“THREE CRABS” AREA ASSESSMENT

An assessment of water quality, flooding, fish and wildlife habitat issues and recommended actions for the “Three Crabs” area between the Dungeness River, and Cassalery Creek, Washington

“Dungeness Comprehensive Water Quality Study”
Washington State Department of Ecology grant # G0600181

Prepared by the **Clallam Conservation District**

March, 2009

2002 DOE aerial photo

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Acknowledgements
This report is the result of efforts from numerous agencies and project-area landowners. Essential financial assistance and support for this project was provided through a Centennial Clean Water Fund grant from the Washington State Department of Ecology.

We would like to extend a huge thank you to all of the landowners who participated in the workgroup and subcommittee meetings. It is a fundamental belief of the Conservation District that solutions to natural resource-related problems are ideally dealt with through the voluntary efforts of individual landowners, and the value of your input and time to this process cannot be overstated. We especially appreciate the input and drainage-specific background information contributed by Matt Heins, Don McInnes, Shawn Hankins, Gary Hussey, Les Jones, and Edy Eberle. Thanks again to all those landowners who were willing to allow CCD staff to access their private property for the assessment.

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EXECUTIVE SUMMARY

The goal of this project was to identify actions that would address existing flood hazards, water quality problems, and salmonid habitat limiting factors associated with the streams, upland and nearshore area between the mouth of the Dungeness River and the mouth of Cassalery Creek in eastern Clallam County, Washington. Three environmental issues prompted the development of this comprehensive assessment and action plan: 1) localized flooding near the mouths of Meadowbrook, Cooper and Cassalery creeks; 2) bacterial contamination in surface waters of the area; and 3) the Threatened status of four salmonids that have historically utilized the waterways of the study area, including Puget Sound chinook, Hood Canal summer chum, bull trout, and Puget Sound steelhead.

Identified resource concerns were broken down into three categories: 1) water quality, 2) flooding, and 3) fish and wildlife habitat. To the greatest extent possible, actions were identified that simultaneously address flooding hazards, improve water quality, and enhance fish and wildlife habitat.

Recommended actions were developed, based primarily on examination of existing studies, reports and existing regulations, stakeholder objectives, GIS analysis, and achievability. Recommended actions are summarized as follows:

- Address human sources of fecal coliform bacteria contamination through continued identification and repair of failing septic systems, investigation of potential regional alternatives to individual on-site septic systems, and continued operation and maintenance outreach and education.
- Control livestock access to streams and other surface waters and associated wetlands.
- Eliminate contaminated irrigation tailwater discharges into surface water drainages and Dungeness Bay through continued irrigation ditch piping.
- Reconnect Meadowbrook Creek mouth to the Dungeness River and estuary area.
- Encourage alternatives to hard beach armoring.
- Restore native riparian vegetation along all streams throughout the study area.
- Replace or reconfigure existing outlet structures at the mouths of Cooper and Casselary creeks.
- Reconstruct lower channelized reach of Cooper Creek to a more natural meandering configuration.
- Alter residential landscaping practices to fit environmental conditions.
- Update County land use codes, such as the Shoreline Master Program, in consideration of climate change predictions.

OVERVIEW

Objectives

The proposal to undertake this project was prompted by chronic localized flooding near the mouths of Meadowbrook, Cooper and Cassalery creeks, and bacterial contamination in each of the streams and Dungeness Bay – their receiving waters. In addition, in 2005 when the proposal was developed, three salmonids that have historically utilized the waterways of the study area – Puget Sound chinook, Hood Canal summer chum, and bull trout – were listed as Threatened under the Endangered Species Act. Since then, Puget Sound steelhead have also been listed as Threatened.

The goal of the project was to identify actions to address existing flood hazards, water quality problems, and salmonid habitat limiting factors associated with the streams, upland and nearshore area between the mouth of the Dungeness River and the mouth of Cassalery Creek in eastern Clallam County, Washington. The ultimate goal was to identify mutually beneficial actions that would go beyond addressing individual public safety and environmental concerns. In other words, we endeavored to identify solutions to flooding hazards that would also improve water quality, and at the same time enhance fish and wildlife habitat. At a minimum, site-specific, single-purpose solutions that could potentially lead to other problems or exacerbate existing problems within the study area were avoided. These goals were pursued by conducting an environmental assessment of the area and developing a comprehensive plan of action.

It is the belief of the Conservation District that the most beneficial land and resource management actions must ultimately be implemented by private landowners, or at the very least be implemented with their consent and cooperation. This, we believe is particularly true for long-lasting environmental improvements. Therefore, in addition to meeting the criteria described above, the recommended actions had to be those of the stakeholders. We did our best to engage the major stakeholders of the project area in the planning process and achieve meaningful participation. Although a thorough and genuine effort was made to reach out to all landowners in the study area and engage them in this problem-solving process, it was not possible to engage everyone. And, it was not possible to achieve complete consensus among those that did actively participate in the planning process. Nevertheless, many landowners and other stakeholders did contribute to the problem identification process, and many suggested possible solutions to pursue.

The existing land use characteristics, habitat conditions, resource concerns, and recommended actions that apply throughout the study area are presented in this chapter. Those characteristics, conditions, concerns, and recommendations that are specific to each sub-basin of the study area are described within each respective sub-basin chapter of this report.

Methods

The steps involved with development of this report began with a review of existing studies and reports pertinent to the study area. Among the most important and relevant reports and studies were the various bacterial studies and reports for the area, the *Salmon and Steelhead Habitat Limiting Factors Analysis – Water Resource Inventory Area 18* (1999), the *Elwha Dungeness Watershed Plan,* the *"Collins Report" [Historical geomorphology and ecology of the Dungeness River delta and nearshore environments from the Dungeness Spit to Washington Harbor* (2005)], and the *Jamestown S'Klallam Tribe Watershed Plan* (2007). In addition, information contained in conservation plans prepared for individual properties by Clallam Conservation District and the USDA Natural Resources Conservation Service over the past 25 years was utilized.

A work group made up of agency and landowner stakeholders was formed to solicit local knowledge about environmental problems, and to foster citizen participation in the planning and problem-solving process. Two public workshops were held, in which outside experts were brought in to give presentations about the geologic development of the area and the shoreline conditions. The work group met twice between May and September of 2006, and a flood subcommittee also met twice. In addition, personal and phone interviews were conducted with numerous landowners within the study area and agency representatives.

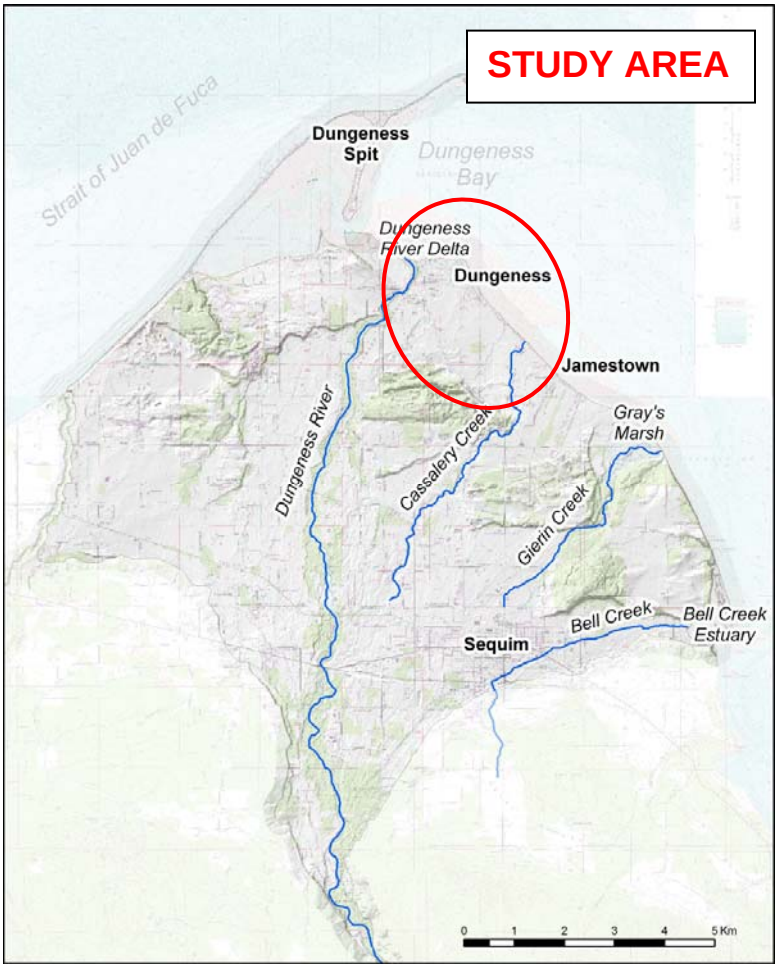


Figure 1 - Study area (background image: Collins, 2006)

A geographic information systems (GIS) analysis was conducted for the study area, including analysis of aerial photographs, topographic data (LiDAR), soils, and County hydrology and Critical Areas GIS data. Results from water quality monitoring conducted by the Jamestown S'Klallam Tribe, Clallam County, and Battelle Marine Lab were utilized for the assessment as well. These water quality monitoring results included fecal coliform bacteria sampling and the first phase of a microbial source tracking (MST) study conducted in Dungeness Bay, Meadowbrook Creek, Golden Sands slough and ditches on the west side of the Dungeness River. The MST study identified many different sources of fecal bacteria in the water, including birds, wildlife, and human sources. Stream assessments were conducted during the summer of 2007 following the Natural Resources Conservation Service Stream Visual Assessment Protocol. The stream assessments were conducted along reaches of streams where access was granted by landowners (limited access was granted along Cooper Creek and Cassalery Creek). Habitat conditions, invasive weed presence, and livestock access were noted and described during these stream assessments.

Experts, including marine geomorphologists and a hydraulic engineer, were consulted to help with the inventory and assessment. The work of geomorphologist Brian Collins was relied upon extensively. Mr. Collins performed a study of the Dungeness Valley land-forming processes and human alterations up until the beginning of the 21st century. The study results are documented in a report entitled *Historical geomorphology and ecology of the Dungeness River delta and nearshore environments from the Dungeness Spit to Washington Harbor* (2005). Mr. Collins provided additional consultation specific to the Three Crabs study area.

Summary of Inventory and Assessment Steps

1. Reviewed existing studies and reports pertinent to the area (**see Appendix A)**
2. Conducted community workshops in order to gather input from stakeholders and foster participation
3. Interviewed stakeholders and resource management agency representatives
4. Performed GIS-based analysis of existing Clallam County aerial photographs and LiDAR elevation data
5. Conducted stream assessments using NRCS Stream Visual Assessment Protocol
6. Consulted with marine geomorphologists, a hydraulic engineer, County On-Site Septic Program managers
7. Characterized resource concerns for individual sub-basins and entire study area

Study Area Description

The project study area consists of the shoreline and adjacent upland area between the mouth of the Dungeness River and the mouth of Cassalery Creek. This area includes three streams draining into outer Dungeness Bay and the upland and shoreline areas associated with these streams. The streams are Meadowbrook Creek (entire length), Cooper Creek (entire length), Cassalery Creek (to river mile 1.2), as well as Golden Sands Slough, which is located between the mouths of Meadowbrook and Cooper creeks. All three streams are small, low elevation streams with headwaters elevations at or below 100 feet above mean sea level. The total watershed area included in this study is approximately 2 square miles (1,300 acres). The streams within the study area comprise approximately 3.75 lineal miles of potential salmonid habitat, in addition to associated estuarine areas. The study area includes approximately 1.7 miles of marine shoreline.

This fragile and dynamic area, at an elevation barely above sea level is bounded on one side by the Strait of Juan de Fuca, on another side by the Dungeness River (confined by a dike, except for the area near the mouth), and traversed by three streams. The delta area where the Dungeness River and Meadowbrook Creek enter Dungeness Bay is particularly dynamic. Collins (2005) estimated that the Dungeness River and

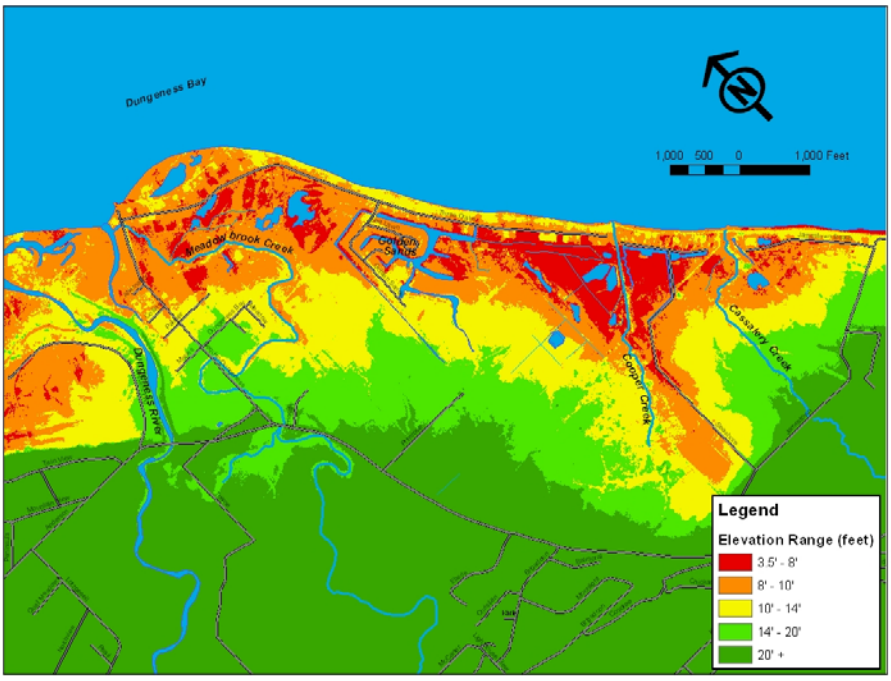


Figure 2 - Three Crabs area relative topography (Based on Clallam County LIDAR data)

Meadowbrook Creek deltas have experienced a net increase of over 80 acres of land over the past 150 years. However, due to losses of shoreland over the past 20 years, the net increase in land from 1942 to 2003 was only 10.6 acres. Collins also hypothesized that the Dungeness River once took the routes of Cassalery Creek and Meadowbrook Creek; the latter as recently as a few centuries ago. Until a dike was constructed along the eastern shore of the Dungeness River in 1963, flood waters flowed through the present community of Dungeness, entering Dungeness Bay through Meadowbrook Creek. Based on Clallam County GIS layers, over 99 percent of the land within the study area is within the jurisdiction of at least one environmentally Critical Area (wetlands, streams, 100 year floodplain, seismic hazard area, critical aquifer recharge area (CARA), or aquatic habitat conservation area). Most of the area falls under more than one Critical Area category. As the figure below illustrates, a substantial percentage of the study area is mapped by Clallam County as wetlands.

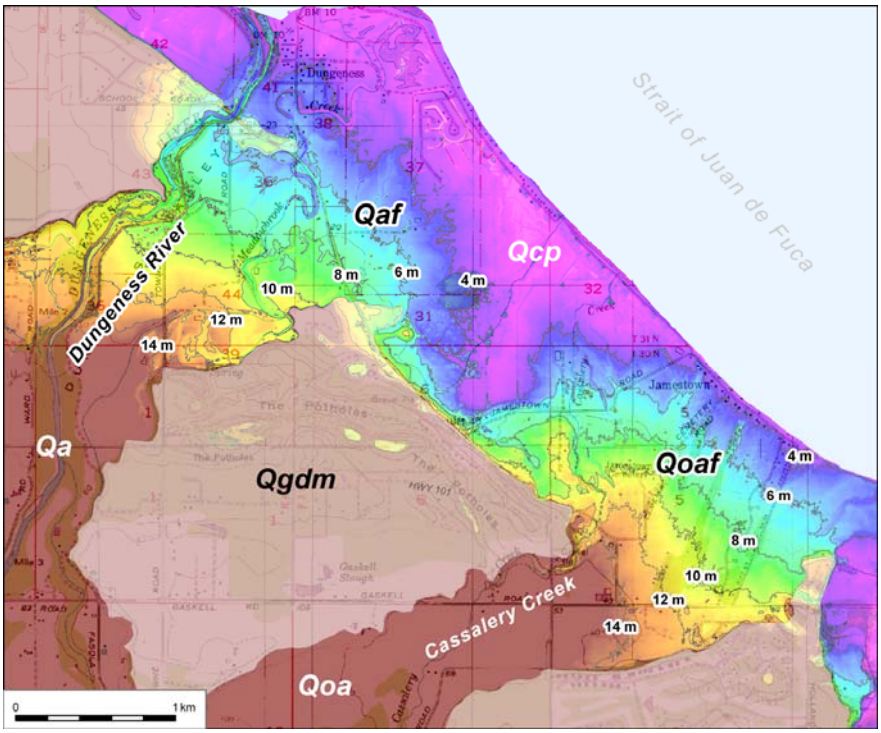


Figure 3 - Geology and deltas of study area (source: Collins, 2006).

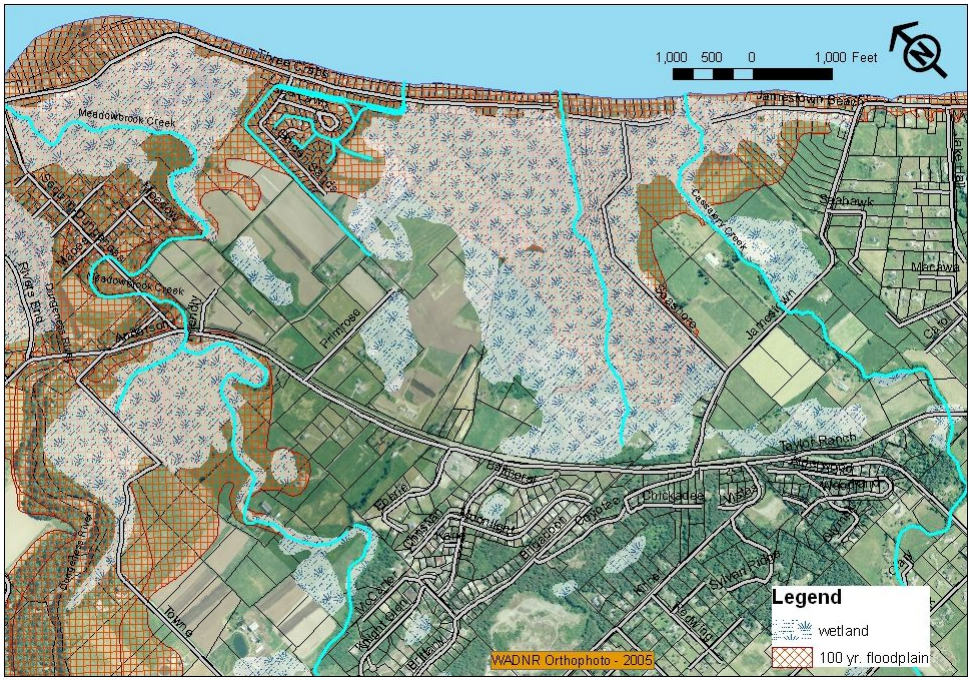


Figure 4 - Wetlands and 100 Year Floodplain (source: Clallam County GIS data).

The study area's most sensitive and vulnerable environment – the shoreline – has experienced the most development and alteration over the past two to three decades, and is characterized by small lot sizes with densely packed residences. Some of these residences were built where Dungeness Bay mud flats existed as recently as 40 years ago (Collins 2005). Based on current zoning standards and existing parcel configurations, the shoreline area north of Three Crabs Road far exceeds the maximum lot density allowed under the current R5 zoning designation (1 dwelling unit per 4.8 acres). Presently, 65 of the 83 parcels in this area are developed with residential structures (Source: Clallam County GIS data, based on Assessors' land use code). This amounts to a residential density of approximately one dwelling unit per 2.7 acres. The "Golden Sands" plat, which was approved by Clallam County in 1966, consists of 91 lots ranging in size from approximately 0.15 - 0.5 acres in area. The historic community of Dungeness, located in the western portion of the study area, is relatively urban in nature; however, the majority of the study area *acreage* to the south of Three Crabs Road is rural, consisting largely of farmland and open space tracts.

Settlement History

The Dungeness watershed (including the study area) was historically occupied by the Jamestown S'Klallam Tribe. The first European settlers came to the Dungeness area around 1850. "New Dungeness" (one of Puget Sound's earliest ports) was established in 1851 along inner Dungeness Bay about one mile west of the Dungeness River (Arksey 2008). In 1891, a three-quarter-mile long pier was constructed out into Dungeness Bay on the east side of the river near the mouth of Meadowbrook Creek. In 1892, the plat of Dungeness was recorded near the pier, becoming the main settlement. That same year the historic Dungeness Schoolhouse was constructed.

Since the arrival of the first European settlers, humans have been manipulating the landscape to suit their needs. Early alterations of the landscape were primarily to develop arable land for farming. These alterations consisted mainly of "…river diking and channelizing, flow diversion, land clearing, and wetland draining" (Collins, 2005 p 35). Collins concluded that the mid to late 1800's experienced extensive land use changes, mainly in the form of forest clearing for agricultural use. According to Collins, the lowlands in the project area were "mostly cleared" by the early 1900's. From the early 1900's to the turn of the century, there was continued clearing and draining, primarily for agricultural uses, followed by another transition to a more urbanized landscape.

The flat topography and favorable scenery along Dungeness Bay have continued to attract residential development and accompanying clearing, grading, and filling over the last several decades (JST, 2007). *Three Crabs Restaurant*, a well known seafood restaurant and the namesake for the road along the shore, was established in 1958. In the decades that followed, the small waterfront lots along the shore side of Three Crabs Road have developed with houses to the present condition, of which approximately 80% have been built upon. Similar development occurred along the Seashore Lane development between Cooper and Cassalery creeks, beginning in the late 1970s. This landscape transition is illustrated in the figures on the following pages. Figure 6 is another image from Collins report, illustrating shoreline changes between 1855 and 2003.

