

CHAPTER 3. ECOSYSTEM PROFILE

3.1 Introduction

This ecosystem profile has been prepared to provide a basis for understanding how watershed processes affect the form and function of Mason County's shorelines. This chapter provides an overview of the watershed conditions across the landscape and describes how ecosystem-wide processes affect the function of the County's shorelines as required under shoreline guidelines outlined in WAC 173-26-210(3)(d). This watershed-scale overview provides context for the reach-scale discussion provided in Chapters 4 through 9. The landscape analysis approach to understanding and analyzing watershed processes developed by Stanley et al. (2005) has been referenced to complete this section of the report. Terms used in this section are defined in the document entitled *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understand Watershed Processes* (Stanley et al., 2005). The maps referenced in this chapter are provided in Appendix A (Map Folio).

Mason County is located generally in the southwestern corner of the Puget Sound Basin in western Washington. According to the U.S. Census Bureau, Mason County has a total area of 1,051 square miles, of which 961 square miles is land and 90 square miles (8.6 percent) is water. Elevations in the County range from 6,400 feet above mean sea level (MSL) in the foothills of the Olympic Mountains, to sea level along the coastline of Puget Sound and Hood Canal.

The County includes portions of five Water Resource Inventory Areas (WRIAs) as outlined below:

- WRIA 14a: Kennedy Goldsborough;
- WRIA 15: Kitsap;
- WRIA 16/14b: Skokomish-Dosewallips and South Shore of Hood Canal;
- WRIA 21: Queets-Quinault; and
- WRIA 22: Lower Chehalis.

These watersheds are illustrated on Map 1 – Regional Context (Appendix A). As a result of recent legislation, the WRIA 16 planning area includes all the Hood Canal drainages along the south shore of the lower canal from the Skokomish to west of Belfair (this area is known as WRIA 14b). The portion of WRIA 21 within Mason

County is located entirely within federal land (Olympic National Park) and is not discussed further in this report.

With the exception of WRIA 22, each of the remaining three basins includes both marine and freshwater shorelines. An overview of the marine shorelines of the county is provided below, followed by a summary of each of the four WRIsAs.

3.1.1 Marine Shorelines

The marine shorelines in Mason County are located in WRIA 14a, 14b, 15, and 16 and cover about 217 linear miles including the inner shores of inlets, embayments, and estuaries. Mason County nearshore character varies considerably and is comprised of numerous geomorphic shoretypes. Controlling factors within the Mason County marine landscape include climate, wave energy (exposure), sea level, and topography and bathymetry. Other variables are of influence to Mason County marine shores include: net shore-drift of sediment, bluff geology (stratigraphy), tidal regime, and numerous fluvial systems the largest of which include the Hamma Hamma and Skokomish Rivers.

The reach scale-discussion of marine shorelines is divided into Hood Canal (Chapter 4) and South Puget Sound (Chapter 5). Hood Canal marine shorelines are located in WRIA 14b and portions of WRIA15, and 16, covering about 85 miles. Hood Canal marine shorelines in Mason County include a total area of roughly 4,003 acres, which includes approximately 2,001 acres of water. South Puget Sound marine shorelines are located in a portion of WRIA 14a. South Puget Sound marine shorelines in Mason County include a total area of roughly 5,980 acres, which includes approximately 2,935 acres of water.

The Mason County marine shores encompass shorelines in two distinct areas of Puget Sound, including southern Hood Canal (from near Triton Head south) and the southern extent of the Southern Puget Sound subbasin from between the Pierce County line in northern Case Inlet to the heads of Hammersley, Totten and Little Skookum Inlets, including Oakland Bay, Pickering Passage, Peale Passage and Harstene Island. Several smaller islands are also encompassed within the County including Stretch, Reach, McMicken and Hope Islands.

Hood Canal and Puget Sound were historically a large freshwater lake called Lake Russell, which was formed by the retreat of the Fraser Glaciation, which was the most recent glacial period. The lake extended from the vicinity of Seattle in the north to the Black Hills, which are located in the southwest portion of WRIA 14, and drained south to the Chehalis River. When the glacier retreated north of the Strait of Juan de Fuca, the freshwater was replaced by saltwater and created the present marine environment of Puget Sound. In South Puget Sound, extensive alluvial deltas

formed at Hammersley Inlet, Oakland Bay, Skookum Inlet, Oyster Bay (Molenaar and Noble, 1970). All of these deltas are located along Mason County marine shorelines in WRIA 14.

Each of the marine shores in Mason County have a geomorphic shoreform unit (GSU) designation. The hierarchy of process unit designation is structured upon two prominent processes that occur around Puget Sound. The processes are littoral drift and riverine deltas. The primary GSUs are Delta Process Units (DPU) and Shoreline Process Units (SPU) (Simenstad et al., 2009; Kramer et al., 2009). The GSUs in Mason County include delta and shoreline process units. The total number of geomorphic process units is 113. In Mason County, there are 34 geomorphic process units along the Hood Canal shorelines and 79 along the South Puget Sound shorelines. Coastal shore types are illustrated in Map 7 – Coastal Shoreform Types (Appendix A). The dominant coastal shoreform type in the County is bluff-backed beach.

3.1.2 WRIA 14a: Kennedy Goldsborough

WRIA 14 covers approximately 243,840 acres at the southwest terminus of Puget Sound (Kuttel, 2002). Of this area, approximately 207,858 acres or 85% of the WRIA is located in Mason County; the remainder of this WRIA is located in Thurston County. The terrain and drainage network are largely the result of past glacial episodes that gouged out the inlets and deposited and reworked large amounts of gravel, sand, and clay sediments (Molenaar and Noble 1970 in Kuttel, 2002). With the exception of the Black Hills in the extreme southwest portion of WRIA 14, the majority of the area is low elevation hills and valleys.

In 2008, the State Legislature passed a bill that split WRIA 14 into two separate areas for watershed planning. The bill (SB 6204) designated WRIA 14b as the portion of Kennedy-Goldsborough that drains into the southern portion of lower Hood Canal. The legislation then states that the WRIA 16 planning efforts must include WRIA14b. No freshwater streams meeting the definition of shorelines of the state are found within this sub-watershed; however, two freshwater lakes do drain to the south shore of Hood Canal in WRIA 14b.

Principal drainages include Cranberry, Goldsborough, Kennedy, Mill, Sherwood, Johns, Deer, and Skookum Creeks. Despite the abundance of creeks, WRIA 14 has no major rivers. Numerous lakes are present. WRIA 14 includes the community of Allyn and the City of Shelton and its urban growth area. The Squaxin Island Tribe Reservation encompasses the entirety of Squaxin Island; the Tribe also holds reservation and trust lands near the mouth and other areas of Skookum Creek.

Land use in the Kennedy-Goldsborough area is primarily forest (71%) with urban and agricultural use accounting for four percent each. Although timber production was (and remains) the dominant industry in WRIA 14a, oyster production is another valuable local commodity. Damming of streams and wetlands to create lakes, and shoreline modifications for residential development, have been common in WRIA 14a. These activities along with conversion of forestland to agricultural or residential land uses have altered the natural flow regime of many streams in the region. Dams and failed culverts may hinder salmonid migration in the Kennedy-Goldsborough Basin.

