

5. NORTH OLYMPIC ECOSYSTEM: FRESHWATER SHORELINES

Newcomers to the north shores of the Olympic Peninsula often have trouble orienting themselves to a landscape where the mountains are south and the rivers¹ flow north. This is a landscape that drops from snowfields at 7,000 feet to sea level in 30 miles or less, resulting in swift and cold rivers that have produced salmon of legendary proportions (real and imagined). The steep drop and heavy winter precipitation of the Olympic Peninsula also creates dynamic rivers that can flood within hours of a heavy rain event, scouring the banks as they move through narrow valleys. In the summer the north Olympic Peninsula rivers look fairly tame, and many rivers and creeks can experience extreme low flow conditions. Summer streamflow in the large rivers depends largely on snowpack, but many local streams are fed primarily by groundwater and wetlands that store winter precipitation. Forest cover plays an essential part in moderating flows by intercepting precipitation, slowing runoff, retaining water, shading rivers (to keep water temperatures low), providing large woody structure and nutrients, and stabilizing banks. The riparian habitats along Clallam County freshwater shorelines also provide critical habitat for many fish and wildlife species, including many State-identified “priority species” (Table 5-1).

Table 5-1. Priority wildlife species mapped along Clallam County freshwater shorelines (Sources: WDFW, WDNR)

Terrestrial	Aquatic
Bald eagle	Coho salmon
Band-tailed pigeon	Chum salmon (fall and summer)
Elk	Pink salmon
Harlequin duck	Sockeye salmon
Peregrine falcon	Chinook salmon (fall and spring)
Red-tailed hawk	Steelhead (summer and winter)
Trumpeter swan	Cutthroat trout
Wood duck	Rainbow trout
	Dolly Varden/Bull Trout

¹ This report uses the terms river and stream interchangeably.

The people who live on the north Olympic Peninsula are very attached to their rivers. West end steelhead fishermen can tell if the river color is right with one glance, and long-time Dungeness farmers can judge the remaining snowpack by looking up at Mount Baldy in July. County residents also know that living in proximity to these rivers can be unpredictable, and fighting natural processes of flooding and channel migration is costly.

The information on freshwater resources in this report (Chapters 5 and 6) is generally confined to the rivers and streams in WRIA 17, 18 and 19 that fall within the jurisdiction of the Clallam County Shoreline Master Program. Rivers and streams are emphasized because there is only one lake in the study area that is a shoreline of the state—Lake Sutherland. The County’s stream and river systems have been studied at length for salmon recovery and watershed management purposes, and this chapter does not attempt to repeat the extensive ecosystem analysis that is already available. Information in this chapter is intended to briefly describe ecosystem processes and summarize baseline conditions of the freshwater shorelines as they presently exist. The chapter also discusses shoreline management considerations-- how the placement of structures in and near the shoreline can affect ecosystem processes and impact downstream neighbors, water quality, and habitat formation in the future. A reach by reach description of the freshwater shorelines is contained in Chapter 6, covering shoreline development, public access, and species and their habitats.

5.1 Overview of Freshwater Shorelines Ecosystem Processes

Rivers and major creeks on the North Olympic Peninsula pass through a complex set of jurisdictions and land uses as they flow north from the Olympic Mountains and foothills to the Strait of Juan de Fuca. Freshwater areas that are designated as shorelines of the state along the north coast of Clallam County include the following (Figure 5-1):

