ISLAND COUNTY MARINE NEARSHORE BEST AVAILABLE SCIENCE

Update Paper

Prepared for:
Island County

November 2008

ESA Adolfson

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1.0 INTRODUCTION

The Washington State Growth Management Act (GMA, RCW 36.70A.172) requires that cities and counties review, and if necessary revise, their Critical Areas Ordinance (CAO) (Island County Code [ICC] 17.02.050.C.3) regulations at least once every seven years. The GMA requires that the CAO be updated using best available science.

Best available science requires an assessment of peer-reviewed scientific research and synthesis by a qualified scientific expert. This paper analyzes and synthesizes recent scientific studies that relate to marine nearshore habitats in Island County, Washington. This paper builds upon previous best available science papers in Washington State, including those published by Island County on wetlands and stream buffers and shoreline biological resources (Adamus, 2007; Sheldon et al., 2005; Castelle, 1999; Adolfson Associates, Inc. 1998). These papers were used to support the current CAO. The purpose of this paper is to update the best available science for protection standards for marine nearshore habitats. This paper addresses the following questions:

- What resources are present in the Island County marine nearshore?
- What is the current best available science for those resources, including current threats and pressures on the resources?
- What are the specific threats and pressures to Island County marine nearshore resources?
- What is Island County current doing to protect those resources?
- What type of management protections or regulations could further protect resources?

1.1 What are Marine Nearshore Habitats?

Marine nearshore habitats occur between the marine riparian zone and the lower limit of the photic zone (~30m below mean lower low water [MLLW]). This zone extends waterward from the edge of upland vegetation to the outer limits where photosynthesis can occur (Williams and Thom, 2001). This area generally consists of the aquatic interface between subtidal marine habitats and associated uplands and contains areas commonly known as shore, beach, intertidal and subtidal zones. Marine nearshore habitats are critical to a variety of physical and biological processes and functions such as habitat formation, primary productivity and carbon cycling. These habitats include important kelp and eelgrass beds; herring, sand lance and smelt spawning areas; and commercial and recreational shellfish areas.

1.2 General Characteristics of Island County Nearshore Habitats and Species

The *Coastal/Shoreline Biological Resources Inventory* (Adolfson Associates, Inc. 1998) compiled existing literature, maps, and field observations to characterize and identify habitats in the nearshore zone of Island County. The Island County Marine Resources Committee (MRC) has updated and supplemented with information from eelgrass surveys, feeder bluff mapping, forage fish assessment and mapping, juvenile salmon habitat use surveys, southern resident killer whale (Orca) surveys, and shoreline hardening surveys (MRC, 2008). Additional information on Island County nearshore habitats comes from Ecology's Coastal Atlas and WDNR's ShoreZone Inventory, WDFW's priority habitats and species database and the Puget Sound Ambient Monitoring Program (PSAMP).

1.2.1 Physical Features

In general, Island County is ringed by broad sand and gravel beaches and flats reflecting areas of high primary productivity and low wave energy. Glacially-carved cliffs and high bluffs are present along the majority of the shoreline, some up to 200 feet in height (CGS, 2005). Stretches of bluffs have abundant large trees and snags and also provide replenishing gravels to beaches below. Large estuarine wetlands also occur in the nearshore zone, covering three times the area of non-estuarine wetlands in Island County (Adamus, 2006).

The Washington State ShoreZone Inventory (2001) identifies over 40% of Whidbey and Camano shorelines as sand and gravel beach, and over 40% as sand and gravel flats or sand flats. These habitat types are highly productive and are frequently in the area of low wave energy. The remaining 20% of the marine shoreline is split between ten other geomorphic classes (rock cliff, mud flat, marsh, etc.). Beach sediment size is strongly influenced by the available sediment coming from bluff erosion as well as wave energy, and therefore varies considerably across the County. Bluff sediment input, primarily glacially deposited units, is the primary source of beach sediment. Landslides and erosion of feeder bluffs deliver up to 90 % of the sediment that constitute a given beach, while rivers and streams provide approximately 10 %.

In 2005, Island County invested in a comprehensive survey of feeder bluffs and accretion shoreforms along the entire shoreline of Whidbey and Camano islands. Coastal Geologic Services conducted boat surveys of the shoreline and mapped shoreline features such as feeder bluffs, landslide areas, and modified areas. Feeder bluffs accounted for 30% of the total county shore length with an additional 8% identified as exceptional feeder bluffs. Exceptional feeder bluffs are present in the southern end of the County at Possession Beach Park and Double Bluff, as well as the western-most shore north of Fort Ebey. Approximately 12 % of the shore is considered modified with bulkheads, revetments or shoreline landfills, while 37% is comprised of spits, points, or barrier beaches where sediment accumulates (identified as accretion shoreforms). CGS identified over 100 sites for future restoration and conservation and ranked those to prioritize opportunities (specific sites are discussed in Section 6.0) (CGS, 2005).

1.2.2 Biological Resources

Island County is located adjacent to some of the most productive salmon-producing rivers in western Washington: Snohomish, Stillaguamish, and Skagit. Historically, the area has served as one of the most important and critical areas for commercial and sport fisheries. Island County's major contribution to salmon productivity is its nearshore habitat. Eight species of salmonids, four of which are currently listed as threatened under the Endangered Species Act (ESA), use nearshore habitats of Island County during juvenile life history stages: Puget Sound Chinook, Hood Canal summer-run chum, steelhead, and coastal-Puget Sound bull trout. In Island County, all salmonids species use nearshore habitats as fry, smolt, or yearling stages, as do returning adults (SRP, 2005). Bull trout and sea-run cutthroat trout are also present as both juveniles and foraging adults.

The nearshore area of Whidbey and Camano Islands provide extensive intertidal eelgrass habitat and spawning beaches for important forage fish species including Pacific herring, surf smelt, Pacific sand lance (SRP, 2005). Eelgrass beds are continuous along the majority of the shoreline of both islands while kelp forests occur as continuous beds along the west-facing shorelines of Whidbey Island and as scattered patches at Deception Pass, Saratoga Passage and Double Bluff (MRC, 2003; WDNR, 2001). The southwestern coastline of Camano Island, along Port Susan, generally lacks eelgrass coverage. Because they are not readily visible in aerial photographs, non-floating kelp beds are not as easily monitored or mapped. .

Pacific herring spawn sites in Puget Sound are well documented by WDFW. The largest spawn sites occur in Skagit Bay. In 2001, the MRC assessed habitat and mapped beaches in Island County for Pacific herring, surf smelt and sand lance. The MRC found extensive surf smelt and sand lance spawning habitat along the southeastern and northern shorelines of Camano Island and along the southwestern portion of Whidbey (SRP, 2005).

WDFW-designated priority habitats and species include waterfowl concentration areas, seal haul out sites and bald eagle territories, among others. Bays and inlets such as Holmes Harbor, Penn Cove, and Crescent Harbor provide both habitat for significant waterfowl concentrations (e.g. surf scoter, American wigeon, Northern pintail) (WDFW, 2008). Crescent Harbor, Deer Lagoon (on the north shore of Useless Bay), Penn Cove, Port Susan Bay, are designated Important Bird Areas by National Aububon Society, which are deemed essential for sustaining wild bird populations (Cullinan, 2001). The Whidbey Island Pigeon Guillemot Survey (2004-onoing) project has documented 23 active guillemot colonies on the island. Tall sandy bluffs, particularly along the island's west side, offer safe burrow sites close to productive feeding areas.

Numerous bald eagle nesting territories occur in the shoreline zone and a harbor seal concentration area is located in Livingston Bay (WDFW, 2008). According to Jeffries et al. (2000), 26 haulout sites (out of water resting sites) are near Whidbey and Camano Islands. Of these 26 sites, 23 are used by harbor seals, 12 are used by California sea lions, and one site is used also used by Northern elephant seals. The majority of the haulout sites are generally waterward of the nearshore environment with Utsalady Bay and Double Bluff occurring closer to shore.