Marine shorelines of WRIA 14a are the shorelines of Case Inlet, Oakland Bay, and Totten Inlet, including islands such as Harstene and Squaxin. Marine shorelines of WRIA 14b include the south shore of Hood Canal.

3.1.3 WRIA 15: Kitsap

WRIA 15 covers approximately 631,100 acres of the Kitsap Peninsula, most of which lies within Kitsap County. Of this area, approximately 80,997 acres or 13% of the WRIA is located in Mason County. The remainder of WRIA 15 is located in both Kitsap and Pierce Counties. The topography of WRIA 15 is generally low in elevation and gradient. Major water bodies in this drainage include the Union River, Tahuya River, Dewatto River, Rendsland Creek, and Mission Creek; many small lakes are also present.

Development trends in WRIA 15 have resulted in an increase in impervious surfaces, associated with conversion of forestland to residential and commercial development. Major land uses in WRIA 15 are forest resources, agriculture, and urban uses. The community of Belfair is located at the eastern end of Hood Canal. Although the degree of shoreline development is high in some areas, the upland watersheds have relatively low impervious surface areas, and predominantly forest or mixed forest/pasture land cover. This area generally lacks large urban/industrial development (Haring, 2000; Pierce County and ESA Adolfson, 2009).

Anadromous salmonid distribution is limited in many east WRIA 15 streams by the presence of natural barriers (falls and cascades), culverts, dams, tide gates, and reduced instream flows. Small dams are common in the eastern portion of WRIA 15 (Haring, 2000). The marine shoreline of Hood Canal borders the western and southern boundaries of WRIA 15 in Mason County.

3.1.4 WRIA 16/14b: Skokomish-Dosewallips

WRIA 16 covers approximately 428,800 acres (WRIA 16 Planning Unit, 2006). Of this area, approximately 242,119 acres or 56% of the WRIA is located in Mason

County. The topography ranges from mountains in the western part of the basin to low-elevation river valleys that drain to Hood Canal. The largest rivers in the Mason County part of the watershed are the Skokomish River and Hamma Hamma River. Many smaller streams, some of which are intermittent, also flow directly into Hood Canal. For watershed planning purposes, WRIA 16 has been combined with WRIA 14b, which includes lands draining to the south shore of Hood Canal from the community of Union to the southern edge of the Belfair Urban Growth Area.

Lake Cushman is a large reservoir formed in the 1920s by damming the North Fork Skokomish River. Kokanee Dam is also located on the North Fork. Numerous small dams are located on smaller streams throughout the WRIA (Correa, 2003).

The economy in WRIA 16 relies largely on shellfish harvesting, commercial forestry, tourism, Christmas-tree farming, and some agriculture (WRIA 16 Planning Unit, 2006). Agriculture and residential development within the floodplains of many WRIA 16 watersheds have resulted in channelization of rivers and tributaries, draining of beaver ponds for livestock grazing, and logging in forested riparian zones. Forest practices in the watershed have caused adverse impacts on salmon habitat in WRIA 16 (Correa, 2003).

The Skokomish Tribe Reservation is located near the mouth of the Skokomish River on Hood Canal. The communities of Hoodsport, Potlatch, and Lilliwaup are located north of the reservation. WRIA 16 extends west into federally owned national park, national forest, and wilderness lands.

WRIA 16 has approximately 8,000 permanent residents, most of who reside along the shore of Hood Canal (WRIA 16 Planning Unit, 2006). In addition to the effects of residential development along the marine shoreline, a major impact to the nearshore environment is SR 101, which extends north/south along the entire shoreline.

3.1.5 WRIA 22: Lower Chehalis

WRIA 22 covers approximately 939,456 acres draining from the southwestern Olympic Mountains. Of this area, approximately 132,145 or only 14% of the WRIA is located in Mason County. Major water bodies in the Mason County portion of WRIA 22 include the East Fork and Middle Fork Satsop River, Cloquallum Creek, and Decker Creek. These water bodies flow south toward the mainstem Chehalis River, which in turn flows west to discharge to Grays Harbor on the Washington coast.

This portion of WRIA 22 has a low population density and is mostly in commercial forestry. Federally owned national forest land occupies the northern part of the drainage in Mason County. No marine shorelines are present in the Mason County portion of WRIA 22.

3.2 Climate, Geology, Landforms, and Channel Migration Zones

3.2.1 Climate

Mason County's climate is a West Coast marine climate with generally mild, wet winters and dry, warm summers. The climate is influenced by the Pacific Ocean, yet sheltered by the Olympic Mountains. Local climate conditions within Mason County can vary significantly depending on topographic position and season. Average temperatures in Mason County range from 32° F in January to 78° F in July (Mason County, 2005). Mason County's average daily temperature is 51° F and average precipitation is 64 inches. The average monthly precipitation varies from a low in July of 0.8 inches, to a high of 10.4 inches in January. The precipitation primarily falls between October and March in frequent rainfalls of low intensity. In the higher elevations, some of this precipitation falls as snow.

Climate Change

Climate change happens on scales ranging from decades to centuries. All of these fluctuations can have an impact on ecological conditions in the shoreline environment. The El Nino-Southern Oscillation (ENSO) process influences weather over months to years and occurs in different phases. Phases of ENSO include neutral, El Nino (warm event), or La Nina (cold event). These phases represent equatorial temperatures that include climate patterns in the northwest and throughout North America. The Pacific Decadal Oscillation (PDO) is similar to ENSO, but occurs over several decades. The impact of PDO is focused on the Pacific Ocean, but the causes and effects of PDO are not as well understood as ENSO, due to the generally longer time scale of the process.

In recent years, significant research has been focused on potential impacts of a changing overall climate regime. Two organizations that have completed extensive research related to climate change are the International Panel on Climate Change (IPCC) and the Climate Impacts Group (CIG), at the University of Washington (IPCC, 2007; CIG, 2009). In Western Washington there are two types of changes that could result from climate change that have the potential to influence ecological processes in Mason County: (1) changes in seasonal temperature and precipitation; and (2) sea level rise.

In the 20th century, the average annual temperature and precipitation generally increased in the Puget Sound region (CIG, 2009). Changing temperature and precipitation patterns could alter how the marine and freshwater systems function. Climate change is likely to have an impact on future water resources in Mason

County. Over the next decades, increased regional temperatures are anticipated to lead to a reduction in snowpack and receding glaciers in the Olympic Mountains. Since many of the tributary streams in WRIA 16 and 22 depend upon snowmelt and glacier melt waters, these streams may be affected over time. Anticipated effects include decreased summer baseflows as snowpack and glaciers are reduced. Spring peak flows are also predicted to occur two to six weeks earlier than they do normally (CIG, 2009). Further, streams without snowmelt or headwaters in the mountains will also be affected (as in WRIA 14 and 15), perhaps more strongly, as streams currently have low in-stream flows.

Additionally, the communities in Mason County that are low-lying and located adjacent to South Puget Sound and Hood Canal could be affected by sea level rise. Sea levels in Puget Sound are projected to rise between 3.0 inches and 22.0 inches by Year 2050 (Mote, 2008). Sea level rise will allow high tides to reach farther into low-lying coastal areas and rise higher on existing flood control structures such as dikes and bulkheads. Coastal flooding will persist longer and could lead to faster rates of erosion on beaches and coastal bluffs (Shipman, 2009). Ecology has directed local governments to consider preparing for sea level rise during the Shoreline Master Program update process (Appendix B - Addressing Sea Level Rise in Shoreline Master Programs).

