FINAL

SHORELINE INVENTORY AND CHARACTERIZATION REPORT

for Portions of Clallam County Draining to the Strait of Juan de Fuca

Clallam County Shoreline Master Program Update

Ecology Grant No. G1000062

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1. BACKGROUND AND PURPOSE OF THE REPORT

Clallam County is undergoing a comprehensive update of its shoreline master program (SMP) in 2011-12 to improve protection of the shoreline environments and ensure their continued use and enjoyment. The County adopted its first SMP in 1976 and has not undertaken a comprehensive review of the program in more than 35 years. The update is also required by the Shoreline Management Act (SMA) of 1971 and the implementing rules known as the shoreline guidelines[1].

One of the first steps in the SMP update process is to inventory and characterize shoreline conditions (Figure 1-1). This involves assessing the lakes, rivers and marine waters that are classified as "shorelines of the state" and their adjoining "shorelands" and characterizing the broader landscape surrounding these lands and waters. The Inventory and Characterization Report (ICR) must be based on the most current, accurate, and complete scientific and technical information available that is applicable to the issues of concern. The ICR serves multiple purposes, such as:

- Identify shoreline resources and areas that provide value to County residents, recreationists, property owners, businesses and other stakeholders to ensure they are managed appropriately according to the goals of the SMA;
- Assess and document current shoreline conditions to establish a baseline against which future conditions can be compared;
- Provide a basis of information to assign of Shoreline Environment Designations (which is one of the next tasks in the update process), and;
- Present information for future SMP policy and regulatory decisions related to shoreline use and development, shoreline ecology, and public access.

A team of consultants[2] prepared this ICR at the request of the County, using grant funds provided by the Washington Department of Ecology (Ecology). This report also presents initial information to support the County's assessment of "no net loss," which is funded by a grant from the Environmental Protection Agency (EPA).

A draft ICR was submitted for public review in December 2011. This final ICR incorporates and reflects the input obtained during the public review.

[1] Revised Code of Washington (RCW) 90.58 and Washington Administrative Code (WAC) 173-26, Part III.

[2] ESA is the lead consultant for the SMP update with support from Coastal Geologic Services, Kramer Consulting, Carol Macilroy Consulting, and Ann Seiter Technical Writing and Editing.

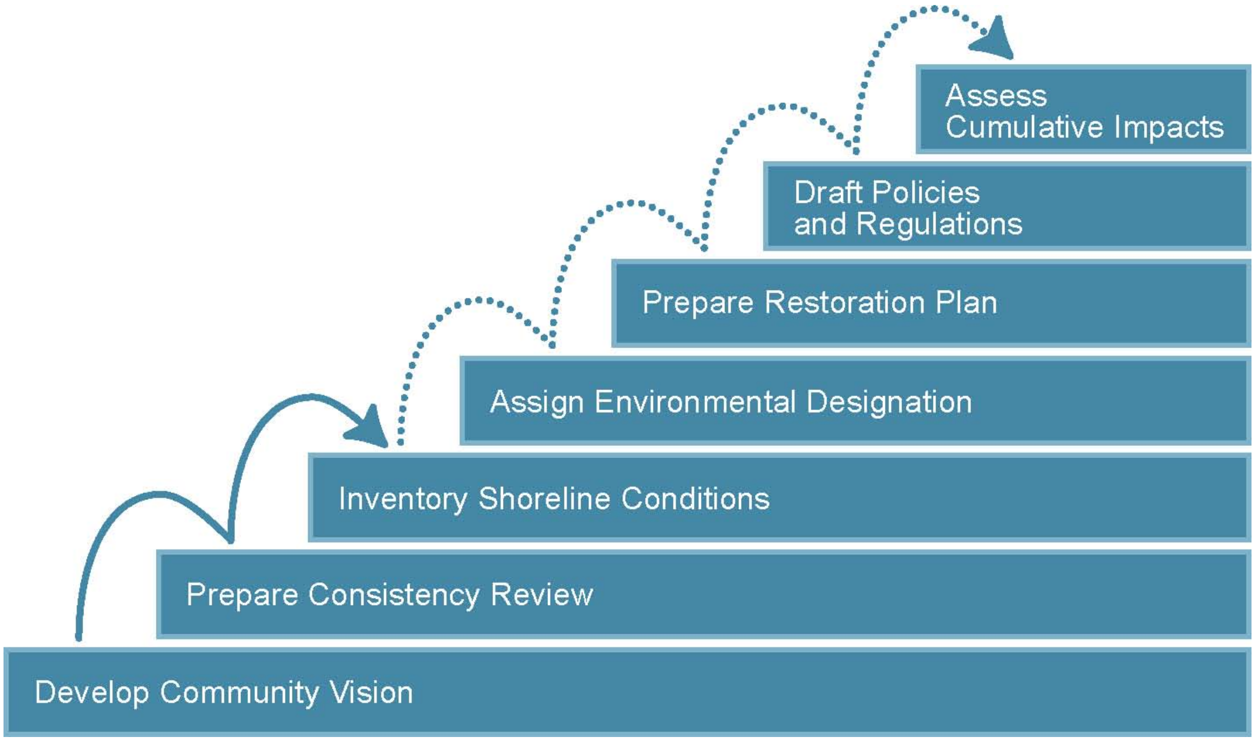


Figure 1-1. Steps in the shoreline master program update process; the public will have opportunities to review and comment on each of the technical products shown here.

Unless stated otherwise, the information presented in this report is limited to that portion of Water Resource Inventory Areas (WRIAs) 17, 18 and 19 within unincorporated Clallam County that drain to the Strait of Juan de Fuca. The emphasis is on portions of the study area that area subject to the Shoreline Management Act (see box). In general is a relatively narrow zone of land and water associated with designated shorelines of the state.

The shorelines within the municipal limits of the cities of Port Angeles and Sequim are not included in this analysis as these shores are under the management of the respective cities. Lands owned by the Jamestown S'Klallam Tribe and Lower Elwha Klallam Tribe are included in the inventory even though tribal lands are not subject to Shoreline Management Act jurisdiction. The Makah Reservation is not included in the inventory because it is geographically fairly isolated.

Shoreline Jurisdiction – Definitions and Terminology

The County's SMP governs all non-federal and non-tribal shorelines of the state as defined in RCW 90.58.030, including shorelines and shorelines of statewide significance.

Shorelines are rivers and streams (or segments thereof) with a mean annual flow of 20 cubic feet per second (cfs) or more, lakes greater than 20 acres, and marine waters between the ordinary high water line and extreme low tide, together with their underlying lands and associated shorelands.

Shorelines of Statewide Significance include rivers with mean annual flow of 1,000 cfs or more; lakes 1,000 acres or larger; and marine waters seaward of extreme low tide.

Shorelands refers to the lands extending landward for 200 feet in all directions from the ordinary high water line; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all associated wetlands and river deltas. Shorelands can include critical areas that occur within shoreline jurisdiction and their buffers.

The shoreline water bodies described in this report include: Dungeness River, McDonald Creek, Morse Creek, Elwha River, Salt Creek, Lyre River/Boundary Creek, Indian Creek/Little River, East Twin River, West Twin River, Deep Creek, Pysht River, Clallam River, Little Hoko River, Hoko River, Sekiu River (and North and South Forks), Bullman Creek; Lake Sutherland; and the Strait of Juan de Fuca. The Strait of Juan de Fuca and the Elwha River are also Shorelines of Statewide Significance.

For information concerning shorelines in WRIA 20 refer to **http://www.clallam.net/RealEstate/html/shoreline_management.htm**

As shown in Figure 1-2, portions of Clallam County that drain to the Pacific Coast (WRIA 20) are addressed in a separate inventory and characterization report being prepared by the Olympic Natural Resources Center (ORNC)[3] for Clallam County.

