top of the bluff (as opposed to the toe). Landslides typically occur during periods of heavy precipitation, on bluffs where a combination of characteristics makes the bluff vulnerable to slope failure (Shipman 2009). These characteristics include the underlying geology, degree of

exposure (to wind and waves), groundwater and surface water conditions and the extent of development on the bluff. Heavy precipitation and/or high groundwater levels can cause concavities to form at the top of the bluff. These depressions can grow into gullies and larger slumps that initiate shallow failures or reactivate large, deep-seated landslides. Bluffs that lack vegetation due to clearing or other development-related actions are often at greater risk for these events (Shipman 2004, Johannessen and MacLennan 2007). Figure 3-2 shows evidence of a recent landslide near Shipwreck Point.

Figure 3-1. Erosion at base of bluff contributing sand, cobble and gravel to the nearshore (Photo by A. MacLennan)

Figure 3-2. Evidence of recent landslide activity near Shipwreck Point (Photo by A. MacLennan)

Buff erosion and landslides contribute sediment to beaches in large quantities (Keuler 1988). The volume of sediment and frequency of landsliding is variable and episodic throughout the region due to a number of variables. Two bluffs in close proximity can demonstrate significant variability in erosion rates due to minor changes in shore orientation, stratigraphy, exposure and/or land use. In addition, some bluffs supply sediment to many miles of down-drift shoreline, others may be of only local significance (Coastal Geologic Services 2011).

Tidal range also affects bluff erosion rates (Rosen, 1977). Erosion tends to increase with decreasing tidal range. This is because a small tidal range focuses wave energy at a narrow vertical band, in comparison to higher tidal ranges which dissipate energy over a larger vertical band. The Strait of Juan de Fuca has a low-moderate tidal range meaning wave energy is focused on the upper beach and bluff toe a substantial percentage of the time (more so than in Hood Canal or portions of the Sound Puget Sound).

Bluff sediments are distributed along the shore by a process called littoral drift. Surface waves typically approach the shore at an angle from the northwest creating longshore currents that transport the sediment down-drift. Net shore-drift refers to the long-term, net result of littoral drift (Figure 3-3).
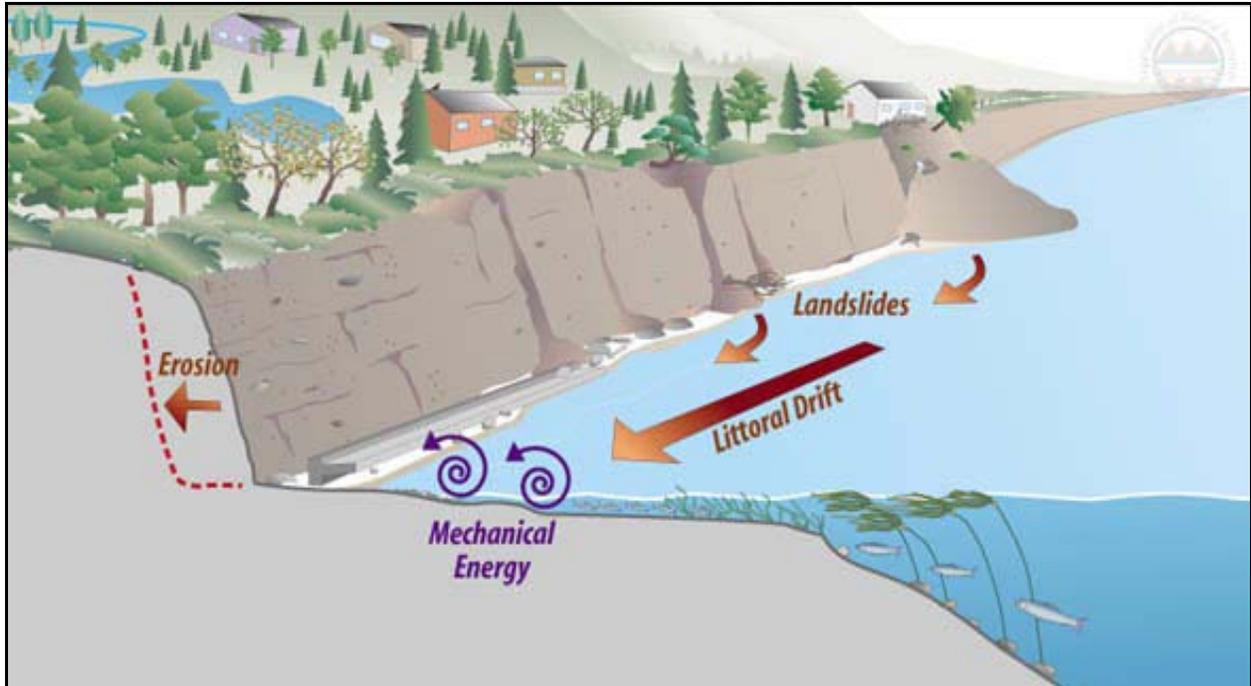
Figure 3-3. Bluff erosion, landslides and littoral drift (Source: King County)

This process of net shore-drift transporting sediment from an erosional feature to a spit or barrier beach creates unique drift cells. Each drift cell acts as a system consisting of three components: a sediment source (called a feeder bluff); a transport zone where sediment is moved alongshore by wave action with minimal sediment input; and a deposition zone where wave energy is no longer sufficient to transport the sediment. For example, the rapidly eroding bluffs down-drift of Dungeness Spit provide the sediment that maintains the spit. While bluff erosion is a natural process that maintains beaches, it can be detrimental to structures (and their occupants) that are built too close to the bluff edge (Figure 3-4).
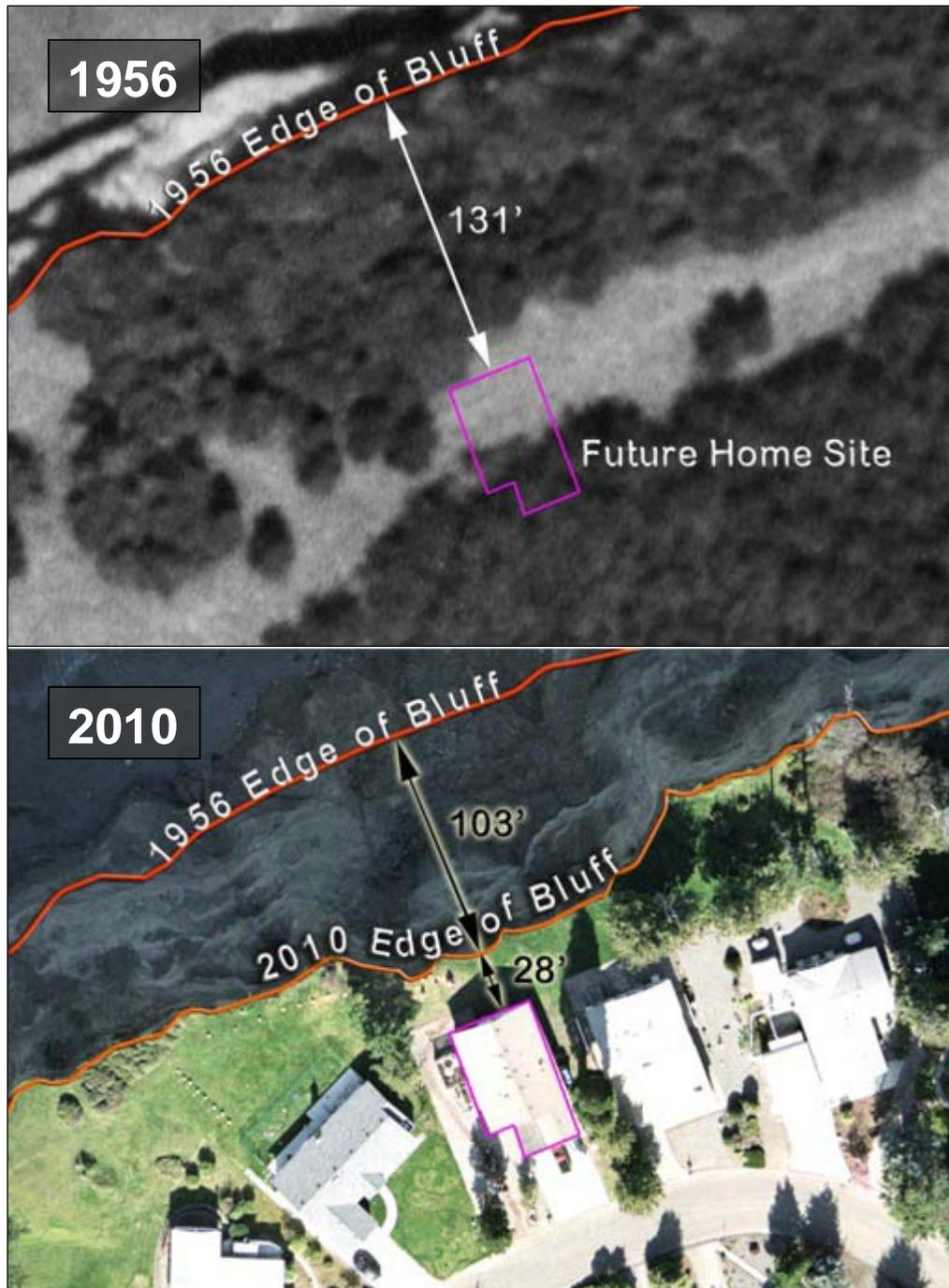
Figure 3-4. Bluff erosion threatening homes along Cypress Circle, west of Dungeness Spit (Source: Randy Johnson)

Properly functioning drift cells are essential for creating and maintaining nearshore habitats for salmon, shellfish and other species. For example, sand lance and surf smelt (called "forage fish") prefer to spawn on beaches of mixed sand and pea gravel (Penttila 2000). Given that littoral drift can rapidly transport particles of this size, the of presence feeder bluffs that erode at a fairly high

rate is directly linked to the extent of suitable sand lance and surf smelt spawning habitat (Shaffer and Ritchie, 2008c).