3.2.2 Geology

The geology of Mason County is shown in Map 5 – Geologic Formations (Appendix A). The bedrock in Mason County is composed of thick beds of basaltic and andesitic lavas during the early and middle parts of the Eocene Epoch of the Tertiary Period. During this period, sea level fluctuated, which caused some of the lava to be deposited in marine waters and streams to erode the volcanic rocks and deposited sediment. These sediments formed interbed and lenses in the lava rock. Volcanic activity decreased during the late Eocene. Thousands of feet of marine sedimentary rocks were laid down on top of volcanic rocks during the late Eocene through the Oligocene and early Miocene Epochs (Garling and Molenaar, 1965).

During the late Pliocene Epoch, north-south uplift produced the Olympic Mountains. The Puget Trough formed by a downwarp associated with building of mountains. Sediments, ranging in size from fine-grained clays to coarse sands and gravels, accumulated through the Pliocene and most of the Pleistocene Epochs in freshwater lakes and swamps. When plant material accumulated at the bottom of these water bodies, peat and lignite formed. During the Pleistocene Epoch, streams draining adjacent mountains and glaciers deposited the coarse sediment (Garling and Molenaar, 1965).

During the Pleistocene Ice Age, glaciers traveled from Canada into the Puget Sound lowland area. The glaciers ranged in thickness from roughly 2,000 to 5,000 feet thick. Climate fluctuations caused the glaciers to advance and retreat repeatedly. The last glaciers in the Puget Sound region retreated about 14,000 years ago. Streams flowed from the melting glaciers, carved channels, and deposited sediments. During periods between glacial advances, vegetation, including forests, recolonized the areas. When the glaciers retreated, the vegetation was buried and formed peat beds. Glaciers distributed till, which consists of cobbles mixed with silt and clay, over the area (Garling and Molenaar, 1965). Once ice left Puget Sound, sea water created the present marine environment of Puget Sound, including the marine water bodies adjacent to Mason County (Garling and Molenaar, 1965). The historic scouring and retreat of glaciers across Mason County can be seen by the north-south orientation of many lakes within the County.

3.2.3 Landforms

The three dominant topographic features in Mason County are: (1) the high jagged peaks and slopes of the Olympic Mountains in the northwest; (2) the lower and more rounded Black Hills along the southern border; and (3) the lower lying, rolling glacial moraine and the outwash plain (Ness et al., 1970). The elevation of the Olympic Mountains in the county is more than 6,000 feet, while elevations in the Black Hills are roughly around 1,500 feet. The glacial plain ranges from sea level to approximately 1,000 feet. Most of the glacial plain topography ranges in elevation from 300 to 400 feet.

The glacial plain is cut by numerous stream channels and inlets of Puget Sound. The main one is Hood Canal which penetrates the county from the north for roughly 20 miles, then turns sharply to the northeast for roughly 17 miles (Ness et al., 1970). The Hood Canal separates roughly 90 square miles from the rest of the county.

Elevations in Mason County range from sea level to 6,445 feet on Mount Skokomish. Most of the towns are located along shores of the Puget Sound inlet, which is on the glacial plain, and only a few are above sea level. All farmlands in the County are located less than 600 feet above sea level (USGS, Date).

3.2.4 Channel Migration Zones

The channel migration zone (CMZ) is the area where a stream or river may migrate laterally over a period of time, resulting in movement of the stream or riverbed. Channel migration is a natural process associated with all sizes of flowing streams and rivers. The Washington Department of Ecology established a methodology for mapping channel migration in 2003 (Rapp and Abbe, 2003). In 2009, Patricia Olson, with the Washington Department of Ecology Shorelines and Environmental

Assistance Program (SEA), prepared a document outlining a method for identifying potential channel migration reaches for SMP updates (Olson, 2009). Steps in determining channel migration include determining channel confinement and gradient, geology erosion potential, bank and floodplain erosion potential, and channel pattern and evidence of channel movement or bank erosion (Rapp and Abbe, 2003; Olson, 2009).

In 2006, a channel migration analysis was completed by GeoEngineers for the Skokomish River from the delta mouth to river mile 11.5 (GeoEngineers, 2006). The study identified significant channel migration in the high-flow corridor and the highest migration rates in the reach from RM 7.5 to 11.5 (GeoEngineers, 2006). The Skokomish River has occupied a definable CMZ for the last 100 years, especially in the upper reaches (Bureau of Reclamation, 2009).

A CMZ characterization for the entire county is currently being undertaken by Ecology and will be completed in the fall of 2011 (Patricia Olson, personal communication, 2011).

3.3 Surface Water and Groundwater

Mason County has significant surface water and groundwater resources. The main source of groundwater recharge is from precipitation. The main water bodies that contribute to the surface water in Mason County include (listed from north to south) the Hamma Hamma River, Lilliwup Creek, Dewato River, Tahuya River, Sherwood Creek, Skokomish River, Deer Creek, John's Creek, Goldsborough Creek and Mill Creek, as well as their tributary streams and lakes. The origin of many of the surface water watersheds are in the Black Hills or Olympic Mountains. Frequently flooded areas in the County are shown on Map 10 and hydrologic features are shown on Map 4 – Hydrology (Appendix A).

In the Black Hills, the majority of the precipitation runs off because of the prevalence of impermeable rock. This causes many headwater streams in the Black Hills to go dry during summer months (Kuttel, 2002). Precipitation that falls on unconsolidated sediment of the glacial plain tends to percolate into the groundwater, providing perennial flow to low lying streams. In late summer, groundwater provides the majority of summer flows to many of the creeks in the County (Molenaar and Noble, 1970).

Minimum instream flow requirements for the watersheds in Mason County are specified in the Washington Administrative Code (WAC). Many of the rivers and creeks in Mason County fall below the statutory minimum levels during some months. These streams have been closed to further appropriations for some or all of

the year. In Mason County, four major areas are identified as critical aquifer recharge areas (Map 11 - Critical Aquifer Recharge).

3.4 Water Quality

One of the major watershed issues within Mason County is degrading water quality. Water quality impairments as defined by the Washington State Department of Ecology for the 2008 303(d) list are illustrated at the county scale on Map 13 – Water Quality.

Marine

Water quality in Puget Sound has been worsening over time. Toxic pollutants are entering the Puget Sound through stormwater runoff. Fecal coliform bacteria concentrations are present from municipal and septic systems or animal waste. Nutrient loads, particularly nitrogen have been identified as a potential stressor to the Puget Sound ecosystem. One consequence of excessive nutrient loading may be low dissolved oxygen concentrations in the water. The Puget Sound Partnership has targeted water quality degradation as a primary issue to be addressed for the recovery of the Puget Sound. Trends in water quality for Puget Sound show degradation over time (PSAMP 2007).