Commerical shellfish areas are located in Holmes Harbor, Penn Cove and the northeast shore of Camano Island. Holmes Harbor was closed to harvest in 2006 due to elevated levels of fecal coliform bacteria. A Shellfish Protection District was established by the Island County Board of Commissioners to identify pollutant sources and correct contamination problems.

Recreational shellfish beaches are abundant on both islands. Softshell, hardshell and subtidal clams are found throughout Island County as well as concentrations of Pacific oyster, rock scallop, Dungeness crab, red rock crab, Pandalid shrimp, and burrowing shrimp. Six geoduck areas are located along the Whidbey Island shoreline with a few small areas off of Camano Island

(Adolfson Associates, 1998; MRC, 2008). Areas of the Island County shoreline are also used for tribal shellfish harvest.

The majority of tidelands and bedlands along the Island County shoreline are held in state ownership or private ownership (WDNR, 2005). State-owned lands are managed by either WDNR, WDFW or Washington State Parks and Recreation Commission. Private ownership tidelands are a result of the sales authorized by the legislature that occurred in between 1889 and 1969. Much of Holmes Harbor is held in private ownership as is more than half of Camano Island shoreline. Areas in federal ownership include much of Crescent Harbor, managed by the Department of Defense, and small sections of the Admiralty Inlet shoreline that are managed by the Department of the Interior (USFWS).

Major land use types along Whidbey and Camano Island shorelines are residential, government-affiliated uses, marinas, public recreational beaches and private beaches. Residential development dominates the County's shoreline. Communities comprising small lots are interspersed with areas of suburban-sized lots, as well as rural lots of 5, 10, and 20 acres. Although parcel sizes are widely mixed in the County, very small lots predominate in shoreline areas.

2.0 NEARSHORE ENVIRONMENTS

2.1 Literature Sources

The County's Critical Areas Ordinance (CAO) and Shoreline Master Program (SMP) (Island County Code [ICC] Chapters 17.02 and 17.05, respectively) protect and regulate use and development of marine nearshore habitats in Island County. This paper discusses the existing nearshore habitats and important ecosystem components in Island County, and the protection of these habitats currently provided by the CAO. We provide management recommendations that pertain to nearshore environment that are applicable to both CAO and SMP regulations.

The Aquatic Habitat Guidelines Working Group (AHG), a multi-agency cooperative committee in Washington State, recently produced *Protecting Nearshore Habitat and Functions in Puget Sound: An Interim Guide* as a guide to BAS for nearshore habitats (EnviroVision et al., 2007). The guidance provides a synthesis of current science on nearshore habitats and processes to assist local planners in making informed decisions about nearshore management. These guidelines were consulted extensively during preparation of this BAS paper. In addition, the Puget Sound Nearshore Partnership (PSNP), a consortium of state agencies and regional scientific experts have developed a series of best available science papers on the nearshore environment. Information from these papers is also incorporated.

2.2 Ecosystem Components

The following is a summary description of the physical and biological components that interrelate and make up the nearshore environment. The sections present the updated best available science for key habitats and species. Threats and pressures to ecosystem processes and components are discussed at the end of this section.

2.2.1 Beaches and Bluffs

Beaches are composed of generally, loose unconsolidated sediment that extend landward from the low water line. Beach sediment in the Puget Sound lowlands can range in size form very small sands up to pebbles, cobbles and occasionally boulders. Feeder bluffs play a critical role in shaping nearshore habitat as they are the primary supply source for the sand, gravel, and larger substrates that build and maintain beaches. Beach structure and substrate composition are also determined by the exposure to wave energy. Wave energy causes beaches to continually evolve by affecting eroding, entraining and transporting sediment. “Shore drift” is the combined effect of longshore drift, the sediment transported along a coast in nearshore waters, and beach drift, the wave-induced motion of sediment on the beachface in an alongshore direction. Net-shore drift is the long-term effect of shore drift occurring over a period of time along a particular coastal section (Jacobsen and Schwartz, 1981).

As an important ecosystem component of the marine nearshore, beaches also provide important habitat for forage fish, juvenile salmon, shellfish and aquatic vegetation such as eelgrass. They also provide valuable commercial uses and recreational benefits.

Bluffs are influenced by the original deposition of glacial material, subsequent atmospheric processes, and by the geology, hydrology, orientation and exposure, erosion rates, and vegetation. Glacial till is the most common bluff type in Puget Sound. Because glacial till is resistant to erosion (compared to silt and clay), it has limited capacity to replenish down slope beaches (Johannessen and MacLennan, 2007). Vegetated bluffs provide habitats for a variety of wildlife species and large trees for perching and nesting raptors.

2.2.2 Forage Fish Habitat

Forage fish are key components of the marine food web and have important commercial and recreational value. They are generally characterized as small, schooling fish that prey upon zoonplankton and are in turn preyed upon by larger predatory fish, birds and marine mammals (Pentilla, 2007). Key forage fish species in Puget Sound include: Pacific herring, surf smelt, Pacific sand lance, northern anchovy, and longfin smelt. Water quality and other conditions that affect food or predator abundance are important for all species of forage fish.

Pacific herring congregate in groups offshore prior to spawning, moving from deeper water into the shallow nearshore zone. Spawning occurs between late January to early June, with the majority of Puget Sound stocks spawning in February and March. They deposit their eggs almost exclusively on marine vegetation, primarily native eelgrass, or red, green, and brown alga in deeper waters. Water clarity, depth and substrate composition (e.g. mud, gravel, cobble) are important factors for vegetation growth, particularly for eelgrass which requires photosynthesis. Forage fish require spawning areas require shade from overhanging riparian vegetation, which keeps the eggs moist when the tide is out during incubation (Penttila, 2000). In especially clear water, herring spawn can extend from shallow subtidal areas to depths of -10 meters MLLW in tidal elevation (Pentilla, 2007). In addition, larval and juvenile herring also use the nearshore zone during rearing.

Surf smelt and Pacific sand lance spawn in nearshore habitats, but occur in the upper sand-gravel beaches of the intertidal and also shallow subtidal zone. Surf smelt spawn at various times of year depending on the stock, with some stocks spawning year-round. They require small gravel and coarse sand (commonly called "pea gravel") as a spawning substrate, which can occur as a broad linear bands along the shoreline or as small discontinuous array of small patches around the high tide line. Incubation time is about two weeks for summer spawning stocks and up to eight weeks during cold winter months. Surf smelt reside in this upper tidal zone for their entire lives. Similar to surf smelt, Pacific sand lance use the upper interidal zone for both spawning and adulthood. However, less is known about sand lance and new spawning sites continue to be documented by WDFW. Spawning typically occurs between November and February during high tides when the upper beach is covered by shallow water. Sand lance excavate shallow pits in the beach substrate, depositing spawn in the pit bottom. Incubation time is approximately one month. The presence of over-hanging trees in the marine back shore is important for moderating and/or preventing wind and sun exposure on eggs of both surf smelt and sand lance (Penttila, 2007).

Northen anchovy and longfin smelt juveniles also use nearshore habitats for rearing, but not for spawning. Northern anchovy are considered a pelagic forage fish that release their floating eggs into open water. Juveniles can be transported to nearshore environments by currents common to Island County and are most likely to be in such habitats during summer. Populations of northern anchovy have not been monitored well enough to determine abundance or trends at this time. Longfin smelt are considered an anadromous species that deposit their eggs on river-bottom sediments near the upper ranges of tidal influence. Since egg mortality is a key limiting factor for forage fish populations, the species that spawn in nearshore habitats (herring, smelt, sand lance) are considered to the be most vulnerable to shoreline development (WDFW, 1998).

2.2.3 Kelp and Eelgrass Habitat

Kelp and eelgrass are marine plants that occur in the nearshore zone and are critical to primary production and generating nutrients and substrate that form the base of the food chain. The plants also provide refuge and foraging habitat for many fish, invertebrates, birds and other organisms, some of which have significant cultural and economic value (Mumford, 2007).