Eelgrass thrives in sediment-rich, low tide terraces (Hirschi 1999). Salmon and other species rely on forage fish for food, gently sloping beaches as safe havens from predators during migration and eelgrass beds for cover and foraging habitat (Groot and Margolis 1991). Overhanging vegetation provides shade for surf smelt and sand lance eggs, serves as a source of terrestrial insects for consumption by marine fishes and provides cover at high tide (Brennan and Culverwell 2004). Bluff-top trees are favorite nesting and perching spots for bald eagles and other bird species. When people build bulkheads, construct overwater structures such as piers and docks, remove vegetation or cause other shoreline modifications, these processes may become altered and diminish the functionality of the nearshore environment. Where drift cells support important features such as spits, the loss of sediment recruitment can have significant unintended impacts. An example is Ediz Hook in the city of Port Angeles, where large-scale shore-defense projects are required to compensate for the reduction of naturally derived sediment caused by shoreline modifications within the drift cell.

Rivers and streams also influence the character and quality of the marine environment. The coarse sediment from rivers and streams is typically transported alongshore in net shore-drift cells, such as at the mouth of the Elwha and Dungeness rivers. Freshwater input from rivers and streams is beneficial because it decreases the salinity of the water locally and can aid in the formation of ecologically valuable habitats including marshes, distributary channels, shallow water deltaic habitats and sand and mudflats.

3.1.1.1 Effects of Climate on Marine Shoreline Processes

Researchers at the University of Washington's Climate Impacts Group and others have devoted significant effort to modeling potential effects of climate change on the Pacific Northwest. They note that under most scenarios Puget Sound/Strait of Juan de Fuca rivers and shorelines will likely experience changes to snowpack and runoff (with increased potential for flooding), accelerated sea level rise and the loss of nearshore habitat.

Rising sea levels could have a major influence on the marine shoreline environment. There are two main components of sea level rise: "eustatic" (global) sea level rise, which is controlled by global processes such as the warming of the oceans and the melting of ice; and "relative" sea level rise, which is controlled by regional vertical land movement including, tectonic uplift and local land subsidence. Relative sea level (RSL) rise is most informative in support of regional land use planning. Even as eustatic sea level rises, geologic studies of the north Olympic Peninsula indicate that the land is also rising. Tectonic uplift is occurring along an east-west gradient with a small measure of change (-0.1– 0.1 mm/yr) in the eastern county (in vicinity of Port Townsend), considerably more uplift at Port Angeles (2.0 mm/yr) and the greatest uplift occurring at Neah Bay (3.5 – 4.0 mm/yr) (Mazzotti et al. 2008, Verdonck 2006). As a result, RSL is currently out-pacing eustatic SLR resulting in a RSL of -2.1 mm/yr in western Clallam County (Mazzotti et al. 2008). In contrast, in eastern Clallam County RSL is currently 1.9 mm/yr.

Estimates of relative sea level rise are anticipated to increase into the future, and it is unknown if the current trend of uplift out-pacing SLR will continue in western Clallam County. There is

considerable uncertainty surrounding the rate of accelerated global SLR. Research is currently in progress to address the sources of uncertainty, which are largely associated with the rate of ice sheet melt in Greenland and the West Antarctic Ice Sheet. Estimates of relative sea level rise for Puget Sound/Strait of Juan de Fuca are shown in Table 3-2 (NW Olympic Peninsula). These estimates are largely derived from Mote et al. (2008) which was based on the United Nations Environmental Programme's Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4). Considerable research has documented that the projections used in the AR4 are on the low side as they underrepresented not only the ice sheet component of global sea level rise but also the emissions scenarios. Mote et al. (2008) included additional SLR contribution from ice sheet loss but only in the very high SLR scenario, and a recent literature review of SLR science for local use noted that the Mote et al. projections are well below other scientific publications since the AR4 IPCC report (Clancy et al. 2010). Therefore, these estimates should be applied appropriately and planning measures should be put in place to assure that the most contemporary, accurate projections can be integrated into the planning process as they become available. The estimates in Table 3-2 are coarse approximations of sea level trends into the future with changes that may be nearly imperceptible from year to year. For these and other reasons, readers are advised not to place too much significance on absolute numbers, or significant digits, in this rapidly evolving area of scientific study.

Table 3-2. Relative sea level rise projections for major geographic areas of Washington State (Huppert et al. 2010, adapted from Mote et al. 2008)

Sea Level Rise Estimate	By the year 2050			By the year 2100		
	NW Olympic Peninsula	Central & Southern Coast	Puget Sound	NW Olympic Peninsula	Central & Southern Coast	Puget Sound
Very low	-5" (-12 cm)	1" (3 cm)	3" (8 cm)	-9" (-24 cm)	2" (6 cm)	6" (16 cm)
Medium	0" (0 cm)	5" (12.5 cm)	6" (15 cm)	2" (4 cm)	11" (29 cm)	13" (34 cm)
Very high	14" (35 cm)	18" (45 cm)	22" (55 cm)	35" (88 cm)	43" (108 cm)	50" (128 cm)

Nearshore areas will respond to sea level rise differently based on the type of landform and the dominant geomorphic processes at work in a given locality. Factors such as sediment supply, resistance to erosion, and the ability of the landform to move (translate) landward will determine how an area responds to SLR (Clancy et al. 2010). Rising sea levels will likely result in an increase in coastal flooding, mass-wasting, beach erosion and overwash, barrier migration, shifting tidal inlets, changes in tidal prism, marsh erosion and accretion, inlet dynamics and accelerated bluff retreat in Clallam County and the Puget Sound region (Clancy et al. 2010). Additional implications of climate change including more frequent and intense storms, El Niño conditions (which can temporarily increase sea level, Mote et al., 2008), and increasing wave heights (Ruggerio and Allen, 2010) are also predicted to occur, which contribute to the frequency

and magnitude of coastal flooding and erosion events. Landslides and flooding of freshwater streams and rivers may also increase along with increases in winter precipitation and altered rainfall patterns. These changes have the potential to affect the breeding, feeding and migration patterns of numerous fish and wildlife species and could have a major impact human health and safety (Casola et al. 2005b).

Implications of sea level rise and climate change will affect numerous nearshore processes, which will have forthcoming effects on the associated nearshore ecosystem. Processes most likely to be affected include: sediment supply and transport, beach erosion and accretion, distributary migration, tide channel process, freshwater input, tidal hydrology, detritus import and export and the exchange of aquatic organisms (Clancy et al. 2010). These implications are likely to result in greater change to the marine landscape at multiple scales. People are likely to respond to these changes by demanding engineered solutions to control and erosion and protect infrastructure. Engineered solutions come at a cost both financially and often to ecosystem processes and the habitats found therein. For example, shoreline armoring can be used to slow marine induced erosion, but inhibits the beach profile from naturally adapting to sea level rise, in a process referred to as *shoreline translation*. Armor not only precludes this natural process but results in intertidal habitat loss as the shoreline migrates landward against the armor.

3.1.2 Evaluation of Marine Nearshore Processes along the Strait of Juan de Fuca

By some measures, the processes that shape and maintain Strait of Juan de Fuca nearshore ecosystem are among the least altered in the Puget Sound basin. The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) completed a comparative analysis that ranked each reach of the Puget Sound/Strait of Juan de Fuca shoreline based on the degree to which the following ecosystem processes were altered:

Sediment Input   Freshwater Input

Sediment Transport   Detritus Import and Export

Erosion and Accretion of Sediments   Exchange of Aquatic Organisms

Tidal Flow   Physical Disturbance

Distributary Channel Formation and   Solar Input
Maintenance

Tidal Channel Formation and
Maintenance

The level of degradation was rated on a relative scale from most degraded to not degraded. It is important to note that PSNERP did not evaluate biological conditions (such as vegetation or habitat availability) per se, but assessed the configuration of the shoreline compared to historic conditions and the presence of modifications or ecological stressors such as fill, armoring, marinas, dams and other features. Overall the reaches of the Strait were less degraded than most other areas of Puget Sound (Schlenger et al. 2010) (Figure 3-5). The low level of degradation