Data collected in South Puget Sound show that portions of the South Sound fall below State water quality standards for dissolved oxygen, particularly Case Inlet. Dissolved oxygen levels decrease when excess nutrients (e.g., nitrogen) enter marine waters and stimulate algae growth. Low DO levels can be harmful to fish and other marine life, affecting the health of the Puget Sound ecosystem. The Washington State Department of Ecology initiated a study (South Puget Sound Dissolved Oxygen Study) to determine whether human sources of nitrogen are contributing to low DO levels (Mohamedali et al., 2011). This study determined that 77 percent of the nitrogen entering the South Puget Sound is attributable to river inputs. On the other hand, in the summer, during low stream flows, up to 90 percent of the dissolved inorganic nitrogen came from wastewater treatment plants (Mohamedali et al., 2011).

In Hood Canal, the main water quality issues are low dissolved oxygen and high summer temperatures, which are related to nutrient loading, summer water temperatures and a lack of natural flushing within the shallow bays and inlets. Although the water quality is good in some locations, low dissolved oxygen levels and high fecal coliform concentrations are problematic during the summers in a certain areas. Ecology's 2008 water quality assessment (Washington Department of Ecology 2008a) documented several segments in Hood Canal that did not meet the

State's water quality standards for dissolved oxygen, fecal coliform or both; and were subsequently placed on the EPA 303(d) list of impaired waters. These problems date back to before the 2008 assessment. Fish kills, presumably the result of low oxygen levels, were reported as far back as 1920 (Newton et. al. 2011). However, recent scientific studies and anecdotal evidence suggest that the frequency, duration, and spatial extent of low dissolved oxygen events are increasing (Newton et. al. 2011).

Aside from dissolved oxygen and fecal coliform, there are no other known water quality impairments for Hood Canal marine waters. Sediment quality analyses conducted by the Department of Ecology in 2005 indicated moderate sediment toxicity at some Hood Canal sampling sites within Mason County, and one site that had 'intermediate/degraded' quality. These results were based on a combination of results for chemical, toxicity, and benthic data referred to as the Sediment Quality Triad Index. No sites had individual chemical concentrations that exceeded State or National Oceanographic and Atmospheric Administration (NOAA) sediment quality standards (Long et. al. 2010).

Rivers and Lakes

Shoreline development and landscape techniques around freshwater rivers and lakes can adversely affect water quality and the habitats that are maintained by specific water quality conditions. Freshwater shorelines, including wetlands and vegetated riparian areas act as buffers to filter and trap pollutants. The increase in impervious surfaces and installation of septic systems, in addition to human activities in the nearshore zone (such as boating, home maintenance, and landscaping techniques that can introduce pollutants) are all potential sources of water quality degradation in lakes and rivers.

In lakes, aquatic plant communities and aquatic plant management activities can also affect water quality. While aquatic plants provide an important physical habitat element in lakes, dense populations of these plants can negatively impact water quality and thereby degrade habitat as well as impact human uses. Few lakes in Mason County have Integrated Aquatic Vegetation Management Plans (IAVMPs) that have been developed by lake managers and community associations. Lakes with IAVMPs include Mason Lake and Lake Limerick (Tyler, personal communication, 2011) and a plan is currently in development for Haven Lake. Implementation of those plans may have indirect implications for water quality.

Available data regarding water quality in Mason County lakes is limited. There are 44 lakes that fall within SMP jurisdiction. Twelve of the 44 lakes were assessed by Ecology during the 1990s, and a summary statement from that assessment is included in this report for those lakes. However, as the data is nearly 25 years old,

no detailed review was performed. There are only a few 303(d) listings associated with these lakes. In this case, the lack of listings is more likely associated with lack of data than it is an indicator of good water quality. There are also four lakes (Island, Limerick, Mason, and Spencer) that are categorized as 4C, waters where some characteristic uses may be impaired due to aquatic habitat degradation that is not the result of a pollutant. In these four cases, the possible impairment is related to the documented presence of invasive exotic plants.

3.5 Fish and Wildlife Habitats

The physiographic regions in Mason County provide many terrestrial and aquatic habitats. These habitats occur in both the marine and freshwater portions of the County. This section describes some of the key Mason County habitats and the ecological functions they provide. Map 8 – Fish & Wildlife Habitat Areas illustrates these occurrences and habitats at the countywide scale.

Marine Beaches

Marine beaches are generally defined as areas with unconsolidated sediments that are moved, sorted, and reworked by waves and currents. The beach area can extend landward into the zone influenced by storm waves and generally includes the upper intertidal, beach face, low-tide terraces, and offshore zone to the limit of wave action. Beaches are typically steeper than tidal flats. Beaches occur throughout Mason County marine shorelines (Hood Canal, Case Inlet, Totten Inlet, Oak Bay).

Ecological functions of beaches include (Williams and Thom 2001; Williams et al. 2004; WDFW 2004):

- Forage fish spawning substrate;
- Habitat and refuge for intertidal fish and wildlife,
- Habitat/substrate for intertidal vegetation;
- Nutrient cycling;
- Primary production; and
- Shellfish habitat.

Tidal Sand and Mud Flats

Tidal flats are gently sloping, intertidal or shallow subtidal areas with unconsolidated sandy or muddy substrates. Mud flats are predominantly silts and clays and are high in organic content, often experiencing anaerobic conditions

below the surface (Simenstad et al. 1991). Sandflats are comprised of larger particles ranging from fine sands to gravels. Sand and mud flats are not necessarily featureless – they frequently contain a number of channels formed by hydrologic processes that transport and distribute water, sediments and organic material, and provide some refuge for fish and invertebrates, especially during low tides.

Sand and mud flats typically occur at mouths of rivers and streams where relatively large supplies of sediment are deposited as currents slow, and in embayments and depositional areas where wave and current energies are low. Because these are depositional areas where sediments are retained or build up over time, toxins (e.g., heavy metals) and/or pathogens associated with sediments also are retained and can build up over time.

The shallow flats and inlets of the Mason County nearshore are highly productive habitats, supporting high primary productivity and a diverse assemblage of benthic invertebrates and fish (SPSSRG 2004). Algal production on the surface of tide flats is an important source of food for prey items of salmonids and other fish. Light levels increase earlier in shallow tidal flats than in some deeper water habitats, such as eelgrass, and algal production on tide flats is important in the production of prey items used by juvenile salmon entering the nearshore in early spring (Redman et al. 2005). The shallow flats in the Mason County nearshore become productive earlier in the season than flats further north, due to higher light levels and warmer temperatures.

Nutrient cycling on tidal flats can be an important source of nutrients for algal growth and algal based food webs (Simenstad et al. 1991). Channels in tidal flats provide habitat and refuge for fish and invertebrates, including chironomids, amphipods (both important prey for juvenile salmon), polychaetes, clams, shorecrabs, tanaids, and mysids (Dethier 1990). Tidal flats also provide habitat and foraging areas for a number of fish, including juvenile Chinook and chum salmon, as well as English sole, starry flounder, sand sole, speckled sanddab, and staghorn sculpin (Simenstad et al. 1991).

In Mason County, sand and mud flat habitats occur in lower energy environments at the head of the major bays, such as Oakland Bay, and at the mouths of rivers such as the Hamma Hamma and Skokomish Rivers. Sand and mud flats also occur in smaller bays and embayments scattered throughout Mason County.