There are 23 species of kelp in Puget Sound, with only two species of floating kelp and 21 that are considered prostrate, or not-floating. The prostrate species are limited to shallower portions of the nearshore zone and comprise the majority of marine vegetation biomass in some areas (Mumford, 2007). Kelps are held to the substrate by holdfasts, which unlike roots do not penetrate the bottom or carry nutrients. Kelps must obtain nutrients directly from the water and require a hard substrate. They favor areas with high ambient light and low temperatures, which occur in nutrient-rich waters with moderate wave energy to circulate the nutrients.

Unlike kelps, eelgrass is rooted in the substrate and can spread horizontally to produce new plants. Eelgrass requires fine-grained substrates and is particularly associated with low to moderate high-energy intertidal and shallow subtidal mud/sand substrates. The plants need sufficient light during summer to support growth and for nutrient storage over winter. Typically, eelgrass beds form between about two meters above MLLW to almost nine meters below MLLW dependant on water quality. However, other factors such as extreme low or high nutrient levels, substrate composition, presence of other species, and toxic pollutants can affect eelgrass abundance and distribution.

2.2.4 Marine Riparian Vegetation

Marine riparian vegetation includes both upland forest communities along the shoreline and adjacent bluffs and nearshore communities characterized by salt-tolerant vegetation on beaches or tidal flood plains. Marine riparian areas are transition zones between upland and aquatic environments that support diverse plant and animal communities and are critical to spawning forage fish and juvenile salmonids. Vegetation in these areas is heavily influenced by microclimate produced by the nearshore environment, which is in turn influenced by vegetation. Marine riparian vegetation provides key nearshore functions related to water quality, soil and bluff stability, filtering surface runoff, providing shade and habitat structure, organic litter, and large woody debris (Brennan and Culverwell, 2004).

Marine riparian vegetation can protect water quality through reducing surface erosion by slowing runoff. It can reduce pollutants by retaining sediments with excess nutrients, metals, and organic chemicals commonly found in stormwater and agricultural runoff (May, 2000). It also prevents excessive turbidity, which can smoother eggs and aquatic vegetation (EnviroVision et al., 2007). Riparian vegetation provides a variety of wildlife habitat functions such as habitat and travel corridors, microclimate regulation, a source for large woody debris and other organic matter, refuge and cooler temperatures for juvenile salmon in some pocket estuaries (Parametrix et al. 2005). Riparian vegetation also supplies terrestrial insects that have been shown to be an important source of juvenile salmon prey, as shown by Brennan et al. (2004). Studies have strongly suggested that the presence of shading vegetation has a positive effect on the survival of surf smelt spawn incubating in sand-gravel beaches in the upper tidal zone of Puget Sound (Rice, 2006; Penttila, 2001). Vegetation serves to moderate water temperature and humidity extremes in microhabitats occupied by early life history stages of spawning fishes otherwise adapted to cold climates (Brennan and Culverwell, 2004; Rice, 2006).

Large woody debris and beach wrack, as structural byproducts of marine riparian vegetation, are important sources for organic detritus as they provide habitat structure for species that are prey for fish and wildlife (Brennan and Culverwell, 2004). LWD also traps and stabilizes sediments in salt marshes and on beaches, creating back beaches, berms, and spits. LWD is also an important source of moisture for the establishment and growth of beach vegetation.

2.2.5 Juvenile Salmon Habitat

Juvenile salmon rely on the nearshore and estuarine marine habitats for food, migration corridors, protection from predators, and a transitional environment that supports the physiological changes that occur as they transition from a freshwater to a marine environment (Fresh, 2006). Spawn and migration timing, and the use of different marine habitats vary widely between salmonid species as well as stocks or subpopulations of the same species. Juvenile salmon find food and protection in shallow water habitats with low wave energy and fine-grained silt or mud substrates, such as marsh and wetland areas and small estuaries. Over time, salmon use a variety of marine habitats for different food sources, deeper water and higher salinity. Connectivity between habitats is critical to foraging success, refuge from predation and successful adaptation to ocean environments.

As described in the *WRIA 6 (Whidbey & Camano Islands) Multi-Species Salmon Recovery Plan* (SRP, 2005), the nearshore areas of Island County provide critical habitats for rearing, shelter from predators, migration, and physiological transition. The shallow water lying between the major salmon-producing rivers of the mainland (Skagit, Stillaguamish and Snohomish) and the islands of Camano and Whidbey provides a migratory path for juvenile salmon transitioning to marine waters. Since 2002, the MRC has been conducting a multi-year study of how juvenile salmonids use the pocket estuaries of Whidbey Basin. Pocket estuaries are non-natal, small lagoons and coastal stream mouths that provide critical habitat for rearing, shelter from predators and high wave energy, and physiological transition. These habitats are particularly important for early migrating Chinook, chum, and pink salmon fry and forage fish (SRP, 2005).

2.2.6 Other Important Habitat Types and Species

Although not discussed by the Aquatic Habitat Guidelines Working Group, the Island County MRC has identified ghost shrimp stock areas as a potential important habitat because of their association with gray whales. Ghost shrimp occur in the sand flats of the intertidal zone and their spawning areas are likely are concordant with surf smelt and sand lance spawning areas. Ghost shrimp are an important food source to marine mammals including migrating gray whales that occur annually in the waters of Saratoga Passage. The gray whale was once federally and state listed as endangered, but its listing status was removed in 1994 as populations recovered. This species is still protected under Marine Mammal Protection Act.

Gray whales migrate from Baja, California to the Bering Sea, with a small population (six to 12 annually) stopping to feed in inland waters of Puget Sound between mid-March and late May (Calambokidis et al., 1994). Gray whales come into nearshore environments to feed by sucking large amounts of water, mud, and invertebrates and forcing the mixture through their baleen plates. They create a series of feeding pits (averaging 9 feet by 5 feet) along the shoreline. Weitkamp et al. (1992) recorded 19,000 feeding pits along the southeast coast of Whidbey Island, the southwest coast of Camano Island, and the Port Susan shoreline. A map of these feeding pits was created by Weitkamp et al. (1992).

The stock of Southern resident killer whales, otherwise known as Orca, inhabits the waters of Puget Sound from early spring until late fall (Ford and Ellis, 2002; Krahn et al., 2002). In the early fall, pods further expand movement into Puget Sound to feed on Chinook and chum salmon runs (Osborne, 1999). Ecologically, Orca are at the top of the food chain, feeding on several species of salmon and bottom fish. Culturally, killer whales have been of great importance to native cultures around the Pacific Northwest.

As noted previously, an abundant and diverse array of shellfish that inhabit the near-shore waters of the Island County. Species such as crabs, clam, oysters, mussels, shrimp, geoduck, and others have ecological, economical, cultural, and recreational importance. Although population trend data is limited, population levels of several species (Olympia oyster and geoduck) have declined in recent decades causing concern for other species (Dethier, 2006).

3.0 THREATS AND PRESSURES

A number of documents summarize the physical factors controlling habitat structure (Dethier et al. 1990), and the relationship between "natural" (predevelopment) estuarine and nearshore habitats and major aquatic resources (Simenstad et al. 1991a). The management of bluffs, beaches and nearshore areas has historically treated these components separately rather than connected and part of a coastal system. This has resulted in substantial negative impacts to coastal erosion, nearshore habitats and wildlife. According to the Northwest Straits Nearshore Habitat Evaluation (Anchor Environmental, 2002), bulkheads, marinas and overwater structures (docks and piers), and sewer outfalls are the key human threats to nearshore processes and functions.

These shoreline alterations threaten two important habitat-forming processes: sediment transport and tidal exchange. Alterations including riprap revetments and vertical bulkheads threaten forage fish spawning habitats through direct losses of habitat as well as indirectly by blocking or delaying the erosion of upland areas and bluffs that replenish the spawning substrate (Johannessen and MacLennan, 2007; Williams and Thom, 2001). Dikes and levees prevent tidal exchange and circulation, altering saltwater habitats over time.