will provide the County with opportunity to achieve multiple goals for environmental protection, restoration, public access and water-related development. The PSNERP analysis is at a very large scale and does not address conditions that may be present for any given location.
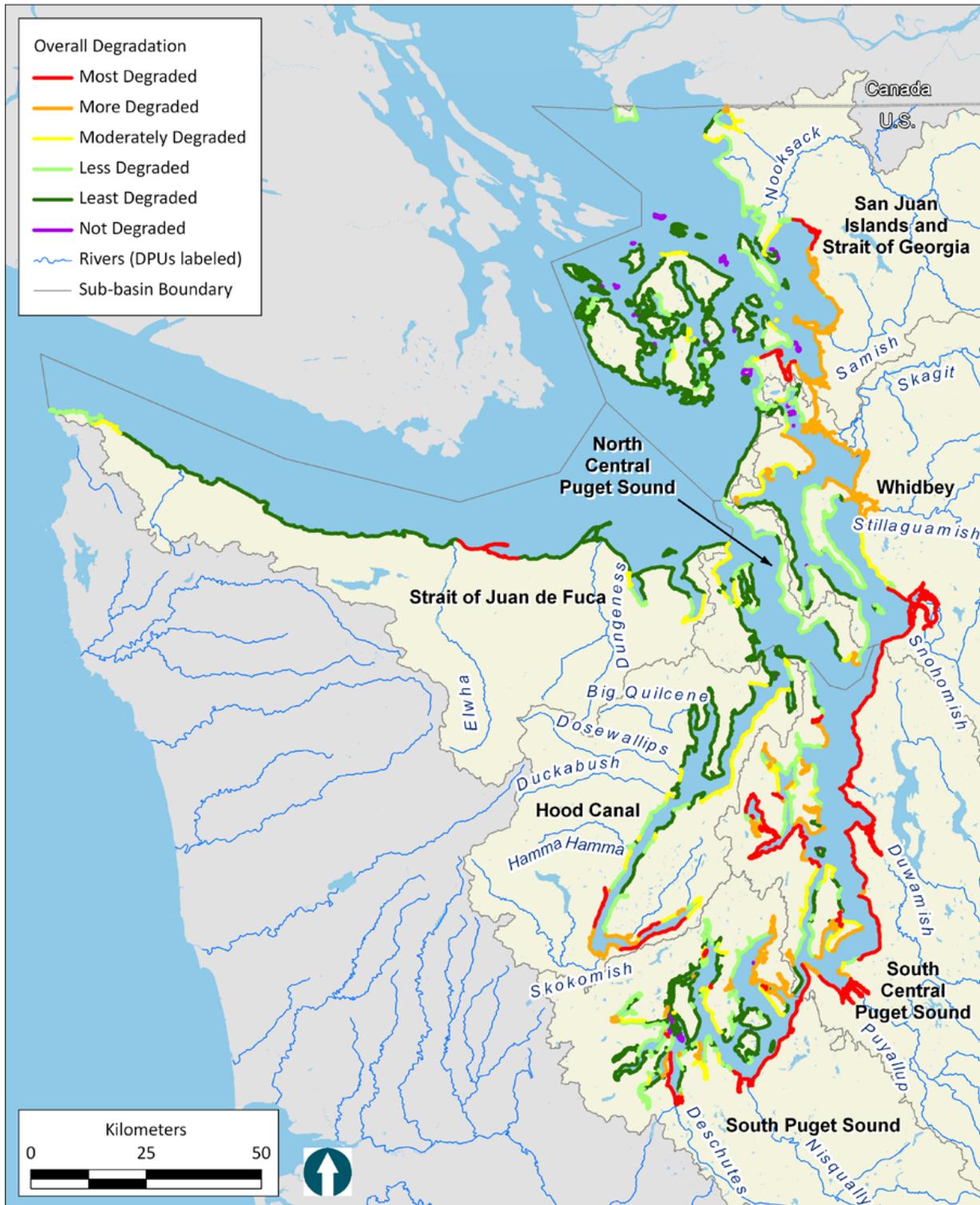
Figure 3-5. Relative degradation of Strait of Juan de Fuca nearshore reaches in terms of nearshore processes (Schlenger et al. 2010)

3.2 *Establishing a Baseline to Measure and Track Marine Ecological Functions*

To comply with the Shoreline Management Act, the County must demonstrate that the updated SMP achieves "no net loss" of shoreline ecological functions compared to the baseline conditions described in this report. Ecology explains the concept of no net loss as follows: *Over time, the existing condition of shoreline ecological functions should remain the same as the SMP is implemented*[1]. In other words, no net loss means that as shoreline development occurs, ecological functions are not diminished.

Ecological functions are dependent on the structure of the shoreline, which is shaped by ecosystem processes (such as erosion and deposition of sediment), which are affected to greater or lesser degrees by the actions people take on the shoreline. This basic model applies to a wide range of actions—many different ecological functions are linked to human actions and therefore to SMP decision. In this way, SMP decisions can lead to increases or decreases in ecological functions over time (Figure 3-6).
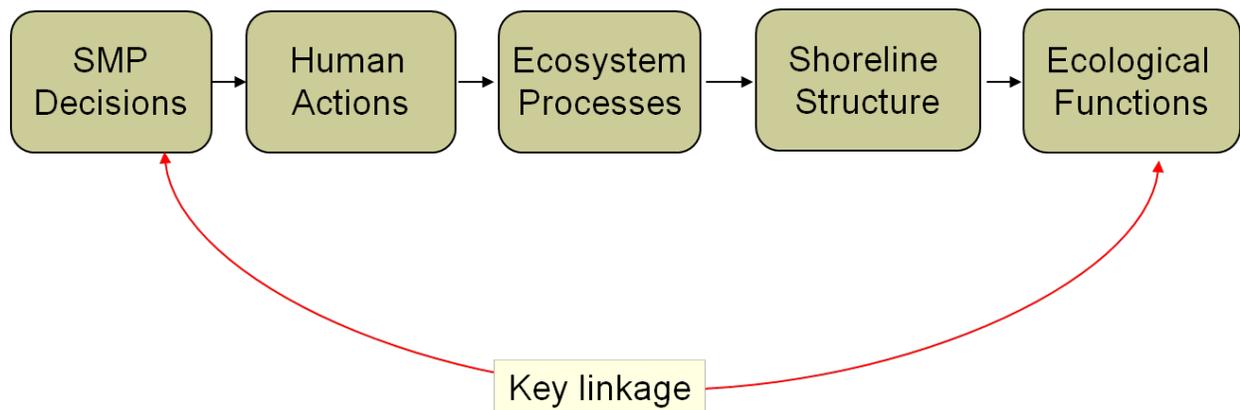
Figure 3-6. Relationship between human actions and shoreline ecological functions in the context of shoreline master programs

As an example, an SMP can regulate when and where bulkheads and other forms of shoreline stabilization are allowed. The construction of bulkheads can, in turn, have direct effects on sediment supply processes, which can affect beach substrates and profile, which can impact the suitability of the beach for forage fish spawning (Figure 3-7).
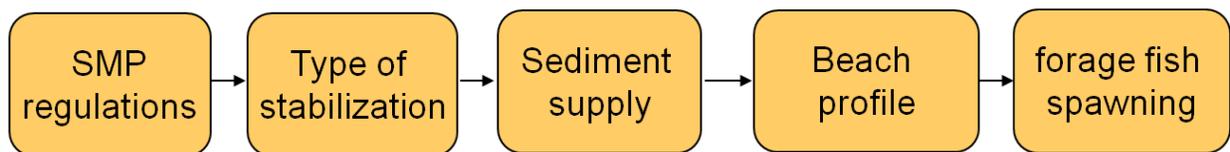
Figure 3-7. Relationship between shoreline stabilization regulations and forage fish functions

[1] See http://www.ecy.wa.gov/programs/sea/shorelines/smp/handbook/Chapter4.pdf

In order to document existing functions and track changes that occur over time, a set of measurable **indicators** is needed to help determine if ecological functions are increasing increased, decreased, or remaining the same. The set of indicators must be specific enough to be tallied in a reliable and systematic way and data must be available through existing sources. Table 3-3 contains a set of suggested indicators that could be used to assess ecological function of Clallam County marine shorelines along the Strait of Juan de Fuca. Measuring these indicators over time would provide an indication of whether, how and to what degree shoreline conditions and functions are changing. The changes could then be reviewed in light of shoreline management decisions to determine if the shoreline master program is achieving no net loss. The Puget Sound Partnership has identified a similar set of indicators to determine how efforts to restore, protect and prevent pollution in Puget Sound are going (see http://www.psp.wa.gov/pm_dashboard.php for more information).

The text that follows describes current condition of each marine reach in terms of these indicators (along with some related pertinent information). Some of the indicators illustrate the intrinsic quality of the shoreline environment and other indicators are measures of the degree of shoreline alteration.

Table 3-3. Suggested indicators of marine shoreline ecological function that can be systematically tallied using existing data for Clallam County

Metrics that Indicate Shoreline Quality	Why Selected?
▪ Percent of shoreland area mapped as feeder bluff (Table 3-7) ▪ Percent of shoreland area mapped as landslide and erosion hazards (Table 3-8) ▪ Percent of aquatic area supporting submerged aquatic vegetation (kelp) (Table 3-12) ▪ Percent closed canopy forest within 200 feet of the ordinary high water line (Figure 3-14)	▪ Feeder bluffs play a critical role in sediment erosion and deposition and transport processes, which are key determinants of the health of marine beaches (Johannessen and MacLennan 2007). ▪ Landslides and erosion are natural shoreline processes that deposit sediment on marine beaches but create hazardous conditions for property owners. ▪ Kelp and other submerged aquatic plants provide food and refuge for a wide variety of invertebrates (e.g., sea urchins and abalone) and fishes (e.g., juvenile rockfishes and salmon) and orca whales (Mumford, 2007; Shaffer 2008). ▪ Marine riparian vegetation has a major influence on functions including habitat, water quality, organic and nutrient inputs and microclimate (Brennan and Culverwell 2004).
Metrics that Indicate Shoreline Alteration	**Why Selected?**
▪ Percent of shoreline classified as modified (Table 3-6) ▪ Percent of feeder bluffs with armoring (Table 3-9) ▪ Percent of hard armoring along shoreline (Figure 3-9) ▪ Number of overwater structures per mile of shore (Table 3-10) and number of overwater structures per mile of sediment transport zone (Table 3-11)	▪ Modified shores are missing important structural elements that provide habitat for various terrestrial and aquatic species. ▪ Armoring can cause loss of beach and backshore habitat which important areas for forage fish spawning. Armoring also affects movement of materials and organisms between the riparian and the aquatic zone or alter natural drainage patterns (Shipman et al., 2010; Hirschi et al. 2003). ▪ Overwater structures impact sediment transport process, solar incidence and exchange of aquatic organisms, which affects wood web functions, habitat availability and species distribution (Schlenger et al. 2010; Nightengale and Simenstad 2001)

3.2.1   Baseline Conditions Overview

Within Clallam County, the Strait of Juan de Fuca shoreline consists of 18 reaches, each composed of different shoretypes that reflect the underlying geology, degree of exposure to wind/waves, long-term patterns of sea level change, the ongoing redistribution of sediment by net shore-drift processes and the influence of freshwater systems including the Dungeness, Elwha, Lyre and other rivers. The reaches are numbered sequentially from east to west and do not include the incorporated areas or tribal lands of the Makah Indian Reservation (Figure 3-8). All marine shorelines inventoried in this chapter are "shorelines of statewide significance" (Strait of Juan de Fuca).