Eelgrass and Kelp Beds

Eelgrass (*Zostera marina*) is a native marine seagrass that forms extensive meadows or beds on gravel, fine sands or mud substrates in the lower intertidal and shallow subtidal zones of protected or semi-protected shorelines (Bulthuis 1994; Thom et al. 1998). Typical locations for eelgrass have medium to fine sands, adequate light,

relatively high levels of organic matter and nutrients (Simenstad 2000). Typical eelgrass locations are shallow tideflats, along channels in tideflats or estuaries, and in the shallow subtidal fringe. The eelgrass zone in Puget Sound is typically confined to areas between tidal elevations of +1 meter to -2 meters relative to mean lower low water (MLLW) (Thom et al. 2001, Simenstad 2000).

In undisturbed areas with optimal conditions, eelgrass can grow to a height of 2 meters, forming a tall, dense canopy. Eelgrass beds can be dense and continuous along a stretch of shoreline, or occur in small, discontinuous patches. On the shallow flats typical of the southern Puget Sound, eelgrass beds can form wide expanses. Eelgrass beds form narrow corridors along the shoreline in areas with steeper beaches, or where light penetration is limited (Simenstad 2000).

Eelgrass ecosystems are highly productive, providing a source of organic matter to intertidal and shallow subtidal food webs. Eelgrass plants produce large amounts of organic carbon that is consumed directly by grazers, as well as forming the basis for complex detrital food webs (Williams and Thom 2001). Eelgrass provides food and refuge for a number of invertebrates, which in turn are important prey for juvenile salmon and other fish (Simenstad et al. 1991). Juvenile salmon, as well as a number of other marine animals, depend on eelgrass habitat structure for refuge from predators. Eelgrass provides physical attachment sites for epiphytic algae and other organisms, and physical structure which absorbs and dampens the energy of waves and currents, providing some buffering for adjacent habitats. Pacific herring use eelgrass for spawning substrate and for protection while eggs and juveniles mature (Williams and Thom 2001).

Eelgrass occurs in several configurations in Puget Sound, defined by location and patch characteristics. Larger, solid and continuous beds are most frequently found on extensive tideflats and are sometimes referred to as “flats.” More fragmented and patchy beds are frequently found on the edges of continuous beds or along more narrow intertidal areas. Patchy eelgrass beds along shorelines with narrow intertidal areas are sometimes referred to as “fringing” eelgrass beds, as they form narrow patches of eelgrass fringing the shoreline (Bell et al. 2006; Berry et al. 2003; Dowty et al. 2005).

In Mason County, eelgrass is generally more abundant in Hood Canal and North Bay. Fewer eelgrass beds occur in South Puget Sound.

Kelp and other macrophytic brown algae can form dense, highly productive undersea forests that support many species of fish and marine mammals. Juvenile salmon and forage fish may preferentially use kelp stands in nearshore habitats (Shaffer 2003). Dense kelp forests also dissipate wave energy and provide sheltered habitat for resting/rafting seabirds and other animals within the kelp forest or adjacent surface waters. Kelp forests are comprised primarily of bull kelp

(*Nereocystis luetkeana*) and other large brown algae, including the introduced Sargassum (*Sargassum muticum*). These plants are attached to the marine bottom with holdfasts and require rocky or coarse substrates. Distribution is limited to areas with appropriate substrates, light penetration to the bottom and moderate wave/current energy.

In Mason County, kelp beds are generally absent in Hood Canal except for patchy areas on the western shore. In South Puget Sound, kelp is documented around Hastene and Hope Islands and in Hammersley Inlet.

Estuaries

Estuaries are embayments (bays) or semi-enclosed inland waters with freshwater inputs that serve as transition zones between marine and freshwater environments. Estuaries include the zone at the mouth of a river or stream dominated by the discharge of freshwater, and generally extends from the head of tidal influence seaward to the point where fluvial influences no longer dominate. Within the larger Puget Sound estuary, there are many river estuaries at the mouths of major rivers, numerous smaller estuaries associated with streams or bays, and localized small embayments that sometimes have freshwater discharge from either surface or groundwater sources (Beamer 2003). These smallest estuaries are sometimes referred to as “pocket estuaries.” Pocket estuaries usually contain emergent marsh, sand or mudflats, a channel structure, uplands and open water in close proximity. They may or may not contain surface freshwater inputs.

Estuaries are characterized by a gradient of salinities in tidally influenced wetlands, ranging from salt marshes at the marine edge to brackish wetlands where there is a greater freshwater influence, to tidally influenced but entirely freshwater emergent, shrub, and/or forested wetlands. Diking and draining of tidally influenced wetlands can result in the complete loss of brackish wetlands. Restricting tidal exchange converts areas that experienced intermediate and fluctuating salinities into areas dominated by freshwater. The presence of brackish wetlands, with salinities intermediate between freshwater and saltwater, and connected by channels to salt marshes and the nearshore, is critical to providing areas for physiological adjustment for outmigrating juvenile salmonids.

Estuarine areas, and tidal channels in estuaries, can be particularly important for physiological adjustment for juvenile salmon transitioning from freshwater to saltwater (Montgomery et al. 2003). Estuaries and large areas of habitat open to tidal exchange contain a wide variety of salinity levels and salinity gradients, which allow juvenile salmon to gradually adjust to saltwater. Complex tidal channel networks also provide a range of depths and velocities, which provide habitats suitable for a wide range of juvenile salmon sizes and life history types (Redman et

al. 2005). Small, shallower tidal channels provide habitat suitable for fry which spend little time in freshwater and enter the estuary at small sizes, while deeper, larger channels provide habitat suitable for larger juveniles entering the estuary after some time rearing in freshwater or larger juveniles transitioning to pelagic habitats. Estuaries also provide large amounts of organic matter to support macro-detritus based food webs, which are particularly important for salmon prey items (Bottom et al. 1991). Estuaries in natal rivers, such as the Skokomish, are critical habitats for juveniles originating in those rivers and can support large numbers of juvenile salmon. However, small estuaries, or pocket estuaries, in streams without salmon runs may also be critical to supporting juvenile salmon, especially when pocket estuaries occur in close proximity to larger estuaries (Beamer et al. 2003).

The primary ecological functions and biological resources of estuarine shorelines include:

- Flood attenuation;
- Tidal exchange/organic matter exchange;
- Stream base-flow and groundwater support;
- Water quality improvement (nutrient retention, nutrient cycling);
- Erosion/shoreline protection;
- Food web support;
- Habitat structure;
- Habitat connectivity;
- Salinity gradients; and
- Refugia – from predators (i.e., turbid waters of tidal channels).

In Mason County, major estuaries are found at the mouth of Hamma Hamma River, Skokomish River, Lynch Cove, Tahuya River, Dewatto River, as well as Goldsborough and Kennedy Creeks.

Non-natal Estuaries and Pocket Estuaries

In addition to the natal estuaries described above, there are tidally influenced systems that are not directly associated with larger rivers or Chinook salmon natal watersheds, but that also provide support to juvenile salmonids (Beamer 2003, Redman et al. 2005). Numerous smaller estuaries and embayments (pocket estuaries) occur within the Mason County marine nearshore environment. In these areas, small streams or seeps provide the freshwater inputs. Linkages or connectivity between natal estuaries, pocket estuaries, and other

shallow/nearshore habitats are critical for providing an array of suitable habitats easily accessible by migrating juvenile salmonids (SPSSRG 2004).