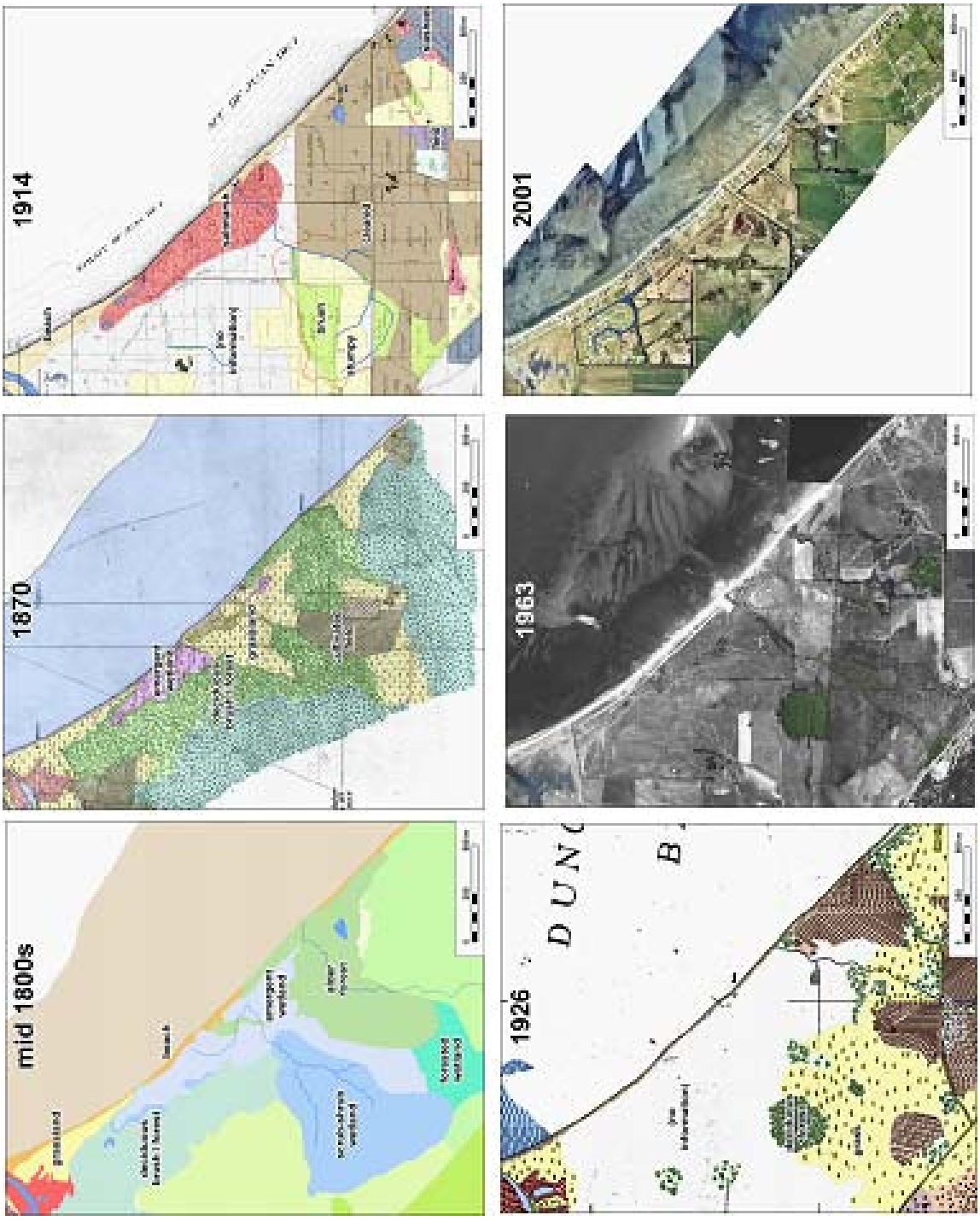


Figure 5 - Landcover changes since settlement (source: Collins, 2006).

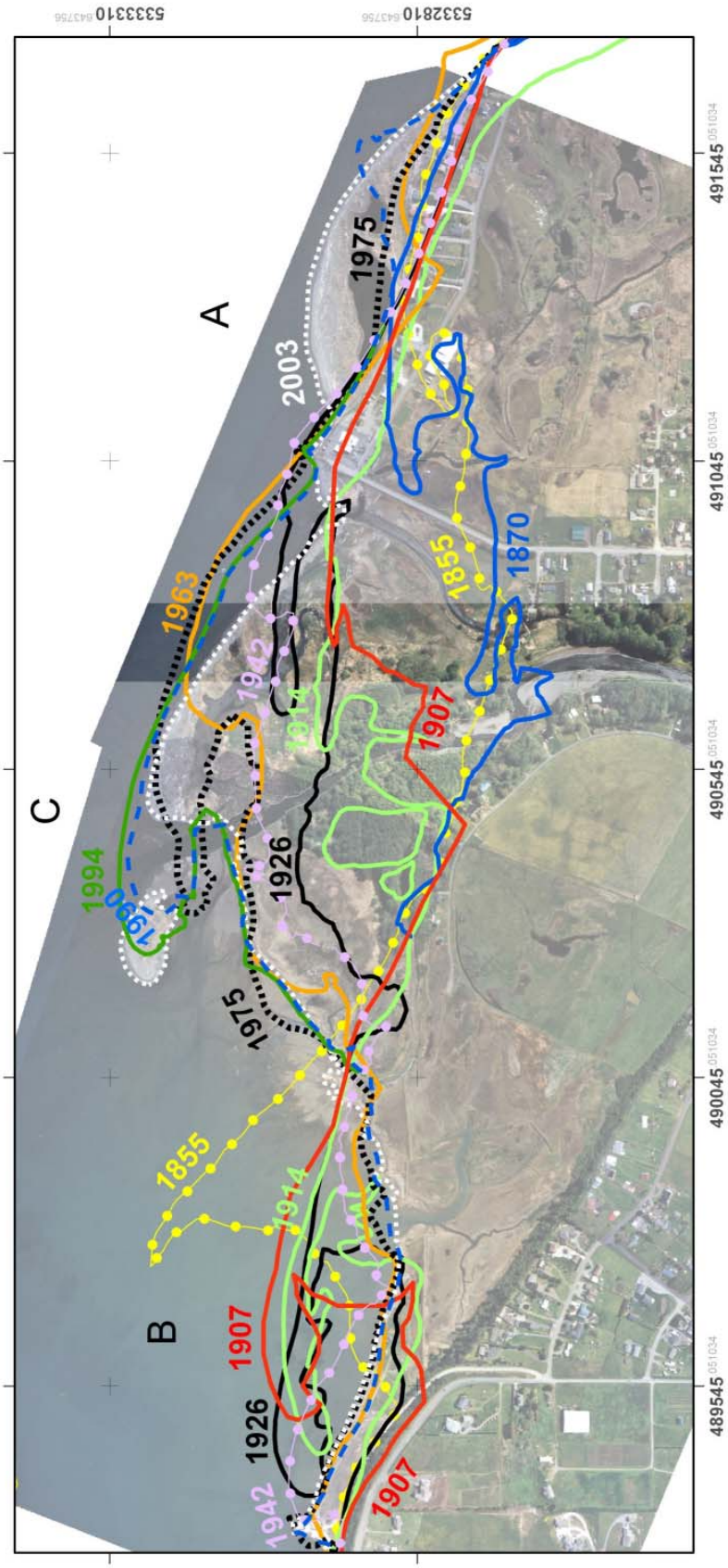


Figure 6 - Shoreline Changes since 1855 (Collins, 2006)

According to Collins, the area from the mouth of Meadowbrook Creek to a distance of about 3,000 feet eastward along the shoreline is within a very dynamic zone of “rapid longshore transport”. Thus, this shoreline area is subject to frequent and rapid changes, including sediment accretion and erosion. The figure on the preceding page depict the significant shoreline changes that have occurred in this area over the last 150(±) years.

Aerial photograph analysis conducted by Collins (2006) revealed that at least one of the houses that are now located along the north side of Three Crabs Road at Brandt Point would have been in the bay as recently as 1963. The symbols in the three photos to the right represent three structures located on the 2003 aerial photograph that were then georeferenced on the 1990 and 1963 photographs. (Also notable within this timeframe, is the change in shoreline immediately to the west of Sequim-Dungeness Way, where the mouth of Meadowbrook Creek breached in 1999.)

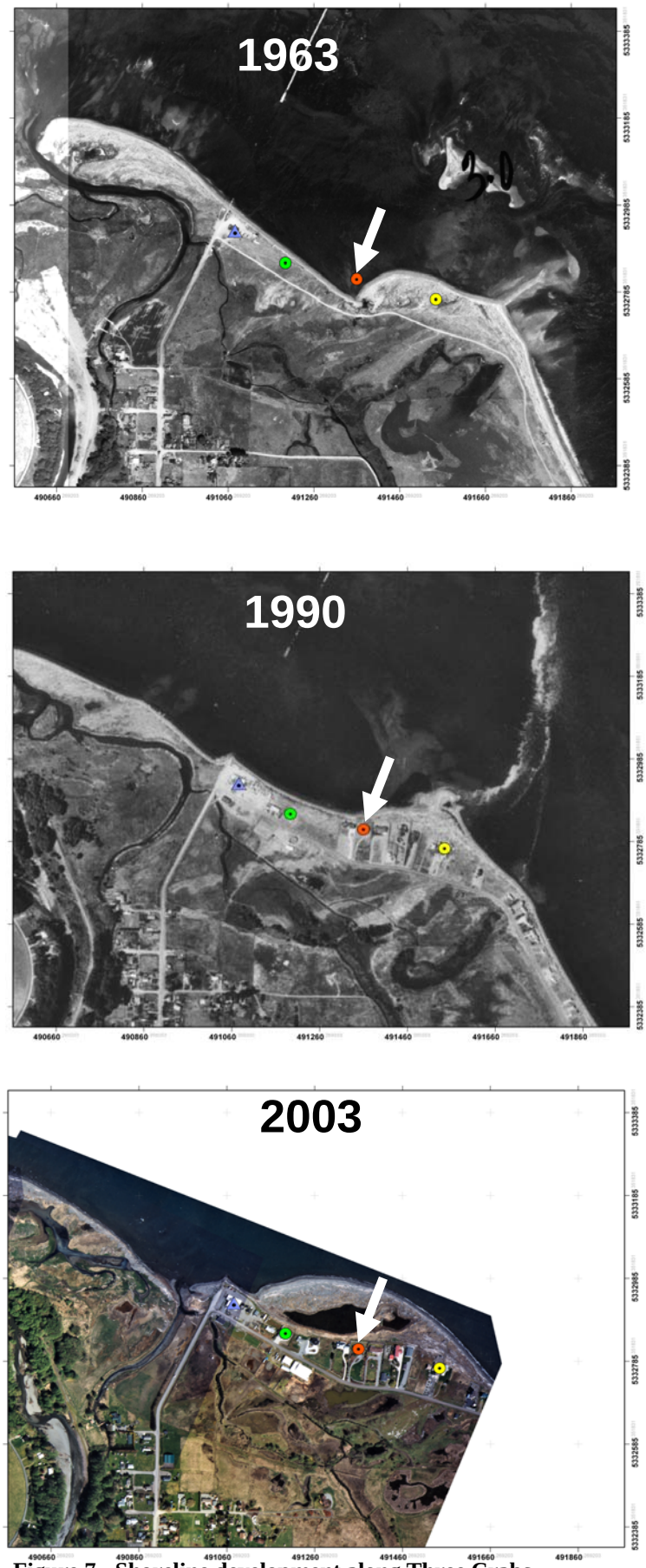


Figure 7 - Shoreline development along Three Crabs Road (source: Collins, 2006).

Collins describes the shoreline area east of Cassalery Creek as a relatively stable shoreline zone (when compared with the shoreline to the west) that remains fairly constant due to "divergent longshore transport".

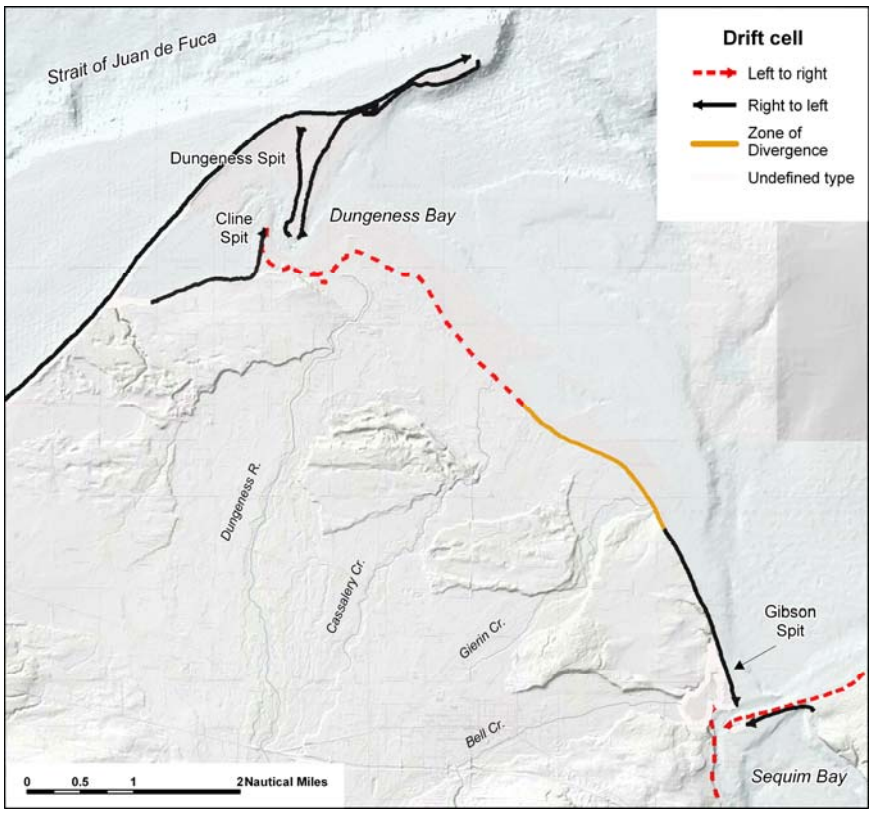


Figure 8 - Longshore drift patterns (source: Collins, 2006).

Regulatory History

The revelation that houses were permitted to be built in an area of land that did not exist just a couple decades prior is shocking news to many. However, most of the small beachfront parcels along Three Crabs Road and within the Seashore Lane development were created prior to the adoption of the current Clallam County zoning and environmental protection standards. Minimum lot size requirements, maximum residential density, and lot configuration standards have since been adopted, such that in most cases, these small and irregular lot configurations would not be approved today.[1]

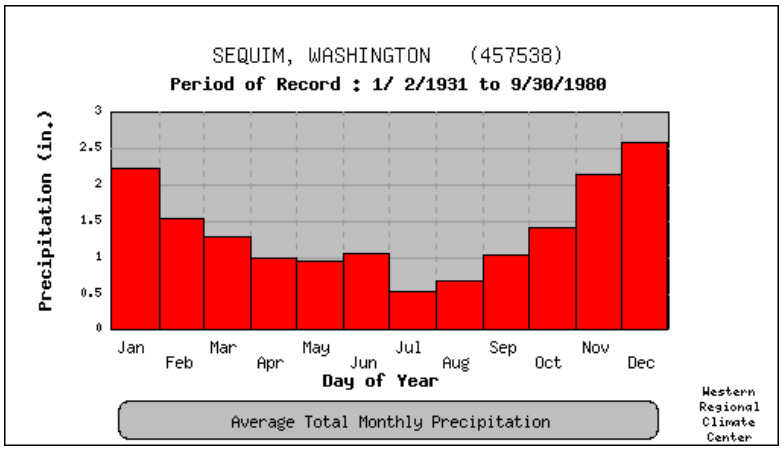
Protection of wetlands and other environmentally "Critical Areas" have existed in Clallam County since 1992 (Ord. No. 471, 1992 – Clallam County Interim CAO (ICAO)). Much of the existing development in the Three Crabs study area was constructed prior to the adoption of the ICAO, and is therefore allowed to be continued and maintained under the "pre-existing uses" section of the current code (CCC 27.12.040). However, new development proposals within the proximity of wetlands, streams, or shoreline areas are subject to compliance with the current protection standards of the CAO, which in most cases, limit or

[1] The Seashore Lane lots, for example, were created with the recording of the "Duck Farm" survey in 1977 (Ref. County Auditor's File number 1977-0471305, Vol. 2, Pg. 145 of *Surveys*) which was prior to the adoption of a County zoning ordinance, CAO, or county subdivision review process applying to lots greater than 5 acres in area. The current R5 lot configuration requirements do not allow the creation of parcels with a width to depth ratio greater than 1:5 (CCC 33.10.020(6)(7). In addition, the CAO currently requires a minimum shore frontage of 150 feet for new land divisions adjacent to shorelines of the state (CCC 27.12.315(9)(c.).

preclude construction, clearing and grading activities, and irregular lot configurations.[2]

Climate and Climate Change

Climate and weather patterns, both present and projected future changes have a significant effect on the marine shoreline environment. Prevailing winds blow through the Strait of Juan de Fuca out of the west. Severe wind storms typically come from the southeast, up Hood Canal. Dry, summer breezes and occasional winter wind storms come across the Strait from the northeast. Precipitation in the project area is among the lowest in Western Washington, averaging less than 15 inches per year. However, approximately two-thirds of the precipitation occurs during a six-month period from October 1 to March 31, which is also when barometric pressure tends to be the lowest, tides are the highest, and winds are the strongest. These factors combine to contribute to localized flooding during the winter.



The shoreline and estuarine areas in the study area are constantly changing as a result of natural processes (seasonal weather patterns, tidal influences, sediment deposition, erosion, and other geological processes). Residents in this area have historically coped with these processes through physical alterations to the environment (armoring, filling, diking, ditching, etc.). While these actions may provide short-term protection of residences, agricultural land and other infrastructure, they can also have long-term negative impacts associated with natural sedimentation and accretion processes (Glick, 2007).

Changes in global climate conditions and an anticipated rise in sea level will likely increase the intensity and potentially destructive nature of severe storm events in the study area. In general, sea water inundation of Pacific Northwest coastal areas is expected to be more common as sea level rises. Sea Level Rise (SLR) will also contribute to the expansion of open water in some inland areas, as dry land becomes saturated from a rising groundwater table. SLR is expected to intensify beach erosion processes and make coastal areas even more susceptible to storm surges (Glick, 2007).

A January 2008 report by the University of Washington Climate Impacts Group and the Washington Department of Ecology provides estimated calculations of “very low”, “medium”, and “very high” rates of sea level change for the years 2050 and 2100. Although it did not provide site-specific estimates for the project area, the report included estimates for the NW Olympic Peninsula, central and southern Washington coast, and Puget Sound. This report cites the “Fourth Assessment Report of the Intergovernmental Panel on Climate Change” (IPCC) projections, which predict that global SLR over the course of this century to be between 18 and 38 cm (7-15”) for their lowest emissions scenario, and

[2] Under “extraordinary” circumstances, variances may be granted from these standards, but are subject to strict approval criteria, mitigation requirements and a public hearing before the Clallam County Hearings Examiner (see CCC 27.12.725). Approvals of variance applications by the County are rare. (Between 2006 and October of 2008, there were a total of three such variances approved, County-wide. Within that timeframe, there was also one denied application, and four others that were withdrawn by the applicant(s). (Source: Clallam County DCD permit tracking system – personal communication with staff).

between 26 and 59 cm (10-23”) for their highest emissions scenario. Under each emissions scenario, the lower-elevation portions of the study area would undoubtedly experience more frequent and severe flooding events during the winter months, along with a greater potential for storm damage from beach logs and other debris.

Area-Wide Resource Concerns

Water Quality

In the spring of 2000, a portion of Dungeness Bay was closed to commercial shellfish harvesting by the Washington Department of Health due to high concentrations of fecal coliform bacteria. The Washington Department of Ecology (DOE) responded by conducting a Total Maximum Daily Load (TMDL) study for bacteria in the lower Dungeness River and its tributaries in 2002, followed in 2004 by a TMDL for Dungeness Bay and its tributaries. Meadowbrook Creek, Meadowbrook Slough, Cooper Creek and Cassalery Creek are listed as impaired on the 303(d) list due to high levels of fecal coliform on the 2008 list submitted by DOE to the Environmental Protection Agency (EPA). Golden Sands Slough is listed as a water body of concern due to high bacteria.

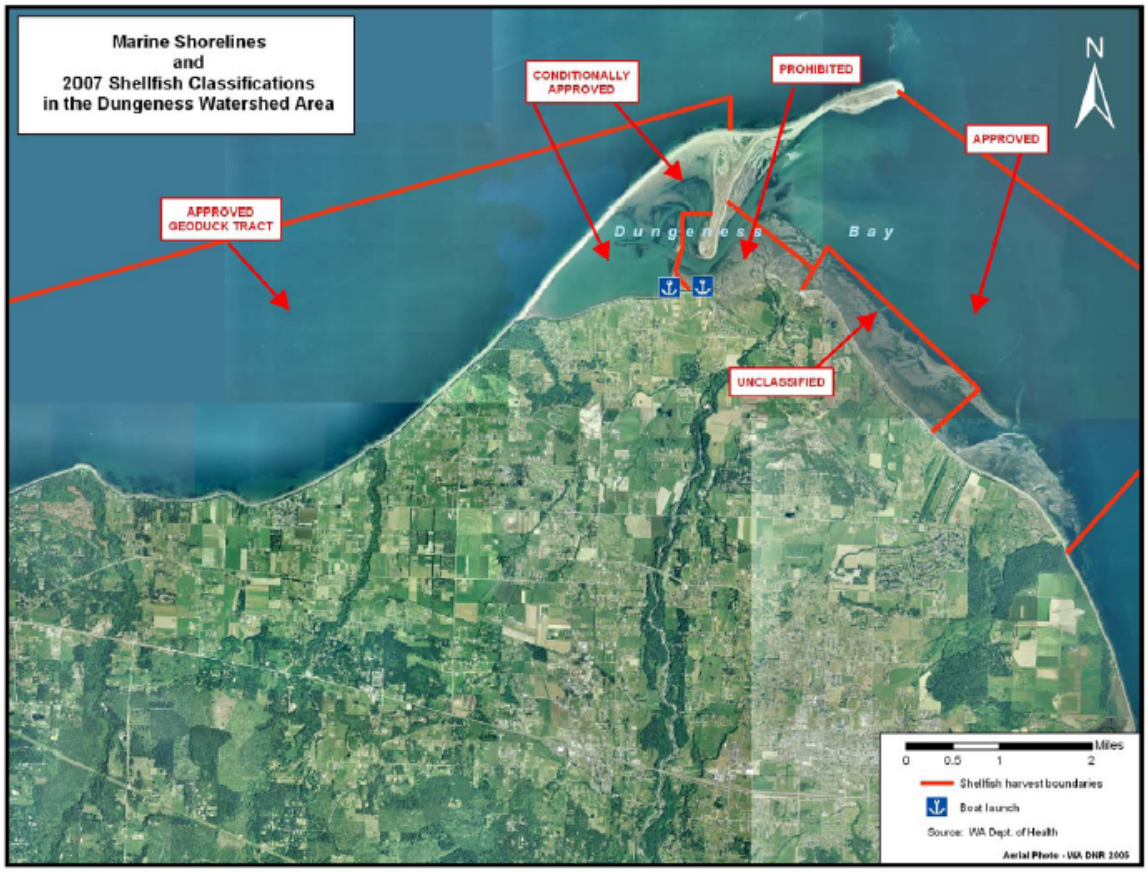


Figure 9 - Shellfish harvest approval boundaries (source: Jamestown S’Klallam Tribe, 2007).