[3] Access the ONRC website at: http://www.onrc.washington.edu/

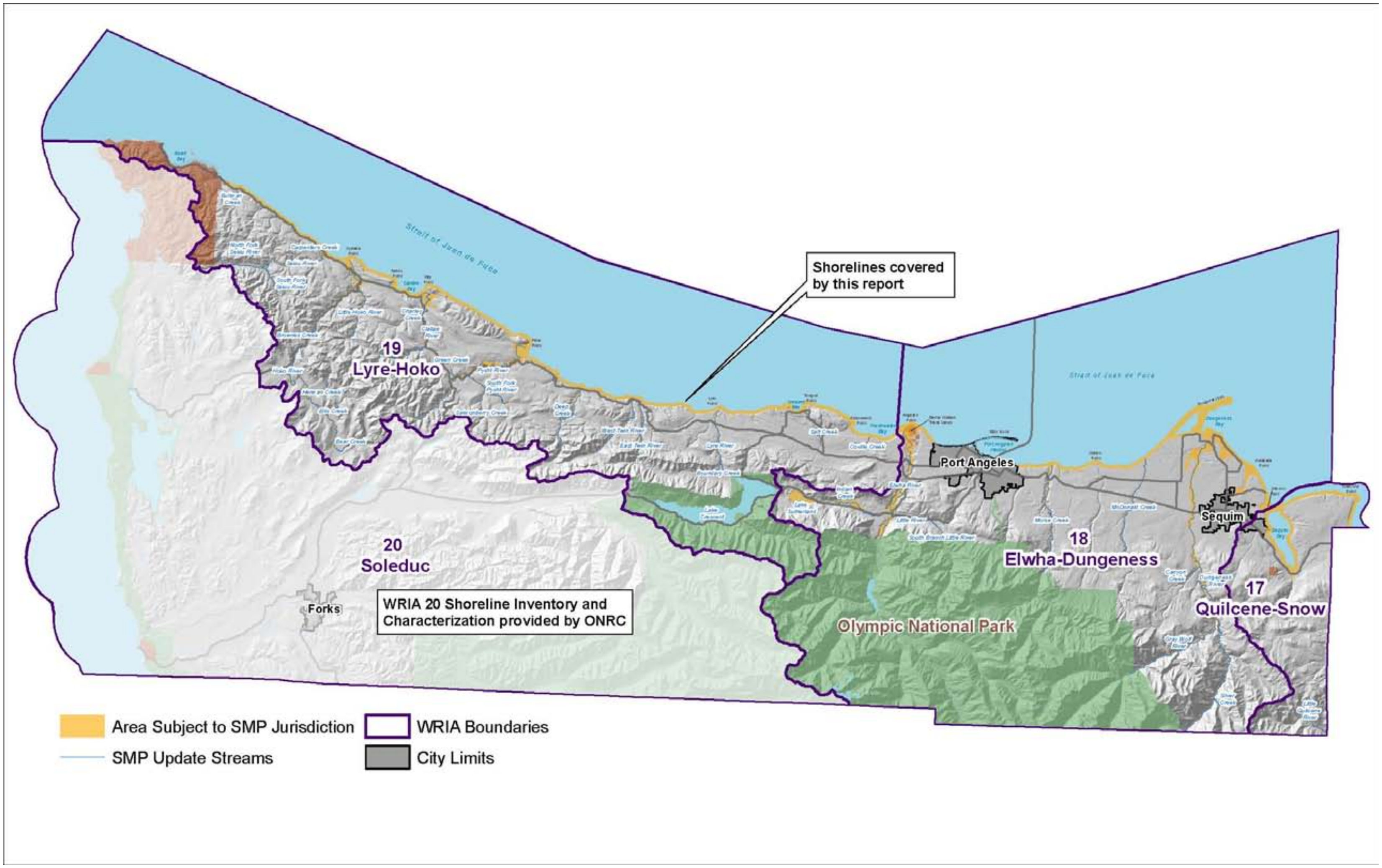


Figure 1-2. Clallam County Shorelines of the State in WRIAs 17, 18 and 19 (purple outline shows the areas covered by this report)

The ICR is one of several sources of information the County will consider in deciding which, if any, shoreline master program policies or regulations need to change. Other sources of information that contribute to the SMP update include the County's Consistency Review report (ESA 2011), public comment and testimony (gathered in accordance with the Public Participation Plan), review of other regulatory plans and programs, and comments from the Department of Ecology. State law requires that Ecology review and approve the updated SMP before it takes effect.

The County and consultant team are working on a separate shoreline restoration plan that will identify and describe restoration needs and opportunities. That report will be issued for public review and comment in March 2012.

1.1 *Report Organization*

The SMP guidelines require a description of existing data, shoreline conditions, and development patterns (inventory), as well as a characterization of the ecological processes and functions of the shoreline and management considerations. The information presented here for the north coast of Clallam County is generally divided geographically, from east to west (Figure 1-2), and is divided into separate "reaches" or segments of marine and freshwater shorelines. **For each reach, a summary sheet illustrating the key inventory features provides an 'at-a-glance' reference to accompany the characterization text**. These "reach sheets" supplement the text—a *Reach Sheet Explainer* is provided to explain the information and data sources used to create both the marine and freshwater reach sheets. Information on cultural/archeological/historic resources will be provided in the final report.

Chapter 2 provides an overview the North Olympic Coast study area describing population, existing land use and zoning. The chapter also examines the future development potential of the lands under the jurisdiction of the County's shoreline master program.

Chapter 3 contains an overview of the marine shoreline processes pertinent to the Strait of Juan de Fuca in Clallam County. This chapter describes physical shore types, feeder bluffs, landslide/erosion hazards and provides a summary of baseline conditions according to specific indicators of ecological function. Potential implications of future development on marine shoreline conditions are also described. Initial shoreline management considerations are summarized in this chapter.

Chapter 4 contains detailed reach-by-reach descriptions of the 18 marine shoreline segments, with baseline conditions, future land use potential, and management issues and opportunities specific to that reach. At the end of this chapter are the "reach sheets" describing each marine reach.

Chapter 5 is overview of the freshwater processes pertinent to WRIAs 17, 18 and 19 in Clallam County. This chapter provides a summary of baseline conditions according to specific indicators of ecological function. Potential implications of future development on freshwater shoreline conditions are also described. Initial shoreline management considerations are summarized in this chapter.

Chapter 6 contains detailed reach-by-reach descriptions of the freshwater shoreline segments with baseline conditions, future land use potential, and management issues and opportunities specific to that reach. “Reach sheets” for Lake Sutherland and each river and stream are included at the end of Chapter 6.

Chapter 7 summarizes the relationship between the shoreline master program and other land use / regulatory plans and programs**.**

Chapter 8 is a list of the references used to prepare this report.

Abbreviations and terms are explained in the **Glossary and Abbreviations** section. **Maps** depicting important information referenced in the text are provided in Appendices A and B (Table 1-1).

Table 1-1. Clallam County Shoreline Inventory Map Themes and Numbers

Map Theme*	Content	Region of the County		
		East	Central	West
Physical Characteristics	• Feeder bluffs • Drift cells • Shoreform types • Stream confinement	1a	1b	1c
Hazard Areas**	• Shoreline slope stability • Erosion and landslide hazards • Floodplains • Tsunami hazards	2a	2b	2c
Ecological Characteristics (Marine)	• Fish distribution • Eelgrass and kelp • Forage fish • Marine mammal haulouts • Wetlands	3a	3b	3c
Ecological Characteristics (Freshwater)	• Fish distribution • Bald eagle habitat • Wetlands • Waterfowl habitat • Shorebird concentrations	4a	4b	4c
Land Use	• Public and private land ownership • Commercial forests • Land Use	5a	5b	5c
Shoreline Modifications	• Fish passage barriers • Armoring • Breakwaters/Jetties • Dikes/Levees/Riprap • Overwater structures • Nearshore fill	6a	6b	6c
*See Appendix A. Inventory maps cover only portions of WRIAs 17, 18, and 19 under County jurisdiction. Federal Land and Incorporated Areas are excluded. WRIA 20 is covered separately. **Channel Migration Zone (CMZ) mapping is presented in Appendix B.				

2. POPULATION, LAND USE, AND SHORELINE DEVELOPMENT IN THE NORTH OLYMPIC COAST STUDY AREA

Clallam County occupies a unique location at the northwest tip of the contiguous United States on the geographically remote Olympic Peninsula. County residents are occasionally reminded of the remoteness when the Hood Canal Bridge goes out or flooding cuts off the single highway that leads to the communities along the Strait of Juan de Fuca. The location and landscape have created diverse, linked communities of people, plant species, and wildlife. Within the space of a few miles are nearshore and alpine ecosystems, rivers and forests, and culturally distinct towns and settlements.

This chapter describes the general extent and types of existing land use and the magnitude of potential future shoreline development to provide context for ecological information contained in the chapters that follow. Understanding existing and future opportunities for human use and enjoyment of shorelines is an essential aspect of the Shoreline Master Program update.

2.1 *Geographic Overview*

For purposes of this report, the North Olympic Coast study area includes the northern portion of Clallam County draining to the Strait of Juan de Fuca. This area includes the north slope of the Olympic Mountains as well as the major population centers of Port Angeles, Sequim and the unincorporated Urban Growth Areas of Clallam Bay-Sekiu, Carlsborg, and Joyce. A majority of the County’s 71,404 residents live in this portion of the County (slightly more than half in incorporated areas).

Along the North Olympic Coast are some major differences in existing and expected future land use. These differences have evolved in response to disparate patterns of human settlement; regional, national and global economic cycles; regulatory changes; and the availability and value of fisheries, forest products, and other natural resources. To address the geographic, ecological, and cultural diversity within the County, the North Olympic Coast study area can be considered in three planning areas--East, Middle and West (Figure 2-1).