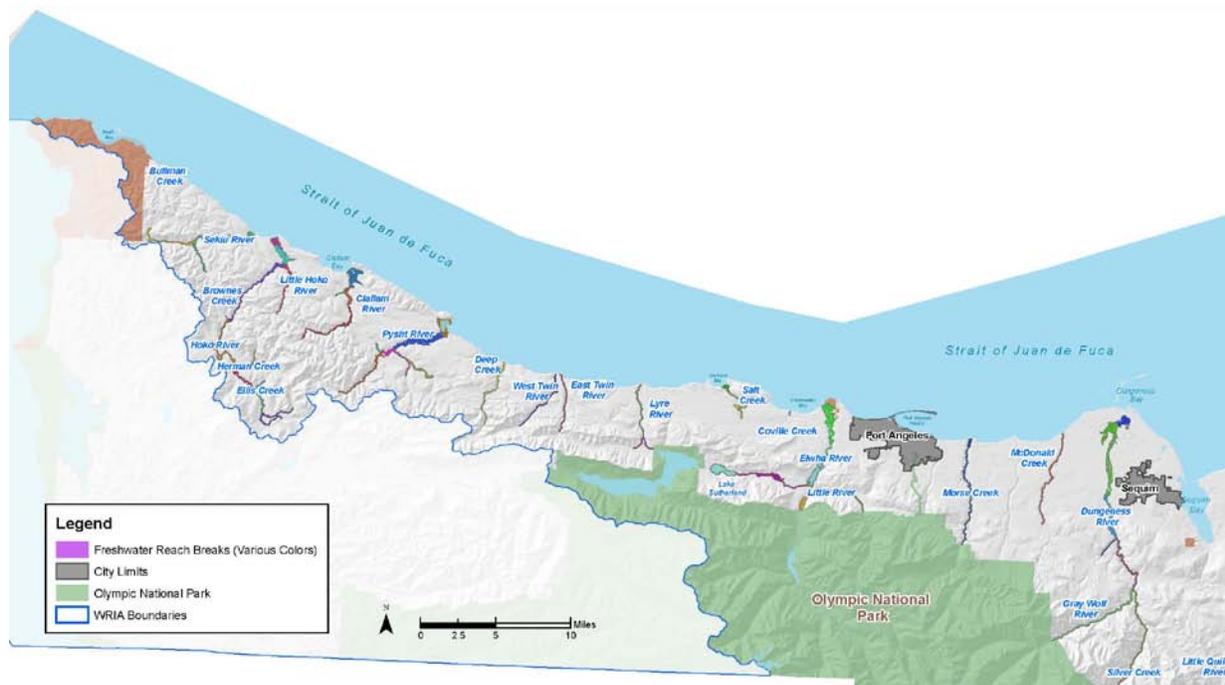


Figure 5-1. Freshwater shorelines of the North Olympic Coast in Clallam County

- East of the City of Port Angeles the shorelines of the state are located in the Dungeness, McDonald, and Morse Creek watersheds. These streams originate on federal lands, and pass through a checkerboard of state and private commercial forest lands before entering areas of dispersed or concentrated residential development and scattered agriculture.
- Similarly, the Elwha River originates in Olympic National Park, and passes through a mix of state and private forest land. The upper Glines Canyon dam is located inside of the National Park, and the lower Elwha dam is downstream of the park. The shoreline areas below the dams have scattered residential development, and portions of the Lower Elwha Klallam Reservation are located in the floodplain.
- Lake Sutherland, which is predominately surrounded by residential development, is drained by Indian Creek, entering the Elwha River at Lake Aldwell--above the lower dam.
- West of the Elwha watershed, land use is predominately forested. The streams that are large enough to be designated as shorelines of the state originate on federal, state, or private forest lands. There is limited residential development along the streams except near the river mouths. Shorelines of the state in the west of the Elwha include Colville Creek, Salt Creek, the Lyre River/Boundary Creek, East and West Twins, Deep Creek, and Pysht and Clallam River watersheds. West of Clallam Bay are the Hoko and Sekiu Rivers, and Bullman (Rasmussen) Creek.
- A small, upper watershed portion of the Little Quilcene River (tributary to Hood Canal) is located in Clallam County, but is within the Olympic National Forest boundary. There is no residential development potential in this reach.

5.2 Processes Affecting Freshwater Shorelines

As with nearshore areas, the health and functioning of freshwater shoreline systems is influenced to a large degree by the movement of water, sediment, nutrients, pathogens, and organic material (e.g., large wood) across watersheds. The freshwater streams and lakes of Clallam County are fed by surface water runoff and groundwater recharge. Precipitation is the primary source of groundwater recharge. Soil permeability and underlying geology influence the amount of precipitation that becomes surface runoff. In mountainous areas shallow soils tend to limit infiltration so water either travels laterally as shallow subsurface flow, or percolates to deep groundwater through cracks and fissures in the bedrock. River valleys in the lowlands tend to have deeper, porous soils that create favorable conditions for groundwater discharge. These areas can store large quantities of water in shallow aquifers (Cox et al. 2005). As a result, naturally functioning floodplains are important for maintaining healthy stream and river systems.

Soils in Clallam County vary from well drained to poorly drained (Clallam County 2011). Based on County soil maps (Figure 5-2), major areas with slow drainage occur around the Sequim/Dungeness Peninsula, near Joyce, and in the western portion of the County (outside of the study area of this report). Well-drained soils occur predominantly in the eastern end of the County, mostly along creeks and rivers.