Pocket estuaries are associated with inlets and smaller streams which occur along Hood Canal, Case Inlet, Hammersley Inlet, Skookum Inlet, and Totten Inlet. Oakland Bay and Oyster Bay provide estuarine and other intertidal wetland habitats. Smaller pocket estuaries are also concentrated around Harstene Island.

Salt Marshes

Salt marshes and brackish marshes are habitats that occur in areas with tidal inundation. Salt marshes typically occur at elevations at and above MHHW in areas where sediment supply and accumulation are relatively high. Therefore, salt marshes can occur in bays, along sand spits sheltered from waves and currents and most commonly on river and stream deltas. Salt marsh vegetation, especially the root mats and dense stems, trap and stabilize sediments. Marshes tend to grow outwards over time as sediments entering the delta from rivers are captured and retained by salt marsh vegetation. Marshes often provide a complex network of tidal channels where juvenile salmonids feed and take refuge from predators, as well as providing habitat connections to riverine and marine environments (Hood 2005).

Ecological processes that are important for creating and maintaining salt marsh habitat include sediment transport and deposition and tidal exchange. Sediment transport and deposition forms the coastal landforms subject to periodic tidal inundation and exposure, which support salt marsh vegetation. Tidal exchange provides the sediment required for building marsh surfaces that are substrate for saltmarsh vegetation, and in addition, provides twice daily flushing of organic matter, nutrients, and pollutants. Organic matter from salt marsh vegetation supports macro-detritus based food webs that provide food items for forage fish and salmonids in nearshore habitats adjacent to salt marshes. Maintenance of salt marsh habitats depends in part on the balance between marsh aggradation due to the buildup of organic matter and sediment trapped in the marsh and sea level rise (Bottom et al. 2005).

The ecological functions and biological resources of salt marshes include:

- Detrital based food webs;
- In-situ production of invertebrate prey items of importance to nearshore fish and birds (e.g., salmonid prey);
- Tidal channels that provide refugia and foraging areas for fish and invertebrates; and

- Primary production– salt marshes are highly productive.

Salt marsh habitat in Mason County is generally coincident with the key bays, mouths of major rivers, and pocket estuaries. Linkages between the estuarine deltas and other shallow nearshore habitats such as pocket estuaries are critical for rearing and migrating juvenile salmonids (SPSSRG 2004).

Marine Riparian Vegetation

Marine riparian zones occur at the interface between upland and marine aquatic systems (Culverwell and Brennan 2003; Brennan and Culverwell 2004). Marine riparian zones occur above the area subject to tidal inundation, but may be in the area influenced by salt spray or storm waves. The type of marine riparian vegetation that occurs along the shoreline is influenced by a number of factors. For example, the underlying geology that influences the type of shoreform, whether feeder bluff, rocky shore, or beach backshore, will influence the type of riparian vegetation present. In addition, adjacent land uses may affect the type of marine riparian vegetation, such as the presence of invasive species, or the replacement of forested riparian vegetation with ornamental landscaping, lawns, or impervious surfaces. Shorelines comprised of very steep or unstable slopes may not support vegetation except at the very top of the slope. In contrast, small bluffs or shorelines may support dense riparian vegetation that overhangs into the upper beach zone. The presence of native trees in the marine riparian zone is of greatest importance due to the ability of trees to provide overhanging cover, detritus, shade and large woody debris (LWD) to the marine environment (EnviroVision et al., 2009).

Healthy marine riparian areas provide a range of essential functions, including water quality protection, sediment stabilization and control, wildlife habitat, nutrient retention, microclimate regulation, insect food sources for juvenile fish, shade/cover, and woody debris to provide complex habitat structure and stabilize beaches (Brennan and Culverwell 2004). Areas with intact riparian vegetation can also help protect slopes and bluffs from erosion hazards, mitigate storm damage, and stabilize slopes. Plant root masses provide stability by holding the soil in place. In addition, evapotranspiration removes moisture from the soil and can prevent high soil moisture or saturated soil conditions, which can lead to landslides or erosion hazards (Brennan and Culverwell 2004). The extent to which riparian zones perform these functions is dependent on vegetation composition, vegetation density, and the area continuously covered with vegetation (e.g., width of buffer and length of shoreline with buffer) (Knutson and Naef 1997).

Brennan and Culverwell (2004) note the following characteristics of healthy nearshore riparian systems:

- Long linear shapes;

- High edge-to-area ratios;
- Microclimates distinct from those of adjacent uplands;
- Standing or flowing water present all or much of the year, or a capacity to convey or retain water;
- Periodic flooding, which results in greater natural diversity;
- Composition of native vegetation differing from upland (inland) systems (e.g., different species composition, abundance, diversity, and structure), and
- Support systems for terrestrial and aquatic biota.

Many areas of marine shoreline in Mason County have relatively intact marine riparian vegetation, with the potential to provide water quality, shoreline stabilization, and LWD functions to the nearshore. The Point No Point Tribal Council has conducted a recent riparian assessment for certain areas within Mason County shorelines using 2009 aerial photographs (PNPTC, 2011). The results of this assessment and other data related to the presence or absence of marine riparian vegetation has been incorporated into this study.

Freshwater Wetlands

The state of Washington (WAC 173-22-030) defines wetlands as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands are known to play a vital role in the landscape by performing:

- Biogeochemical functions related to trapping and transforming chemicals and improving water quality in the watershed;
- Hydrologic functions related to maintaining the water regime in a watershed and reducing flooding; and
- Food web and habitat functions (Granger et al., 2005).

The U.S. Fish and Wildlife Service’s National Wetland Inventory (NWI) (1989) identifies freshwater wetlands associated with streams and lakes throughout Mason County. No countywide inventory of wetlands has been conducted by Mason County; therefore this analysis relies on the NWI mapping (Map 4 – Hydrology).

Freshwater Riparian Areas

Freshwater riparian areas function in many of the same ways as nearshore riparian areas. Riparian zones contribute to healthy streams by dissipating energy and

inhibiting sediment input, suppressing the erosional processes that move sediment, and by mechanically filtering and/or storing upland sediments before they can enter stream channels (Knutson and Naef, 1997). Riparian areas also perform water quality functions related to pollutant removal. This occurs primarily through denitrification and trapping/storing phosphates and heavy metals that are adsorbed to fine sediments. Riparian vegetation provides shading and nutrient input to adjacent water bodies.

One of the most crucial roles that riparian areas play in the ecosystem is creating habitat. Riparian zones are a major source of LWD input to streams. Approximately 70 % of the structural complexity within streams is derived from root wads, trees, and limbs that fall into the stream as a result of bank undercutting, mass slope movement, normal tree mortality, or windthrow. LWD creates complex hydraulic patterns that allow pools and side channels to form. It also creates waterfalls, enhances channel sinuosity, and instigates other physical and biochemical channel changes. The in-channel structural diversity created by LWD is essential to aquatic species in deep, low velocity areas for hiding, overwintering habitat, and juvenile rearing, in all sizes of streams and rivers (Knutson and Naef, 1997).