Concentrations of fecal coliform are indicative of the presence of fecal material and associated pathogens responsible for the transmission of serious diseases such as salmonella, hepatitis and typhoid in humans. Anecdotal evidence over the years has pointed toward a number of potential sources of fecal coliform bacteria in the watershed and Bay. These include but are not limited to: failing septic systems, domestic animals, wild mammals, farmed and exotic animals, birds and marine wildlife. However it has not been clear if a multiple sources or predominantly one source was responsible for the elevated levels of fecal

coliform bacteria. In 2003, a microbial source tracking (MST) feasibility study was conducted for the Dungeness watershed to determine the most appropriate methods for identifying the sources, particularly those that could be mitigated for (Woodruff and Evans, 2003). Based on the recommendations of the feasibility study, an MST study was initiated in May of 2006 as part of the EPA Targeted Watershed Initiative. A DNA ribotyping methodology was selected that allows for identification of host organisms to the species level. This method is based on developing a DNA "fingerprint" of source *E. coli* bacteria from potential known host animals and comparing those to water samples with *E. coli* "fingerprints"of unknown origin.

The study was conducted over a 13-month timeframe with over 1100 bacteria colonies analyzed. Samples were collected from Dungeness Bay, Matriotti Creek, Meadowbrook Creek, Golden Sands Slough and a marine bluff ditch site. From those sites over 92% of the bacteria could be identified to a known host organism. At least 34 species or animal groups were identified as present at one or more sites throughout the course of the study. The predominant source identified at all sites was birds, followed by wild mammals. The presence of human sources was identified at each site as well, although this source was not present at each sampling period.

A follow-on study is currently underway, funded by the Department of Ecology, to investigate the human source in greater detail (i.e. a source that can be remediated). In this study an MST molecular marker for *Bacteroides* is being used to identify the presence of human sources in water samples. Although the study period is much shorter, the sampling sites have been expanded to include the areas listed above as well as Cassalery and Cooper Creeks. Results from this study are expected in the spring of 2009. A final report of the results from both studies is expected in May of 2009 (Woodruff et al, in prep).

On-site septic systems

The entire study area is served by on-site septic disposal systems. Hydric soils (drainage class D and C), indicative of wetlands dominate the study area. Current regulations would require the installation of very sophisticated on-site septic systems in these soils, if not prohibit them for new proposals. Development is at or near urban densities throughout much of the study area. Therefore, inadequate sewage treatment is an area-wide water quality concern. The recently adopted County on-site septic system ordinance that requires implementation of a septic system inspection program will help ensure that systems function properly. However, the on-site septic system inspections are only intended to determine if a system is operating according to design. No determination is made regarding whether the original design was appropriate for the site; therefore, older systems that may not be adequately treating sewage to today's standards are not necessarily addressed through these inspections. None the less, as inspection records are compiled, these data can be compared with water quality problems and dysfunctional systems can more easily be identified.

The Clallam County Environmental Health Division (Environmental Health) is responsible for permitting individual on-site septic disposal systems in Clallam County. Environmental Health maintains "as-built" records for septic systems in Clallam County. As-builts are available from as early as 1968, but systems installed since the mid-1980s are more likely to have accurate as-builts available (see also: http://www.clallam.net/EnvHealth/html/os_asbuilts.htm). Since the year 2000, Environmental Health has been inventorying and evaluating existing on-site septic systems within the Dungeness Bay watershed. Through this evaluation, Environmental Health has compiled a list of "septics of concern." A septic of concern (SOC) is an on-site septic system that: 1) lacks any permit reords, 2) has a record of chronic repairs or failures, or 3) is greater than 10 years old. As of December, 2008, a total of 35 parcels had been identified as having SOC's in the Three Crabs area. Four parcels were identified as failures and have been repaired. A total of 61 parcels in the Dungeness Bay study area have been replaced or repaired (Source: Clallam County Environmental Health Division).

In 2008, Clallam County adopted the state onsite rule requiring maintenance and inspections of existing septic systems. The County is obligated to inform homeowners when inspections are due and provide operation and maintenance guidance to onsite septic system owners. The development of the septic

system operation and maintenance program was mandated by the State to ensure that septic systems are being used and maintained in a way that is safe for public health in marine counties of Puget Sound. Clallam County designated a Marine Recovery Area equivalent to the Dungeness Clean Water District. Septic system owners within this area are required to regularly inspect their septic systems. The first inspection must be performed by a qualified inspector. Subsequent inspections will eventually be allowed to be performed by the owners, provided that they have completed a self-inspection training course approved by the County. The Clallam County Environmental Health Division created a homeowners guide to septic system maintenance, and offers free septic maintenance classes (Septics 101), which have been very popular. However, there is no stable funding source for the County's Operation and Maintenance (O&M) program. One potential source of funding that has been identified is an annual assessment on septic systems in the county. Nearly all funding to date for this program has come from state and federal grants.

Potable Water

Potable water in the study area is provided by a combination of public water systems and individual wells (see figure 10). A total of 8 public water systems (Group A or B) exist within the study area.[3] Although public systems are available within much of the area, some landowners have opted to drill individual wells on their property. The exact number of individual wells in the study area is not known. Generally speaking, unregulated individual wells can be a problem in higher density residential areas, since each new well can act as a potential conduit for groundwater contamination. This is especially true of the study area, due to the potential for flooding, and the high density of on-site septic systems.

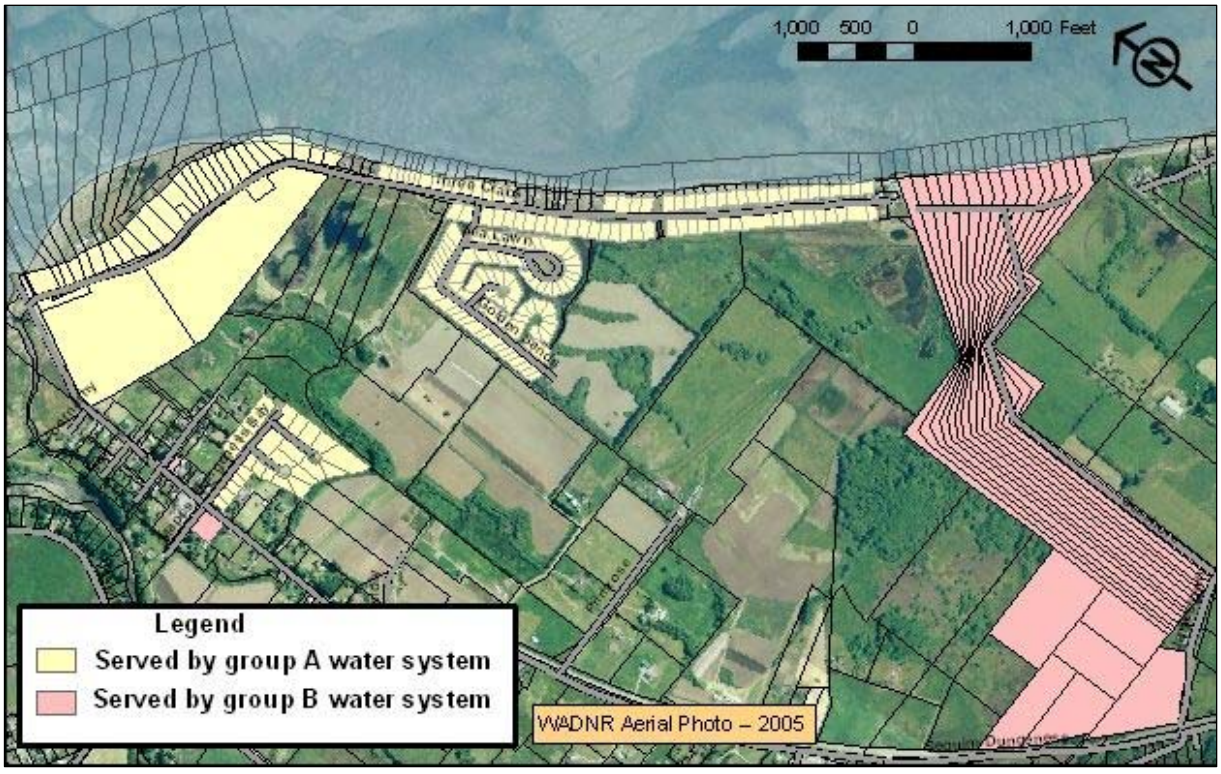


Figure 10 - Public water systems within the study area

[3] A "Group A" water system is a public water system that has 15 or more connections, or serves 25 or more people per day for 60 or more days per year. A "Group B" water system is a public water system that provides less than 15 connections and less than 25 people for 60 days or more per year, or less than 15 connections and serving any number of people for less than 60 days per year (Source: Clallam County Environmental Health Division water system chart (http://www.clallam.net/envhealth/assets/applets/System_Chart.pdf)).

Wildlife

The Dungeness National Wildlife Refuge is located in close proximity to the study area, and includes Dungeness Spit, Graveyard Spit, and portions of Dungeness Bay and harbor. The refuge is approximately 631 acres in area, and is used by more than 250 species of birds, 41 species of land mammals and eight species of marine mammals, including some listed as threatened or endangered (source: http://www.dungeness.com/refuge/). Several landowners in the study area plant annual grain crops for waterfowl utilization and to improve hunting opportunities.

Flooding

The flooding in the Three Crabs study area over the past decade has not been recognized by Clallam County Emergency Management and other departments as a serious public safety hazard. Flooding is primarily limited to the areas near the mouths of each of the streams, and typically results from a blockage at the mouth, an influx of tidal water up the stream, or a combination of these two factors. The blockages at the mouths of Cooper and Cassalery creeks are associated with the structures at their outlets. In the case of Cooper Creek, there is a box culvert and a tide gate that occasionally plugs during winter high tides. A 100-foot box culvert at the mouth of Cassalery Creek is also susceptible to plugging. Natural blockages of sand, gravel and marine debris occur at the mouth of Meadowbrook Creek. Flooding tends to be of short duration (typically not much longer than a few hours) after the high tide. Extreme high tides and easterly winds occasionally cause waves to breach the beach in low places, causing some localized flooding and damage from beach logs.

Property damage that has resulted from flooding in this area has been relatively minor, and limited mainly to landscaping. Only one residence is known to have been flooded when tidal water flowed up Meadowbrook Creek during an extreme high tide event in 2006. Subsequent flooding of Three Crabs Road has been infrequent and of very short duration. The main public health and safety concern with the flooding is associated with on-site septic system function and well contamination. (Wells provide all of the potable water in the study area.)

Although the exact causes of flooding differ somewhat between the three primary sub-basins (Meadowbrook, Cooper, and Cassalery), there are some issues that are common to the entire study area. Most of the residences along the north side of Three Crabs Road are situated atop a natural beach dune. This dune is the high ground that separates Dungeness Bay from the low wetland areas associated with the three streams. (see figure 2). Cooper Creek and Cassalery Creek must flow through flumes constructed beneath the elevated dune in order to reach Dungeness Bay; otherwise, the outlets to these streams would become impounded. Meadowbrook Creek flowed around the west side of the beach dune, towards (and at times into) the Dungeness River until 1999, when it breached the dune and created a new channel directly to the north, into the Bay.

Habitat

The streams in the study area are all short, low-flow, low-gradient streams. Their habitat value is relatively limited, particularly for spawning habitat for salmon. Perhaps their highest habitat value is as rearing habitat for Chinook salmon, particularly in the stream estuaries. However, throughout the study area, estuarine function is limited due to drainage ditches, channelization and other land-use alterations, and access is restricted due to structures and natural blockages at the mouths of the streams. A lack of native riparian vegetation is common along the vast majority of the streams, with some reaches dominated by reed canarygrass, Himalayan blackberry and other invasive species.

There are approximately 1.7 miles of shoreline in the study area, measured from the mouth of Meadowbrook Creek at the west end of the study area to Casselary Creek to the east. Approximately 37 percent of this shoreline (0.63 miles) is armored with boulders, rip-rap, concrete, and wooden bulkheads. These armored beaches have detrimental effects on beach habitat, particularly spawning habitat for forage fish such as sand lance and surf smelt. Hard armoring also transmits wave energy along the beach, making other areas of the beach (especially adjacent properties) more vulnerable to erosion.

Where and when they are capable of being enforced, Clallam County CAO requirements provide substantial protection of existing functional habitat features in the study area. While these regulations do provide for essential environmental protections from new development, they do little to encourage good stewardship and restoration. Under some circumstances, the CAO requires a landowner to agree to restoration of degraded critical area buffers as a permit condition (see CCC 27.12.215(1)(c), & CCC 27.12.315(1)(c)); however, follow-up with these landowners to determine if they implement their restoration plans is rare.

Area-Wide Recommended Actions

Water Quality

Human sources of fecal coliform bacteria were detected at every testing site in the MST study area, indicating an area-wide problem with on-site septic systems. Addressing the human sources of fecal coliform bacteria contamination should be a top priority for the entire area. Specifically, community sewage treatment options should be explored for the higher density areas within the Dungeness Village LAMIRD and along Three Crabs Road.

A number of issues need to be considered in order to determine the feasibility of such a project within the Three Crabs area, including funding source(s), suitable drainfield location(s), distribution line route(s), and Growth Management Act (GMA) compliance. Although new innovations in sewage treatment have recently become much more affordable on a small scale than was ever possible in the past, the prospects for the development of a public sewage treatment facility in this vicinity may prove to be difficult, due to GMA provisions that discourage (and in some cases prohibit) the construction, or extension of urban governmental services into "rural" areas (RCW 36.70A.110 (4)).[4] The rural and agricultural zoned properties along Three Crabs road would not be eligible for a public sewer system. However, public sewer service may be appropriate, and allowable within the Dungeness Village LAMIRD.

The Sunland Water and Sewer District operates a sewage treatment plant for the Sunland community approximately 2.5 miles from the center of the community of Dungeness. Sunland is designated as a LAMIRD by Clallam County. The Sunland sewage treatment plant, which achieves Class A standards for its effluent, is currently designed for full capacity of the Sunland community, only (Mike Langley, personal communication). However, future expansion of the facility to handle additional connections could have benefits for the community of Sunland and any other beneficiaries, and is worthy of consideration for Dungeness Village.

Development of a "Large Onsite Septic System" (LOSS) may be a viable option for properties along Three Crabs Road. A LOSS is a wastewater facility designed to accommodate flow rates between 3,500 and 100,000 gallons per day, and is under the regulatory jurisdiction of the Washington State Department of Health (DOH). The DOH reviews and approves LOSS project applications, performs soils and post construction inspections, conducts enforcement actions for failures, and provides technical assistance.

[4] RCW 36.70A.110(4) provides: "*In general, cities are the units of local government most appropriate to provide urban governmental services. In general, it is not appropriate that urban governmental services be extended to or expanded in rural areas except in those limited circumstances shown to be necessary to protect basic public health and safety and the environment and when such services are financially supportable at rural densities and do not permit urban development.*" The meaning of this as it has been applied to extending sewer services from a municipal system was recently challenged in a WWGMHB hearing regarding a proposed sewer line extension to waterfront lots in unincorporated Thurston County. (Thurston County WWGMHB decision in 2003 -- No. 00-2-0003). Although there were documented water quality issues and septic issues in the area, the WWGMHB ruled against extending public sewer service to residential waterfront lots with documented septic issues.

Finding a suitable drainfield area for a LOSS in close proximity to the study area may be difficult, given the lack of suitable soil types in the area. Due to the low elevation of the project area, any centralized system would also likely require the construction of extensive distribution and pumping systems.

Until community sewage treatment options are fully explored, Clallam County should continue to identify failing on-site septic systems in the study area, and pursue means to repair, or replace them as funding permits. Stable funding (such as an assessment on septics) must be secured in order to fund Clallam County's "Septics of Concern", O&M program, and other associated outreach and education efforts.

Additional landowner stewardship education and outreach are needed throughout the study area, in order to discourage dumping of landscape debris and other potential pollution sources in, or adjacent to waterbodies. Debris disposal alternatives should be promoted, such as a community composting site, or yard waste collection program. Landscape planting alternatives should also be promoted, emphasizing the use of native drought-tolerant and salt tolerant vegetation (Appendix B).

Irrigation ditch piping should continue, in order to eliminate livestock inputs, and polluted tailwater discharge into surface water drainages in the study area, and Dungeness Bay

Flooding

Recommended solutions to the flooding problem are different in each drainage. There is no single permanent solution to prevent floods from occurring throughout the entire study area. However, the impacts or hazards associated with flooding can be addressed. The two primary flooding concerns that were identified by residents in the study area are associated with landscaping and septics. Emergency access or evacuation along Three Crabs Road was also expressed as a significant concern.

The Meadowbrook Creek area flooding issues could largely be addressed by reconnecting the mouth of the stream to the Dungeness River or near the mouth of the river. Addressing the Meadowbrook Creek flooding problems is also likely to reduce potential adverse impacts to on-site septic systems, wellheads and to improve estuarine habitat for fish and wildlife in the area. The long term success of this solution (as with any alternative) will depend in large part, upon the natural longshore drift and river migration processes that will continue to change the shoreline in this area.

There is no easy or inexpensive solution to the flooding near the mouths of Cooper and Cassalery creeks. The current tide gate configuration at the mouth of Cooper Creek appears to be effective at preventing tidal influx, thus preventing salt water flooding under most circumstances. Given that this area is already heavily developed, and the flooding is fairly infrequent and not severe, adapting to and coping with these flood events appears to be the most feasible option for the foreseeable future. Replacement of the flume at the mouth of Casselary Creek with a larger structure may reduce the frequency of blockages, but would also allow for greater salt-water intrusion into the adjacent pasture areas. This issue is addressed further under the "Cassalery Creek" section of this report.

Climate Change and Sea Level Rise

A detailed site-specific assessment of climate change impacts in the study area is beyond the scope of this report. However, based on the existing problems and topography in the study area, it is clear that *any* accompanying relative increase in sea level will increase flooding and associated impacts to residents and local shoreline and estuarine environments. County development standards and land use plans should take this into consideration, in order to prevent further inappropriate placement of infrastructure into areas that will be even more prone to flooding and storm damage over time. Clallam County is required to update their Shoreline Master Program (SMP) by 2011. During the update process, the County should consider updating policies specifically related to the flood-prone portions of the study area.

Fish and Wildlife Habitat

The most significant area-wide habitat improvements are associated with the nearshore. Alternatives to hard armoring of the beach should be pursued, where it is feasible. In locations where residences are

adequately set back from the OHWM, “soft” armoring and bioengineered alternatives can be an effective alternative to rip-rap for the protection of beachfront properties while reducing detrimental effects to the nearshore environment and adjacent properties. Soft armoring (anchored beach logs) and native beach revegetation techniques were successfully implemented to protect residences in the Seashore Lane community that were threatened by winter storms in 2005-2006.

Many of the residences along the north side of Three Crabs Road are constructed too close to the OHWM of Dungeness Bay to allow for bioengineered beach stabilization techniques like those implemented at the Seashore Lane project. In these cases, existing rip-rap and other hard armoring must be periodically maintained and / or replaced in order to protect property and houses from winter storm impacts. Relocating these homes further from the OHWM might be a temporary solution, but this would be expensive, and may require setback variances from Three Crabs Road. Furthermore, effects of SLR may render this alternative a temporary fix. Acquisition and removal of these structures may be the only permanent remedy to future flooding hazards.

Restoring native riparian habit along each of the streams in the study area will also contribute significantly to fish and wildlife habitat conditions. The Conservation Reserve Enhancement Program (CREP) is a joint program of the US Department of Agriculture and the Washington Conservation Commission that is administered by conservation districts. Designed primarily as an incentive program for farmland owners with salmon-bearing streams, CREP provides for all the riparian forest restoration costs, including site preparation, planting and maintenance until plantings are established. Property owners receive rental payments for the land that is enrolled in the program for up to 15 years. Rental payments are based on soil type. The predominant soil types and annual per acre rental rates for the study area are: Lummi ($130), Mukilteo muck ($130), Puget ($130) Dungeness ($122), and Carlsborg ($85). Additional drainage-specific recommendations are provided later in this report.

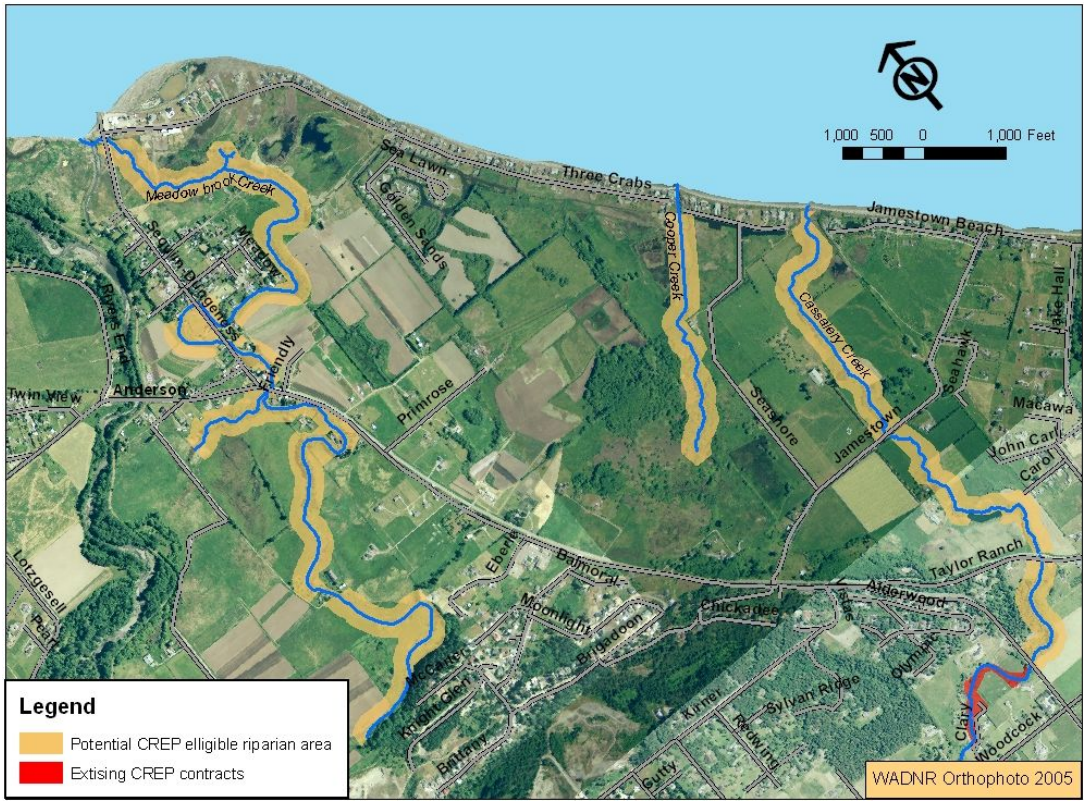


Figure 11 - potential CREP-eligible stream reaches in the study area

MEADOWBROOK CREEK

Stream and Sub-Basin Description

Meadowbrook Creek is the westernmost stream in the study area. It is located immediately east of the Dungeness River, to which it has historically been a tributary. Meadowbrook Creek is a small, low gradient stream falling less than 50 feet over its 2.4 mile length (<0.4 percent gradient). Originating from springs at the base of Kirner Ridge near Towne Road, it winds its way through farmland and the community of Dungeness to Dungeness Bay.

