Fidalgo Bay Aquatic Reserve Management Plan

April 2019

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

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List of Acronyms

CSC	Citizen Stewardship Committee
Corps	U.S. Army Corps of Engineers
DNR	Washington State Department of Natural Resources
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
DVRP	DNR Derelict Vessel Removal Program
EPA	United States Environmental Protection Agency
MLLW	Mean Lower Low Water
NOAA	National Oceanographic and Atmospheric Administration
PSC	Puget SoundCorps
PSP	Puget Sound Partnership
QMH	Quartermaster Harbor
RCW	Revised Code of Washington
SVMP	DNR Submerged Vegetation Monitoring Program
SEPA	State Environmental Policy Act
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WSDA	Washington State Department of Agriculture

1. Executive Summary

The Fidalgo Bay Aquatic Reserve was established in 2000 as an environmental reserve to protect the unique habitats and species of the area. Fidalgo Bay is a shallow embayment supporting extensive mudflats and eelgrass beds southeast of Anacortes, Washington. As of 2019, the reserve includes approximately 780 acres of tidelands and bedlands. The Skagit Land Trust holds a conservation easement on ___ acres of the reserve.

This plan identifies conservation elements in the Fidalgo Bay Aquatic Reserve and management strategies implemented by the Washington State Department of Natural Resources (DNR) and partners. The intent of the plan is to conserve these resources with an emphasis on environmental protection above all other actions.

DNR will not approve new uses in the reserve with the exception of research and monitoring, restoration, environmental education, and public access, where consistent with the purpose and goals of the reserve. DNR management authority extends only to the state-owned aquatic lands; and therefore this plan does not apply to privately owned tidelands or upland property.

The following management goals are established for the Fidalgo Bay Aquatic Reserve:

1) **Natural functions and processes**: Protect, enhance and restore the natural functions and processes of nearshore ecosystems

2) **Native habitats and species**: Conserve and enhance native aquatic habitats and species with an emphasis on conservation priorities

3) **Monitoring and research**: Gather and assess ecological and human use information to support adaptive management decisions

4) **Environmental education, stewardship, and partnerships**: Promote stewardship of the aquatic reserve by facilitating environmental education and citizen science, strengthening community partnerships, and promoting public use

5) **Authorized uses**: Authorized uses on state-owned aquatic lands must be consistent with the aquatic reserve long-term vision and management goals and the conservation easement

The first management plan was prepared in 2008. Since management plans are intended to be reviewed and updated every ten years throughout the 90-year term of the reserve designation, the 2019 edition contained here is the first ten-year update for Fidalgo Bay. Changes in ecosystem condition and existing uses of state-owned aquatic lands since the establishment of the reserve are included in this update. The most current research and monitoring data will be used to evaluate how well management strategies are meeting the goals and objectives of the reserve. Through adaptive management, strategies will be modified and improved to best achieve the plan goals.

This updated plan draws upon existing data and other scientific information on the aquatic resources at the site, integrating a number of new studies and reports from the past ten years. An enthusiastic group of interested stakeholders, including local and state government, the Samish Indian Nation, the Swinomish Tribal Community, non-government organizations, local citizen scientists, and industry was convened in October 2018 to begin the update process. Their ideas regarding how to promote the conservation of aquatic resources and ecosystem health at the site helped develop and improve this plan update.

Figure 1: Great Blue Heron (Ron Holmes Photo)

2. Introduction

Washington's Department of Natural Resources

The Washington State Department of Natural Resources (DNR) Aquatic Resources Division manages about 2.6 million acres of state-owned aquatic lands. This includes 64,000 acres of tidelands, 32,000 acres of shorelands, and 2.46 million acres of marine and freshwater bedlands. In addition, there are approximately 13,000 acres of other aquatic lands, such as Harbor Areas, waterways and abandoned lands, that fall under DNR management.

DNR is directed by the Revised Code of Washington (RCW) to manage state-owned aquatic lands to provide a balance of public benefits that include encouraging public access, fostering water-dependent use and access, ensuring environmental protection, and utilizing renewable resources. In addition, DNR is directed to generate revenue from state-owned aquatic lands when it is consistent with the other public benefits. DNR manages the state's sensitive aquatic lands and when necessary, removes them from conflicting uses. As part of this authority, under Washington Administrative Code (WAC) 332-30-151, DNR can establish environmental, scientific, and education aquatic reserves on state-owned aquatic lands. The Fidalgo Bay Aquatic Reserve was established as an environmental aquatic reserve in 2000, and confirmed as a reserve candidate in 2003. This management plan update began in 2018 and was completed in early 2019.

Aquatic Reserves Program

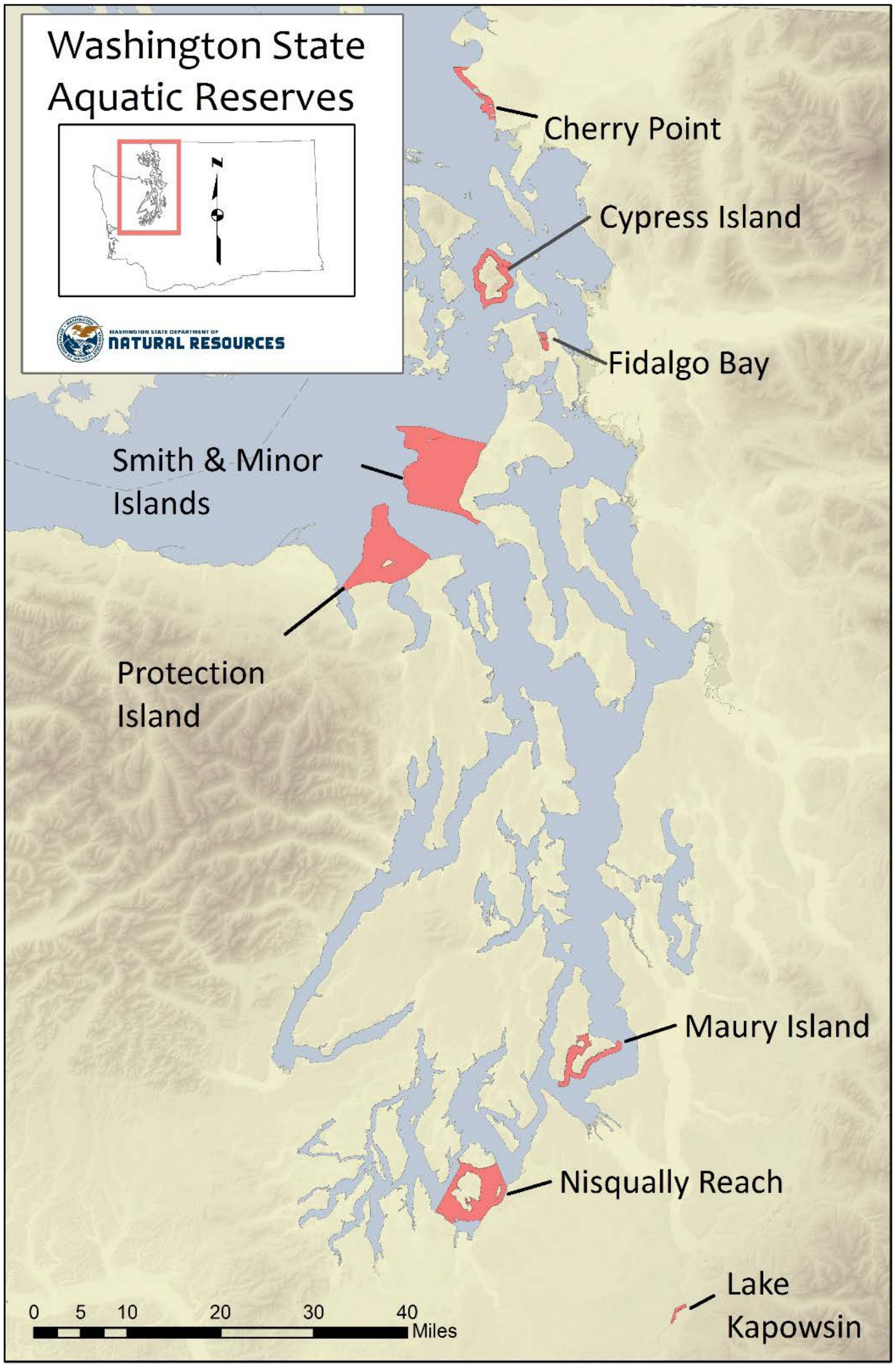
DNR established the Aquatic Reserves Program to promote preservation, restoration, and enhancement of important native ecosystems on state-owned aquatic lands.

The successful record of accomplishment demonstrated in Aquatic Reserve management helps ensure that reserves are proposed, reviewed and designated in a fair and transparent process, and conserve the most important aquatic resources.

Three types of aquatic reserves may be established through the Aquatic Reserves Program: environmental, scientific, or educational. The objectives for each reserve category can be found in the *Aquatic Reserve Program Implementation and Designation Guidance*, on DNR's webpage www.dnr.wa.gov.

DNR and its partners manage each reserve in a manner consistent with the goals for the type of reserve established and site-specific management plans.

Figure 2: Washington State Aquatic Reserves



Legal Authorities for Establishing State Aquatic Reserves

One of DNR's primary directives for the management of state-owned aquatic lands is RCW 79.105.030, which identifies environmental protection as the overarching goal of the Aquatic Reserves Program. WAC 332-30-151 directs DNR to consider lands with educational, scientific, and environmental values for aquatic reserve status, and identifies management guidelines for aquatic reserves. WAC 332-30-106(16) defines environmental reserves as sites of environmental importance, which are established for the continuance of environmental baseline monitoring and/or areas of historical, geological, or biological interest requiring special protective management. RCW 79.10.210 further authorizes DNR to identify and withdraw from all conflicting uses public lands that can be utilized for their natural ecological systems. DNR does not acquire properties to establish reserves; they are designated on existing state-owned aquatic lands or donated aquatic lands.

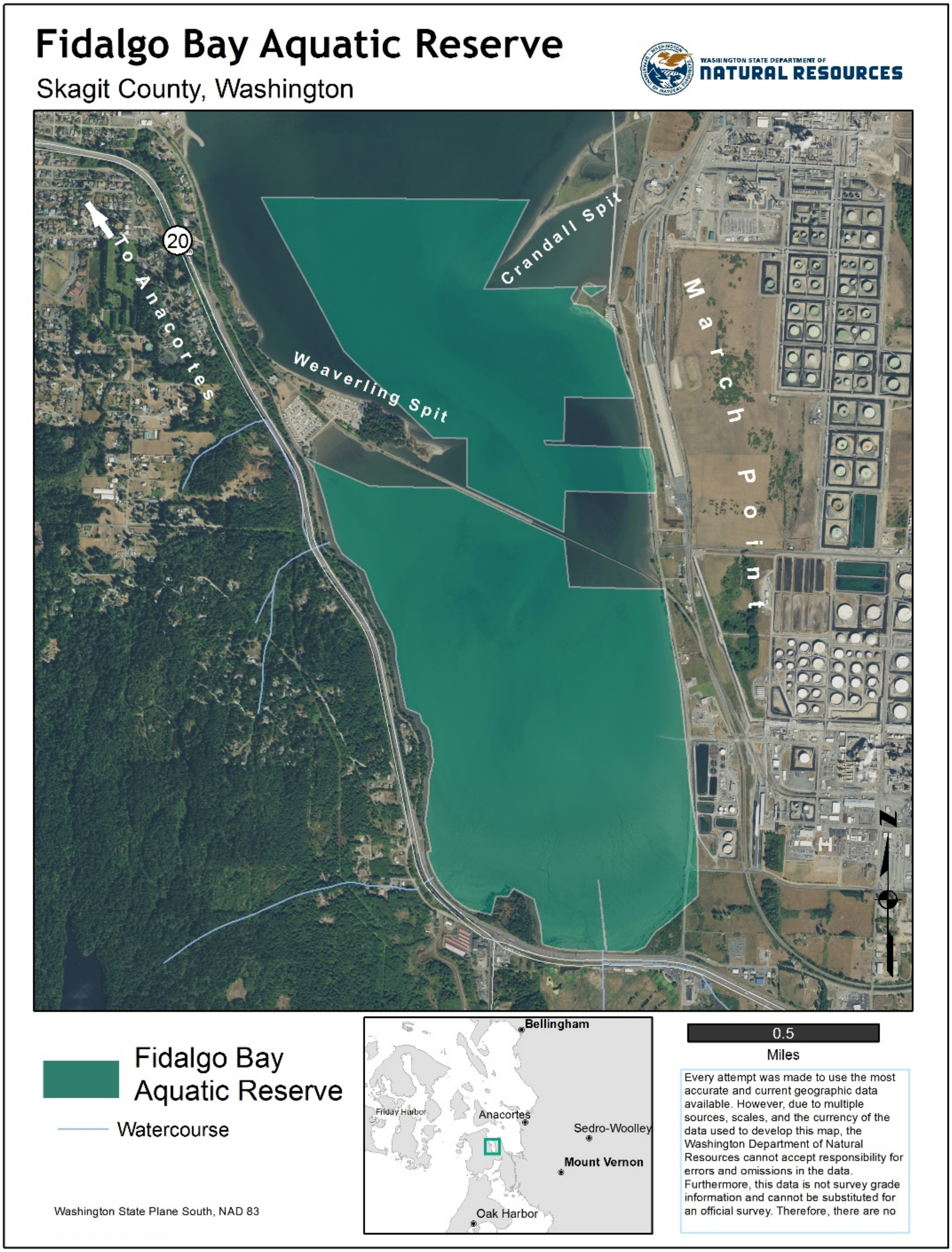
Fidalgo Bay Aquatic Reserve

The Fidalgo Bay Aquatic Reserve encompasses approximately 780 acres of state-owned tidelands and bedlands. The reserve boundaries extend from the southern end of Fidalgo Bay north to a line drawn east and west from Crandall Spit (Figure 3). The reserve was established to protect important conservation elements such as large eelgrass beds, forage fish spawning beaches, intertidal and important bird habitat. Section 3 of this document provides a thorough geographic, physical and biological description of the Fidalgo Bay Aquatic Reserve and details about the conservation elements.

Legal Boundaries

For a complete legal description of the Fidalgo Bay Aquatic Reserve boundaries please refer to Appendix D.

Figure 3. Fidalgo Bay Aquatic Reserve Boundary



Purpose of the Fidalgo Bay Aquatic Reserve Management Plan

This plan describes the habitats and species identified for conservation in the aquatic reserve and the actions that will be taken to protect these resources. The management emphasis will place protection of these resources as the highest priority. Community and regional interests and values are important for the long-term existence and support for the reserve and are recognized as essential elements of the plan as well.

The Fidalgo Bay Aquatic Reserve Management Plan has been developed in accordance with the State Environmental Policy Act. This plan will serve as DNR's primary management guidance for the 90-year term of the reserve. The plan lays out the goals, objectives and strategies for managing the reserve, and is updated every ten years to reflect current conditions.

Decision making and planning regarding management of the aquatic reserve will be guided by information and content contained in the following three sections of this plan:

- **Section 2: Ecosystem description, Human impact and Stressors:** This serves as an introduction to the site. Resource characteristics are identified and current ecological conditions are described for the site. Potential impacts and data gaps are also identified in this section.
- **Section 6: Management Guidance**: This section identifies the desired future ecological conditions. Goals and objectives are also identified that will aide in the site management decision making. Strategies are outlined for implementing the goals.
- **Section 7: Implementation Guidance**: This section introduces the process for ongoing decision making, local involvement and inclusion of a wide range of participants.

Plan Updates and Adaptive Management

This is the first update of the plan following adoption of the original management plan in 2008. Every ten years, the plan is reviewed and updated with current scientific, management, and site-specific information. During the development of each update, DNR works with partners and stakeholders to establish cooperative management for activities within and adjacent to the reserve. These activities will conserve, enhance and restore habitats and species within the reserve, and support public access and education.

DNR intends to manage the reserve using a process called Collaborative Adaptive Management[1]. This is a structured process of decision making in the face of uncertainty, with an aim to reduce uncertainty over time via system monitoring. Collaborative Adaptive Management helps DNR integrate changes in scientific knowledge concerning the site, conditions of habitats and species, and uses of state-owned aquatic lands. Knowledge gained from research and monitoring activities provides objective data about how well management actions are meeting goals and objectives for the reserve. This process improves site management through learning about the system, using results from data generated by DNR and local partners to evaluate management

[1] Williams, B. K., and E. D. Brown. 2012. Adaptive Management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

actions and develop new strategies. For instance, data on forage fish spawning sites can be used to evaluate whether restoration work is increasing egg survival or spawning areas are expanding. In the past ten years, significant studies were completed that provide science-based information to support management actions in the upcoming ten-year period. Monitoring is ongoing that will provide information about the effects, and success of various restoration projects that are completed or envisioned.

By establishing a stronger process to engage stakeholders and partners during the 2018-2019 management plan update, DNR will support the collaborative aspect of adaptive management. The management plan will be regularly updated, as needed, throughout the 90-year term of the reserve designation. DNR will include new scientific results in plan updates, and new inclusions and adaptations will not be restricted to every 10 years. Plan updates will be posted on the aquatic reserves webpage and emailed to the stakeholder group.

Fidalgo Bay Aquatic Reserve Important Conservation Elements

The Fidalgo Bay Aquatic Reserve is established to protect and conserve key elements of the natural environment and preserve valued ecosystem goods and services, which are listed below. Protecting, enhancing and restoring these elements will be the focus of conservation efforts and management actions in the reserve. Managing the complexity of this ecosystem and its many values to the community require a broad array of expertise that is reflected in the plan's emphasis on collaboration. We continually refer to the important conservation elements as we prioritize areas of focus for research, monitoring, and resulting actions.

Figure 4. Northern Pintail *(Ron Holmes Photo)*

Conservation Elements

Category	Conservation Element	Description
Physical Processes	Hydrologic processes	Freshwater inputs to the bay, tidal exchange, the amount of flushing, and other functions that are unimpeded by structures and modifications.
	Sediment movement	Critical functions of healthy nearshore habitat areas are supported by sediment drift cells on beaches with minimal armoring. Restoration is essential to maintain, enhance or restore natural functions and habitat.
Habitats and Communities	Submerged Aquatic Vegetation	Extensive native eelgrass beds (*Zostera marina*) provide complex structural and biological habitat for many species, including spawning, nursery, refuge, and foraging areas for juvenile and adult fishes and birds.
		Understory kelps, macroalgae and emergent saltmarsh vegetation support primary productivity and structural and biological habitat for spawning, nursery, and foraging juvenile and adult fishes, invertebrates, and birds.
	Tideflats, intertidal nearshore	The intertidal zone and large mudflats support diverse habitats for resting and foraging birds, juvenile fishes, crabs, numerous small crustaceans, and invertebrate species. It functions as a storm buffer, minimizing flooding and facilitating water absorption; water temperatures warm earlier and retain heat; detritus, carbon, nutrients are retained; and contaminants are taken up.
	Beaches that support spawning habitat	Shorelines with upper intertidal areas of mixed sand, and fine gravels, particularly depositional features such as the spits, provide critical habitat for forage fish spawning and foraging birds.
Species	Surf smelt and Pacific sand lance	Forage fish provide a food source for many seabirds, salmon, and marine mammals. Surf smelt are the most prevalent species of forage fish in the bay and spawn year-round. Spawning is prolific on beaches north of the trestle with a well-documented climax in the summer.
	Pacific herring	Although, spawning has declined precipitously in recent years in Fidalgo Bay and throughout the region, broad year-to-year fluctuations are typical of Pacific herring. Preserving and optimizing available spawning habitat areas continues to be a priority in the reserve.
	Juvenile salmonids	The reserve provides refuge and forage areas for juvenile salmon. Coho salmon, Chinook salmon, and Chum Salmon utilize the bay as migratory corridors and rearing area.

Category	**Conservation Element**	**Description**
	Waterbirds[2]	The reserve is an important wintering and migratory waterbird area, providing shallow protected waters and foraging areas. Seasonal and migratory waterbirds include geese, grebes, loons, scoters, diving and dabbling ducks, terns and gulls. Resident birds include Great Blue Heron, Bald Eagle, Osprey, and several species of cormorant.
	Olympia oysters	Native Olympia oysters are thriving in Fidalgo Bay following a series of ongoing re-introductions. Oysters provide many ecosystem services including 3-dimensional structural habitat, increased biodiversity, local harvest of cultured or wild food, and as filter feeders, maintaining or improving water quality.
Valued Cultural Features	Public values for Tommy Thompson Trail	The everyday value and use of the trail is integrated into community life as a cornerstone recreational and transportation feature. The trail provides access, fosters nature education, and enjoyment of Fidalgo Bay with unimpeded views of the surrounding aquatic reserve.
	Weaverling Spit	The Samish Nation is committed to maintaining the cultural, historical and ecological benefits and opportunities provided by Weaverling Spit. Inclusive community use and public benefit is promoted through scientific, educational, and recreational activities. This centrally located feature is a cornerstone value for the community and aquatic reserve.
	Traditional uses – shellfish harvest	Shellfish resources are a valued traditional food source for local native tribal communities. A healthy, tribally controlled harvest of shellfish in parts of the bay can assure the sustainability of shellfish resources. Continued monitoring and possibly enhancement will aid in maintaining a viable population in the bay.
	Aesthetics - Scenic Beauty	Public access to water views, wildlife, and restored shorelines that recognizes and emphasizes the importance of scenic beauty.

[2] Waterbirds. For this plan, the term *waterbird* is used to describe birds that occupy and use shallow inland marine bays and salt marsh habitats. These include marine diving ducks and alcids, shorebirds of all kinds, dabbling ducks, gulls, and brants geese.

Relationship to Federal, State, Local, and Tribal Management

The successful management of the Fidalgo Bay aquatic reserve requires coordination and collaboration with public and private entities as well as local, state, federal, and Tribal government, and non-government organizations. The following provides information regarding ongoing management interests at or near Fidalgo Bay.

Tribal Interests at Fidalgo Bay

The following Tribes have asserted a claim to usual and accustomed areas in Fidalgo Bay:

1. Lummi Nation
2. Nooksack Indian Tribe
3. Suquamish Tribe
4. Tulalip Tribes
5. Swinomish Indian Tribal Community

In addition, the Samish Indian Nation owns 40 acres of tidelands and 30 acres of upland properties on Weaverling Spit. The Samish Nation has historic and cultural ties to Fidalgo Bay and the surrounding area and has expressed a strong interest in restoration of forage fish spawning habitat, improving water quality, restoration of native shellfish populations and restoration of natural shoreline processes in Fidalgo Bay.

The Swinomish Indian Tribal Community owns 26 acres of tidelands adjacent to the eastern shore of the reserve and March Point Road. This community also has historic and cultural ties to Fidalgo Bay, March Point, and the surrounding area. The Swinomish Tribe has completed several nearshore restoration projects in and around Fidalgo Bay.

Conservation goals and management activities identified in this management plan are not meant to conflict with Tribal treaty, natural resource, or cultural interests. DNR will continue to engage in a government-to-government dialog with the Tribes to ensure that treaty rights are upheld, and that historical and cultural ties to Fidalgo Bay are maintained.

Washington Department of Fish and Wildlife

The Department of Fish and Wildlife (WDFW) is dedicated to preserving, protecting, and perpetuating the state's fish, wildlife, and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities. The agency has primary responsibility for regulating fishing and hunting including within aquatic reserves. WDFW staff are key partners in research projects on aquatic reserves, and DNR shares essential monitoring data with WDFW.

Washington Department of Ecology

The mission of the Department of Ecology is to protect, preserve, and enhance the environment for current and future generations. The agency is responsible for regulating air, water, and sediment quality, toxic waste, and spill prevention and response. Ecology has also played a lead role in shoreline and intertidal cleanup in and near Anacortes, with adjacent benefit to the reserve.

Padilla Bay National Estuarine Research Reserve

The Padilla Bay National Estuarine Research Reserve was designated in 1980 and is located approximately 3 miles east of Fidalgo Bay Aquatic Reserve. It is one of 27 reserves in the National Estuarine Research Reserve System, established to provide for research and education about estuaries around the coastal United States and Puerto Rico. The Padilla Bay Reserve offers educational programs for school groups and the general public, monitors natural resources and promotes research in Padilla Bay. Volunteer and professional training that benefits Fidalgo Bay is often held at the Padilla Bay facility. The National Estuarine Research Reserve program is a jointly administered federal and state program, under the U.S. Department of Commerce, N.O.A.A., Office of Coastal Resource Management, Estuarine Reserves Division. The Reserve is managed by the Washington State Department of Ecology.

The Padilla Bay Reserve encompasses 11,000 acres, 7,500 of which are eelgrass meadows, important nursery areas for juvenile fish and crab, as well as feeding areas for migratory shorebirds and waterfowl, such as the black brant goose. Padilla Bay itself is considered an "orphaned" estuary, cut off from its major freshwater sources by conversion of salt marshes to agricultural land in the late 1800s and early 1900s. Many of the shore birds and waterfowl known to occur in Padilla Bay also can be found in Fidalgo Bay. In addition, the close proximity between Fidalgo Bay and Padilla Bay provides good habitat connectivity for several species of out-migrating juvenile salmonids.

Cypress Island Aquatic Reserve

DNR established the Cypress Island Aquatic Reserve in 2000 and adopted a management plan for this site in 2007. The reserve is located about 6 miles northwest of Fidalgo Bay Aquatic Reserve in the extreme northwest corner of Skagit County. The site contains a diverse assemblage of habitats and species including; rocky reefs, eelgrass and kelp beds, pocket beaches, rocky shorelines, abalone, sea urchins, scallops, sea cucumbers, crabs, reef dwelling and demersal ground fish, salmon and forage fish.

The close proximity of the Cypress Island Aquatic Reserve to the Fidalgo Bay Aquatic Reserve may provide some level of habitat connectivity for those species that are found at both sites, such as forage fish, salmon, crabs and marine birds.

Hat Island NRCA

Hat Island Natural Resource Conservation Area (NRCA) is one of the eastern most islands in the San Juan group, located about 2.5 miles northeast of the Fidalgo Bay aquatic reserve. The 91-acre island contains Douglas-fir, Pacific madrone and Pacific yew dominant forests, and grass headlands composed of blue wild rye, red fescue, camas and clover. The conservation area provides habitat for bald eagles, sea and shore birds. The island is located in the Padilla Bay National Estuarine Research Reserve and provides research and education opportunities.

Local Land Use Designations

Most of the Fidalgo Bay Aquatic Reserve shoreline is located within the Anacortes city limits or the urban growth area of Anacortes. Land use zoning and designations, and potential impacts are covered in Section 4 - Current Uses and Stewardship (see Zoning and Land Use Changes). DNR will work with the local governments and Tribes to address those impacts through shoreline master plan development and other mechanisms.

Figure 6. Fidalgo Bay, foraging Great Blue Herons, and Hat Island in background

3. Ecosystem Description, Human Impacts and Stressors

This section describes the key elements of ecosystems and habitats of the Fidalgo Bay Aquatic Reserve, and potential impacts and stressors to those systems. For a more detailed description of the ecosystem elements and potential stressors, see Appendix A.

I. Ecosystem Description

Geographic Context

Fidalgo Bay is a U-shaped shallow embayment located immediately south and east of downtown Anacortes, Washington in Skagit County (see Figure 3). The bay occupies an ancient delta of the Skagit River consisting of shallow mudflats that drop off steeply into deeper water from Cap Sante Head, adjacent to Anacortes. Gravel and sand spits form prominent features on both sides of the bay. Weaverling Spit is the distinctive feature protruding eastward from the western shoreline, while the large projection of Crandall Spit and to a lesser degree, Little Crandall Spit extend westward into the bay from the eastern shoreline of the March Point peninsula. A small embayment tucks into the southeasterly end of Crandall Spit. Highway 20 flanks the southern portion of the reserve and continues northward parallel to the bay, separating the steeply sloped western uplands from the reserve area. Along the eastern boundary of the reserve two large petroleum refineries occupy most of the upland area of the March Point peninsula.

Physical Description

Fidalgo Bay undergoes a regular mixed semi-diurnal tidal cycle with two low tides and two high tides of different elevations each day, with an average range between low and highs of 1.5 meters. The bay experiences moderate tidal currents with various wave regimes (National Ocean Survey Tide Tables 1980). Shallow depths and large tidal ranges drive water movement in the adjoining Guemes Channel and entrance to Fidalgo Bay vicinity. The bay is open to southerly and northerly winds but greater wave heights occur when the northerly winds combine with the larger northern fetch distance. Fidalgo Bay is well-mixed vertically with temperatures, salinity and dissolved oxygen measurements similar to regional values (Antrim et al. 2003).

No major freshwater streams flow into the Fidalgo Bay Aquatic Reserve area. However, just south of Anacortes Marina, Ace of Hearts Creek flows down from Heart Lake and maintains minimal year-round flow into the bay. Surface runoff and overland flow, with a few small intermittent creeks, and outfalls are the predominant fresh water sources during the rainy season. Direct seepage around the bay is likely the major freshwater contributor during low precipitation periods (City of Anacortes 2000).

The shoreline around the bay has been modified extensively by fill and armoring. The most notable feature crossing the bay is the late 1800s revetment/causeway and railroad trestle, since converted to a multiple use trail. These features have greatly altered water and sediment movement in the bay by filling small embayments and saltmarsh areas with sediments, eliminating backshore vegetation, and cutting-off or drastically reducing the flow of upland sediment to beaches and nearshore areas (Appendix C, map C-6). These conditions have resulted in a sediment-starved intertidal zone and significant coarsening of substrate on the upper beach faces (Johannessen 2007).

Extensive intertidal mixed fine/mud flats occupy nearly all the tidal area south of the railroad trestle (Appendix C, map C-5). The area north of the trestle contains intertidal beaches, lower intertidal and shallow subtidal flats, and deeper subtidal areas including a maintained channel of about 4 meters below mean lower low water (MLLW) (City of Anacortes 2000).

Habitat Characteristics

The aquatic reserve area contains diverse physical habitats that include tidal flats, salt marshes, lagoons, sand and gravel beaches, and expansive native eelgrass beds. These habitat areas provide essential benefits to the reproductive, foraging, and rearing success of many fish, bird, and invertebrate species in the reserve.

Intertidal substrates in the bay include mud, an assortment of mixed fine sediments, organic-based soil, as well as mixed sand and gravel beaches (Appendix C, map C-4). Limited areas of bedrock and artificially hardened shorelines encroach from a narrow backshore zone onto the beaches. In salt marshes, organic soils mixed with sand, silt and clay are the more prevalent substrates. Lower intertidal beaches, tidal flats and the shallow subtidal inner bay are generally composed of mixed fine sediment including clays, silts and fine sands. Deeper subtidal areas include muddy bottoms with varying amounts of sand, gravel or cobble substrate, with a few areas of hard bottom, that are both natural and man-made (City of Anacortes 1999).

Figure 8. Native eelgrass and *Ulva* species (*Aaron Baarna)*

Eelgrass (*Zostera marina*) covers a significant portion of the lower intertidal and shallow subtidal areas in the reserve. The majority of the eelgrass area in the reserve is north of the trestle and remains stable. In the southern part of the reserve, eelgrass is less robust with more limited depth distribution and diminished coverage. Since 2008, this portion of the reserve has experienced a significant decline. Between 2008 -2018, the DNR Submerged Vegetation Monitoring Program (SVMP) analysis showed significant losses in an area south of the revetment, but west of the trestle (Appendix A, figure A-1; DNR-Nearshore Habitat Program SVMP 2019).

Non-canopy forming kelp mixed with other macroalgae (seaweed) are common in many lower intertidal and shallow subtidal areas in the bay. These may be occasionally intermingled with eelgrass. During the winter months, several species of seaweed, especially red algae (*Gracilaria* spp.), may intermix with or exist adjacent to eelgrass. Both eelgrass and red macroalgae are the most common substrate for herring spawn deposition in Fidalgo Bay. Macroalgae is also considered a key habitat component of the bay (Pentec 1994) and, like eelgrass, provides critical habitat for many invertebrates and fishes.

Saltmarsh vegetation, dominated by pickleweed (*Salicornia virginica*) and saltgrass (*Distichilus spicata*) can be found intermittently fringing the shoreline including the spits. Along with the fringing marsh plants in the southern end of the bay, bulrush species (*Schoenoplectus* spp.), expand into the mudflats often topping isolated eroding mounds that are patchy, but distinctive features at slightly lower tidal elevations.

Spit/berm vegetation and habitat areas are present along the upper beach face of Crandall and Weaverling spits and in narrow margins or constrained backshore zones around southern portions of the bay. Subjected to salt spray and infrequent inundation, this unique splash zone habitat type promotes a different plant community including dune grass (*Leymus mollis*), gumweed (*Grindellia integrifolia*), yarrow (*Achillea* sp.), and silver burweed (*Ambrosia chamissonis).*

Fish and Wildlife Resources

Despite alteration in the associated uplands, much of the aquatic lands within the reserve support habitat for numerous fishes, migratory and resident birds, and marine invertebrates. Extensive aquatic vegetation, diverse substrates and sufficient ecosystem functions within the upland-marine interface provide for these productive habitat areas.

In neighboring Padilla Bay to the east and nearby waters, at least 57 species of fish have been identified (UDC 1980). Many of these species are likely to use nearby Fidalgo Bay, with its similar habitat. Appendix A, Table 1 provides a current list of species observed in Fidalgo Bay.

Fidalgo Bay's large tidal flats and pocket estuary habitat contain productive eelgrass and macroalgae beds (Appendix C, map C-7). These in turn provide important structure and prey resources for juvenile salmonids, for example harpacticoids, copepods, and amphipods. Juvenile chum salmon (*Oncorhynchus keta*) and Chinook salmon (*O. tshawytscha*) are known to occur in Fidalgo Bay during spring out-migrations (Beamer et al. 2006). These are likely Skagit and Samish River-derived stocks. No published information exists on the occurrence of bull trout (*Salvelinus confluentus*) in Fidalgo Bay, however the area is located in the proposed critical habitat for coastal bull trout (Federal Register 2005b).