2.1.1 East Planning Region

The East Planning Region extends from the Jefferson County line at Discovery Bay to the east edge of the Morse Creek watershed. This area encompasses a small portion of Discovery Bay, the Miller Peninsula, and Sequim Bay (all located in Water Resource Inventory 17), as well as portions of East WRIA 18 including Dungeness Spit and Green Point. The river systems that are large enough to be designated as shorelines of the state in this planning region are the Dungeness River and its major tributaries, McDonald Creek, and the upper reaches of the Little Quilcene River (which drains to Hood Canal through Jefferson County. Other important streams in this area include Eagle Creek (draining to Discovery Bay); Jimmycomelately, Dean and Johnson

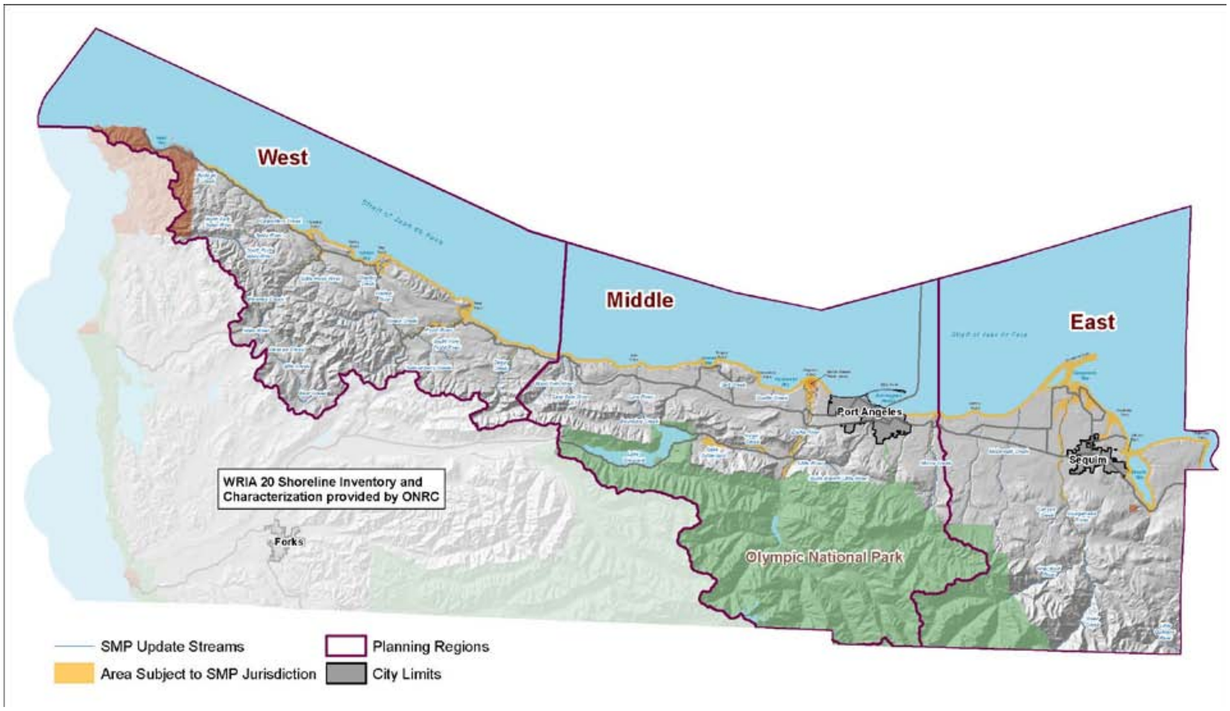


Figure 2-1. East, Middle and West planning regions in Clallam County

Creeks (Sequim Bay tributaries); and independent streams directly entering the Strait of Juan de Fuca including Siebert, Gierin, Cooper, Meadowbrook, and Cassalary Creeks.

The East Planning Region has only one incorporated area, the City of Sequim, and two designated Urban Growth Areas (UGAs), the Sequim UGA and the Carlsborg UGA. The Jamestown S'Klallam Tribe Reservation is located along Sequim Bay in the Blyn area and the Tribe has several commercial and administrative facilities on or near the marine shoreline. Most tribal members live outside of the reservation boundaries and tribal shoreline development is non-residential. Publicly owned shorelands in this region include the Sequim Bay State Park, Miller Peninsula State Park and the Dungeness National Recreation Area.

The only water-dependent commercial facility on the shoreline in this planning region is the John Wayne Marina located on Sequim Bay within the City of Sequim. Public access to the shorelines for recreation and enjoyment is available in many areas. Dungeness Spit and Dungeness Bay, the shoreline between Sequim Bay and Discovery Bay, and numerous parks and open spaces throughout the East Planning Region provide access to the water. County parks include the Dungeness Recreation Area, Panorama Vista, Marlyn Nelson, Dungeness Landing, Three Waters and Cline Spit. Other public lands also abut shorelines.

Residential use has become the most prevalent form of development. Agricultural uses are concentrated in the inland portions of the County, with only a small percent of the shorelines in agricultural production. Although this portion of the County has seen the largest population growth in recent years, there are still large portions of the shorelines that are undeveloped.

2.1.2 Middle Planning Region

The Middle Clallam County planning region includes the Strait of Juan de Fuca shorelines from and including the Morse Creek watershed on the east to the Twin Rivers watershed on the west; the City of Port Angeles and the Lower Elwha Klallam Tribe Reservation are located in this region. Shorelines of the state in this region are the Strait of Juan de Fuca, Lake Sutherland, the Elwha River, Colville Creek, Salt Creek, the Lyre River, and the East and West Twin Rivers. Removal of the Elwha River dams from 2011 to 2014 is expected to dramatically affect the river environment downstream of the dam and at the delta. Among other changes, dam removal is expected to create substantial shifts in sediment loading and transport along the lower river and marine shorelines.

Residential development along the shoreline occurs primarily in eastern portions of this region, particularly at the mouth of Morse Creek, Freshwater Bay and bluff areas near the Elwha River. West of Freshwater Bay shoreline land use is predominately public and private commercial timber management. Lake Sutherland is heavily developed with single family residential homes. Public access to shorelines in the middle region is available at Salt Creek and Striped Peak recreation areas near Tongue Point, Freshwater Bay and areas along the Elwha River. There is also a public boat launch at Lake Sutherland (maintained by the Washington Department of Fish and Wildlife). Steep erodible banks preclude public access to public lands in several areas. Private campgrounds are operated at Whiskey Creek, Crescent Beach and the Lyre River.

2.1.3 The West Planning Region

The West Planning Region extends from the eastern boundary of the Makah Tribal Reservation to the Deep Creek watershed. In addition to the marine shorelines along the Strait of Juan de Fuca, shorelines of the state in this area include Deep Creek, the Pysht River, Clallam River, the Hoko and Sekiu Rivers, and Bullman Creek.

Land use in the west planning region is predominately commercial forest. With the exception of the Clallam Bay/Sekiu UGA, most of the marine shoreline is undeveloped. Additional pockets of moderate to high density residential development are located at Bullman Beach and the Hoko River estuary. Water-dependent commercial facilities include several private resorts. Highway 112 is located within the SMP jurisdiction in several locations.

The Clallam Bay shoreline is the most heavily developed area of the western planning region and several water-dependent commercial facilities are located along the shoreline. There are two marina breakwaters and several docks supporting these facilities.

Public access to the shoreline in this region is generally limited to informal access along State Highway 112, Pillar Point County Park, and the Clallam Bay/Sekiu area. Private access is available from resort areas. Although there are substantial public forest lands along the marine shorelines, most of the area is not accessible by land. Washington State Parks has recently acquired land in the Hoko River estuary and additional public access is possible in the future.

2.2 *Population*

The total population in Clallam County (including WRIA 20) increased by 10.7 percent from 2000 to 2010, as compared to the 14.2 percent overall population increase for Washington State.

Population growth in the unincorporated areas of Clallam County was only slightly lower at 9.19 percent for the same time period, while growth in the incorporated areas has varied widely (OFM 2011). Population growth in the eastern portion of the County (Sequim and Sequim UGA) has been much higher than other portions of the County (Table 2-1).

Table 2-1. Clallam County Population Growth by Region

Area	Total Population in 2000	Total Population in 2010[1]	Percent Growth
Total County	64,525	71,404	10.7%
Unincorporated County	38,674	42,228	9.2%
East Planning Region			
Sequim	4,334	6,606	52.4%
Sequim UGA	5,923	6,364[1]	7.4%
Carlsborg UGA	806	828[1]	2.7%
Middle Planning Region			
Port Angeles	18,397	19,038	3.5%
Port Angeles UGA	21,080	21,610[1]	2.5%
Joyce UGA	58	581	0
West Planning Region			
Clallam Bay-Sekiu UGA[2]	462	435	-5.8%

Source: Washington State OFM, Census 2010 Redistricting Data for Washington, 2011.
[1] Population estimates for the county UGAs is not yet available from the 2010 census. For the purposes of this report, the OFM population estimates for 2006 were used.
[2] The Clallam Bay-Sekiu UGA population obtained from OFM does not include the prison population at the Clallam Bay Correction Facility.

The County used a 20-year planning period for comprehensive planning and based its plans on the population estimates from the Washington State Office of Financial Management (OFM). The population of Clallam County over the planning period is expected to increase by 10,000 to 12,000 people by 2025 (Clallam County, 2007b). The 2007 State population estimate for Clallam County was 68,500 persons (OFM, 2007). According to the Urban Growth Areas Analysis and 10-Year Review (“UGA Report”), growth trends support using the State growth management 2000 – 2025 High Series Population Forecast (OFM, 2002) for Clallam County of 86,927 persons. Based on this forecast, the County needs to plan for approximately 18,427 new people between 2007 and 2025. Most of this population increase is anticipated to occur within Central and Eastern Clallam County.