Figure 12 - Meadowbrook Creek sub-basin

The drainage area of the Meadowbrook Creek sub-basin is approximately 800 acres (1.2 square miles). Meadowbrook Creek has two tributaries: a short tributary that joins the mainstem at river mile (RM) 1.65, and Meadowbrook Slough, which joins Meadowbrook Creek just upstream of the present-day mouth – immediately downstream of the bridge at the north end of Sequim-Dungeness Way (SDW). The stream enters Dungeness Bay less than 500 feet downstream from that point. The mouth of the stream breached the sand spit in 1999, and has since been slowly migrating towards the west, as longshore drift processes build the beach in front of the armored point formed by the terminus of Sequim-Dungeness Way. Two irrigation tailwater ditches discharge surplus flows to Meadowbrook Creek. The most significant tailwater discharge is at RM 0.90, and the other is at RM 1.64.

It is speculated that Meadowbrook Creek was once the main channel of the Dungeness River, perhaps as recently as a few hundred years ago (Collins 2005). Meadowbrook Creek functioned as a flood relief channel for the Dungeness River until 1963, when a levee was constructed along the east side of the river. Today, it is a small, independent, low gradient stream with limited flushing capability (Haring, 1999).

Development Patterns and Land Use

The Meadowbrook Creek sub-basin landscape has changed dramatically over the past few centuries. The first European settlers arrived in the area in 1851. In 1891, the community of Dungeness was relocated from the bluff overlooking Dungeness Bay on the west side of the Dungeness River to its present location on the east side of the river, between the river and Meadowbrook Creek (Keeting, 1976). That same year a pier was constructed from the shoreline out into Dungeness Bay, the remnants of which remain in the bay today. It is important to note that at the time the pier was constructed, the Dungeness Bay shoreline was roughly 1,000 feet inland from current shoreline. A submersed power line extends from the shoreline at the terminus of SDW to the lighthouse on Dungeness Spit. The shoreline at this location is armored with rock to protect the power pole and the adjacent parking lot for the Three Crabs Restaurant.

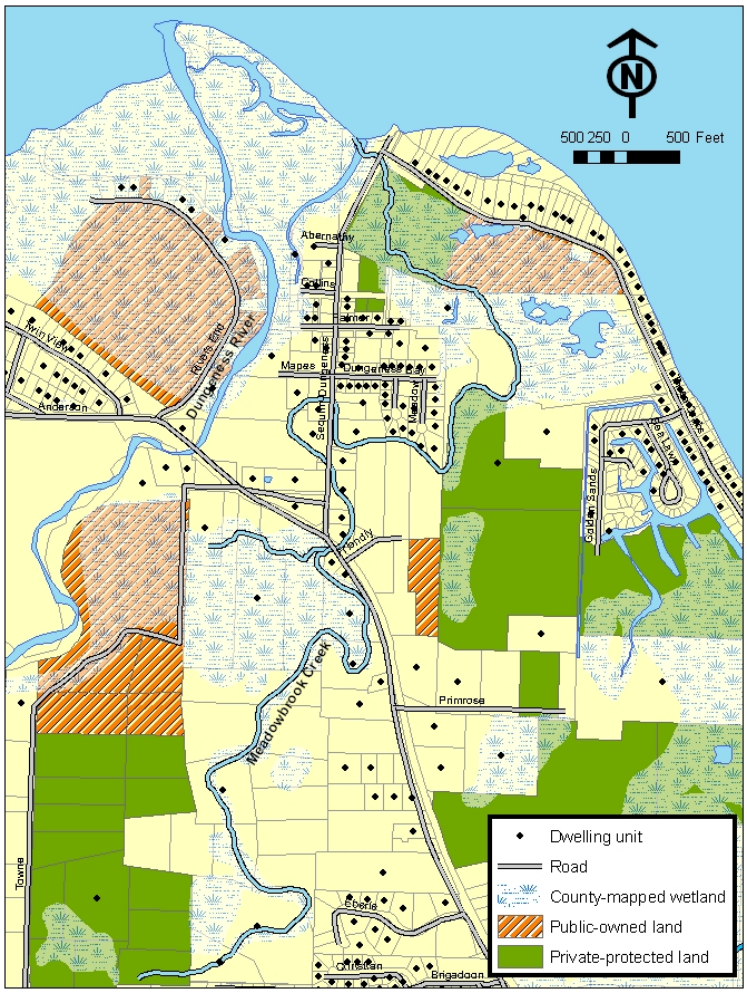


Figure 13 - Meadowbrook Creek sub-basin general ownership and land cover. (Source: 2007 Clallam County GIS data, with updated 2008 information for Rivers End Road)

In 1963, the Army Corps of Engineers built a levee along the east side of the Dungeness River from near the mouth to river mile 1.7. This levee ceased the historic flooding of the community of Dungeness by the Dungeness River, the floodwaters of which entered Dungeness Bay through Meadowbrook Creek. The levee also cut off Meadowbrook Slough, a significant distributary channel of the Dungeness River along its east side. According to a recent Bureau of Reclamation study, in a 100 year flood, the levee could potentially be breached, which could result in flooding of portions of the Dungeness community and potential failure of the levee. Planning is currently underway to pull back the Army Corps of Engineers levee upstream of Schoolhouse Bridge, which should eliminate that risk.

Present land use in the sub-basin is a mix of farmland, residential and open space-wetland. The upper third of Meadowbrook Creek's total length is relatively undeveloped, although significantly altered from its natural condition – mainly old pasture/ hayland and cropland. The lower two-thirds of the sub-basin are considerably more developed, including the community of Dungeness.

Sequim-Dungeness Way (SDW) is the main road through the community of Dungeness and terminates near the shoreline. The stream passes under SDW four times in this area. At the point where SDW terminates, Three Crabs Road begins, following the shoreline to the east and southeast. Along the north side of Three Crabs Road, residential development dominates the landscape, having grown from a couple of residences prior to 1970, between Meadowbrook Creek and Cooper Creek, to over 50today.

Approximately one-quarter of the sub-basin area is actively farmed. The principal farming activity is organic vegetable production by a single farm operator (*Dungeness Organic Produce*). Dungeness Organic Produce also raises small grains, green manure crops, and a small number of livestock (poultry and hogs) as part of their diversified farming operation. Other farming activities in the watershed include a few acres managed as pasture, and several acres of former dairy farms that are cut for hay once or twice a year.

Between approximately RM 2.0 and 1.0 Meadowbrook Creek meanders through residential areas, including a low density residential area immediately upstream of SDW and medium to high density residential areas through the south edge of the community of Dungeness. For the most part, land use along the north side of the stream is residential and on the south side, it is agricultural.

From RM 1.0 to its mouth Meadowbrook Creek flows through open space land maintained primarily for wetland and waterfowl habitat. Immediately prior to joining Meadowbrook Slough and entering Dungeness Bay, Meadowbrook Creek crosses SDW under a wooden county bridge with a span of approximately 15 feet.

In 2002, there were 128 residential units in the Meadowbrook Creek sub-basin of the Dungeness watershed area. The estimated total number of potential residential units anticipated at full build-out is 354 – nearly three times the number of units that existed in 2002 (JSKT CWA 319 Plan, 2007 – based on Clallam County data). However, the total build-out potential within this watershed has likely decreased since the 2007 JSKT report, due to zoning changes that were recently adopted in response to a Western Washington Growth Management Hearings Board (WWGMHB) decision. This issue is discussed further, below.

Community water systems serve roughly half the residences in the community of Dungeness. *Class A* water systems (systems serving businesses or more than 15 residences) in the Meadowbrook Creek area include the "Meadowbrook Village," "Dungeness Beach," and "Brandt Point" systems. Though complete records do not exist, it is assumed that the remaining residential parcels in the Dungeness area are served by individual wells. Sewage disposal consists entirely of individual on-site septic systems.

Most of the land in the upper part of the Meadowbrook Creek watershed consists of parcels that are five acres or more in area. Parcel size decreases north of SDW, with most parcels ranging from two to five acres south of the stream and more urban-density parcels (½ acre and smaller lots) within the community of Dungeness. The stream flows through several larger properties in the lower reach that are in the 5-20 acres range. Small residential lots (one acre and less) are located along the majority of the marine shoreline to the north of Three Crabs Road.

Zoning

Most of the area in the upper reaches of Meadowbrook Creek (south of SDW) is zoned *Agricultural Retention* (AR). The stated purpose of the AR zone is *to maintain and enhance the agricultural resource industry of Clallam County through the conservation of productive agricultural lands and discouragement of incompatible land uses within the zone* (CCC 33.07.010). This zone provides a density bonus for land divisions that are developed in a "cluster" configuration that preserves active farmland and situates homesites to minimize conflicts with farming activities.

Several existing parcels (>40 total acres) in the vicinity of the Meadowbrook Creek headwaters and four parcels (13.8 total acres) adjacent to the south side of SDW are presently zoned *Rural Moderate* (R2). The R2 zone is primarily a residential zone that allows a maximum residential density of one dwelling unit per 2.4 acres. R2-zoned properties throughout the County were recently given an 'interim' zoning designation of *Rural Low* (R5), which is also primarily a residential zone, but allows a maximum of one dwelling unit per 4.8 acres. The R5 zoning designation was adopted in response to a recent Western Washington Growth Management Hearings Board (WWGMHB) decision and compliance order (WWGMHB No. 07-2-0018c). (The final outcome of the WWGMB compliance order has yet to be completely resolved as of the publication date of this report.)

From approximately RM 1.65 to approximately RM 1.0, Meadowbrook Creek flows through the community of Dungeness, an area designated by Clallam County as a "Limited Area of More Intense Rural Development" (LAMIRD). The LAMIRD designation generally allows for higher residential densities, commercial uses and services in pre-established (prior to 1990) moderate to high density residential and limited commercial areas, where they would otherwise be prohibited or discouraged by the Growth Management Act (GMA). The LAMIRD boundaries and zoning designations recently changed in response to the aforementioned WWGMHB order. Part of this change included the removal of several parcels from the north portion of the LAMIRD and one parcel from the south, and rezoning the southwest portion of the LAMIRD to a newly created "Rural Village 2" (RV2) district. The new RV2 zoning

designation provides for a variety of low-intensity, tourist related commercial and residential activities, with a half-acre minimum lot size and one dwelling unit per acre maximum residential density.[1]

Several properties in the Meadowbrook Creek watershed are protected from further development by permanent conservation easements. Thirteen parcels totaling approximately 74 acres in the upper part of the watershed have had their development rights retired so the land will remain in agriculture. The stream originates in one of these parcels but does not flow through any of the others. Another five parcels (approximately 57.5 acres) in the upper watershed are owned by the Washington State Department of Fish & Wildlife (WDFW). Again, the stream does not flow through these parcels; however, one of these parcels is comprised of wetlands that feed a tributary to Meadowbrook Creek.

There are two parcels in the lower watershed comprising over 37 acres that were recently acquired by the WDFW and a private party. Meadowbrook Creek flows through both these parcels, which had previously been used as horse pasture and were in a highly degraded condition. The WDFW purchased a 19-acre parcel approximately one-half mile from the stream mouth in 2006. The current management plan includes enhancement of the site with native vegetation. Immediately downstream of this WDFW property is an 18-acre parcel recently purchased by the Dungeness Farms hunting club. Dungeness Farms placed a conservation easement on the property and manages the land primarily for waterfowl habitat, and secondarily for anadromous fish and other wildlife habitat. They are in the process of developing plans to improve fish habitat in this reach, including the removal two culverts that are partial fish passage barriers, and rerouting the stream into an historic channel. Portions of this project are being undertaken in partnership with Ducks Unlimited and the Jamestown S'Klallam Tribe.

Critical Areas

Meadowbrook Creek is regulated as a *Type 3 Aquatic Habitat Conservation Area* under the Clallam County Critical Areas Ordinance. *Type 3* streams require protective buffers of 60 feet for "minor new development" and 100 feet for "major new development" and new land divisions.[2]

Regulated wetlands cover approximately one-quarter of the Meadowbrook Creek sub-basin, according to Clallam County Critical Areas maps. Protective buffers, which are required from the delineated edge of wetlands, range from 25 feet to 200 feet, depending on the wetland classification and the type of proposed development. Development and land disturbing activities are prohibited within regulated *Wetlands* and their associated buffers.

In addition, the vast majority of the study area is within a *Critical Aquifer Recharge*

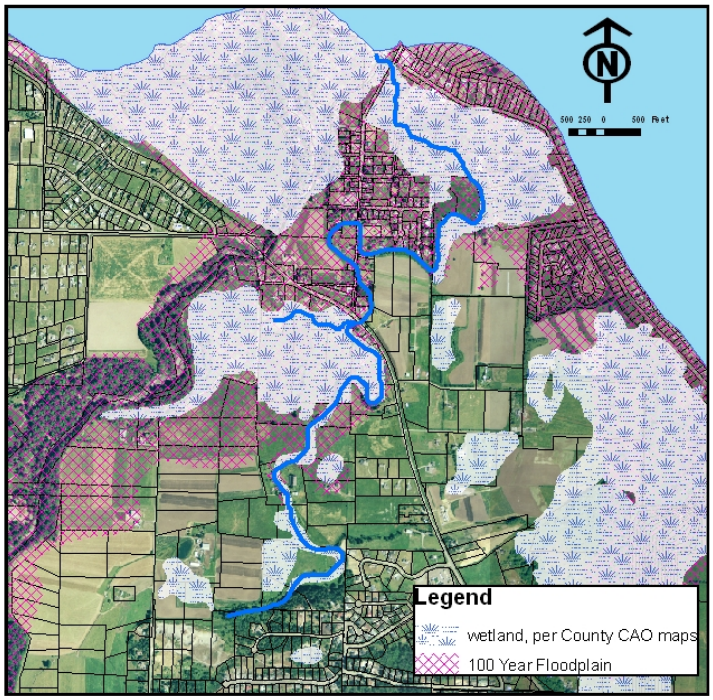


Figure 14 - Wetlands and 100 Year Floodplain (source: Clallam County GIS data).

[1] The previous RV designation of this area allowed for a minimum lot size of 12,500 square feet (0.287 acre) and maximum residential density of one dwelling unit per acre. The RV zoning designation remains, in the north portion of the Dungeness Village LAMIRD.

[2] "Minor New Development" generally refers to the construction of a single family dwelling on a site that has less than 4000 square-feet of impervious surface, and where grading does not exceed 500 cubic yards. "Major New Development" includes proposals that exceed the Minor New Development thresholds, in addition to commercial developments and uses requiring conditional use permits (for complete code citation, see CCC 27.12.900(35), (38)).

Area (CARA). A CARA is a geographical area which contains hydrogeologic conditions that provide the recharge to an aquifer(s) which is a current or potential potable water source and, due to its geological properties, is highly susceptible to the introduction of pollutants, or because of special circumstances, has been designated as a critical aquifer recharge area in accordance with WAC 365-190-080 by Clallam County (CCC 27.12.610). Land divisions and other development proposals within CARAs require evaluation by Clallam County for their potential impacts to groundwater. At the discretion of the County, special studies may be required for storage tanks or vaults used for hazardous, or potentially dangerous substances within CARAs.

Other Critical Areas within this watershed include 100-year floodplain, wildlife (bald eagle) habitat, tsunami hazard, seismic hazard, and CARA. Many areas along the stream corridor have overlapping buffers and other protection standards that restrict or prohibit new development entirely, without approval of a Critical Areas Variance or Reasonable Use Exception.

Resource Concerns

Water Quality

Water quality sampling has been conducted in Meadowbrook Creek for several years. Bacterial contamination levels that exceed State water quality standards have been documented within each of the drainages in the study area (Lower Dungeness TMDL, May 2002, WRIA 18 Watershed Plan, May, 2005). Some of the most intensive sampling was conducted by the Washington Department of Ecology as part of the 1999-2000 *Lower Dungeness Total Maximum Daily Load* (TMDL) study. Since the TMDL study, follow-up water quality monitoring has been conducted on Meadowbrook Creek by Clallam County and the Jamestown S'Klallam Tribe. As noted in the "overview" section, the predominant fecal coliform sources identified during a Microbial Source Tracking study included birds and wild mammals. However, human sources were identified at all sampling sites.

The Clallam Conservation District stream assessment revealed residential landowner stewardship issues in some of the more urbanized parts of Meadowbrook Creek. These stewardship issues include compost piles in close proximity to the stream (potential nutrient source), landscape ponds connected to the stream (potential contributor to high temperature and dissolved oxygen problems), ornamental landscaping in riparian areas (landscape fabric along the streambank, and potentially invasive exotic species). However, there were no obvious single sources identified that could be positively linked to the persistent fecal coliform contamination problems.

Septics

Reports of failing septic systems and "septics of concern" are not surprising, given the environmental challenges in this area. According to the USDA Soil Conservation Service *Soil Survey of Clallam County Area, Washington*, the predominant soil type in the Meadowbrook Creek area is Lummi silt loam, a hydrologic group D soil (hydric). It has a seasonal high water table from October to June that is within 6-24 inches of the surface. This soil has a severe limitation for on-site

Figure 15 - Flooded septic drainfield along Three Crabs Road.

septic systems due to wetness and is not suited for conventional septic drainfield systems.

Furthermore, in the lower reaches of Meadowbrook Creek, residential density is more typical of an urban area that would be served by a community sewage treatment facility than individual, on-site septic systems. County data evaluated in 2006 revealed that nearly half of the parcels (32) within the Dungeness community were less than 0.3 acres in area.

Periodic flooding and drainfield or septic tank inundation can be a potential source of pollution. This threat exists, regardless of whether the system was installed properly or is normally functioning according to design.

Irrigation Ditches

The 1999-2000 study TMDL identified high fecal coliform loading to Meadowbrook Creek from the Dungeness Irrigation District (DID) tailwater ditch at the corner of SDW and East Anderson Road (RM 1.64). There have been two significant changes since the TMDL water quality data were collected. Now, the majority of water in the DID ditch is diverted into a lateral ditch immediately downstream of Primrose Lane, thus significantly reducing the amount of irrigation tailwater spills to Meadowbrook Creek at the SDW-East Anderson Road location. The Primrose Lane lateral does occasionally spill tailwater into Meadowbrook Creek at RM 0.95. However, this is after passing through a fairly large wetland just upstream of the last irrigation pump station and outfall to the creek. Recent water quality sampling data indicate that this tailwater site continues to occasionally have high fecal coliform counts; however, tailwater spills at this location are much less frequent during the irrigation season than they were at the other location.

The other major change to the DID ditch system was a change in the probable sources of bacterial contamination. During the time of the TMDL study, the main source of bacterial contamination to the irrigation ditch was presumed to be two beef cattle operations located along Towne Road where cattle had access to the open canal. The cattle were removed from the property on the downstream side of Towne Road in 2002 after that property was sold and converted to an organic vegetable farm. The beef cattle operation immediately upstream of Towne Road remains in operation. This reach of the irrigation canal, which has unrestricted livestock access, has been identified as a significant source of bacterial contamination, and is being replaced with a buried pipeline. This piping work is scheduled to be complete by the beginning of the 2009 irrigation season. This will completely eliminate existing livestock access to the irrigation system within the study area.

Beef cattle had unrestricted access to the Meadowbrook Creek tributary, located east of Towne Road near the intersection with Anderson Road, until 2007 when they were removed from that property. Small numbers of cattle have at times had limited access to the Meadowbrook Creek mainstem just upstream of the uppermost SDW crossing, as well as the DID irrigation ditch between Primrose Lane and Friendly Lane. At the time this report was being prepared, livestock did not have access to either the creek or the ditch in these locations.

Flooding

Lower Meadowbrook Creek has likely always experienced periodic flooding. Prior to the 1963 construction of the Army Corps of Engineers levee along the east side of the Dungeness River, Meadowbrook Creek was the outlet for much of the Dungeness River floodwaters. The levee has prevented any further flooding associated with the river. Although flooding near the mouth of the stream is not well documented, it likely has occurred at least sporadically. Most of the lower Meadowbrook Creek area consisted primarily of undeveloped land until the past 20 years, so most flooding had a relatively minor impact.

The landscape – both natural and developed – has changed in recent years. Beginning in 1999, following a breach of the sand spit near the stream mouth, the lower half mile or so of stream and adjacent land has been subject to annual or near annual flooding. That same year a row of Leyland cypress trees along the

west side of SDW began dying from salt water intrusion up Meadowbrook Slough. Prior to the sand spit breach, the stream outlet to Dungeness Bay was over 1,500 feet farther west, very near the mouth of the Dungeness River. The additional one-third of a mile (approximately 15% of the total stream length) of stream allowed for a more sinuous, less direct route to the bay. This greatly moderated the tidal effects upstream. Now, Meadowbrook Creek joins Meadowbrook Slough just downstream of the SDW bridge, less than 500 feet from where the combined channels enter Dungeness Bay. Flooding typically results during extreme high tides when salt water flows up the stream channel nearly unimpeded. Additionally, high tides prevent the outflow of freshwater from the stream, thus backing up stream flows. Occasionally the stream mouth closes off with sand, gravel and marine vegetation, impounding the stream and causing it to back up and overflow its banks onto adjacent low-lying land.

Portions of the streambed where the creek breaches the beach dune, consists of a dense mat of fibrous material that appears to be compressed, partially decomposed organic matter mixed with silt and some gravel. This material appears to be very resistant to erosion. The stream has been moving westward from the original breach location as the drift cell in front of the Three Crabs Restaurant grows and migrates westward.

Figure 16 - End of Sequim-Dungeness Way, Meadowbrook Slough and mouth of Meadowbrook Creek in 1994 (left) and 2006 (DOE shoreline aerial photos).