Forage fish are small, prolific species of fish that constitute a major portion of the diets of salmonids and other fishes, seabirds, and marine mammals. Three species of forage fish—Pacific herring (*Clupea pallasi*), surf smelt (*Hypomesus pretiousus*) and Pacific sand lance (*Ammodytes personatus*)—use intertidal beaches and shallow subtidal areas in Fidalgo Bay for spawning habitat. Extensive surveying for forage fish spawning beaches in the reserve area has found that surf smelt spawning occurs year round. In particular, surf smelt spawn prolifically and almost everywhere on beaches north of the trestle. Adult herring are reported to congregate outside the bay in the area to the east of Guemes and Hat Islands (WDFW 2019), before periodic migrations into Fidalgo Bay for spawning (Appendix A, map C-10). Herring larvae are present in the south bay after hatching, and after the first summer they likely vacate the immediate area to grow and mature (D. Penttila, WDFW, personal communication, 2007). Throughout the 1990's and earlier, herring spawn had been found wherever eelgrass existed in the bay, even in areas where eelgrass is distributed only sparsely (Penttila 1995). Once considered a medium-sized northern herring stock, the Fidalgo Bay stock has decreased substantially since 2001. The stock is now considered in Critical status (WDFW 2018). Because of uncertainty regarding factors limiting the Fidalgo Bay herring population, WDFW considers the status of this stock of particular interest (WDFW 2018). More details can be found in Appendix A.

Figure 10: Pacific herring (Oregon Coast Aquarium)

Marine flatfish such as starry flounder (*Platichthys stellatus*), rock sole (*Pleuronectes bilineatus*), English sole (*Pleuronectes vetulus*), and sand sole (*Psettichthys melanostictus*) typically use the mudflats and shallow embayments found in Fidalgo Bay. Most of these species may remain nearshore even as adults (L. LaClair, WDFW, personal communication, 2019).

Fidalgo Bay provides foraging and resting grounds for many resident and migratory shorebirds, sea ducks and waterfowl (collectively "waterbirds"). Of the 239 bird species known to use Fidalgo Bay as well as Padilla and Samish bays to the east, birds of interest include black brant, cormorants, peregrine falcons, and bald eagles, as well as many shorebirds, dabbling and diving ducks (See list of observed species, Appendix B Table B-1). In addition, a large Great Blue Heron rookery is located on the southeast side of March Point and birds from this rookery regularly feed in Fidalgo Bay (Antrim et al. 2003; Eissinger 2007). The diverse and abundant bird use is primarily due to the bay's location within the Pacific flyway. Several species known to use this area meet the listing criteria for State Endangered, Threatened, or Sensitive Species: the Western Grebe (*Aechmophorus occidentalis*),Common Loon (*Gavia immer*) and Brandt's Cormorant (*Phalacrocorax penicillatus*), Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*), Great Blue Heron (*Ardea herodias*), Osprey (*Pandion haliaetus*), Common Murre (*Uria aalge*), and Marbled Murrelet (*Brachyramphus marmoratus*). Other at risk species found in the Fidalgo Bay Aquatic Reserve include the Purple Martin (*Progne subis*), and Vaux's Swift (*Chaetura vauxi*).

Invertebrates, such as marine worms, snails, clams, crabs, shrimp and other crustaceans provide vital links in the Fidalgo Bay food chain. Many of these invertebrates are primary consumers and support local populations of birds, fishes and mammals. For a list of other marine invertebrates found in the bay, see Appendix B.

Figure 11. Common loon *(Ron Holmes photo)*

While no harbor seal haul-out sites are located within the reserve, several are located nearby (Jefferies 2000). Seals regularly forage in the bay. River otters (*Lontra Canadensis*), raccoons (*Procyon lotor*), mink (*Mustela vison*) and Columbia black tailed deer (*Odocoileus hemionus columbianus*) are known to forage along the shoreline and within the southern portion of the bay (T. Woodard, Samish Indian Nation, personal communication 2019).

II. Human Impacts and Ecosystem Stressors

Various forces, both natural and human-caused, may impact the creatures, habitats and ecosystems of Fidalgo Bay. These can be grouped into two categories: Large-scale or societal forces driving observed and future changes and the actual physical or biological stressors affecting organisms and systems. When combined, these can profoundly impact ecosystem health.

Potential drivers of future changes

Multiple human-derived pressures may contribute to (or "drive") future changes that could affect the reserve's species, habitats and ecosystems. In particular, human *population increase* and *climate change* are expected to drive future changes substantially. Understanding these drivers can help managers anticipate and plan more carefully, preparing for possible contingencies. Each potential driver is described below.

Regional and Local Population Increase

Population growth both regionally and locally will continue to influence the degree of use and environmental quality within the reserve. According to the Office of State Procurement, Washington has been gaining about 1,000,000 people per decade, and Skagit County is projected to gain nearly 17,000 people between 2020 and 2030 under a moderate growth scenario (Office of Financial Management 2018) There were about 16,600 people living in the City of Anacortes in 2010 (OFM 2018).

This rapid growth is the main focus of anticipated future impacts to the aquatic reserve. Expanding growth will contribute to a suite of potential impacts through ground water withdrawals, increased impervious surface area and associated runoff, increased sewage, and greater overall impacts to local infrastructure, including recreational areas. These changes could also affect habitat of upland species that utilize the reserve.

Many existing programs, zoning laws, and shoreline designations, however will likely mitigate potential impacts of population growth. For instance, shoreline land uses are controlled by the City of Anacortes and Skagit County's Shoreline Master Programs (SMP). The City's SMP Environment Designation of "Conservancy" adjacent to most of the reserve, as well as existing land elevation and slope constraints limit further upland build-out in areas surrounding the southern portion of the bay. Additionally, annual updates to the City's Stormwater Management Plan provide a check and review to help accommodate and mitigate for proposed expansion and land use changes. For example, the WSDOT's recent stormwater bio-swales on Highway 20 at the Sharpe's Corner round-about provide mitigating filtration for stormwater, which would otherwise enter the bay untreated.

Climate Change

Physical, biological and chemical changes to the marine environment associated with climate change will intensify naturally occurring events and conditions and in Fidalgo Bay. Current trends in climate change may contribute to the following ongoing fluctuations in ocean conditions (Snover 2013), all of which could have an impact on existing physical and biological resilience in the aquatic reserve area:

- Sea level rise and storm surge will inundate low-lying areas adjacent to the reserve.
- Sea level rise will further submerge current subtidal and intertidal habitat areas, having the potential to adversely affect fish and wildlife resources and associated habitat.
- Rising water temperatures create additional stressors on marine organisms.
- Lower dissolved oxygen concentrations, related to increases in water temperature, create additional stressors for fish and at extreme levels can be fatal.
- More frequent and heavy precipitation events can contribute more pollutants and alter water chemistry.
- Eutrophication from increased nutrient loading can intensify the impacts of decreased pH and low dissolved oxygen.
- Ocean acidification can make it difficult for calcifying organisms, such as Olympia oysters and other shellfish to produce shell. It can also affect biological processes such as bio-sensory functions in salmon and forage fish, inhibiting their ability to locate natal areas, food sources, and to detect predators.

Sea-level rise due to human-caused climate change is predicted to increase in the Puget Sound Region. In the Fidalgo Bay area, based on the "most likely to occur" scenario over a 10-year period from 2020 - 2030, sea level is projected to rise from 2.4 – 5.9 inches (61- 150mm) (Miller et al. 2018). A more detailed summary table is included in Appendix A, Table 1 and includes two additional time periods, two greenhouse gas emission scenarios, and a range of probabilities for more extreme estimates.

Compounding the effects of sea-level rise, increasing storm intensity and frequency will also produce greater wave energy, more wave run-up, more extreme storm surges, and potential rises in groundwater levels (Grossman et al. 2018). These combined effects will cause erosion and alterations to the shoreline and the physical structure in the bay.

Since Fidalgo Bay is a relatively narrow, confined, "U-shaped" bay, it is more vulnerable to the impacts of increased storm intensity and frequency. Effects of this physiographic constriction can include greater availability and exposure time to beach habitat areas, which can result in altered substrate composition, increased scour, changing nearshore bathymetry, burial of submerged aquatic vegetation or reduction in light availability, and potential damage or destruction of adjacent infrastructure and upland vegetation.

The extensive armoring and physical location of infrastructure in and adjacent to Fidalgo Bay may intensify effects and limit opportunities to buffer the impacts described above. Such armoring includes transportation infrastructure surrounding the reserve on three sides (State Highway 20, March's Point Road, and Fidalgo Bay Road), development along the City of Anacortes shoreline, the southern portion of Samish Nation RV Park on Weaverling Spit, and two refineries on March Point.

Spills of Toxic Substances

Given the proximity of the reserve to a major state highway, an active railroad, two large petroleum refineries, bulk fuel loading docks in the bay, a petroleum pipeline, marinas and various maritime shipbuilding industries, future spills of toxic substances may affect the bay. In 1991 over 23,500 gallons (560 barrels) of crude oil was spilled into the bay from the Texaco refinery, entering the east shore of the bay through an industrial stormwater pipe not far from the trestle. Oil fowled many birds, beaches, salt marsh and intertidal habitat areas along the southeast shore. A cleanup and subsequent natural damages settlement funded the purchase of tideland properties, beach enhancement and restoration actions along the eastern shoreline. Depending on the size and magnitude of a spill, considerable resources may be required and ecosystem recovery can take months, years or decades. The Department of Ecology is responsible for creating and maintaining Geographic Response Plans (GRP) for initial spill response at marine and inland waters. Each GRP specifies actions and prioritizes locations to protect first. Currently, the North Puget Sound GRP from 2011 covering Fidalgo Bay is in the process of being updated.

Change in Land Uses

Changes in adjacent upland ownership or future land uses could also affect the bay. For example, if substantial changes were made to industrial, residential, or open space designations near the reserve, it could affect the levels of risk associated with water quality degradation or potential toxic spills. If residential ownership were to increase near the bay it could also spark more interest in how the reserve is managed, or create additional demand for public access to the reserve. However, any such changes will be guided by requirements of Washington's Growth Management and Shoreline Management Acts, involving ample public input (See section 3, Zoning and Land Use Designations). Additionally, the scale of current transportation infrastructure immediately adjacent to the bay may logically restrict future changes to shoreline uses.

Increased Recreational Use

Anacortes and nearby waters will continue to see increased recreational boat traffic—supported by continued demand for boating, favorable docking and mooring sites along with the close proximity to the San Juan Islands and other desirable destinations. Additional boating use in the bay may increase the likelihood of impacts such as chronic lubricant and fuel leakage, marine debris, increased boat wake activity, propeller scour, physical disturbance to wildlife, impacts from pet and human waste, and increased shading of aquatic vegetation from boat moorages and overwater structures.

Greater recreational use of public access sites, including the Tommy Thompson Trail and the Fidalgo Bay Resort, could adversely impact habitat and wildlife resources through increased physical disturbance. Additional pressure to biological resources from fishing, crabbing, clamming may exacerbate existing issues of poaching and perceived overharvest.

Ongoing educational programs and existing signage that fosters public awareness and stewardship of natural resources and the ecological values of Fidalgo Bay will help build support for policies and actions protecting the bay, and will help mitigate potential effects of overuse.

Environmental Restoration

Removing creosote pilings, especially the hundreds of supports for the Tommy Thompson Trestle, would eliminate a source of contaminants and improve long-term sediment and water quality. Replacing the trestle and associated causeway (figure 9) with a more flow-friendly design could restore natural current, wave, and sediment movements that have been altered for more than 130 years. Restoring beaches, salt marsh habitat and adjacent riparian areas could provide greater spawning opportunity for forage fish, and improved foraging activity for juvenile salmonids and other wildlife in the bay area. The Fidalgo Bay Causeway Feasibility Study Report (Ridolfi 2008) was prepared for the Sammish Indian Nation to provide preliminary information and options for removing the causeway and trestle. Additionally, the Samish Indian Nation has conducted a Fidalgo Bay Salt Marsh Restoration Feasibility Study (Ridolfi 2014) examining options for restoring beach and salt marsh habitat on private tidelands just south of the Fidalgo Bay Resort.

Figure 13. Creosote pilings support the Tommy Thompson recreational trail across the bay. View looking west. *(DNR Photo)*

Land Conservation and Protection

Additional aquatic land parcels could be added to the reserve in the future, expanding the management boundary. This could include either private tidelands donated to DNR, or state owned bedlands to the north of the reserve. Also, protection or restoration of upland parcels could influence freshwater inputs (i.e. enhanced water quality) to the bay. Tree planting and restoration of shoreline riparian areas could provide shading and nutrients to improve poorly functioning nearshore areas. Recently the Skagit Land Trust purchased a one-quarter acre residential property with 200 feet of shoreline on the southwest shore of the bay. The upland structures have been removed and restoration of riparian vegetation is ongoing.

Ecosystem stressors

The larger scale drivers affecting change discussed above contribute to the level of stress experienced by the organisms, habitats and ecosystems of the bay. A number of ecosystem stressors and potential future impacts have been identified in Fidalgo Bay, which may affect the health of the reserve. The term *ecosystem stressor* refers to any condition or agent causing a potential stress response or impact to the ecosystem, whether abiotic or biotic. Knowledge of the stressors affecting reserve ecosystems can help managers anticipate, alleviate and avoid further impacts through management actions. Additional details on each stressor can be found in Appendix A.

Shoreline modifications & habitat loss

Shoreline modifications, including filling of historic backshore, saltmarsh and upper intertidal areas, shoreline armoring, overwater structures, and loss of shoreline riparian vegetation, are the primary contributors to altered physical processes and the reduction of critical habitat in the bay. Historically, Fidalgo Bay was connected to the north end of Similk Bay and at high tide could support shallow vessel traffic. In the late 1800s, the area between the two bays was diked and drained to create farmland. This action permanently eliminated estuarine habitat, cutting off the natural flow of sediments to the bay and subsequently leading to greater siltation in the south end of Fidalgo Bay. Around 1930 the construction of a golf course further filled, drained and altered original wetland habitat in the area.

A detailed analysis of armoring in the bay by Antrim et al. in 2003, showed dramatic continual erosion to Crandall Spit, substrate coarsening on beach faces, loss of substrate elevation along armored shoreline, as well as a two to four feet of sediments deposited and gained in areas south of the trestle (Antrim et al. 2003; Williams et al. 2003). The rate of erosion at Crandall Spit over the last 16 years has not been quantified.

Intertidal and shallow subtidal habitats available for native hardshell clams have been reduced or eliminated in some areas by shoreline fill or alterations to the substrate. Fill and armoring have also buried or “squeezed” upper intertidal areas on beaches throughout the bay, restricting habitat availability for beach spawning forage fish and foraging birds. The compounded loss of shoreline vegetation reduces food resources and availability for juvenile salmonids, and can exacerbate forage fish egg mortality due to desiccation from sun exposure.

Habitat impacts from armoring are beginning to be addressed through beach enhancement and other restoration techniques, detailed in Section 4 and Appendix A.

Overwater and In-water Structures

Historic losses of eelgrass, including herring spawning habitat have occurred in Fidalgo Bay. Some of this loss is a direct impact from dredging in the bay and the filling adjacent shoreline areas (Williams et al. 2003). Smaller areas of eelgrass and macroalgae have been eliminated by shading from overwater structures such as the March Point piers and the railroad trestle/revetment (Penttila, 19xx). Additionally, the barriers to circulation created by the trestle and later, the extensive riprap revetment have substantially decreased water and sediment flow rates for more than 100 years in the south portion of the bay, leading to increased turbidity (reduced water clarity) and fine sediment deposition. Major losses of eelgrass directly south of the revetment have recently been documented between 2009 -2016 (DNR Nearshore Habitat Program 2019), potentially related to sediment deposition.

Figure 15. Damage to the causeway revetment from storm surge *(DNR photo)*

Sediment and Water Quality Impacts

Slightly northwest of the aquatic reserve, historical industrialization of the shoreline has contributed to the degradation of local sediment and water quality through deposition of wood waste and industrial debris (Penttila 1995). However, many of these contaminated sediment areas have now been cleaned up or mitigated.

The Washington Department of Ecology’s (Ecology) Toxic Cleanup Program undertook a major cleanup of sites in Fidalgo Bay between 2007 and 2013. The site closest to the reserve is known as the Custom Plywood Mill site. For over 100 years, this site hosted wood mill operations producing at various times lumber, boxes, wooden pipes, shingles and plywood until it burned down in 1992. The dilapidated mill structure partially constructed of creosote pilings built out over the bay, coupled with the massive amounts of unconfined sawdust, burned and other wood waste at the site was considered the largest contributor to contaminants found in the bay (source). Large portions of nearshore areas in close proximity to the northwestern reserve boundary were affected by toxic contaminants. In the last 10 years, most of the wood waste and contaminants have now been cleaned up, with the remaining contaminated substrate to be permanently capped in 2019.

Recently, through participation in the WDFW’s Mussel Watch Program, data on mussel ingestion of waterborne contaminants in the reserve showed comparatively low concentrations of

PAHs, metals, and other contaminants. In 2012-13, the two sample sites in or adjacent to the aquatic reserve were at Weaverling Spit and the northern end of March Point; both sites tested consistently low for PAHs. Sampling in 2014-15 and 2017-18 only occurred at the Weaverling Spit site and was consistent with findings from 2013 showing low levels of PAHs with the sources identified as pyrogenic (burning of fossil fuels and other non-point sources from the air), not petrogenic (direct contact with petroleum product). During the three winters of sampling from 2013 - 2018, approximately 150 separate chemicals were analyzed, with the Weaverling Spit site testing as “pretty clean” for all contaminants (J. Lanksbury, WDFW, personal communication, 2019). This finding is of interest due to the presence of nearby refineries and previous oil spills in the bay. Although several documented oil spill incidents have occurred in the bay over the past several decades, according to the Mussel Watch data analysis, the current primary source of PAH compounds is attributed to atmospheric deposition from combustion sources rather than oil spills in the area (J. Lanksbury, WDFW, personal communication, 2019).

Creosote is also included as a “pyrogenic source” of PAH contaminants. There are hundreds of creosoted pilings in the substructure of the trestle (figure 9). Creosote leaches into the surrounding substrate, and higher levels of PAHs have been found in the sediment around the pilings (Ridolfi 2008).

The overall sediment quality of the area managed by DNR appears to be relatively clean but varies with the diversity in grain size. Prior studies (source) in the area have determined that, with the exception of the PAH constituents discussed above, the levels of metals and organic compounds in Fidalgo Bay sediments are comparable or lower than levels in sediments from reference areas (areas removed from sources of contamination) in Puget Sound.

Roadways and impervious surfaces can contribute to water quality impairments and affect the quantity of freshwater flows. The compounding effects of more impervious surfaces from future development reduces the amount of upland recharge area, reducing the capacity to store water for later release through groundwater recharge. This could negatively affect the amount of freshwater inputs into the bay during dry periods. Increased traffic and development also produces greater amounts of contaminants that can later enter the bay through runoff, drainage ditches, or outfalls. Particularly, during early fall rains, soil and other built-up contaminants are released from roads and other impervious surfaces as overland flow. In more heavily populated areas, such intense contaminant-laden runoffs have been known to result in localized fish kills in the freshwater environment. The recent traffic circles and widening to Highway 20 can potentially increase the amount and focus of direct discharge or seepage into the bay. As part of this project, the Washington State Department of Transportation installed several new bio-swales to treat highway runoff and reduce potential contaminants associated with runoff from highway 20 entering the bay.

Additionally, excess nutrients and pathogens could enter the bay through poor agricultural practices, such as unmanaged livestock waste, combined sewer outfalls, septic system failures, or from direct discharge of untreated sewage. The Skagit Conservation District has worked with upland farm managers adjacent to the reserve to implement Best Management Practices to improve and protect water quality and reduce the potential for runoff of agricultural nutrients.

Oil Spills

Two oil refineries on March Point currently operate adjacent to the eastern boundary of the reserve. The southern refinery is owned by Shell Oil, the northern by Marathon Petroleum. One of the pipelines transporting crude and processed oil to and from oil tankers runs adjacent to the reserve along most of the eastern boundary. The refineries have necessary procedures and technologies in place to significantly reduce the likelihood of oil spills or minimize spill volume. However, spills have occurred in the past and the possibility exists for future spills. The effects of oil spills on organisms, ecosystems and wildlife are well-known and vary depending upon the type of oil, weather, tides and other conditions. Effects could vary from minor to acute. Other possible sources of petroleum derived pollutants and contaminants are prevalent adjacent to the reserve area, including from March's Point Road, residential areas, and various commercial facilities northwest of the Reserve.

Washington Department of Ecology (Ecology) updated the Oil Spill Response Plan for the bay (2012) and established booming strategies to protect sensitive areas and resources of the bay, including Crandall and Weaverling Spits. Ecology's Oil Spill Response Team, in collaboration with Samish Indian Nation supported the purchase of a boat to aid in oil spill response. The vessel will be delivered in May 2019, which will enable trained tribal staff to transport spill response and NRDA personnel in Samish traditional territory. Other potential spill related boat tasks could include use as a transport asset for Focus Wildlife during any spill in the area (T. Woodard, Samish Tribe, personal communication, 2019).

Non-native Fauna and Flora

Non-native species can disturb native ecosystems and habitats. Depending upon the ecological niche or place a non-native species occupies, it can physically displace, outcompete, or consume native species, upsetting the natural ecosystem. In other cases, a species may not have an immediate, obvious, or significant long-term impact on the native biological community or habitat.

A wide-variety of non-native invertebrates persist in the area including purple varnish clams (*Nuttallia obscurata*) and the abundant Asian mud snail (*Battilaria attramentaria*) (Antrim et al. 2003). Common cordgrass (*Spartina anglica)* was detected and removed in Fidalgo Bay for the first time in 1999. Since then, the Skagit County Noxious weed crew regularly monitor these areas and have removed small isolated infestations. Two sites in the reserve area, at Sharps Corner in the south end of the bay and in the Samish RV Park's inner bay, continue to have reinfestations of *Spartina.* The non-native seaweed, *Sargassum muticum,* and Japanese eelgrass (*Zostera japonica)* are also present in Fidalgo Bay, but not extensively in the reserve area. Although the Japanese littleneck clam (*Venerupis phillipenarum*) and Pacific oysters (*Crassostrea gigas*) are present in the bay and of foreign/non-native origin, they are not considered nuisance species.

In the summer of 2016, the invasive European green crab (*Carcinus maenas*) were found in neighboring Padilla Bay. In the Spring of 2017through September and again in 2018, the Samish Nation, DNR and Washington Sea Grant (WSG) Crab Team have performed seasonal monitoring for European green crab but have not found any during their surveys. However, in August 2018, a Green crab carapace was found on the beach at little Crandall Spit in the aquatic reserve. As a result, WDFW's Nuisance Species Program set out an aggressive trapping array in the south bay, but did not catch any Green crabs or find other carapaces. The Samish Indian Nation DNR and the Washington SeaGrant crab team intend to continue their seasonal monitoring program, and WDFW will regularly monitor areas in the south bay to prevent green crab establishment (A. Plius, WDFW, personal communication, 2019).

Bryozoans (*Bugula* sp.) and invasive tunicates (*Botrylloides violaceus*) are the other documented non-native species of concern in the bay (Cohen et al. 1998). However, neither organism has been found at any Olympia oyster restoration or spat colonization sites over many years of sampling.

Increased Recreational Use and Habitat Disturbance

Physical disturbance as well as the active capture and harvest of organisms can negatively affect the ecosystems of the reserve. As human populations in Skagit County and around Anacortes increase, the demand for recreation in or adjacent to the reserve will continue. Extractive recreation like fishing, crabbing, clamming and waterfowl hunting can affect populations of organisms in the bay – through both removal of individuals, and from possible physical stress the harvest activity can have on adjacent (non-harvested) individuals. Increased boating activity in the bay could increase the total stress on foraging and resting waterbirds, as well as harbor seals. Increased use of tidelands and the Tommy Thompson Trail could increase the degree of physical disturbance to wildlife utilizing the bay.

4. Uses and Ownership

This section examines the human uses of the reserve, both historic and current. It includes a brief discussion of ownership, as well as current zoning affecting the type of uses nearby.

Aquatic Ownership in and Adjacent to the Reserve

All of the tidelands and bedlands within the reserve boundary are state-owned, and are managed by DNR (Appendix C, map C-1). For a complete legal description of the reserve boundary, see Appendix XX).

Ownership types adjacent to the reserve include tribally-owned uplands and tidelands, private residential uplands and tidelands, commercial uplands, agricultural uplands, industrial refinery-owned uplands and tidelands, one parcel of uplands and tidelands held in private conservation, county roads and state highways. Two dominant natural features of the bay, both adjacent to the reserve, are Weaverling Spit on the western shore (owned by the Samish Indian Nation), and Crandall Spit to the northwest (owned by Shell).

Prior to creation of the Fidalgo Bay Aquatic Reserve, most of the tidelands currently in the reserve were privately owned. In 1999, the Skagit Land Trust acquired and conveyed ownership of 450 acres of tidelands in the southern portion Fidalgo Bay to the State, under a permanent conservation easement (Appendix C, map C-2). In 2006, the land trust added another 82 acres through an amended easement. Lands from these gifts currently make up approximately two-thirds of the reserve area.

Aquatic lands beneath the Tommy Thompson Trail were originally owned by the Seattle and Northern railroad prior to statehood, and thus were never owned by the State. The City of Anacortes subsequently acquired this land from the railroad and received federal funding to convert the railroad to a trail.

Harbor Areas and waterways, as designated in State statute (see RCW 79.120.010, RCW 79.115.010) still exist within the reserve. However, aquatic lands within the reserve, including the Harbor Area and waterways, were withdrawn from DNR's general leasing program under the 2008 Commissioner's Withdrawal Order that created the reserve (Appendix D). Under the Withdrawal Order, the Harbor Area is no longer reserved for landings, wharves, streets, and other conveniences of navigation and commerce under RCW 79.115.010 and WAC 332-30-109. Similarly, any uses allowed in the waterways must clearly be consistent with the reserve's purpose and management goals and fall within the Allowable Uses outlined in Chapter 6. Waterway uses will not be prioritized or authorized under WAC 332-30-117(4).

Cultural and Historic Uses

The protected shores and productive tidelands and waters of Fidalgo Bay have been used for at least the last 10,000 years by Coast Salish (Lkungen and Lushootseed-speaking) tribes as winter gathering and village sites (Ruby and Brown 1992). This is evidenced through tribal stories and by multiple locations of shell midden deposits, neolithic scatter, and burial sites near the reserve (DAHP database 2018).

Historically, Fidalgo Bay was connected to the north end of Similk Bay through a slough passable at high tide, which would have supported shallow vessel traffic (B. Carteret, personal communication, 2019). In the late 1800s, the area between the two bays was diked and drained for farmland cutting off this connection

Figure 17. Two Native Americans, probably from the Samish tribe village on Guemes Island, sitting in a dugout freight canoe (Anacortes museum)

Although there are no recorded archaeological sites reflecting pre-historic uses of the reserve's tidelands and bedlands *per se*, such sites may still exist. This is due to the shallow depth and geologic history of the bay and immediate surroundings, the potential for archaeological resources deposited accidentally or as a purposeful in-water feature, and from known documented sites in similar embayments in Western Washington (M. Major, personal communication, 2018).

Homesteading settlers first moved into the area in 1850s following the Treaty of Port Elliott, which ceded tribal lands to the United States but reserved some rights to fishing and shellfish harvest. Settlement around Fidalgo Bay expanded for several decades, especially along the eastern and southern shore of the bay. In 1872, the first General Land Office map of the area showed three settlers. By 1909, the USGS map showed nearly two dozen structures scattered around the bay, linked by an unpaved shoreline road. By the 1936 map, however, the number of structures on the east side of Fidalgo Bay was decreasing, while nearly every flat area on the steeper west shore was occupied.


Figure 19. View looking northwest from the southeast corner of Fidalgo Bay around 1890. (Anacortes Museum)

During this time, the growing City of Anacortes provided a valuable deep-water port from which to ship goods like timber products and seafood. In 1890, the Seattle and Northern Skagit railroad line was completed from Sedro-Woolley to Anacortes, creating a boom of settlers and businessmen to the City of Anacortes and surrounding area. Two trestles were built across Fidalgo Bay in 1890; one for rail traffic, the other for horse-drawn wagons (PHOTO, CHART).

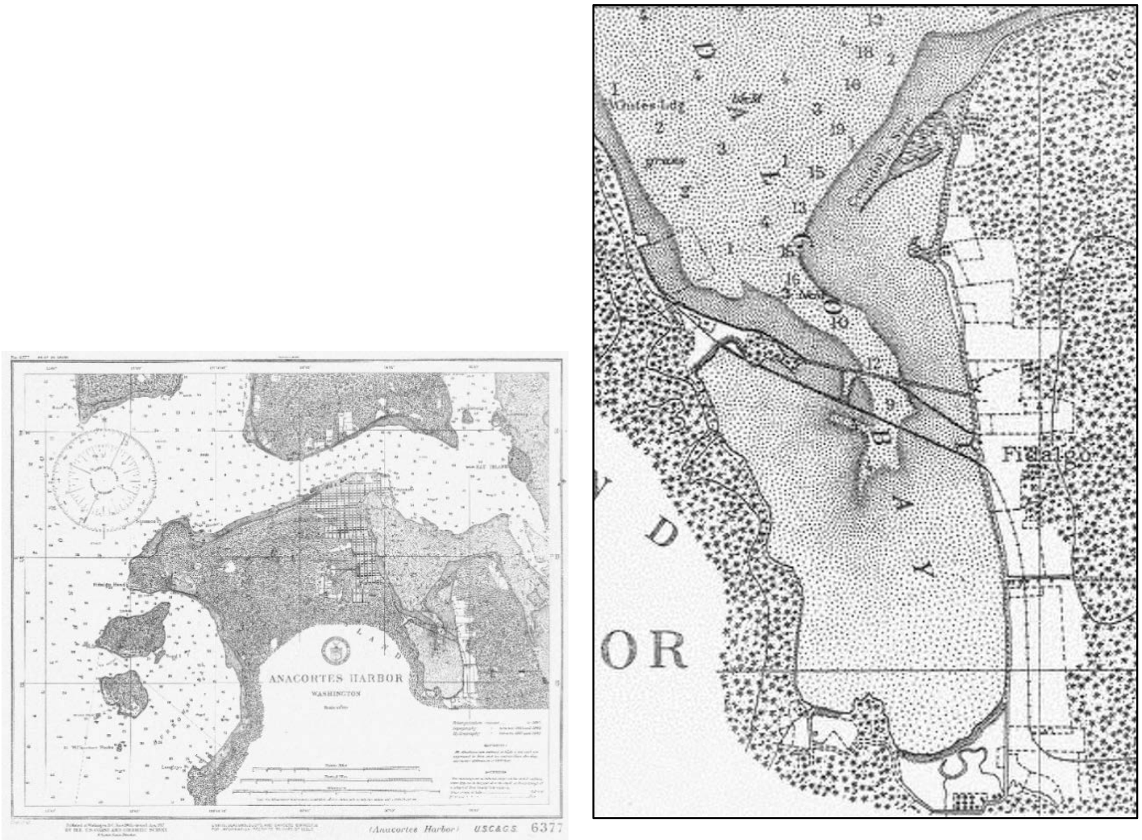


Figure 20. 1917 NOAA chart of Anacortes with highlight showing dual trestles across the bay. Enlarged section to the right shows the railroad trestle on the south, skirting the southern portion of Weaverling Spit, while the wagon trestle comes off the northeast portion of the spit. The wagon trestle was dismantled in the early 1920s.

The wagon trestle was abandoned in the early 1920s and subsequently removed. In the early 1920s (see article in Anacortes American 8-12-1920 stating blasted rock at Spit would be used to construct causeway), a rock and earthen causeway was constructed across the western half of the trestle, replacing the wooden pilings. The train trestle has been in place for nearly 130 years and is recorded in the State's DAHP database as a historical archaeological site.

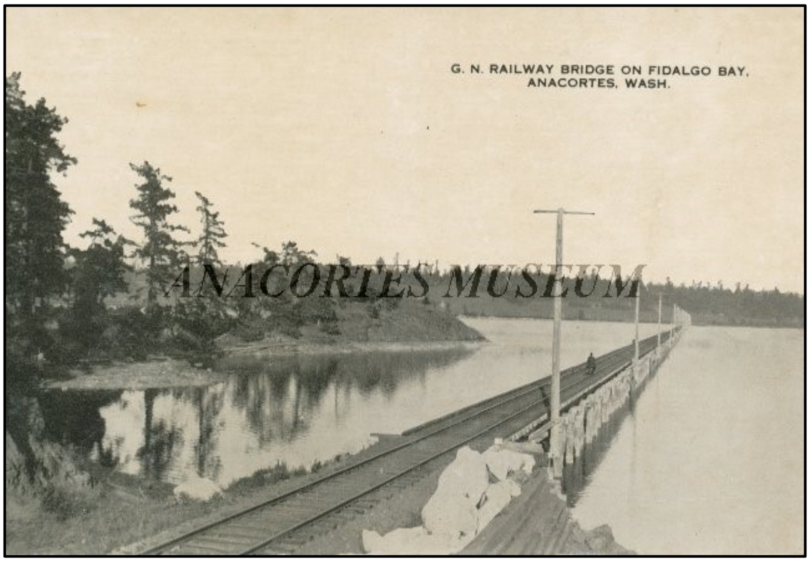


Figure 21. Photo from 1907 of Great Northern Railroad trestle looking east from Weaverling Spit. Note wooden piling construction of entire trestle prior to causeway construction. (Anacortes Museum)

The railroad enabled the shipment of logs and lumber to and from local mills. Many mills sprang up along the western shorelines of Fidalgo Bay near Anacortes, operating for decades. Wood product mills included lumber, pulp, plywood, shingle, and box mills. In 1928 alone, there were four sawmills, three box factories, five shingle mills, and a pulp mill operating within the Anacortes city limits (Hodges 2003). In order to supply the mills, tugboats regularly floated rafts of logs by the hundreds into Fidalgo Bay, north of the trestle. Logs were also dumped into the western portion of the bay from rail cars. For example, the Mitchell Log Booming operated just North of Weaverling Spit for more than half a century, using 30-35 rail car loads of logs per day to supply Anacortes mills (Friends of Skagit Beaches, Trail Tales signage).