2.3 *Existing Land Use and Zoning*

The three planning regions vary in terms of the types of land use that occur adjacent to river, lakes and marine shorelines (Figures 2-2 and 2-3; note that timber extends beyond top of graph). Residential uses are a significant component of the east planning region while timber is the dominant use in the middle and west regions. Agriculture comprises a modest percentage of the land use on the marine shore (mostly in the east planning region), but there is relatively little agricultural use occurring along freshwater shorelines in Clallam County. Commercial, industrial, and port-related land uses are even less common adjacent to County shorelines and are mostly limited to marinas, fishing resorts, campgrounds and other recreation-related enterprises.

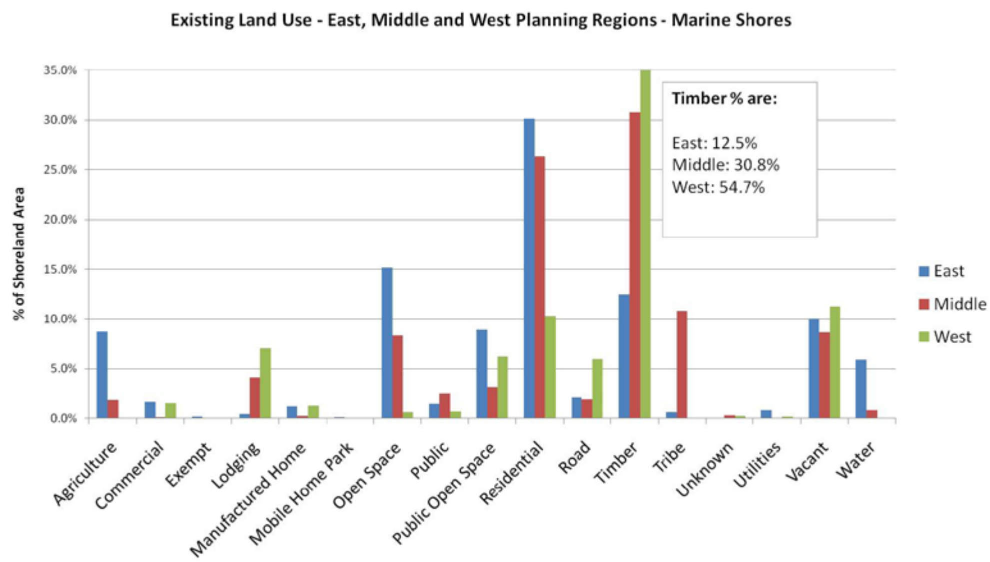


Figure 2-2. Existing land use as a percent of the marine shoreland area

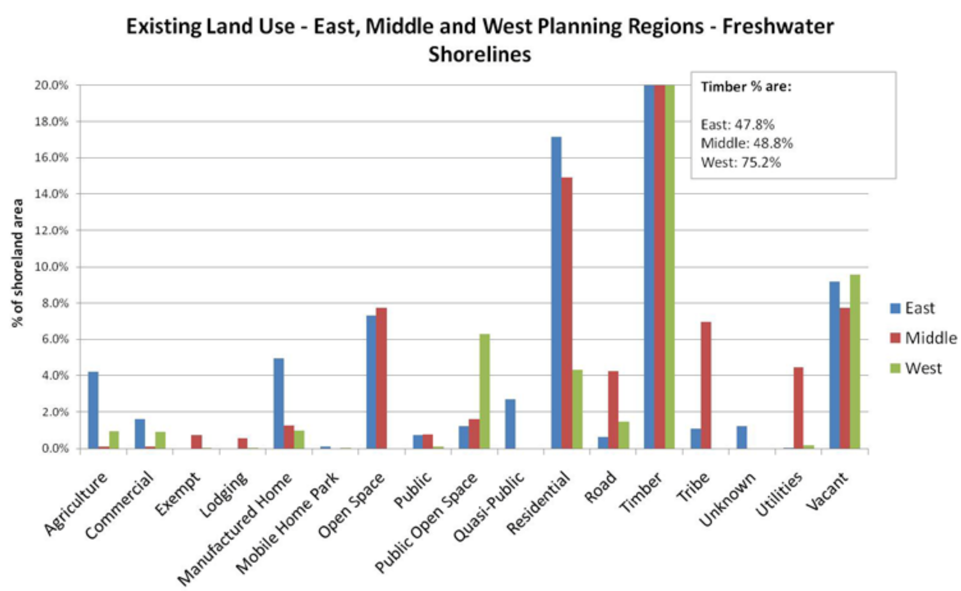


Figure 2-3. Existing land use as a percent of the freshwater shoreland area

Existing land use is fairly consistent with the current zoning, which is heavily weighted toward residential uses on all types of shorelines (river, lake and marine) in all three regions (Figure 2-4 and 2-5; note that timber extends off the top of the graph). Commercial forestry is the second most prevalent shoreline zoning designating, accounting for as much as 66 percent of the marine and 40 percent of the freshwater shoreline area in the west alone.

These land use and zoning patterns suggest that, compared to other types of land use, residential uses and forest practices have the greatest potential to impact the future health and quality of the shoreline environment. Residential development is regulated as a priority use under the Shoreline Management Act, but forest practices are mostly governed by a different set of rules (known the Forest Practices Act, RCW 76.09); therefore residential uses are a major focus of this analysis and of the SMP update in general.