Piers and marinas can also alter wave energy and current patterns, obstruct littoral drift and longshore sediment transport, and alter fluctuations of temperature, salinity, and water levels (Williams and Thom, 2001). The presence of overwater structures such as residential docks and piers similarly alters nearshore sediment transport, tidal exchange and hydrology, while also leading to declines in eelgrass bed (salmon migration corridors), changes in beach sediment size and by potentially introducing harmful chemicals (Williams and Thom, 2001; Nightingale and Simenstad, 2001). Sewer outfalls introduce nutrients and pollutants to the nearshore area altering current cycles and food web interactions.

Alteration and loss of marine riparian vegetation has also been identified as one of the most significant factors negatively influencing marine ecosystems (Brennan and Culverwell, 2004; Brennan, 2007; EnviroVision et al. 2007). Clearing of vegetation can destabilize coastal bluffs or other steep slopes, resulting in landslides that could affect nearby residential development. It also reduces sources of detritus and terrestrial insects, affecting the forage base as well as direct food sources for salmonid species (Brennan and Culverwell, 2004). For example, Penttila (2001) found higher egg mortality in spawning surf smelt on unshaded (sun-exposed) beaches that lacked overhanging vegetation. Similarly, that lack of natural LWD dropped onto beaches from adjacent riparian areas can influence sediment transport and deposition (Gonor et al. 1988). The loss of riparian vegetation can also disrupt wildlife movement and migration for many wildlife species that depend on wide, continuous corridors and distance from human disturbance (Brennan and Culverwell, 2004).

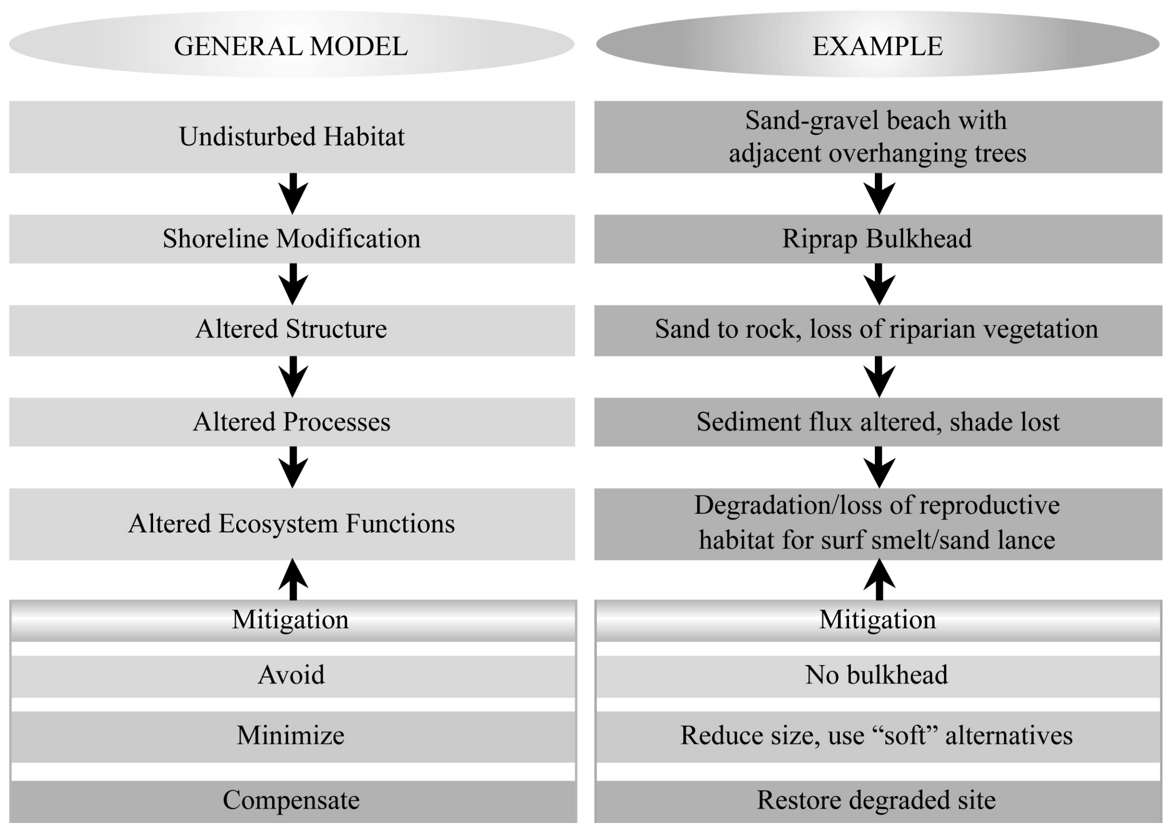
Clearing riparian vegetation can also reduce the amount of pollutants that are removed from surface water runoff and associated sediments, and creates conditions harmful to aquatic species (EnviroVision, 2007). Surface water runoff contains varying levels of silt, waste, and chemical constituents that could otherwise be absorbed or removed by allowing for infiltration, detention, and absorption by soils and vegetation (Brennan and Culverwell, 2004). Contaminants can be taken up directly by aquatic organisms or can accumulate in sediments affecting benthic and epibenthic organisms. Contamination can also affect commercial or recreational shellfish beds, thus resulting in economic and cultural impacts.

Lastly, nearshore habitats are at risk due to global climate change and development at the shoreline may be at increased risk in the long-term. Sea level rise in Puget Sound is expected to accelerate as a result of global warming, with changes projected anywhere from four to 35 inches during this century (PSAT, 2007). Modeling conducted by the Intergovernmental Panel on Climate Change (IPCC) has produced the currently accepted range of sea-level rise scenarios. The IPCC models suggest a 3.0-inch rise in the global average sea level by 2050 and a 27.3-inch rise by 2100. The latest literature indicates that the global rise in sea levels could actually be progressing more rapidly than previously assumed, and new predictions are anticipated. The National Wildlife Federation (2007) has modeled the impact of sea-level rise on coastal habitats for eleven specific sites throughout Puget Sound. The model results indicate the region is likely to face a dramatic shift in the extent and diversity of its coastal marshes, swamps, beaches and other habitats.

One of the sites modeled in NWF (2007) covers Whidbey Island, Port Townsend and Admiralty Inlet. The model predicts that 74% of brackish marsh, 29% of inland fresh marsh, and a small protion of low-lying dry lands will be inundated with salt water and converted to saltmarsh and tidal flat by 2100. A combination of inundation and erosion is predicted to have significant effects on beach, especially on western Whidbey Island. Overall, the area is predicted to experience a 72% loss of estuarine beach by 2050 and an 80% loss by 2100.

The loss of estuarine beaches will affect spawning habitats for forage fish and thus much of the marine food web. Inundation of tidal flats in some areas would reduce stopover and wintering habitat for migratory shorebirds and loss of coastal marshes would affect habitats of local importance for wintering waterfowl. Changes in the composition of tidal wetlands would significantly diminish the capacity for those habitats to support salmonids, particularly juvenile Chinook and chum salmon. Lastly, beach loss and inundation will also negatively affect aquaculture businesses operating within nearshore environments.

The graphic below (adapted from Williams and Thom, 2001) is a general model and a hypothetical example for evaluating the effects of shoreline armoring and mitigation actions. In the example, an undisturbed fully functional shoreline habitat is modified by addition of a rock bulkhead. This human modification substantially alters the structure of the original habitat, increasing the original site elevation, changing the beach substrate composition from sand-gravel to hard rock, and removing riparian vegetation. In turn, habitat support processes are altered as sediment dynamics change, due to increased reflective wave energy and loss of sediment supply, and riparian shading is lost. Altered processes are reflected in changes to ecosystem functions, such as the loss of adequate beach spawning habitat for forage fish, which have specific elevation, sediment, and temperature requirements for successful egg hatching. Actions that can mitigate these impacts include avoidance (i.e., no bulkheading), minimization of impacts (use of alternative shoreline armoring strategies), and compensation (restoration of other degraded sites).