Figure 23. Early photo looking north toward Anacortes from Weaverling Spit. Mitchell's log booming occupied tidelands north of the spit for many decades, feeding many early mills. (Anacortes Museum)

Thus, many portions of the bay – especially north and west of the trestle – were used for decades to boom rafts of floating logs, many of which would rest on the exposed tidelands during low tides. This practice continued in the bay up through the 1970's, with the last mill (Custom Plywood) closing in 1992 following a fire.

The southern portion of the bay beyond the train trestle has experienced very few uses due to its presence as a barrier for nearly 130 years. No log storage or mill activity was ever known to occur there. In contrast, the tidelands and bedlands north of the trestle were used extensively for log storage for many decades.

Transportation, Industrial and Refinery Activities Affecting the Reserve

Figure 25. Log rafts north of the trestle in Fidalgo Bay possibly around 1960 (*Anacortes Museum*)

In the mid-late 1950s, the fields and forestlands on March Point (to the east and north of the reserve), were replaced by two large petroleum refineries. This required extensive earth moving and construction activity, including the filling of tidelands and construction of March's Point Road, which today forms nearly all of the reserve's eastern boundary. The northern refinery is now owned by Marathon Petroleum and the southern is owned by Shell Oil. Together, the two refineries employ hundreds of workers for many decades with a current combined production of a quarter million gallons of petroleum product per day (Shell 2018, Marathon 2018). Raw materials and refinery products are shipped by rail, truck, tanker ship, barge, and underground pipelines.

Although the refineries have had relatively few environmental spills causing impacts to the bay over 60 years of operations, in 1991-1992, four separate but related oil spill events spilled more than 23,500 gallons (560 barrels) of crude oil into the bay from the Texaco refinery (now owned by Shell). Oil entered the east shore of the bay through an industrial stormwater pipe not far from the trestle. Beaches, intertidal areas, wildlife, and cultural resources in the bay were affected by oil. A subsequent Natural Resources Damages Assessment in 2004 awarded money for beach restoration work, which occurred along the reserve's eastern boundary in 2008-09 (see Appendix A, Restoration, Enhancement and Mitigation of Impacts). The refineries have instituted multiple measures, plans and contingencies in place to prevent future spills.

State Highway 20 is a major highway, transporting approximately 34,000 vehicles per day (DOT 2017) to Fidalgo and Whidbey Islands. This highway, with an estimated 2,500 feet of right-of-way abutting the southern reserve boundary, poses a potential source of spills and stormwater runoff into the bay.

From the 1950s through the 1980s, many of the City of Anacortes' wood products-related waterfront properties were converted to commercial marinas, vessel maintenance and upland storage facilities. While not located within the reserve itself, these commercial activities pose potential environmental threats to water and sediment, possibly affecting the reserve. However, extensive cleanup and mitigation of contaminated sediments has also occurred at many of these sites, improving environmental conditions near the reserve. In 1992, the Custom Plywood mill (Figure 17), located approximately one mile north of Weaverling Spit, burned to the ground releasing wood waste, dioxins and other toxic chemicals from treated and burned wood into the nearshore. This site has since undergone extensive cleanup and restoration activities as part of Ecology's Fidalgo Baywide Cleanup effort (Ecology 2019).

Figure 27. Anacortes Veneer, which later became Custom Plywood operated on this site from 1939-1992. (Anacortes Museum)

Current and Future Uses - within the reserve itself

DNR Authorized uses

Projects taking place on or over state-owned aquatic lands require an authorization from DNR. DNR authorizations are legal contracts signed by both DNR and the proponent that outline the terms and conditions of the use and convey certain property rights to the user in exchange for rent or fees. DNR issues different types of use authorizations (i.e. rights-of-entry, licenses, leases, and easements) depending on the type of use. Currently, there are no DNR use authorizations within the Fidalgo Bay Aquatic Reserve. Such authorizations will only be issued in the future if they support the objectives of the reserve, fall within the Allowable Uses outlined in Chapter 6, and meet the terms of the conservation easement (described below).

The Conservation Easement

All of the reserve parcels donated to the state by the Skagit Land Trust in 1999 and 2006 contain a restrictive conservation easement (available on the DNR web site at https://www.dnr.wa.gov/managed-lands/aquatic-reserves). Any uses must follow the conservation intent of the easement, set up "…to preserve and maintain a continuation of compatible land uses. These include public access which provides opportunity for low intensity recreation, and management and restoration of native plant communities for wildlife, open space and scenic quality..." (DNR 1999, p. 5).

Culturally Important Areas

Native tribes, including the Samish Indian Nation and Swinomish Indian Tribal Community, have continually affirmed the cultural and natural resource importance of Fidalgo Bay in its entirety.

Specifically, when asked what the most important features are to protect in the reserve, tribal representatives indicated the importance of conserving and fully restoring all of the natural elements of the bay. Traditionally, and depending on the season, shellfish gathering, crabbing and fishing for surf smelt were important in many parts of the bay. Therefore, continued water quality restoration and improvements is crucial to renewing these traditional uses, including the harvest of successfully restored Olympia oysters. The restored beaches and the associated Samish Indian Nation land at Weaverling Spit has become an important location for tribal events and cultural access to the bay, including annual canoe journey landings.

Recreation and Public Access

Recreation occurring within the reserve include motorized boating, kayaking, wildlife viewing, birding, clamming, crabbing, fishing, waterfowl hunting, and beachcombing. Additional activities occur along the Tommy Thompson Trail such as walking, jogging, skating, cycling, and picnicking.

The main upland public access is via one of three access points to the Tommy Thompson Trail and trestle. Minimal parking is available near the trestle. Currently, access for up to eight vehicles is available at the Samish Indian Nation's Fidalgo Bay Resort on the west end of the trestle. Although private, this is the closest parking access. The main public parking for trail access is via the City of Anacortes Parks Department's 22nd street trailhead (located two miles west of the trestle) or the 34th Street access trailhead (located one and a quarter miles to the west). While trail access is provided at the east trestle entrance, no public parking is available.

Boating access to the reserve can be gained via public boat launches at Washington Park (west of Anacortes) and Swinomish Channel (east of March Point), or at various marina launch facilities in Anacortes. Although much of the bay is very shallow, anchoring boats for overnight moorage is currently allowed in the reserve. A few small boats have been known to anchor temporarily on aquatic lands fronting the Samish RV Resort during summer. Larger boats may anchor outside the reserve, closer to Anacortes marina facilities. DNR anchorage rules stipulate a maximum stay of 30 days and prohibit liveaboards.

Besides the extraordinary views from the Tommy Thompson Trail, view access to the bay is best acquired from roads such as March's Point road along the eastern boundary and Fidalgo Bay Road along the southwest boundary.

In 2009, a portion of the Tommy Thompson Trail trestle caught fire, damaging about 300 feet of the trail. The section of trail was repaired by June 2010 after the community raised more than $325,000 for major repairs through efforts of the Anacortes Parks Foundation and others.

Figure 29. 2009 trestle fire affecting 300 feet of the Tommy Thompson Trail. (Photo credit: Trailbear, Rails To Trails Conservancy) https://www.traillink.com/trail-gallery/tommy-thompson-trail/)

Recreational fishing, shellfish harvest, and waterfowl hunting are all allowed in Fidalgo Bay (see www.wdfw.wa.gov/fishing/saltwater.html). The Washington Department of Fish and Wildlife (WDFW) has authority over fishing and hunting within reserves, not DNR. As of 2018, there is currently a commercial crabbing season in the bay from March 1-April 15. Harvest levels and trends are unknown in the bay since the WDFW does not keep records of harvest specific to Fidalgo Bay.

While there are no Washington Department of Health (DOH) shellfish consumption safety monitoring sites in Fidalgo Bay, DOH does issue temporary shellfish harvest closures for the bay based on sampled biotoxins or pollution found at nearby sites. Additionally, in 2010 DOH conducted a health consultation for Fidalgo Bay to examine the potential human health effects of exposure to toxins in the bay and found elevated levels of polycyclic aromatic hydrocarbons (PAH's), along with a concern for heavy metals and dioxin (DOH 2010). The report concluding that:

- Touching, breathing, or accidentally eating sediments from Fidalgo Bay is not expected to harm the health of adults or children.
- Eating bottom fish or shellfish from Fidalgo Bay is not expected to harm the health of the general population.
- Eating bottom fish or shellfish from Fidalgo Bay at a tribal consumption rate (higher consumption than the general population) could harm people's health.

However, as noted in Section 3 and Appendix A, recent Mussel Watch results have shown relatively low (i.e. close to background) levels of PAH's in muscles grown in wintertime cages placed on Weaverling Spit.

Both the Swinomish Indian Tribal Community and Samish Indian Nation have expressed their strong desire to return Fidalgo Bay to a healthy state, enabling full fish and shellfish tribal consumption rates.

Zoning and land use designations

City and county zoning laws act to control the type of uses permitted in and around the reserve. Understanding current zoning restrictions helps inform our management approach to future proposals affecting the reserve.

Zoning of shoreline uses falls under the jurisdiction of Washington's Shoreline Management Act (RCW 90.58). This act requires local entities like cities and counties to go through a careful planning process called a Shoreline Master Program (SMP). The SMP defines acceptable shoreline use categories called *Shoreline Environment Designations* within 200 feet of the shoreline (mean high water). These designations are based on results of biological surveys, local community's goals and needs, and requirements to protect features of statewide importance. By law, each SMP must be reviewed and updated every 10 years. DNR staff provide input on draft SMP plans, urging congruency with DNR policy, legal mandates, and management objectives – including for the aquatic reserves.

The City of Anacortes SMP was completed in 2010 and applies to all shorelines of the bay under the City's jurisdiction up to the eastern trestle entrance, where Skagit County assumes jurisdiction. The City's SMP Shoreline Environment Designation for the Fidalgo Bay shoreline is "Conservancy" (Appendix C, map C-4). The Conservancy designation is described in detail in the City's 2010 SMP (pp. 50-55), and states uses will only be allowed that, "Protect shoreline functions and resources by limiting, to the extent feasible, new uses and activities in the Conservancy designation to recreational, cultural and historic uses located and designed to avoid shoreline impacts" (City of Anacortes SMP, p. 51). The city's 2010 SMP did not include any shorelines along the eastern boundary, adjacent to their Urban Growth Area. These shorelines fall under the jurisdiction of Skagit County (Appendix C, map C-4).

While nearly complete, the Skagit County SMP is still a draft. The County still maintains shoreline SMP jurisdiction for lands north of the trestle on the east side of the bay. For this area, the County's draft SMP Environment Designation is "High Intensity" (Appendix C, map C-4). The draft plan states the purpose of the High Intensity designation is to "provide for high intensity water-oriented commercial, transportation, and industrial uses while protecting existing ecological functions and restoring ecological functions in areas that have been degraded (draft Skagit County SMP, p.)." This designation supports the shoreline's ownership and proximity to the two petroleum refineries, as well as the March Point access road abutting the bay/reserve. For shorelines designated *High Intensity*, the draft plan stipulates that;

- Full utilization of existing urban areas should be encouraged prior to the expansion of intensive development.
- Proposals for new development in shoreline jurisdiction should be designed to result in no net loss of shoreline ecological functions.
- Where feasible, visual and physical public access should be provided.

Until the draft is final, the county is still operating under the 1976 SMP environmental designation of *Urban Shoreline*[3].

[3]The Urban Shoreline Area is a shoreline area of intensive development including, but not limited to residential, commercial, and industrial uses. Areas suitable are those presently subjected to intensive use as well as those planned to accommodate urban expansion. (Skagit County S1976).

Upland zoning is controlled by Washington's Growth Management Act. The City of Anacortes zoning applies to lands within city limits, including much of the uplands to the west and south of the reserve, and also the city's March Point Urban Growth Area, east of the reserve. Uplands more than 200 feet from the shoreline near the reserve are zoned "Commercial Marine" (areas west of Weaverling Spit), "Light Manufacturing 1" (south of trestle), or "Heavy Manufacturing" (in the City's March Point Urban Growth Area, north and east of the trestle) (See Map XX). The Light Manufacturing zone allows for single family residences as conditional uses. Commercial Marine allows multi-family residential as a conditional use, providing "it can be demonstrated that the uses will not weaken the district's tourist or marine-oriented purpose, nor diminish the marine values inherent in the district such as physical and visual access to waterways and shoreline" (Anacortes Municipal Code Chapter 7, Section 21 (2008)). New residences are not allowed in the March Point Heavy Manufacturing zone.

Presently, three or four single-family residences are located along the eastern shore from Little Crandle Spit to the vicinity of the trestle's east entrance. A small RV park is located on Little Crandall Spit and livestock are grazed in the fields across the road from the trestle entrance. Otherwise, petroleum refinery infrastructure occupy the eastern shoreline and upland parcels. A few commercial businesses are located along the southwestern shoreline, along with a handful of single-family residences and a condo complex. A unique, 9-acre undeveloped rocky forested promontory on the south shoreline (directly north of the Highway 20 spur intersection) is currently for sale. The Fidalgo Bay Resort RV park is located on Weaverling Spit.

Future Land Use Changes and Stewardship

As the population of Skagit County, tourism and the local economy continues to grow, changes will inevitably occur which may affect the reserve, and the bay itself. Anticipated future "drivers" of these changes were described in Section 3ii., along with ecosystem stressors connected in various ways to land use changes.

5. Progress Made Towards Achieving Plan Goals

This section details progress made in the past 10 years towards achieving the Fidalgo Bay Aquatic Reserve management plan (2008) goals. It represents a record of the invaluable work, partnerships and types of activities conducted during this time-frame.

Prior to establishment of the reserve in 2008, many successful projects were initiated or completed in and adjacent to Fidalgo Bay supporting the reserve objectives. This important work included removal of large quantities of creosote from the Tommy Thompson Trail, Crandall and Weaverling spits, and other locations; beach enhancement and restoration of forage fish habitat along sections of the shoreline North and East of the trestle; reintroduction of Olympia oysters in multiple places within the reserve; and completion of various intertidal, eelgrass, forage fish and bird surveys. Details of these activities are not included below.

Partners and projects accomplished from 2008-2018

Major support for work in the reserve has come from: The Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee, the Skagit Marine Resources Committee, The Samish Indian Nation, RE Sources for Sustainable Communities, the Friends of Skagit Beaches, the Skagit Land Trust, and the City of Anacortes Parks and Recreation Department. Both Shell and Tesoro (now Marathon) have provided funding in support of multiple projects through these partners.

Figure 30. Beach Seine demonstration at Fidalgo Bay Day

Since its creation in 2012, the Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (CSC) has provided initiative and essential support toward achieving the reserve goals. The CSC is a volunteer group comprised of local community members with a strong interest in citizen science, environmental education, and conservation of the reserve. The group helps garner support for the reserve, providing a local point of contact and an information conduit with DNR on issues affecting the reserve. CSC-sponsored citizen science projects have included yearly intertidal monitoring at four sites, seasonal shore-based marine bird surveys at four sites, and forage fish beach spawning surveys on both sides of the bay. The CSC also conducts outreach, assists with events such as the annual Fidalgo Bay Day, hosts shoreline interpretive walks, and raises awareness of important issues affecting the reserve, like stormwater management. From 2013–15, the CSC was supported by a

Figure 32. Dan Penttila, (Salish Sea Biological) sharing knowledge at Fidalgo Bay Day

grant from EPA's National Estuary Program (NEP) managed by the Washington Environmental Council. Continued support was provided by a second EPA NEP grant from 2016-2018 managed by DNR. RE Sources for Sustainable Communities, a local non-profit organization, has been a fiscal sponsor providing staff support for the CSC's many efforts since 2013.

Since 1999, the Skagit Marine Resources Committee (MRC), funded through the Northwest Straits Commission, has provided many educational, citizen science, and habitat restoration support functions in Fidalgo Bay. The MRC is the lead organizer for Fidalgo Bay Day, with the Samish Indian Nation sponsoring the venue. Fidalgo Bay Day is a community event focused on environmental education, responsible beach etiquette and maintaining healthy habitats for creatures in the bay. This one-day event has occurred annually since 2004. The MRC also sponsors a "Kids on the Beach" initiative to educate K-12th graders about forage fish. The Skagit MRC trains volunteers in citizen science through their Salish Sea Stewards program, supported by funding from Friends of Skagit Beaches. The MRC has provided expertise, staffing and fiscal support for the successful reintroduction of the Olympia oyster in the bay for many years.

The Samish Indian Nation has supported reserve goals through collaborative projects with state and federal agencies; through tribal research and monitoring projects, for example water quality, forage fish, and nearshore fish use (beach seining); and through direct conservation actions like creosote wood removal and cleanups. Their restoration of more than 1,600 linear feet of beach and riparian areas along Weaverling Spit provides a major habitat enhancement of lands immediately adjacent to the reserve. The Samish Indian Nation also commissioned a valuable feasibility study to model the hydrologic effects of various causeway and trestle removal scenarios. (Ridolfi 2008). This study provides important information for potential future habitat enhancements in the southern half of the reserve.

Friends of Skagit Beaches (Friends), a local non-profit volunteer-run organization has also provided support of reserve goals for many years. They received a grant from the Washington Department of Ecology to create a "Trail Tales" shoreline interpretive program from 2011–2015. Friends offered Trail Tails interpretive walks, using 17 different interpretive signs created and installed by Friends along the Tommy Thompson Trail from 34th street trailhead to March Point. DNR staff partnered with Friends on several signs and co-led interpretive walks in the reserve.

Figure 34. Interpretive station highlighting citizen science intertidal monitoring on tidelands adjacent to the Tommy Thompson trail.

The City of Anacortes Parks and Recreation Department has provided important support for the primary access to the reserve via the Tommy Thompson Trail. Through the creation of trailheads, parking and interpretive signage, regular maintenance, and emergency response and management, Anacortes Parks creates long-term opportunities for the community to enjoy the reserve.

Besides the partners mentioned above, various researchers, organizations and agencies have also contributed to our knowledge of the reserve. These include researchers from academic institutions like Western Washington University and University of Washington - Tacoma. Additional research is conducted by DNR's Nearshore Habitat and Aquatic Assessment and Monitoring Teams.

The Washington Department of Ecology (Ecology) is conducting an ongoing bay-wide cleanup of contaminated sites outside of the reserve, with mitigation and restoration actions that will strengthen and improve the long-term ecosystem health of the reserve. In particular, cleanup of wood waste and other contaminants at the Custom Plywood mill site to the northwest of the reserve, along with associated eelgrass plantings and creation of a pocket estuary contribute to a healthier reserve.

Completed and ongoing activities

Tables 1-3 below illustrate activities carried out in the past decade in support of the 2008 reserve management plan goals. The activities in each table support a specific 2008 plan goal, although some may have been initiated well before 2008. Activities may support multiple goals, however, for simplicity each activity is listed just once under the assumed primary goal the activity supports. This information was gleaned from various sources, and this record may be incomplete.

Activities in Table 1 primarily support the reserve goal of *preserving, restoring and enhancing natural ecosystem function and processes in the reserve.* Projects have included: beach enhancements to bring in natural materials for habitat purposes, removal of creosote treated wood, planting of native eelgrass, re-introduction of native shellfish, and regional modelling assessments to identify restoration and protection priorities.

Table 1. Completed activities in or near the reserve supporting the 2008 goal of preservation, restoration and enhancement of natural ecosystem function and processes.

Activity	Description	Lead Organization	Event Completion Year(s)**
Fidalgo Bay Causeway Feasibility Study Report	Report assessing the technical feasibility and benefits of different removal options for the trestle and causeway.	Samish Indian Nation, DNR, City of Anacortes	2008
Beach habitat restoration	Beach restoration & shoreline enhancement (phases 1, 2 and 3) at Weaverling Spit. Restored approximately 1,600 ft. of shoreline.	Samish Indian Nation	2014-2017
	West March Point beach enhancement/forage fish habitat restoration.	Skagit River System Cooperative, Tesoro, Skagit Marine Resources Committee (Skagit MRC), DNR	2010, 2011, 2012,
	Invasive plant and green crab surveys (Weaverling spit restoration).	Samish Indian Nation, Washington Dept. of Fish and Wildlife (DFW), Washington Sea Grant, Skagit County	Ongoing 2017-present
Beach riparian restoration	Removal of structures and riparian restoration, southwest side of Fidalgo Bay.	Skagit Land Trust	Ongoing 2017-present
Spill contingency planning & response	Geographic Response Plan for oil spill response: North Puget Sound GRP was completed 2012.	Washington Dept. of Ecology (Ecology), industry, tribes	2012
	Spill response equipment and training for Samish Indian Nation (Ecology Oil Spill Response Team).	Ecology, Samish Indian Nation	2018, ongoing
Eelgrass restoration	Scott paper mill remediation site - planted eelgrass meadow is successfully established and expanding on tidelands adjacent to the reserve.	Ecology	???
Riparian and nearshore toxics cleanup and restoration	Custom Plywood site. Cleanup, remediation and enhancement of nearshore & riparian location just north of the reserve. Removal of wood waste and toxics from the uplands and nearshore, construction of pocket estuary.	Ecology	??
Olympia oyster research	Olympia oyster larval dispersal studies (Shawn Arellano WWU, Bonnie Becker UW Tacoma).	WWU Shannon Pt., UW Tacoma	??
	Long-term/ongoing Olympia oyster restoration projects in multiple locations in reserve (project began in 2002).	Skagit MRC, Puget Sound Restoration Fund	Ongoing 2008 - present
Outfall improvement & pollution reduction	Samish Indian Nation outfall data used to upgrade, addressing problems in cooperation with City.	Samish Indian Nation	Ongoing 2015 - present

Activity	Description	Lead Organization	Event Completion Year(s)**
Marine debris & creosote removal	Creosote Inventory & Removal Project.	Skagit MRC	2008, 2009
	Marine debris and creosote removal.	Samish Indian Nation	Ongoing 2014 - present
	Marine debris survey (NOAA protocols)	PugetSound Corps	2016
	Marine debris cleanup (during regular forage fish surveys)	PugetSound Corps	2012-2016
Fidalgo Bay Salt Marsh Restoration Feasibility Study	Report assessing options, feasibility and benefits to restoring saltmarsh habitat, located south of the Samish RV Park in south Fidalgo Bay.	Samish Indian Nation	2014
Assessment & prioritization	Fidalgo Island Geomorphic Assessment & Drift Cell Restoration Prioritization (ref.).	Skagit MRC, Skagit Land Trust	2008
	Marine Shoreline Protection Assessment (ref. Report 2014).	Skagit MRC, Skagit Land Trust	2014
	PSNRP Shoreline Assessment (ref. watershed characterization Wildlife piece).	Puget Sound Partnership, DFW	2012?

Figure 37. A shell enhancement plot established along the east side of Fidalgo Bay by Puget Sound Restoration Fund in 2013. A cultch shell monitoring bag is in the foreground

Figure 36. Heavy Olympia oyster natural recruitment on a shell enhancement plots observed in 2016. The recruits are oysters that settled in the summers of 2014 and 2015. (From 2018 Olympia oyster report.) oyster report.)

Activities in Table 2 primarily support the reserve goal of *inventorying native habitats, focusing on mudflats, sandflats, forage fish spawning areas and eelgrass.* Projects have included beach

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enhancements to bring in natural materials for habitat purposes, removal of creosote treated wood, planting of native eelgrass, reintroduction of native shellfish, and regional modelling assessments to identify restoration and protection priorities.

Table 2. Completed activities supporting the inventory of native habitats (with focus on mudflats, sandflats, forage fish spawning, and eelgrass).

Activity	Description	Lead Organization	Event Completion Year(s)**
Inventory (or monitoring?)	Clam surveys (temp, md & creosote).	Samish Indian Nation	2009, Ongoing 2015 - present
Nearshore fish surveys	Beach seining for salmonids & small fish.	Samish Indian Nation	Ongoing 2016 - present
Eelgrass monitoring	Repeat eelgrass transect surveys.	DNR Submerged Vegetation Monitoring Program	2008, 2009-2013, 2016, 2018
	Samish Indian Nation eelgrass transects in a cooperative study with Padilla Bay NERR.	Samish Indian Nation	2017, 2018
Water quality monitoring	Fidalgo Bay Contamination Study (stormwater monitoring).	Skagit Marine Resources Committee (MRC), Samish Indian Nation	2007-2009
	Monitoring outfall water quality into the bay (began 2005).	Samish Indian Nation	Ongoing 2008 - present
	Continuous temperature monitoring.	Samish Indian Nation	Ongoing 2009 - present
	Real time water quality monitoring stations (ANeMoNe) – dissolved oxygen, pH, salinity, temp, chlorophyll, etc.	DNR Aquatic Assessment and Monitoring Team	Ongoing 2016 - present
	Puget Sound Mussel Watch (cages with mussels to measure contaminants).	WDFW, DNR Aquatic Reserve Program staff, Samish Indian Nation	Winter 2012/13, 2015/16, 2017/18
Bird surveys	Shore-based marine bird surveys (seasonal? Monthly? Sept-May).	Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (CSC), Skagit Audubon	Ongoing 2017-present
	COASST surveys.	University of Wa. - Julia Parish; DNR Puget SoundCorps, Samish Indian Nation	Since 2014
	Great Blue Heron studies/citizen science (since 2002).	Skagit Land Trust, Friends of Skagit Beaches, Skagit County Heron Forage Monitoring Team	Ongoing 2008-present

Activity	Description	Lead Organization	Event Completion Year(s)**
Forage fish surveys	Forage fish surveys.	WDFW, Salish Sea Biological, CSC, DNR Puget SoundCorps	2008 -2012 Ongoing 2012 - present
Intertidal surveys	Intertidal monitoring citizen science project.	CSC, Anacortes Public Schools, WWU	Ongoing 2013-present
Sediment cleanup & monitoring (adjacent to reserve)	Site cleanup, biological and physical monitoring Scott paper mill and Custom Plywood (eelgrass, upland veg, forage fish, intertidal, salmonid).	Department of Ecology (Ecology)	??
Sediment cleanup & monitoring (adjacent to reserve)	Custom Plywood site. Ongoing monitoring of forage fish spawning and salmonid habitat, intertidal area, upland riparian vegetation).	Ecology	Ongoing
Shellfish larvae recruitment in eelgrass beds	Comparison of larval shellfish recruitment within and outside of eelgrass beds (associated with ANeMoNe project).	DNR Aquatic Stewardship Science staff	2017, 2018
Study & prioritization	Fidalgo Bay circulation study (funded by Samish Indian Nation).	USGS- Eric Grossman	2013

Activities in Table 3 primarily support the reserve goal of *environmental education and outreach.* Projects have included: citizen science activities like intertidal monitoring, bird surveys, and forage fish sampling, classroom presentations; hands-on interpretive events on the beach; volunteer trainings; educational booths at festivals; and creating interpretive signs.

Table 3. Completed activities supporting Environmental Education and Outreach

Activity	Description	Lead Organization	Event Completion Year(s)**
Beach clean-up	Beach clean-up opportunities.	Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (CSC), NOAA, Surfrider Foundation	2015
	Crandall Spit beach cleanup.	Shell, Friends of Skagit Beaches (Friends), ReSources	2018
Citizen science	Avian monitoring citizen science opportunity.	CSC	Ongoing 2017-present
	Forage fish survey, monitoring and lab work - citizen science opportunity.	CSC	Ongoing 2013-present
Classroom presentation	Salish Sea Stewards classroom presentation about DNR's Aquatic Reserves program, how to volunteer in the reserves.	Skagit Marine Resources Committee (MRC), DNR Aquatic Reserves Program	Ongoing 2013-present

Activity	Description	Lead Organization	Event Completion Year(s)**
	Skagit Watershed Masters - Class demonstrations.	CSC, Skagit Conservation District	Ongoing 2013-present
Educational display/activities	Created stormwater educational PowerPoint and display materials and presented to local civic groups.	CSC, City of Anacortes, Friends of Skagit Beaches (Friends)	2015 - present
	Fidalgo Bay Day - including displays, interactive games, mobile touch tank, beach seine demonstration.	CSC, MRC, Friends, Puget Sound Corps	Ongoing/ annually 2004 - present
	Fidalgo Shoreline Academy booth (sharing what?).	CSC, Friends	Ongoing annually 20xx - present
	Skagit Bald Eagle Festival - talk, booth, and forage fish activities.	CSC, Concrete Chamber of Commerce	Ongoing/ Annually 2015-2018
	Science on the Bay – Science Symposium featuring work by scientists and citizen scientists in Fidalgo Bay Aquatic Reserve.	CSC	2018
Advocate for bay wide water quality improvements	Comment on development proposals in support of low impact devp. planning for projects in the Fidalgo Bay watershed (Anacortes High School rain garden, HWY 20 roundabout).	CSC, Anacortes School District, WSDOT, Samish Indian Nation, MRC, City of Anacortes	2014-2018
Public workshop	Shoreline Land Owner Workshops (MRC).	MRC	2015–2018
Citizen science	Opportunities for students to participate in intertidal monitoring events.	CSC, Anacortes Public Schools, WWU	Ongoing 2013 - present
Hands-on interpretive stations	Kids on the Beach - forage fish education for K-12 students (beach + classroom).	MRC, CSC, Friends, Anacortes Public Schools, other local schools	Ongoing 2017–present
	Use of educational stations at forage fish and intertidal monitoring events.	CSC, Friends	Ongoing 2015 - present
Interpretive signs, associated interpretive walks	Install 17 interpretive signs along the trestle portion of Tommy Thompson trail (34th St. entrance to March Point). Interpretive walks with docents interpreting signage along the trail. Create web site with matching story and video content.	Friends, City of Anacortes, CSC, DNR staff	2012-2015
	Creation and installation of road signs that clearly identify the aquatic reserve.	CSC, City of Anacortes, WSDOT, DNR Aquatic Reserves Program	2015

Administrative support

Aquatic Reserve management by DNR also includes the administrative support necessary to accomplish the stated goals. Such work includes providing ongoing support to the Citizen Stewardship Committee through grant proposals and administration (for example, the 2016–18 EPA National Estuary Program grant); creating signs, maps, videos, brochures and interpretive materials; maintaining and updating web sites; coordinating with partners; and participating in outdoor education and citizen science.

Land acquisition/transactions for habitat conservation

Approximately two-thirds of the current reserve area was originally protected through acquisition by the Skagit Land Trust in the early 2000s. These aquatic land parcels have a Conservation Easement placed on their deed stipulating they can only be used for conservation purposes. In 2016 the Skagit Land Trust acquired a 1-acre residential shoreline property just south of Weaverling Spit and adjacent to the Reserve. The structure was removed and the site is being planted with native species to restore riparian conditions.

Achievement of 2008 Plan goals and lessons learned

Some of the 2008 plan goals that were not realized include assessing salmonid use in the reserve, developing monitoring plans to evaluate trends in the reserve, regularly surveying for Threatened and Endangered Species, and reducing the amount of shoreline alteration in the bay.

Following establishment of the Fidalgo Bay Aquatic Reserve, DNR management focused on responding to urgent issues on reserves as well as establishing five new reserves. Some of the aspirational goals of the original management plan were beyond the scope of what the program could address alone, such as significantly reducing the amount of shoreline alteration. The need for Threatened and Endangered species surveys turns out to be minimal, since these species are not generally found in the reserve. Monitoring plans were developed in conjunction with citizen science projects, and system-wide projects like forage fish monitoring. The program did not have capacity to also develop trend monitoring plans.

During the next ten years, DNR may be able to support juvenile salmonid assessments, and develop more robust monitoring plans in conjunction with partners. The 2008 Threatened and Endangered Species survey goal is now wrapped into the general species and habitats goals.

It should be noted that within this time-frame, both Ecology and the Samish Indian Nation carried out major restoration activities on lands adjacent and northwest of the reserve, with actions congruent with reserve goals.

6. Management Guidance

The Fidalgo Bay Aquatic Reserve is established as an environmental reserve to protect and restore important native ecosystems, to foster environmental stewardship, and to facilitate collaborative partnerships. This section of the plan identifies the long-term vision for the reserve and provides goals and objectives to support this vision. The management guidance was developed collaboratively with reserve stakeholders through public meetings and written feedback during the 10-year management plan update process.

Long-Term Vision

The long-term vision describes the overall target or ideal conditions through the 90-year term of the aquatic reserve. The vision provides a framework for developing the management goals and conditions.

Over the 90-year term of the reserve, the Management Plan ensures strong protection of the state-owned aquatic lands to prevent further habitat degradation and to enhance the natural character of the bay. Natural processes and functions that support a healthier nearshore environment will be restored. Shoreline restoration will lead to improved habitats for native species and enhance spawning, refuge and rearing fish habitat. Improved ecological conditions will also promote foraging opportunities for resident and migratory birds and marine mammals.

Partnerships with adjacent landowners and land managers are essential to address potential impacts from conditions adjacent to Fidalgo Bay Aquatic Reserve. Efforts will focus on reducing water quality impacts to the aquatic reserve and the adjacent nearshore areas, improving riparian shoreline characteristics, and supporting permanent restoration of Olympia oysters.

Fidalgo Bay Aquatic Reserve will also be an essential resource to the community for environmental education, research, monitoring, recreational and cultural use, as well as aesthetic enjoyment of scenic views.