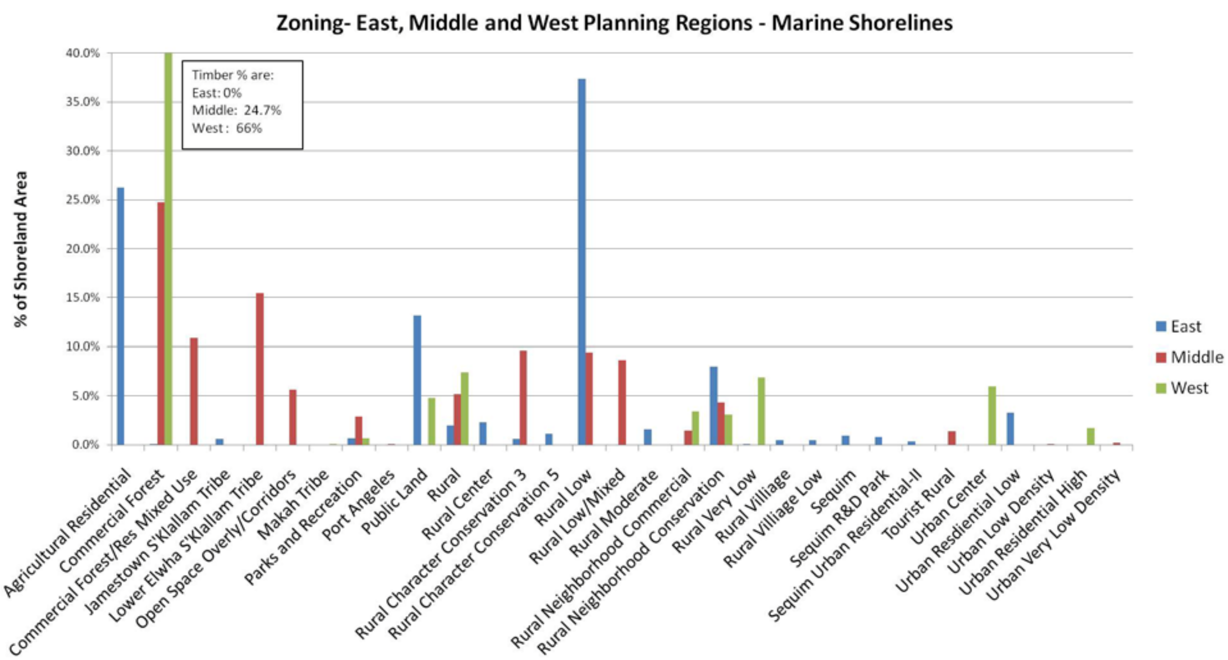


Figure 2-4. Percent of the marine shoreland area in each zoning category

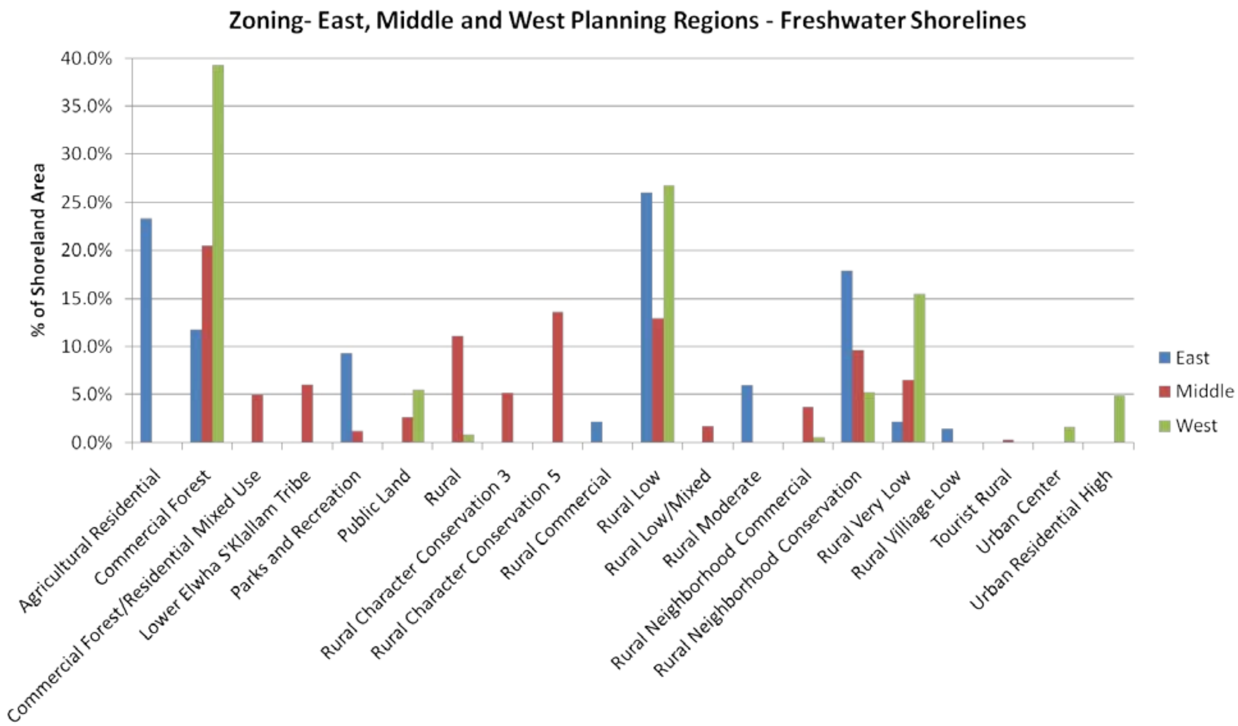


Figure 2-5. Percent of the freshwater shoreland area in each zoning category

2.4 *Future Development Potential in SMP Jurisdiction*

There are approximately 2,700 individual parcels of land that directly adjoin shorelines of the state in Clallam County (excluding WRIA 20). To understand the effect that residential and other types of land use could have on shoreline conditions, it is important to consider the future build out potential of the lands within the jurisdiction of the County's shoreline master program. Future development potential for the planning regions is shown in the following tables. These are rough estimates based on assessors' data.

These development potential data allow for a general comparison of the relative development potential of different areas of the County but are not a parcel-specific prediction of future development. There are many factors that can affect the development potential of a given parcel or area of the County including infrastructure availability, presence of critical areas, ability to meet on-site septic system requirements, lot configuration, etc. In addition, development intensity and type are controlled by County zoning regulations. For example, a parcel within an R1 zone (one dwelling per one acre) can be developed more intensively than a parcel in an R5 zone (one dwelling per five acres). On many parcels, the property boundaries include areas both within and outside of the shoreline jurisdiction. Therefore, future development on such lots could also occur near, but outside the SMP jurisdiction.

Private parcels that are zoned for commercial forestry are technically developable and can be subdivided, but most of this land is less likely to be developed in the relatively near future than non commercial forest lands. Therefore, commercial forest-zoned lands are not considered as "potentially developable" in the tables below. That said, these lands would be subject to ongoing timber harvest and related forest practices (e.g., road building, etc). Most residential development on lands zoned for commercial forestry would require a conditional use permit and the newly created lots would have to be at least 80 acres. Other uses such as wood manufacturing are also allowed on these lands to support forestry uses.

2.4.1 Marine Shorelines

A substantial portion of the land within SMP jurisdiction along the Strait of Juan de Fuca is vacant or "underdeveloped" (meaning the parcel is partially developed, such as with one dwelling, but zoning regulations would allow parcel subdivision and additional development). These lands include both subdividable and non subdividable parcels and are likely to be developed in the future (Table 2-2).

Table 2-2. Potentially Developable Lands within SMP Jurisdiction along the Marine Shoreline (excluding WRIA 20)

Planning Region	Total Area Within SMP Jurisdiction (acres)	Potentially Developable Lands (acres)	Percent (%) Developable Lands
East	2,538	760	30%
Middle	866	146	17%
West	971	264	27%

In both the east and west planning regions, approximately one-third of the land area along the marine shoreline is vacant or underdeveloped, and could be more intensively developed. In the middle planning region a smaller but still significant portion (17%) of the land area along the marine shoreline is vacant or underdeveloped.

2.4.1 Freshwater Shorelines

As with lands along the Strait of Juan de Fuca marine shore, lands along Clallam County freshwater shorelines have potential for new subdivision and development (Table 2-3). The amount of developable lands increases from the east to the west planning regions from 12 to 45 percent.

Table 2-3. Potentially Developable Lands within SMP Jurisdiction along Freshwater Shorelines (excluding WRIA 20)

Planning Region	Total Area Within SMP Jurisdiction (acres)	Potentially Developable Lands (acres)	Percent (%) Developable Lands
East	3,601	434	12%
Middle	4,049	981	24%
West	6,814	3,073	45%

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).

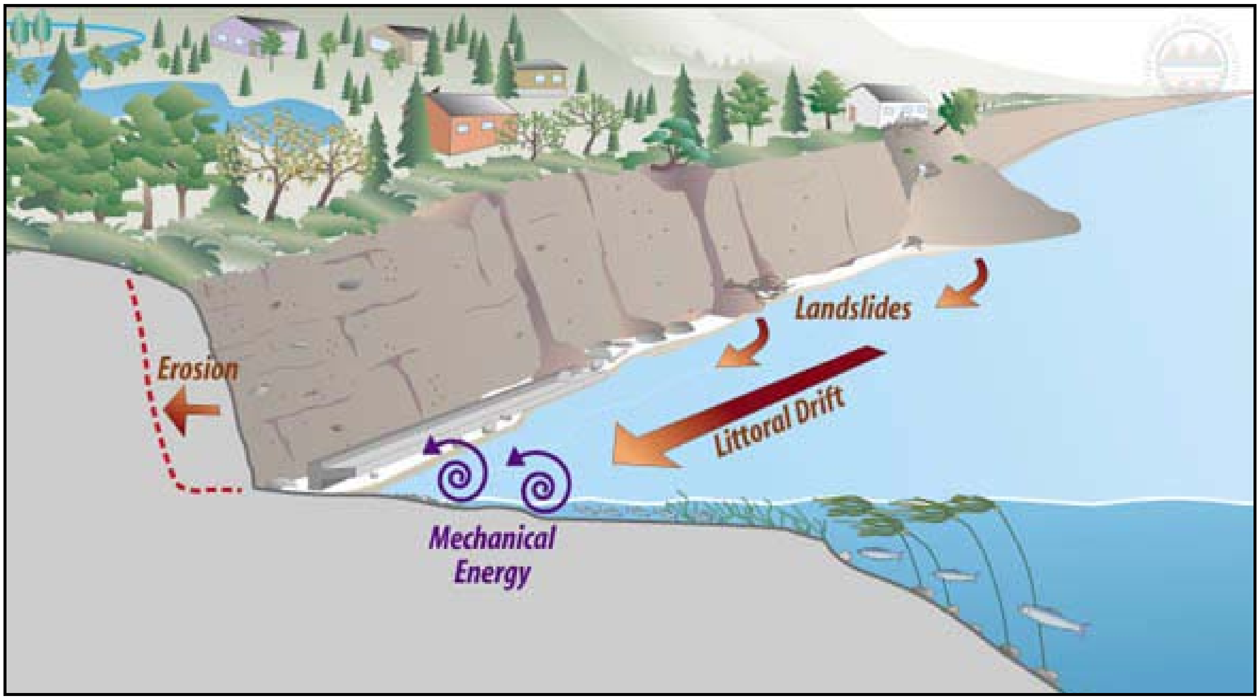


Figure 3-3. Bluff erosion, landslides and littoral drift (Source: King County)

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).