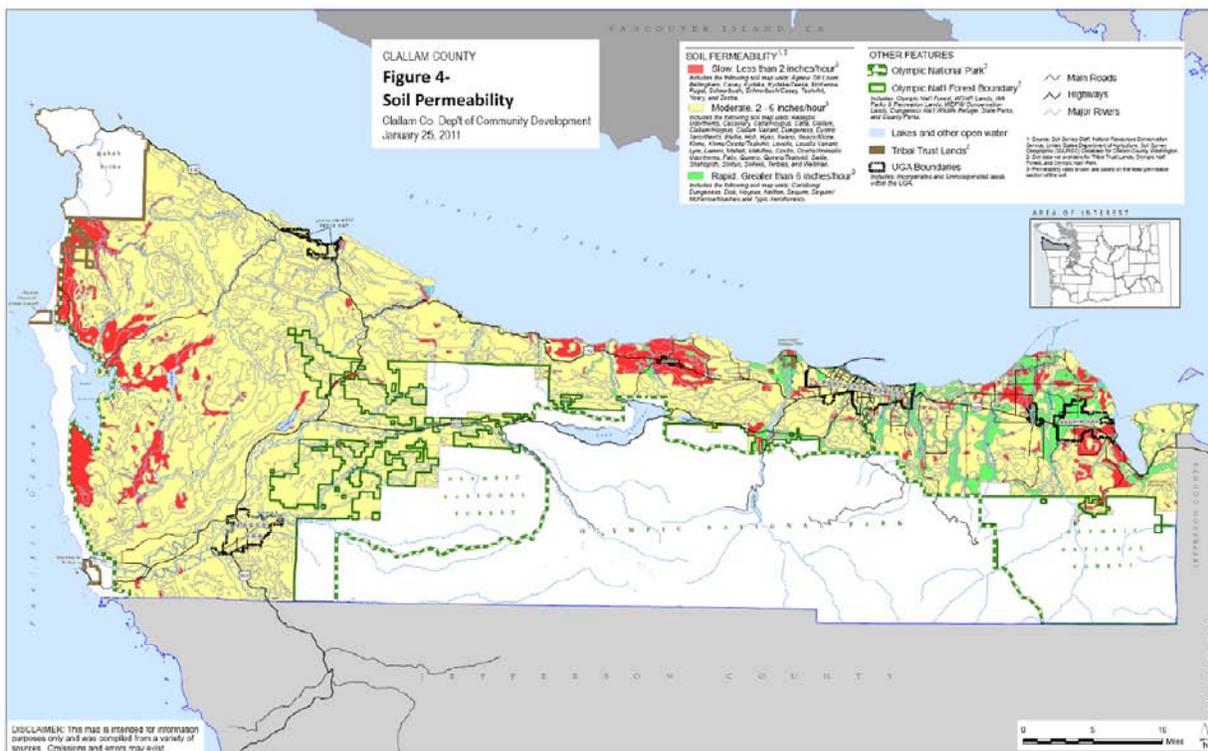


Figure 5-2. Soil permeability in Clallam County (from the Draft Comprehensive Stormwater Management Plan, 2011)

High runoff rates can be damaging to rivers, streams and lakes because they can erode banks, cause scour and contribute sediments and nutrients that harm water quality. On the North Olympic Peninsula, high runoff rates occur due to natural geologic conditions and climate factors. Projections by the University of Washington Climate Impacts Center indicate that runoff patterns in the Puget Sound region are likely to change in the next 50 years, with reduced snowpack and earlier runoff. Although overall levels of impervious surfaces in Clallam County are low, except in a few localized areas, these surfaces can block infiltration resulting in significant and measurable changes in flow.

Runoff rates also increase when surface water storage areas become disconnected from the hydrologic system. Reduced storage and connectivity occur as a result of dikes, revetments and/or levees along stream channels; stream channelization; and floodplain and wetland fill. The loss of surface water storage potential can increase the magnitude and frequency of peak flows and can increase water level fluctuations in river and lake systems (Collins et al., 2003). In contrast, unaltered floodplains help to mitigate effects of increased runoff. Connected floodplains allow for overbank storage, which dissipates the erosive forces of the flood. Floodplains often contain important wetland and side channel habitats that serve as foraging, over-wintering, and refuge areas for fish (Swales and Levings, 1989; Bjornn and Reiser, 1991).

As with marine systems, sediment delivery and transport processes have a substantial effect on the health and sustainability of freshwater aquatic ecosystems. Surface erosion and landslides are naturally occurring mechanisms of sediment supply, but large amounts of sediment can have adverse effects on salmon and other species (Figure 5-3). Sediment can build up in stream

channels and reduce conveyance capacity, which can lead to flooding. Changes in stream morphology brought on by altered sediment supply-transport processes can also increase bank erosion and channel migration rates. Fine sediment can impact fish habitat quality and availability by causing turbidity or smothering spawning gravels. The Dungeness River is one area where the contribution of sediment to the river by landslides in the upper watershed is a major concern due to the potentially adverse impacts of this sediment to anadromous fish habitat (Bureau of Reclamation 2002). Conversely, the Elwha dams cut off sediment transport to lower portions of the river, starving the lower system of coarse gravels that form potential spawning areas and eliminating a portion of the sediment delivery to the nearshore of the Strait (Shaffer et al., 2008; Press et al., 2008).

Water flow and sediment dynamics can influence water quality processes in aquatic ecosystems. This is because water and sediment transports nutrients and pathogens from upland areas to receiving waters. For example, runoff from fertilized agricultural fields or residential areas can carry excess nitrogen and other nutrients to nearby streams or lakes. Fertilized areas that are also prone to erosion can be a major source of phosphorous pollution since phosphorus binds to sediment particles. Surface runoff is also believed to be a major transporter of bacteria and other pathogens, so areas that retain water and sediments such as wetlands, floodplains, permeable soils and forest cover are important areas for pathogen removal. The U.S. Environmental Protection Agency (2001) showed that standing water (in wetlands, for example) promotes pathogen removal through increased filtration and predation by other microbes.



Figure 5-3. Pacific salmon need healthy rivers for spawning, rearing and migration

Water quality is a significant factor in maintaining suitable habitats for fish and other aquatic species. Salmonids, in particular, require water that is both colder and has lower nutrient levels than many other types of native fish. Dissolved oxygen (DO) is one of the most influential water

quality parameters for stream biota, including salmonids (Bjornn and Reiser, 1991). The most significant factor affecting DO levels in most streams is temperature, with cooler waters maintaining higher levels of oxygen than warmer waters. Other factors that can contribute to DO levels include water turbulence (the amount of aeration) and biochemical oxygen demand created by decomposition of nutrients. Nutrients may originate from human-induced sources such as fertilizers (both chemical and natural), leaking sewers and septic systems, municipal sewer discharge, pet waste, or from natural processes such as decomposing algae or dead plant materials that fall into streams (Lamb, 1985).