The point where SDW terminates at the beach is well armored with rock rip-rap. This is the location of the former pier, which originated some 1,130 feet inland where SDW makes a slight turn. Approximately 100 feet from this point is a power pole where power lines to the Dungeness Spit lighthouse go from overhead to buried/ submersed. The shoreline armoring also protects the western parking lot for the Three Crabs Restaurant. Clallam County Public Works maintains a right-of-way there and also maintains the shoreline armoring. The armoring of this point affects the deposition and erosion of marine longshore drift, exacerbating scour and beach erosion immediately west of this point.

During the most extreme flood events, flood waters have inundated portions of Three Crabs Road with 6-12 inches of water (personal communication with landowners). During the 2006 flood, a total of 17 lots along the north side of Three Crabs Road were impacted by flood waters. Ten of these 17 lots were heavily impacted with inundated driveways, landscaping and septic drainfields. Three of the 17 lots (including one of the ten heavily impacted) were undeveloped. Two of the residences on the ten heavily impacted lots were vacant, while eight were rentals, vacation homes or otherwise absentee owned. Flood waters surrounded at least one residence on the north side of Three Crabs Road up to the top of the foundation and a horse barn (no longer used for housing horses) on the south side of the road. Most of the on-site septic systems in the flood-prone area are mound systems, and therefore do not experience complete inundation during flood events. Existing non-elevated conventional on-site septic systems in the same area however, are likely subject to complete inundation during flood events.

The majority of residences in the flood-impacted area are served by the "Brandt Point" community water system. The source of water for this system is a well located on the south side of Three Crabs Road [parcel number 033130-310030] approximately one-quarter mile east of the Three Crabs Restaurant.

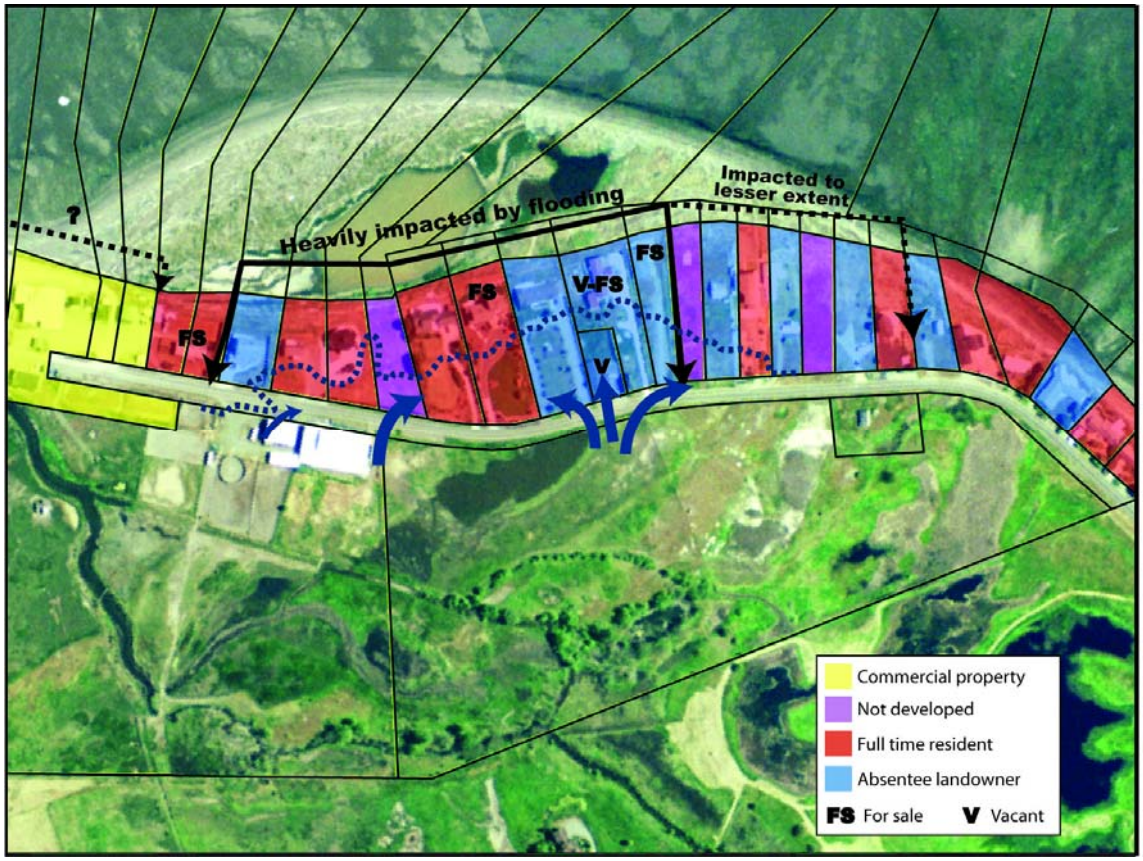


Figure 17 - Impacts from 2006 flood.

Because Three Crabs Road is a dead-end road, flooding can potentially strand residents, many of whom are elderly. To date, flooding has not been significant enough in terms of depth or duration to present a serious emergency vehicle access or evacuation problem. However, the situation would be much different if the SDW bridge were to become impassable.

As noted above, Meadowbrook Creek flooding is largely attributable to salt water flowing upstream during extreme high tides and blockages at the stream mouth that impound outgoing flows. Other possible factors contributing to flooding problems include:

- Channel constriction at SDW bridge less than 300 feet from bay (LFA & JSKT CWA 319 Plan, 2007) and hard armoring along stream bank immediately upstream of bridge
- The low elevation of surrounding land upstream of SDW bridge (this area is lower in elevation than the beach berm and developed properties along Three Crabs Road)
- Two partially functional culverts (4' and 18" diameter) on Dungeness Farms property (approximate RM 0.23) (JSKT CWA 319 Plan, 2007) (pg. 43)

Fish and Wildlife Habitat

Meadowbrook Creek supports runs of steelhead and coho salmon (Haring, 1999), cutthroat trout, stickleback, and sculpin. A survey conducted by Clallam Conservation District in the 1990's identified chum salmon in Meadowbrook Creek, as well. Due to its short length, low flows, low gradient, and silt substrate there is limited spawning habitat in Meadowbrook Creek. However, with the creek as a tributary to the Dungeness River, the salmon habitat value for Meadowbrook Creek would be rearing

habitat. Monitoring of juvenile salmon at the Dungeness River slough channel (which formerly connected Meadowbrook to the Dungeness) found high usage of this area (Sather 2008). Its proximity to the mouth of the Dungeness River however, does present great potential value for estuarine habitat.

Riparian forest cover is the exception, rather than the rule along Meadowbrook Creek. Nearly 100% of the total 2.4 miles of stream length lacks riparian forest cover of any significance (see figure 11 – CREP eligible map). Reed canarygrass and Himalayan blackberry dominate the riparian area in some of the upper reaches of Meadowbrook Creek, as well as a remnant oxbow channel feature near RM 0.95.

A common corollary to lack of riparian cover is high water temperatures, which were noted in the 1999 Salmon and Steelhead Habitat Limiting Factors Analysis (Haring). In addition to an overall lack of shade-providing riparian tree canopy along much of the stream, several constructed ponds adjacent to Meadowbrook Creek, as well as beaver ponds in the main channel near the headwaters, may contribute to high temperatures in the lower reaches during summer months.

Fish passage appears to be a relatively minor concern on Meadowbrook Creek. During the 2007 stream assessment conducted by CCD, a total of 18 crossings were identified throughout the entire length of the stream, including driveways, foot bridges, livestock, and road crossings.. Three of the four SDW crossings are bridges; the uppermost crossing (RM 1.64) is a culvert. All these crossings are passable by fish. In addition to the SDW crossings, there are 14 private stream crossings. Two culverts – one 4' diameter and one 18" diameter – provide for old agricultural stream-crossings on the Dungeness Farms Hunt Club property (RM 0.23). These culverts constrict the stream channel and are partial barriers to fish passage; however, they are proposed for removal and/or replacement in 2009. An old wooden bridge exists at RM 0.64. Meadowbrook Creek passes through three driveway crossings and footbridges in the community of Dungeness. Other stream crossings include a wooden bridge at RM 1.74, the Dungeness Irrigation District main canal conduit crossing at RM 1.97, and an old dilapidated farm crossing at RM 2.19.

The latter crossing located less than a quarter mile from the headwaters and consisting of an old wooden bridge and a 12" culvert, has been utilized by beaver to dam the stream around. In its present condition, it is a near, if not complete barrier to fish passage. Similarly, the irrigation canal crossing, which consists of a 24-inch concrete pipe over the stream, has been used by beaver as the foundation for a beaver dam. A dam in that location was cleared in 2008 and the beaver were trapped and removed from the area. The mouth of the stream occasionally closes with sand, gravel and marine debris; however, this phenomenon is temporary, as the stream flow naturally clears the blockage within a few days.

Meadowbrook Estuary

Estuarine function is limited, due to the sand spit breach at the current stream mouth and by the bridge at SDW. Historically, the mouth of Meadowbrook Creek drained into Dungeness Bay either as a tributary to the Dungeness River, or directly into the bay much farther downstream, near the mouth of the river. The location of the Meadowbrook Creek mouth has moved around as the longshore drift of marine sediment in the bay continually shifts in an east to west direction (Collins, 2005). As recently as the latter part of the 19th century, the shoreline in the area of the present-day mouth of the stream was approximately 1,000 feet farther inland than it is today. A substantial estuary, including lagoon and salt marsh existed in this area at that time (Collins, 2005). Today, a significant beach berm forms the shoreline and separates the former estuary from the bay. This beach berm is the highest elevation in the area and has been built up with houses and the Three Crabs Restaurant.

As was discussed under the Flooding section, the sand spit that protruded in a northwesterly direction immediately to the west of this point eroded in the winter of 1998-99, cutting into the Meadowbrook Creek channel. This effectively shortened the stream length by over 1,500 feet, making it much more vulnerable to high-tide influences. Now, stream access by juvenile Chinook salmon seeking quiet, estuarine backwater areas is more difficult than under pre-sand spit breach conditions.

Figure 18 - Meadowbrook Creek outlet, slough, estuary, and Dungeness River (DOE photos, 2006)

In addition, the loss of Dungeness River flood waters that historically utilized Meadowbrook Creek as a flood release channel has also deprived the Meadowbrook Creek delta of sediment. Prior to construction of the Army Corps of Engineers dike, during high water events, flood waters from the Dungeness River spilled into Meadowbrook Creek, depositing sediment and increasing stream energy in the lower reach. Therefore, although the delta area at the mouths of Meadowbrook Creek and the Dungeness River are relatively young and very dynamic, it is very likely that the loss of Dungeness River flood flows and sediment are contributing factors to the recent sand spit breach (Haring, 1999, Collins, 2005).

Areas near the mouth of the Dungeness River have been identified as important habitat for "Taylor's Checkerspot" butterfly (*Euphydryas editha taylori*), which was listed as endangered by the State of Washington in 2006, and is a candidate for listing under the federal Endangered Species Act. Identified threats to this species include: pesticides, destruction of native grasslands by agriculture, residential and commercial development; encroachment by nonnative plants, and the replacement of caterpillar host plants by nonnative plants (WDFW, USFWS).

Recommended Actions

Water Quality

The most apparent and controllable source of water pollution to Meadowbrook Creek is the irrigation tailwater from the DID ditches. Livestock access to the DID main canal in the upper area of the sub-basin is a known source of contamination and can be completely eliminated through piping. The piping of this section of canal should be complete prior to the start of the 2009 irrigation season. Additional piping of the DID ditch system could eliminate all irrigation tailwater discharges to Meadowbrook Creek, thus should be given a high priority.

Other known water quality problems are associated with human waste treatment, namely on-site septic systems. Unfortunately, due to the dispersed and concealed nature of on-site septic systems, identification of individual problem systems is very challenging. Septic surveys should continue to be conducted in order to identify failing systems. However, such surveys require a certain amount of cooperation on the part of property owners. Furthermore, system failures may be of a seasonal nature. Therefore, failures may not be readily detected through a one-time survey. Clallam County's on-site septic system operation and maintenance program may provide regulatory mechanisms to accomplish this more readily. However, until stable funding is secured and inspections and repairs are consistently mandated, the problem of failing systems will likely persist.

Because of the small lot sizes, poor soils, pervasive problems, and detection challenges with existing septic systems, a community sewage treatment facility and / or connection to an existing sewer treatment facility (Sunland) should be considered for properties within the Dungeness Village LAMIRD. As noted in the overview section however, the extension of sewer service from the existing Sunland treatment plant may be a possibility in the future for lots within the Dungeness Village LAMIRD, but would require buy-in from the Sunland Sewer and Water District and a funding source.

Flooding

The flooding problems in the lower reaches of Meadowbrook Creek are due to the topography of the area, salt water flow up Meadowbrook Creek during extreme high tides, and periodic blockages at the mouth of the stream that impound the out-flowing freshwater. The sand spit that separated the lower one-third mile of Meadowbrook Creek from Dungeness Bay prior to the 1998-99 breach is building up again. As the marine longshore drift accretes to the northwest, Meadowbrook Creek also extends farther in that direction. Less than 500 feet presently separate Meadowbrook Creek and Meadowbrook Slough from the lower elevation, isolated portion of the former channel. It is merely a matter of time before the sand spit builds up enough for the former stream channel to reconnect. However, how much time it will take, and what impacts may result in the meantime, are difficult to predict.

The reconnection of the old channel and subsequent extension of the stream length could be accelerated by excavating a short channel. Approximately 200 feet of new channel would need to be excavated in an almost due west direction from the SDW bridge in order to connect to a remnant channel that drains into the old Meadowbrook Creek channel. Such a channel connection would extend the mouth of the channel a distance of over 2,000 feet toward the northwest.

Reconnecting to this channel would have several advantages, both for flood hazard management and for habitat enhancement, which is discussed later. The addition of 2,000 feet of stream channel near the mouth and the increased flows and energy from the Dungeness River would greatly diminish the effects of high tides. The river would much more effectively flush sediment accumulations near the mouth, thus lessen the likelihood of stream mouth blockages and subsequent impoundments of out-flowing freshwater. And, Meadowbrook Creek and Slough would more readily function as tributary habitat of the river.

Even though the physical work to be done to reconnect the channel may be relatively simple and minor, considerable preparatory work is required. Stream channel excavation in this estuary environment would require numerous permits, including a Critical Areas Ordinance Certificate of Compliance from Clallam County, a Hydraulic Project Approval from the Washington Department of Fish and Wildlife (WDFW), as well as consultation and possible permits from the Army Corps of Engineers, just to name a few. In addition, this area has a relatively high potential for cultural and historic resources. Marine and riverine shorelines were commonly utilized by Native Americans, and this area was the site of some of the first European settlement in the area. These factors warrant the conducting of a cultural resources survey prior to any ground-disturbing activities. The completion of a cultural resources survey and the processing of permits can take many months; therefore, even if a decision were to be made tomorrow to excavate a new channel, by the time the all the necessary permits are processed, nature may do the work of building up the sand spit enough to reconnect the channel itself.

Ducks Unlimited is currently conducting a feasibility study and exploring several design alternatives for enhancement of the lower Meadowbrook Creek reach, which may also include reconnection to the Dungeness and / or a second channel across Sequim-Dungeness Way. Modeling is being done to assess potential effects of such modifications, in an effort to further explore alternatives and inform design.

In addition to channel reconnection, other flood abatement alternatives were discussed by area residents, Clallam County Public Works Department and Emergency Management staff, WDFW officials, and

Jamestown S'Klallam Tribal representatives at flood subcommittee meetings. Alternatives discussed during the meetings included:

- Raising the grade of Three Crabs Road where floodwaters cross
- Constructing a berm along the south side of Three Crabs Road
- Excavation on WDFW property for flood storage
- Connection to Golden Sands Slough

Because flood events are usually tidally influenced, excavation for storage would not provide any relief. Furthermore, the shallow groundwater in the area would quickly fill any newly excavated areas, rendering the "storage" space useless. Connection to Golden Sands Slough would provide limited (if any) flood relief due to the limited size (2' diameter) of the slough outlet to the bay, and may expand existing water quality issues beyond the excavated slough and into the salt marsh to the west. Alterations to (or adjacent to) Three Crabs Road would require Public Works approval, and could be costly. Furthermore, impounding additional floodwaters on the south side of the road could impact properties in the Dungeness community further to the south.

Anecdotal evidence from recent floods along Three Crabs Road indicates that the vast majority of the damage was to landscaping. The most severe damage to landscaping was from salt water intrusion, whereby landscape plantings not tolerant of salt water were killed. Adapting landscaping to the existing marine shoreline conditions is highly recommended. Utilizing native species tolerant of a saltwater shoreline environment would have multiple benefits, including reduced maintenance requirements and improved habitat conditions for native wildlife adapted to such vegetation. Appendix B includes lists of plants that are appropriate for these conditions.

Recent flooding and existing flood risks are all based on current climate and sea level conditions. As noted in the overview section, several models predict a measurable rise in sea level in the study area within the next 50-100 years. It may be impossible to predict with any certainty, exactly what might happen with sea level conditions in this area, however it is reasonable to assume that sea level will not be dropping significantly and that existing flood hazards will persist, if not increase over time.

Whether or not anything is done to mitigate the factors contributing to area flooding, Clallam County and individual property owners should take action to minimize the associated hazards, including septic system maintenance, installation of salt-tolerant native vegetation and protection of wellheads. Further development in the area along Three Crabs Road will be susceptible to additional flood damage. Therefore, very serious consideration of flood hazards and environmental impacts should be given to any additional building permit applications for properties in this area.

Fish and Wildlife Habitat

Perhaps the most significant habitat value in the Meadowbrook Creek sub-basin is estuarine. As discussed previously in the Flooding section, extension of the Meadowbrook Creek stream channel near the mouth to its former channel has numerous benefits, including habitat. If the former stream channel were to be reconnected, juvenile salmon would once again have direct access from the Dungeness River into Meadowbrook Creek. This would have benefits for Coho and endangered Chinook populations, which (along with most other salmon species) utilize estuaries and near shore areas at some time during their lives. (Chinook salmon spend most of their first year in the estuary and near shore areas.) Furthermore, a 15-acre estuary area between the mouth of the river and Meadowbrook Slough would become more accessible. Again, reconnecting these channels is a relatively simple and inexpensive project, but fairly complex with regards to permitting and cultural resources.

Just upstream of the most downstream SDW bridge is the 18-acre Dungeness Farms hunting club property. This property is managed primarily for waterfowl habitat, and the owners placed a conservation easement on the property to prevent any further development. Contiguous with this property is a 19-acre parcel owned by the Washington Department of Fish and Wildlife. Instream and wetland improvements

in and adjacent to Meadowbrook Creek are proposed on the Dungeness Farms hunting club property. A partial barrier stream crossing is proposed for replacement in 2009. This will allow for more free-flowing water – both freshwater and saltwater – and no longer be an impediment to fish migration. Removal of small dikes along the banks of the stream will enhance up to 40 acres of the surrounding wetland and salt marsh habitat (DU, 2008).

Increasing the lower SDW bridge span and removing the bank armoring immediately upstream of the bridge would allow for less impeded flow (freshwater and intertidal) of water in Meadowbrook Creek. However, the costs, versus the habitat benefits of such a project has not been fully evaluated.

The vast majority of Meadowbrook Creek's 2.4 miles are in need of riparian forest restoration. The slow-moving stream is dominated by invasive plants, such as reed canarygrass, that impedes flows and outcompetes beneficial native riparian vegetation. In addition, the lack of shade contributes to high water temperatures. Riparian forest vegetation establishment would eventually shade out invasive plants and provide shade and other benefits to the stream itself. The vast majority of the stream's 2.4 miles is potentially eligible for the Conservation Reserve Enhancement Program (CREP) (see CREP elligibility map - figure 11).

Enhancement and replanting plans for the lower Meadowbrook Creek area should include consideration of important plant species and habitat needs of Taylor's Checkerspot butterfly. Taylor's Checkerspot habitat can be enhanced by planting native vegetation and practicing natural landscaping by residents, as well. Host plants for the Taylor's Checkerspot butterfly include Paintbrush and Plantain; Sea Plantain (*Plantago maritime*), Alaskan plantain (*P.macrocarpa*) and Ribwort (*P.lanceolata*) (Knowles, 2006).

GOLDEN SANDS

Description

The "Golden Sands" community is located on the south side of Three Crabs Road approximately three-quarters of a mile east of the mouth of Meadowbrook Creek and on-half mile west of the end of Three Crabs Road. This development is comprised of 91 small platted lots (0.15 to 0.5 acres in area) that were created with the recording of the *Golden Sands Division No. 1* mobile home subdivision on June 6, 1966. Golden Sands is bordered by agricultural and open space land to the west, south, and east, and by the "Dungeness Beach Estate" subdivision to the north.

Figure 19 - 2006 DOE oblique aerial photograph

A series of canals were excavated into wetlands south of Three Crabs Road as part of a recreational component of the original Golden Sands development. This waterway (referred to as the "Golden Sands Slough") is directly connected to Dungeness Bay through an approximately 250-foot long concrete flume under Three Crabs Road. These waterways were presumably constructed to provide boating access to Dungeness Bay. However, the developers abandoned the project (allegedly leaving the area with the investment money) and the canals were never completed (CWD Bacterial / Nutrient / Flow Effectiveness Monitoring QAPP, September, 2005).

Today, approximately 50 percent of the lots within the Golden Sands subdivision are developed. Existing development within Golden Sands includes a mixture of permanent residences, outbuildings and developed recreational lots. Some lots are served by septic systems and others utilize holding tanks (Ibid.). There is a 64' deep well located within the Golden Sands subdivision that serves the Dungeness Beach public water system.

Resource Concerns

Water Quality

Water quality testing in the Golden Sands Slough has revealed **bacterial pollution** levels that exceed State water quality standards (Lower Dungeness TMDL, May, 2002). Due to current environmental health regulations, new septic systems are effectively prohibited within the Golden Sands development. However, existing systems within this development are a suspected contributor to bacterial contamination of the adjacent slough and Dungeness Bay. Based on test results from the May, 2002 TMDL study and the fact that septic system functionality is questionable, it was recommended that waste treatment systems for the Golden Sands development be investigated.

The Golden Sands Slough has been subject to ongoing water quality monitoring, in order to determine whether fecal colifom bacteria levels are improving and to determine the effectiveness of remediation measures. As noted in the overview section, samples were taken from the Golden Sands slough during phase I of the MST study. Preliminary results of phase I have revealed human sources of fecal coliform bacteria within the slough. Complete results of both phases of the MST studies are expected to be published in May, 2009 (Woodruff, 2009).