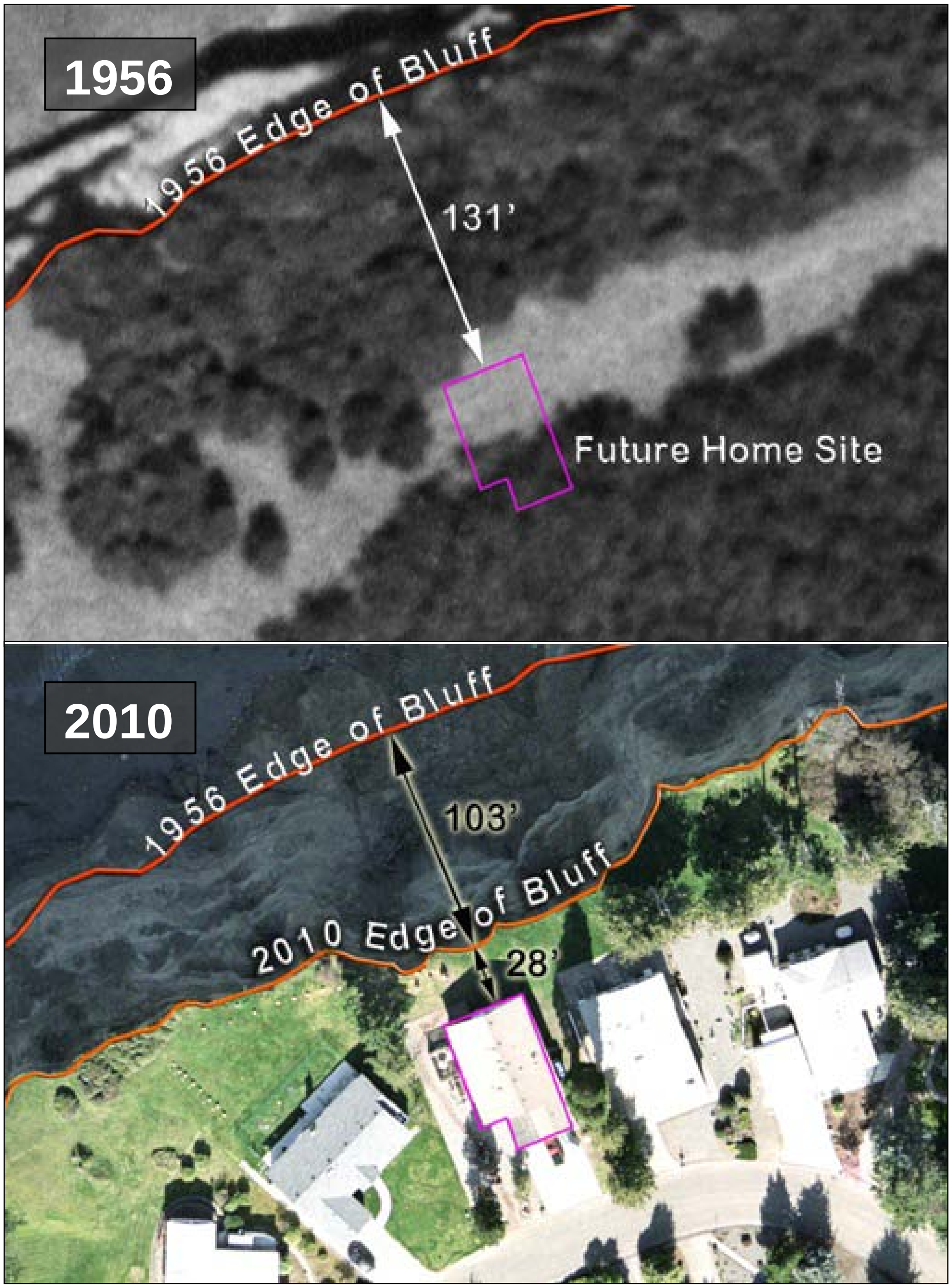


Figure 3-4. Bluff erosion threatening homes along Cypress Circle, west of Dungeness Spit (Source: Randy Johnson)

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
- Sediment Transport
- Erosion and Accretion of Sediments
- Tidal Flow
- Distributary Channel Formation and Maintenance
- Tidal Channel Formation and Maintenance
- Freshwater Input
- Detritus Import and Export
- Exchange of Aquatic Organisms
- Physical Disturbance
- Solar Input

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.

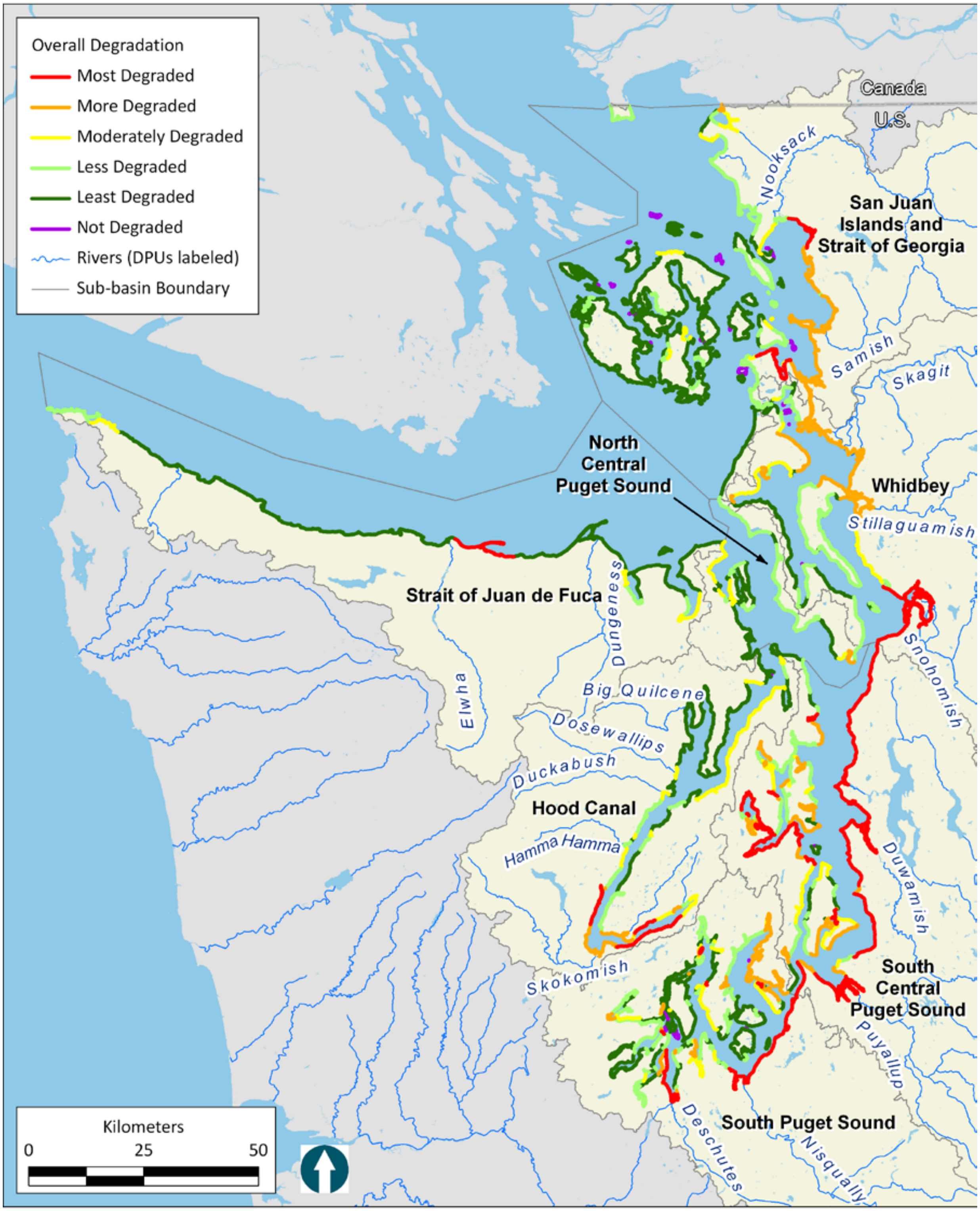


Figure 3-5. Relative degradation of Strait of Juan de Fuca nearshore reaches in terms of nearshore processes (Schlenger et al. 2010)

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).

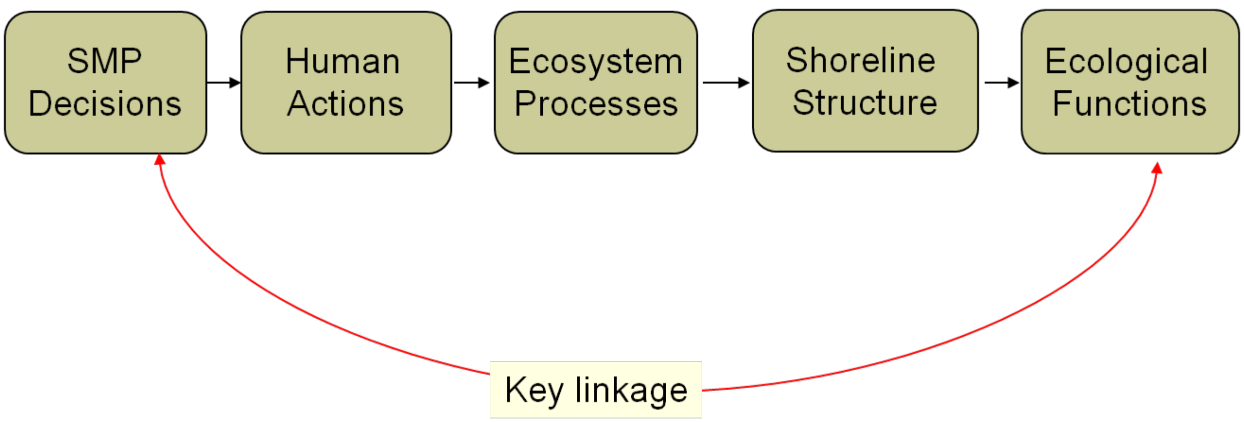


Figure 3-6. Relationship between human actions and shoreline ecological functions in the context of shoreline master programs

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).