Goals

The following management goals have been established for the Fidalgo Bay Aquatic Reserve:

1) **Natural functions and processes**: Protect, enhance and restore the natural functions and processes of nearshore ecosystems
2) **Native habitats and species**: Conserve and enhance native aquatic habitats and species with an emphasis on conservation priorities
3) **Monitoring and research**: Gather and assess ecological and human use information to support adaptive management decisions
4) **Environmental education, stewardship, and partnerships**: Promote stewardship of the aquatic reserve by facilitating environmental education and citizen science, strengthening community partnerships, and promoting public use
5) **Authorized uses**: Authorized uses on state-owned aquatic lands must be consistent with the aquatic reserve long-term vision and management goals and the conservation easement

Objectives and Strategies

Goal 1: Natural functions and processes *Protect, enhance and restore the natural functions and processes of nearshore ecosystems*	
Objectives & Strategies	
1.1	**Nearshore processes and drift cells -** Maintain or enhance nearshore processes, proper drift cell function, and sediment movement
	a) Work with partners, adjacent landowners and adjacent land managers to remove bulkheads and reduce shoreline modification
	b) Evaluate barriers to sediment movement, such as the revetment/causeway, and propose restoration or enhancement solutions
1.2	**Restoration and enhancement -** Restore and enhance impaired or degraded native nearshore habitat and natural processes to better functioning conditions
	a) Coordinate with tribes and partners to identify and prioritize restoration projects, develop restoration plans and seek funding
	b) Work with tribes and partners to remove the causeway, railroad trestle and associated creosote pilings while maintaining a pedestrian trail by replacing with a climate-resilient structure that allows tidal exchange and improved water circulation
	c) Restore and enhance shoreline habitat and processes through removal of shoreline modifications, planting of native vegetation in backshore areas, and beach nourishment to improve sediment/substrate availability
	d) Remove creosote piles and other derelict structures from Fidalgo Bay (These are mostly in the northeast part of the reserve)
	e) Work with tribes and partners to remove marine debris, derelict crab pots and fishing gear, and reduce plastics
	f) Work cooperatively with adjacent landowners, on a voluntary basis, to identify and address specific habitat restoration and conservation opportunities
1.3	**Land acquisition** – Encourage protection of important nearshore habitats by working with partners to acquire adjacent tidelands, encouraging placement of lands into protective status, and acquiring additional reserve lands directly through gifts.
	g) Encourage placement of important upland and aquatic habitats adjacent to the reserve into conservation easements
	h) Work with Skagit Land Trust and other partners to establish priorities for land acquisition and conservation easements

	i) If aquatic lands directly adjacent to the reserve come into state ownership, DNR can choose to include these areas in the aquatic reserve

Goal 2: Native habitats and species *Conserve and enhance native aquatic habitats and species with an emphasis on conservation priorities*	
Objectives & Strategies	
2.1	**Native habitats** – Protect and restore the documented extent and diversity of native aquatic vegetation, mudflats, salt marsh and other important habitats
	j) Identify and support enhancement and restoration projects that would benefit aquatic vegetation, salt marsh and other important habitats
	k) Partner with tribes and landowners to identify habitat protection opportunities adjacent to the reserve
	l) Promote and support research projects that focus on long-term trends, human impacts to native habitats, stressor response and causes of local declines
2.2	**Fish habitat** - Protect fish spawning and rearing habitat, and movement corridors with a focus on surf smelt, sand lance, herring and salmon
	m) Identify impaired habitats that would contribute to forage fish or salmonid survival if habitat functions were enhanced or restored such as degraded beaches and pocket estuaries (Big Crandall Spit, Samish Tribe living marsh project by Weaverling Spit)
	n) Improve forage fish spawning habitat by planting native shoreline vegetation to increase shading
2.3	**Waterbird habitat** - Protect nearshore waterbird habitat areas and maintain undisturbed habitats where birds can feed, breed, and overwinter
	a) Protect and restore specialized nearshore habitats, such as mudflats, pocket estuaries and salt marshes
	b) Identify and monitor activities that have the potential for disturbing foraging and nesting waterbirds
2.4	**Native species** – Enhance and protect native species through restoration projects and control of invasive species.
	Work with Skagit MRC, tribes and other partners to support Olympia Oyster restoration
	Support ongoing surveys, with a focus on early detection, and control of European green crabs, spartina and other aquatic nuisance and invasive species

2.5	**Water quality -** Promote and support partnerships focused on improving water quality that reduce impacts to sensitive species and habitats
	o) Coordinate with partners, such as City of Anacortes, Samish Indian Nation, and citizen Stewardship Committee, to identify and address sources of water quality impairment, including stormwater and non-point sources
	p) Work with municipalities to ensure water quality standards are met (e.g. NPDES)
	q) Work collaboratively with the Department of Ecology and industries to ensure adequate spill response coordination and planning
2.6	**Climate change adaptation and resiliency** – Cooperate with tribes and partners to advance climate change adaptation planning and coastal resilience
	r) Coordinate with tribes and partners to conduct a vulnerability assessment to identify potential climate change impacts, especially related to sea-level rise and ocean acidification
	s) Identify and pursue opportunities to enhance ecosystem and coastal resilience
	t) Incorporate sea-level rise and other climate change adaptations into long-term planning efforts associated with the reserve
	u) Increase monitoring efforts to identify key early indicators of climate change so that the reserve can act as sentinel site to track environmental change associated with climate change in the region
	v) Identify opportunities to reduce non-climate-related stressors to the reserve such as, removing creosote pilings, reconstructing the causeway and trestle, and protecting undeveloped land to allow beach migration

Goal 3: Monitoring and Research *Gather and assess ecological and human use information to support adaptive management decisions*	
Objectives & Strategies	
3.1	**Data gaps and data organization** – Identify data gaps and improve access to data and research results
	w) Update and refine baseline inventory of aquatic habitats and species that use the reserve area
	x) Coordinate with partners to inventory data and identify gaps, and then prioritize strategies to address the gap
	y) Coordinate monitoring and research efforts with tribes, local and state agencies, local non-profits, universities and citizen science groups

3.2	**Assessment, baseline inventory and trend monitoring** – Conduct, facilitate and support inventory and monitoring programs to guide management
	z) Focus forage fish monitoring efforts on egg survival, habitat improvement, shoreline vegetation and shading, identifying sand lance spawning habitat, and trends in spatial distribution of spawning habitat
	aa) Conduct pre and post-restoration monitoring to improve adaptive management and use to prioritized future restoration projects
	bb) Coordinate with adjacent land owners to increase access to survey sites
3.3	**Research** - Promote and support research within the reserve with an emphasis on climate change impacts, emerging science and studies with management applications
	cc) Support research that focuses on conservation priorities identified in this plan
	dd) Promote and support research that focuses on the potential effects of climate change (sea-level rise, ocean acidification, changes in water temperature and salinity) on the resources within the reserve
	ee) Support research that focuses on efficacy and site-comparisons of the aquatic reserve network and other marine protected areas in Puget Sound

Goal 4: Environmental education, stewardship and partnerships

Promote stewardship of the aquatic reserve by facilitating environmental education and citizen science, strengthening community partnerships, and promoting public use

Objectives & Strategies

4.1	**Education and stewardship -** Increase public awareness and stewardship of the reserve through environmental education, outreach, and citizen science
	ff) Support the Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee and other partners conducting environmental education, outreach and citizen science
	gg) Promote education programs that engage the public in reserve stewardship and increase understanding of the importance of ecological, geologic, cultural and historic components of Fidalgo Bay
	hh) Promote and support citizen science that fills data gaps, establishes long-term trends and increases stewardship of the reserve
	ii) Maintain interpretive signs and assess the need for additional signage to increase awareness of the reserve
	jj) Work with tribes to develop educational materials that incorporate cultural and historical topics and current environmental stewardship opportunities

4.2	**Stewardship & community values** – Foster public engagement, stewardship and volunteerism that promotes community and cultural values
	kk) Protect cultural resources, traditional uses and partner with tribes to promote public awareness of cultural values
	ll) Integrate historic and cultural uses of Fidalgo Bay pre and post contact in outreach materials
	mm) Incorporate community uses and values in outreach and education programs to increase stewardship and sense of ownership of the reserve
	nn) Conduct surveys to understand the public use and values related to Fidalgo Bay
4.3	**Partnerships -** Develop partnerships with tribes, local and state governments, universities, local schools, non-profit organizations, local businesses and citizens to increase the Aquatic Reserve Program's effectiveness
	oo) Organize annual stakeholder meeting to evaluate progress and plan for the coming year of plan implementation
	pp) Work cooperatively with partners to develop outreach and education materials and interpretive signage
	qq) Collaborate with partners to identify and fund potential enhancement and restoration activities that will support the aquatic reserve
	rr) Work with local entities to ensure designations and programs under both the Shoreline Management and the Growth Management Acts support the goals and objectives of the reserve.
	ss) Work with WDFW and tribes to create better understanding of management and harvest of key marine species in the reserve such as herring, forage fish, and Dungeness crab.
4.4	**Public access -** Foster sustainable use and public access to state-owned aquatic lands within and adjacent to the reserve
	tt) Collaborate with adjacent land owners and managers to provide safe public access
	uu) Provide information on public access areas, including installation of identification signs
	vv) Inventory types and impacts of recreational and other human use activities, and work cooperatively with partners to manage use and reduce human impacts

Goal 5: Authorized Uses *Authorized uses on state-owned aquatic lands must be consistent with the aquatic reserve long-term vision and management goals and the conservation easement*	
Objectives & Strategies	
5.1	**Allowable uses** – DNR will review the following new uses for state-owned aquatic lands within or directly adjacent to (abutting) the reserve: • Public access that provides opportunity for low intensity recreation and sustainable use where consistent with the long-term vision and management goals; • Ecological monitoring if conducted under a monitoring plan approved by DNR; • Research in support of the reserve's goals and objectives; and • Restoration projects that are consistent with the management of the reserve and conducted under a restoration plan approved by DNR.
	ww) DNR will perform a critical review of new use proposals pursuant to WAC 332-30-151 and make a determination about the consistency of the proposed use with the reserve management guidance
	xx) Ensure proposed new uses meet or exceed DNR's Aquatic Habitat Stewardship Measures
	yy) DNR will work with partners to ensure restoration projects and monitoring plans are consistent with the reserve goals and for adaptive management
5.2	**Prohibited uses -** DNR will not authorize any uses that do not comply with the strategies in Section 5.1
	zz) Any uses proposed on state-owned aquatic lands adjacent to the reserve must not conflict with the purpose of the reserve designation and specifically with the habitat and species identified for conservation within the reserve
	aaa) Unauthorized uses must be removed by the owner
	bbb) DNR will remove the unauthorized use when the owner cannot be identified and funding sources are available

7. Implementation Guidance

The successful management of the Fidalgo Bay Aquatic Reserve requires coordination and collaboration with public and private entities as well as local, state, federal, and tribal government, and non-government organizations. Review and evaluation of sound scientific and management information will guide future development, restoration and protection decisions in the reserve.

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (CSC)

Currently, the Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (CSC) meets monthly to collaborate on projects, events, and provide input to DNR on reserve management. The CSC is composed of representatives from various groups interested in the reserve, and residents at large. The results of their many initiatives and projects are well documented in other sections of the plan. The CSC also provides a critical and regular conduit of information between local interests and DNR.

Figure 39. Members of Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee and DNR staff

Fidalgo Bay Aquatic Reserve Stakeholder Group

Based on interest expressed by participants during the update of this management plan, DNR will begin convening an annual Fidalgo Bay Aquatic Reserve Stakeholder meeting to increase collaboration and decision-making about the reserve. The stakeholder group represents a larger, more diverse group of participants than the CSC with a broad array of interests and perspectives. The annual meeting will help guide implementation of this plan and coordinate stewardship strategies that may improve and protect the long-term health of the Fidalgo Bay ecosystem.

The stakeholder group will advise and assist with the cooperative implementation of this management plan. This may include:

1. Identification of partnerships for implementing management actions;

2. Recommending and evaluating proposals for restoration, research, monitoring, and educational needs, with emphasis on results that will facilitate collaborative adaptive management;
3. Evaluate and consider potential sources of funding for implementing management actions.

The group is not required to operate on consensus, and DNR will consider comments from individual group members. The stakeholder group will meet annually, with at least one interim email update. The group includes approximately 32 members from a broad spectrum of representation, including:

- Adjacent landowners/residents
- Scientific community, including Western Washington University, Shannon Point Laboratory, and local scientists
- Skagit Marine Resources Committee
- Environmental non-profits, such as ReSources for Sustainable Communities, Skagit Land Trust
- Local industries, including Shell and Marathon representatives
- Local and State Government, including City of Anacortes, Port of Anacortes, Skagit County, WA Department of Fish and Wildlife
- Tribal government, including Samish Indian Nation and Swinomish Indian Tribal Community
- Community groups, including Fidalgo Bay Citizens Stewardship Committee

Potential new members will be invited to join the group by means of formal invitation, either by email or by letters.

Vision for the Future: Collaborative Adaptive Management

In the first ten years since the reserve's establishment, DNR and partners have learned a great deal about the status of species and ecosystem function in the reserve. As we move into the next ten-year period, we plan to collaborate with researchers and partners to refine monitoring objectives to understand how proposed restoration actions may affect the reserve. The stakeholder group can help with this process by identifying, on an annual basis, the key resources and issues that management should focus on, and continue to learn about in the next decade. Management decisions will be made based on objective data developed by a group of partners focused on shared goals and a willingness to learn, and adapt to new information. Meanwhile, the Citizen Stewardship Committee's regular meetings and organized efforts throughout the year provide on-going monitoring, communication with DNR staff, and essential education for building long-term support for the reserve.

DNR believes that collaborative partnerships are vital to the reserve management and strategy implementation. Excellent stewardship and management of a reserve stems from a close working relationship with the community, stakeholders, agencies, Tribes and non-profits. The work of program staff can be matched and multiplied through volunteer organizations, grants, and local partner organizations. High quality monitoring programs can be developed and research data collected with the support of university and college faculty that use and support the reserve. All these efforts lead to synergy among project partners and positive outcomes for both the site and the community that surrounds it.

8. References (Including Appendix A)

Anacortes American 1920. Article in the Anacortes American newspaper dated Aug. 12, 1920 reported that “contractors were to explode 75 tons of high explosives on the point, blow off the old mine, and "lift the whole point off and break it up to a great extent. Rock will be used for riprapping fill being put in across Fidalgo Bay." From Anacortes Museum on-line photo repository [Internet].[Cited14-Mar-19]. Available from https://anacortes.pastperfectonline.com/photo/88A7E967-68C2-4E63-8C22-145987155681

Anacortes Museum 2019. Caption of Photo #WF 2126. Text accompanying an online photo of Weaverling Spit, quoting an Aug. 12, 1920 Anacortes American newspaper article. Online accessed on 3/14/19. https://anacortes.pastperfectonline.com/photo/88A7E967-68C2-4E63-8C22-145987155681

Andeavor 2018 [Internet]. [Cited 15-Dec-18]. Available from http://www.andeavor.com/refining/anacortes/

Armstrong, D.A., J.L. Armstrong, and P. Dinnel. 1987. Ecology and population dynamics of Dungeness crab, Cancer magister, in Ship Harbor, Anacortes, Washington. Final report. Aquatic Research Consultant Services (ARCS). Prepared for Leeward Development, Inc. and the Washington Department of Fisheries, Olympia.

Antrim, L.D., A.B. Borde, R.M. Thom, and J.A. Southard. 2003. Plan for Habitat Protection, Restoration,and Enhncement, Fidalgo Bay and Guemes Channel. Prepared by Batelle Marine Sciences Laboratory, Sequim, WA, for the City Of Anancortes, 54p.

Bailey, A., Ward, K. & Manning, T. 1993. A Field Guide for Characterizing Habitats Using a Marine and Estuarine Habitat Classification System for Washington State. Olympia, WA: DNR Nearshore Habitat Program.

Beamer, E., A. McBride, R. Henderson, J. Groffith, K. Fresh, T. Zackey, R. Barsh, T. Wyllie-Echeverria, and K. Wolf. 2006 Habitat and fish use of pocket estuaries in the Whidbey Basin and North Skagit County Bays 2004 and 2005. Skagit River System Cooperative, La Conner, WA.

Beamer, E.M. and A. McBride. In draft. North Fidalgo Island nearshore habitat restoration vision. Skagit River System Cooperative, La Conner, WA.

Beamer, E.M., A. McBride, R. Henderson, and K. Wolf, 2003 [Internet].The importance of non-natal pocket estuaries in Skagit Bay to wild Chinook salmon: an emerging priority for restoration, Skagit River Systems Cooperative, La Conner, Washington, 9p. [Cited 04-Apr-19] Available from http://skagitcoop.org/documents/

Bilienikoff, N., Shell, email communication on file, personal communication 2/6/2018 and 2/28/2019

Brennan, J.S., and H. Culverwell. 2004 Marine Riparian: An Assessment of Riparian Functions in Marine Ecosystems. Published by Washington Sea Grant Program Copyright 2005, UW Board of Regents Seattle, WA. 34 p

Carteret, B. 2019. Friends of Skagit Beaches personal communication by email 2019. On file at DNR Aquatics, Olympia WA.

City of Anacortes 2019a. Anacortes Municipal Code, Section 17 (zoning definitions and descriptions). Available from
https://anacortes.municipal.codes/AMC

City of Anacortes 2019b [Internet]. Online GIS map, city zoning data [Cited 03-Apr-19]. Available at
http://anacortesgis.maps.arcgis.com/apps/PublicInformation/index.html?appid=ca9c713831414cfea7eb6a3d5b35ef6f

City of Anacortes. 2000. Revised Final Integrated Fidalgo Bay-Wide Plan & EIS.

City of Anacortes 1999. South March Point Comprehensive Drainage Study. Prepared by LBS Inc. 20p. Adopted January 18, 2000. City of Anacortes Department of Planning and Community Development, Anacortes, WA.

City of Anacortes. In review. Shoreline Master Plan.

City of Anacortes. 1999. South March Point Annexation Comprehensive Drainage Study. Prepared by Leonard, Boudinaot & Skodje Inc., 20p

Christiaen, B. DNR SVMP, email sent 1/28/2019).

Cohen, A, Mills, C., Berry, H., Wonham, M., Bingham, B., Bookheim, B., Carlton, J., Chapman, J., Cordell, J., Harris, L, Klinger, T., Kohn, A., Lambert, C., Lambert, C., Li, K., Secord, D., & Toft, J. (1998). Puget Sound Expedition: A Rapid Assessment Survey of Non-indigenous Species in the Shallow Waters of Puget Sound. Olympia, WA: DNR Nearshore Habitat Program.

DAHP 2018. Washington Department of Archaeologic and Historic Preservation database accessed by DNR Cultural Resource Specialist Maurice Major on 12/2019.

Dethier, M.N. 1990. A Marine and Estuarine Habitat Classification System for Washington State. Washington Heritage Program. Department of Natural Resources. 56pp. Olympia, WA.

Dinnel, P.R., M. Schwertner, R.Barsh, J. Robinette, I. Dolph, J.Giboney and R.Knowles. 2005. Restoration of the native Oyster in Fidalgo Bay: Year Three Report. Report by Skagit Marine Resources Committee for the Northwest Straits Commission, Mount Vernon, Washington. 20pp + Appendices.

Dinnel, P. 2018. Restoration of the native oyster, *Ostrea lurida*, in Fidalgo Bay, Padilla Bay and Cypress Island. Year sixteen report. Final Report by Skagit County Marine Resources Committee for the Northwest Straits Commission, Mount Vernon, WA. 54 pp.

Dionne, Phill, WDFW, personal communication, 2/1/2019.

Eissinger, A.M. 2007. Great Blue Herons in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Federal Register. 2005b. Endangered and threatened wildlife and plants; designation of critical habitat for the bull trout; Final Rule 70(185):56212-56311.

Friends of Skagit Beaches 2016 [Internet]. Trail Tales – History and Culture, Mitchell's Log Booming. Educational web page, and accompanying interpretive sign along the Tommy Thompson Trail. Reference for # of rail cars dumping logs into Fidalgo Bay [Cited 03-Apr-19]. Available from
https://skagitbeaches.org/history/mitchells-log-boom.html

Friends of Skagit Beaches 2015 [Internet] Trail Tails Fidalgo Bay interpretive web page (Mitchell Log Booming) with accompanying signage [Cited 03-Apr-19] Available from https://skagitbeaches.org/history/mitchells-log-boom.html

Greiner C.M., Klinger T., Ruesink J.L., Barber J.S., and Horwith M.J. 2018. Habitat effects of macrophytes and shell on carbonate chemistry and juvenile clam recruitment, survival, and growth, Journal of Experimental Marine Biology and Ecology [Internet]. [Cited 03-Apr-19] Available from doi.org/10.1016/j.jembe.2018.08.006

Grossman, E., B. Labiosa and P. Barnard, 2018 [Internet]. PS-COSMOS Puget Sound Coastal Storm Modelling System. USGS Pacific Coastal and Marine Science Center [Cited 03-Apr-19]. Available from
https://www.usgs.gov/centers/pcmsc/science/ps-cosmos-puget-sound-coastal-storm-modeling-system?qt-science_center_objects=0#qt-science_center_objects

Hodges, Charles. 2003. Cultural Resources Reconnaissance for the Thompson Trail Project, Phase 2 City of Anacortes, Skagit County, Wa. NWAA Report Number WA03-11. Northwest Archaeological Associates, Seattle WA.

Horwith, M. WDNR, personal communication, 2/7/19

Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of Seal and Sea Lion Haulout Sites in Washington. Washington Department of Fish and Wildlife1, Wildlife Science Division, 600 Capitol Way North, Olympia WA. pp. 150.

Johannessen, J. and A. MacLennan. 2007. March Point Geomorphic Assessment & Restoration Prioritization. Prepared by Coastal Geologic Services Inc. for Skagit Marine Resources Committee and Skagit County Public Works, Mount Vernon, WA Johannessen, J. and A.

MacLennan, 2007. March's Point Geomorphic Assessment and Drift Cell Restoration Prioritization. Prepared for Skagit County Marine Resources Committee.

Major, M. 2019. Personal communication by email 12/13/18. Washington DNR Cultural Resources Specialist. On file at DNR Aquatics, Olympia WA.

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assessment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, Oregon State University, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.

National Oceanographic and Atmospheric Administration (NOAA) 1917 [Internet].Anacortes Harbor (chart). NOAA's Historical Map and Chart Collection[Cited 03-Apr-19]. Available from https://historicalcharts.noaa.gov/historicals/preview/image/6377-4-1917

Johnson, A. 1997. Survey for Petroleum and Other Chemical Contaminants in the Sediments of Fidalgo Bay. Washington Department of Ecology Pub. No. 97-338. 40p.

Johnson, A. 2000. Sediment quality on the west side of inner Fidalgo Bay. Washington Department of Ecology Pub. No. 00-03-007. 17p.

LaClair, WDFW, personal communication, 1/17/2019.

Lanksbury, J. WDFW, personal communication, 2/1/, Shell, email communication on file, 2/6/20182019).

Lemberg, N. A., M. F. O'Toole, et al. (1997). 1996 Forage Fish Stock Status Report. W. S. D. o. F. a. Wildlife, Washington State**:** 82.

Murmane, J. July 1999. Personal communication. Cascade Drilling Inc. Woodinville,Washington. (Personal communication by Carlotta Cellucci)

Nearshore Habitat Program. 1999. Puget Sound Intertidal Habitat Inventory 1996 CD-ROM. Olympia, WA: DNR Nearshore Habitat Program. Skagit County Intertidal Habitat Inventory.

NOAA Tides and Currents. 2019 [Internet]. Datums - Port Townsend , WA. [Cited 03-Mar-19]. Available from https://tidesandcurrents.noaa.gov/datums.html?units=0&epoch=0&id=9444900&name=Port+Townsend&state=WA

Padilla Bay NERR. 2008. Padilla Bay National Estuarine Research Reserve Management Plan. Padilla Bay National Estuarine Research Reserve, Mount Vernon, Washington.

Penttila, D.E. 2001. Effects of shading upland vegetation on egg survival for summer-spawning surf smelt, Hypomesus, on upper intertidal beaches in Northern Puget Sound. In: Proceedings of

Puget Sound Research, 2001 Conference. Puget Sound Action Team, Olympia, WA.Penttila, D.E. Personal Communication. 2006. Washington Department of Fish and Wildlife, LaConner, WA.

Penttila, D.E. Personal Communication. 2/2/2019. Salish Sea Biological, Anacortes,WA.

Penttila, D.E. 1995. Baitfish resources and habitats of Fidalgo Bay, Skagit County, WA. Manuscript Report. Washington Department of Fish and Wildlife, Mount Vernon, WA.

Rice, C.A., 2006. Effects of shoreline modification on a northern Puget Sound beach: microclimate and embryo mortality in surf smelt. Estuaries and Coasts 29(1):63-71.

Ridolfi 2008. Fidalgo Bay Causeway Feasibility Study Report. Prepared for Samish Indian Nation by RIDALFI Inc.

Ridolfi. 2014. Samish Indian Nation Fidalgo Bay Salt Marsh Restoration Feasibility Study, Anacortes, WA. Prepared for the Samish Indian Nation, RIDOLFI Inc.

Ruby, Robert H. and John A. Brown. 1992. A Guide to the Indian Tribes of the Pacific Northwest. University of Oklahoma Press, Norman.

Sandell, T, Lindquist A., and Dionne ,P. 2018. 2016 Washington State herring stock status report. Washington Department of Fish and Wildlife, SS FPA 16-0x.

Sandell, T. Lindquist, A. and Stick K. WDFW 2016 Washington State Herring Stock Status Report January 2018.

Shell. 2018 [Internet]. Puget Sound Refinery. [Cited 15-Dec-18]. Available from https://www.shell.us/about-us/projects-and-locations/puget-sound-refinery.html

Simenstad, C.A., B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of Ferry Terminals on Juvenile Salmon Migrating along Puget Sound Shorelines. Phase I.

Simenstad, C. A., W. J. Kinney, S. S. Parker, E. O. Salo, J. R. Cordell, and H. Buechner. 1980. Prey community structures and trophic ecology of outmigrating juvenile chum and pink salmon in Hood Canal, Washington: A synthesis of three years' studies, 1977-1979. Final Rep., Univ. Wash., Fish. Res. Inst., FRI-UW-8026. Seattle, WA. 113 pp.

Skagit County 2016. Skagit County Shoreline Master Program Public Comment Draft Feb. 4, 2016[Internet]. [Cited 03-Apr-19]. Available from https://www.skagitcounty.net/Departments/PlanningAndPermit/SMPmain.htm

Snover, et al. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle..

Spencer L.H., Horwith M.J., Timmins-Schiffman E., and Roberts S.B. 2019. Pacific geoduck (Panopea generosa) resilience to natural pH variation, Comparative Biochemistry and Physiology – Part D: Genomics and Proteomics [Internet] [Cited 03-Apr-19] 30:91-101 Available at doi.org/10.1016/j.cbd.2019.01.010

U.S. Department of Commerce and Washington Department of Ecology. 1980. Final Environmental Impact Statement: Padilla Bay Estuarine Sanctuary.

Venkataraman Y.R., Timmins-Schiffman E., Horwith M.J., Lowe A.T., Nunn B., Vadopalas B., Spencer L.H., and Roberts S.B. 2019. Characterization of Pacific oyster Crassostrea gigasproteomic response to natural environmental differences, Marine Ecology Progress Series [Internet] [Cited 03-Apr-19]. 610:65-81. Available from doi.org/10.3354/meps12858

Vines, C.A., T. Robbins, F.J. Griffin, and G.N Cherr. 2000. The effects of diffusible creosote-derived compounds on development in Pacific herring (Clupea pallasi). Aquatic Toxicology 51 Todd Woodard, Samish Indian Nation DNR, personal communication via email, on file, 2/05/19 (2):225-239.

Wandler, R. Skagit Land Trust, personal communication via email 3/7/2019.

Washington Department of Ecology. 2019 [Internet]. Fidalgo and Padilla Bay Cleanups. Page describing multiple toxic cleanup and restoration efforts in Fidalgo Bay[Cited 08-Apr-19]. Available from https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Cleanup-sites/Toxic-cleanup-sites/Puget-Sound/Fidalgo-Padilla-baywide

Washington Department of Fish and Wildlife website [Internet]. [Cited 11-Feb-19]. Available from https://wdfw.wa.gov/ais/nuttalia_obscurata/

Washington Department of Fish and Wildlife [Internet]. European Green Crab webpage. [Cited 18-Feb-19]. Available from https://wdfw.wa.gov/species-habitats/invasive/carcinus-maenas

Washington Department of Natural Resources Nearshore Habitat Program SVMP. 2019. Unpublished data.

Washington Department of Natural Resources. 1999. Environmental site assessment, Fidalgo Bay Environmental Survey, Skagit County, Washington. Prepared by Tetra Tech, Seattle, WA. 69p.

Washington Department of Natural Resources. 2006. Amended Conservation Easement signed Oct. 23, 2006 between the Skagit Land Trust and Washington Department of Natural Resources. On file at DNR Aquatics Division, Olympia WA.

Washington State Department of Health. 2010. Health Consultation - Fidalgo Bay [Internet]. Under Cooperative Agreement with the US Agency for Toxic Substances and Disease Registry, Dept. of Health and Human Services, Feb. 25, 2010 [cited 03-Apr-19]. Available from https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-223.pdf

Washington Department of Transportation, 2017 [Internet]. WSDOT Traffic GeoPortal web-based mapping application. Highway 20 Traffic Data (2017), Annual Average Daily Counts [Cited 03-Apr-19]. Available at http://www.wsdot.wa.gov/data/tools/geoportal/?config=traffic&layers={%22layer0%22:[],%22layer1%22:[0,1,2,3,4],%22layer2%22:[0,1],%22Traffic+Data%22:[0,1],%22PTR+Sites%22:[0,1],%22Located+Segment%22:true,%22Located+Milepost%22:true}&center=-122.55731217559931%2C48.45770565454274&zoom=7

Washington State Office of Fiscal Management. 2018. County Growth Management Population Projections by Age and Sex: 2010–40[Internet]. [cited 1-Dec-18]. Available from https://ofm.wa.gov/sites/default/files/public/dataresearch/pop/GMA/projections17/GMA_2017_county_pop_projections.pdf

Williams, B.W., S. Wyllie-Echeverria, A. Bailey. 2003. Historic Nearshore Habitat Change Analysis for Fidalgo Bay and Guemes Channel. Prepared for the City of Anacortes by Battelle Marine Sciences Laboratory. Sequim WA. 29pp + Appendices.

Wonham, M, M. O'Connor, and C. Harley. 2003. Multiple positive interactions among mudflat invaders. Presented during the Third International Conference on Marine Bioinvasions, La Jolla, CA. March 16-19, 2003.

Woodard, T. Samish Indian nation DNR, personal communication, 2/1/2019.
Woodard, T. Samish Indian Natio

Appendix A – Fidalgo Bay Site Characteristics

NOTE TO REVIEWERS

Over the past several months DNR has worked to update important information on ecosystem conditions and stressors.

A big thank-you to our subject experts who have already provided excellent input!

While the draft presented here contains much updated information, it is still incomplete, and DNR is still actively working to gather additional information. We are especially awaiting additional information to update our knowledge of sediment and air quality sections.

Please let us know of any additional studies, reports, sources or results we should incorporate for any topic area.

Appendix Organization

The Fidalgo Bay Aquatic Reserve contains diverse physical habitat areas that include emergent salt marsh, sand and gravel beaches, and extensive tidal flats and eelgrass beds. These habitat areas are recognized as essential contributors to the reproductive, foraging, and rearing success of many fish, invertebrate and bird species. A primary motivation for creating this reserve was to preserve critical herring spawning habitat. Due to development in northern portions of the Bay, and uncertainty regarding factors negatively affecting the Fidalgo Bay herring population, protection of herring spawning habitat is still a critical resource issue in Fidalgo Bay, as it is throughout marine nearshore areas of the Salish Sea.

Section 1 “Environmental Setting” provides a broader overview of the physical and biological characteristics within or adjacent to the aquatic reserve. The major physical processes described are tidal regime, circulation, wave and current exposure, net shore drift, fresh water and sediment input. These processes — coupled with landforms and sediment types — provide the foundation and constraints for the biological community within and adjacent to the Fidalgo Bay aquatic reserve. A brief description of the primary habitat types, species and their distribution summarizes the ecological conditions. Understanding the processes and functions in Fidalgo Bay helps guide aquatic land management actions that influence the reserve and its associated ecological relationships.

Section 2 “Current Environmental Conditions and Ecosystem Stressors” presents our collective knowledge of the current physical, biological and environmental conditions affecting the health of the aquatic reserve, with particular focus on the ecosystem stressors contributing to these conditions.

All Appendix references can be found combined in Section 8 of the Management Plan.

ENVIRONMENTAL SETTING

Physical Environment

Regional Physiography

Fidalgo Bay occupies an ancient delta of the Skagit River consisting of generally shallow mudflats that drop off steeply away from an arc that runs south and east from Cap Sante Head (City of Anacortes 2000). Spits are prominent landform features on both sides the bay. Extending out from the northeastern shore are Crandall Spit and the less pronounced Little Crandall Spit. Weaverling Spit sweeps out from the western shoreline trending out to the southeast about a third of the way across the bay. Structural remnants of a railroad trestle, constructed in the 1890s bisect the bay at Weaverling Spit, constricting water and sediment movement in the southern portion of the bay. Extensive intertidal sand/mudflats occupy nearly all the tidal area south of the railroad trestle (Map C-5). The sand/mudflats north of the trestle include some lower intertidal areas but are mostly subtidal with depths shallower than 12 feet below mean low lower water (MLLW).

The general bathymetry north of the bay consists of a fairly deep channel reaching depths greater than 10 fathoms (60 feet) within Guemes Channel and extending eastward to Hat Island, where it turns northward. The oil refinery loading docks located off March Point are constructed to reach these deeper waters and regular dredging maintains a minimum channel depth of approximately 40 feet in this area. A deep, circular hole lies between Cap Sante — the southeast point on Guemes Island — and Hat Island, with depths in excess of 40 fathoms (City of Anacortes 2000).

Across the northern portion of the bay, two navigation channels have been dredged providing medium draft boats clear passage to marinas and industrial properties along the eastern shoreline (City of Anacortes 2000). Along the northeastern shoreline of the bay about a quarter mile offshore, a natural channel about 15- to 20-feet deep (MLLW) continues south maintaining a narrow channel under the railroad trestle. Steadily shoaling south of the trestle, the channel diffuses into a fan-shaped, permanently flooded area of approximately 4-6 feet deep (MLLW). About a quarter of the way into the south bay, continued shoaling gives rise to extensive mudflats creating the dominant feature of the inner bay.