Several "Septics of Concern" were recently identified and repaired within the Golden Sands development. A thorough investigation to identify existing systems and underground holding tanks within this development has not been conducted. One of the difficulties in investigating contaminant sources [failing septic systems] within this development is a lack of permitting history for many of the lots. In most cases, building code regulations in Clallam County do not apply to recreational vehicles (RVs). This becomes problematic when RVs are "permanently" installed, or seasonally occupied as a residence. When a building permit is not required or submitted for these installations, even well-intentioned land owners who install their own underground holding tank or septic system without proper design considerations or the assistance of certified installers, can create potential environmental health and / or water quality problems.

Fish and Wildlife Habitat

Since the slough is an excavated waterbody, Clallam County has made the determination that it does not constitute an *Aquatic Habitat Conservation Area*, or *Wetland.*[1] Therefore, there are no County-mandated protective buffers required for clearing and grading activities and other uses adjacent to, or within the slough. However, WDFW has previously required Hydraulic Permit Approvals for work done within the slough.

Recommended Actions

Water Quality

Due to the documented fecal coliform bacteria issues and confirmed human sources within the slough, this community should be assigned high priority for Septics of Concern / identification and remediation.

Fish and Wildlife Habitat

The County should reconsider the classification and regulation of the Golden Sands slough. Given the direct connection to Dungeness Bay, it should receive protection similar to natural waterways.

[1] CCC 27.12.210 and 27.12.310 provides the classification and designation provisions for *Aquatic Habitat Conservation Areas* and *Wetlands* (Clallam County Critical Areas Ordinance)

COOPER CREEK

Stream and Sub-Basin Description

Cooper Creek is a small, low-gradient stream, roughly one mile in length with a watershed area of approximately 340 acres. It empties into Dungeness Bay through a tide gate between the terminus of Three Crabs Road and West Seashore Lane, approximately two miles east of the mouth of the Dungeness River and 1,500 feet west of the mouth of Cassalery Creek. Cooper Creek originates from low elevation, palustrine wetlands and agricultural land near the base of Kirner Ridge, north of Sequim Dungeness Way.

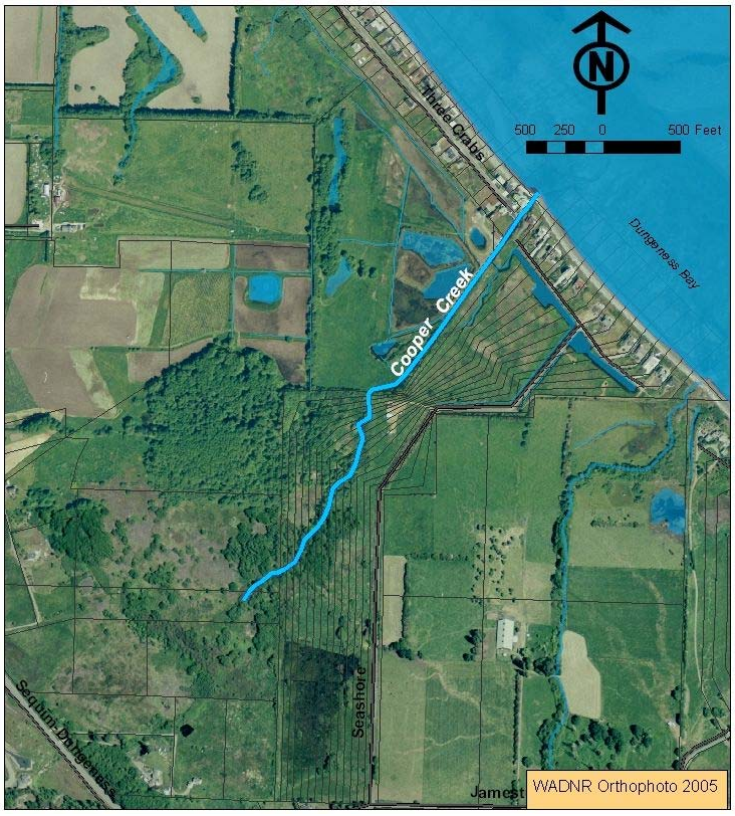


Figure 20 – Cooper Creek and vicinity

The Cooper Creek watershed is characterized by significant human alterations related to agricultural uses and residential development. These alterations have been most significant along and adjacent to the marine shoreline, where almost all of the beachfront properties have been developed with residences. The most notable alteration is a 3 ½-foot by 4-foot flume and tide gate at the mouth of the stream. Other significant alterations include stream channelization, placement of fill in wetland areas for road construction and homesite development, and excavation of ditches to drain wetlands. Further inland, wetlands have presented a more formidable obstacle to development and have experienced considerably less impact.

Flow measurements recorded at the mouth of Cooper Creek during the late 1980s and early 1990s indicate an average flow of just over five cubic feet per second (cfs). Low flows were around three cfs, and the highest flow was over 18 cfs, recorded in December 1991. The stream channel is straight, with fairly uniform banks and bottom for a distance of about 1,600 feet upstream from the mouth. An old, meandering channel parallels the channelized reach, joining it approximately 500 feet from the mouth.

Development Patterns and Land Use

It is uncertain to what extent the wetlands in the lower Cooper Creek watershed area were naturally influenced by salt water. Records from the time of European settlement in the mid 19th century suggest that they were primarily freshwater wetlands (Collins, 2005). By the early 20th century drainage ditches had been dug to facilitate cultivation. Maps from that time indicate that the area was “saltmarsh” (Collins, 2005). It is likely the area was naturally brackish wetland. Long-time residents report that the existing straight channel was constructed in the 1940s with dynamite and bulldozer; however, the 1914 Clallam County Assessor maps show that a somewhat shorter length of straight channel from the mouth existed in the early part of the century. At the time of the construction of the present channel, the stream was periodically dammed near the mouth in order to flood lands immediately upstream and enhance duck-hunting habitat. In 1943, a memorandum of agreement between the property owners in the vicinity

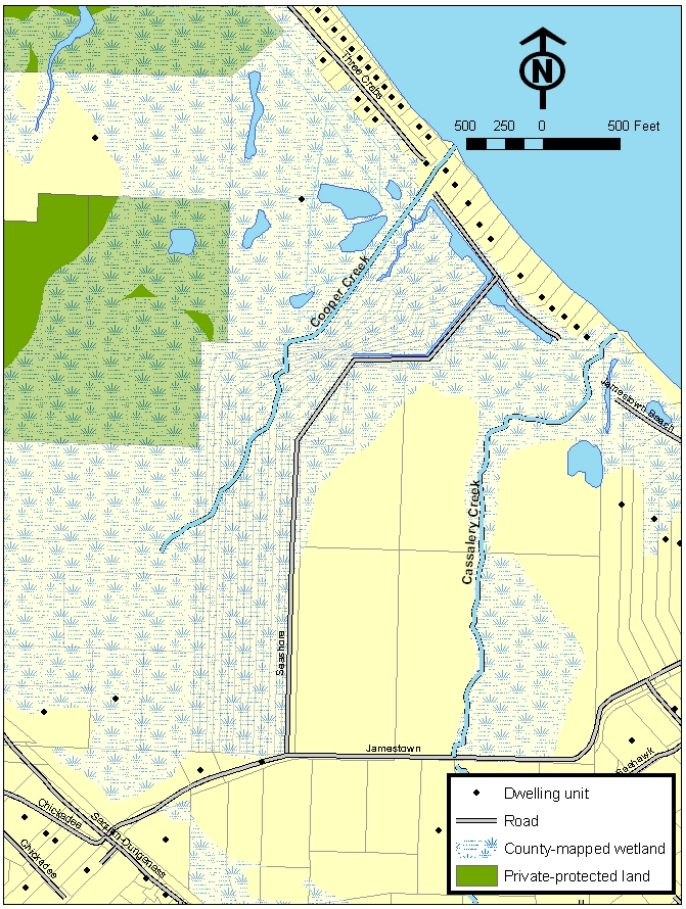


Figure 21 - General ownership patterns and land cover in the Cooper / Cassalery Creek area (Source: 2007 Clallam County GIS data)

(McInnes, Fitzgerald, Bell, Evans) was filed with the Clallam County Auditor stating that none of the parties to the document would "…obstruct the flow of the waters of Cooper Creek by damming the flume or otherwise…"[1]

In the late 1970s, the Seashore Lane development was initiated with the construction of Seashore Road from Jamestown Road to the beach east of the tide gate. An elaborate network of drainage ditches and ponds were constructed as part of this road construction. In addition, a low dike was constructed to prevent flood waters from Cassalery Creek from overflowing into the Cooper Creek floodplain.

The 15-parcel Seashore Lane development consists of long, narrow parcels with homesites situated along the beach frontage. The remaining acreage is managed as common open space, the vast majority of which is within regulated wetlands. Thirteen of the parcels are currently developed with residences. The residences are all located along the narrow, sandy, beach dune that separates Dungeness Bay from the ponds, ditches and low-lying wetlands that are just inland. Individual lot sizes within this development are approximately five acres, each; however, the developable portions of the lots (area for structures, driveways and septic system absorption fields) average less than one-half acre. This development is served by two Class 'B' community water systems from two 150-200-foot artesian wells located a short distance from the beach, just east of Seashore Road and south of East Seashore Lane,.

In the late 1980s, side-channel ponds were excavated on the west side of Cooper Creek for waterfowl habitat improvement. The landowner also installed a control structure at the outlet to the pond network in order to regulate water levels and restrict salt water intrusion. In addition to preventing salt water intrusion, this tide gate enabled better freshwater management, including impounding water to attract waterfowl in the fall, as well as draining to allow for seasonal cultivation and planting of waterfowl forage crops such as barley.

Since the early 1990s, considerable residential development has encroached on the stream and stream buffer near the west side of the mouth of Cooper Creek. During the late 1990s, a concrete bulkhead was installed along the lower 100 feet of the west bank of the stream.[2] This bulkhead continues west along the shoreline from the tide gate a distance of approximately 150 feet. A Class 'A' water system ("Dungeness Beach Water System") serves a majority of residents along Three Crabs Road to the west of Cooper Creek.

[1] See volume 159, Page 288 of Deeds (December 23, 1943).
[2] According to the landowner, the bulkhead was originally constructed in this location in approximately 1968, and restored in the late 1990's.

Sewage disposal for residences in the Cooper Creek area is provided entirely by individual on-site septic systems. Almost all of the development in the Cooper Creek watershed is along the shoreline and has occurred since 1980, the majority occurring since 1990. Therefore, due to the soils of the area and the more stringent septic system design requirements imposed in the early 1990s, many of the on-site septic systems are mound systems.

The upper reaches of the Cooper Creek sub-basin consist primarily of undeveloped wetland areas. Approximately 80 acres in the middle portion of the sub-basin is actively farmed (vegetables and small grains). Two large parcels (with a total acreage of approximately 80 acres) to the west of the middle reach are protected from further land division by conservation easements held by the North Olympic Land Trust (NOLT). These parcels are managed for agriculture and wildlife habitat.

Zoning

Current zoning in the vicinity of Cooper Creek between Sequim Dungeness Way to the southwest and Dungeness Bay to the northeast, is *Rural Low Density* (R5). The R5 zone limits new developments to a residential density of one (1) dwelling unit, per 4.8 acres, with a minimum lot size of one (1) acre. This zone also provides a maximum width to depth ratio for new lots of 1:5. The area surrounding Cooper Creek has a mix of lot sizes, with several larger tracts (20-40 acres) to the west, long and narrow five-acre parcels to the east and several parcels between five and ten acres in the upper portion of the sub-basin along Jamestown Beach Road and Sequim-Dungeness Way. For the most part, the beachfront properties to the west of the mouth of the stream consist of small lots ranging from approximately one-quarter (0.25) to one-half (0.5) acre in area.

Critical Areas

Cooper Creek is regulated as a *Type 4* and *Type 5 Aquatic Habitat Conservation Area* (AHCA) by the Clallam County Critical Areas Ordinance (CAO). The *Type 4* designation extends from the mouth to approximately three-quarters of a mile upstream, where it becomes a *Type 5*. The CAO requires a minimum 50-foot protective buffer from the Ordinary High Water Mark for new development, as well as clearing and grading activities on both *Type 4* and *Type 5* streams.

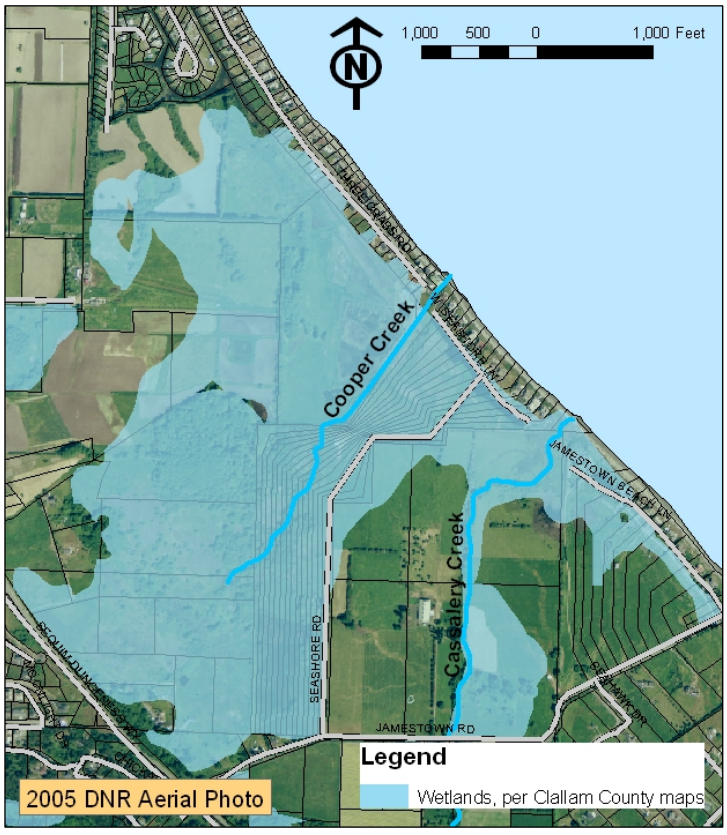


Figure 22 - County-mapped wetlands in the Cooper Creek Subbasin

Roughly 70 percent of the 340-acre Cooper Creek sub-basin is mapped as regulated wetlands on the Clallam County Critical Areas maps. Regulated wetlands are subject to protective buffers ranging from 25 to 200 feet, depending on the size and quality of the wetland and intensity of the proposed development. In addition to buffers, there are restrictions on most clearing and grading activities within 200 feet of the delineated edge of any regulated wetland. Other regulated critical areas affecting development within the Cooper Creek watershed include geologically sensitive (*Seismic Hazard*) *Areas*, *100 year floodplain*, and *Critical Aquifer Recharge Areas*.

Regulatory Context

The small beachfront parcels along Three Crabs Road and within the Seashore Lane development were created prior to the adoption of the current Clallam County zoning standards. Minimum lot size requirements, maximum residential density, and lot configuration standards have since been implemented or modified, such that in most cases, these lot configurations would not be approved today.[3]

As stated above, roughly 70 percent of the Cooper Creek sub-basin is mapped as regulated wetlands. Protection of wetlands and other Critical Areas have existed in Clallam County since 1992 (Ord. No. 471, 1992 – Clallam County Interim CAO (ICAO)). Land divisions in the Cooper Creek sub-basin, as with most of the Three Crabs study area occurred prior to the adoption of the ICAO, therefore development of these parcels is difficult to prevent. However, new development proposals within the proximity of wetlands, streams, or shoreline areas are subject to compliance with the current protection standards of the CAO, which in most cases, limit or preclude construction, clearing and grading activities, and irregular lot configurations[4]

Resource Concerns

Water Quality

Water quality testing in Cooper Creek has revealed bacterial pollution levels that exceed State water quality standards (Lower Dungeness TMDL, May, 2002, WRIA 18 Watershed Plan, May, 2005). The last summary of available TMDL data showed a sampling geometric mean of 21 fc/100ml and a 90th percentile of 142, which does not meet TMDL targets (Streeter, 2005).

No definitive data are available to pinpoint the sources of pollution; it is classic nonpoint source pollution originating from many and varied sources. However, a "Microbial Source Tracking" (MST) study is currently underway in the lower Dungeness River and Dungeness Bay area by the Jamestown S'Klallam Tribe in partnership with Battelle Marine Sciences Laboratory and funding from the Environmental Protection Agency. There were no sampling stations in Cooper Creek for phase 1 of the study; however, samples were taken from Dungeness Bay. Phase 2 of the MST study will include sampling near the mouth of Cooper Creek. The results of Phase 2 will be available in June of 2009.

Until the mid 1990s livestock were kept in the area adjacent to Cooper Creek and did have access to the stream; however, this is no longer the case. Beef cattle are kept within the Cooper Creek sub-basin but not on land draining into Cooper Creek; rather, the land drains into Golden Sands Slough. Therefore, livestock can be ruled out as a source of water pollution to Cooper Creek. Furthermore, virtually all the residences in the watershed are along the shoreline, thus it is likely that human sources of bacterial contamination are relatively insignificant with regards to the stream itself.

[3] The Seashore Lane lots, for example, were created with the recording of the "Duck Farm" survey in 1977 (Ref. County Auditor's File number 1977-0471305, Vol. 2, Pg. 145 of *Surveys*) which was prior to the adoption of a County zoning ordinance, CAO, or county subdivision review process applying to lots greater than 5 acres in area. The current R5 lot configuration requirements do not allow the creation of parcels with a width to depth ratio greater than 1:5 (CCC 33.10.020(6)(7)). In addition, the CAO currently requires a minimum shore frontage of 150 feet for new land divisions adjacent to shorelines of the state (CCC 27.12.315(9)(c.)).

[4] Under "extraordinary" circumstances, variances may be granted from these standards, but are subject to strict approval criteria and mitigation requirements and a public hearing before the Clallam County Hearings Examiner (see CCC 27.12.725). Approvals of variance applications by the County are rare. (Between 2006 and October of 2008, there were a total of three such variances approved, County-wide. Within that timeframe, there was also one denied application, and four others that were withdrawn by the applicant(s). (Source: Clallam County DCD permit tracking system – personal communication with staff).

As noted above, sewage disposal in this area is provided entirely by individual on-site septic systems. According to the USDA Soil Conservation Service *Soil Survey of Clallam County Area, Washington*, the predominant soil types in the Cooper Creek watershed are "Lummi silt loam" and "Mukilteo muck". Both of these soil types are characterized by the soil survey as having severe limitations to the development of sanitary facilities, due to wetness and seasonal flooding. Conventional on-site septic drainfields are not appropriate in these soil types. However, the majority of the drainfields in this watershed consists of mound systems and these are located in the beach soil along the shoreline. The improper functioning of on-site septic systems would most likely be of a seasonal nature, associated with a high water table and high tides.

If contamination from failing septic systems is occurring, there may be a higher probability of contamination directly to Dungeness Bay than to Cooper Creek. However, it is possible for septic systems on the small East and West Seashore Lane lots to contaminate the backwater slough area along the south side of this road. This slough is connected to Cooper Creek. Because most septic systems are not designed to treat nutrients, nutrient loading to the bay is more probable than bacterial contamination. Water quality monitoring during the early 1990s indicated that nutrient levels were relatively high in Cooper Creek; however, there are no recent data on nutrient levels in the stream.

Therefore, given the existing land use in the Cooper Creek watershed, the most likely sources of bacterial contamination include waterfowl and other wildlife, including raccoons, muskrats, otter, and rodents. Pets may also be a source of contamination.

Flooding

Localized flooding typically occurs when the tide gate at the mouth fails. As evidenced by figure 23, the Cooper Creek drainage area is a low-elevation basin, relative to the surrounding landscape to the east and west, and the beach dune and Three Crabs Road to the north. It is therefore, susceptible to flooding during high tide and heavy rain events – especially when the tide gate is not functioning properly.

During an extreme high tide event in 2005, the protective beach berm in front of several homes along East Seashore lane was breached. The berm eroded and salt water spilled over the beach around several homes. A beach restoration project, involving the installation and anchoring of numerous logs and planting of dune vegetation was completed during the summer of 2006. The restoration project was very successful in stabilizing the shoreline, with the exception of a limited area

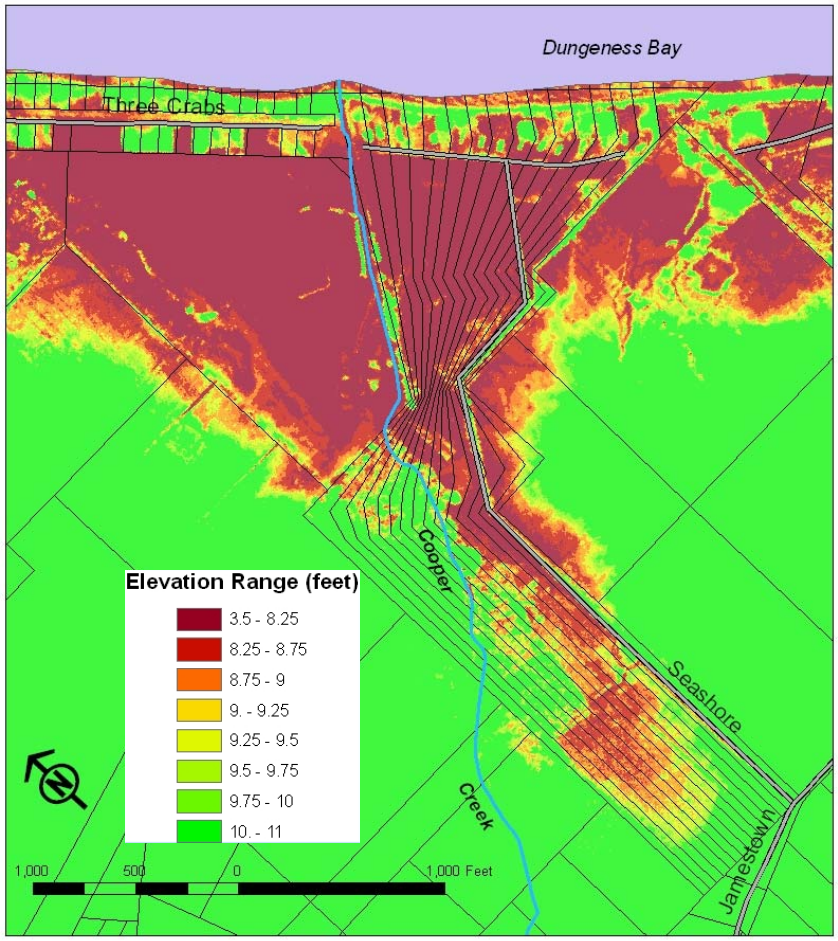


Figure 23 – relative elevations (based on Clallam County LIDAR GIS data)

immediately adjacent to the concrete bulkhead at the mouth of the Creek.