4.0 PROTECTIVE BUFFERS

Few scientific studies have considered buffer requirements and/or development standards for marine and nearshore habitats. Most of the current science on nearshore vegetation management areas and buffers comes from studies of freshwater and riverine systems. Some of the functions provided by freshwater riparian areas are similar to functions in the marine system, such as pollutant removal, large woody debris recruitment, and nesting and migration habitat for fish and wildlife. However, there are several functions provided by protective buffers that are specific to nearshore environments.

The key issues for marine nearshore protection, as identified by Brennan and Culverwell (2004), are water quality, sediment control, wildlife habitat, microclimate, nutrient input, fish prey production, shade, and habitat structure as large woody debris. Some of these functions benefit from a wider buffer between the habitat and the built environment, particularly water quality, nutrient input, and large woody debris recruitment. Other functions are influenced more by overwater structures and shoreline armoring than buffer width. These alterations to the shoreline affect nearshore processes such as sediment transport, shore-drift, and beach replenishment from feeder bluffs, thus impacting microclimate for forage fish and rearing and migratory habitat for juvenile salmonids.

A variety of technical reports summarize the scientific literature on riparian buffer functions and make recommendations for stream riparian buffer widths, including May (2003); Castelle et al. (1992); Desbonnet et al. (1994); Johnson and Ryba (1992); Knutson and Naef (1997); and Pollock and Kennard (1998). The majority of these reports pertain to freshwater systems and are discussed in detail in the *Streams/Lake BAS Update Paper* (ESA Adolfson, 2008).

There is no consensus in the literature recommending a single buffer width to protect a particular function or to protect all functions, and there is large variability in the findings of these reports. Overall, buffer widths of less than 33 feet (10m) are considered functionally ineffective (Castelle etl al. 1994 in City of Seattle, 2005). Brennan and Culverwell (2004) state that buffer requirements may need to be adjusted for marine systems to account for the effects of wind, salt spray, desiccation, and general microclimatic effects. Levings and Jamieson (2001) recommend a variable width approach based on site-specific conditions. When applied properly, variable width buffers can be more ecologically sound because they have the potential to reflect the true complexity of the environment and management goals (Haberstock et al. 2000; IMST, 2002). Variable width buffers should consider several important functions specific to marine environments, including the buffer's ability to provide shade, supply and/or filter shore derived sediments, stabilize shorelines, and filter and mineralize non point organic pollutants such as nitrate from septic fields (Levings and Jamieson, 2001).

Other local jurisdictions in Puget Sound similar to Island County that have adopted protective buffers based on best available science include King, Kitsap and Whatcom counties. King County updated their CAO in 2004 to provide variable buffers on aquatic areas dependent on whether the resource is inside or outside the county urban growth area (UGA) (KCC 21A.24). For S-type aquatic areas, which include the Puget Sound marine shoreline, the buffer for areas within the UGA is 115 feet. The buffer for areas outside the UGA is 165 feet. The Kitsap

County CAO applies buffers to fish and wildlife habitat conservation areas based on the shoreline designation in its SMP (KCC 19.300.315). For saltwater shorelines within Urban, Semi-rural and Rural designations a 150-foot buffer is used. For saltwater shorelines in the Conservancy and Natural designations, 50-foot and 100-foot buffers are applied, respectively. The Whatcom County CAO applies protective buffers of 150 feet to shoreline streams and other habitat conservation areas. Other habitat conservation areas also have a 150-foot buffer, such as commercial and recreational shellfish beds, kelp and eelgrass beds, forage fish spawning areas, and local habitats of importance (WCC 16.16.740).

5.0 ISLAND COUNTY CONDITIONS

Island County is the second smallest county in Washington State, but is the second fastest growing (WSCC, 2000). Between 1980 and 1990, the County's population grew by 37%, the highest in the state. The 2000 population was 71,600 and the projected population at 2025 is over 100,000 permanent residents. The incorporated urban growth areas of Oak Harbor, Langley and Coupeville comprise about 35% of the population. Sixty-two percent of Island County is zone for residential land use. Residential development encompasses much of the shoreline and is expanding into rural and forested areas. The shorelines are in high demand for private beachfront homes and sites with scenic vistas of water and mountains. The parcels comprising nearly 80% of the County's shoreline are developed, primarily with platted single-family communities.

Shoreline residential homes continue to have a major impact on the nearshore environment. Residential bulkheading is typically designed to limit the erosion of the backshore area or bluff, but has numerous direct and indirect impacts on nearshore systems. Of the 212 miles of shoreline that occur on Whidbey and Camano Island, approximately 25% have been altered by development (WRIA 6, 2005). Bulkheads are present along approximately 15% of the shorelines accounting for approximately 33 miles. Marinas and overwater structures number 31 sites and cover approximately 5% of the shoreline. Bulkheads, docks, groins, and marinas all impact salmon habitat and nearshore processes.

Tidal exchange and hydrology have been altered by the presence of 35 dikes along Island County shores, accounting for up to 20 miles of shoreline. The *Salmon Habitat Limiting Factors WRIA 6 Island County* (WSCC, 2000) noted that much of the habitat damage to the salt marshes and estuaries has resulted form the loss of connectivity to Puget Sound tidal waters. Agriculture and shoreline residential development has had the biggest impacts on tidal connectivity. In the early 1990s, drainage districts were established in agricultural areas to move water off of the land and allow for development. In more recent decades, numerous residential developments have been constructed on natural or augmented sand spits to raise homes above tidal flood levels, creating a barrier to saltwater flow (WSCC, 2000).

One wastewater treatment plant is located in Oak Harbor and there are six sewer outfalls along the Island County shoreline. Most residents rely on septic systems for sewage treatment. Water quality impacts occur when septic systems are installed for domestic sewage and experience flooding in relation to naturally fluctuating water levels. Lack of maintenance and repair of these systems has resulted in water quality problems in some areas, as in South Holmes Harbor.

Non-native cordgrasses (*Spartina)* also pose a threat to some WRIA 6 nearshore areas. Cordgrass invasions eliminate native salt marsh vegetation, displace native plants and animals, raise the elevation of the estuary substrate, and lead to an increase in flooding (SRP, 2005). The primary areas targeted for *Spartina* control are located around the north half of Camano Island. They include Davis Slough, West Pass, Livingston Bay and Triangle Cove. Much smaller infestations occur around Whidbey Island. There, control activities are in place at Cultus Bay, Deer Lagoon, Lake Hancock, and other locations.

The nearshore habitats that have been most significantly impacted by human activities are areas that were historically highly productive - protected bays, lagoons and marshes - providing a wide range of functions to salmon and forage fish. However, it is important to note that while freshwater and marine ecosystem processes and habitats in Island County have been degraded over time, the impacts are not as far reaching as those in many of the surrounding watersheds. In urban areas of Puget Sound, nearshore development has altered 90-100% of the historical habitats, in comparison to the 25% of Island County.

6.0 ISLAND COUNTY PROTECTION OF NEARSHORE RESOURCES

6.1 Regulations

Many of the threats and pressures to nearshore environments previously described are addressed under multiple and overlapping regulatory provisions. All development within the shoreline zone, such as in-water work, clearing, grading, and building construction, is regulated by local, federal and state authority. Federal and state agencies with jurisdiction include the Army Corps of Engineers, Ecology, and WDFW, EPA, WDNR, and tribal governments.

In addition to the federal and state permit requirements, the Shoreline Management Act (SMA) regulates the use and development of all marine shorelines through the county’s Shoreline Master Program (SMP). Overall, the requirements of the SMA apply to private projects on privately owned lands, and to private, local government, and state government actions on local or state government lands. The SMA emphasizes accommodation of reasonable and appropriate uses, protection of shoreline environmental resources and protection of the public's right to access and use the shorelines. It requires local jurisdictions to ensure no-net loss of shoreline functions and to mitigate adverse impacts.