Due to its salinity profile, proximity to the ocean, and at least occasional freshwater runoff, Fidalgo Bay exhibits estuarine water regime characteristics (Dethier 1990). From May 2006 to May 2016, the Samish Indian Nation environmental staff regularly sampled at three water quality sites throughout the bay. The recorded salinities range between 23.3 parts per thousand (ppt.) and 35.59 ppt. with an average of 29.18 ppt. (T.Woodard, Samish Indian Nation, personal communication, 2019). These data technically represent higher transitional salinities than a typical estuarine regime. However, geographic location, the morphological character of the bay, the biological assemblage and functions, and predominantly estuarine processes, sustain an estuarine water regime category (Dethier 1990).

Watershed-Drainage Basin description

The south Fidalgo Bay drainage area flows primarily north into the bay and encompasses approximately 1,575 acres. The area is divided into two primary sub-basins with two additional sub-basins. The largest sub-basin is located west of Highway 20 and is primarily steep and forested, with small residential and commercial facilities in the vicinity of Highway 20 and the Highway 20 spur to Anacortes. There are several crossings of the Highway 20 spur, all of which discharge into Fidalgo Bay almost immediately after crossing the road. The area east of Highway 20 also drains into Fidalgo Bay. This region encompasses a mix of commercial, residential, and forested uplands (some with conservation easements), and includes a portion of the Similk Beach golf course (now Swinomish Golf Links). (Anacortes S. March Pt. Annexation Comprehensive Drainage Study 1999).

Two smaller sub-basins are located north of Highway 20: One sub-basin drains westerly via ditches and culverts into an area at the southeastern side of the bay. This area is separated from the bay by a dike. The fourth sub-basin, on the east side of the bay, drains westerly from the ridge crest of the March Point Peninsula towards Fidalgo Bay.

Surface water and Runoff

No major freshwater streams flow into the Fidalgo Bay Aquatic Reserve area. However, just south of Anacortes Marina, Ace of Hearts Creek flows down from Heart Lake and maintains minimal year round flow into the bay. Most freshwater input is limited to runoff into the bay (non-point sources), a few small intermittent creeks, and numerous outfalls. Surface water input at the south end of the bay has mostly been cut-off by Highway 20. Runoff throughout the southwest basin is primarily collected in roadside ditches and conveyed towards the golf course, where it is pumped across Highway 20. The pump station, owned by Skagit County, consists of a pump house located between Similk Beach Golf Course and Highway 20. The pump station is surrounded by ditches, which run adjacent to Highway 20, and a large pond that is incorporated into the golf course. According to information received from the County, the runoff discharges through an 18-inch water main at up to 7,500 gallons per minute. The estimated drainage area contributing to the pump station is 536 acres. During extreme storm events, water that backs up behind the pumping facility will pass through a culvert beneath Highway 20 and discharge into Fidalgo Bay (City of Anacortes, South March Pt. Annexation Comprehensive Drainage Study 1999). In 2018, a roundabout was constructed at Sharpes Corner along the southwest side of the bay. The project included use of best management practices, i.e., Compost Amended Vegetated Filter Strips (CAVFS). The project design exceeds the requirements of the Hydraulics Manual guidelines and the Highway Runoff Manual (HRM) to treat stormwater runoff. These Best Management Practices (BMPs) have the capacity to treat ~ 3.5 times more than the area required (Skagit County MRC Minutes, Meeting with WSDOT 1-11-18). [More details provided in the hyperlink to the shoreline variance.]

On the Shell Puget Sound Refinery property (east side of the bay), surface run-off from 558 acres of the refinery area is collected and directed to the refinery's wastewater treatment plant. In areas outside of the refinery's process units, run-off is collected through a network of ditches and culverts referred to as the 'clean water sewer' and directed to the stormwater pond (settling basin) to remove suspended solids, (N. Biletnikoff, Shell, personal communication, 2/28/2019). Shell treats process water, domestic wastewater, and stormwater in primary and secondary systems consisting of two tanks which serve as both surge and overflow tanks. The system includes a three bay API oil/water separator, three dissolved air flotation units, a pretreatment bioreactor; a three-bay oxidation channel, two clarifiers, and an intermediary retention basin, a stormwater pond, a final holding pond, and a chlorination system. Treated process water, sanitary wastewater, stormwater, and ballast water from the refinery are treated, tested and then discharged through an outfall approximately one mile out into Guemes Channel (Outfall 001). The outfall is a 24-inch multi-port submerged diffuser located at a water depth of 42 feet MLLW [Dept. of Ecol. NPDES Permit Fact Sheet, 2016].The remaining area draining into the east side of the bay includes a few small intermittent streams which form during times of high precipitation, and small areas with limited surface run-off that drains into ditches along the West March's Point Road and discharges into the bay (City of Anacortes 2000).

The city of Anacortes, to the west, has three combined sewer overflows that discharge into Guemes Channel, to the north and west of the reserve. However, the stormwater outfall collected from city streets and parking lots drain untreated into the Fidalgo Bay (City of Anacortes 20xx). There are twenty-four city outfalls that drain directly into Fidalgo Bay in close proximity to the aquatic reserve area. The Samish DNR have sampled outfalls in Fidalgo Bay since 2005. At a few sites, where they had identified high fecal coliform counts related to a City outfall, they have worked with the city to investigate and resolve some of these issues. The city and the Samish Tribe will continue to collaborate with water quality sampling in the Fidalgo Bay watershed as well as other stormwater related projects. Other projects to improve stormwater treatment flowing into the bay include part of the Custom Plywood Mill cleanup project. Washington State Department of Ecology (DOE) constructed a bioswale and pocket estuary for stormwater flowing down from the area of 34th Street and possibly Fidalgo Bay Road above the area. During wet months the pocket estuary has standing water that varies with tidal influence but during the summer it is primarily dry (B. Carteret, personal communication, 2019).

Groundwater

Information regarding groundwater-monitoring wells installed near West March's Point Road by Cascade Drilling, Inc. states that groundwater was first encountered at a depth of approximately 15 feet below land surface (J. Murnane, personal communication,1999). In this same vicinity, Shell Puget Sound Refinery has 128 groundwater wells on their property, some are regularly monitored and others intermittently monitored (20 percent have been decommissioned after post-closure). Groundwater depths on the west side of March Point vary between approximately 5 to 30 feet below the surface depending on the wetness of the season (Biletnikoff, Shell, personal communication, 2019). Given suitable soil types, the groundwater surface in an unconfined aquifer will mimic local topography, and groundwater will flow toward topographic lows (DNR 1999), the direction of shallow groundwater flow is predominantly toward Fidalgo Bay. The ground water flow rate towards Fidalgo Bay is approximately 110 feet per year (Rhodes, personal communication). A portion of freshwater flow, originating from groundwater flows, still seeps directly into the bay, particularly in the south end of the bay.

Upland Surficial Geology

In general, the soils within the Fidalgo Bay drainage area consist of moderately deep (poorly drained and moderately drained), level-to-steep soils on terraces and hills. The soil groups include approximately 44 percent Bow soils, 21 percent Coveland soils, and 20 percent Swinomish soils. The remaining 15 percent are components of minor extent.

Bow soils overlay glacial remnant terraces, and are described as very deep and somewhat poorly drained. The surface layer is gravelly loam over very gravelly sandy loam about 14 inches thick. The upper layer of the subsoil is gravelly loam about 8 inches thick. The lower part of the subsoil, to a depth of 60 inches or more, is clay loam over silty clay. Coveland soils are located on swales on glaciated hills and are described as very deep and somewhat poorly drained. The subsoil and substratum to a depth of 60 inches or more are silty clay.

Swinomish soils are located on glaciated hills. The soils are characterized as moderately deep and moderately well drained. The surface layer and upper part of the subsoil are gravelly loam about 20 inches thick. The lower part of the subsoil and the substratum are very gravelly sandy loam about 11 inches thick over dense glacial till. Depth to dense glacial till ranges from 25 to 40 inches (U.S. Department of Agriculture Soil Conservation Service 1989). There are a few areas of exposed bedrock (sedimentary rocks including sandstone and breccias), along the south and western sides of the bay.

Intertidal and Subtidal substrate

Intertidal substrates within Fidalgo Bay include mud, sand, and gravel/cobble sediments, as well as, limited areas of natural bedrock and artificial hard substrates such as riprap, concrete, steel, and creosote wood pilings. Along the south fringe of the bay, associated with the rim of salt marsh plants, the substrate consists of sand, silt and clay mixed with decomposed organic matter. It includes peat deposits and locally inter-bedded layers of volcanic material (Pessl et al. 1989). The inner bay encompasses large tide flats of mixed fine clays, silts and sands that are predominant within the lower intertidal zone (approximately 2 feet above MLLW, to approximately -4.0 feet below). Subtidal sediments include mud bottoms with varying amounts of sand, gravel or cobble substrates, as well as, hard bottom areas that are both natural and man-made (City of Anacortes 1999).

Mixed sand and gravel substrates dominate the upper intertidal shoreline along both sides of the bay. The western shore has a few areas where there is exposed bedrock, but surficial unconsolidated sediments are dominant and vary between 0 - 3 meters deep (Pessl et al. 1989). Along the eastern shore of the bay including Crandall and little Crandall spits to just south of the trestle, a narrow patchy band of pea gravel and coarse sand exists in the upper intertidal zone. These substrates are well suited for forage fish spawning and have been documented as regular surf smelt spawning areas. A few zones of predominantly “fluffy sands” also are utilized as sand lance spawning substrate (D. Penttila, Salish Sea Biological, personal communication, 2019).

Additionally, DNR’s 1996 Intertidal Habitat Inventory includes a classification of intertidal substrate types for Fidalgo Bay (DNR 1996). However, these polygon delineations do not depict finer scale variations in substrate composition, such as upper intertidal mixed sand and pea gravel necessary for forage fish spawning habitat.

Shoreline Characteristics

The majority of the shoreline in Fidalgo Bay has been extensively modified and armored. Shoreline filling and armoring, such as “riprap” and concrete bulkheading dominate the eastern and western shorelines in the bay. Of the 6 linear shoreline miles in or directly adjacent to the Reserve, 4 miles have been hardened or modified. Williams et al. (2003), report that most of the shoreline has been filled and approximately 73.8 percent of the shoreline in the greater Fidalgo Bay area has been armored. This includes the highly developed northwest shoreline from inside Cap Sante Head, south to slightly north of Weaverling Spit. Beach restoration projects improved more than 1600 feet of shoreline adjacent to the Samish RV Park and DOE clean-up sites, (the old Scott Paper Mill and the Custom Plywood Mill site), also had beach armoring removal and beach restorations, improving the characteristics of this section of shoreline. Less armoring and fill have taken place in the rest of the bay, however the percent of shoreline armored is greater than 60 percent (Williams et al. 2003).

The backshore areas and a considerable amount of the adjacent upland surrounding the bay is cut-off by shoreline armoring, which prevents the natural sediment replenishment of the beaches. Also, associated with shoreline development and armoring is the removal of riparian vegetation. In the area previously mentioned on the northwest side of the bay and along the roadsides, especially March's Point Rd, most of trees and woody shoreline vegetation has been denuded. Some bluffs of unconsolidated materials are located just north of Weaverling Spit, however, erosion of these bluffs and the sediment influx into the bay is practically eliminated by riprap or other armoring.

Physical Processes

Tides

Tides within the region and bay are a mixed semi-diurnal tidal cycle, with two lows and two highs of different sizes each day, and an average range of 1.5 meters between low and highs. The bay experiences moderate tidal currents with various wave regimes (National Ocean Survey Tide Tables 1980). At Anacortes, the mean tide range, defined as the average difference in height between Mean High Water (MHW) and Mean Low Water (MLW), is approximately 5 feet (City of Anacortes 1999). The diurnal tide range, defined as, the average difference in height between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) is 8.5 feet. Each day 50 to 60 percent of the water in Fidalgo Bay is flushed out and refilled by tidal currents (Antrim 2005). Flood tide currents flow northeast from Guemes channel, then south into Fidalgo Bay and reverse on the ebb tide. Observations of the subject property during high tide conditions revealed that the entire subject property is inundated with water, with the tops of several eelgrass patches exposed. Observations were subsequently made during a minus low tide condition approximately 6.5 hours later, revealing that approximately two thirds of the area south of the trestle is exposed tidal flat (Antrim 2005).

Wave Energy

Energy classifications as defined by Bailey et al. (1993) describe the relative degree of physical energy from waves and currents. These energy designations are applied to broad areas and describe landscape-level characterization of intertidal energy.

Fidalgo Bay fetch distances are generally short for westerly, easterly, and southerly winds. The strongest wind and wave energy originates from the northern part of Fidalgo Bay and travels most strongly towards March Point. The waves dissipate as they travel along the eastern shore of the aquatic reserve. Smaller waves generated from north Fidalgo Bay head directly south and are mostly deflected by Weaverling Spit. This northern portion of the bay is characterized as maintaining a "partly enclosed" energy level (Bailey et al. 1993). This classification refers to bays partially enclosed by headlands, bars, spits, or artificial obstructions reducing circulation. Wave action occasionally is strong enough to maintain a mixed sand/gravel intertidal substrate that is used for forage fish spawning. Crandall Spit and the railroad trestle also deflect and dissipate the wave energy from heading farther into the south end of the bay. Since this southern portion of the bay is largely enclosed, it has been classified at the lowest wave energy level as a "lagoon", receiving little wave or current energy.

Water Currents

Due to the shallow depth of the bay and relatively large tidal range, tidal currents dominate the movement of water into and out of Fidalgo Bay (City of Anacortes 1999). These currents are affected to some extent by winds. Freshwater within the system also slightly affects the tidal circulation. As freshwater enters nearshore areas, it begins moving seaward over several tidal cycles. In return, the more saline waters present at depth are drawn landward. Within the bay there is little mixing between the east and west side of the bay. Through the Olympia oyster restoration project, recent years of data with Olympia oyster natural recruitment in Fidalgo Bay, reveal largely north-south flowing currents during the summer on each side of the bay (Eric Grossman, USGS, personal communication, 2018).

Current meter records available for Guemes Channel and Fidalgo Bay indicate that the apparent net flow within Guemes Channel is westward into Rosario Strait at all depths measured. Typical net flow velocities range from approximately 5 to 30 centimeters per second (0.1- to 0.6 knots). The deeper ocean water entering into the Fidalgo Bay region is most likely from Haro Strait, which then returns southward either via Rosario Strait. Insufficient measurements are reported from within Fidalgo Bay to assess either the net circulation or tidal current strengths. However, drogue (apparatus used for current analysis) trajectories have shown movement of water during ebb tide conditions from the March Point piers almost directly northwestward toward Cap Sante. Drogue and drift stick observations available within the bay are of such short duration and areal extent, that they do not contribute greatly to an understanding of tidal circulation patterns within the bay (City of Anacortes 1999). In general, due to the bay’s shallow depths, water entering and exiting the bay first follows or is drawn to the deeper channels. Once filled, and during slack tides, surface water movement is primarily wind driven.

North of the subject area, visual observations, plus drift stick and drogue trajectories performed in previous studies, revealed that generally strong flood tides pass through Guemes Channel and begin to spread out after passing Cap Sante. Those headed east split as they reach Hat Island, heading either north or southwest into Padilla Bay, and deeper waters stay within the deep channel headed north. After passing Cap Sante, a portion of the surface flow rotates southward into Fidalgo Bay, and a large clockwise rotating eddy is reportedly formed to the east and south of Cap Sante during flood tides, causing a northward-directed current along its eastern face (City of Anacortes 1999). Ebb currents that leave Fidalgo and Padilla Bays converge with currents headed south from Samish Bay, merging west of Hat Island. A convergence zone where surface debris collects is often located south to southwest of Hat Island during ebb tides. Due to the water leaving Fidalgo Bay, during ebb tides a small counterclockwise eddy likely exists just north of Cap Sante. During both strong flood and ebb currents, back eddies along both shorelines have been noted, especially shoreward of piers (City of Anacortes 1999).

Net shore-drift

Net shore-drift is the long-term, net effect of shore drift occurring over a period of time along a particular coastal sector, also referred to a drift cell (Jacobsen and Schwartz 1981). A drift cell is defined as consisting of three components: a site that serves as the sediment source and origin of a drift cell; a zone of transport, where wave energy moves drift material alongshore; and an area of deposition that is the terminus of a drift cell. Deposition of sediment occurs where energy is no longer sufficient to transport the sediment in the drift cell (MacLennan 2010). Coastal

Geologic Services mapped drift cells and analyzed current net-shore drift patterns in the Fidalgo Bay area in 2007, see Map C-6.

A drift cell occurs in the northwest sector of the bay, just south of the marinas, with net drift southward to the tip of Weaverling Spit. The shoreline in this sector was completely modified and therefore largely eliminates upland sediment input to the spit. As a result, scouring has taken place along the northern base of the spit due to the limited sediment sources and increased energy down drift from the shoreline armoring (Aundrea McBride, *pers. comm*. 2007). Since 2014, three phases of beach restoration covering approximately1600 feet of shoreline on the northwest side of Weaverling spit have restored some of the natural dynamics of this drift cell. The beach face was transfigured to accommodate a soft-armored backshore area with a significant quantity of sediment added to elevate the beach profile. Logs are systematically placed and anchored cross-shore in the mid to upper intertidal zone to moderate sediment movement down drift. Just north of the reserve boundary, up-current in this same drift sector, wood waste and sediment clean-up of the Custom Plywood Mill have added to improve overall habitat and sediment quality in this portion of the bay.

On the east side of Fidalgo Bay, nearshore drift from the northern end of March Point is predominantly westward, (north of the reserve). The westward littoral drift sector forms Crandall Spit at the northeast corner of the reserve. Areas of deposition include the beaches at Crandall Spit, however analysis by Johannessen (2007) shows this drift sector is sediment starved by evidence of significant loss in area to Crandall Spit. Since, there are few remaining natural sources for shoreline sediment along this drift sector, this appears to be affecting Little Crandall Spit as well. A northerly drift sector lies north of Little Crandall Spit along a lightly modified shoreline.

Within the south bay area, transport processes move lightly to the north along the eastern shoreline but are disrupted by widespread shoreline armoring and the railroad trestle. Originally constructed in 1891, the railroad trestle spanned the bay entirely on pilings. In 1950's the western portion of the trestle was modified with extensive fill and riprap built up around the pilings. This extensive modification extends along the south side of Weaverling Spit and continues more than half way across the bay. Although the remaining portion of the trestle is built on pilings that allow water flow, the entire structure has seriously hindered the natural flow patterns and continues to impede sediment distribution for the bay. The consequent and continual decrease in the tidal prism, with no appreciable drift at the head of the bay, has led to significant sediment deposition in the south bay (A. McBride, Coastal Geologic Services, personal communication, 2007).

Biological Environment

Habitat Resources

For the purposes of this report, we are specifically focusing on the ecosystem continuum of nearshore habitats adjacent to or within the boundaries of the aquatic reserve. The processes presented in the previous sections — such as tidal regime, circulation, wave and current exposure, net shore drift, fresh water and sediment input, coupled with landforms, sediment types, and anthropogenic alterations — provide the foundation and constraints for the biological community found within and adjacent to the reserve. Nearshore areas serving key habitat functions within or adjacent to the bay range from the deep-water mud and sand bottoms of outer Fidalgo Bay, to the emergent salt marshes along the southern fringe of the inner bay. Most of the adjoining backshore areas and uplands have been cut off from the bay by roads, shoreline armoring or other development.

Habitat Areas

Several distinct intertidal and shallow subtidal habitat areas exist within the bay. The upper intertidal areas intermittently support a fringe of emergent marsh vegetation on mixed fine substrate. Below this fringing marsh, in the southern end of the bay, is a broad crescent-shaped area of siltier tidal flats dissected by small tidal sloughs and with pronounced islets of *Salicornia*. At slightly lower elevations and farther out in the flats are isolated pillar-like hummocks with sparse remnants of sedge and other salt marsh vegetation on top. Extensive tidal flats of fine unconsolidated sand, silt and clays are inundated by the highest tides and form the bulk of the intertidal area in the south bay and the majority of the intertidal area in the reserve. This extensive area provides foraging and resting grounds for resident and migratory shorebirds, waterfowl, and fish. Mudflats in shallow embayments are also particularly critical as nursery and foraging habitat for many species of fish, particularly flatfish and other juvenile fishes. These low energy tidal flats contain productive microalgae and macroalgae and provide prime habitat for juvenile salmonid prey resources such as harpacticoids, copepods, and amphipods (*Corophium* spp.) (Healy 1979, Healy 1980, Simenstad et al. 1980).

Other intertidal habitat areas within the bay include mixed fine, gravel/cobble beaches, as well as limited areas of natural bedrock and artificial hard substrates such as pilings and riprap. Other salmonids, specifically, steelhead, sea-run cutthroat and anadromous bull trout are likely to utilize the low energy mixed gravel and cobble beaches of the bay for foraging and shelter (Healy 1982). In addition, areas of sand to mud bottom between the lower intertidal zone (approximately 2 feet above MLLW, and approximately -4.0 feet below MLLW) support patchy to lush growths of eelgrass (*Zostera marina).* Often a variety of macroalgae and epiphytes grow in association with the eelgrass. Other areas in the same depth range, but with scattered gravel/cobble substrates, support dense growths of macroalgae that maintain a variety of habitat functions. Macroalgae beds, dominated by soft brown kelp species often grow intermixed with the eelgrass. Other subtidal habitats include mud bottoms with varying amounts of sand and gravel, and some hard bottom areas that are both natural and man-made (City of Anacortes 2000).

Aquatic Vegetation

Eelgrass

Eelgrass beds of varying size and densities in Fidalgo Bay-Guemes channel-Padilla Bay provide unique expanses of vegetated habitat with connectivity covering about 7,000 acres. This extensive eelgrass is the largest areal coverage of this habitat type in the southern Salish Sea.

Eelgrass is the primary ecologically important habitat in the Fidalgo Bay aquatic reserve and supports multiple functions in the bay that include:

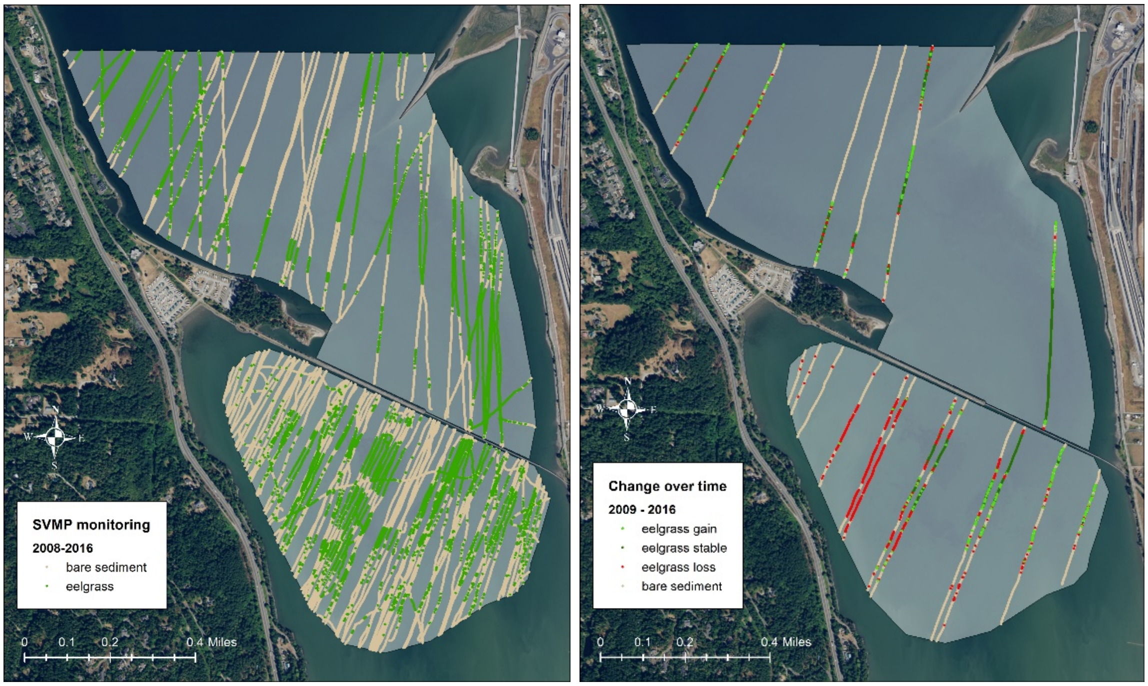
- providing substrate for epiphytic algae, epifauna, and substrate structure for spawning of Pacific herring,
- providing rearing habitat for juvenile salmon, crab, other fishes, by providing shelter and an abundance of prey species,
- altering the physical environment by modifying current and wave energy,
- providing shade and thus cooler water and higher dissolved oxygen during summer low tides,
- contributing to food webs - food for herbivores and detritivores via primary production,
- providing high capacity form for carbon sequestration,
- and buffering the local waters by sustaining lower levels of pH (Horwith, personal communication, 2/7/19)

Several distinct intertidal and shallow subtidal areas within the bay support lush growths of eelgrass (*Zostera marina*) which is a key habitat component of the bay. Eelgrass historically covered a large portion of the shallow subtidal areas in Fidalgo Bay at varying densities. The broad mudflats and other areas of the bay with better circulation appear to have sustained more or less continuous eelgrass beds (Figure A-1). The majority of the bay, however, now maintains patchy eelgrass beds with relatively low stem densities compared to the densities and expanses found in nearby Padilla Bay. Often a variety of macroalgae grow in close association with the eelgrass.

Fidalgo Bay eelgrass is critical spawning habitat for a declining northern Puget Sound herring stock. Historically, herring spawn was found wherever eelgrass existed in Fidalgo Bay, even in areas where eelgrass was only sparsely distributed. Eelgrass is found in the bay from +1 feet MMLW to -12 feet MLLW (Pentec 1994).

Significant loss of eelgrass and consequently herring spawning habitat has occurred in Fidalgo Bay. Historic losses occurred primarily from log storage practices, dredging, development and filling of the shoreline and intertidal areas particularly in the northern portions of the bay where there are several large marinas and concentrated commercial activity. Additionally, less extensive areas of eelgrass and macroalgae have been diminished by shading from overwater structures, such as the March Point piers and the railroad trestle. DNR Submerged Aquatic Vegetation Program (SVMP) has monitored eelgrass in the bay from 2004 to 2018. Bart Christiaen, from the SVMP staff conducted a recent trend analysis of Fidalgo Bay eelgrass monitoring data over the past decade.
"DNR surveyed Fidalgo Bay seven times between 2009 and 2018. During this period, there was on average 76 (± 5) ha of eelgrass within the boundaries of the aquatic reserve. The majority of eelgrass occurred north of the railroad trestle. Most eelgrass was found between -0.5 and -2 m (MLLW). Eelgrass had a more limited depth distribution in the southern part of the reserve. North of the railroad trestle, eelgrass was relatively stable over time. South of the trestle, eelgrass beds experienced a significant decline between 2009 and 2016. The decline was most pronounced at the western side of the Bay." (B. Christiaen, DNR SVMP, 2019).

Figure A-1. Comparison of SVMP eelgrass transects clipped to the reserve boundary. Left photo shows presence/absence for all transect locations over 7 total (?) sample years; Right photo shows transect gains, losses and stable locations at repeat transects taken in 2009 and 2016.



Because of these significant losses in both depth and spatial distribution and the uncertainty regarding factors limiting the Fidalgo Bay and other herring populations, WDFW and DNR consider the protection of eelgrass habitat, herring spawning habitat and other forage fish spawning areas to be a critical resource issue statewide.

Macroalgae

Intertidal and subtidal algae provide habitat for countless invertebrates and fish. Macroalgae (seaweed) provides many similar ecological functions as eelgrass beds —such as creating more habitat structure, and contributing to the higher productivity of the ecosystem. The macroalgae assemblage present in the reserve area is composed of many species adapted to a variety of habitat types. Overall, species distribution and coverage provides a broader distribution both vertically and laterally than eelgrass.

Within the upper intertidal areas of the bay, on hard substrates starting below approximately 6 feet MLLW, areas of dense growths of seaweeds are prevalent and are dominated by the perennial rockweed, *Fucus gardneri*, *Porphyra* spp., *Mastocarpus* spp. and ulvoids. The predominant seaweed assemblage in both intertidal and subtidal areas of unconsolidated mixed fine sediment are green algas, or ulvoids such as *Ulva*, *Ulvella* and *Enteromorpha*. Primarily in summer, these species are commonly present throughout intertidal areas often extending below MLLW and into eelgrass beds. These species also provide a variety of functions including supporting microhabitats for juvenile crab and other invertebrates and releasing nutrients back to the marine environment. A variety of red algae species, such as *Gracilaria pacifica*, and *Graciliariopsis sjoestedii are f*requently found intermixed with and adjacent to eelgrass beds which also provide a substrate for herring spawn deposition.

Other lower intertidal and shallow subtidal areas with scattered hard substrates support growths of large-bladed laminarian kelps, with the most common species being *Saccharina lattisima*

(*Laminaria saccharina)*, *Costaria costata* and the brown alga *Desmerestia* sp. Juvenile fishes including salmon, as well as Dungeness crab utilize the shallow subtidal macroalgae beds, for nursery, refuge and foraging areas.

Salt marsh

Although there are no large expanses of salt marsh habitat in the bay, fringing and patchy salt marsh areas provide important feeding and rearing habitat for many species of fish, shorebirds, invertebrates and other wildlife. Small patches of salt marsh rim the head of the bay and are dispersed along the shoreline on both sides of the inner bay including a pocket in the south corner of Weaverling Spit. These marsh areas are dominated by pickleweed (*Salicornia virginica*) and saltgrass (*Distichilus spicata*), as well as an occasional show of saltwort (*Glaux maritima*) and sea-side arrow grass (*Triglochin maritimum*). Crandall and Little Crandall spits also have small areas of upper intertidal salt marsh. A rim persists beneath the beach berm on both sides of Crandall Spit and in a small “embayment” encompassed by the spit.

These habitat areas are important to estuarine ecosystems like Fidalgo Bay (reference). The salt marsh bordering the southern boundary of the bay provides the necessary transition zone between freshwater and saltwater. Likewise, this area furnishes connectivity to the terrestial system adjacent to the reserve. This habitat also serves the functions of providing an impediment to erosion, a source of tidally exported detritus and nutrients throughout the bay, and shelter as well as, foraging ground for marine invertebrates, birds and juvenile salmon.

Berm vegetation

Berm vegetation is interspersed throughout the bay on both Crandall and Weaverling spits and in narrow fringes or small patches in the inner bay. Berm areas are beyond the reach of the highest tides, and are infrequently inundated by salt water - in the “spray zone”.
Since these locales are subject to salt spray and seldom get inundated, a different plant community subsists in this zone. The plant species identified in the bay are dune grass (*Leymus mollis*), gumweed (*Grindellia integrifolia*), Yarrow (*Achillea millefolium*), and Ambrosia (*Ambrosia artemisiifolia)*. The substrate is usually a mixture of sand and smaller gravel, with drift logs often present.

Freshwater Wetland

A few brackish and freshwater wetland areas have been identified in Fidalgo Bay and adjacent to the Aquatic Reserve. A map (xxx) details wetlands identified and classified under the National Wetlands Inventory and verified in subsequent mapping efforts. At the southeastern corner of the bay is a small seep wetland that is dominated by cattails (*Typha latifolia*). It is bisected by March’s Point Road and is also associated with stormwater runoff from the north side of Highway 20. This wetland is separated from the bay by a dike. As with many wetlands, this area functions as a water retention and filtration buffer, potentially improving water quality. On the bay side of the wetland, along the inner edge of the dike is a narrow band of obligate salt marsh plants indicating saltwater seepage through the dike into the outer edge of the wetland.

Fish and Wildlife

Most of the aquatic lands within the aquatic reserve area support a wide range of migratory and resident birds, fish and marine invertebrates. The extensive eelgrass beds are used annually in the late winter, by a small, and in recent years, barely present herring spawning stock. Additionally, Fidalgo Bay is identified as a juvenile and larval rearing ground for Dungeness crab, salmonids, herring and other marine fish. A large number of great blue herons feed in the bay year-round and substantial numbers of migratory birds are found in the bay in the winter. Extensive mudflats and fringing salt marsh attract shorebirds and juvenile fishes while the large, intact sand spits — Crandall and Weaverling spits — are important for forage fish spawning and marine bird refuge. The bay supports habitats and species similar to two other local bays — Samish Bay and Padilla Bay. Padilla Bay is a National Estuarine Research Reserve jointly managed by the National Oceanic and Atmospheric Administration (NOAA) and state Ecology.

In neighboring Padilla Bay and the nearby waters, at least 57 species of fish have been identified (US Dept. of Commerce 1980). Many of these species are likely to use nearby Fidalgo Bay with its similar habitat. In the last several years, the Samish Tribe has identified 30 species of fish in just two years of beach seining surveys. A partial list of fish species observed in Fidalgo Bay can be found in Appendix A, table 2.

Salmon

Limited observations have been made on salmonid distribution and abundance within the study area, however, more regular surveys are planned (Beamer et al 2006). Based on studies in Skagit Bay, the Swinomish Channel, and northern Fidalgo Island - in Guemes channel, juvenile salmon are present during the major spring migrations out of the Skagit and Samish Rivers (City of Anacortes 1999). Although the number of salmonids using Fidalgo Bay has not been quantified, in April 2004, Beamer et al captured 0+ chum and pink salmon averaging 1,250 juvenile salmon per hectare. The Samish Tribe DNR beach seine surveys between 2015-2017 also found juvenile chum and pink salmon to be a common catch and documented the brief presence of Chinook and coho salmon in the bay (M. Castle, Samish DNR, personal communication, 2019).The eelgrass beds provide shelter and an abundant food supply for smaller juvenile salmon. Additionally, juvenile salmon utilize the shallow subtidal macroalgae beds and the low energy tidal flats that are well known foraging areas for amphipods, such as *Corophium* spp.. Although the broader mudflats without eelgrass may support an abundant prey base, they are less used by juvenile salmon since they lack cover for refuge.

Other species of salmonids, such as steelhead, sea-run cutthroat, and anadromous Bull Trout likely utilize the low energy mixed gravel and cobble beaches for foraging and shelter. Although there is no published information on the occurrence of Bull Trout in Fidalgo Bay, the area is located in the proposed critical habitat for coastal Bull Trout (Federal Register 2005b).