Figure 3-8. Inventory reaches along the Strait of Juan de Fuca numbered form east to west (MR= marine reach)

In general, the Strait of Juan de Fuca marine shoreline is characterized by considerable wave exposure and moderate tidal range (Shipman 2008). Physical conditions vary dramatically from east to west. The bluffs along the eastern Strait of Juan de Fuca are composed mainly of glacially derived deposits, while the western bluffs are predominantly bedrock. Large scale depositional landforms are common in east Clallam County, while depositional landforms in the western portion of the Strait tend to be more limited to river mouths.

The Puget Sound Nearshore Ecosystem Restoration Project (2009) delineated the shoreline into geomorphic units called shoreforms as a way to further describe and differentiate the physical characteristics that are present along the shoreline. In Clallam County, most of the marine shoreline falls into one of two shoreform categories: bluff backed beach and rocky platform, although all 11 shoreform types are present to some degree (Table 3-4, see Map 1 in Appendix A).

Table 3-4. Breakdown of shoreform categories on the Strait of Juan de Fuca shoreline in Clallam County as a percent of shoreline length (Source: PSNERP 2009)

Shoreform Category	Percent of the Juan de Fuca Shoreline
Artificial	2.1%
Barrier Beach	19.4%
Barrier Estuary	6.6%
Barrier Lagoon	2.7%
Bluffed-Backed Beach	31.1%
Closed Lagoon Marsh	0.6%
Delta	7.4%
Open Coastal Inlet	0.7%
Pocket Beach	3.4%
Plunging Rocky Shoreline	0.2%
Rocky Platform	25.8%
Total	**100.0%**

This geomorphic context has a strong influence on shoreline management since the ecological processes, potential risks (such as landslides and erosion) and ecological functions will vary depending on the shoreform. As a result, strategies for addressing land use, public access and ecological protection will be different for a barrier beach (such as Gibson Spit) than for a rocky platform (such as Tongue Point), river delta (Dungeness river mouth) or bluff.

To further delineate differences in the physical character of the marine shore and assess bluff erosion characteristics, Coastal Geological Services (CGS) examined the marine shoreline of the Strait of Juan de Fuca in Clallam County (east of the Makah Indian Reservation) and classified it into one of 7 different shoretypes based on the criteria in Table 3-5 (see Map 1 in Appendix A):

Feeder Bluff Exceptional (FBE) – Applied to rapidly receding bluff segments with the highest volume sediment input areas per lineal foot. This classification was more common in the study area than in other Puget Sound region areas.

Feeder Bluff (FB) – Areas of substantial sediment input into the net shore-drift system. Feeder bluff segments have periodic sediment input with a longer recurrence interval as compared to feeder bluff exceptional segments.

Feeder Bluff (FB-TS) – Coastal bluffs/sea cliffs that are actively receding and have a history of erosion/landslides but are primarily found within areas mapped as bedrock. These areas function as bedrock sediment sources (typically marine sedimentary units such as sandstone and conglomerate). These bluffs likely recede/erode at a slower rate than typical feeder bluffs and therefore are distinctively different from the

unconsolidated, glacially deposited bluffs that the term feeder bluffs typically represents. Feeder bluff–talus units provide beach sediment in the form of shallow landslides and/or large deep-seated landslides that deliver soil and large woody debris with boulders, cobbles, sand and gravel (often via sandstone and conglomerate talus with soil) to beaches.

Transport Zone (TZ) – Areas that did not appear to be contributing appreciable amounts of sediment to the net shore-drift system, nor showed evidence of past long-term accretion.

Accretion Shoreform (AS) – Areas that are currently depositional or were depositional in the past.

Modified – Areas that have been bulkheaded or otherwise altered to a state where the natural geomorphic character of the shore is largely concealed by the modification such that the bank no longer provides sediment input to the beach system.

No Appreciable Drift (NAD) – Areas where there was no appreciable net volume of littoral sediment transport was occurring due a lack of adequate wave energy for littoral transport to occur, or along bedrock shores with an insufficient volume of sediment in transport.

Table 3-5. Strait of Juan de Fuca shoretype mapping and criteria for Clallam County (CGS 2011)

Shoretype	Criteria		Photo Example
	Presence of (priority in order):	**Absence of:**	
Feeder Bluff Exceptional (FBE)	1. Bluff/ bank 2. Recent landslide scarps 3. Bluff toe erosion 4. Abundant sand/gravel in bluff 5. Colluvium/ slide debris 6. Primarily unvegetated or vegetated slumps 7. Trees across beach 8. Boulder/ cobble lag 9. Steep bluff (relative	1. Shoreline bulkhead/ fill 2. Backshore 3. Old/ rotten logs 4. Coniferous bluff vegetation 5. Bulkhead	South of Dungeness River (Reach 4)

Shoretype	Criteria		Photo Example
	Presence of (priority in order):	**Absence of:**	
	alongshore)		
Feeder Bluff (FB)	1. Bluff/ bank 2. Past landslide scarps 3. Intermittent toe erosion 4. Moderate sand/gravel in bluff 5. Intermittent colluvium 6. Minimal vegetation 7. Trees across beach 8. Boulder/ cobble lag 9. Steep bluff (relative alongshore)	1. Shoreline bulkhead/fill 2. Backshore 3. Old/rotten logs 4. Coniferous bluff vegetation 5. Bulkhead	 Northwest Sequim Bay (Reach 3)
Feeder Bluff –Talus (FBT)	1. Bluff/ bank 2. Past landslide scarps, mapped landslides 3. Bedrock with particle size relevant to beach material, bedding or jointing conducive to breaking and abrasion 3. Intermittent toe erosion 5. Intermittent colluvium 6. Minimal vegetation on bluff face	1. Shoreline bulkhead/fill 2. Backshore 3. Old/rotten logs 4. Basalt 5. Bulkhead	 East of Salt Creek (Reach 9)

Shoretype	Criteria		Photo Example
	Presence of (priority in order):	**Absence of:**	
	7. Trees across beach 8. Boulder/ cobble lag 9. Steep bluff (relative alongshore)		
Transport Zone (TZ)	1. Coniferous bluff vegetation 2. Apparent relative bluff stability 3. Gentle slope bluff (relative alongshore) 4. Unbulkheaded transport zone adjacent	1. Visible landslide scarps 2. Toe erosion 3. Backshore & backshore vegetation 4. Old/rotten logs 5. Colluvium 6. Trees across beach 7. Bulkhead	 Harrison Beach (Reach 10)
Modified (M)	1. Bluff/bank 2. Shoreline bulkhead (mostly intact) 3. Substantial shoreline fill	1. Backshore & backshore vegetation 2. Lagoon/wetland /marsh behind berm 3. Backshore "platform" 4. Old/rotten logs 5. Fine, well sorted sediment (relative alongshore)	 West of Hoko River (Reach 17)

Shoretype	Criteria		Photo Example
	Presence of (priority in order):	**Absence of:**	
Accretion Shoreform (AS)	1. Backshore & backshore vegetation 2. Lagoon/wetland /marsh behind berm 3. Backshore "platform" 4. Old/rotten logs 5. Fine, well-sorted sediment (relative alongshore)	1. Bluff/bank in backshore 2. Toe erosion at bank 3. Landslide scarps 4. Boulders on beachface 5. Bulkhead	 Dungeness Spit (Reach 5)

According to this assessment, roughly 28 percent of the marine shore is mapped as feeder bluff (FB, FBE or FB-T), 30 percent is accretion shoreform and the remainder is either classified as transport zone, no appreciable drift or modified shoreline (Table 3-6). Most of the feeder bluffs and feeder bluff exceptional areas are in eastern Clallam County east of Port Angeles, while the feeder bluff-talus areas occur west of Crescent Bay (Table 3-7). This suggest that bluff erosion rates in eastern Clallam County would be greater compared with the western Strait. Actual rates of erosion are unknown and are likely highly variable. Shipman (2004) citing data from Galster and Schwartz (1990) reported that erosion rates for bluffs west of Port Angeles were as much as one meter per year before the shoreline was armored. Preliminary data from a Jamestown S'Klallam Tribe study on the 8.5 mile-long segment of the shoreline west of Dungeness Spit indicates that average erosion rates range from 0.15 to 3.28 feet per year during the time period from 1956-2010. The largest amount of bluff retreat measured for the 2-year period of 2008 to 2010 was 26.4 feet at a site in Monterra. This assessment is still in progress (Personal communication from Randy Johnson to Andrea MacLennan, May 9 2011).

Table 3-6. Strait of Juan de Fuca shoretype mapping and criteria for Clallam County (CGS 2011)

Marine Shoretype	Percent of Shoreline
Accretion Shoreform	30.5%
Transport Zone	19.2%
No Appreciable Drift	12.7%
Feeder Bluff - exceptional	10.3%
Feeder Bluff	9.2%
Feeder Bluff-talus	8.1%
Modified	10.0%

Table 3-7. Percent of each reach mapped as feeder bluff along the Strait of Juan de Fuca in Clallam County (data from CGS 2011)

Marine Reach	Reach Miles (approx)	Feeder Bluff Area as a Percent of Reach Length		
		Feeder Bluff - Exceptional	Feeder Bluff	Feeder Bluff - Talus
1– Diamond Point	12.5	14%	30%	0%
2 – Sequim Bay	8.2	0%	28%	0%
3 – Gibson Spit	6.1	28%	10%	0%
4 – Kulakala Point	7.9	0%	6%	0%
5 – Dungeness Spit	15.7	0%	0%	0%
6 – Green Point	10.4	63%	8%	0%
7 – Angeles Point	7.3	3%	22%	1%
8 – Observatory Point	4.9	0%	0%	0%
9 – Crescent Bay / Low Point	10.7	0%	4%	35%

Marine Reach	Reach Miles (approx)	Feeder Bluff Area as a Percent of Reach Length		
		Feeder Bluff - Exceptional	Feeder Bluff	Feeder Bluff - Talus
10 – Twin Rivers	7.4	7%	7%	68%
11 – Deep Creek	5.3	0%	0%	47%
12 – Pysht River	2.4	0%	0%	4%
13 – Pillar Point	2.1	0%	0%	63%
14 – Slip Point	6.8	0%	0%	0%
15 – Clallam Bay	5.7	0%	0%	0%
16 – Sekiu River /Kaydaka	3.6	0%	0%	14%
17 – Shipwreck Point	6.9	0%	0%	0%
18 – Rasmussen /Bullman Creek	4.6	0%	0%	0%

The presence of feeder bluffs is an important indicator of the value of the reach in terms of supporting nearshore processes and it also an indicator of the suitability of the shore for human development. The Washington Department of Natural resources has mapped a substantial portion of the Strait of Juan de Fuca shoreline as a landslide and / or erosion hazard area (Table 3-8, see Map 2 in Appendix A) suggesting that large segments of the marine shore are potentially dangerous places to live. Some of these areas are already partially developed with single family homes. Additional development in these erosion or landslide hazard areas could put more people at risk.