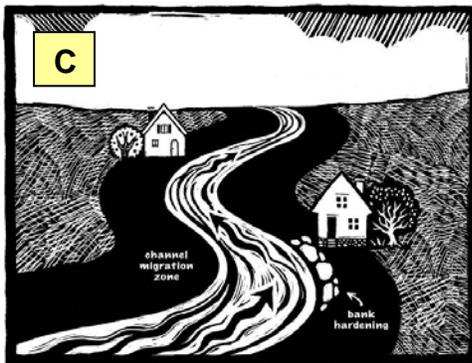
Organic material, including large woody debris, enters freshwater systems primarily via streambank erosion and treethrow/windthrow processes operating within roughly 200 feet of stream channels. These processes play a significant role in stream channel maintenance and in-stream habitat formation and are therefore critical to the health of freshwater systems. Woody debris adds roughness to the stream channel, which slows water velocities and traps sediment (Shirvell, 1990). Because coniferous logs are slower to decompose, they generally provide more benefit as large woody debris than deciduous species (May et al., 1997). Riparian forest cover is the primary source of organic / woody debris. According to some studies more than half of all large woody debris recruitment is from within 25 feet of streams, and about 90 percent comes from trees growing within about 50 feet of streams (Murphy and Koski, 1989; McDade et al., 1990; Van Sickle and Gregory, 1990). In addition, for larger streams that are prone to avulsion (such as the lower Dungeness River), large woody debris can be recruited from distances much greater than 50 feet. For these reasons, forested riparian buffers are essential for healthy streams (Figure 5-3).

Riparian vegetation also provides food for salmonids, both directly and indirectly (Meehan et al., 1977). Insects falling from overhanging vegetation provide food for fish, while leaves and other organic matter falling into streams provide food and nutrients for many species of aquatic insects, which in turn provide forage for fish. Salmonids consume a wide range of food sources throughout their life cycles. Most juvenile salmonids that rear in streams prey on aquatic invertebrates and terrestrial insects that fall into streams from overhanging vegetation (Horner and May, 1999; May et al., 1997).



Figure 5-4. Large woody debris “recruited” from adjacent riparian forest (Photo: Dungeness River Audubon Center)

5.2.1 Channel Migration Zones



Channel migration is a natural process that has a dramatic effect on freshwater rivers and streams and the people who live near them (Figures 5 and 6). River channels naturally move across and sometimes outside of their mapped floodplains by eroding the outside banks of a meander bend, or through channel avulsion. This can create very hazardous situations for development within the channel migration zone (CMZ), which can be damaged or destroyed by gradual or sudden channel shifts (Figure 5-5b). Where vegetation along the river has been removed, the risk of channel migration is generally greater.

People often try to contain rivers within their channels by hardening the banks with riprap or other materials that resist erosion (Figure 5-5c). Bank hardening reduces the quality for the stream for salmon and other species and can accelerate the flow, transferring the erosive energy downstream and potentially creating problems for other property owners. Locating development outside of the CMZ and maintaining riparian vegetation along stream banks is a safer, less costly and ecologically preferred alternative (Figure 5-5d).

In general, the extent of a CMZ is difficult to accurately determine at a site- or parcel-scale; an in-depth study of an entire river reach by a professional hydrogeologist is required for accurate mapping. Some rivers in Clallam County have been analyzed by qualified professionals trained in CMZ mapping: the Jamestown S’Klallam Tribe (2008) mapped the Dungeness River and Ecology (2011) mapped several other river systems (Table 5-2). This existing CMZ mapping generally excludes commercial forestry-zoned lands, and is limited to the lower reaches of the studied rivers. The presence and extent of CMZs on other rivers within the County is unknown. Existing CMZ mapping is presented in Appendix B.

Figure 5-5a-d. Channel migration areas are potentially hazardous areas and development within these areas should be avoided to reduce safety risk and prevent ecological impacts (From the Dungeness Flood Hazard Management Plan; sketches by Amanda Kingsley, used with permission)



Figure 5-6. Dungeness River channel migration event (Photo: Randy Johnson)

Table 5-2. Clallam County streams with mapped channel migration zones

Stream	Mapping Source
Clallam River	Ecology (2011)
Deep Creek	Ecology (2011)
Dungeness River	Jamestown S' Klallam Tribe (2008)
East Twin River	Ecology (2011)
Herman Creek	Ecology (2011)
Hoko River	Ecology (2011)
Little Hoko River	Ecology (2011)
Lyre River	Ecology (2011)
Morse Creek	Ecology (2011)
Pysht River	Ecology (2011)
Seiku River	Ecology (2011)
West Twin River	Ecology (2011)

5.2.2 Evaluation of Freshwater Processes along the Strait of Juan de Fuca Tributaries

Freshwater processes have been thoroughly reviewed and documented watershed by watershed for most Strait of Juan de Fuca tributaries through salmon recovery plans and watershed management planning efforts.