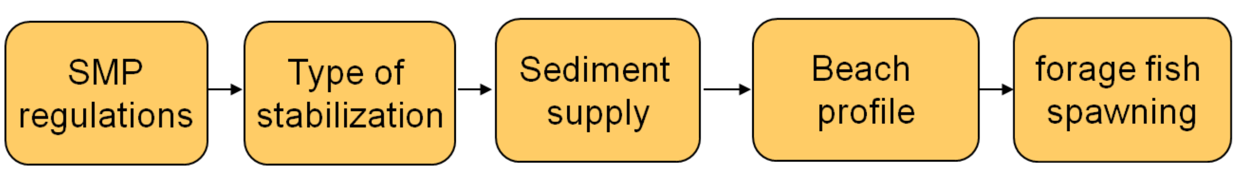


Figure 3-7. Relationship between shoreline stabilization regulations and forage fish functions

[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		Feeder Bluff Area as a Percent of Reach Length		
	Reach Miles (approx)	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.

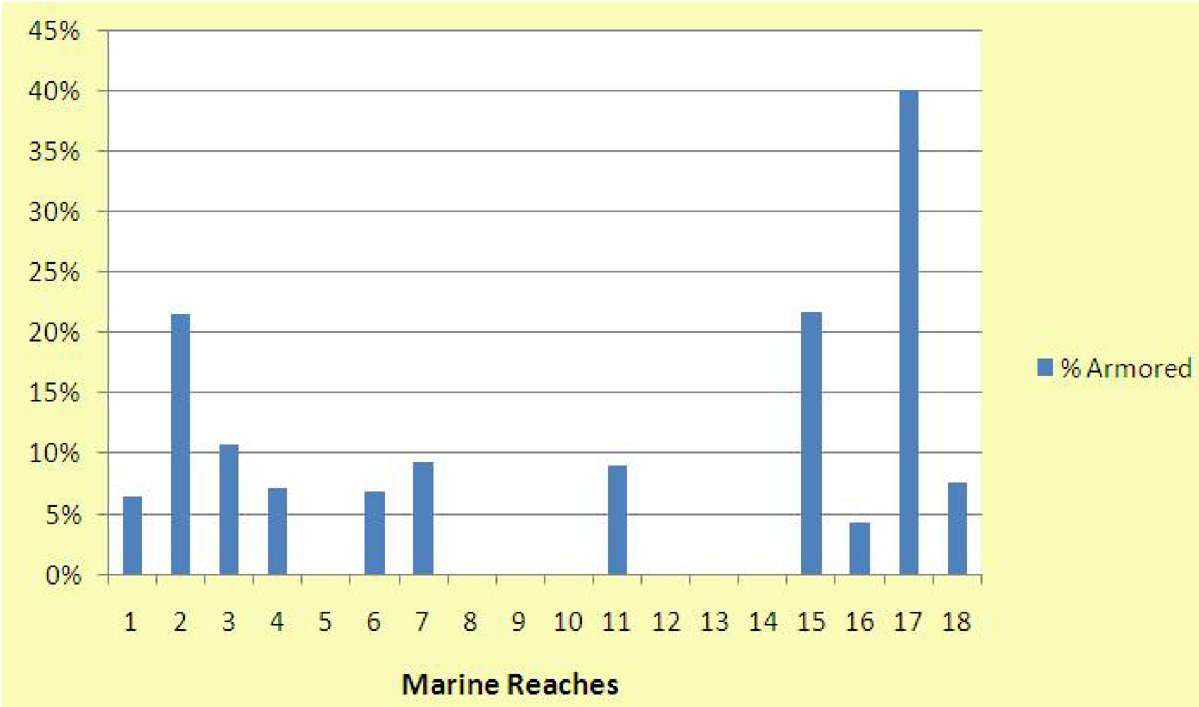


Figure 3-9. Percent of each reach with hard armoring along the Strait of Juan de Fuca in Clallam County (data from point PSNERP 2009, Battelle 2008)

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)

	Armoring Effects [a]						
Resource Species	**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.

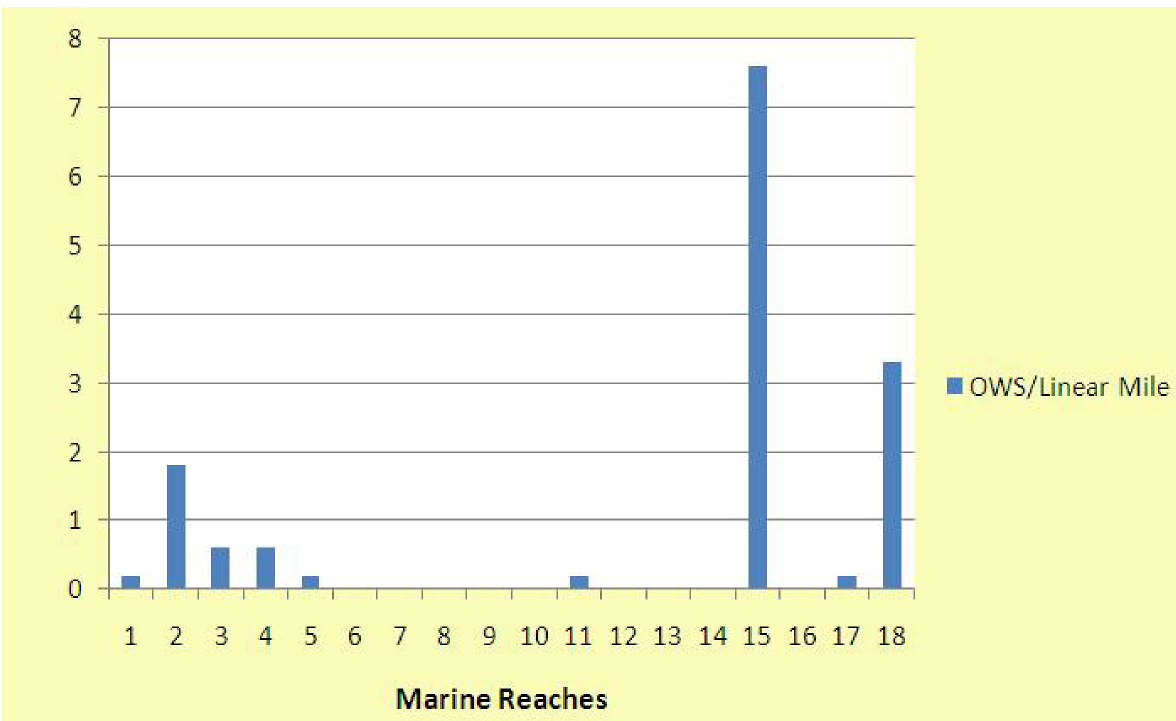


Figure 3-10. Number of overwater structures per mile of reach along the Strait of Juan de Fuca in Clallam County (data from PSNERP 2009)

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)