The Island County SMP consists of policies and development regulations that apply to areas within shoreline jurisdiction (200-feet upland of OHWM and lakes larger than 20-acres in size). Projects, including new development and redevelopment, within the SMP jurisdiction are reviewed by Island County Planning and Community Development staff to ensure compliance with ICC 16.21 Shoreline Management and 17.05 Shoreline Use Regulations. Shoreline uses are identified as either permitted, conditional, or prohibited depending on the shoreline environment designation. This designation is essentially shoreline zoning that is based on an inventory of existing uses. Island County revised its SMP in 2001. The current SMP places strict limitations on the ability to construct new bulkheads, over water structures and waterfront subdivisions. A primary theme of the SMP is to require bioengineering solutions wherever feasible. As required by the Legislature, GMA, Island County will be updating its SMP again before 2011 to comply with the state shoreline guidelines (WAC 173-26), which were adopted by the state in 2003.

Island County also regulates development in the shoreline zone through its CAO regulations. Some marine nearshore habitats as designated Fish and Wildlife Habitat Conservation Areas (FWHCAs), as defined in ICC 17.02.50, as:

a. Areas with which endangered, threatened, and sensitive species listed by the federal or state government have a primary association.
b. Streams.
c. Commercial and recreational shellfish beds.
d. Kelp and eelgrass beds.
e. Herring and smelt spawning areas.
f. State natural area preserves.
g. State natural resource conservation areas.
h. Species and habitats of local importance (*Species:* great blue heron, common loon, osprey, pileated woodpecker, and trumpeter swan. *Habitats:* Bos Lake, Crockett Lake, Deer Lagoon, Newman Road Lakes, Cultus Bay Flats, Whidbey Game Farm, Penn Cove, Hastie Lake, and Useless Bay)

All marine FHWCAs have a required 75-foot buffer and any disturbance to protected species or habitats requires a permit from the County. Maps of marine FWHCAs are maintained by Planning and Community Development and are consulted during site review. Kelp and eelgrass beds, surf smelt and Pacific herring spawning areas, and commercial and recreational shellfish beds are protected by a 75-foot buffer, meaning that the area within 75 feet of these habitats must be retained in an undeveloped and undisturbed condition. The buffer may be reduced for single-family residences when adjacent development is closer, but no other development is permitted in the buffer area, including decks, patios, or landscaping.

To assist the general public in understanding the county code and regulations, the Island County Planning and Community Development Division provides "Development Information Bulletins" (DIBs) on a variety of topics. Over 25 DIBs pertain to CAO and SMP regulations with several of those pertaining specifically to development standards in shoreline areas (e.g. setbacks, buffers, bulkhead requirements, etc.).

6.2 Zoning and Permitting

Island County also protects its shorelines and nearshore habitats through zoning regulations and a precedent of careful permitting. In response to the GMA, Island County has concentrated growth in its three cities: Oak Harbor, Langley and Coupeville. Since the 1980s, the County has down-zoned much of the area outside of these population centers to a point that 93% of the land has low density rural zoning. This includes approximately 90% of the shoreline to a density of one dwelling unit per five acres.

In terms of permitting, a Biological Site Assessment (BSA) is required when a development proposal (e.g. clearing and grading, excavation, bulkheads, docks) is located on lands which may contain a habitat for protected species (other than bald eagle nesting territories, which have a specific plan) or when the applicant proposes to alter, decrease or average the standard buffer. A qualified biologist must prepare the BSA which must include standard items such as a site plan, description of marine FWHCAs in area, proposed project, impact analysis, regulatory summary, and proposed mitigation measures and/or conceptual plan.

The Island County Planning and Community Development department permit records show that since 2001, the County has issued an average of 7.5 new bulkheads per year (22 within lagoon communities and 31 outside lagoon communities). Many of these new bulkheads were requested after February 2006 when a large storm event resulted in extensive flood damage to shoreline communities. Fourteen of the 53 new bulkheads are considered “soft shore” bulkheads and comprise 32% of the total distance of all new bulkheads since 2001, which signifies the increase in alternatives to conventional stabilization techniques.

Proposals for new overwater structures (floating docks, piers, boat ramps, groins, jetties, breakwaters, and marine railings) and any expansion of existing overwater structures are not common. Since 2001 there have been 11 new docks issued within lagoon communities and four outside lagoon communities. WDFW requires eelgrass surveys for all proposals. A professional and qualified diver must perform the survey and meet WDFW standards.

6.3 Science and Monitoring

Island County has committed significant resources and effort toward furthering the understanding of its resources, including:

- A 13-member Marine Resources Committee (MRC), authorized in 1998 by the Northwest Straits Marine Conservation Initiative. The MRC conducts and supports scientific research, education and voluntary action.

- A 12-member Water Resources Advisory Committee (WRAC), created in 1999 by the Board of Island County Commissioners. The WRAC mission is to ensure that the water resources of Island County are managed and protected in such a way as to ensure their sustainable use, while protecting habitat and environmental and human health. The WRAC was responsible for the *Island County Water Resource Management Plan*, adopted 2005, thirty-one recommendations or strategies for comprehensively ensuring safe and adequate water supplies. They have also completed and *Implementation Plan* that contains specific actions.

- Surface Water Monitoring – the County has established a comprehensive monitoring program in 48 watersheds. Data collection is conducted two times per month (includes dissolved oxygen, fecal coliform, nitrate, pH, phosphorus, temperature, turbidity, conductivity, hardness and vegetation.

- Groundwater Monitoring - the Island County Health Department has developed an extensive program for ground water monitoring and management. A groundwater database exists that includes well logs from over 6000 wells, stratigraphy, and water quality data. An interface to this data has also been developed to assist in evaluating groundwater availability, water quality and seawater intrusion issues.

- Holmes Harbor Shellfish Protection Program– established in 2007 to respond to the Washington State Department of Health (DOH) closure of the area due to public health concerns (fecal coliform bacteria resulting in unsafe harvest and consumption of shellfish). The Program includes public education and involvement in actions that identify and reduce and/or eliminate upland point and non-point pollution sources that can adversely affect public health and the marine environment. Water quality data is being collected to determine when conditions have improved enough that the area is safe enough for the protection district to be dissolved.

6.4 Incentives and Stewardship

Island County provides and supports multiple incentive and stewardship programs that result in the protection of nearshore environments, including:

- Rural Stewardship Plan – offered by the Island County Planning and Community Development Division to property owners within unincorporated areas whose residential parcel is one acre or larger. Property owners comply with broad range of conservation practices in exchange for priority permit processing, a reduction in property-tax valuation or a lowered land use intensity rating. Each plan is customized to the landowner's goals and the property's features.

- Shore Stewards – in 2003, a Shore Stewards program was created in an effort to help shoreline residents feel more connected to the nearshore ecosystem. It is a voluntary program sponsored by the Washington State University (WSU) Extension and the Island County MRC with grants from the Salmon Recovery Funding Board and Northwest Straits Commission. Over 500 households in Island County are a part of the program, which follows the *10 Guidelines for Shoreline Living in Island County*.

- Homeowner Septic Training (HOST) Program – the Island County Public Health Department offers a free, multi-media 3-hour short course for homeowners to improve inspection and maintenance of their residential septic systems. The State Department of Health passed a law in July 2007 requiring inspection of conventional systems every three years and other systems every year. Homeowners with conventional systems may conduct their own inspections when certified through HOST.

- Septic repair funding – Island County Public Health Department offers low-interest loans and grants for septic system repair or replacement.

6.5 Education and Outreach

Island County actively educates residents about the nearshore environment through educational materials and mailings as well as outreach programs. *Our Islands, Our Waters, Our Future* is a publication produced by the Planning and Community Development Resource Enhancement

Program and released in September 2007. It provides comprehensive information on several topics such as septic system education, water conservation, pet waste pollution, LID techniques, as well as county monitoring programs and pollution prevention plans. The County provides a webpage of information about LID techniques including a list of locations where LID has been used that are accessible to the public. The County provides pollution prevention techniques to its residents, including a poster campaign educating residents about proper pet waste disposal where residents provide photos of their own pets.