The Department of Ecology and the Puget Sound Partnership evaluated the condition of all of the freshwater watersheds in the Puget Sound Basin in terms of water flow processes as part of the Puget Sound watershed characterization project (Stanley et al. 2010). This coarse-scale analysis considers the degree of importance that each sub basin has in performing natural hydrologic processes and the degree to which those processes have been impaired or altered by increased impervious surface, reduced forest cover, loss of wetlands, floodplain disconnection, etc.

The results provide a relative ranking of sub basins into one of three categories (Figure 5-7):

- Protection – these sub basins are highly important in terms of infiltration, recharge, water storage and other natural water flow processes and have minimal alteration. Protection of the existing conditions is a high priority.
- Restoration – these sub basins areas are also very important to natural hydrology, but have experienced alteration. Restoration in these areas could help to increase ecological process and functions.
- Development – these sub basins are less important—on a relative scale—for hydrology processes and they have been moderately to highly altered. Development in these areas would generally have less impact on hydrology than in either of the other two categories.

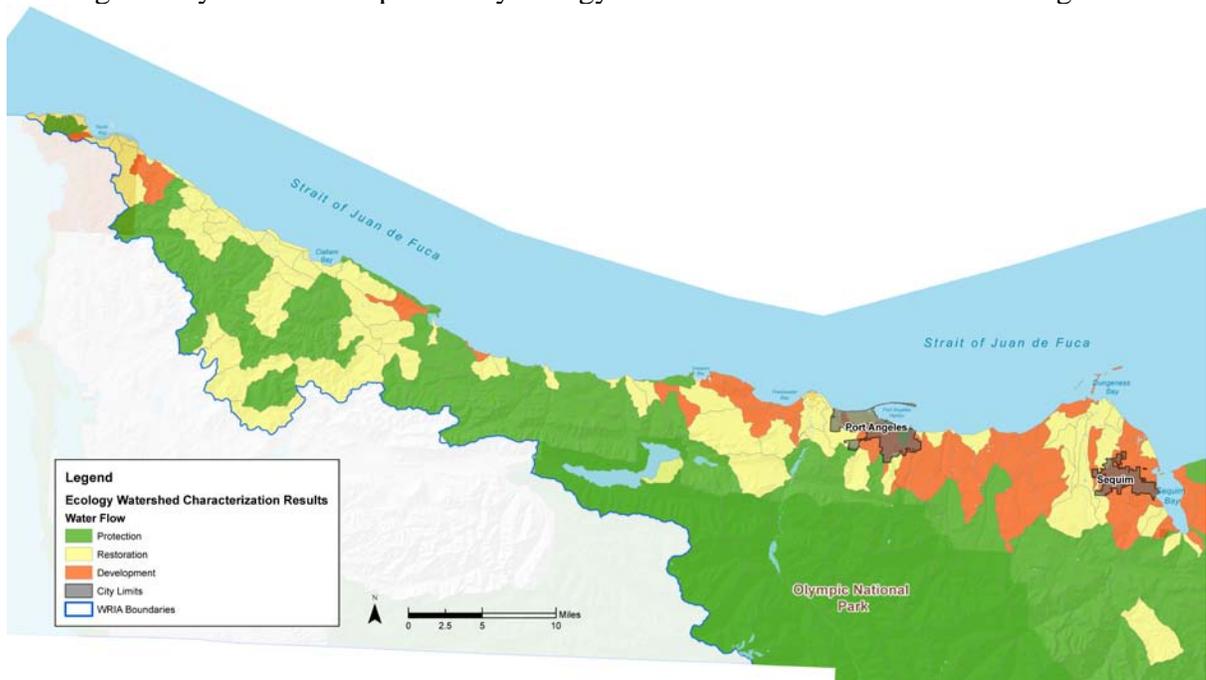


Figure 5-7. • Ecology’s relative ranking of the water flow processes for each sub basin draining to the Strait of Juan de Fuca

- In Clallam County most of the lowland sub basins are in the protection or restoration categories. A few of the sub basins around Sequim Bay, McDonald Creek, Morse Creek, and Freshwater Bay are considered to be more appropriate for development given existing levels of alteration. However, development within these sub-basins may negatively impact valuable fish and wildlife habitats.

5.3 *Establishing a Baseline to Measure and Track Freshwater Ecological Functions*

As noted in Chapter 3, shoreline master programs regulate development actions, which can affect shoreline processes, structure and functions. As an example, an SMP can regulate how much streamside vegetation must be retained on a parcel slated for development. The amount of vegetation will have a direct influence on the stability of the streambed and banks, which can affect the quality of the spawning habitat, which has a direct effect on the productivity of the salmon runs in that watershed (Figure 5-8). This basic model applies to a wide range of actions—meaning that many different ecological functions are affected by human actions and therefore have a direct link to SMP decisions. As a result, SMP decisions can lead to increases or decreases in ecological functions over time.



Figure 5-8. Relationship between vegetation retention regulations and salmon production in freshwater rivers and streams

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, decreasing, or remaining the same. The set of indicators must be specific enough to be tallied in a reliable and systematic way, using available data from existing sources. Table 5-1 contains a set of suggested indicators that could be used to assess ecological function of Clallam County’s freshwater shorelines. 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 Table 5-3 describes current freshwater shoreline conditions in terms of these indicators² (along with some related pertinent information). Some of the indicators illustrate the intrinsic quality of the shoreline environment and other indicators are measures of

² There are no indicators at this time for Lake Sutherland

the degree of shoreline alteration. Readers are invited to suggest other indicators in addition to or in place of the ones suggested here.