Table 3-8. Percent of each reach mapped as landslide and erosion hazard along the Strait of Juan de Fuca in Clallam County (data from WDNR 2007)

Marine Reach	Reach Miles (approx)	Landslide and Erosion Hazard Areas as Percent of Reach Length
1 – Diamond Point	12.5	62%
2 – Sequim Bay	8.2	11%
3 – Gibson Spit	6.1	5%

Marine Reach	Reach Miles (approx)	Landslide and Erosion Hazard Areas as Percent of Reach Length
4 – Kulakala Point	7.9	3%
5 – Dungeness Spit	15.7	7%
6 – Green Point	10.4	61%
7 – Angeles Point	7.3	26%
8 – Observatory Point	4.9	8%
9 – Crescent Bay / Low Point	10.7	54%
10 – Twin Rivers	7.4	68%
11 – Deep Creek	5.3	66%
12 – Pysht River	2.4	27%
13 – Pillar Point	2.1	96%
14 – Slip Point	6.8	90%
15 – Clallam Bay	5.7	27%
16 – Sekiu River /Kaydaka	3.6	67%
17 – Shipwreck Point	6.9	11%
18 – Rasmussen /Bullman Creek	4.6	37%

A majority of the landslide- and erosion-prone land is high bluff and not conducive to traditional forms of shoreline stabilization (such as concrete bulkheads). Bulkheads are sometimes used to reduce bluff toe erosion but that approach has not been widely used in Clallam County, as bluff toe armoring is generally ineffective in the high-energy Strait of Juan de Fuca shoreline environment. Overall, only about 8% of the marine shoreline in unincorporated Clallam County is armored (Figure 3-9, see Map 6 in Appendix A). Currently, very little of the armoring occurs in areas that are mapped as feeder buffs (Table 3-9), with the exception of some feeder bluff shorelines in Sequim Bay and the Gibson Spit vicinity. The few reaches that are more heavily armored tend to be low bank accretion shores or bays such as Sequim Bay and Clallam Bay. In those places, the armoring is typically intended to prevent waves from overtopping, reduce flooding, minimize storm damage, retain fill, support marina development and/or protect pier abutments, outfalls and transportation/utility infrastructure.
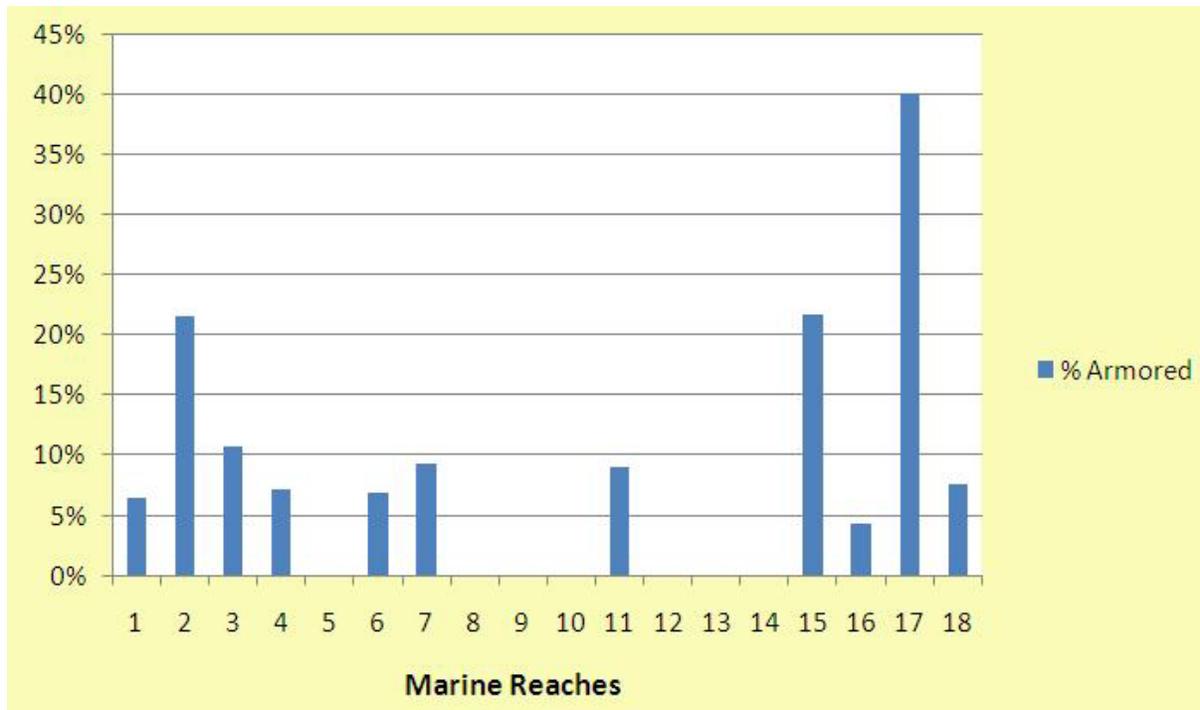
Figure 3-9. Percent of each reach with hard armoring along the Strait of Juan de Fuca in Clallam County (data from point PSNERP 2009, Battelle 2008)

Table 3-9. Reaches where armoring occurs at the base of mapped feeder bluffs along the Strait of Juan de Fuca in Clallam County

Reach ID	Length Feeder Bluff w/ Armor (Miles)	Total Feeder Bluff Length (Miles)	Reach Length (Miles)	Percent of Feeder Bluff that is Armored
2 – Sequim Bay	0.17	1.4	8.2	12.1%
3 – Gibson Spit	0.05	1.1	6.1	4.6%
Grand Total	0.22			

NOTE: Reaches 2 and 3 are the only reaches that have feeder bluffs with armoring

Minimizing, and in some cases prohibiting, new shoreline armoring is one of the ways that Clallam County can protect and maintain shoreline ecological functions. Bulkheads and other forms of hard shoreline armoring can have adverse effects on nearshore process, structure and function—and the effects can vary depending on where and how the bulkheads are constructed (MacDonald et al. 1994). On bluff backed beaches and low bank features (such as spits) armoring cuts off the sediment supply which can lead to beach starvation potential loss of fragile low bank features.

Regardless of where they are constructed, hard structures also tend to reflect wave energy back onto the beach, causing scour and coarsening of the beach over time as sand and gravel are washed way. This can lead to shifts in composition of beach fauna. Bulkheads also alter the movement of juvenile fish, moving them further offshore. Bulkhead installation weakens the linkage between the upland area and the marine environment, especially when riparian vegetation is removed. The loss of riparian vegetation reduces leaf litter and insect inputs to nearshore food webs, destabilizes shorelines and causes desiccation of intertidal habitat. Bulkheads can also displace or eliminate habitat for a number of important species such as rock sole and surf smelt (Table 3-10) (Williams and Thom 2001). Often the effect of building a bulkhead is not just confined to the footprint of the structure, but extends down-drift affecting adjacent properties within the drift cell (Johannessen and MacLennan 2007; Shipman et al. 2010; Williams and Thom 2001). The impacts can be cumulative, particularly as they affect net shore-drift sediment supplies and beach substrate.

Table 3-10. Effects of hard armoring on some marine species (from Thom et al. 1994)

Resource Species	Armoring Effects [a]						
	Armoring-related Habitat Shift	Loss of Spawning Habitat	Loss of Shoreline Riparian Vegetation	Loss of Wetland Vegetation	Loss of Large Organic Debris	Changes in Food Resources	Loss of Migratory Corridors
Surf Smelt	●	●	●		⊕		
Pacific Sand Lance	●	●	●		⊕		
Rock Sole	●	●	●		⊕		
Juvenile Salmonids	●		●	●	●	●	●
Pacific Herring	⊕	⊕					
Hardshell Clams	●	⊕				●	
Geoduck	○						
Oysters	○	○				○	
Dungeness Crab	⊕	⊕				⊕	
Sea Cucumber	○					○	
Sea Urchins	○					○	

[a] Filled circles represent well documented evidence of negative effects, cross-filled circles represent high potential for negative effects but not documented, and open circles indicate some potential for longterm effects but not documented.

The same factors that make much of the marine shoreline prone to erosion and landslides (namely wind and wave exposure) also make it largely unsuitable for moorage (such as docks, piers and marinas) and other types of overwater structures (OWS). Overwater structures can have a number of adverse effects on marine shore functions (Williams and Thom 2001). For example, structures alter wave energy and sediment transport dynamics, changing substrate size and stability, which in turn can affect benthic animal communities and forage fish spawning. The close placement of pilings can diminish wave energy, causing finer sediments to fall out of suspension where they normally would remain in transport. Reduced wave energy associated

with pilings can also prevent transport of larger sediments that require higher wave energy for transport. Overwater structures also reduce light levels, which affects photosynthesis and therefore growth and reproduction of phytoplankton and submerged aquatic vegetation such as eelgrass. Fish migrating along the shoreline alter their behavior when they encounter docks, sometimes dispersing or changing direction (Nightingale and Simenstad 2001).