In 2006, the MRC co-published *Getting to the Water's Edge* with WSU Beach Watchers. The book provides descriptions for public access of the shoreline while educating the public about nearshore best practices, stewardship and existing stewardship programs. To help introduce the Island County Marine Stewardship Areas and raise awareness of marine resources and shoreline processes, the MRC initiated a shoreline signage project in 2006. Interpretative signage has been installed at parks, peirs and waysides throughout the county.

To gauge its progress and track the effectiveness of ongoing efforts to influence the community's understanding, attitudes and behavior, the MRC conducted a survey of the public in 2007. It included questions to determine community knowledge and attitudes about Island County nearshore conditions, problems and needs, and to assist in identifying issues that residents consider important and need addressing.

6.6 Sponsored Projects and Studies

The MRC has initiated and completed a variety of studies assessing nearshore habitat resourced, including:

- Eelgrass survey - in June of 2000 the MRC secured a grant from the Northwest Straits Commission (NWSC) for a two-part project to locate and map eelgrass beds on our shoreline. The survey incorporated both a property-owner survey, working with WSU Beach Watchers, and underwater videography.

- Forage fish survey – the MRC spearheaded a regional forage fish spawning habitat survey in 1999, which grew encompass all seven NWSC counties. As the largest geographic forage fish habitat assessment/ mapping project in the world, its goal was to biologically identify beaches used as spawning areas by surf smelt, Pacific sand lance and herring that form the core of the food chain for salmon, rockfish, shore birds, diving birds and many marine mammals.

- Shoreline hardening survey - in 2002, the MRC initiated efforts to survey shoreline hardening in Island County and provide more accurate information beyond the WDNR ShoreZone Inventory. WSU Beach Watchers and MRC contractors subsequently surveyed the shorelines of both Whidbey and Camano islands with satellite GPS systems. They mapped and photographed structures; including, bulkheads, groins, ramps, piers, pilings, concrete, steel rails and rubber tires, and produced detailed reports of each survey segment.

- Pigeon guillemot survey – in 2004 the MRC began a partnership with Whidbey Audubon and Audubon Washington to conduct a multi-year breeding survey of pigeon guillemots on Whidbey Island.
- Feeder bluff survey - in 2006, MRC contractor Jim Johannessen of Coastal Geologic Services Inc. completed a comprehensive survey of feeder bluffs and accretion shoreforms along the entire shoreline of Whidbey and Camano islands.
- Orca data analysis – the MRC is working with the Orca Network to compile geospatial data from resident orca populations that occur in the waters off Island County.
- Estuary seining project – the MRC is currently engaged in a multi-year study of how juvenile salmon use the pocket estuaries of Whidbey Basin. Partners include NOAA Fisheries and WSU Beach Watchers.

6.7 Protection and Restoration

Island County has identified and designated important nearshore habitats and is currently engaged in several shoreline restoration projects. Two Marine Stewardship Areas, Saratoga Passage and Admiralty Inlet, were designated in 2003 by Island County Commissioners. Stewardship areas are meant to bring awareness to marine life, habitat and water quality. The Saratoga Passage Marine Stewardship Area encompasses all the inside waters of Saratoga Passage, Skagit Bay and Port Susan from Deception Pass in the north to Possession Point in the south. The Admiralty Inlet Marine Stewardship Area encompasses all the outside waters of Admiralty Inlet from Deception Pass to Possession Point.

The eight areas identified as habitats of local importance protected through the CAO total over 6,000 acres and are important migratory bird and waterfowl habitat. These include: Bos Lake, Crockett Lake, Deer Lagoon, Newman Road Lakes, Cultus Bay Flats, Whidbey Game Farm, Penn Cove, Hastie Lake, and Useless Bay.

Restoration projects have recently focused on Cornet Bay in Deception Pass State Park and have included creosote removal, eelgrass bed protection and forage fish habitat area improvements. The MRC received a $216,000 grant from the National Fish & Wildlife Federation has started restoration projects in this area. MRC hopes to fund three additional restoration projects in the future.

The *Island County Feeder Bluff and Accretion Shoreform Mapping* (CGS, 2007) identified 75 areas on Whidbey Island and 27 areas on Camano Island as potential restoration areas. Restoration activity types include removal of bulkheads, failing bulkheads, derelict piles, rock groins, rock revetments, and tidegates in order to restore and reconnect habitats and lagoons. Monitor and removal of *Spartina* in several areas is also recommended. CGS (2007) also located areas with conservation potential, identifying 13 areas on Whidbey Island and 10 areas on Camano Island. Conservation potentials on Whidbey Island include intact bluff vegetation and intermittent backshore, small stream mouths and coastal wetland marshes adjacent to Skagit delta. Several areas in Penn Cove have also been targeted for conservation. On Camano Island, conservation potentials occur along Port Susan and in Triangle Cove.

7.0 MANAGEMENT AND REGULATORY RECOMMENDATIONS

Based on a review of the best available science for the nearshore environment and the current conditions of Island County, it is our opinion that the majority of the existing CAO regulations in conjunction with best management practices required by Island County adequately protect marine nearshore resources. Many of the ecosystem components and nearshore habitats described in this paper are protected as FWHCAs, including Pacific herring and surf smelt spawning habitats, kelp and eelgrass beds, shellfish beds, and juvenile salmon habitat (as listed species). Potential gaps or habitats not protected by existing CAO regulations are: areas of marine riparian vegetation that occur outside FWHCAs or buffers; and, ghost shrimp stock areas that occur outside of surf smelt spawning sites.

However, as described previously, the key issues for Island County include: water quality degradation from septic systems, shoreline alteration, and a loss of connectivity between nearshore and upland habitats. Island County is addressing water quality issues through the creation of the Surface Water Monitoring Program, Holmes Harbor Shellfish Protection District, the HOST program, adoption of agricultural BMPs, and education programs to county residents. The County maintains strict requirements for new overwater structures and expansion of existing structures, and requires applicants to assess the need for bulkheads or other armoring. Further protection of the shoreline is provided through the SMP, which requires Shoreline Substantial Development Permits (SDPs) or conditional use permits (CUPs) for development within the shoreline zone.

The loss of connectivity is a result of historic development of the shoreline for residential and agricultural uses. Re-establishing connectivity along the shoreline is occurring through restoration projects in the County and via stewardship programs for single-family residents. Connectivity is also preserved, and in some cases, re-established, through the required 75-foot undisturbed buffer applied to FWHCAs. In terms of protective buffers, the use of variable buffer widths in conjunction with best management practices is preferred. To ensure no net loss of function in nearshore areas, we recommend that variable buffers be linked to the shoreline inventory and an analysis so that the most important shoreline processes and habitat areas receive the greatest protection via buffers. This includes areas such as feeder bluffs identified by CGS (2007), commercial and recreational shellfish harvest areas, areas vulnerable to non point organic pollutants (such as nitrate from septic fields), and areas vulnerable to future flooding from sea-level rise. In addition and as discussed in the WRIA 6 Salmon Recovery Plan (2005), the protection of the remaining accessible marshes and lagoons is imperative to the regional salmon recovery efforts. Voluntary enhancement and restoration of the degraded and inaccessible habitats is also imperative to salmon recovery. These habitats should be identified during the shoreline master plan update and given the greatest protective buffer.

Several non-buffer approaches to preservation and restoration of marine nearshore functions are listed in the following matrix. It addresses general categories of shoreline modification and their impacts on nearshore habitats in Island County. The table is adapted from EnviroVision (2007), but has been tailored to include those recommended protections specific to Island County. Overwater structures, shoreline armoring, and riparian vegetation alteration represent the most common activities and account for the vast majority of adverse environmental impacts.