Table 5-3. Suggested indicators of freshwater ecological function that can be systematically tallied using existing data for Clallam County

Metrics that Indicate Shoreline Quality	Why Selected?
<ul style="list-style-type: none"> ▪ Salmonid stock status (Table 5-3) ▪ Percent of reach area within 200 feet of the ordinary high water line with closed canopy forest (Table 5-4). 	<ul style="list-style-type: none"> ▪ Salmon species a culturally and economically significant species that require a wide range of freshwater habitats for spawning, rearing, and migration. Increasing the amount and quality of available habitat is a major goal. ▪ Streamside vegetation has a major influence on stream health. It provides habitat for wildlife, stabilizes streambanks, provides a source of large woody debris and organic matter, and provides shade to lower stream temperatures.
Metrics that Indicate Shoreline Alteration	Why Selected?
<ul style="list-style-type: none"> ▪ Percent of stream channel with levees or revetments (Table 5-5). ▪ Percent of impervious surface within shoreline jurisdiction (Table 5-6). 	<ul style="list-style-type: none"> ▪ Impervious surfaces adversely reduce infiltration which can impact groundwater recharge, stream baseflows, instream fauna and other functions. ▪ Levees disconnect stream channels from their banks 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.

Freshwater rivers and streams in Clallam County are vital to the health of many Puget Sound salmon stocks, including Chinook salmon, summer chum salmon, bull trout and steelhead, which are listed as threatened under the federal Endangered Species Act (Table 5-4, Map 3 in Appendix A). Historically, the basins of the Dungeness, Elwha, and Lyre rivers and Morse Creek were among the most productive of the north Olympic coast (NOPL Strategy available at <http://www.noplegroup.org/nople/pages/strategy/PrioritizedWatersheds.htm>). These and other basins have experienced significant declines in stock productivity likely caused by habitat loss, harvest practices, and changes in ocean conditions. The Sekiu, Clallam, Pysht, Twin, Hoko, Deep Lyre-Crescent basins are all at risk of losing one or more runs of Chinook, chum and/or coho salmon (Table 5-4). The shoreline master program can play a role in helping to revise these trends by promoting effective land use practices, requiring mitigation to offset potential habitat impacts and encouraging restoration to improve the amount and quality of freshwater salmon habitat.

Table 5-4. Summary of salmon stock status for North Olympic Coast rivers in Clallam County (from NOPL 2005, adapted to correspond to SMP study area)

Geographical Unit (Revised 15June03)	No. of Stocks or Stock Component on a Historic Basis	Critical and Extirpated Stocks		Current <i>Known</i> Trends as per NOP TRG		Specific Stocks at Risk of Extirpation as per NOP TRG
		Crit.	Ext.	Healthy or Depressed but Declining	Critical and Declining	
Central Strait Clallam Independents (McDonald, Siebert, & Bagley)	4		Fall chum	Fall coho, winter steelhead		Coho
Clallam Basin	4	Fall chum				Chum
Deep Basin	1	Fall chum			Fall chum	Chum
Dungeness Basin	11	Spring/summer chinook, fall pink, summer steelhead			Fall pink, summer steelhead	
E&W Twin Basins	4	Fall chum		Fall coho, winter steelhead	Fall chum	Chum
Eastern Strait Clallam Independents (Bell, Gienn, Cassalery, Cooper, Meadowbrook) ¹	1					Coho
Elwha Basin	10	Summer pink, fall chum	Spring/summer Chinook	Summer/fall Chinook bull trout	Summer pink, fall chum	
Ennis Basin	3		Fall chum	Fall coho		
Goodman Complex (Cedar, Goodman, Mosquito)	1	Unknown	Unknown			

Geographical Unit (Revised 15June03)	No. of Stocks or Stock Component on a Historic Basis	Critical and Extirpated Stocks		Current <i>Known</i> Trends as per NOP TRG		Specific Stocks at Risk of Extirpation as per NOP TRG
		Crit.	Ext.	Healthy or Depressed but Declining	Critical and Declining	
Hoko Basin	5	Fall chum				Chum
Jimmy Come Lately	4	Summer chum			Summer chum	Chum, coho
Lyre-Crescent Basin	5	Fall coho		Fall chum		Chum
Morse Basin	8	Fall coho, summer pink, fall chum	Spring/summer Chinook			
Nearshore	124+	24+	7+	16+	11+	See basins
Pysht Basin	5	Summer/fall Chinook		Fall chum		Chinook
Salt Basin	4					
Sekiu Basin	5	Summer/fall Chinook, fall chum				Chinook, chum
Sequim Bay (Johnson, Chicken Coop, Dean) ²	3			Fall coho		
Western Strait Clallam Independents (Village east to Colville Creek) ¹	4	Fall coho, fall chum			Fall coho, fall chum	Coho, chum

Salmon and other aquatic organisms rely on processes sustained by the dynamic interaction between the stream and the adjacent riparian area (Naiman et al., 1992; Naiman et al, 2000; Opperman et al., 2011). Riparian forest cover has a major impact on stream functions, as described above. In Clallam County, most streams have fairly high percentage of forest cover within 200 feet of the ordinary high water line (Table 5-5). This is especially true of the rivers in

western Clallam County. The lower reaches of the Clallam River, Dungeness River, Elwha River and Salt Creek have less forest cover in the riparian zone than most other reaches.