There are relatively few overwater structures along the Strait and most occur in bays and other sheltered areas (Figure 3-10, see Map 6 in Appendix A). Because the majority of these structures are not in sediment transport zones, they generally do not have a major effect on net shore-drift (Table 3-11). On the other hand, these structures create shade that can limit or reduce the suitability of aquatic areas for eelgrass and kelp. Minimizing the number and extent of overwater structures in transport zones and in areas that support submerged aquatic vegetation will help ensure no net loss of ecological functions.
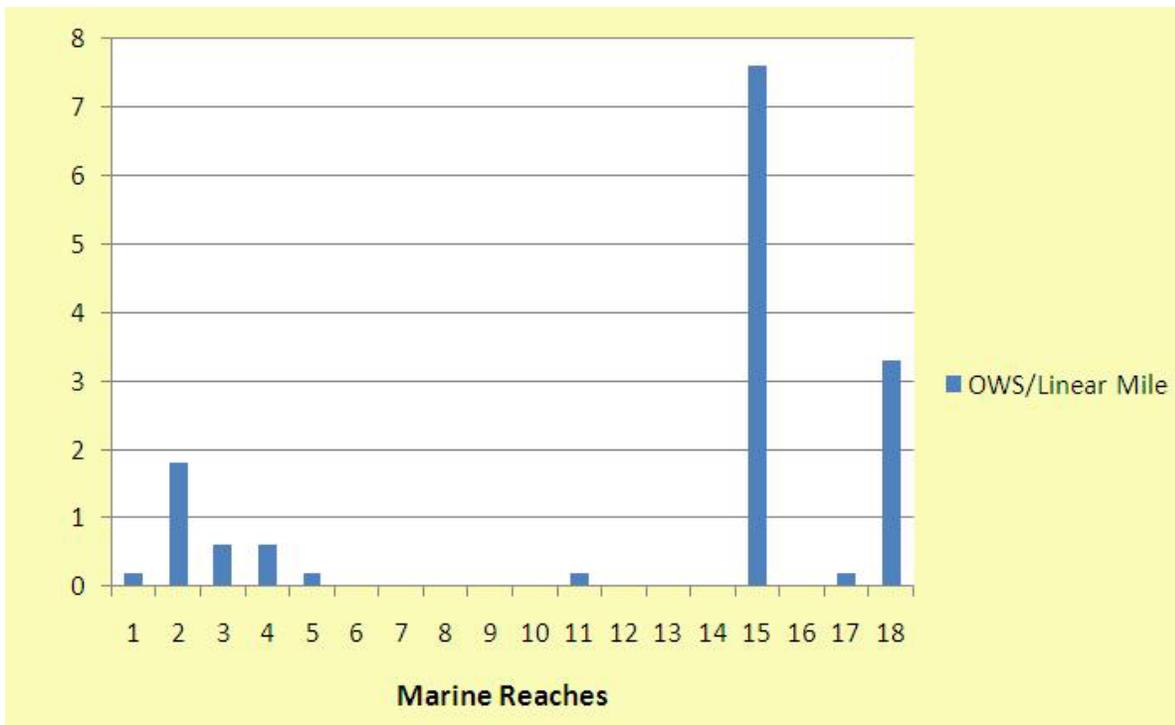

Figure 3-10. Number of overwater structures per mile of reach along the Strait of Juan de Fuca in Clallam County (data from PSNERP 2009)

Table 3-11. Reaches where overwater structures occur within sediment transport zones along the Strait of Juan de Fuca in Clallam County (data from PSNERP 2009 and CGS 2011)

Marine Reach	# OWS	Total Miles of Transport Zone	# OWS/ Miles of Transport Zone
1 – Diamond Point	2	9.2	0.2
2 – Sequim Bay	15	6.2	2.4
3 – Gibson Spit	4	3.5	1.1
4 – Kulakala Point	4	6.6	0.6
5 – Dungeness Spit	2	12.1	0.2
6 – Green Point	0	9.7	0
7 – Angeles Point	0	6.3	0
8 – Observatory Point	0	0	0
9 – Crescent Bay / Low Point	0	9	0
10 – Twin Rivers	0	6.8	0
11 – Deep Creek	1	4.7	0.2
12 – Pysht River	0	2	0
13 – Pillar Point	0	0.6	0
14 – Slip Point	0	0	0
15 – Clallam Bay	16	2.1	7.6
16 – Sekiu River /Kaydaka	0	2.5	0
17 – Shipwreck Point	1	4.9	0.2
18 – Rasmussen /Bullman Creek	3	0.9	3.3

The relative lack of shoreline armoring and overwater structures on the Strait of Juan de Fuca indicates that the Strait has likely retained its value and function for many of the aquatic organisms that rely on healthy nearshore systems. Overstory kelp (e.g., bull kelp) and eelgrass

are among the most important plant species in the nearshore as they serve as underwater meadows and forests for aquatic organisms (These aquatic plants are relatively abundant along the Strait occurring as continuous communities or in patches in places such as Freshwater Bay, Dungeness Bay, Crescent Bay and some areas just west of the Twin Rivers (WDNR 2007, Marine Resources Consultants 2006, Shaffer 1991). Table 3-12 shows the abundance of kelp within each reach (see Map 3 in Appendix A).

Table 3-12. Kelp abundance per mile of reach along the Strait of Juan de Fuca in Clallam County (data from WDNR 2004)

| Marine Reach	Acres of Kelp	Total Aquatic Area of Reach (acres)	Percent
1 – Diamond Point	92	1295	7%
2 – Sequim Bay	0	843	0%
3 – Gibson Spit	0	577	0%
4 – Kulakala Point	5	845	1%
5 – Dungeness Spit	234	1622	14%
6 – Green Point	492	1336	37%
7 – Angeles Point	507	833	61%
8 – Observatory Point	237	524	45%
9 – Crescent Bay / Low Point	467	1113	42%
10 – Twin Rivers	451	860	53%
11 – Deep Creek	219	590	37%
12 – Pysht River	1	239	0%
13 – Pillar Point	141	261	54%
14 – Slip Point	461	809	57%
15 – Clallam Bay	222	390	57%
16 – Sekiu River /Kaydaka	290	454	64%
17 – Shipwreck Point	444	737	60%
18 – Rasmussen /Bullman Creek	435	546	80%

Kelp and eelgrass species occur primarily in the shallow subtidal areas, although some plants can be found low on the shore (Figure 3-11). Kelp prefer hard substrate in shallow water and can grow where pilings and other artificial surfaces exist (Mumford 2007). Eelgrass thrives in softer substrates (such as mud to clean sand) and can grow from the mid to upper intertidal zone down to the shallow subtidal area to the depth of light penetration. Humans use kelp as a source of micronutrients and as a stabilizing agent in foods, paints and inks (Mumford 2007).

Figure 3-11. Kelp on Bullman Beach (Photo by A. MacLennan)

Kelp and eelgrass are vulnerable to physical disturbance (from boat propellers for example), toxins and other stressors. Overwater structures such as piers, docks and moored boats (such as at marinas) can reduce amount of light available to theses plants (Nightingale and Simenstad 2001; Williams and Thom 2001). Plants can also be stressed from changes in salinity, temperature and / or oxygen levels. Sedimentation from upland runoff can cause smothering and light blockage (Mumford 2007).