Table 1 – Summary of Common Threats and Pressures to Ecosystem Components and Recommended Protections (adapted from EnviroVision, 2007)

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Beaches and bluffs	Any activity that alters erosion or wave energy and changes the supply or distribution of sediments along the shore can result in impacts such as; • Loss of backshore due to shoreline armoring • Direct loss of beach through downcutting (often caused by shoreline armoring) • Indirect loss of beach through armoring of updrift bluffs, the resultant loss of sediment supply followed by changes in beach substrate character and downcutting • Loss of nearshore vegetation and shading • Simplification of habitat structure due to removal of large wood, overhanging branches, and boulders • Substrate modification due to piling placement (shellhash formation) and grounding of boats and/or structures • Reduced bluff and beach stabilization, and increased erosion due to vegetation removal • Loss or change to beach substrate and conditions that support aquatic and riparian vegetation and spawning habitat for forage fish	➢ Identify feeder bluffs and protect them (and their functions) through appropriate shoreline designation and SMP regulations ➢ Identify existing canopy cover and forested buffer by reach and protect through appropriate shoreline designation and SMP regulations ➢ Identify intact beaches and protect them through appropriate shoreline designation and SMP regulations ➢ If tree removal is unavoidable, leave felled trees or create snags for wildlife habitat ➢ Minimize displacement of beach area by pilings or other structures. Where such structures are unavoidably necessary, prohibit the use of treated wood in favor of concrete, steel, or recycled plastic ➢ Prohibit grounding of floats, rafts, docks and vessels

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Forage fish habitat	• Alteration of wave energy or other shoreline processes that affect beach substrate or morphology through shoreline modification activities • Decreases in terrestrial food supply, shading, and protection from overhead predators due to clearing of marine riparian vegetation • Loss of marine vegetation from shade impacts of boats and floats, and scouring from buoy anchors causing reductions in spawning, rearing, and refugia habitat available to forage fish. • Changes to substrate, increased egg mortality, and fish avoidance from prop wash and grounding of boats during low tides • Changes to substrate structure/vegetation due to accumulation of shell fragments adjacent to pilings resulting in decreased habitat available for herring spawning • Uptake of contaminants (leading to decreased survival) by herring eggs deposited on chemically treated wood pilings • Decreased survival, due to desiccation, for herring eggs spawned on pilings at high tide elevations	➢ Designate inventoried spawning areas as natural or conservancy shorelines ➢ Minimize displacement of beach area by pilings ➢ Prohibit grounding of floats and rafts on the beach ➢ Promote overwater structure designs that result in improved light levels (e.g., minimize width, use grating, orient north-south to minimize shading resulting from new and rebuilt structures ➢ Minimize the footprint and number of pilings associated with overwater structures and do not allow use of treated wood ➢ Place structures to perpendicularly span the shoreline spawning habitat zone ➢ Do not allow construction activity during egg deposition and incubation periods ➢ Avoid placing docks or piers in tidal flats because these locations require very long structures

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Kelp and eelgrass habitat	• Reduction or loss of beds due to shading by over-water structures • Loss of substrate appropriate for attachment or growth due to beach loss or substrate change from changes in wave energy and other physical processes • Loss of appropriate habitat or direct vegetation impacts due to pilings (shellhash), dredging, prop wash, buoy anchor chain scour, and grounding of boats or structures • Habitat reduction due to reduced light levels from short and long term increases in turbidity • Loss of vegetation (eelgrass) due to increased shading from ulvoids and epiphytes (due to eutrophication)	➢ Identify all marine vegetation within intertidal and subtidal zones and protect them through appropriate shoreline designation and SMP regulations ➢ Require survey of intertidal and shallow subtidal areas prior to permitting any structures or activities that could impact existing beds ➢ Prohibit placement of overwater structures over marine vegetation ➢ Require structure designs that minimize shading and disturbance of the substrate including from prop wash ➢ Prohibit grounding of floats and rafts
Marine riparian vegetation	• Loss of function due to direct removal or disturbance during clearing and grading activities • Reduction in functional value due to decreases in vegetated riparian area width and plant diversity or density • Reduction or loss of riparian function through pruning overhanging pieces and/or removal of large trees • Increased pollutant load due to change from established native community to non native landscaping requiring use of fertilizers and pesticides • Increased incidence of invasive species due to site disruption • Increased beach substrate temperatures during low tide in summer due to removal of overhanging vegetation • Reduction or loss of localized terrestrial insect input from shoreline vegetation due to vegetation removal	➢ Require site surveys of existing conditions including vegetation function analysis ➢ Identify marine riparian protection areas that support existing functions through no-touch buffers in undeveloped areas and enhancement and mitigation requirements related to expansions or redevelopment of developed areas ➢ Promote off-site mitigation to address cumulative impacts using the restoration component of the shoreline master program

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Juvenile salmon habitat	• Decreases in terrestrial food source due to loss of nearshore vegetation • Changes in prey diversity and abundance due to alterations in beach substrate and structure • Disruption of nearshore migration and feeding areas due to noise and turbidity associated with construction activity • Substrate change and fish use impacts (avoidance) during low tides from prop wash and grounding • Increased wave energy due to armoring modifies habitat form and function • Loss of nearshore habitat structure and function due to removal or large wood, boulders, and vegetation • Substrate modification due to accumulation of shell fragments adjacent to pilings • Altered migration behavior and potentially increased predation due to shading from overwater structures • Increased water temperatures and bird predation due to loss of overhanging riparian vegetation • Increased injury risk (lesions, tumors) and reduced prey and habitat due to water quality degradation from increased stormwater runoff and wastewater discharges • Reduced prey and habitat due to loss of marine vegetation	➢ Provide protected shallow water migration corridors, especially between estuaries and marine waters through shoreline designations ➢ Minimize and limit over-water structures and improve light conditions under these structures through design specifications (width, grating, etc.) ➢ Minimize pilings, avoid use of treated wood, and eliminate grounding of boats and structures ➢ Protect marine riparian areas and require mitigation for lost habitat elements such as trees, logs, and boulders

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Ghost Shrimp	• Loss of backshore due to shoreline armoring • Direct loss of beach through downcutting (often caused by shoreline armoring) • Indirect loss of beach through armoring of updrift bluffs, the resultant loss of sediment supply followed by changes in beach substrate character and downcutting • Loss of nearshore vegetation and shading • Simplification of habitat structure due to removal of large wood, overhanging branches, and boulders • Reduced bluff and beach stabilization, and increased erosion due to vegetation removal	➢ Designate inventoried ghost shrimp stock areas as natural or conservancy shorelines ➢ Minimize displacement of beach area by pilings ➢ Prohibit grounding of floats and rafts on the beach ➢ Do not allow construction activity during egg deposition and incubation periods

Ecosystem Component	Threats & Pressures	Protections & Recommendations
Shellfish Areas	• Habitat loss and degradation • Urban land-use activities alter sediment loads and size that are of significant importance to shellfish settlement and growth • Chemical changes to the water column attributed to terrestrial (industrial) and aquatic (dinoflagellate and algal blooms) activities – directly affecting shellfish species and plankton (a major shellfish food source) • Over-harvesting • Introduced predator/parasite species	➢ Preserve forest cover near marine shorelines. Native vegetation and soils provide irreplaceable functions. Replant trees and amend soils in areas that have been cleared or damaged ➢ Preserve continuous riparian corridors with mature, native vegetation to protect and buffer streams, shorelines and other water bodies ➢ Limit impervious surfaces—such as rooftops, concrete and asphalt—that generate stormwater runoff. Wherever possible, disconnect these surfaces from pipes and other drainage systems and use alternative materials and approaches to reduce runoff and promote onsite infiltration ➢ Prevent pollution. Pollution is hard to control and expensive to clean up. Take care of onsite sewage systems and wastes from domestic animals, boats and other fecal sources ➢ Plan for protection. Determine land uses based on long-term protection and use of water resources. Use local planning tools to tailor development policies and standards to needs and conditions in different areas ➢ Use appropriate infrastructure. Try to avoid development densities that require use of large-scale sewer systems. Instead, aim to use low impact development principles and practices and decentralized wastewater approaches that support rural density land uses in shellfish watersheds

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