Table 5-5. Acres of closed canopy forest within 200 feet of the ordinary high water line (Data from Point No Point Treaty Council 2011)

Reach Name	Acres of Riparian Forest within 200' Shoreline	Total Acres of Reach	% of Riparian Forest
Bear_Cr_01	121	130	93%
Boun_Cr_01	54	55	99%
Brow_Cr_01	10	13	75%
Bull_Cr_01	11	18	58%
Cany_Cr_01	71	77	91%
Char_Cr_01	30	42	72%
Clal_Rv_01	59	110	53%
Clal_Rv_02	19	30	64%
Clal_Rv_03	31	89	35%
Clal_Rv_04	291	322	90%
Covi_Cr_01	15	15	100%
Deep_Cr_01	258	280	92%
Dung_Rv_01	15	45	33%
Dung_Rv_02	114	263	43%
Dung_Rv_03	83	175	48%
Dung_Rv_04	238	250	95%
Dung_Rv_05	326	330	99%
Dung_Rv_06	170	170	100%
Elli_Cr_01	35	44	79%
Elwh_Rv_01	104	214	49%
Elwh_Rv_02	51	147	34%
Elwh_Rv_03	68	102	67%
Etwi_Rv_01	201	216	93%
Gray_Rv_01	375	392	96%
Gree_Cr_01	27	33	83%
HERM_CR_01	51	84	61%
HERM_CR_02	37	55	68%

Reach Name	Acres of Riparian Forest within 200' Shoreline	Total Acres of Reach	% of Riparian Forest
HOKO_RV_01	36	44	81%
HOKO_RV_02	66	115	57%
HOKO_RV_03	264	319	83%
HOKO_RV_04	64	103	63%
HOKO_RV_05	185	246	75%
HOKO_RV_06	131	179	73%
HOKO_RV_07	110	150	73%
HOKO_RV_08	90	117	77%
HOKO_RV_09	105	124	85%
INDI_CR_01	174	238	73%
LAST_CR_01	2	3	67%
LHOK_RV_01	149	211	71%
LITT_RV_01	111	115	96%
LYRE_RV_01	171	187	91%
LYRE_RV_02	65	65	100%
MCDO_CR_01	242	350	69%
MORS_CR_01	274	424	65%
NBHE_CR_01	43	52	82%
NFSE_RV_01	206	244	84%
OLDR_CR_01	13	24	56%
PYSH_RV_01	60	92	65%
PYSH_RV_02	189	264	72%
PYSH_RV_03	41	69	60%
PYSH_RV_04	183	251	73%
ROYA_CR_01	17	17	100%
SALM_CR_01	25	47	52%
SALT_CR_01	9	37	24%
SALT_CR_02	158	183	86%
SBLI_RV_01	69	70	100%
SEKI_RV_01	178	272	66%

Reach Name	Acres of Riparian Forest within 200' Shoreline	Total Acres of Reach	% of Riparian Forest
SFPY_RV_01	44	67	66%
SFPY_RV_02	116	145	80%
SFSE_RV_01	114	124	92%
SILV_CR_01	34	34	100%
SUTH_LK_01	1	3	39%
WTWI_RV_01	206	256	80%
Grand Total	6,623	8,695	76.2%

The interaction of a stream with its adjacent riparian area is adversely affected by stream bank modifications such as levees and revetments. Levees and revetments are typically constructed to constrain channels and/or prevent flooding. Although not known to be widespread in Clallam County (Table 5-6), levees and revetments restrict channel movement and can concentrate flow, which alters the natural morphology and reduces instream habitat value. Levees on the lower Dungeness River, for example, have been implicated as contributing to declining salmon runs (Recommended Restoration Projects for the Dungeness River, 1997; Limiting Factors Analysis WRIA 18, 1999; Summer Chum Initiative, 2000). Avoiding and minimizing the need for new levees and revetments will be an important element of the County's overall no net loss strategy

Table 5-6. Acres and Number of Revetments and Levees on SMP streams in WRIA 17, 18 and 19 streams in Clallam County by reach (no systematic data available; estimates are from Clallam County staff and local experts)

Freshwater Reach	Revetments / Levees	
	ACRES	COUNT
Dungeness River Reach 01	7.1	2.0
Dungeness River Reach 02	4.8	1.0
Dungeness River Reach 03	6.7	5.0
Elwha River Reach 01	14.6	22.0
Elwha River Reach 03a	7.3	2.0
Little River Reach 01	3.9	1.0
Morse Creek Reach 01	3.7	4.0
Pysht River Reach 01	18.6	3.0
Grand Total	66.8	40.0

Minimizing new impervious surfaces can also help to maintain ecological functions in freshwater streams. Currently, there is relatively little impervious cover within 200 feet of most freshwater

streams in Clallam County (Table 5-7). This means that infiltration and recharge processes are largely intact in these areas, which helps to maintain hydrologic, water quality and habitat functions. Exceptions to this are the upper reach (Reach 3) of the Clallam River, Lake Sutherland and the lower reach of Morse Creek (Reach 1). These areas have roads near the shoreline, so the levels of impervious surface areas are ~10 percent or more.