The Eelgrass Meadow — A World of Microhabitats
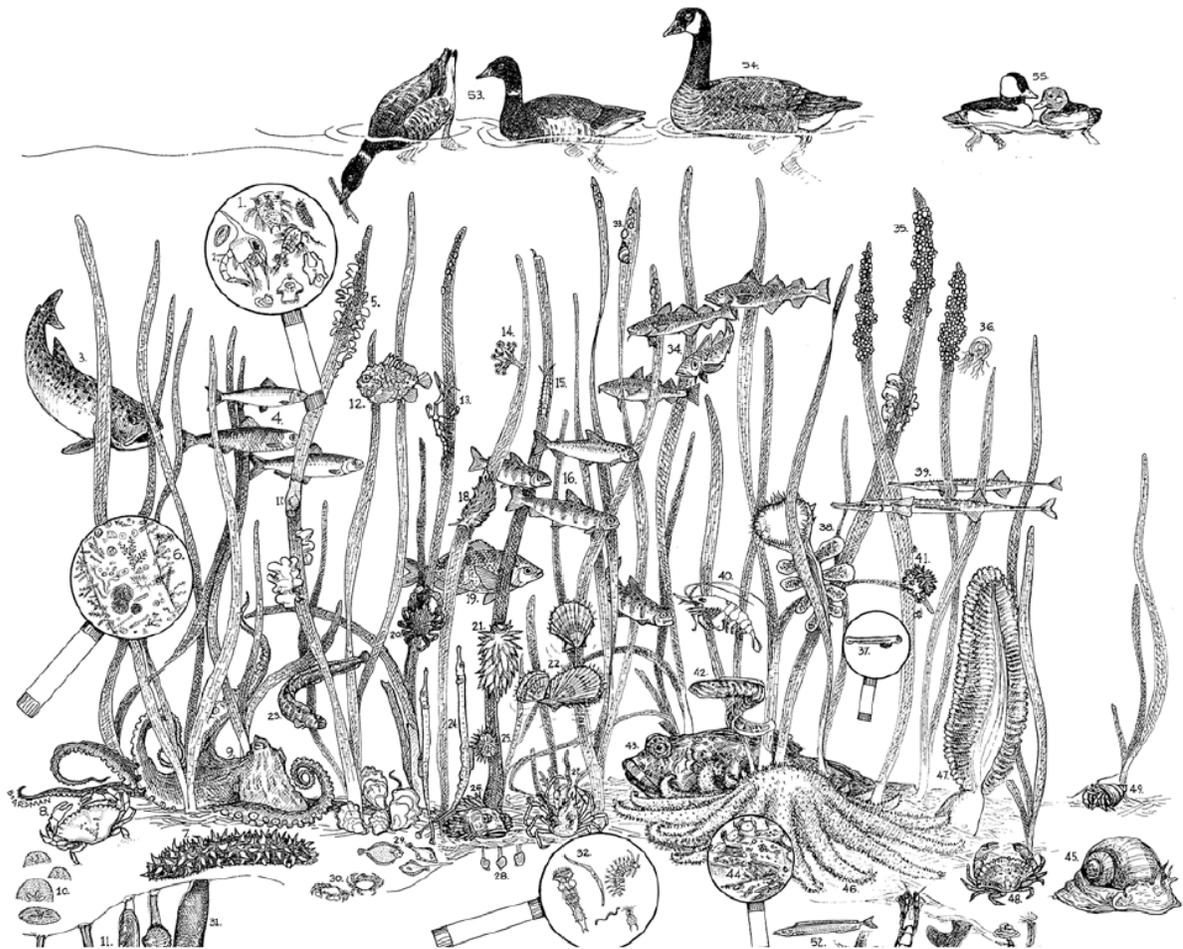
1. Zooplankton	14. Stalked jellyfish	29. Juvenile flounder And sole	41. Brooding anemone
2. Larval crab	15. Eelgrass isopod	30. Juvenile crab	42. Prickleback
3. Salmon	16. Juvenile salmon	31. Geoduck	43. Sculpin
4. Herring	17. Bubble shell	32. Sediment microfauna	44. Bacteria on detritus
5. Epiphytic macroalgae	18. Opalescent nudibranch	33. Snail and snail eggs	45. Moonsnail
6. Epiphytic microalgae, Hydozoa, and bryozoa	19. Perch	34. Juvenile cod, tomcod And wall-eyed pollock	46. Sunflower seastar
7. Sea cucumber	20. Juvenile kelp crab	35. Herring eggs	47. Sea pen
8. Dungeness crab	21. Alabaster nudibranch	36. Jellyfish	48. Red rock crab
9. Octopus	22. Scallop	37. Larval fish	49. Hermit crab
10. Sand dollars	23. Gunnel	38. Melibae-hooded nudibranch	50. Worms
11. Clams and cockles	24. Bay pipefish	39. Tubesnout	51. Ghost shrimp
12. Pacific spiny Lumpsucker	25. Sea urchin	40. Shrimp	52. Sand lance
13. Caprellid amphipod	26. Juvenile sculpin		53. Black Brant
	27. Decorator crab		54. Canada Goose
	28. Juvenile clams		55. Bufflehead

Figure 3-12. Illustration of the importance of eelgrass meadows as microhabitat for numerous species (from Port Townsend Marine Science Center; used with permission)

Healthy, sustainable marine ecosystems require well established riparian vegetation in addition to productive aquatic plant communities (Figure 3-13). There is a growing body of evidence to suggest that marine riparian systems play a key role in supporting marine biota and the integrity of the nearshore environment (Brennan and Culverwell 2004; Desbonnet et al. 1994). Some of the key functions provided by marine riparian vegetation include: soil and slope stability, sediment control, wildlife habitat (for example perching, nesting, cover and breeding for various species), water quality enhancement, nutrient and prey input from overhanging vegetation, shade to control temperature on beach spawning substrates; and large woody debris input (which provides roosting, nesting, foraging, spawning and attachment substrate for invertebrates and plants. Woody debris can also serve to stabilize beaches and backshore areas (Penttila 2000; Brennan et al. 2009).

Figure 3-13. Healthy stands of marine riparian vegetation, such as this area just east of Green Point, perform important functions related to wildlife habitat, water quality, slope stability and food web support (photo: Ecology)

To help inform effective management of riparian vegetation in Clallam County, the Point No Point Treaty Council conducted a detailed assessment of riparian cover along Clallam County's marine and freshwater shorelines, mapping vegetation composition/ canopy cover within 200 feet of the ordinary high water line of the marine shoreline (Figure 3-14). Some reaches (mostly in western Clallam County where commercial forestry is the dominant land use) are almost totally forested, while other reaches (between Sequim and Port Angeles, for example) lack well developed marine riparian communities. Because vegetation plays such an essential role in performing so many ecological functions, maintenance of forest cover and revegetating areas that have lost forest cover should be important goals of the SMP update.
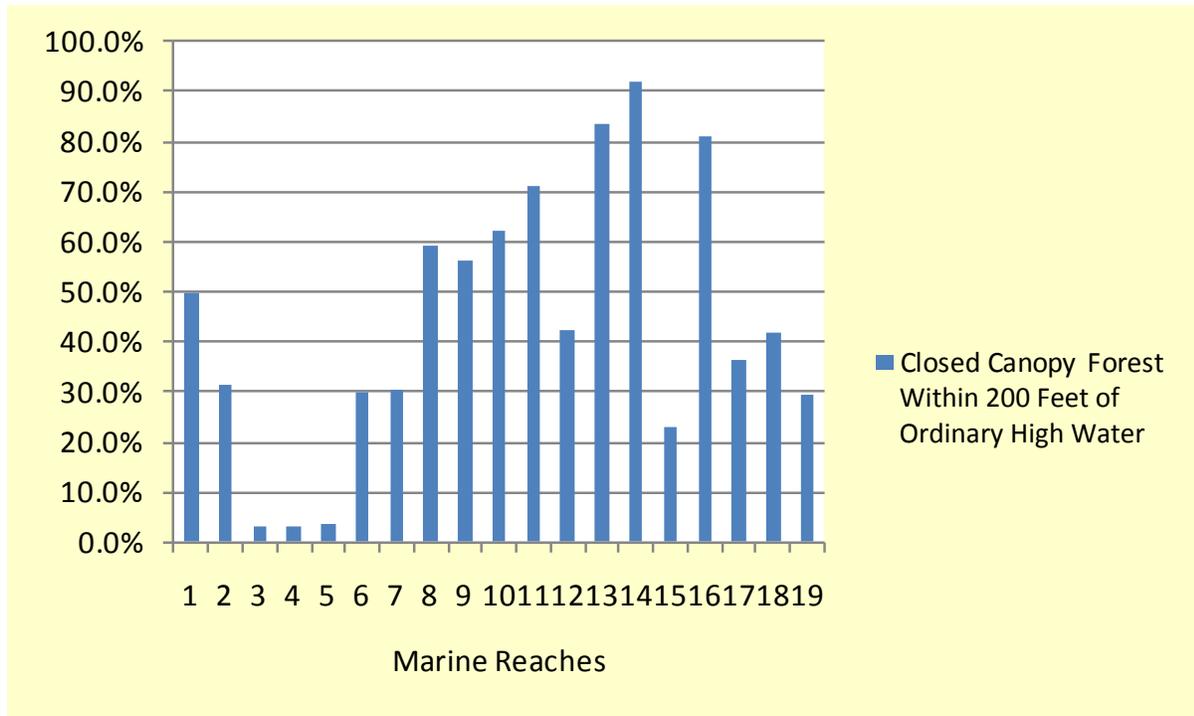
Figure 3-14. Percent of each marine reach with closed canopy forest cover along the Strait of Juan de Fuca in Clallam County (data from Point No Point Treaty Council 2011)

3.2.2 Potential Effects of Future Development and Baseline Conditions

This section describes some of the ways that future development could impact the baseline conditions. This analysis builds of the land use assessment presented in Chapter 2 and considers effects of future buildout on three specific attributes: forest cover, feeder bluffs and the suitability of Clallam County beaches for forage fish spawning.

In most cases, development of vacant or undeveloped lands requires some clearing of vegetation. The effects of the clearing activity are typically most pronounced when the vegetation being cleared is closed canopy or mature forest within 200 feet or less of the ordinary high water line. Some reaches of the Clallam County marine shore (mainly west of Twin Rivers) could experience substantial loss of forest cover because there are extensive areas of developable land with closed canopy forest (Table 3-13). Limits on vegetation clearing in affected areas could help to minimize loss of ecological functions.

Table 3-13. Developable Lands (Vacant Parcels) that have Closed Canopy Forest along the Strait of Juan de Fuca in Clallam County

Marine Reach	Vacant Parcel Area with Closed Canopy Forest (Acres)	Total Reach Area (land only)	Percent of Reach Area
1– Diamond Point	25.9	268.2	9.7%
2 – Sequim Bay	24.5	254.8	9.6%

Marine Reach	Vacant Parcel Area with Closed Canopy Forest (Acres)	Total Reach Area (land only)	Percent of Reach Area
3 – Gibson Spit	16.0	616.7	2.6%
4 – Kulakala Point	20.5	920.1	2.2%
5 – Dungeness Spit	4.2	248.8	1.7%
6 – Green Point	26.2	280.1	9.3%
7 – Angeles Point	53.7	322.1	16.7%
8 – Observatory Point	4.3	107.3	4.0%
9 – Crescent Bay / Low Point	50.0	252.7	19.8%
10 – Twin Rivers	69.4	175.0	39.7%
11 – Deep Creek	87.1	127.4	68.4%
12 – Pysht River	21.5	65.7	32.7%
13 – Pillar Point	25.8	48.6	53.0%
14 – Slip Point	132.6	154.7	85.7%
15 – Clallam Bay	5.4	96.1	5.6%
16 – Sekiu River /Kaydaka	51.0	93.4	54.6%
17 – Shipwreck Point	24.4	156.9	15.5%
18 – Rasmussen /Bullman Creek	42.3	119.2	35.5%
Grand Total	684.9		

The potential for new development to occur on or adjacent to feeder bluffs varies per reach. (Table 3-14, see Maps 1 & 5 in Appendix A). Reaches where there are a substantial number of vacant lots on or adjacent to feeder bluffs are Gibson Spit, Green Point, Twin Rivers, Deep Creek and Pillar Point. To minimize loss of shoreline ecological functions, development in and around these lots should be designed so as not to interfere with normal bluff erosion process. Also, given that these same areas are also prone to erosion and landslides, limits on new development would also have benefits to human health and safety.