Terrestrial Habitats

Mason County is located in the Puget Trough ecological province, which encompasses Puget Sound, the Cowlitz River valley, and the upper Chehalis River basin (Franklin and Dyrness, 1973). Westside lowlands conifer-hardwood forest is the dominant native habitat type throughout lowland areas of western Washington, including Mason County (Johnson and O'Neill, 2001). In the county, lowland forests form a mosaic with wetlands, riparian areas, and marine nearshore habitats. Residential and agricultural areas are concentrated near lake and marine shorelines.

Significant portions of the forested habitat in Mason County are used for commercial timber harvest, particularly in WRIA 22. Clearcut logging encourages the growth of plant species that colonize disturbed areas, such as red alder, salmonberry, and big-leaf maple. Forestlands are often replanted with Douglas-fir, leading to a reduced diversity of tree species in these managed areas. (Johnson and O'Neill, 2001)

Natural Heritage Habitats

The Washington State Natural Heritage Program (WNHP) has identified more than 50 types of high-quality or rare plant communities and wetland ecosystems in Mason County (WNHP, 2011). Table 3-1 lists those that have been identified within the County's shoreline planning areas, by WRIA.

Table 3-1. WNHP Identified Vegetation Communities in Mason County Shoreline Planning Areas

Community Type	WRIA 14	WRIA 15	WRIA 16	WRIA 22
Beakrush – (Bog Cranberry)/ Sphagnum Spp.		X		
Blunt-leaved pondweed	X			X
Bog Labrador-Tea-Bog-Laurel/Sphagnum Spp.	X	X		
Brewer's Cliff-brake			X	
Chain Fern			X	
Douglas fir/Western Hemlock/Evergreen Huckleberry	X			
Estuarine Zone	X			
Few-flowered Sedge		X		
Freshwater Tidal Surge Plain Wetland			X	
Low Elevation Sphagnum Bog	X	X		
Lyngby's Sedge	X		X	
Lyngby's Sedge/ Pacific Silverweed			X	
Mixed fine and Mud: Partly Enclosed, Eulittoral, Mesohaline (Marsh)	X		X	
Mountain, Sitka Alder/Skunk Cabbage – Water- parsley	X			
Northern Grass-of-parnassus			X	
Organic: Partly Enclosed, Backshore, Mesohaline (Marsh)			X	
Organic: Partly Enclosed, Backshore, Polyhaline (Marsh)	X			
Pacific Silverweed – Douglas Aster			X	
Shore Pine/Bog Labrador-Tea/ Sphagnum Spp.	X			
Shore Pine/Douglas-fir/ Salal		X		
Sitka Spruce / Slough Sedge – Skunkcabbage			X	
Tufted Hairgrass – Pacific Silverweed	X			
Water lobelia	X			X

3.6 Fish and Wildlife Species

The terrestrial and aquatic habitats in Mason County support numerous fish and wildlife species, including species listed as threatened or endangered under the state and/or federal Endangered Species Act (ESA).

Marine Mammals

A number of marine mammals occur in the nearshore and marine waters of Mason County, including harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and Southern Resident killer whales, or Orcas (*Orcinus orca*). Steller sea lions (*Eumatopias jubatus*) may also occur occasionally in the South Sound. Orcas are not as common in the South Sound as in the northern portions of Puget Sound, in part because they tend to occur in deeper marine areas and much of the South Sound is comprised of nearshore habitats less than 20 feet deep.

Marine mammal haulouts have been mapped by the Washington Department of Fish and Wildlife (WDFW) along the shorelines of Hood Canal, Oakland Bay, Harstene Island, and Totten Inlet (Map 8 – Fish & Wildlife Habitat Areas).

Seabirds and Waterfowl

Both resident and migratory seabirds and waterfowl are associated with Mason County shorelines. Commonly occurring seabirds or waterfowl include loons (*Gavia* spp.), cormorants (*Phalacrocorax* spp.), mergansers (*Mergus* spp.), grebes (*Aechmophorus* spp.), herons and egrets (Ardeidae), geese (*Branta*), brants (*Branta bernicla*), gulls (Larinae), sandpipers (Scolopacidae), and ducks (dabbling and diving) (Buchanan 2006). In addition, a number of bird species identified as state priority wildlife species are associated with and forage along shorelines of Mason County, including bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and great blue heron (*Ardea herodias*) (WDFW 2007).

Waterfowl concentrations in Mason County are located in bays and inlets, including Annas Bay, Lynch Cove and Hamma Hamma estuary. Bald eagle nesting occurs in many areas, including the North Fork Skokomish and along Hood Canal.

Salmon and Trout

Mason County rivers and streams support numerous species of salmon and trout (Map 8; Table 3-2). Some of these species are federally listed under the Endangered Species Act. In addition to data provided by WDFW, the Squaxin Island Tribe and Skokomish Tribe monitor salmon production in rivers within Mason County. In addition, the Wild Fish Conservancy (WFC) is currently conducting a

stream typing assessment in Mason County to determine the presence or absence of salmon and trout within streams and rivers in the County. This work is being carried out in partnership with Mason County Conservation District and Washington State Recreation and Conservation Office (RCO). The assessment is based upon field surveys conducted by WFC staff and will be completed in 2012 (see projects at <http://wildfishconservancy.org/>).

Table 3-2. Salmon and Trout Species Identified in Mason County Shoreline Planning Areas

Species	WRIA 14	WRIA 15	WRIA 16	WRIA 22
Bull trout/Dolly Varden*			X	X
Chinook salmon *	X	X	X	X
Chum salmon*	X			
Coastal cutthroat trout	X	X	X	X
Coho salmon	X	X	X	X
Kokanee salmon	X		X	
Pink salmon	X		X	
Rainbow trout	X	X	X	X
Sockeye salmon			X	
Steelhead trout*	X	X	X	X

* Federally listed under the Endangered Species Act.

State Priority Species

The Washington Department of Fish and Wildlife (WDFW) has identified several additional priority habitats and species as occurring in Mason County (WDFW, 2010). Table 3-3 lists those that have been identified within the County's shoreline planning areas, by WRIA. Some of these species are also federally listed under the Endangered Species Act.

Table 3-3. WDFW Identified Priority Habitats and Species in Mason County Shoreline Planning Areas

Priority Species	WRIA 14	WRIA 15	WRIA 16	WRIA 22
Bald eagle	X	X	X	
California myotis			X	
Cascade frog			X	
Cascade torrent salamander			X	
Common loon	X			
Cope's giant salamander			X	X
Fisher			X	
Great blue heron	X			
Little brown myotis			X	
Long-eared myotis			X	
Marbled murrelet*			X	
Mink	X			
Mountain quail	X		X	
Olympic mudminnow	X			
Olympic torrent salamander			X	X
Osprey	X	X	X	
Pacific lamprey	X			X
Pileated woodpecker			X	
Purple martin		X		X
Reticulate sculpin	X		X	X
Riffle sculpin			X	X
Roosevelt elk	X			
Salish sucker			X	
Tailed frog			X	X
Townsend's big-eared bat			X	
Van Dyke's salamander			X	
Western pearlshell	X			
Western toad		X	X	X

* Federally listed under the Endangered Species Act.