Forage fish

Forage fish are a vital link in the food chain and constitute a major portion of the diets of salmon, seabirds, marine mammals, and other fish. Three important species of forage fish utilize intertidal and shallow subtidal areas in Fidalgo Bay for spawning habitat.

Pacific herring (*Clupea pallasi*), is an important baitfish and commercial fish in the northern Puget Sound Region. Adult herring (pre-spawners) are reported to congregate in the area to the east of Guemes and Hat Islands before spawning. Small groups reportedly move south into Fidalgo Bay intermittently as each group matures. Historically, spawning in Fidalgo Bay was more or less continuous from early February into April but deposition of spawn has been consistently reported as "very light" to "trace" in the WDFW rating system.

Herring deposit their eggs indiscriminately on eelgrass or macroalgae (particularly, *Gracilaria pacifica*). Herring spawn has been found wherever eelgrass exists in Fidalgo Bay, and even in areas where eelgrass is sparsely distributed. Appendix C - x shows the areas of identified herring spawning beds over a 45-year span highlighting the trends for the last decade in Fidalgo Bay.

Herring roe on eelgrass provides critical seasonal feeding opportunities for waterfowl, fish and invertebrate species. Herring eggs hatch approximately 2 weeks following deposition, and many larvae appear to remain in the bay for several months. The back or southern portion of the bay contains large numbers of herring larvae around the end of March (D. Penttila, WDFW, personal communication 2006). Herring larvae provide nutrients to out-migrating salmon smolt and other fish species that use these nearshore waters for nursery and feeding grounds. After their first summer, it is uncertain where the maturing herring go to complete their growth and maturation before returning to spawn 3 to 4 years later.

Surf smelt (*Hypomesus pretiosus*) also are an important forage fish in the Salish Sea. During the winter months, surf smelt, possibly from the Fidalgo Bay spawning populations, are the subject of a vigorous recreational jig fishery in the La Conner area, and along the March Point shoreline. In the summer, there is bustling recreational dip net activity for surf smelt along the western shore, slightly north of the reserve boundary.

Surf smelt spawn at middle to upper intertidal elevations (in Fidalgo Bay area, + 5 feet MLLW to mean higher high water, MHHW) on pea gravel and coarse sandy beaches. Spawning beaches are ubiquitous in the bay north of the trestle with spawning beaches documented south of the trestle as well, (see Appendix C - X). Spawning tends to occur year round in Fidalgo Bay. Trained citizen scientists have conducted forage fish beach spawning surveys in the bay since 2012. Presently, approximately 4.3 lineal miles of surf smelt spawning beach has been identified within the bay. In spite of extensive armoring, the remaining narrow, patchy strips of suitable substrate at the base of armored shoreline are still utilized for spawning. This habitat and substrate area is very vulnerable to disturbance and continued loss, for lack of sediment replenishment. In Appendix C - 8 illustrates the locations of documented surf smelt spawning beaches in Fidalgo Bay. Little is known of the larval and post-larval life history of surf smelt in the area.

Pacific sand lance (*Ammodytes personatus*) have been found to spawn in the upper intertidal area on several beaches throughout the bay. Sand lance have a limited spawning window in the greater Puget Sound area, generally from early November through mid-February with eggs present into March. Sand lance tend to utilize similar substrate as surf smelt, preferring pea gravel, shell hash, and sand at slightly lower tidal elevations. In addition, sand lance demonstrate a preference for well-aerated soft sand; spawning in the bay is reported primarily in this soft sand. Sand lance spawn is documented in some of the same areas as surf smelt spawning.

Spawning beaches have been identified at the northeast tip of March Point, south of Crandall Spit, on the eastern end of Weaverling Spit, and in mid reach on the eastern side of the reserve, north of the trestle. (WDFW 2005, Fidalgo Bay CSC 2018).

Other Marine Fish

WDFW has not focused any specific surveys on marine fishes in Fidalgo Bay. However, the mudflats and shallow embayments throughout the bay are considered the most important habitat for flatfish species. Many flatfish —such as starry flounder, English sole, speckled sanddab and sand sole, show a distinct preference for shallow waters in the bay and may remain near the shore even as adults. Flatfish spawn is found in small quantities within the bay. The two flatfish in the area of greatest commercial importance are starry flounder (*Platichthys stellatus*), and English sole (*Pleuronectes vetulus*). For a list of fish observed in the bay, see Appendix A2, Table x.

Marine Invertebrates

Many species of marine worms, snails, clams, crabs, small crustaceans, and other invertebrates provide vital links in the Fidalgo Bay food chain. Many of these primary forage species help support the local populations of birds, fish and mammals.
Systematic data collection on intertidal species is limited for the Fidalgo Bay Aquatic Reserve. In addition to Tribal shellfish surveys, three years of intertidal biota monitoring have been carried-out by the Fidalgo Bay Citizen Stewardship Committee. From 2016- 2018, these surveys have been conducted in four locations on the west side of the bay. These data are contributing up-to-date baseline information for plant and animal presence and distribution. Eventually, the data may provide the opportunity to look at trends and analyze different beach treatments on this side of the bay. For a partial list of marine invertebrates found in the bay, see Appendix A, Table x.

Shellfish

No comprehensive surveys of Fidalgo Bay have been conducted for hard-shelled clams. However, several species of clams — including the butter clam (*Saxidomus gigantea*), native littleneck (*Leukoma staminea*), Japanese littleneck (*Venerupis philippinarum*), horse and gaper clam (*Tresus* spp.), and the cockle (*Clinocardium nuttallii*) — are common on Weaverling Spit beaches. Samish Indian Nation in conjunction with students from the Anacortes High School Green Program conduct shellfish surveys in the summer on the north side of Weaverling Spit. Surveys are carried-out at several tidal elevations during a minus tide in May. Data from these surveys also notes other species including, Eastern soft-shell clams (*Mya arenaria*), Macoma spp., and the non-native purple varnish clam (*Nuttalia obscurata*). However, an important finding from the tribal clam surveys shows primarily one size class and low populations of butter clams. For this reason, tribal harvest of butter clams is closed on Samish owned beaches in Fidalgo Bay until the population recovers (T. Woodard, Samish DNR, personal communication, 2019e). Hard-shelled clams also are found on beaches north of the trestle in lower intertidal areas containing an appreciable amount of gravel mixed with sand, silt and mud. Shellfish harvest is popular and permitted on several beaches in the bay with a WDFW shellfish license.

During the 1950s, Fidalgo Bay supported extensive oyster culture operations until they died out or moved in the 1960s to more favorable grounds to the north in Samish Bay. Limited numbers of Pacific oysters were consistently found in Fidalgo Bay. However, a large recruitment of oysters occurred in the early 1990s and was observed again in 2005. Possible sources for these events appear to be natural recruitment from Samish Bay or from the modest population of Pacific oysters residing in Fidalgo Bay (Dinnel et al. 2005). These events are episodic and the persisting population of Pacific oysters continues to be relatively small.

The Olympia oyster (*Ostrea lurida)* is the native oyster once found at scattered sites throughout Puget Sound including Fidalgo Bay. The bay has favorable habitat conditions and unlike other bays in the area is free from a significant population of Pacific oysters, and the associated, devastating Japanese oyster drills (Robinette 2004). In 2002, Fidalgo Bay was selected as a planting site to restore a population of Olympia oysters in the region. Olympia oyster seed has been planted and monitored in the bay since 2002 and subsequently in 2003, 2004, and 2006.

More deployments of oyster spat have continued over the years along with non-seed bearing oyster shell to increase habitat availability and help build oyster beds (Dinnel et al. 2018). Over the years, the population of oysters has increased with large fluctuations in natural recruitment. Annual recruitment of invertebrate broadcast spawner species often tends to be highly variable, and Olympia oysters are no exception (Dinnel et al. 2018). Through this project, “Spatial patterns of settlement in Fidalgo Bay have been nicely defined. Sampling from 2008 to 2018 strongly indicate that most larvae are retained inside the bay and that settlement has almost exclusively been limited to the east side of the bay, with the causeway area one of the focal points. Few oyster larvae are making their way to the west side of the bay due to largely north-south flowing currents during the summer on each side of the bay with little mixing between them, (Dinnel et al. 2018; Eric Grossman, USGS, personal communication, 2018). As of 2018, the number of oysters has gradually grown to approximately 2.9 million in the bay. Other encouraging findings include natural recruitment of native oysters in several sloughs in the south bay (Dinnel et al. 2018).

The geoduck *(Panopea abrupta*) is likely to be present in the deeper regions of the bay (Munce et al. 2000). WDFW has not conducted any geoduck surveys in the area. Provided with the appropriate substrate types, mainly sand and silts, geoducks are generally found from the lower intertidal zone to at least 360 feet (110 meters) in depth. The presence of geoduck is likely within the bay in less disturbed subtidal areas with sand to silt sediment.

Dungeness crab (*Metacarcinus magister*) are widespread throughout the Fidalgo Bay area, and are expected to use all habitats below a depth of approximately 2 feet above MLLW, except perhaps for bedrock outcrops and other hard bottom areas where the red rock crab (*Cancer productus*) is expected to be more abundant (City of Anacortes 1999). Eelgrass beds, macroalgal beds, and areas with an abundance of broken shell material provide preferred areas for juvenile crabs.

There are no regularly surveyed WDFW index stations for Dungeness crabs in the Fidalgo Bay area. There is regular fishing effort in Fidalgo Bay by State Recreational, State Commercial, Tribal recreational, and Treaty Commercial fishers. Northwest Straits Foundation contracted Natural Resource Consultants to complete a large-scale derelict gear recovery program in the deeper water areas north of the bay.

A significant occurrence in the Fidalgo Bay and Guemes Island area is over-wintering of ovigerous (bearing or carrying eggs) female Dungeness crabs (Armstrong et al. 1987). Female crabs spend most of a 3-to 4-month period between November and April buried in the sediment in the eelgrass between 0.5 meters and 4 meters in depth (MLLW). The population of ovigerous crabs in 1985/86 was estimated to be 60,000, with about 25 percent found in nearby Ship Harbor. Although very few of these crabs have been documented in other regional bays, the unique importance of this sensitive life stage and proximity to Fidalgo Bay reinforces the importance of minimizing negative impacts to these habitats. Armstrong et al. (1986) found that young-of-the-year Dungeness crabs use vegetated portions of Fidalgo Bay as rearing habitat before moving to deeper waters (Armstrong et al. 1987).

Birds

Fidalgo Bay is part of a larger area that is recognized as one of the most important waterfowl wintering spots along the Pacific flyway, providing critical habitat connectivity for migratory and over-wintering ducks and waterfowl. The main species of bird-life that use Fidalgo Bay's rich and productive habitat include Black Brant, cormorants, peregrine falcons, great blue herons, loons, and bald eagles, along with many gulls, shorebirds and dabbling and diving ducks (Antrim et al. 2000). Approximately 240 birds have been identified in the broader Padilla, Samish, and Fidalgo Bay area (Padilla Bay NERR 2008). Many of these birds are not marine and shoreline dependent and not all the marine dependent birds use Fidalgo Bay habitat areas. None-the-less, numerous bird species associated with marine and shoreline habitat are observed in Fidalgo Bay. The highest occurrences and diversity of bird species are found during the winter months and occur at much lower levels or are absent the rest of the year.

In addition to being sheltered and undisturbed by boat traffic in the southern portion of Fidalgo Bay, the site offers a plentiful food supply for waterbirds[4], including forage fish, shellfish, other small invertebrates, juvenile salmon and eelgrass. Large populations of wintering Pacific Brant are documented in Fidalgo Bay and exclusively depend on eelgrass as fodder, and need the shallow areas to pull themselves out of the water and collect gravel for digestion. Dabbling ducks (American wigeon, mallards, pintails, and canvasbacks) primarily feed on eelgrass and other submerged aquatic vegetation. (See Appendix A2 - X for a list of observed bird species).

In 2017, the Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee began bird surveys in the southern area of the bay focusing on species and numbers found. Thus far, two seasons of monthly surveys between September and May have identified the largest presence in the bay are duck species, with the three most abundant species in south Fidalgo Bay as bufflehead, green-winged teal and Northern pintail.

Eight species of birds that specifically use Fidalgo Bay and adjacent areas meet the listing criteria given for species listed by Washington State as Sensitive, Threatened, or Endangered. These are listed below with general status and habitat descriptors:

1. Common Loon (*Gavia imm*er) is a State Candidate species that utilizes the shallow protected areas of the reserve for staging and wintering.

[4] Waterbirds: The term waterbird is used to describe birds that occupy and use shallow inland marine bays and salt marsh habitats. These include marine diving ducks and alcids, shorebirds of all kinds, dabbling ducks, gulls, and brants geese.

2. Brandt's Cormorant (*Phalacrocorax penicillatus*) is a State Candidate species found in the reserve intermittently during the migratory seasons.
3. Bald Eagle (*Haliaeetus leucocephalus*) nesting sites are located on Weaverling Spit and along Hwy 20 above the Custom Plywood site. Other nesting sites occur near Fidalgo Bay, primarily, on Hat Island, Guemes Island, and on the Marathon Petroleum property (T. Woodard, Samish DNR, personal communication, 2019f.). Eagles utilize the bay for foraging.
4. Peregrine Falcon (*Falco peregrinus*) is a State Endangered Species. Peregrine falcons from active nests near Seafarer's Park (T. Woodard, Samish Tribe, personal communication, 2019g.) and on Guemes Island feed in the bay.
5. Great Blue Heron (*Ardea herodias*) maintain a very large rookery located on the southeastern portion of March Point. WDFW recommends priority habitat protections for seasonal aggregation (nesting) areas.
6. https://wdfw.wa.gov/publications/01371/wdfw01371.pdf
7. Osprey (*Pandion haliaetus*) nest sites have been located inland in close proximity to the bay. One-mile Island has an osprey nest and osprey regularly feed on fish from the waters of Fidalgo Bay.
8. Common Murre (*Uria aalge*) is a State Candidate species. The common murre feeds on small forage fish that are found in Fidalgo Bay.
9. Marbled Murrelet (*Brachyramphus marmoratus*) is a State Endangered and Federal Threatened Species. Annual aerial surveys from 1992-99 (Nysewander, WDFW) consistently observed 1 to 2 Marbled Murrelets in Fidalgo Bay. More recent observations of Marbled Murrelets in the area include the National Audubon Society Christmas bird counts.

Other species at risk species found in the Fidalgo Bay Aquatic Reserve include Vaux's Swift and Purple Martin.

Great Blue Heron

Great blue herons are a bird species of particular interest at Fidalgo Bay due to the bay's proximity to a large heron rookery at the southeast portion of the March Point peninsula. This is the largest heron rookery in the state, and has been increasing in size. This heronry is becoming more critical for their survival as it becomes larger in size at the expense of other smaller ones (Eissinger 2007). Herons routinely feed on small fish in the shallow waters of Fidalgo Bay, and extensively use the shoreline in the bay including upper intertidal habitat, shoreline perches and riparian vegetation. During diurnal high tide periods, herons seek foraging opportunities in the upper reaches of the intertidal zone. Large woody debris and floating rafts serve as platforms for individual herons foraging at high tide. Areas of undeveloped shoreline offer greater shoreline habitat complexity and less human disturbance for foraging herons. Saltmarshes also provide habitat for both foraging and loafing.

Given unexplained mass abandonment of colonies (Eissinger 2007), major geographic shifts in the breeding population and population decline in certain areas, consistent monitoring and status of the Great Blue Heron population is necessary. Standard methods of data collection both for productivity estimates and accurate post-season colony nest counts are vital to monitoring this population over time. Annual colony monitoring is also necessary to track colony success and changes, since colonies may fail, abandon, fragment or relocate in any given year. The Skagit Land Trust owns most of the land where the March Point heronry is located and has conducted annual nest counts for many years.

Marine Mammals

Eight harbor seal (*Phoca vitulina*) "haul outs" are located in close proximity to Fidalgo Bay. These sites are used year round as resting sites and serve as pup rearing sites from mid-June through mid-August (WDFW). Harbor seals frequently forage in Fidalgo Bay and pups are seen in the bay during the summer months.

Other non-marine mammals are often seen along the shoreline, foraging on the beaches adjacent to the aquatic reserve. A family of river otters raccoons and black-tailed deer are regularly seen been in the south bay along the western shore. Mink and long-tailed weasel have been observed transitioning from the bay to the beach near Weaverling Spit (T. Woodard, Samish Indian Nation DNR, personal communication, 2019).

CURRENT ENVIRONMENTAL CONDITIONS AND ECOSYSTEM STRESSORS

This section presents current physical, biological and environmental conditions contributing to the health of the aquatic reserve, with particular focus on the ecosystem stressors promoting these conditions. Ecological Stressors are physical, chemical, and biological stimuli that impact the condition and integrity of ecosystems and can change the trajectories of species and ecosystems. Stressors can be natural, such as, drought, storms, insect or disease outbreaks, or anthropogenic like climate change, pollution, shoreline alteration, or trampling. (USGS, https://www2.usgs.gov/ecosystems/environments/stressors.html, accessed 2/28/2019). Since the effects of climate change (sea level rise, warming, ocean acidification, and precipitation) act as an overlay on exiting local stressors, a summary of anticipated influences or changes of climate change is presented first. Where relevant, a discussion of restoration and mitigation actions conducted that may help reduce the effects of a stressor are presented along with any information on anticipated added stressors due to climate change.

Effects of Climate Change

The effects of climate change pose a myriad of potential new, intensifying, or compounding stressors for the organisms and habitats of the reserve. Therefore, likely changes are described below, along with anticipated impacts and associated stressors.

Physical, biological and chemical changes to the marine environment associated with climate change will exacerbate naturally occurring events and conditions in Fidalgo Bay. Current trends in climate change may contribute to the following ongoing fluctuations in ocean conditions (Snover 2013), all of which could have an impact on existing physical and biological resilience in the aquatic reserve area:

- Sea level rise and storm surge will inundate low-lying areas adjacent to the Reserve. May also result in more shoreline armoring to protect infrastructure.

- Sea level rise (Table 1.) will further submerge current subtidal and intertidal habitat areas, having the potential to adversely affect fish and wildlife resources and associated habitat.
- Rising water temperatures create additional stressors on marine organisms.
- Lower dissolved oxygen concentrations, related to increases in water temperature, create additional stressors for fish and at extreme levels can be fatal.
- More frequent and heavy precipitation events can contribute more pollutants and alter water chemistry.
- Eutrophication from increased nutrient loading can intensify the impacts of decreased pH and low dissolved oxygen.
- There is a demonstrated decrease in the upper-ocean pH by 0.1 units and this decline is expected to continue (WBRP 2012a). The rate of ocean acidification is accelerating from anthropogenic carbon emissions and is currently "ten times faster than anything the earth has experienced during the past 50 million years." (WBRP 2012b). Ocean acidification can interfere with shell and skeleton building for calcifying organisms, such as Olympia oysters and other shellfish. It can also affect biological processes such as bio-sensory functions in salmon and forage fish, inhibiting their ability to locate natal areas, food sources, and to detect predators.

Sea-level rise due to human-caused climate change is predicted to increase throughout the Salish Sea Region. Based on the "most likely to occur" range of estimates for the 10-year period from 2020 – 2030, sea levels in the Fidalgo Bay area may rise from 2.4 – 5.9 inches (61- 150mm), (Miller et al. 2018). For more detail see Table 1 below. This table includes two time periods, two greenhouse gas emission scenarios, and a range of probabilities for more extreme estimates.

Table A-1. Sea Level Rise Predictions[5] for Fidalgo Bay

Scenario Year Ending	**Emissions Scenario**	**Most Likely Scenario (increase in ft.)**		**Most Extreme Estimate (increase in ft.)**		
		Central Estimate (50%)	**Likely Range (83-17%)**	**10% probability**	**1% probability**	**0.1 % probability**
2030 (10 yrs. out)	**RCP 4.5**	*0.3*	*0.2 - 0.5*	*0.5*	*0.6*	*0.8*
	RCP 8.5	*0.3*	*0.2 - 0.4*	*0.5*	*0.6*	*0.7*
2050 (30 yrs. out)	**RCP 4.5**	*0.7*	*0.4 – 0.9*	*1.0*	*1.3*	*1.9*
	RCP 8.5	*0.7*	*0.5 – 1.0*	*1.0*	*1.4*	*2.0*

[1] **Summary of absolute sea level projections**, in feet, relative to contemporary sea level for Washington State, for two greenhouse gas scenarios (RCP 4.5 and RCP 8.5) and two time periods, and across a range of probabilities. *Source*: Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assessment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, Oregon State University, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.RCP "Representative Concentration Pathways (RCPs)". *IPCC*. Retrieved 11 March 2019.

Compounding the effects of sea-level rise, are increasing storm intensity and frequency that will also produce greater wave energy, more wave run-up, more extreme storm surges, and potential rises in groundwater levels (USGS Puget Sound Coastal Storm Modeling System). These combined effects will cause erosion and alterations to the shoreline and the physical structure in the bay.

Fidalgo Bay is a relatively narrow, confined, "U-shaped" bay, which makes it more vulnerable to the impacts of increased storm intensity and frequency. Effects of this physiographic constriction can include greater exposure time to beach habitat areas resulting in altered substrate composition, increasing scour, changing nearshore bathymetry, burial or reduction in light availability for submerged aquatic vegetation, and damage of adjacent infrastructure and upland vegetation. This may also result in further armoring to protect infrastructure and therefore less ability for nearshore habitats to migrate upshore. The extensive armoring and physical location of adjacent infrastructure in Fidalgo Bay already creates a classic "coastal squeeze" phenomenon, intensifying effects and limiting opportunities to buffer the impacts described above. Such armoring includes transportation infrastructure surrounding the reserve area on three sides (Hwy 20, March's Point Road, and Fidalgo Bay Road), development along the City of Anacortes shoreline, the southern portion of Samish Nation RV Park on Weaverling Spit and two refineries on March Point.

Research to better prepare for and mitigate some of the adverse physical and biological effects of climate change are ongoing in the aquatic reserve. The Samish Tribe is working with USGS to develop a more detailed SLR model bringing in wave and storm surge data for the area to better inform the community about impacts (T. Woodard, Samish Tribe, personal communication, 2019h.). Regarding a mitigative approach, the WDNR Acidification Nearshore Monitoring Network (ANeMoNe) was established in 2016 to measure the progress of acidification and climate change in shallow marine waters across Washington State. Now spanning 10 sites, ANeMoNe supports research that aims to enhance the resilience of marine aquatic resources. At each site, sensors take measurements inside and outside of eelgrass, to test the potential of these plants to counteract acidification at local scales. ANeMoNe overlaps with the WDNR Aquatic Reserves program at Fidalgo Bay, Cherry Point, Maury Island, and Nisqually Reach (M. Horwith WDNR, personal communication, 2019).

ANeMoNe also serves as a foundation for a growing number of peer-reviewed publications on topics that range from investigations of practical management options to buffer against acidification to explorations of the causes of shellfish stress (M. Horwith WDNR personal communication, 2019). In Fidalgo Bay, biologists from the Swinomish Indian Tribal Community explored whether recycled oyster shells could protect juvenile Manila clams by buffering against ocean acidification. Juvenile Manila clams were grown with and without recycled shells, and with and without kelp or eelgrass present. Recycled shells were effective in reducing acidity and increasing pH in the sediment where the clams live, but had no effect on clam growth. Clams grew more slowly in the presence of kelp or eelgrass. This study improves our understanding of the tools available to counteract acidification at small scales (Greiner et al 2018).

WDNR and University of Washington scientists measured how Pacific oyster physiology responds to temperature, pH, and the presence of eelgrass. Juvenile Pacific oysters were moved from a hatchery to five ANeMoNe sites, including Fidalgo Bay. After 29 days, the oysters were collected, dissected, and the proteins in their gill tissue were analyzed using novel laboratory techniques. Pacific oyster physiology differed between Puget Sound and a Washington coastal estuary, perhaps reflecting that oysters in the estuary experienced more heat stress. These results help us understand differences in shellfish stress across Washington State, and the potential for particular areas to provide refuge from climate change and acidification (Venkataraman et al 2019).

WDNR and University of Washington scientists tested the response of geoduck physiology to temperature, pH, and the presence of eelgrass. Juvenile geoducks were transplanted from a hatchery to five ANeMoNe sites, including Fidalgo Bay. Over the following 29 days, eelgrass appeared to reduce acidity and increase local pH, but this had no effect on the geoducks. Instead, geoducks appeared to respond to differences in temperature and dissolved oxygen. This study helps us predict how geoducks and their fishery may respond to warmer and more acidic waters (Spencer et al 2019).

The State legislature has acted to slow down climate change. In 2008, the Legislature adopted reduction targets for greenhouse gases (commonly known as GHG or carbon pollution). Washington's current targets are to:

- Reduce overall greenhouse gas emissions to 1990 levels by 2020.
- Reduce overall greenhouse gas emissions 25 percent below 1990 levels by 2035.
- Reduce overall greenhouse gas emissions 50 percent below 1990 levels by 2050.

Washington DOE publishes a greenhouse gas report that helps track progress toward meeting the state's reduction limits. **Washington State Greenhouse Gas Emissions Inventory: 1990-2015** In 2015, Washington's largest contributors of greenhouse gases were:

- Transportation sector — 42.5 percent
- Residential, commercial, and industrial sector — 21.3 percent
- Electricity sector — 19.5 percent

Shoreline Modifications and Overwater Structures

Extensive historic modification of the shoreline, including armoring, filling of intertidal and salt marsh areas, along with effects from overwater structures like the trestle/causeway bisecting the reserve continue to alter the natural processes and ecosystems of the bay, contributing to environmental stressors.

Shoreline Modifications

Williams et al. (2003) report that within Fidalgo Bay, 47 acres have been filled, 8 acres are affected by overwater structures, 45 acres were altered at depth, and approximately 8 acres have been dredged. The shoreline around the bay has been modified extensively by fill and armoring. Armoring adjacent to the aquatic reserve includes the transportation infrastructure surrounding the reserve area on three sides - Hwy 20, March's Point Road, and Fidalgo Bay Road, development along the City of Anacortes shoreline, portions of the RV Park on south

Weaverling Spit and two refineries on March Point. Approximately 29,000 feet or 64.7 percent of the shoreline in Fidalgo Bay is armored including 4,800 feet of riprap along both sides of the causeway (Williams 2003).
The most notable structure in the aquatic reserve is the railroad trestle, along with the hardened revetment/causeway crossing the bay. This structure now supports the Tommy Thompson Trail**.** In 1890, when the railroad connection to Anacortes was constructed, the west shoreline of the bay was substantially built-up with fill and hard armoring to enable construction of the railroad tracks**.** Originally, the trestle was wood all the way across. It wasn't until the 1950s that the riprap revetment was constructed, burying the creosote piling substructure of the trestle and armoring the western portion.

Physical effects

The analysis of armoring by Antrim in 2003, still generally summarizes the present conditions in the reserve area. This includes the continual erosion to Crandall Spit, substrate coarsening on beach faces, loss of substrate elevation along armored shores, and the 2- 4 foot elevation gain in areas south of the trestle from the deposition of fine sediments and organic materials (Antrim et al. 2003, Williams et al. 2003).

Historically, Fidalgo Bay was connected to the north end of Similk Bay and at high tide could support shallow vessel traffic. The area was diked, drained, filled, and converted to pasture land. Since filling aquatic lands and habitat conversion occurred early and extensively, the native condition of the shoreline and extent of habitat types in the bay is poorly known (Collins 2005). Severing connectivity to the Whidbey basin not only modified the water, sediment and energy regimes in the bay, but also changed the biological structure of the bay. The presence of Highway 20, directly adjacent to the head of the bay, magnifies the effects of diking and the conversion of wetlands to uplands. The additional filling and associated shoreline armoring further interrupts natural processes including altering and reducing freshwater inflows, as well as, the erosion and accretion of sediments.

The fill and armoring of the western causeway portion of the Tommy Thompson Trail has had multiple significant deleterious effects to the bay. The structure has impeded the natural flow of sediments and water flow, in some areas cutting-off water circulation all together. The consequent and continual decrease in the tidal prism, with no appreciable drift at the head of the bay, has led to significant sediment deposition in this portion of Fidalgo Bay (Aundrea Mc Bride, *pers. comm*. 2007).

Due to continuous bulkheads and other shoreline modifications throughout the bay, there are few remaining natural sources for shoreline sediment. Crandall Spit, adjacent to the reserve at the northern boundary, has been shown to be sediment starved, and the reduction of net shore drift sediment volumes in this part of the bay has caused significant areal loss to the west end of the spit. Similar depletion on the west side of the bay has led to reduced area of Weaverling Spit (Johannessen 2007).

Shoreline modifications, almost without exception, damage the ecological functioning of the nearshore coastal systems (Thom et al 1994).

Biological effects of stressors on habitat

Because armoring structures modify or cut off the natural sediment supply and water flow, they eventually alter the habitat structure and the biological community at many levels. The culpable physical stressors include potential shifts to higher wave energy levels- eroding the beach face and profile, removing finer sediments and therefore the base for organisms to live in or on. In a few locations in the bay, the surface sediment has been eroded to expose hardpan (Antrim, 2000), which eliminated forage fish spawning substrate and habitat for infaunal organisms, such as clams. It has been shown that clam populations are negatively affected by bulkheading. Significantly lower abundances of clams are found below bulkheads than in otherwise similar adjacent natural areas (Yoshinaka and Ellifrit 1974). Penttila (personal communication, 2019) suggests most of the historical natural shoreline and beaches in the bay supported surf smelt spawning. In spite of, extensive historical development including intertidal habitat burial in the northwestern part of the bay, surf smelt have sustained a resilient population in the area.

In addition to changing the configuration of the substrate, shoreline development and armoring often includes the removal of riparian vegetation and large woody debris. Riparian vegetation and large woody debris (LWD) in backshore and upper intertidal areas provide a multitude of functions – structural and biological (Brennan 2005). The loss of available “terrestrially-derived” organic debris, nutrients and insects, as well as shade to upper intertidal areas distress the local ecosystem and species. Shade derived from shoreline vegetation maintains more stable upper intertidal substrate temperatures, protects against desiccation, and moderates conditions for infauna. Penttila (2001) found significantly higher surf smelt egg mortality on unshaded beaches than adjacent shaded beaches. Several dietary studies of marine fish show that salmon benefit the most from riparian vegetation. During out-migration, juvenile salmonids are known to be dependent upon shallow, nearshore waters where insects from the terrestrial environment are important prey species, (Brennan 2005).

The loss of aquatic vegetation, i.e., from direct burial, dredging….
The filled/riprapped portion of the Tommy Thompson trail and the consequent increased sediment deposition in portions of the south bay, arrested eelgrass growth in those areas contributing to a the loss of spawning structure/habitat for Pacific herring. The herring spawning population is ….

The long-term biological consequences including the cumulative impacts of these activities are broad ranging, tenacious, difficult to repair and unknown if they can be rectified.

Overwater Structures

Overwater structures can include any object placed on or above aquatic lands such as jetties, groins, docks, piers, individual pilings, or concrete boat ramps. Within the aquatic reserve these include the major Tommy Thompson trestle/revetment, the Samish RV park concrete boat ramp and a few remnant groins. The overwater structures north of the reserve like the March Point piers and the pipeline and the multiple large marinas also affect physical processes in the bay.

Physical and biological effects

Overwater structures including boat ramps and groins disrupt sediment flow down drift. The largest overwater structure and greatest threat to the long-term ecological stability in the bay is the trestle and revetment. As a formidable armored and overwater structure, the adverse effects from the trestle are complex, but include loss and reduction in marine habitat area, shading effects on intertidal vegetation and biota, disruption to sediment and water flow, and contamination from creosote pilings that support the structure.

Overwater structures block sunlight from penetrating the water column which is necessary for eelgrass to flourish. These structures can also affect the migration patterns of certain fish species, particularly juvenile salmonids (Simenstad 1999). In Puget Sound, juvenile Chinook salmon, chum, and pink salmon migrate along the shorelines and feed extensively on shallow water epibenthic invertebrates. However, juvenile salmonids typically avoid shaded areas where predators may be present (Haas 2002).

Restoration, Enhancement and Mitigation of Impacts

Several beach nourishment projects, soft armoring treatments, and other major clean up and restoration projects in the bay have contributed to reducing the stressors discussed above. Some of the projects are reviewed in previous sections, however a summary with positive impacts that influence the present and future conditions in the aquatic reserve will provide further context for management actions. These include:

- West March Point beach nourishment project (2010 – 2011) cleaned up, regraded and added sediment, including a special topping of fine gravel "fish mix" to target restoring forage fish spawning habitat. This project includes approximately 3000 feet of beach north of the trestle along the east side of the bay. A minimal amount of riparian vegetation was planted to stabilize sediment, moderate substrate temperatures and improve forage fish egg survival.
- Three phases of Samish RV Park beach property enhancement includes approximately 1700 feet of beach restoration with sediment nourishment to restore forage fish spawning habitat, regrading to restore a natural beach slope and the strategic placement of large woody debris across-shore on the beach to slow down along shore sediment transport. Removing large imported boulders and riprap and creating a bermed, soft-armored backshore can mitigate some potential effects of sea level rise. Also, backshore riparian vegetation was planted to stabilize the shoreline, create shade, and contribute natural detrital material to shore zone areas.
- North of the reserve area but within the south flowing drift cell on the west side of the bay are two major contaminant clean-up sites - the Custom Plywood and the Scott Paper mill sites. These sites were multifaceted on many levels with extensive removal of armoring, fill, construction debris, degraded piers and overwater structures, derelict pilings and contaminants. In 2011-2013, contaminated sediment and wood waste were removed from the more southerly site - Custom Plywood. Some highlights of this extensive restoration effort include the creation of a small embayment ("pocket estuary"), a naturally graded and re-nourished beach (reestablishing 4400 feet of functional habitat-enhanced beach), reestablished forage fish spawning habitat, and planting traditional native salt marsh, backshore and riparian vegetation In 2019-2020, the remaining contaminated substrate associated with this project will be permanently capped (reference). More discussion on

benefits from contaminate removal at the site are discussed below in the sediment quality/wood waste section. Farther north, the Scott Paper Mill site also included large scale upland, backshore and intertidal debris removal and restoration. As remediation for dredging and associated habitat destruction, a successful eelgrass restoration project is connected with this more northern site.