Table 3-14. Length and Percent of Developable Lands (Vacant Parcels) that also have Feeder Bluffs along the Strait of Juan de Fuca in Clallam County

Marine Reach ID	Length of Feeder Bluff along Vacant Parcels (Miles)	Total Reach Length (Miles)	% of Reach with Feeder Bluffs along Vacant Parcels
1– Diamond Point	1.0	12.5	8.2%
2 – Sequim Bay	0.2	8.2	2.4%
3 – Gibson Spit	0.7	6.1	11.5%
4 – Kulakala Point	0.0	7.9	0.3%
5 – Dungeness Spit	0.0	15.7	0.0%
6 – Green Point	2.1	11.4	18.5%
7 – Angeles Point	0.8	7.3	10.6%
8 – Observatory Point	0.0	4.9	0.0%
9 – Crescent Bay / Low Point	0.8	10.7	7.8%
10 – Twin Rivers	2.7	7.4	36.0%
11 – Deep Creek	0.7	5.3	14.1%
12 – Pysht River	0.0	2.4	1.9%
13 – Pillar Point	0.3	2.1	14.0%
14 – Slip Point	0.0	6.8	0.0%
15 – Clallam Bay	0.0	5.7	0.0%
16 – Sekiu River /Kaydaka	0.2	3.6	6.6%
17 – Shipwreck Point	0.0	6.9	0.0%
18 – Rasmussen /Bullman Creek	0.0	4.6	0.0%
Grand Total	**9.8**	**131.3**	**7.4%**

The potential that development of vacant lots will impact beaches that provide suitable forage fish spawning habitat varies by reach (Table 3-15, see Maps 3 & 5 in Appendix A). The risks to forage fish spawning potential are greatest near Diamond Point, Gibson Spit, Dungeness Spit, Angeles Point and most areas west of the Twin Rivers. In these areas special care should be given to minimize construction of new bulkheads and maintain riparian vegetation to ensure forage fish functions.

Table 3-15. Length and Percent of Developable Lands (Vacant Parcels) in areas that provide suitable forage fish spawning habitat along the Strait of Juan de Fuca in Clallam County

Marine Reach	Forage Fish Suitability Class (data from Anchor Environmental and Marine Resources Committee 2002)					
	Very Low	Low	Moderate	High	Very High	Grand Total
1– Diamond Point	0.0%	1.4%	0.0%	11.2%	6.6%	19.2%
2 – Sequim Bay	0.0%	0.0%	0.0%	8.9%	1.0%	10.0%
3 – Gibson Spit	0.0%	0.8%	3.1%	14.2%	16.5%	34.6%
4 – Kulakala Point	0.0%	0.0%	10.7%	0.3%	0.0%	10.9%
5 – Dungeness Spit	0.0%	6.6%	2.4%	9.4%	22.9%	41.2%
6 – Green Point	0.0%	1.8%	11.1%	0.0%	0.2%	13.0%
7 – Angeles Point	0.0%	7.2%	13.3%	11.2%	0.0%	31.6%
8 – Observatory Point	0.0%	0.0%	1.9%	0.0%	0.0%	1.9%
9 – Crescent Bay / Low Point	0.0%	3.8%	7.2%	5.0%	0.0%	16.0%
10 – Twin Rivers	0.0%	0.0%	0.0%	23.0%	0.0%	23.0%
11 – Deep Creek	3.8%	0.0%	20.5%	9.4%	0.0%	33.7%
12 – Pysht River	0.0%	0.0%	30.4%	0.0%	0.0%	30.4%
13 – Pillar Point	0.0%	0.0%	25.2%	0.0%	0.0%	25.2%
14 – Slip Point	0.0%	0.0%	70.9%	0.0%	0.0%	70.9%
15 – Clallam Bay	7.3%	10.4%	20.7%	0.0%	0.0%	38.5%
16 – Sekiu River /Kaydaka	4.0%	56.4%	0.7%	0.0%	0.0%	61.1%
17 – Shipwreck Point	0.0%	25.6%	12.2%	0.0%	0.0%	37.8%
18 – Rasmussen /Bullman Creek	7.0%	5.2%	57.9%	0.0%	0.0%	70.1%

3.3 *Summary of Baseline Conditions and Initial Management Considerations for the Strait of Juan de Fuca Marine Shore*

The Strait of Juan de Fuca is an important transport zone for the entire Puget Sound region. People use the marine corridor along Clallam County for commercial and recreational ship traffic and the Strait is a transport zone for sediment, salt and freshwater and migrating species of fish and wildlife, including Endangered Species Act-listed stocks of Chinook salmon.

The baseline analysis of the marine shorelines in Clallam County indicates that the Strait of Juan de Fuca is in relatively good condition compared to other portions of Puget Sound, but there are local pockets of degradation and shoreline modification that provide opportunities for restoration, clean-up and other forms of stewardship. Several river mouths along the Strait shoreline have been modified by roads, levees and structures and many of these have been are slated for restoration. Kelp forests and eelgrass meadows are prevalent along the Strait, serving as feeding and rearing areas for many resident and migratory species. Shoreline riparian vegetation is fairly intact in the forested areas west of Port Angeles, but bluff and low bank areas near the east end of the County have been cleared and are more developed. Bald eagles use a substantial percentage of the land along the Strait as foraging, perching and nesting habitat.

Physically, the shorelines along the Strait are on the move as feeder bluffs are continually eroding to form beaches and sustain sand spits. Outside of incorporated cities, only a small percentage of Clallam County marine shoreline is armored and most of the armoring that is present does not directly impede sediment delivery from feeder bluffs. Only 12.7% percent of the Strait of Juan de Fuca shorelines in Clallam County have no appreciable amount of net shore-drift because they are composed of erosion resistant rock or are located in sheltered bays. Relatively few overwater structures are located in Clallam County, but they are generally concentrated in sheltered bays and the cumulative effects on shading and forage fish spawning will need to be considered in shoreline management strategies.

3.3.1 Key Management Considerations

The issues that appear to be the most pertinent for Clallam County to consider along the Strait of Juan de Fuca include residential use (particularly in the east end of the County) and shoreline vegetation management. Commercial forestry is the second most dominant land use, especially on the western reaches; however, forest practices are generally not regulated by the Shoreline Management Act. Unincorporated portions of Clallam County marine shorelines have little commercial, industrial, or port use and these uses are not included in the key management considerations.

These findings are presented as general considerations that will require further exploration and discussion with stakeholders including citizens, shoreline property owners, County staff, elected officials, neighboring jurisdictions and the Department of Ecology. This is not an exhaustive list of issues and it is not intended to limit the focus of the SMP update as there are other issues including other types of uses or modifications that the State shoreline guidelines require to be addressed.

1. New residential development in and around feeder bluffs, landslide hazard areas and erosion hazard areas

    - Protect natural sediment processes and maintain human health and safety by ensuring that new structures are set back an adequate distance from feeder bluffs and other erosion or landslide-prone areas. Setback considerations should take into account the life of the structure (generally defined as 100 years), expected erosion for that duration and effects on neighboring or down-drift properties. Setting structures back from the shoreline can also reduce the need (and associated cost) of future, potential shoreline stabilization measures along eroding shorelines.

- Avoid the acceleration of erosion processes in and near erosion/ landslide -prone areas by preserving forest cover along marine shorelines. Limitations on the removal of forest cover also help maintain shoreline habitat for many wildlife species and the formation of nearshore habitat for aquatic species. The management of forest cover along shorelines also necessitates consideration of connectivity to adjacent upland forests for birds and other species that move between terrestrial and marine environments.

- Reduce risk factors that can cause slope instability by designing and managing runoff from new developments in ways that minimize soil saturation.

- Provide incentives and flexible regulatory/permitting procedures to allow relocation of existing homes in rapidly eroding or other potential dangerous areas to safer areas of the property.

2. New residential development on low bank accretion shores:

- Set structures back from the shoreline to decrease the potential risks of coastal flooding and tsunami damage and minimize the need (and associated landowner costs) for hard shoreline armoring. Effects of armoring on down-drift properties should be fully evaluated before new bulkheads are allowed to prevent impacts to neighbors and shoreline processes.

- Locate and design new shore stabilization to avoid impacts on forage fish spawning habitats.

- Use "soft armoring" techniques to protect existing structures. These generally have less negative impact to shoreline processes, forage fish spawning and salmon rearing habitat than traditional "hard armoring" methods (such as rock/concrete bulkheads).

- Protect embayment and lagoon habitats from further encroachment by development. These areas provide habitat for a diversity of species and perform flood storage and water quality functions. Compared to some shoreforms, lagoons and coastal embayments have been disproportionally affected by shoreline development throughout the Puget Sound / Strait of Juan de Fuca system so protection of the remaining areas is a high priority for regional resource managers.

- Location, design and operation of residential septic systems remains an ongoing challenge so as not to degrade water quality or cause the closure of shellfish beds for recreational and commercial harvest.

3. New in-water and overwater structures such as docks, piers, marinas (marine shorelines):

- Limit of the proliferation of new in-water or overwater structures (such as docks) to prevent impacts on submerged aquatic vegetation, sediment transport and aquatic fish species. Where structures are allowed, the number, design and location should incorporate considerations of sediment transport zones, shading of aquatic vegetation and the effect on spawning habitat for forage fish species.

- Public access should be located, designed and managed to avoid sensitive habitats such as forage fish spawning beaches or areas that could be unsafe due to slope instability or other factors.