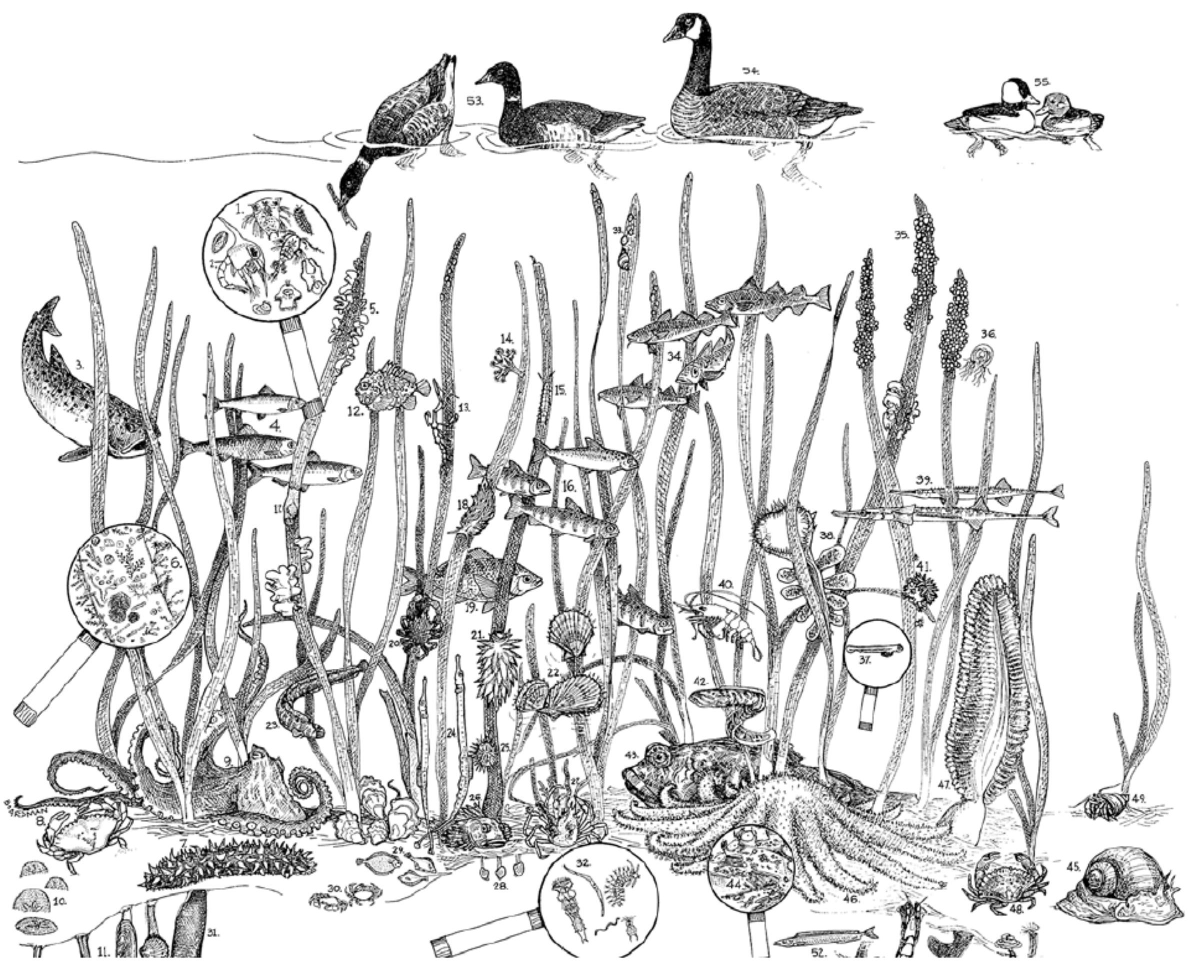
Marine Reach	Acres of Kelp	Total Aquatic Area of Reach (acres)	Percent
1 – Diamond Point	92	1295	7%
2 – Sequim Bay	0	843	0%
3 – Gibson Spit	0	577	0%
4 – Kulakala Point	5	845	1%
5 – Dungeness Spit	234	1622	14%
6 – Green Point	492	1336	37%
7 – Angeles Point	507	833	61%
8 – Observatory Point	237	524	45%
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
2. Larval crab
3. Salmon
4. Herring
5. Epiphytic macroalgae
6. Epiphytic microalgae, Hydozoa, and bryozoa
7. Sea cucumber
8. Dungeness crab
9. Octopus
10. Sand dollars
11. Clams and cockles
12. Pacific spiny Lumpsucker
13. Caprellid amphipod
14. Stalked jellyfish
15. Eelgrass isopod
16. Juvenile salmon
17. Bubble shell
18. Opalescent nudibranch
19. Perch
20. Juvenile kelp crab
21. Alabaster nudibranch
22. Scallop
23. Gunnel
24. Bay pipefish
25. Sea urchin
26. Juvenile sculpin
27. Decorator crab
28. Juvenile clams
29. Juvenile flounder And sole
30. Juvenile crab
31. Geoduck
32. Sediment microfauna
33. Snail and snail eggs
34. Juvenile cod, tomcod And wall-eyed pollock
35. Herring eggs
36. Jellyfish
37. Larval fish
38. Melibae-hooded nudibranch
39. Tubesnout
40. Shrimp
41. Brooding anemone
42. Prickleback
43. Sculpin
44. Bacteria on detritus
45. Moonsnail
46. Sunflower seastar
47. Sea pen
48. Red rock crab
49. Hermit crab
50. Worms
51. Ghost shrimp
52. Sand lance
53. Black Brant
54. Canada Goose
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).

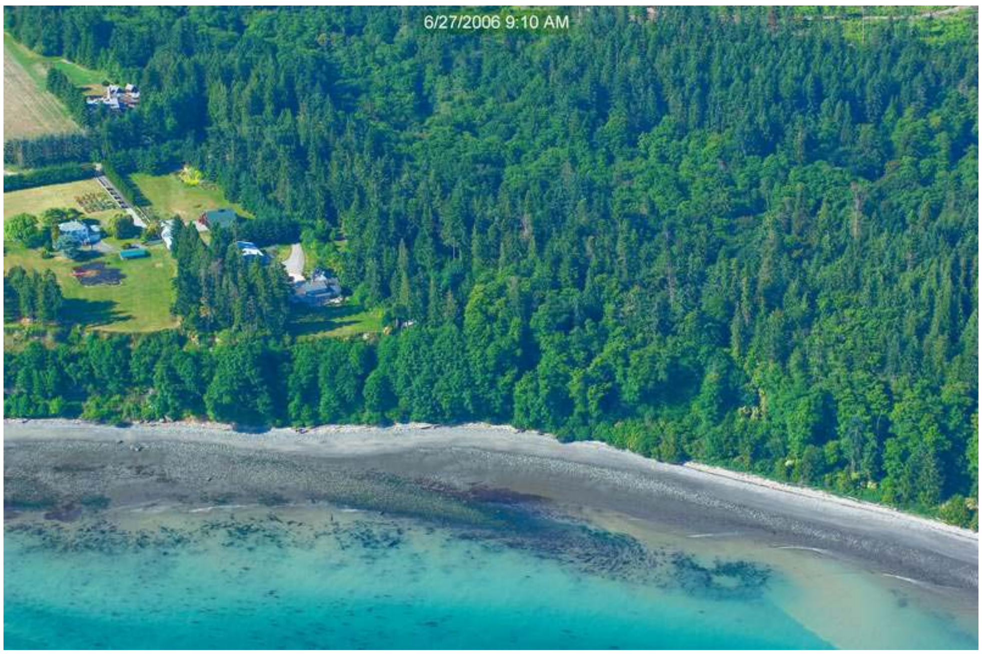


Figure 3-13. Healthy stands of marine riparian vegetation, such as this area just east of Green Point, perform important functions related to wildlife habitat, water quality, slope stability and food web support (photo: Ecology)

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.

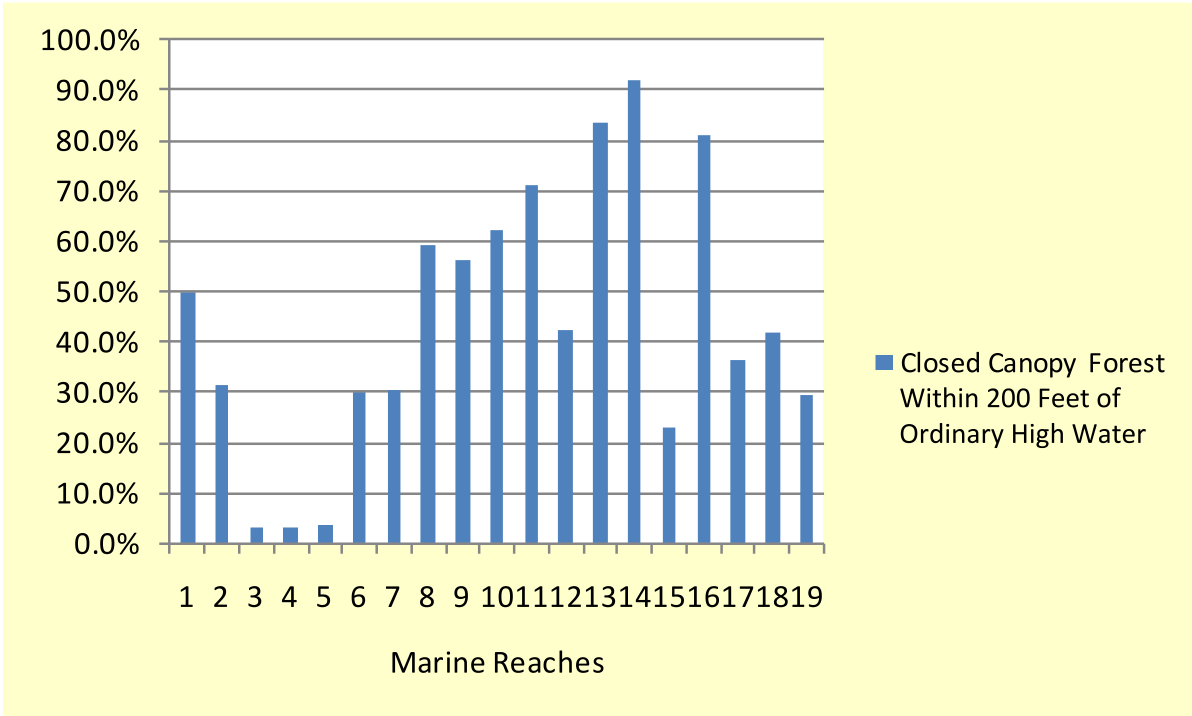


Figure 3-14. Percent of each marine reach with closed canopy forest cover along the Strait of Juan de Fuca in Clallam County (data from Point No Point Treaty Council 2011)

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

	Forage Fish Suitability Class (data from Anchor Environmental and Marine Resources Committee 2002)					
Marine Reach	**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.