Table 5-7. Impervious surface area as a percent of the shoreland jurisdictional area for streams in WRIA 17, 18 and 19 streams in Clallam County by reach (From National Land Cover Data Set)

Freshwater Reach	Percent Impervious Area (excludes aquatic areas)
Bullman Creek Reach 01	5.0%
Canyon Creek Reach 01	1.1%
Charlie Creek Reach 01	0.9%
Clallam River Reach 01	3.0%
Clallam River Reach 02	4.9%
Clallam River Reach 03	15.0%
Clallam River Reach 04	1.3%
Deep Creek Reach 01	0.5%
Dungeness River Reach 01	2.4%
Dungeness River Reach 02	3.0%
Dungeness River Reach 03	6.1%
Dungeness River Reach 04	0.3%
East Twin River Reach 01	0.8%
Elwha River Reach 01	0.6%
Elwha River Reach 02	3.7%
Elwha River Reach 03	7.9%
Green Creek Reach 01	0.0%
Hoko River Reach 01	2.4%
Hoko River Reach 02	1.6%
Hoko River Reach 03	1.3%
Hoko River Reach 04	1.1%
Indian Creek Reach 01	5.8%

Freshwater Reach	Percent Impervious Area (excludes aquatic areas)
Lake Sutherland Reach 01	18.1%
Little River Reach 01	0.7%
Lyre River Reach 01	1.3%
McDonald Creek Reach 01	2.4%
Morse Creek Reach 01	9.8%
Pysht River Reach 01	0.2%
Pysht River Reach 02	4.1%
Pysht River Reach 03	5.7%
Pysht River Reach 04	2.1%
Salt Creek Reach 01	2.3%
Salt Creek Reach 02	1.5%
Sekiu River Reach 01	7.5%
Grand Total	3.5%

5.4 General Management Considerations for Freshwater Shorelines

Human development has changed the freshwater shorelines of the North Olympic Peninsula—dams, water diversions, bank armoring, bridges, roads, pavement, home building, and vegetation removal have altered freshwater ecosystem processes. Future use and development of freshwater shorelines may restore ecosystem processes as recovery plans are implemented. At the same time, continued development will put additional pressure on freshwater ecosystems. Some of the future issues and management considerations that are common to multiple areas of the Clallam County freshwater shorelines include the following:

1. Conversion of forest land and removal of existing forest cover along the river corridors may degrade habitat, reduce water quality, alter flow patterns, and destabilize river banks.
 - Limit the removal of forests and other natural vegetation communities within the watershed, and particularly within the channel migration zone of the river. Riparian vegetation helps stabilize eroding river banks, and provides habitat and shade for fish and wildlife.
 - Reforest riparian corridors and floodplain areas to increase stream bank integrity, reduce bank erosion, maintain organic inputs to streams and maintain habitat connectivity.

2. Placement of structures in floodplains, channel migration zones, and landslide hazard areas increases the risk to human health and safety, adversely alters water quality and flows, degrades habitat, and increases the risk of downstream flooding and erosion.
 - To protect property, human health and safety, and the ecological health of streams, avoid development in floodplains and channel migration zones.
 - Limit the construction of levees and other types of hard armoring along stream banks. Armoring degrades riparian habitat, and may increase erosion potential downstream.
 - Explore opportunities for land acquisition and easements to remove development or potential development in flood hazard areas including floodplains and channel migration zones.
3. There is significant restoration potential for reforestation, placement of large woody debris, barrier removal, and other restoration projects in many watersheds as outlined in detail in the NOBLE strategy and individual watershed recovery plans. These include:
 - Use LWD to improve habitat quality by restoring pool/riffle structure and forage/cover habitat. Properly designed LWD also reduces the potential for channel incision problems.
 - Protect and restore habitat connectivity where feasible by setting back or removing fill, levees, or other barriers to historic floodplain areas, former meanders, wetlands, and estuarine river deltas.
 - Identify and replace fish barriers and barrier culverts within identified watersheds. Eliminate road, culverts, or other land uses that cause mass wasting events.
 - Reforest riparian and floodplain areas to increase stream bank integrity and reduce bank erosion. Reforest unutilized pasture areas and degraded riparian/floodplain areas.
 - Explore possibility of habitat acquisition and/or easements to protect high quality riparian and floodplain estuarine habitats.
4. Regulations for SMP areas overlap with the Critical Areas Ordinance and required setbacks vary in their effectiveness.
 - Setbacks from the Ordinary High Water Mark may not sufficiently protect landowners from channel migration, resulting in flood hazards, non-conforming uses, and restrictions on rebuilding or expansion.
 - Regulations should be streamlined to allow landowners to move structures back from the channel migration zone, if feasible.
 - Provide landowners with accessible information about potential flood/erosion hazards and other potential development issues along freshwater shorelines.