Forage Fish

In Puget Sound, forage fish species constitute a significant part of the marine food web, being particularly important as prey for fish species, including salmonids, and for marine mammals and seabirds (Fresh et al. 1981; Pentilla 1995; Bargmann 1998). Three species comprise the main forage fish species: surf smelt (*Hypomesius pretiosus*), Pacific herring (*Clupea harengus pallasii*), and Pacific sand lance

(*Ammodytes hexapterus*). Forage fish species use a range of nearshore and estuarine habitats for feeding, rearing, and spawning.

Surf smelt and Pacific sand lance both spawn within a limited range of tidal elevations in the upper intertidal zones of beaches, and have specific habitat requirements including substrate size and type (Pentilla 1978, 1995). Surf smelt spawn on coarse sand or pea gravel; gravels ranging in size from 1 to 7 millimeters. Surf smelt spawning occurs during high tides, most typically during afternoons or early evening (WDFW 2004). Pacific sand lance spawn over a wider range of substrate sizes than surf smelt, ranging from fine sand beaches to beaches with gravel up to 30 millimeters in size (Pentilla 1995; Lemberg et al. 1997). Pacific herring spawn in intertidal and shallow subtidal areas, depositing eggs on marine vegetation at elevations between 0 and -10 feet MLLW (WDFW 2000). Eelgrass beds are important spawning substrate for Pacific herring; adhesive eggs are deposited on leaf blades of eelgrass and to a lesser extent on a variety of marine algae (Lemberg et al. 1997; Pentilla 1995). Due to the spawning requirements of these species, suitable spawning habitat for forage fish is limited, and these species are particularly vulnerable to changes in beach morphology (relative depth, exposure), beach sediment characteristics (substrate size - sediment sources, transport, or deposition), and nearshore riparian vegetation cover (WDFW 2000, 2004).

Documented forage fish spawning beaches in general are not as common in the South Sound as in more northern portions of Puget Sound, and spawning areas in the South Sound tend to be smaller and more scattered than further north (WDFW 2000, 2004). However, potential forage fish spawning habitat is widespread in marine nearshore areas of Mason County (Map 8 – Fish & Wildlife and Habitat Areas, Appendix A).

Extensive Pacific herring spawning and adult holding areas are located in Hood Canal between the mouths of the Tahuya and Union Rivers (Map 8, Appendix A). Scattered smelt and sand lance spawning areas are also located along Hood Canal shorelines (WDFW, 2010).

Hammersley Inlet supports Pacific herring spawning. Smelt and sand lance spawning areas are common along the shores of Totten Inlet, Case Inlet, Harstene Island, Hope Island, and Squaxin Island (WDFW, 2010).

Shellfish

Cobble to fine sand beaches and sand and mud flats are important habitat for many native shellfish species. Intertidal and subtidal areas that support the native Dungeness crab (*Cancer magister*) occur more abundantly in the northern portions of Puget Sound, but also occur in the South Sound, often associated with estuaries and eelgrass beds (Stevens and Armstrong 1984). Geoducks (*Panopea abrupta*)

occur offshore in fine substrates of mud or soft sand, and typically burrow up to 2-3 feet deep into the substrate. A number of hardshell clams, including butter clams (*Saxidomus gigantean*), native littleneck (*Protothaca staminea*), manila clams (*Venerupis philippinarum*), and horse clams (*Tresus capax* and *T. nutallii*) also inhabit the intertidal shorelines. Olympia oyster (*Ostreola conchaphila*) and non-native Pacific oysters (*Crassostrea gigas*) are common in the South Sound. Other nearshore shellfish include a number of filter feeders that remove plankton from the water column, such as cockles (*Clinocardium nutallii*) and softshell clams (*Mya arenaria*). Some nearshore shellfish such as the macoma clams (*Macoma* spp.) are detritivores that feed on organic detritus on the surface of sediments. Shellfish resources in Mason County are important as the basis for commercial, recreational, and tribal harvesting.

Shellfish beds perform a number of important ecological functions including nutrient cycling, stabilizing substrate, enhancing water quality (filtering and retention), creating and maintaining habitat structure (e.g., oyster reefs), and providing food for a wide variety of marine invertebrates, birds, fish and mammals. As filter feeders, shellfish consume large quantities of plankton and particulate organic matter, cleaning the water column of organic matter (and any pathogens or pollutants that are present). Shellfish species occupy a range of substrate types from mud to gravels, with each species having a preferred or optimal substrate size for larval settling and adult growth (Dethier 2006). Siltation can negatively impact larval shellfish by smothering, and adult shellfish through interfering with filter feeding. Shellfish are therefore sensitive to changes in sediment dynamics, especially increased erosion and inputs of fine sediments or changes in substrate type or size (Dethier 2006). Because shellfish filter the water column, they retain and concentrate pathogens and pollutants in the water – although this helps improve water quality, contaminated shellfish can negatively impact people and other animals that eat shellfish.

Native shellfish beds are found along most of the marine shorelines of Mason County (WDFW 2010). In Hood Canal, native geoduck beds are documented at the mouth of Tahuya River, in the Skokomish River delta, and several other areas specifically in the “Big Bend” region. Oyster beds are identified at the mouth of the Hamma Hamma River whereas Dungeness crab is found throughout Hood Canal. Hardshell clam are found in the Skokomish River estuary. In South Puget Sound, native geoduck beds are found on the eastern shore of Harstene Island, on shores of Squaxin Island, and portions of Pickering Passage and Totten Inlet. Hardshell clam are documented for North Bay in Case Inlet, Oakland Bay, Skookum Inlet and Oyster Bay. No Dungeness crab or native oyster beds are mapped by WDFW in Case Inlet, Totten Inlet or the rest of South Puget Sound in the County.

Polluted water has caused health officials to close shellfish harvest areas in the past. The Washington State Department of Health identified several harvest areas in Mason County as being “threatened” with closure in 2009 due to increasing pollutants. The sites potentially to be closed were Hood Canal 9 (near Lynch Cove), Oakland Bay, North Bay and Pickering Passage. Pickering Passage is listed as a “threatened” shellfish growing area this year (WDOH, 2011).

In addition to native shellfish harvest, there are numerous commercial shellfish operations in Mason County. A map showing commercial and recreational shellfish growing areas January 1, 2010 is prepared by WDOH. This shows that most of Hood Canal (with the exception of the shallowest portion of Lynch Cove) and South Puget Sound are approved for shellfish growing. Oakland Bay is considered conditional or prohibited. Polluted water has caused Department of Health to close a portion of at least one commercial shellfish harvesting area. The North Bay site has been partially closed near Allyn.

3.7 Land Cover

Land use and land cover are important parameters affecting watershed functions and ecosystem processes. Within Mason County, human uses fall into four general types: (1) managed forest lands, (2) agriculture, (3) residential land uses, and (4) industrial uses. All of these land uses represent some level of deforestation, but the managed forest lands include forest regrowth in their cycle.

Spatial patterns of existing land cover are shown on Map 15 – Land Cover, representing GAP analysis data from 2009. Managed forest lands can be seen to be dominant in the southern part of the County, particularly in WRIA 22. A mixture of unharvested and managed forest is present throughout most of the rest of Mason County. Agricultural areas are limited and typically located in the floodplains of major streams such as the Skokomish River. Residential land uses, included in the “developed” category on Map 15, are focused along lake and marine shorelines and within the communities of Shelton and Belfair. The only major industrial area in the County is located on Oakland Bay in Shelton.