- North of the reserve but within the southwest flowing drift cell on the east side of the bay is Northwest March Point beach nourishment project site. This project included restacking of angular rock which had fallen onto the beach and the addition of 2,230 tons of beach nourishment to restore forage fish spawning habitat. Spawning surveys have consistently documented surf smelt spawning since the project's completion in 2014 (J. Morgan, NWS Commission, personal communication, 2019).
- Sharp's Corner

A multitude of varied benefits come out of these projects. Biological and physical resilience and processes and ecological functions all improve by cleaning up and restoring habitat. including forage fish spawning habitat and eelgrass beds. In the case of the Scott Mill, eelgrass was successfully planted (and is expanding?). These actions enrich species diversity, help build organism populations, and provide a sediment supply to replenish depleted down-drift-cell locations. Cultural benefits include improving overall aesthetic value of the bay, providing better public access, renewing community involvement and pride and educational venues for learning about Fidalgo Bay and the value of maintaining healthy ecological resources.

Other potential future projects and actions will continue to improve and restore ecological processes, functions and habitat areas throughout the bay. The 2008 Fidalgo Bay Causeway Feasibility Study presents a variety of trestle and causeway removal scenarios and design alternatives that would reduce ecological stressors and alleviate some of the impacts from the presence of the overwater structure and the revetment. Removal or structural replacement of portions of the trestle and revetment is a priority for DNR, the Samish Indian Nation, and the City of Anacortes.

Possible future effects to shoreline modifications and overwater structures

Shoreline modifications and overwater structures will be physically affected by future climate change due to increased intensity and frequency of storm events, particularly increased sea level elevation in the bay (see 'Climate change' above). This will demand more regular maintenance of structures, along with possible re-designs and re-builds of structures. Anticipating these changes creates opportunities for reducing stressors by planning for and accommodating these impacts.

Water and Sediment Quality

Ecological stressors from impaired water quality can affect any organisms using the bay and interacting with the water. Water quality impairments or contaminants eventually may settle out into sediments, affecting sediment quality and the organisms regularly in contact with, or making their home in sediments. Contaminants such as wood waste from past industrial and commercial activity can also directly impair sediment quality.

All dredging activity has taken place to the north of the reserve.

Sediment quality

The following section provides an overview of the findings for the Fidalgo Bay Aquatic Reserve's environmental assessment conducted by Tetra Tech on behalf of the Washington State Department of Natural Resources. This assessment was conducted based on the scope of services and assessment --objectives identified by DNR, and in general accordance with the specifications established by American Society for Testing and Materials (ASTM) Standard Practice E 1527-97 for real estate transfer due diligence.

Tetra Tech reviewed 14 previous sediment and surface water quality investigations conducted within the project area. For the purposes of this effort, those sampling stations lying within the area south of a line drawn from the northern terminus of the March Point refinery docks to the north tip of Fidalgo Island were identified as being pertinent to the assessment. This area was selected based on proximity to the subject properties proposed for the aquatic reserve, and the potential for current and tidal influences to transport sediment and surface water to the intertidal areas of south Fidalgo Bay. These studies were conducted between 1986 and 1997.

Ecology performed sediment sampling within the above stated area. Sample locations were selected based on known or suspected areas of potential upland and .offshore impacts. A total of 12 samples were collected within the subtidal and intertidal zone on June 14, 1995. Samples were collected from the top 10 centimeters of substrate and submitted for laboratory analysis. Tests for the presence of semi-volatile organic compounds (SVOCs) and polycyclic aromatic hydrocarbons (PAHs). Results for SVOC, PAH, and polychlorinated biphenyls (PCB) compounds were reported after being normalized, based on total organic carbon. Results for sediment samples analyzed for SVOC and PAH compounds revealed that the detected concentrations were below both sediment quality standards (SQS), and minimum cleanup levels (MCUL). The reported PCB concentration of 40.42 mg/kg exceeded the quality standard but was below the minimum cleanup level. At a sample station located within 0.1 mile north of the railroad trestle, and within an equivalent distance of the eastern shore of the bay, elevated concentrations of total petroleum hydrocarbon (TPH) in the motor oil range were identified, along with exceedances of standards for several PAH constituents. This sample station is near the location of the 1991 crude oil spill. However, the report also states that roadway runoff from a nearby culvert may have contributed to the contaminants present at this location. THP analysis of the sediment samples from the site did not show evidence of crude oil.

Sediment samples analyzed for metals content revealed that no inorganic elements were present above either of the cleanup standards. However, three winters of Mussel Watch sampling in 2013, 2015 and 2017 off Weaverling Spit, detected increasing levels of Copper, Arsenic, and Cadmium – all still low levels, but slightly trending up in concentration (J. Lanksbury, WDFW, personal communication, 2019c.).

The Ecology-led bay wide cleanup, more recently focused on the Custom plywood site north of the aquatic reserve area. Wood waste and chemical contaminants were found in upland soil, groundwater and sediment on the Site, which consists of upland, wetland, intertidal and subtidal

in-water areas. This site included contamination from dioxins, PCB's, cPAHs, heavy oils, metal contamination and wood wastes.
Other sediment samples that exhibited concentrations of contaminants exceeding Washington State sediment management standards are primarily associated with the Cap Sante Marina area and the refinery outfall discharge areas. Of the seven sample stations in the Fidalgo Bay area where criteria were exceeded, five revealed elevated concentrations of PAH constituents. Of the remaining two stations, one station exceeded established criteria for the inorganic element cadmium only and one exceeded criteria for the semi-volatile organic compound bis (2-ethylhexyl) phthalate (BEHP) only.

Since 1997, numerous environmental investigations have been conducted throughout Fidalgo Bay (SAIC 2007). Results from the studies have shown that sediment quality within the Fidalgo Bay project area and the inner bay is in compliance with screening criteria. Some contaminants, such as polycyclic aromatic hydrocarbons (PAHs) have been detected at higher concentrations than reference areas sampled in Padilla Bay (WDNR, 2007).

In 2007, Ridolfi staff collected soil, sediment and surface water samples for the Fidalgo Bay Causeway Feasibility Study (Ridolfi 2008). Sediment samples collected adjacent to the causeway show that copper is the only metal reported at levels greater than the sediment screening level and only in one sample. Several semi-volatile organic compounds (SVOCs), including polycyclic aromatic compounds (PAHs) were detected at concentrations greater than the screening levels in sediment at the site. The greatest concentrations of PAHs were detected at sediment sample locations adjacent to the creosote-piling trestle. Fourteen PAHs were detected in samples from this area with concentrations exceeding screening levels by up to one order of magnitude. (Ridolfi 2008).

Threats to Sediment Quality

The residual contaminants left from the Custom Plywood site and cleanup, act as a looming threat to overall ecosystem health and recovery. Otherwise, it is difficult to anticipate the potential for other future negative environmental impacts to the reserve area, given the wide range of factors that influence such occurrences (e.g., changes in development and land use scenarios, spill scenarios). Although best management practices for stormwater and wastewater are regulated by the City of Anacortes, direct discharge of polluted stormwater still occurs at times. Sewage inflow to the bay from future residential, agricultural, commercial or industrial development is possible, but less likely with greater local monitoring and planning efforts.

In addition, the prevailing currents within Guemes Channel and the mouth of the bay appear to limit the potential for future deposition of contaminated sediments into the subject area. The records review conducted for the sediment assessment (Johnson 2000) indicates that the existing commercial and industrial operations in the area are in general compliance with their respective operating, discharge, and air quality permits. The potential for a catastrophic incident to occur in the reserve area may be elevated to some extent by the presence of the major industrial activities on March Point. However, the number of incidents of this nature has been limited in the past, and prevention and preparedness practices are ongoing at these facilities. Continued efforts to maintain this status will serve to minimize these environmental threats.

As discussed in the following section, as long as creosote pilings remain in the bay there will be a continual hazard from contaminated sediments adjacent to the pilings.

Creosote Pilings

Several areas within the aquatic reserve maintain a prevalence of creosote pilings. There are over 770 remnant creosote pilings as part of the original railroad trestle. Creosote from pilings has been documented to be toxic to some marine biota and can readily leach into the aquatic environment (Vines et al. 2000, Xaio 2002). Chemical testing of sediment, soil, and surface water identified PAHs, a creosote-related set of chemicals in surface sediment samples collected near the trestle pilings. Concentrations exceeded Ecology's sediment management standards. The extent of contamination was not determined either laterally or vertically but it is likely to be limited to a zone within a few feet or few tens of feet of pilings, (Ridolfi 2008). Also, distributed throughout the northeastern tidal flats of the reserve, remnant pilings that held the log rafts are still common in areas. Since creosote pilings represent an ongoing source of contamination, remediating this issue is a management priority for the Fidalgo Bay aquatic reserve. The 2008 Fidalgo Bay Feasibility Study by Ridolfi addresses piling removal and replacement as well as some alternatives.

Wood Waste

Fidalgo Bay once was one of the nation's largest timber distribution points. In Fidalgo Bay, logs by the thousands were dumped into holding areas—called log booms. Historically, log rafting storage practices occurred extensively north of the railroad trestle, on the central east shore and northwest shore of the reserve (during much of the last century through about the 1970s).

Figure A-2. Log rafts north of the trestle in Fidalgo Bay possibly around 1960 (*Anacortes Museum*)

Presently, a minimal amount of visible primary source wood waste in the reserve is from bark and branches from the large log rafts anchored throughout the bay in the previous century. However, images from that period show errant logs resting on the substrate outside of the booming areas and scattered throughout the bay, including just south of the trestle on the east side. It is probable many of these logs remain buried in the substrate. Other significant wood waste deposits and wood debris pollution from the old Scott Paper Mill operations and the Custom Plywood Mill exacerbated the deleterious repercussions from log-rafting practices.

Approximately one mile to the north of Weaverling Spit, is the Custom Plywood Mill site, the DOE cleanup site closest to the aquatic reserve boundary. For over 100 years, this site hosted wood mill operations producing at various times lumber, boxes, wooden pipes, shingles and plywood. From 1939 to 1992 the large plywood mill took over operations at the site. The mill created massive amounts of unconfined sawdust leaving areas where during cleanup 12 feet of sawdust had to be excavated out from the intertidal area. In 1992, the plywood mill structure (partially constructed of creosote pilings over the bay) burned to the ground and collapsed into the water releasing wood waste, heavy concentrations of dioxins and other toxic chemicals from treated and burned wood into the nearshore. The large quantities of sawdust coupled with the other wood waste was the largest contributor to contaminants found in the bay.

Once wood waste covers the native sediment, or the surface sediment mixes with significant amounts of wood waste - the number and diversity of species present decreases as shown by several studies:

- Populations of suspension feeders may begin to decline when wood waste accumulations approach 1 centimeter (Conlan and Ellis, 1979).
- Bark accumulation greater than 2.5 centimeters may eliminate mollusks and several polychaete species (Jackson, 1986).
- Impacted areas with up to 15 centimeters of wood waste may show a reduced diversity and biomass, with only a few deposit-feeding polychaetes and crustaceans (Conlan and Ellis, 1979).
- The presence of the marine bacteria Beggiatoa species has historically been a good indicator of the organic enrichment that is typical when wood waste is present. Beggiatoa is a filamentous genus of proteobacteria and forms colonies that produce bacterial mats. Beggiatoa is tolerant of high sulfide concentrations, while eelgrass is intolerant of these conditions. Once eelgrass beds are eliminated by the inhospitable environment, Beggiatoa will move into the area. As a rule, Beggiatoa live in low or acidic pH environments. It is unclear whether they themselves produce toxic by-products because of their chemosynthetic activities (Department of Ecology 2013).

The DOE cleanup site closest to the aquatic reserve boundary, approximately one mile to the north of Weaverling Spit, is the Custom Plywood Mill site. For over 100 years, this site hosted wood mill operations producing at various times lumber, boxes, wooden pipes, shingles and plywood. From 1939 to 1992 the large plywood mill took over operations at the site. The mill created massive amounts of unconfined sawdust leaving areas where during cleanup 12 feet of sawdust had to be excavated out from the intertidal area. In 1992, the plywood mill structure (partially constructed of creosote pilings over the bay) burned to the ground and collapsed into the water releasing wood waste, heavy concentrations of dioxins and other toxic chemicals from treated and burned wood into the nearshore. The large quantities of sawdust coupled with the other wood waste was the largest contributor to contaminants found in the bay (reference). Cleanup of this site began in 2011 and most contaminated sediment and wood waste were removed or capped by 2013.

Presently, a minimal amount of visible primary source wood waste in the reserve is from bark and branches from large log rafts anchored throughout Fidalgo Bay during much of the last century through about the 1970s. However, images from that period show errant logs resting on the substrate outside of the booming areas and scattered throughout the bay, including just south of the trestle on the east side. It is probable many of these logs remain buried in the substrate. Discuss potential lingering effects after wood waste clean-up…

Water Quality

Water quality concerns include sources from stormwater, direct runoff from adjacent farmlands, oil spills and contaminants, temperature, pH and nutrient changes from climate change.

Stormwater

Stormwater is considered one of the biggest contributors to water pollution in the urban areas of Washington State because it is ongoing and damages habitat, degrades aquatic environments, and can have serious impacts on the health of the Puget Sound (Lanksbury 2017).

The city of Anacortes, to the west, has two combined sewer overflows that discharge into Guemes Channel, to the north and west of the reserve, averaging less than one overflow per year (D. Hennebert, City of Anacortes, personal communication 2019). However, the stormwater outfall collected from city streets and parking lots drain untreated into the Fidalgo Bay. Some stormwater ponds and vaults help with stormwater treatment prior to discharge into the bay. Twenty-four of the thirty-two outfalls that drain directly into Fidalgo Bay are in close proximity to the aquatic reserve area. The Samish Nation DNR in 2005 identified and mapped 43 outfalls representing a wide range of inputs, into the bay. In 2005, the Tribe started sampling the outfall sites including five marine sampling sites intended to assess overall impact of inputs to the bay. Sites were sampled for nitrogen and fecal coliform contamination. After successive years of sampling, a few outfalls on the west side of the bay intermittently presented high fecal coliform levels. Working with the City of Anacortes, they traced the source of contamination “upstream” and found several residents that had sewer pipes plugged directly into the stormwater system rather than the city sewer. Work with the City of Anacortes to ascertain whether upstream modifications have resolved this particular situation is ongoing. Sampling with sufficient “post-fix” data will continue to provide the needed feedback to assure improved conditions.

In 2010, in collaboration with the City of Anacortes the Tribe redesigned and expanded its’ sampling program now including analysis of phosphorus and nitrate/nitrite as well as fecal coliform, DO, pH, temperature and salinity.

In 2013, the Mussel Watch Program was introduced and expanded throughout the inner marine waters of Washington State by WDFW. Three seasons of sampling occurred in the Fidalgo Bay aquatic reserve at Weaverling Spit. The sampling season spanned three winter months from November to February, and included 2013-2014, 2015-16 and 2017-18. Nearshore mussel monitoring efforts are intended to characterize the extent of contamination present in nearshore biota. The study analyzed the concentration of several major contaminant classes in mussels: polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs, or flame retardants), chlorinated pesticides (including DDTs) and six metals (lead, copper, zinc, mercury, arsenic, cadmium) (Lanksbury 2017).

Throughout the Sound, the most abundant organic contaminants measured were PAHs, PCBs, PBDEs, and DDTs. PAHs and PCBs were detected in mussels from every site, and the concentrations were significantly higher in Puget Sound's most urbanized areas, as measured both by municipal land-use classification (i.e., cities and unincorporated-UGAs) and by the percent of impervious surface in upland watersheds adjacent to the nearshore (Table 3). Although lower in overall concentration, PBDEs and DDTs followed a similar pattern (Lanksbury 2017)

In Fidalgo Bay, all three years, the levels of PAHs were well below the mean in the lowest category and considered not of concern. Also low in overall concentration, PBDEs and DDTs followed a similar pattern. Five of the six metals (lead was the exception) were found in mussels from all the study sites, though their concentrations were relatively low in Fidalgo Bay. Only cadmium and copper were in a medium category - still considered low, but trending up in concentrations over the 3 sampling periods. (J. Lanksbury, personal communication, 2019).

Agricultural Runoff

Properties directly upland of the reserve on the east side of the bay are currently used to raise livestock. Typically, livestock grazing areas can introduce nitrogen and other nutrients into adjacent waterways. Fecal coliform contamination from local livestock could affect water quality in the southeastern portion of the bay. Water quality sampling by the Samish Tribe DNR has found higher fecal coliform counts in outfalls along March's Point Road. This may be linked to cows grazing on the adjacent hillslope with direct access to ephemeral streams draining into the bay (T. Woodard, Samish Tribe, personal communication, 2019i.).

The landowner raising livestock is working with the Skagit Conservation District to implement Best Management Practices (BMPs) that will improve and protect water quality. The BMPs included in the farm plan include manure storage, heavy use protection area, roof run-off collection, and underground outlets preventing clean rainwater from coming in contact with manure. The District also provides technical assistance for better pasture management that helps maintain good grass production maximizing nutrient uptake and reducing erosion of fine sediments to the bay. The District helps provide cost share funding granted by the Washington State Conservation Commission for the design and construction of recommended BMPs.

Effects on species and habitats

Both water and sediment quality can have deleterious effects on organisms, from acute to chronic, from minor to the complete death of organisms. Contaminants like heavy metals and some organic compounds can have carcinogenic and mutagenic effects. Excess nutrients can change important geochemical cycles and biological processes, affecting the quality and quantity of available habitat.

The potential impact of a major oil spill on the regional great blue heron population could be significant due to the close proximity of major breeding centers and foraging grounds to oil ports and refinery complexes. The largest breeding colony in the state and its associated feeding areas are located adjacent to the March Point facilities.

Creosote pilings can be toxic to some life stages of marine organisms. Researchers from the Bodega Marine Lab at University of California / Davis, found that nearly all herring eggs collected from creosote pilings at their study site failed to develop properly and died (Estuary 1997). Furthermore, there was an effect observed on spawn deposited near the pilings as well. Egg hatching success was found to be reduced by 50 percent at creosote concentrations of 50 parts per billion (ppb). Herring spawn has not been observed on creosoted pilings in Fidalgo Bay.

Restoration, Enhancement and Mitigation of Impacts

→Placeholder for Custom Plywood wood waste cleanup/mitigation description (anticipated from Ecology by 3/31/19).

Potential future drivers affecting water and sediment quality

Climate change

The increased frequency and intensity of storm events may re-suspend or move contaminated sediments in the bay, or overwhelm stormwater treatment facilities creating pulses of toxic releases into the bay. Climate change is anticipated to lower the pH of the bay (due to increased carbon in the atmosphere), affecting shellfish reproductive capacity and biological success as well as causing potential shifts in biological community structure and populations. Warmer water temperatures will affect nutrient dynamics and basic respiration of organisms by reducing oxygen. Lower freshwater upland recharge capacity may reduce freshwater inputs coming into the bay during the summer, affecting nearshore salinity.

Contaminants and Oil Spills

Since the reserve is in close proximity to Highway 20, county roads, several marinas and commercial facilities, including boat building and repair facilities, and the two refineries, an accidental discharge or spill of pollutants into the bay is possible. As the population increases, more vehicular traffic will be generated along Hwy 20 and roads around Fidalgo Bay creating increased sources of stormwater pollution and possible spill incidents.

Two oil refineries on March Point currently operate adjacent to the eastern boundary of the reserve. The northern refinery is now owned by Marathon Petroleum; the southern by Shell Oil. Together, the two refineries have a combined production of a quarter million gallons of product per day (2018 web sites). Raw materials and products are shipped by rail, truck, tanker ship, barge, and underground pipelines. Ships and bulk transport facilities in the bay (including more than 7,500 feet of elevated pier transport piping), underground liquefied natural gas pipelines directly east and south of the reserve, railroad tank cars on rail lines directly east of the reserve, and trucks transporting petroleum products on March's Point Road (which runs adjacent to the entire eastern boundary of the reserve) are all potential sources of petroleum spills into Fidalgo Bay.

The refineries, in cooperation with state and federal regulatory agencies and the Tribes have established spill response plans and contingencies in case of an oil spill. The Washington Department of Ecology last updated its Geographic Response Plan for North Puget Sound in 2012. This plan, which is currently being updated, establishes initial response priorities and booming strategies to protect sensitive areas and resources of the Bay. Protection of Crandall and Weaverling Spits is a priority. The Swinomish Tribe has a lot of oil spill response equipment and along with the Samish Tribe, actively participate in oil spill response drills and other planning and training events. Recently, the Department of Ecology Oil Spill Response Team, in collaboration with Samish Tribe, awarded money for them to purchase a boat to aid in Oil Spill response. The boat will be delivered in May 2019, and will enable trained tribal staff to transport spill response and NRDA personnel in Samish traditional territory in the case of a spill. Other potential spill related boat benefits include use as a transport asset for potential wildlife rescue efforts during any spill in the area (T. Woodard, personal communication, 2019).

Spills have occurred over the 60 years of refinery operations and may occur in the future. The former Texaco refinery (now owned by Shell) had four separate oil spill events in 1991-1992 spilling more than 560 barrels (23,500 gal.) of crude oil into the bay. Beaches, intertidal areas, birds and cultural resources in the southern portion of the bay were affected by oil and/or cleanup operations from these spills. Following cleanup and remediation, reports by the Department of Ecology showed no significant residual contamination (Johnson 1997, 2000). A Natural Resources Damages Settlement was awarded in 2004 for damages associated with these spills, providing money for a 2008-09 beach restoration along portions of the reserve's eastern boundary which were damaged by oil (see XX).

Air Pollution

The Washington Department of Ecology Air Quality Program manages smoke, car pollution, industrial emissions, and other pollutants so communities have healthy air to breathe. The Air Quality Program issues permits, enforces state regulations, and maintains a reporting system intended to keep air pollution at healthy levels.

The Northwest Clean Air Agency is the primary government agency responsible for protecting the air in Island, Skagit and Whatcom counties. They are responsible for monitoring sulfur dioxide in the March Point area. In (YEAR), a records review conducted by Tetra Tech for DNR indicated that the existing commercial and industrial operations were in general compliance with their respective operating and air quality permits. However, there have been several "upsets" reported at both refineries with reported air quality falling below permitted standards during power outages or equipment failures, or during shut down and start up times.

According to the Washington Air Quality Monitoring Network website; https://fortress.wa.gov/ecy/enviwa/ (accessed 2/8/19), two air monitoring sites in Anacortes nearest to refinery operations have recorded "low" or "good" air quality values and air pollution. Air quality monitoring found the air quality in the area of Fidalgo Bay as "so low there is little health risk."

Future effects on species and habitat

Air pollution can include gas or particulates from major sources like personal and commercial vehicles (especially those traveling on Highway 20), wood stoves, ferries, ships and trucks associated with refineries, emissions from industrial shipbuilding or refinery operations.. While Washington has strong air pollution regulations, there have been occasional emergencies and accidental releases of air pollution in excess of regulatory requirements. As the human population of the area continues to grow, or if industrial or refinery operations expand in the future, the air quality in the reserve could be affected.

Non-Native Species

Fidalgo Bay and adjacent environs have been colonized by a wide variety of non-native species. The variety of species, their abundance, and impacts to native populations have not been fully described and in many circumstances are not fully known. While ecological functions and benefits can be prescribed to virtually all species, including non-native invasive species, the habitat and biological community changes that result from the establishment and spread of invasive species can adversely impact native species. Invasive species are broadly recognized as the second leading cause of threatened and endangered species loss after habitat destruction (Pimental et al. 2000).

Some non-native species were deliberately introduced to the region through aquaculture such as, Pacific oysters *(Crassostrea gigas).* Other non-natives were accidently introduced along with the Pacific oyster, including Manila clams (*Venerupis philippinarum*), Japanese eelgrass *(Zostera japonica*), the Pacific oyster drill (*Ocinebrellus inornatus*), and Asian mud snail (*Battilaria attramentaria*). The Asian mud snail was first recorded in Padilla Bay in the 1960s, however the invasion likely occurred sometime earlier. Today, the Asian mud snail is the most abundant macrofauna on mudflats in both Padilla (PSWQAT 2000) and Fidalgo Bays. Exclusion experiments suggest that *Battilaria* may facilitate the invasions of other non-native species including another mud snail (*Nassarius faterculus*) (Wonham et al. 2003). The purple varnish clam (*Nuttallia obscurata*) was apparently introduced via ballast water from Asia and is common on several beaches in the reserve area. Varnish clams tend to inhabit the upper one third of the intertidal zone, decreasing in the middle and lower intertidal zone. (WDFW website, https://wdfw.wa.gov/ais/nuttalia_obscurata/ 2019).

In September 2016, a few invasive European Green crabs (*Carcinus maenas*) were found in neighboring Padilla Bay. This recently introduced exotic species has the potential for great habitat destruction and could severely injure Washington State's oyster, clam, mussel, and Dungeness crab populations and industries, among others (Holmes 2001).

Beginning in Spring 2017- 2018, the Samish Nation DNR and Washington Sea Grant (WSG) Crab Team carried-out monthly surveys from April -September for Green Crab at two sites in Fidalgo Bay. Green crabs were not found during any of these surveys. However, in August 2018, while doing forage fish surveys, a Puget Sound Corps staff found a green crab carapace on the beach at Little Crandall Spit in the aquatic reserve. As a result, WDFW’s Nuisance Species Program set out an aggressive trapping array in accessible and likely habitat areas in the most southern portion of the bay, but did not trap any green crab. The Samish Tribe DNR and WSG crab team will proceed with the seasonal monitoring program in 2019 at the two sites in the bay. The Tribe will continue to carry out future green crab surveys beyond 2019 if funding and priorities allow. WDFW and WSG are committed to monitoring and controlling the spread of green crab in Washington’s marine and estuarine waters and will persist in regularly monitor in Fidalgo Bay and neighboring areas to curtail green crab establishment.

Spartina anglica was first discovered in Fidalgo Bay in 1999 with two smaller infestations in the bay, along the southeastern shore and in the Samish RV park inner bay of Weaverling Spit; both areas were reportedly treated and eradicated (2005). The Skagit County noxious weed crew regularly monitor the bay and have removed small infestations of *Spartina* in the same general locales.

Puget Sound Expedition (Cohen et al. 1998), was a collaborative rapid assessment of non-indigenous species in Puget Sound, and had an assessment site at Cap Sante Marina. Although this site is located within Fidalgo Bay, it is 1.4 miles north of the reserve boundary. Several invasive species listed below were observed. Most of these are known to degrade the quality of the habitat and/or compete with native species. To date, no systematic survey has been attempted to assess which species are within the reserve boundaries. Non-native species observed or present at Cap Sante Marina include:

1. *Spartina anglica*
2. *Zostera japonica*
3. Bryozoan (*Bugula*)
4. Tunicate (*Botrylloides violaceus*)
5. Japanese littleneck (*Venerupis phillipenarum*)
6. Pacific Oyster (*Crassostrea gigas*)
7. Horn shell snails (*Battillaria attramentaria)*
8. Varnish Clam (*Nutallia obscurata)*

Impacts

Some invasive, non-native species may cause ecological disruption by competition with native species - changing ecosystem structure, and in the case of the aquaculture industry, may cause significant economic losses as well. Monitoring and control of potentially harmful species is essential for maintaining the existing health status of the bay. Several non-native invasive species pose a continual threat to physical and biological habitat areas and functions within the bay. Since *Spartina* is an invasive aquatic plant species that can degrade the quality of the tideflats, threaten native marsh communities and encroach on critical shorebird and juvenile salmon habitat, vigilant monitoring and eradication are necessary. *Sargassum muticum* can out compete native kelp species and become a monoculture. *Sargassum* is present in northern parts of the bay, but generally not a threat in the aquatic reserve due to the lack of coarse gravel/cobble substrate. For several of the other non-native species, the long-term detrimental effects are undetermined or controversial.

As discussed in the preceding section, the recent expansion of European green crabs to Padilla Bay and the molt on the beach in Fidalgo Bay warrants collaborative and diligent surveying and trapping efforts in the bay. In areas where the green crab has established reproducing populations, they have had dramatic impacts on other species, like smaller shore crab, snails and small oysters. While the crab cannot crack the shell of a mature Pacific oyster, it can prey upon young oysters, and will dig down six inches to find clams to eat. One green crab can consume 40 half-inch clams a day, as well as other crabs its own size. As previously mentioned, green crabs can and do consume Dungeness at up to their own size, according to laboratory studies (Cohen et al. 1995, Grosholz and Ruiz 1995, as cited by Cohen and Carlton 1995). Since Dungeness crabs spend part of their early life in the intertidal zone, they may be at risk of predation by green crabs during that time (WDFW, https://wdfw.wa.gov/ais/carcinus_maenas/ 2019). As nursery habitat for Dungeness crab and with the reintroduced Olympia oysters in the bay, a potentially expanding population of green crab in the region is of major concern and could have devastating effects to these species.

Reintroduced Olympia oyster populations could be vulnerable to periodic surges in local populations of Pacific oysters, it is therefore important to monitor for this species. Pacific oysters out compete Olympia oysters for settlement substrate, which is limited in Fidalgo Bay. Additionally, a surge in the Pacific oyster population in the bay could be accompanied by the invasive Asian and/or eastern oyster drills. Other non-native species that are in close proximity to the aquatic reserve, such as the tunicates found at marinas in the bay, can pose a threat by enveloping substrates used for settlement by oysters and other indigenous sessile species and stifling native species.

The non-native polychaete worm *Clymnella torquata* (bamboo worm) is a more recent invader of Samish Bay flats and poses a serious threat to the quality of substrate and the ecology of the existing epibenthic and infaunal communities in areas with extensive sand and mudflats.

Habitat Disturbance by Humans

Ecological stressors can include disturbance of habitat by humans. Physical disruption of foraging and resting habitat, noise and light levels can impact habitats.
Physical disruption may include activity from boaters or kayakers in the bay, or recreationists using the Tommy Thompson Trail. Lights from refinery activities may affect portions of the bay, in turn affecting nocturnal behaviors. As the future population of the area increases, without mitigation measures stressors from human disturbance could increase.

APPENDIX B – Observed Species List

NOTE TO REVIEWERS

Over the past several months DNR has worked to update important information on ecosystem conditions and stressors. While the draft presented here contains much updated information, DNR is still actively working to gather additional information on the following topic areas:

- Observed species list. Current list is based on limited available recent surveys and likely does not completely represent species richness in the bay.

We need your help! Please let us know of any actual species observations not yet on these lists, or if you feel some species should be removed.

Tables A-1 to A-5 identify the documented flora and fauna within the area of the Fidalgo Bay Aquatic Reserve.

The species lists include birds, fish, marine mammals, invertebrates, and intertidal and shallow subtidal marine vegetation. Various organizations and individuals who use the area in and around the Fidalgo Bay Aquatic Reserve have identified the species listed below.