Past problems with tide gate function have been attributed to clogging of the culvert with woody debris from upstream and kelp and gravel from the beach side. During heavy rain events in recent years, freshwater has backed up behind the clogged culvert and tide gate, flooding adjacent land upstream. The box culvert at the mouth is approximately 4 feet wide by 3½ feet tall with a "baffle" several inches off the bottom that tends to catch debris, contributing to clogging problems. No structures have been flooded during these events, but there have been reports of localized erosion and damage to landscaping.

Figure 24 - tide gate at mouth of Cooper Creek (existing configuration)

Figure 25 - Mouth of Cooper Creek (2006 DOE oblique)

Fish and Wildlife Habitat

Salt water influx is limited in the lower reach of Cooper Creek by the tide gate at the mouth. Under the current configuration, the tide gate creates hydraulic conditions that make it difficult if not impossible for fish to enter the stream. The extent to which fish migration is restricted has not been quantified, but it is assumed that the tide gate is 100 percent impassable during high tides, and only minimally passable, if at all, during outgoing tides.

Based on examination of the mid 19th century historical reconstructions of the coastline areas in the Collins report, it is not clear whether there was a natural year-round surface connection between Cooper Creek and Dungeness Bay (see "mid 1800's" map - figure 5). The typically low-energy flows associated with Cooper Creek, and longshore sediment drift patterns along this shoreline area, may have severely limited fish access or obstructed it entirely at times, due to impoundment by the beach dune.

The total Cooper Creek stream length, including its network of drainage ditches, is approximately 2.5 miles – all low gradient aquatic habitat. Juvenile steelhead, coho salmon, and cutthroat trout have all been observed in Cooper Creek. Otters, beavers, ducks, raptors and other predatory birds, amphibians, coyote, deer, amphibians, and various other wildlife species also utilize the creek and surrounding area. In recent years, landowners have observed increasing numbers of otters within the lower reach of the creek and in the shoreline areas adjacent to the tidegate (personal communication with Gary Hussey and Shawn Hankins, 2009).

Channelization, a lack of pools, a lack of large woody debris (LWD), and constructed drainage ditches have all been identified as habitat limiting factors within the Cooper Creek drainage area (Harring, 1999, WRIA 18 Watershed Plan, 3.14.2, May, 2005, NHC, 2007). In addition, invasive plant species such as reed canarygrass dominate streamside vegetation in portions of the lower half of the stream, impairing riparian function.

Several habitat enhancement projects have been undertaken on Cooper Creek over the last two decades, including construction of off-channel ponds, woody debris installation, excavation of pools, placement of spawning gravel, and modifications to the tide gate at the stream outlet. As part of the stream enhancement work, in 1994, an opening measuring 18 inches wide by 12 inches tall was cut in the tide gate to allow for better fish passage. In 2006, the tide gate flap was replaced with a flap that does not have an opening.

Recommended Actions

Water Quality

Based on the existing land use in the Cooper Creek watershed, it appears that the likely sources of bacterial contamination are predominantly waterfowl and other wildlife, and are thus difficult to control. Pet waste and contamination from failing on-site septic systems appears less likely but cannot be ruled out.

On-site septic systems should be inspected to ensure they are operating properly and effectively treating wastes. Inadequately designed systems should be replaced and failing systems should be repaired. The new on-site septic system operation and maintenance program adopted by Clallam County requiring regular inspections should adequately identify failing systems. Alternatively, development of a community sewage treatment facility or connection to the Sunland Water and Sewer District sewage treatment plant should be explored.

Flooding

The property owners controlling the majority of the land on the west side of the mouth of Cooper Creek presently do not support projects that would allow additional tidal flux. Concerns are related to increased

flood hazard, salt water intolerant vegetation mortality from increased salt water influx, and a decreased ability to maintain freshwater for waterfowl habitat in the wildlife ponds. Property owners on the east side of Cooper Creek are cautiously receptive to the possibility of Cooper Creek estuary restoration. It is important to note that even with proper maintenance of the existing water control structures in the lower reaches of Cooper Creek, periodic flooding is likely to occur, due to the low elevation, seasonally high water table, and proximity to the beach. Such flooding under existing conditions is primarily by freshwater, thus the freshwater ponds and salt intolerant wetland vegetation are not as significantly impacted as they would be with complete tide gate removal. Nevertheless, freshwater flooding poses risks to wellheads and septic system drainfields.

Fish and Wildlife Habitat

Without improving fish access at the mouth of Cooper Creek, large scale habitat improvement projects would have limited (if any) measurable benefits to salmonids. In order to achieve large scale ecosystem restoration of any significance, landowners would, at a minimum, have to consent to the hydrologic changes that would occur on their properties. This includes salt water intrusion and subsequent alterations in the vegetation. In some cases, it may be necessary to remove or significantly alter the existing infrastructure, including tide gates, bulkheads, buildings and roads. Determining which properties and infrastructure are most susceptible to flooding and most at risk from tidal influx is beyond the scope of this study. Such a determination would require extensive hydrologic and hydraulic analyses. The lack of support by area property owners is also a formidable barrier to estuarine habitat restoration. While restoring tidal flux within this area may have habitat benefits for salmonids, the potential for further flooding impacts to existing residents must be thoroughly considered. As noted above, the risk of property damage and the potential public health hazards that can be created by wellhead and / or septic drainfield inundation is significant with the current land use in this area.

Removing the entire culvert and tide gate from the mouth (thus, creating an open outlet to Dungeness Bay) would require the acquisition of several nearby developed properties, and would likely be an extremely expensive endeavor. Based on a simple review of Clallam County Assessment records, acquisition of the three adjacent parcels in the lower reach of Cooper Creek would likely cost more than 2 million dollars. This expense alone could make such a project prohibitive, and would likely require the acquisition of additional properties, in order to fully restore estuarine function in this location. Furthermore, it is questionable whether an open outlet (and thus, fish access) would be maintained over the long term, due to sediment deposition from longshore drift.

Replacing the existing tide gate with a “pet-door” or “gate-in-gate” type control structure may provide conditions suitable for fish passage while maintaining benefits achieved through restriction of salt water influx (NHC, 2007). Such an opening in the tide gate would need to be more sophisticated than the simple 12-inch by 18-inch opening that existed from 1994 to 2006, in order to more effectively control salt water intrusion and still allow for fish passage. The past jamming of the culvert and tide gate attributable to small woody debris floating downstream appears to no longer be a problem. However, the existing configuration of the box culvert at the mouth is currently (and would continue to be) susceptible to plugging, regardless of whether the tide gate were modified or removed.

Recreating a more natural, meandering channel configuration would improve fish habitat, particularly in the channelized lower reaches of the stream. Pool and riffle sections could be created by constricting the channel in some areas to increase velocities and installing LWD to induce local scour, create pools, and provide cover (NHC, 2007). Preliminary work that should be done prior to restoration activities include field-based topographic surveys; salinity influence, intrusion and concentration studies; stream discharge measurements; hydrologic and hydraulic modeling (NHC, 2007).

Approximately three-quarters of a mile of Cooper Creek is eligible for enrollment in CREP (Conservation Reserve Enhancement Program - see CREP eligible parcels graphic in overview section). Enrolling this acreage into CREP would pay for the costs of restoring riparian vegetation along the stream banks, creating a riparian forest buffer 35 to 180 feet wide on each side of the stream. CREP also compensates

landowners by paying rent for the land enrolled. Rent is based on the soil type, and in the case of Cooper Creek, the soil types are Lummi and Mukilteo and the current rental rate for both these soils is $130 per acre per year.

Seashore Lane property owners have recently expressed some interest in establishing a conservation easement on a portion of their common area to the west of Seashore Road. The property in this area consists of narrow panhandle portions of contiguous parcels that narrow to approximately 10 feet in width, and are almost entirely within regulated wetlands. As such, this area is regulated by the protection standards of the CAO, and is likely also within the regulatory jurisdiction of the Army Corps of Engineers. Establishment of a conservation easement would provide further incentive for the property owners to protect the area, and may make it easier to coordinate potential future fish & wildlife enhancement projects.

CASSALERY CREEK

Stream and Sub-Basin Description

Cassalery Creek is the easternmost drainage in the study area. It is approximately 4.2 miles long, with a watershed area of approximately 1,500 acres (2.3 square miles). It empties into Dungeness Bay through a wooden box culvert between East Seashore Lane and Jamestown Beach Road approximately 1,500 feet east of the mouth of Cooper Creek. This culvert is approximately 100 feet long. The headwaters are located slightly northeast of Old Olympic Highway, and are primarily spring-fed. Cassalery Creek primarily drains low elevation land, and generally has low velocity flows.

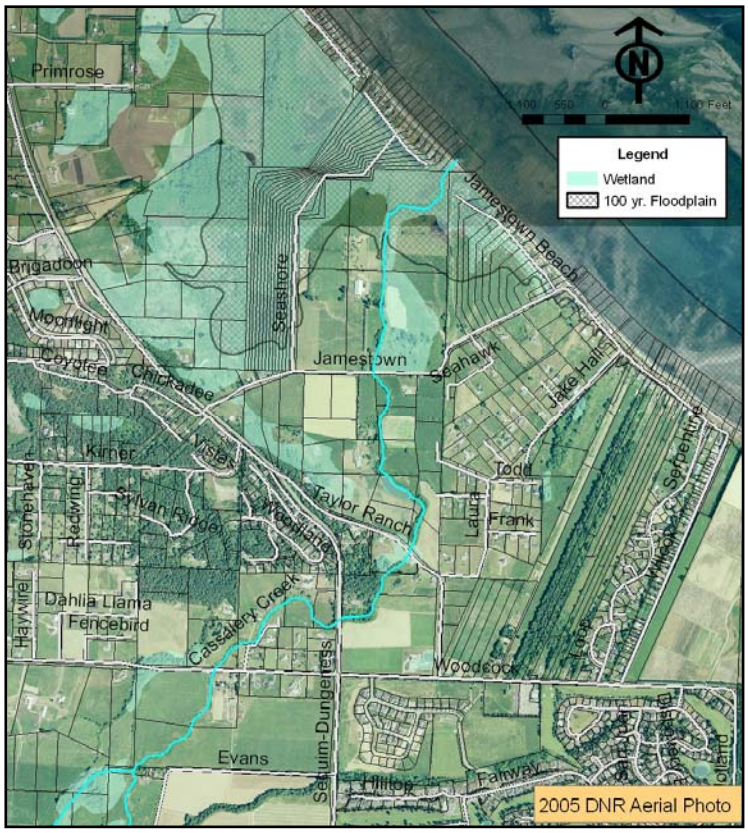


Figure 26 - lower Cassalery Creek subbasin

Development Patterns and Land Use

The upper reaches of Cassalery Creek are developed with medium, to high-density rural residential uses, with most parcels ranging in size from approximately 0.5 to 2 acres in area. North of this area, Cassalery Creek flows through agricultural and moderate density rural-residential areas before crossing Sequim-Dungeness Way just north of the Woodcock Road intersection at the southern extent of the study area.

Development downstream of Sequim-Dungeness Way consists of low density residential and agricultural uses (hayland, horse and cow pasture). The lower half-mile of Cassalery Creek flows through a 117-acre family farm that is currently leased for cattle grazing and seasonal waterfowl hunting. The property consists of six contiguous parcels that have been under the ownership of the McInnes family for several generations. Existing development on this property consists of an approximately 20,000 square-foot barn, associated outbuildings, a well, and a mobile home.

Several habitat restoration and livestock management projects have been completed on the McInnes farm in cooperation with the Natural Resource Conservation Service (NRCS), Soil Conservation Service, and Clallam Conservation District (CCD), beginning in the 1980's. The CCD is currently working with the landowners to update their management practices to address potential livestock access issues in the northern portion of the property.

The majority of developed properties in the Cassalery Creek watershed are served by on-site septic systems, with the exception of the community of Sunland, which has its own sewage treatment plant. An

effluent reuse spray field is located adjacent to the plant and has been in use since 1979. Class "A" waste water from the sewage treatment plant is used as irrigation water on the hay field. The facility is located on an approximately 25-acre parcel that is bordered along the north by Cassalery Creek (RM 1.4).

Zoning

Zoning in the headwater area of Cassalery Creek is "Rural Low" (R5), which allows a maximum residential density of one dwelling unit per 4.8 acres. The middle and lower reaches of Cassalery Creek have an *Agricultural Retention* (AR) zoning designation. The purpose of the AR zone (as stated in the Clallam County Zoning code) is "*to maintain and enhance the agricultural resource industry of Clallam County through conservation of productive agricultural lands and discouragement of incompatible land uses…*" Residential density in the AR zone is limited to one dwelling unit per 16 acres or one dwelling unit per parcel on pre-existing parcels less than 16 acres in size. Additional transferrable development rights may be available in some circumstances, provided that special development standards are adhered to that require a "cluster housing" configuration and permanent protection of agricultural land.

Critical Areas

The headwater tributaries of Cassalery Creek are regulated by the CAO as *Type 4 Aquatic Habitat Conservation Areas*. The remainder of Cassalery Creek downstream to the mouth is classified as a *Type 3 Aquatic Habitat Conservation Area*. Type 4 streams require a minimum 50-foot protective buffer from the Ordinary High Water Mark (OHWM) for new development, clearing and grading activities. Type 3 streams require a minimum 60-foot buffer for "minor new development", clearing and grading activities and a 100-foot buffer for "major new development", clearing and grading activities. There are associated wetlands in the lower reach, which are also subject to protective buffers and restrictions on clearing and grading activities. The entire Cassalery Creek sub-basin within the study area is classified as a CARA. There are also several bald eagle habitat areas depicted on the Clallam County Critical Areas Maps near the mouth.

Fish & Wildlife habitat

Cassalery Creek has historically supported coho and chum salmon, steelhead, cutthroat trout, rainbow trout, and dolly varden (WRIA 18 Watershed Plan, 2005). Adult salmon and steelhead have been observed in Cassalery Creek above the Jamestown Road crossing (LFA, 1999). Otters, ducks, bald eagles and other predatory birds, amphibians, coyote, deer, beaver, amphibians, and various other wildlife species also utilize the creek and surrounding area.

Resource Concerns

Water Quality

Water quality testing in Cassalery Creek has shown **bacterial pollution** levels that exceed State water quality standards (WRIA 18 Watershed Plan -- May, 2005, Water Quality Assessment (303[d]) List of impaired waters). In-depth investigation of potential pollution sources upstream of Sequim-Dungeness Way was not performed during this study. Recent water quality sampling by Clallam County Streamkeepers however, has shown high fecal coliform bacteria concentrations at Clary Lane, upstream of the study area.

As with many of the streams in the study area, definitive data are not currently available to pinpoint sources of bacterial pollution in Cassalery Creek. Although there were no sampling stations in Cassalery Creek for the first phase of the MST study, human sources were identified as contamination sources at all of the other sampled freshwater locations in the area and in Dungeness Bay.[1]

[1] Samples were obtained from the mouth of Cassalery Creek for the second phase of the MST study. Complete results from this study are expected to be published in May of 2009.

Although the Sunland sewage treatment plant sprayfield is adjacent to Cassalery Creek, surface runoff to the creek would be extremely rare. Furthermore, the treated effluent meets Class "A" water quality standards and can legally be discharged to surface waters (Langley, 2008). Because effluent is sprayed on the field throughout the year, it is also possible that nutrients could enter the creek via groundwater (Cupps, 2005). The sewage treatment plant is required to follow an operation and maintenance plan approved by the Washington State Department of Ecology and State of Washington Department of Health.

Flooding

Seasonal flooding occurs at the mouth of Cassalery Creek when the culvert plugs with seaweed, wood, sand, gravel, and other debris. Debris must be manually removed when this happens; otherwise, impounded water from the stream floods neighboring properties, posing a hazard to septic drainfields, landscaping, roads, and other infrastructure. The approximately 100-foot long, by 2-foot, by 4-foot culvert at the mouth of Cassalery Creek has a wooden trash rack on the upstream end. It has been rebuilt at least twice over the past 80 years. When it was last rebuilt in 1986, it was constructed adjacent to the west side of the old culvert. This required the stream channel to make a slight curve at the inlet to the culvert, thus causing headloss and hampering the capacity to flush debris and sediment out of the culvert (NHC, 2007). According to the 1999 LFA, the mouth of Cassalery Creek likely formed a wetland pond/marsh on the upstream side of the beach berm prior to installation of the existing culvert.

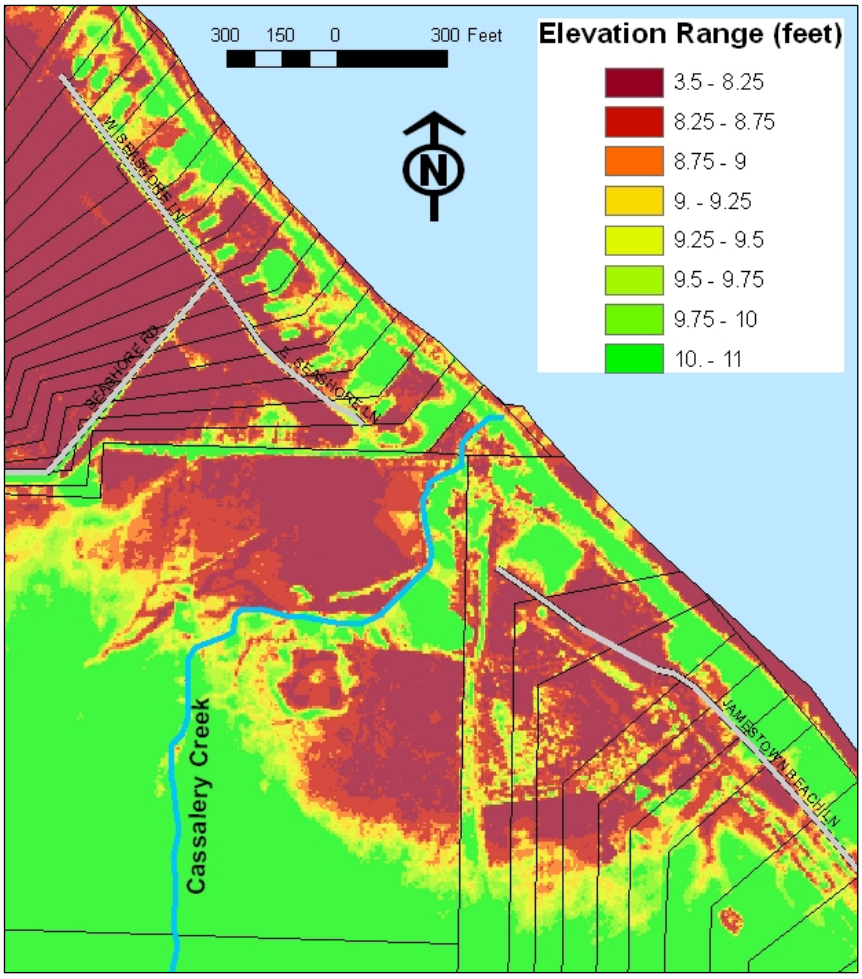


Figure 27 – Bottom reach of Cassalery Creek relative elevations (based on Clallam County LIDAR GIS data)

Extreme high tides in winter can also result in salt water intrusion up the stream channel when the culvert is not plugged with debris. This contributes to localized flooding in the pasture immediately upstream and to the west of the culvert. The plant community in this area is indicative of salt water intrusion, consisting of a mix of pasture species and salt-tolerant herbaceous species, interspersed with large areas of bare ground.

Figure 28 -Cassalery Creek culvert inlet (2007)

Figure 29 -Cassalery Creek culvert outlet (2000)

Fish and Wildlife Habitat

There is very little channel diversity or spawning gravel available in the lower reach of Cassalery Creek downstream of Jamestown Road. This has been attributed to channelization, loss of floodplain, the loss of tidal flux, and culvert failures (clogging) at the mouth during high flows (LFA, 1999, WRIA 18 Watershed Plan).

Past agricultural activities degraded riparian areas in the reach between Jamestown Road and Sequim Dungeness Way. The Conservation District worked with landowners during the 1990's to enhance salmon habitat, fence out livestock, and provide fish passage in this area and riparian conditions have improved. Habitat projects were implemented, including culvert replacement at Jamestown Road and on a private crossing upstream of Jamestown Road, silt removal, stream gravel enrichment, LWD placement, pool construction, livestock exclusion fencing, and riparian tree and shrub planting. Minimal riparian vegetation exists along some portions of the stream in the vicinity of Woodcock Road; however, projects are currently underway to restore riparian forest buffers in this area. Invasive plant species such as reed canarygrass and Himalayan blackberry dominate streamside vegetation in portions of the lower reach, impairing riparian function.

Grazing impacts from cattle access to the lower marsh area of the McInnes farm are clearly evident. Cattle on the McInnes farm currently have direct access to the wetland area near the creek mouth, including drainage ditches that flow directly into Cassalery Creek. Although the forage production in this area is marginal, it does produce needed forage during late summer when the upland areas of the farm dry

Figure 30 - Cassalery Creek mouth and estuarine area (2006 DOE photo)

out.[2] Forage production is marginal at best, and the lowest and wettest areas that are most prone to salt water intrusion during the winter have large areas of bare ground.

Fencing was constructed along the creek on portions of the McInnes farm in 1989. Fencing, riparian planting and other restoration activities were also conducted in the reach above Jamestown Road during the late 1990s. This reach of Cassalery appears to have improved habitat conditions, although the buffer width is very narrow, averaging approximately 30 feet on each side of the stream.

Recommended Actions

Water Quality

In order to minimize water quality impacts to the lower reach of Cassalery Creek, livestock should be excluded from the low-lying area that is most susceptible to salt water intrusion and flooding (approximately 3 acres), and allowed seasonal access to the wet pastures surrounding this area. Good

[2] This property is neither within an irrigation district, or irrigation company service area, and does not have irrigation water rights.

pasture management, including prescribed grazing, livestock exclusion, and harrowing following grazing to spread the manure left by livestock will protect water quality and maintain good forage production. The Conservation District is currently working with the McInnes family to update a farm conservation plan for their property. The update is addressing all resource concerns and habitat enhancement opportunities on the property. Financial assistance is available through the Conservation District and other programs to help pay for the costs of fencing.

A more comprehensive solution to the problems associated with livestock access to the marsh that would also benefit wildlife would be wetland/estuary restoration. This alternative is discussed under the habitat section below.

Flooding

In order to improve fish passage and to reduce upstream flooding, the wooden box culvert at the creek outlet should be replaced with a larger structure (NHC 2007) or at least a rounded, smooth-walled culvert that is less susceptible to plugging. A larger culvert would be less susceptible to plugging, thus reduce the flooding upstream; however, it would also allow more salt water intrusion upstream. The estate manager for the McInnes Farm has expressed concerns about losing potential grazing area if additional salt water influx were allowed by a larger structure. As was explained above, some alternative pasture management scenarios could be pursued that would minimize impacts to production.

An alternative to culvert replacement would be a realignment of the stream channel at the upstream end of the culvert in order to direct more flow and energy directly into the culvert. Such a project would be relatively simple and inexpensive; however, this would not completely eliminate the need for maintenance of the culvert and long-term benefits are difficult to predict. Realignment and other projects that would alter existing drainage patterns in this area must be approached cautiously, and in close consultation with landowners. Preliminary work that is needed prior to restoration activities, include topographic surveys; salinity influence, intrusion and concentration studies; stream discharge measurements; hydrologic and hydraulic modeling. (NHC, 2007)

Fish and Wildlife Habitat

Estuarine restoration at the mouth of Cassalery Creek holds great potential for habitat improvement on the stream, due to the relatively undeveloped condition and contiguous property ownership. However, estuarine restoration would also significantly alter the surrounding landscape and vegetation. Due to the impacts to property, estuary restoration typically requires property acquisition. Preliminary discussions with the estate manager of the McInnes Farm regarding potential culvert improvements and restoration or enhancement of the historic estuary area have been positive. Presently the landowners are not interested in selling off portions of the family farm; however, dedication of a conservation easement may be a possibility. Provided that the landowner is willing to cooperate, a conservation easement, or similar instrument may serve the same purpose as acquisition, while maintaining development rights and other landowner objectives on appropriate areas of the property. A parcel reconfiguration, conforming to the "Agricultural Retention" (AR) standards may also have benefits both for habitat and the landowner, provided that development lots are situated in appropriate upland portions of the property. Other potential sources of assistance for estuary restoration and landowner compensation include the USDA Wetland Reserve Program, CREP, the WDFW Landowner Incentive Program (LIP), and assistance through Ducks Unlimited (DU).

Creating channel diversity in the lower reach, (similar to the area above Jamestown Road) and removing invasive vegetation would likely improve fish habitat. Developing pool and riffle sections could be created by constricting the channel to increase velocities in some areas. Installing LWD would induce scour, create pools, and provide cover (NHC 2007). Restoring the channel's access to the floodplain

would improve the sedimentation problems in the channel by allowing sediment to settle out onto the floodplain.

Intensive riparian forest buffer restoration is needed in some reaches, particularly where invasive plant species have taken over. There are approximately three miles of property along Cassalery Creek that are eligible for enrollment in CREP. CREP pays for all the costs associated with restoring riparian forest conditions, as well as rent to landowners for the land enrolled in the program. Rent is based on the soil type, and in the case of Cassalery Creek, the soil types are primarily Puget, Lummi and Mukilteo and the current rental rate for these soils is $130 per acre per year.

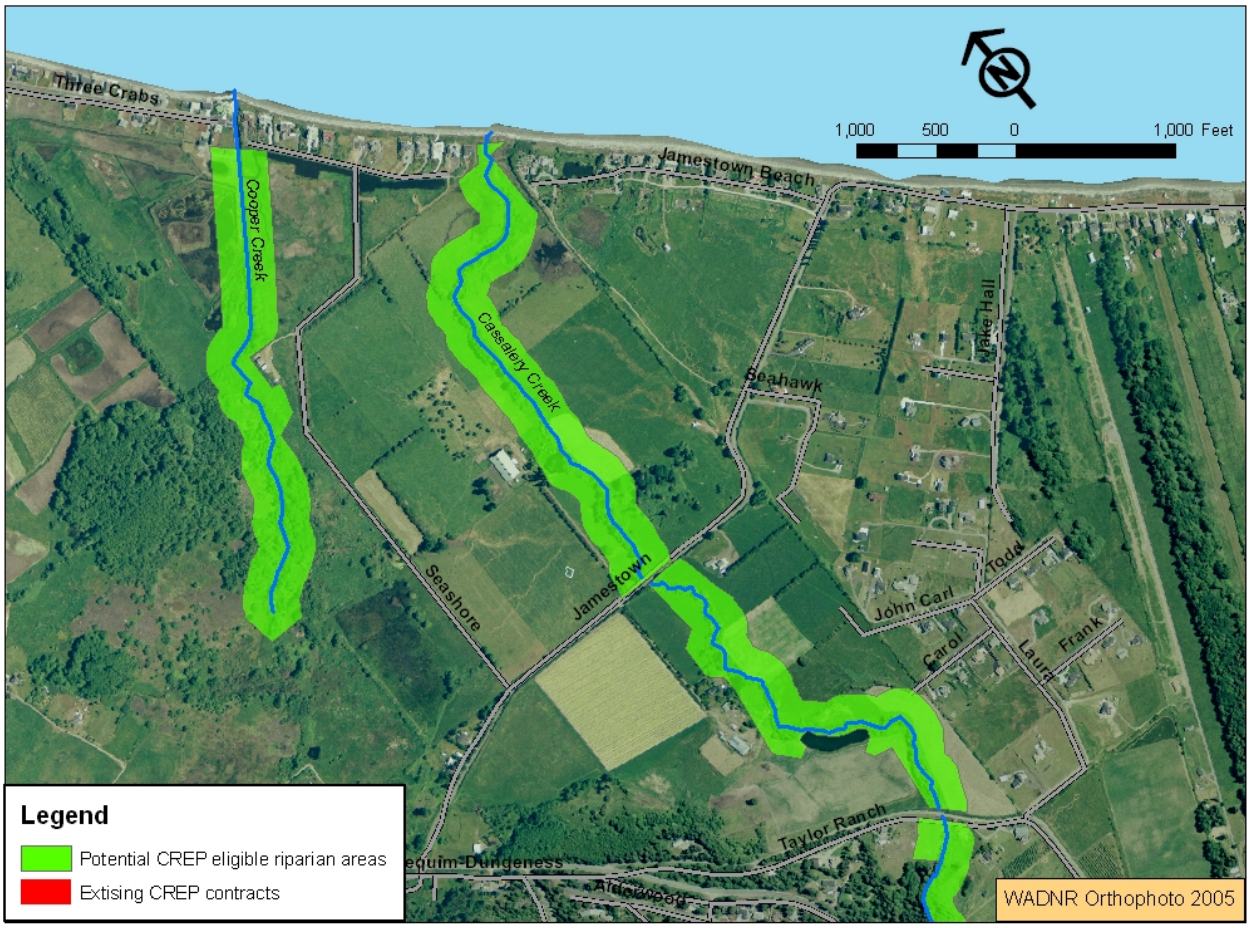


Figure 31 - Potential CREP eligible riparian areas for Cooper Creek and lower Cassalery Creek

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Appendix A

PRIORITIZED ACTIONS

WATER QUALITY RECOMMENDATIONS

Water Quality Action 1: **Address Human sources of fecal coliform bacteria contamination:**

- Identify and repair failing on-site septics through County Operation & Maintenance and Septics Of Concern programs.
- Investigate possible regional alternatives to on-site septics**:**
  - Large On-Site Septic Systems, or off-site community drainfield(s)
  - Connection to existing sewage system(s) where allowed [by GMA]
- Identify funding source(s) to continue septics program and/or alternative large-scale treatment options, such as an assessment for septic system owners.

Water Quality Action 2: Continue landowner education & outreach efforts

- Landowner stewardship
  - Discourage dumping of landscape debris and pet waste in or adjacent to surface water
  - Investigate interest in a community composting site away from surface waters, or a yard waste collection program
  - Provide landscaping alternatives, emphasizing native drought-tolerant and salt-tolerant vegetation (see appendix B)
- Proper operation and maintenance of existing on-site septic systems must be emphasized in flood-prone areas, through the continued implementation of the County SOC program, "Septics 101" courses, or other similar educational programs.

Water Quality Action 3: Control livestock access to creeks and associated wetlands

- Continue work with Cassalery Creek farm operator and Golden Sands drainage ditch farm operator to control livestock access to waterways and wetlands.

Water Quality Action 4: Continue irrigation ditch piping, in order to eliminate tailwater discharge into surface water drainages and Dungeness Bay

Water Quality Action 5: Provide Critical Areas Ordinance protection to the Golden Sands Slough by designating it an Aquatic Habitat Conservation Area

HABITAT RECOMMENDATIONS

Habitat Action 1: Reconnect Meadowbrook Creek mouth to Dungeness River and estuary area

- Multiple benefits, including attenuation of floods

Habitat Action 2: Encourage alternatives to hard beach armoring

- Require or provide incentives for the use of "soft armoring" and beach nourishment when constructing or repairing bulkheads, wherever feasible

- Consider acquisition and removal of structures from properties where existing bulkheads are too close to the Ordinary High Water Mark for repair using soft armoring and bioengineering techniques

- Strengthen County policies relating to shoreline armoring during upcoming Shoreline Master Program update

Habitat Action 3: Restore native riparian vegetation along all streams throughout study area

- Continue to provide incentive-based programs such as CREP to encourage landowners to restore riparian buffers

- Provide outreach and education to residents along each stream corridor, regarding appropriate riparian vegetation, maintenance, and debris disposal. Investigate the possibility of developing a community compost facility.

Habitat Action 4: Replace existing wooden box flume at mouth of Cassalery Creek in order to improve fish access

- Install larger diameter, round or oval, smooth-walled culvert

Habitat Action 5: Replace existing tide gate at mouth of Cooper Creek with a functional tide gate that will allow for fish passage

Habitat Action 6: Recreate a more natural, meandering channel configuration in the lower reaches of Cooper Creek.

- Utilize portions of the common open space tract in the south portion of the Seashore Lane development.

FLOOD RECOMMENDATIONS

Flooding Recommendation 1: Reconnect Meadowbrook Creek mouth with Dungeness River estuary

Flooding Recommendation 2: Alter landscaping practices to fit environmental conditions

- Utilize salt-tolerant native vegetation adapted to shoreline environment

Flooding Recommendation 3: Replace the existing wooden box flume at the mouth of Cassalery Creek in order to reduce blockages

- Install larger diameter, round or oval, smooth-walled culvert

Flooding Recommendation 4: Update County land use codes, such as Shoreline Master Program, in consideration of climate change predictions

Appendix B

PLANTS FOR SHORELINE LANDSCAPES

Shoreline landscapes, such as those in the Three Crabs area are extremely sensitive and dynamic areas adapted to frequent environmental disturbance. Appropriate landscape plantings must be very hardy, tolerant of salt and wind and alternating wet and dry conditions.

The safest and surest strategy for landscape success and environmental protection is to maintain existing native vegetation. In situations in which the natural vegetative cover has been removed or where enhancement of the existing vegetation is desired, the following lists of plants are recommended.

Most of the plants are native to Strait of Juan de Fuca shorelines. Some dune, salt marsh and mudflat species may be hard to find in nurseries; collecting from the wild is not recommended. You will see some plants appear on multiple lists - many of these plants are tolerant of a wide variety of conditions and salt exposure.

The lists include categories specific to sandy or gravelly dunes and marshes or mudflats. The "Zone" categories refer to areas other than dunes and mudflats. These zones are based on conditions of soil moisture and salt water tolerance that are typical of conditions found along shoreline properties.

DUNES
Dunes are fragile and dynamic, sandy or gravelly environments subject to persistent wind and tidal action. Seasonal high tides and storm events inundate these areas with salt water.

SALT MARSHES and MUDFLATS
Salt marshes and mudflats typically have fine-grained soils and high water tables. They are fragile environments subject to regular tidal inundation.

ZONE 1
This area is characterized by a seasonal high water table and/or ponding on the surface. Plants for this area tolerate wind, salt spray, very wet soil conditions, and rare and brief salt water inundation. The plants in this category are not tolerant of daily tidal inundation.

ZONE 2
This is the upland area surrounding ZONE 1. Plants for this zone are tolerant of well drained and dry soil conditions that may become seasonally wet due to high water table or surface ponding. All plants are tolerant of wind and salt spray. All trees and shrubs listed for ZONE 1 are appropriate for ZONE 2. The plants in this category are not tolerant of daily tidal inundation.

DUNES

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Abronia latifolia Yellow sand verbena	Sun	Ground-cover	Summer	Yellow flowers throughout spring and summer
Abronia umbellata Pink sand verbena	Sun	Ground-cover	Summer	Pink flowers throughout year
Carex macrocephala Large-headed sedge	Sun/partial shade	4-16 inches		Well drained, sandy soils
Convolvulus soldanella Beach morning-glory	Sun	Ground-cover		Well drained, sandy soils; pinkish-purple flowers
Distichlis spicata Seashore saltgrass	Sun	<1 foot		Moist to seasonally saturated soils; rhizomatous
Elymus mollis Native beach grass	Sun	2-5 feet		AVOID European beach grass, which is very invasive
Glehnia littoralis Beach-carrot	Sun	Ground-cover		Well drained, sandy soils
Jaumea carnosa Fleshy jaumea	Sun	Ground-cover		Occurs at or just above mean high tide level
Poa macrantha Seashore bluegrass	Sun	6-16 inches		Well drained, sandy soils; rhizomatous
Potentilla anserina Pacific silverweed	Sun	1-2 feet	July	Moist to dry soils; yellow flowers
Salicornia viginica Pickleweed	Sun	Ground-cover		Tidally inundated sites
Salix hookeriana Hooker willow	Sun	To 26' tall	April	Wet soils; tolerates seasonal flooding

SALT MARSHES and MUDFLATS

Most, if not all of the species listed for DUNES should work in or immediately adjacent to salt marshes and mudflats.

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Carex lyngbyei Lyngby sedge	Sun/partial shade	6-40 inches		Moist to seasonally saturated soils; rhizomatous
Carex obnupta Slough sedge	Sun/partial shade	1-5 feet		Moist to seasonally saturated soils; shiny foliage; excellent soil binder; drought tolerant
Deschampsia cespitosa Tufted hairgrass	Sun	2-6 feet		Moist to seasonally flooded soils; grows in dense hummocks
Juncus effusus Common rush	Sun/partial shade	2-3 feet	Summer	Wet soils; evergreen perennial; hardy and adaptable; drought tolerant
Juncus supiniformis Spreading rush	Sun	6-30 inches		Moist to inundated soils; stoloniferous, forming uniform mats
Scirpus acutus Hardstem bulrush	Sun	4-8 feet		Wet soils; favors prolonged inundation; excellent soil binder; rhizomatous
Scirpus americanus Three-square bulrush	Sun	6-40 inches		Wet soils; rhizomatous
Scirpus maritimus Seacoast bulrush	Sun	1-5 feet		Tidally inundated sites; rhizomatous
Triglochin maritima Seaside arrowgrass	Sun	1-4 feet		Mud flat colonizer

ZONE 1 – TREES

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Pinus contorta contorta Shore pine	Sun	to 60' tall		Dry, gravelly to saturated bog soils low in nutrients; hardy; fast growing; does not tolerate competition

ZONE 1 – SHRUBS

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
*Myrica californica*** Pacific wax myrtle	Sun/partial shade	To 30 feet	May - June	Evergreen shrub/small tree preferring moist soils; inconspicuous spring flowers; drought tolerant
Myrica gale gale Sweetgale Pacific bayberry	Sun/partial shade	To 6 feet	May - June	Deciduous shrub preferring moist soils; inconspicuous spring flowers
Rosa nutkana Nootka rose	Sun/partial shade	6-10 feet	May - June	Moist to fairly dry soils; tolerates inundation and saturated soils; aggressive spreader; fruits persist
*Rosa rugosa** Rugosa rose	Sun	To 8 feet	Summer	Drought resistant; hardy, vigorous and aggressive; highly prickly; fragrant white to purple flowers; fruits persist
Salix hookeriana Hooker willow	Sun	To 26' tall	April	Wet soils; tolerates seasonal flooding

**Non-native.*
***Native to southwest Washington coast and south.*

ZONE 2 – TREES

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Arbutus menziesii Madrona	Sun	To 90' tall 40' spread	Spring	Well drained soils; broad-leafed evergreen; white flowers, orange-red berries
*Arbutus unedo** Strawberry tree	Sun/partial shade	8-35' tall 8-20' spread	Late fall	Tolerant of extremes; tolerant of urban/ industrial pollution; broad-leafed evergreen; white or greenish white flowers; variety 'Compacta' grows to 10 feet
*Cordyline australis**	Sun	20-30' tall		Narrow, evergreen, palm-like tree
*Juniperus virginiana** Eastern red cedar	Sun	40-50' tall 15-30' wide		
Malus fusca Pacific crabapple	Sun/partial shade	To 40' tall 35' spread	May	Tolerant of prolonged soil saturation; produces fruit
*Quercus ilex** Holly oak	Sun	30-60' tall & wide		Evergreen oak; shrubby along seashore
*Pinus thunbergiana** Japanese black pine	Sun	To 100' tall 40' spread		Dry to moist soils; hardy; fast growing

**Non-native.*

ZONE 2 – DECIDUOUS SHRUBS

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Holodiscus discolor Oceanspray	Sun/partial shade	To 15 feet	June	Dry to moist soils; drought tolerant; fragrant white to cream flowers; good soil binder
Ribes sanguinium Red-flowering currant	Sun/partial shade	To 8 feet	Spring	Well drained soils; pink to red flowers attract hummingbirds; bluish berries
Symphoricarpos albus Snowberry	Sun/shade	2-6 feet		Wet to dry soils, clay to sand; excellent soil binder; drought tolerant; provides good erosion control; spreads well in sun; white berries; flowers attract hummingbirds

ZONE 2 – EVERGREEN SHRUBS

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
*Baccharis pilularis** Coyote brush	Sun	8-24" tall 6' spread		Wet to seasonally dry soils; drought resistant; good groundcover
*Cistus purpureus** Orchid rockrose	Sun	To 4 feet	June-July	Moist to dry well-drained soils; drought resistant; fast growing; reddish purple flowers
Escallonia x exoniensis 'fradesii'* Pink Princess	Sun/partial sun	5-6 feet	Spring - Fall	Tolerant of varying soils but prefers lower pH; drought tolerant when established; pink to rose colored flowers; good hedge or border plant; attracts butterflies
*Ilex vomitoria** Yaupon	Sun/partial shade	15-20' tall		
*Juniperus spp.** Junipers	Sun/partial shade	vary		Includes shrubs and groundcovers
*Lavandula angustifolia** Lavender	Sun	To 2 feet	May - August	Adaptable to various soils; blue, lavender, pink to white flowers, semi-evergreen aromatic perennial
Mahonia aquifolium Tall Oregon grape	Sun/partial shade	6-10 feet	March - April	Dry to moist soils; drought resistant; evergreen; blue-black fruit; bright yellow flowers; 'Compacta' form averages 2 feet tall
*Pinus mugo mugo** Mugho pine	Sun/partial shade	4-8' tall 8-15' wide	April	Slow growing shrub pine
*Rosmarinus officinalis** *Rosemary*	Sun	6-20 feet	Winter - spring	Requires good drainage; garden herb

**Non-native.*

ZONE 2 – EVERGREEN GROUNDCOVERS

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Arctostaphylos uva-ursi Kinnikinnik	Sun/partial shade	To 8 inches	Spring	Prefers sandy/rocky, well-drained soils; pinkish-white flowers; bright red berries; slow to establish; plant closely for good results
Gaultheria shallon Salal	Partial shade/shade	3-7 feet	Spring	Dry and moist soils; white or pinkish flowers; reddish-blue to dark-purple fruit
Fragaria chiloensis Beach/Coastal strawberry	Sun/partial shade	To 8 inches	Spring	Sandy well drained soils; white flowers; small hairy strawberries; evergreen; aggressive spreader

ZONE 2 – PERENNIALS & ORNAMENTAL GRASSES

SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	BLOOM TIME	COMMENTS
Achillea millefolium Western yarrow	Sun	4-30 inches	Summer	Dry to moist, well-drained soils; white to pink/reddish flowers; many other yarrows are also available
Aquilegia formosa Western columbine	Sun/partial shade	1-3 feet	Spring	Moist soils of varying quality; tolerant of seasonal flooding; red and yellow flowers attract hummingbirds and butterflies
Armeria maritima Thrift Sea pink	Sun	2-18 inches	May	Drought tolerant perennial
Aster chilensis Common California aster	Sun	1.5 – 3 feet	June - September	Moist soils; white to purple flowers
Aster subspicatus Douglas aster	Sun	6-30 inches	June - September	Moist soils; blue to purple flowers
*Carex buchannii** Leather leaf sedge	Sun/partial shade	1-3 feet		Prefers well-drained soils; copper-colored foliage; perennial clumping grass; tolerant of a wide range of soils; inconspicuous flowers
*Carex comans** 'Frosty curls' New Zealand hair sedge	Sun/partial shade	1-2 feet		Prefers moist soils; finely textured and light green; compact, clumping perennial grass; drought tolerant when established; inconspicuous flowers
Erigeron speciosus Showy fleabane	Sun/partial shade	To 2 feet	Summer	Moist to dry soils with good drainage; dark violet or lavender blooms; fibrous roots
*Eschscholzia californica** California poppy	Sun	To 2 feet	Summer	Dry soils with good drainage; orange blooms; native to Oregon and south but naturalized in Washington
*Festuca ovina glauca** Blue fescue	Sun/partial shade	4-10 inches		Tolerant of variety of soil types, prefers well-drained soil; clumping blue evergreen grass
*Helichrysum italicum** Curry Plant	Sun	To 2 feet	Summer	Moist or dry soils; hardy evergreen perennial; fragrant bright yellow flowers
*Helictotrichon sempervirens** Blue oat grass	Sun/partial shade	1-1.5 feet		Tolerant of a variety of soil types but prefers well-drained soil; clumping bright blue evergreen grass
Lupinus spp. Lupines	Sun	To 5 feet	Spring-summer	Moist to dry soils; blue to purple, violet to white flowers; native and non-native varieties
*Penstemon fruticosus** Shrubby penstemon	Sun	8–10 inches	May	Prefers well-drained soils; evergreen perennial; drought tolerant; violet-blue flowers 1" long attract hummingbirds
Potentilla gracilis Graceful cinquefoil	Sun	1-2 feet	July	Moist to dry soils; yellow flowers
Smilacina racemosa False Solomon's seal	Partial sun/shade	1-3 feet	April - May	Moist soils; creamy white flowers; red berries
Solidago canadensis Canadian goldenrod	Sun/partial shade	1-2 feet	Aug-Oct	Dry to moist soils; yellow flowers

**Non-native.*