These are preliminary species lists, not comprehensive lists. <u>Only species observed and documented by a confirmed source were included.</u>

Table A- 1: Birds Observed in Fidalgo Bay Aquatic Reserve

* Species protected by the Federal Migratory Bird Treaty Act

◊ Birds Characteristic of Saltwater Habitat[6]

⊕ Birds Characteristic of Sandy and Gravel Shoreline, Mud Flats and Salt Marshes[6]

Species of Concern Status (State and Federal) was obtained from Washington Department of Fish and Wildlife in 2019.[7]

Common Name	Scientific Name	State Status	Federal Status	Source
Waterfowl - Anseriformes				
Northern Pintail ⊕	*Anas acuta*		*	1, 2, 3, 4, 5, 8, 10
American Wigeon ⊕ ◊	*Mareca americana*		*	1, 2, 3, 4, 5, 8, 10
Eurasian Wigeon ⊕ ◊	*Mareca penelope*		*	1, 3, 4, 5, 7, 8, 9
American Wigeon x Eurasian Wigeon ⊕ ◊	*Mareca* sp.			5, 7
Northern Shoveler	*Spatula clypeata*		*	1, 3, 4, 8, 10
Common Teal	*Anas crecca*		*	1, 2, 3, 4, 10
Mallard ⊕ ◊	*Anas platyrhynchos*		*	1, 2, 3, 4, 5, 8, 10
Gadwall	*Mareca strepera*		*	1, 3, 4, 8, 10
Snow goose	*Anser caerulescens*		*	1, 3, 4, 7, 8, 10
Lesser Scaup	*Aythya affinis*		*	1, 3, 4, 8, 10
Ring-necked Duck	*Aythya collaris*		*	1, 3, 4, 8, 10
Greater Scaup ◊	*Aytha marila*		*	1, 3, 4, 5, 7, 8, 10
Brant ⊕ ◊	*Branta bernicla*		*	1, 2, 3, 4, 5, 8, 10
Canada Goose ⊕ ◊	*Branta canadensis*		*	1, 2, 3, 4, 5, 8, 10
Bufflehead ◊	*Bucephala albeola*		*	1, 2, 3, 4, 5, 7, 8, 10
Common Goldeneye ◊	*Becephala clangula*		*	1, 2, 3, 4, 5, 7, 8, 10
Barrow's Goldeneye ◊	*Becephala islandica*		*	1, 2, 3, 4, 5, 8, 10
Long-tailed Duck	*Clangula hyemalis*		*	1, 3, 4, 7
Trumpeter Swan	*Cygnus buccinator*		*	1, 3, 4, 7, 8
Harlequin Duck ⊕ ◊	*Histrionicus histrionicus*		*	1, 3, 4, 5
Hooded Merganser ◊	*Lophodytes cucullatus*		*	1, 2, 3, 4, 5, 8, 10

Common Name	Scientific Name	State Status	Federal Status	Source
Surf Scoter ◊	*Melanitta perspicillata*		*	1, 2, 3, 4, 5, 7, 8, 10
Common Merganser ◊	*Mergus merganser*		*	1, 3, 4, 5, 8, 10
Red-breasted Merganser ◊	*Mergus serrator*		*	1, 3, 4, 5, 7, 8, 10
Ruddy Duck ◊	*Oxyura jamaicensis*		*	1, 2, 3, 4, 5, 8, 10
Black Scoter ◊	*Melanitta nigra*		*	1, 3, 4, 5, 7
Loons – Gaviiformes				
Common Loon ◊	*Gavia immer*	Sensitive	*	1, 2, 3, 4, 5, 7, 8, 9, 10
Pacific Loon ◊	*Gavia pacifica*		*	1, 2, 3, 4, 5, 7, 10
Red-throated Loon ◊	*Gavia stellata*		*	1, 3, 4, 5, 7, 8, 10
Grebes – Podicipediformes				
Western Grebe ◊	*Aechmophorus occidentalis*		*	1, 2, 3, 4, 5, 8, 10
Horned Grebe ◊	*Podiceps auritus*		*	1, 2, 3, 4, 5, 7, 8, 10
Red-necked Grebe ◊	*Podiceps grisegena*		*	1, 2, 3, 4, 5, 8, 10
Pied-billed Grebe ◊	*Podilymbus podiceps*		*	1, 3, 4, 5, 7, 8, 10
Pelicans, Cormorants and Allies – Pelicaniformes				
White Pelican	*Pelecanus erythrorhynchos*		*	1, 3, 7, 4, 9
Pelagic Cormorant ⊕ ◊	*Urile pelagicus*		*	1, 3, 4, 5, 8, 10
Brandt's Cormorant ⊕ ◊	*Urile penicillatus*		*	1, 3, 4, 5, 7, 8
Double Crested Cormorant ⊕ ◊	*Nannopterum auritus*		*	1, 2, 3, 4, 5, 8, 10
Herons, Ibises and Allies – Ciconiformes				
Great Blue Heron ⊕ ◊	*Ardea herodias*	Monitor	*	1, 2, 3, 4, 5, 7, 8, 9, 10
American Bittern	*Botaurus lentiginosus*		*	1, 3
New World Vultures, Hawks, Falcons and Allies – Falconiformes				
Cooper's Hawk	*Accipiter cooperii*		*	1, 3, 4, 7, 8, 10
Merlin ⊕	*Falco columbarius*	Candidate	*	1, 3, 4, 5, 7, 8, 9, 10
Peregrine Falcon ⊕	*Falco peregrinus*	Sensitive	*Delisted	1, 3, 4, 5, 7, 8, 9, 10
Bald Eagle ⊕ ◊	*Haliaetus leucocephalus*	Sensitive	*Delisted	1, 2, 3, 4, 5, 7, 8, 9, 10

Common Name	Scientific Name	State Status	Federal Status	Source
Turkey Vulture	*Cathartes aura*			6
Osprey	*Pandion haliaetus*			6
Shorebirds, Gulls, Auks and Allies – Charadriiformes				
Black Turnstone ⊕	*Arenaria melanocephala*		*	1, 3, 4, 5, 7, 8, 10
Marbled Murrelet ◊	*Brachyramphus marmoratus*	Threatened	*Threatened	1, 3, 4, 5, 6, 9, 10
Sanderling ⊕	*Calidris alba*		*	1, 3, 4, 5, 7, 10
Dunlin ⊕	*Calidris alpina*		*	1, 3, 4, 5, 8, 10
Western Sandpiper ⊕	*Calidris mauri*		*	1, 3, 4, 5, 7, 8, 10
Pigeon Guillemot ⊕ ◊	*Cepphys columba*		*	1, 3, 4, 5, 8, 10
Snowy Plover	*Charadrius nivosus*	Endangered	*Threatened	1, 3, 9
Killdeer ⊕	*Charadrius vociferus*		*	1, 3, 5, 6, 8, 10
Black tern	*Childonias niger*		*	1, 3
Northern Harrier	*Circus hudsonius*		*	1, 3, 4, 7, 8, 10
Mew Gull ⊕ ◊	*Larus canus*		*	1, 3, 4, 5, 8, 10
Ring-billed Gull	*Larus delawarensis*		*	1, 3, 4, 8, 10
Glaucous-winged Gull ⊕ ◊	*Larus glaucescens*		*	1, 3, 4, 5, 8, 10
Western Gull ◊	*Larus occidentalis*		*	1, 3, 4, 5, 8, 10
Bonaparte's Gull ⊕ ◊	*Larus philadelphia*		*	1, 3, 4, 5, 10
Long-billed Dowitcher	*Limnodromus scolopaceus*		*	1, 4, 7, 10
Black-bellied Plover	*Pluvialis squatarola*		*	1, 3, 4, 7, 10
Caspian Tern ⊕ ◊	*Hydroprogne caspia*		*	1, 3, 4, 5, 7, 9, 10
Greater Yellowlegs ⊕	*Tringa melanoleuca*		*	1, 3, 4, 5, 8, 10
Flycatchers, Songbirds and Allies – Passeriformes				
Red-winged blackbird ⊕	*Agelaius phoeniceus*		*	1, 3, 4, 5, 8, 10
Willow Flycatcher	*Empidonax traillii*		*	1, 3, 4
American Crow ⊕	*Corvus brachyrhynchos*		*	1, 3, 4, 5, 10
Common Raven	*Corvus corax*		*	1, 3, 4, 7, 8, 10

Common Name	Scientific Name	State Status	Federal Status	Source
Yellow Warbler ⊕	*Setophaga petechia*		*	1, 4, 5, 7
Brewer's Blackbird	*Euphagus cyanocephalus*		*	1, 3, 4, 8, 10
Song Sparrow ⊕	*Melospiza melodia*		*	1, 3, 4, 5, 8, 10
Savannah Sparrow ⊕	*Passerculus sandwichensis*		*	1, 3, 4, 5, 10
Purple Martin ⊕	*Progne subis*	Candidate	*	1, 3, 4, 5, 7, 10
Common Starling ⊕	*Sturnus vulgaris*			1, 4, 5, 10
Swifts - Caprimulgiformes				
Vaux's Swift	*Chaetura vauxi*	Candidate	*	1, 3, 4, 9

Sources:

1. IUCN 2018. *The IUCN Red List of Threatened Species. Version 2018-2.* http://www.iucnredlist.org. Downloaded on 31 January 2019.
2. Marine Bird Abundance in the Cherry Point and Fidalgo Bay Aquatic Reserves 2013-2018 Appendices.
3. Migratory Bird Treaty Act Protected Species List. U.S. Fish and Wildlife Service. 2013.
4. Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink, and S. Kelling. 2009. Ebird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142: 2282-2292.
5. *The Birds of Vashon Island: A Natural History of Habitat & Population Transformation* by Ed Swan (2nd Edition)
6. Todd Woodard, Samish Indian Nation on 2/5/2019. Personal communication.
7. Skagit Audubon Society bird counts. 2015-2019.
8. Skagit Audubon Society; Padilla Bay Christmas Bird Count. 2008-2018.
9. Washington Department of Fish and Wildlife. Species of concern. Olympia (WA): Washington Department of Fish and Wildlife; [cited 15 Feb 2019]. Available from http://wdfw.wa.gov/conservation/endangered/
10. Williams, B.W., S. Wyllie-Echeverria, A. Bailey. 2003. Historic Nearshore Habitat Change Analysis for Fidalgo Bay and Guermes Channel. Prepared for the City of Anacortes by Batelle Marine Sciences Laboratory. Sequim WA. 29 pp. + Appendices.

Table A- 2: Fish Observed in Fidalgo Bay Aquatic Reserve

Common Name	Scientific Name	State Status	Federal Status	Source
Ratfishes or Chimaeriformes - Chimaeriformes				
Spotted Ratfish	*Hydrolagus colliei*			2, 3
Herrings - Culpeiformes				
Pacific Herring	*Clupea pallasii*	Candidate	Species of Concern	2, 3, 4, 5
Sticklebacks and Seamoths – Gasterosteiformes				
Tube-snout	*Aulorhynchus flavidus*			3, 4
Three-spined stickleback	*Gasterosteus aculeatus*			4
Smelts – Osmerifromes				
Surf Smelt	*Hypomesus pretiosus*			4
Perch-likes – Perciformes				
Pacific Sand Lance	*Ammodytes personatus*			3, 4
Penpoint Gunnel	*Apodichthys flavidus*			3, 4
Shiner Perch	*Cymatogaster aggregata*			3, 4
Snake Prickleback	*Lumpenus sagitta*			3
Crescent Gunnel	*Pholis laeta*			3, 4
Saddleback Gunnel	*Pholis ornata*			3, 4
Pile Perch	*Rhacochilus vacca*			3
Flatfishes – Pleuronectiformes				
Speckled Sanddab	*Citharicthys stigmaeus*			3
Rock Sole	*Lepidopsetta bilineata*			3
English Sole	*Parophrys vetulus*			4
Starry Flounder	*Platichthys stellatus*			3, 4

Common Name	Scientific Name	State Status	Federal Status	Source
Salmons – Salmoniformes				
Pink Salmon	*Oncorhynchus gorbuscha*			4
Chum Salmon	*Oncorhynchus keta*	Candidate	Threatened	4, 5
Chinook Salmon	*Oncorhynchus tshawytscha*	Candidate	Threatened	2, 4, 5
Coho Salmon	*Oncorhynchus kisutch*	Candidate		2,5
Scorpionfishes and Flatheads – Scorpaeniformes				
Great Sculpin	*Myoxocephalus polyacanthocephalus*			3, 4
Tidepool sculpin	*Oligocottus maculosus*			
Tadpole sculpin	*Psychrolutes paradoxus*			4
Buffalo Sculpin	*Enophrys bison*			1
Pacific Staghorn Sculpin	*Leptocottus armatus*			3
Copper Rockfish	*Sebastes Caurinus*	Candidate		3, 4
Lingcod	*Ophiodon elongatus*			4, 5
Pipefishes and Seahorses – Sygnathiformes				
Bay Pipefish	*Sygnathus griseolineatus*			4

Sources:

1. Cherry Point and Fidalgo Bay Aquatic Reserves Intertidal Monitoring Report Appendices 2013-2018; p. 39-49: https://www.aquaticreserves.org/wp-content/uploads/CPAR_FBAR_Intertidal_Monitoring_Report_2019_Appendices_FINAL.pdf
2. IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 31 January 2019.
3. Miller, B.S., and Borton, S.F. 1980. Geographical distribution of Puget Sound fishes: maps and data source sheets. Volumes 1 and Seattle (WA): Fisheries Research Institute, College of Fisheries, University of Washington.
4. REEF. 2018. Reef Environmental Education Foundation Volunteer Survey Project. Key Largo (FL): REEF; [cited 8 Feb 2019]. Available from http://www.reef.org/db/reports/geo.
5. Samish Indian Nation; Fidalgo Bay Nearshore Fish Use 2015-2017.
6. Washington Department of Fish and Wildlife. Species of concern. Olympia (WA): Washington Department of Fish and Wildlife; [cited 15 Feb 2019]. Available from http://wdfw.wa.gov/conservation/endangered/

Table A – 3: Mammals Observed in Fidalgo Bay Aquatic Reserve

* Species protected by the Federal Marine Mammal Protection Act

Common Name	Scientific Name	State Status	Federal Status	Source
Carnivores – Carnivora				
North American River Otter	*Lutra Canadensis*			1, 2, 4
Northern Raccoon	*Procyon lotor*			1, 2
North Pacific Harbor Seal	*Phoca vitulina richardii*		*	1, 2, 3, 4
American Mink	*Neovison vison*			1, 2
Long-tailed Weasel	*Mustela frenata*			5
Black-tailed Deer	*Odocoileus hemionus*			5

Sources:

1. IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 21 February 2019.
2. Ebird; Skagit Audubon Society bird counts. 2015-2019.
3. Lance, M. M., Chang, W-Y., Jeffries, S. J., Pearson, S. F., & Acevedo-Gutiérrez, A. (2012). Harbor seal diet in northern Puget Sound: Implications for the recovery of depressed fish stocks. Marine Ecology Progress Series, 464, 257-271. http://dx.doi.org/10.3354/meps09880
4. The Whale Trail. 2018. The Sites > Washington Park (WA): The Whale Trail; [cited 8 Feb 2019].
5. Todd Woodard, Samish Indian Nation on 2/5/2019. Personal communication.

Table 4: Invertebrates Observed in Fidalgo Bay Aquatic Reserve

Common name	Scientific Name	State Status	Federal Status	Source
Segmented Worms - Annelida				
Bamboo Worm	*Axiothella rubrocincta*			
Arrow Worm	*Chaetognatha floreana*			
Spiny-skinned Animals - Echinodermata				
Purple Sea Star	*Pisaster ochraceous*			
Crustaceans (Barnacles, Crabs and Allies) - Arthropoda, Crustacea				
Acorn Barnacle	*Balanus glandula*			1, 2, 3
Giant Barnacle	*Balanus nubilus*			2, 5
Red Rock Crab	*Cancer productus*			
Graceful Rock Crab	*Metacarcinus gracilis*			
Dungeness Crab	*Metacarcinus magister*			2, 3, 5
Red Rock Crab	*Cancer productus*			2,3,5,8
Skeleton Shrimp	*Caprella amphipod*			1
Small Brown Barnacle	*Chthamalus dalli*			1, 2
Crabs	*Cancer* spp.			1,
Purple Shore Crab	*Hemigrapsus nudus*			1, 2, 3
Shrimp	*Heptacarpus* spp.			1, 3
Shrimp	*Crangon sp.*			1
Pink Ghost Shrimp	*Neotrypaea californiensis*			1
Graceful Decorator Crab	*Oregonia gracilis*			1
Dock Shrimp	*Pandalus danae*			1
Graceful Kelp Crab	*Pugettia producta*			3
Isopods and Amphipods - Arthropoda, Isopoda/Amphipoda				
Amphipod	*Allorchestes angusta*			1, 2, 3

Common name	Scientific Name	State Status	Federal Status	Source
Amphipod	*Eogammarus oclairi*			1, 2, 3
Pill Bug Isopod	*Gnorimosphaeroma oregonensis*			1
Eelgrass Isopod	*Pentidotea resecata*			3
Rockweed Isopod	*Pentidotea wosnesenskii*			
Beach Hopper	*Orchestia traskiana*			
Clams, Oysters and Allies - Mollusca, Bivalve				
Heart Cockle	*Clinocardium nuttalii*			1, 2, 5
Pacific Oyster	*Crassostrea gigas*			1
Slipper Shell	*Crepidula dorsata*			3
Pacific Littleneck Clam	*Leukoma staminea*			1,2,3,5,8
Baltic Macoma	*Macoma balthica*			5
Bent-nosed Macoma	*Macoma nasuta*			5
Eastern soft shell Clam	*Mya arenaria*			5
Pacific blue mussel	*Mytilus trossulus*			2, 3
Purple Varnish Clam	*Nuttallia obscurata*			5,8
Olympia Oyster	*Ostrea lurida*			6
Washington Butter Clam	*Saxidomus gigantea*			1, 2, 3, 5
Horse/Gaper Clam	*Tresus* spp.			2, 3
Manila Clam	*Venerupis philippinarium*			1, 2
Rough Piddock	*Zirfaea pilsbryi*			
Snails and Slugs - Mollusca, Gastropoda				
Japanese Mud Snail	*Batillaria attramentaria*			
Bubble Shell	*Hamonea vesicula*			2, 3,8
Top Snail	*Lirularia lirularia*			2
Checkered Periwinkle	*Littorina scutulata*			1, 2, 3

Common name	Scientific Name	State Status	Federal Status	Source
Sitka Periwinkle	*Littorina sitkana*			1, 2, 3
Finger Limpet	*Lottia digitalis*			1, 2, 3
Shield Limpet	*Lottia pelta*			1, 2, 3
Mask Limpet	*Lottia persona*			1, 2
Hooded Nudibranch	*Melibe leonina*			7,8
Purple Nudibranch	*Chromodoris willani*			
Chitons - Mollusca, Polyplacophora				
Mossy Chiton	*Mopalia mucosa*			1, 2

Sources:

1. Cherry Point and Fidalgo Bay Aquatic Reserves Intertidal Monitoring Report Appendices 2013-2018: https://www.aquaticreserves.org/wp-content/uploads/CPAR_FBAR_Intertidal_Monitoring_Report_2019_Appendices_FINAL.pdf
2. Intertidal Monitoring in the Fidalgo Bay Aquatic Reserve 2013 Monitoring Report: http://file.dnr.wa.gov/publications/aqr_resv_fb_2013_intertidal_monitoring.pdf
3. IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 31 January 2019.
4. REEF. 2018. Reef Environmental Education Foundation Volunteer Survey Project. Key Largo (FL): REEF; [cited 8 Feb 2019]. Available from http://www.reef.org/db/reports/geo.slug
5. Samish Indian Nation DNR shellfish surveys, 2009-2018.
6. Skagit County Marine Resources Committee annual Report 2017: http://www.skagitmrc.org/media/36282/2017%20SMRC%20Annual%20Report6.pdf
7. Todd Woodard, Samish Indian Nation on 2/5/2019. Personal communication.
8. WDNR staff
9.

Table A- 3: Intertidal and Shallow Subtidal Vegetation Observed in Fidalgo Bay Aquatic Reserve

Common Name	Scientific Name	State Status	Federal Status	Source
Brown Algaes - Orophyta				
Winged Kelp	*Alaria marginata*			2,
Oyster Thief	*Colpomenia bullosa*			
Seersucker	*Costaria costata*			
Broad Acid Weed	*Desmarestia ligulata*			
Maiden's Hair	*Ectocarpus* sp.			
Rockweed	*Fucus gardneri*			2,
Bull Kelp	*Nereocystis luetkeana*			2, 5
Sugar Wrack Kelp	*Saccharina latissima*			1, 2,
Wireweed, Japanese Weed, Sargassum	*Sargassum muticum*			1
Whip Tube, Soda Straws	*Scytosiphon lomentaria*			1
Brown Algae	*Scytosiphon simplicissimus*			
Green Algaes – Chlorophyta				
Green Rope	*Acrosiphonia* spp.			1
Mekong Weed	*Cladophora* sp.			2,
Gut Weed	*Ulva intestinalis*			1, 2, 3
Sea Lettuce	*Ulva lactuca*			1, 2, 3
Bright Grass Kelp	*Ulva linza*			2, 3
Red Algaes – Rhodophyta				
Red Algae	*Agardhiella tenera*			1, 3, 4
Beautiful Leaf Seaweeds	*Callophyllis* spp.			4,
Turkish Towel	*Chondracanthus exasperatus*			2,
Crustous Coralline	*Corallinales* spp.			2, 4
Red Algae	*Gracilaria* spp.			2, 3, 4
Red Spaghetti	*Gracilariopsis* spp.			1, 4
Iridea	*Iridaea cordata*			4,

Common Name	Scientific Name	State Status	Federal Status	Source
Turkish Washcloth	*Mastocarpus papillatus*			1, 2, 4
Iridescent Seaweed	*Mazzaella splendens*			4,
Red Algae	*Petalonia fascia*			3,
Red Algae	*Pyrioia lanceolata*			3,
Lobster Horns	*Polysiphonia* sp.			1, 4
Diatoms	*Navicula distans*			
Diatoms	*Odonthalia Washingtonesis*			
Nori	*Porphyra* sp.			1, 2, 4
Red String Algae, Sea Noodles	*Sarcodiotheca gaudichaudii*			2,
Seagrass Kaver	*Smithora naiadum*			2, 3
Vascular Plants – Anthophyta				
Dwarf Eelgrass	*Zostera japonica*	Invasive		2, 4, 5
Eelgrass	*Zostera marina*			1, 2, 4, 5
Sedges, Amaranthaceae, Morning-glories, Grasses, Daisy Family and Plantains - Salt Marsh Plants				
Lyngby's sedge	*Carex lyngbyei*			
Fat-hen	*Atriplex patula*			1,
Saltwort	*Glaux maritima*			
Pickleweed	*Salicornia virginica*			
Salt Marsh dodder	*Cuscuta salina*			
Turfted Hairgrass	*Deschampsia cespitosa*			1
Salt Grass	*Distichlis spicata*			1
American Dunegrass	*Leymus mollis*			1
Gumweed	*Grindelia integrifolia*			
Seaside plantain	*Plantago maritima*			
Cordgrass	*Spartina anglica*			

Sources:

1. Cherry Point and Fidalgo Bay Aquatic Reserves Intertidal Monitoring Report Appendices 2013-2018; p.39 - https://www.aquaticreserves.org/wp-content/uploads/CPAR_FBAR_Intertidal_Monitoring_Report_2019_Appendices_FINAL.pdf
2. [DNR] Washington State Department of Natural Resources. 2014. Washington Marine Vegetation Atlas. Olympia (WA): Washington State Department of Natural Resources, Nearshore Habitat Program.
3. Intertidal Monitoring in the Fidalgo Bay Aquatic Reserve 2013 Monitoring Report: http://file.dnr.wa.gov/publications/aqr_resv_fb_2013_intertidal_monitoring.pdf
4. IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 21 February 2019.
5. REEF. 2018. Reef Environmental Education Foundation Volunteer Survey Project. Key Largo (FL): REEF; [cited 8 Feb 2019]. Available from http://www.reef.org/db/reports/geo.slug

Ferrier. Pers. comm. 2014 22 May. Washington State Department of Natural Resources, Nearshore Habitat Program. On File. Washington State Department of Natural Resources, Aquatic Resources Division.
Healey, M. C. 1979. Detritus and juvenile salmon production in the Nanaimo Estuary: I. Production and feeding rates of juvenile chum salmon (Oncorhynchus keta). Journal of the Fisheries Research Board of Canada 36: 488-496.

APPENDIX C – Maps

Table of Contents:

Base Map Data Sources:
Bathymetry and Topography: Finlayson D.P. (2005) Combined bathymetry and topography of the Puget Lowland, Washington State. University of Washington, (http://www.ocean.washington.edu/data/pugetsound/)
Fidalgo Bay Aquatic Reserve: DNR

State-owned aquatic land is derived from DNR ownership index plates and does not represent actual spatial extent of tidelands and shorelands. Bedlands are not separately represented on this map, however are included within the areas represented by the tideland and shoreland classifications.
Extreme care was used during the compilation of this map to ensure accuracy. However, due to changes in data and the need to rely on outside sources of information, the Department of Natural Resources cannot accept responsibility for errors or omissions, and, therefore, there are no warranties which accompany this material.

State-owned aquatic land is derived from DNR ownership index plates and does not represent actual spatial extent of tidelands and shorelands. Bedlands are not separately represented on this map, however are included within the areas represented by the tideland and shoreland classifications.
Extreme care was used during the compilation of this map to ensure accuracy. However, due to changes in data and the need to rely on outside sources of information, the Department of Natural Resources cannot accept responsibility for errors or omissions, and, therefore, there are no warranties which accompany this material.

Figure C- 9: Assumed aquatic lands ownership

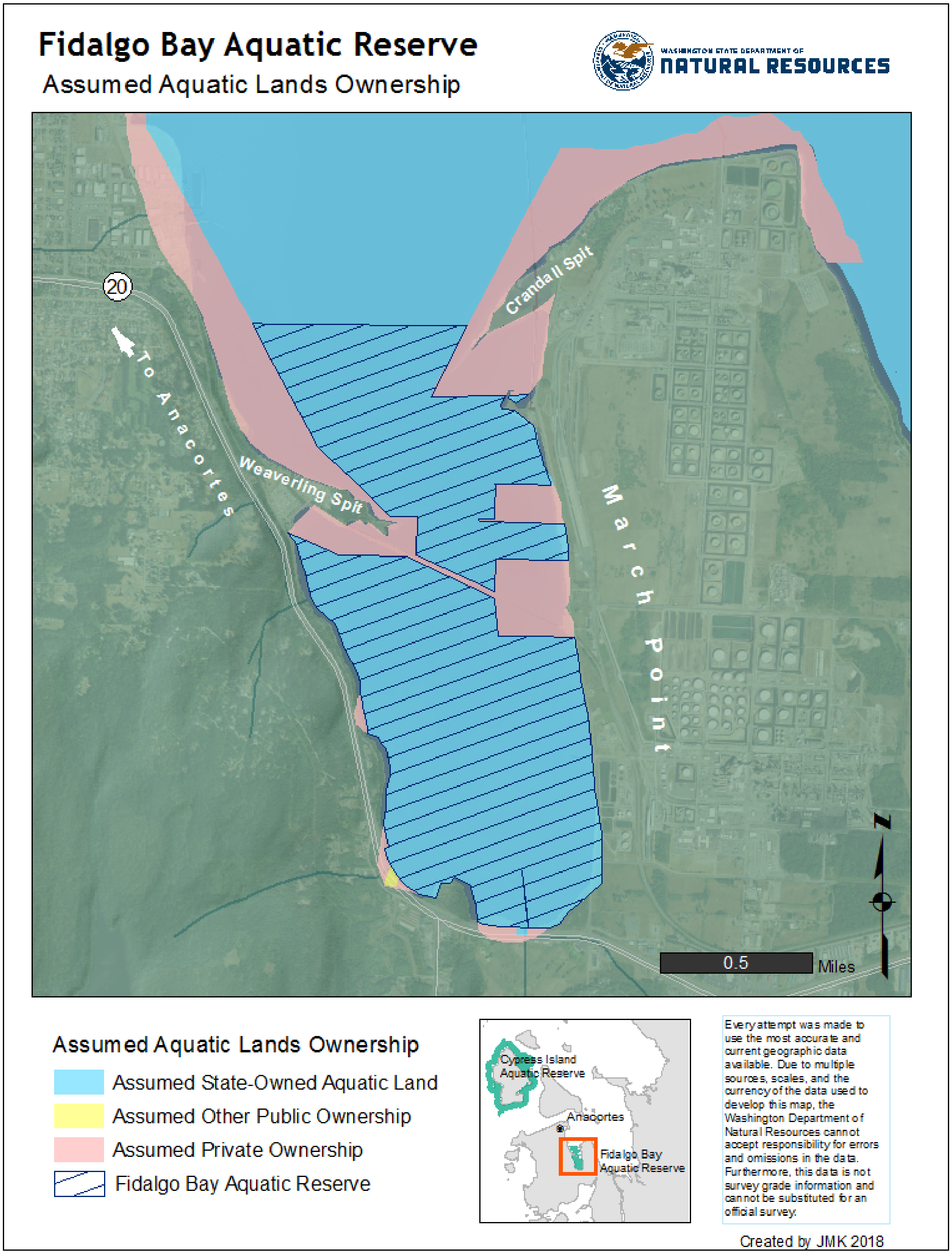


Figure C- 10: Skagit Land Trust Acquisitions and Donations

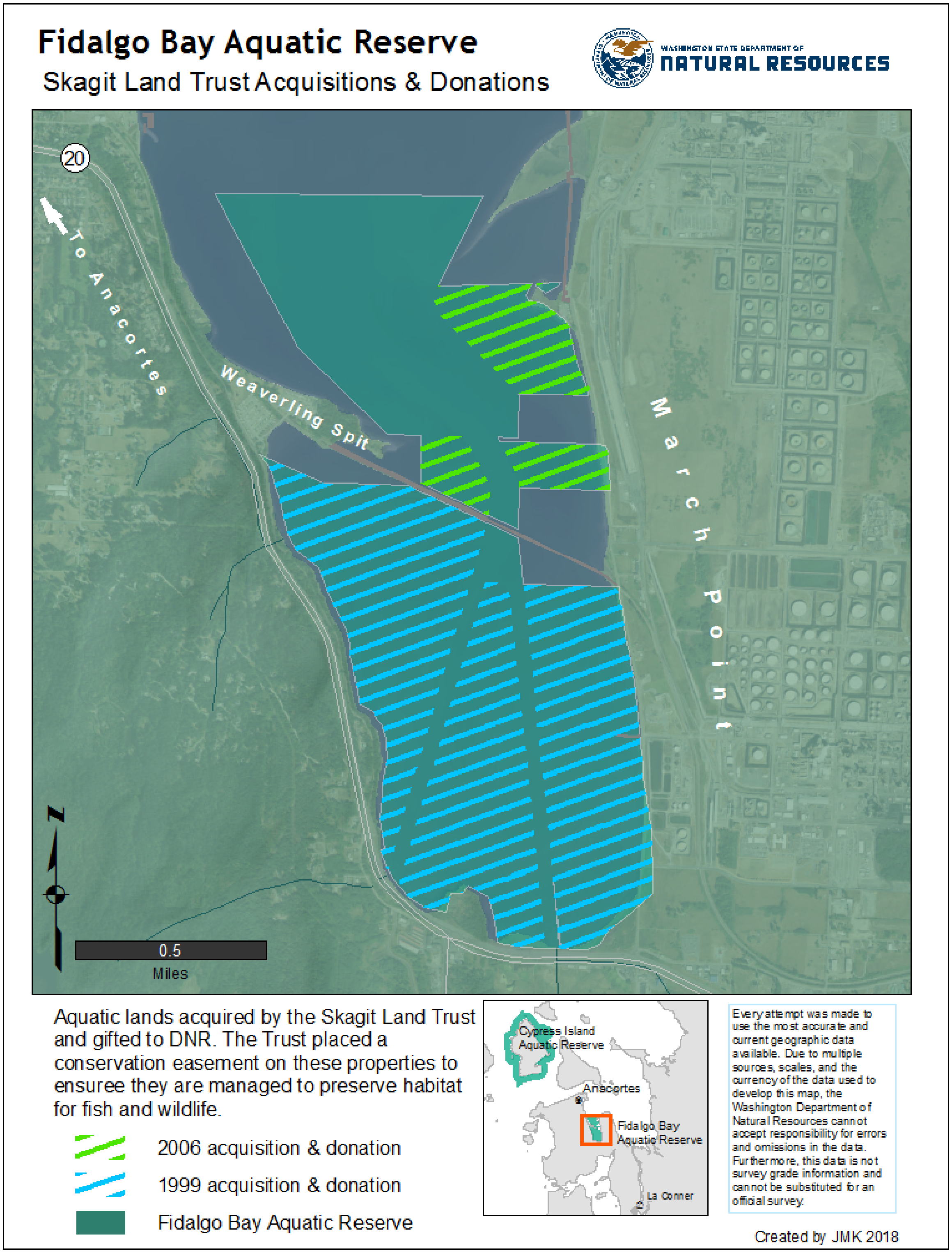


Figure C- 11: NOAA Navigation Chart

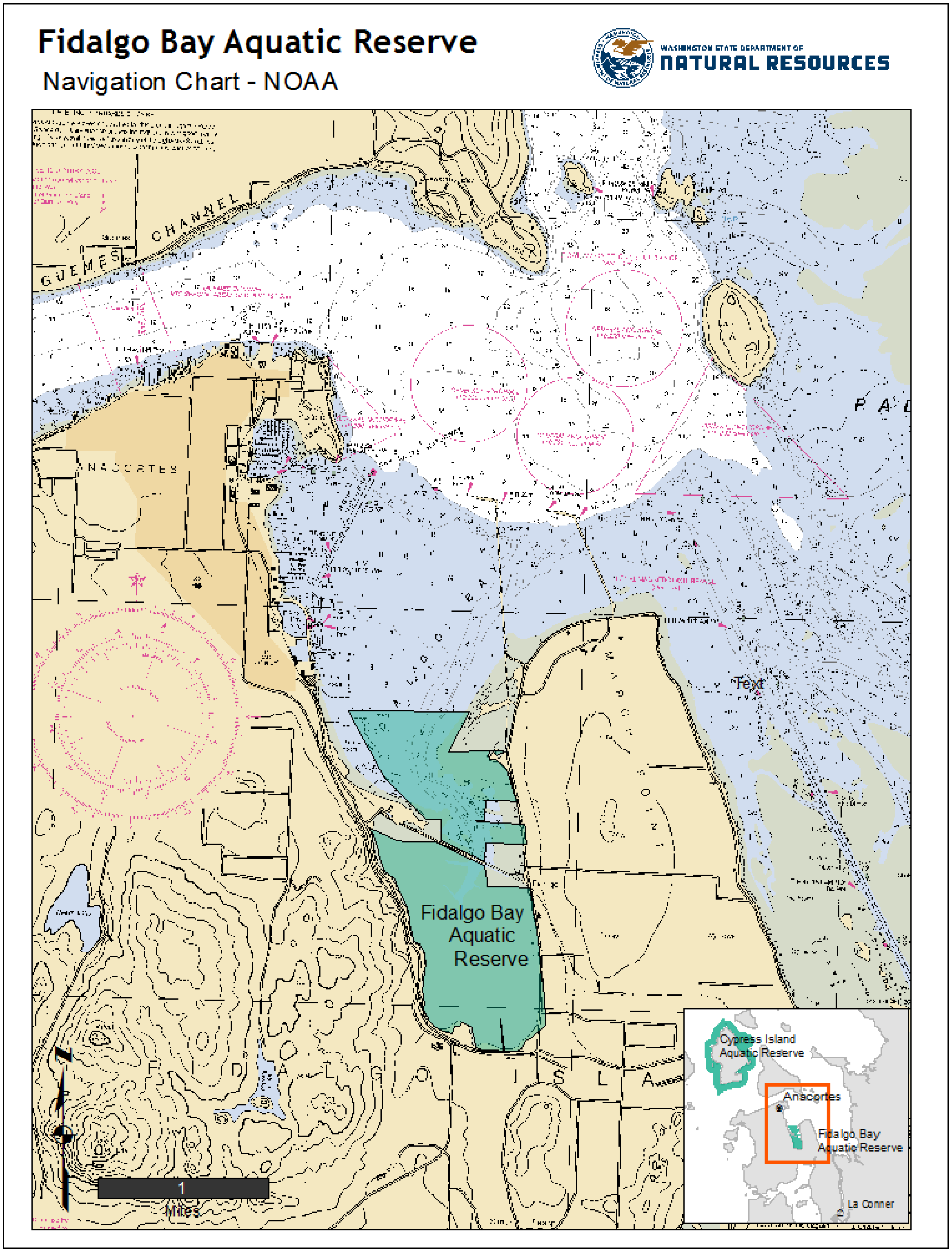


Figure C- 12: Shoreline Designations

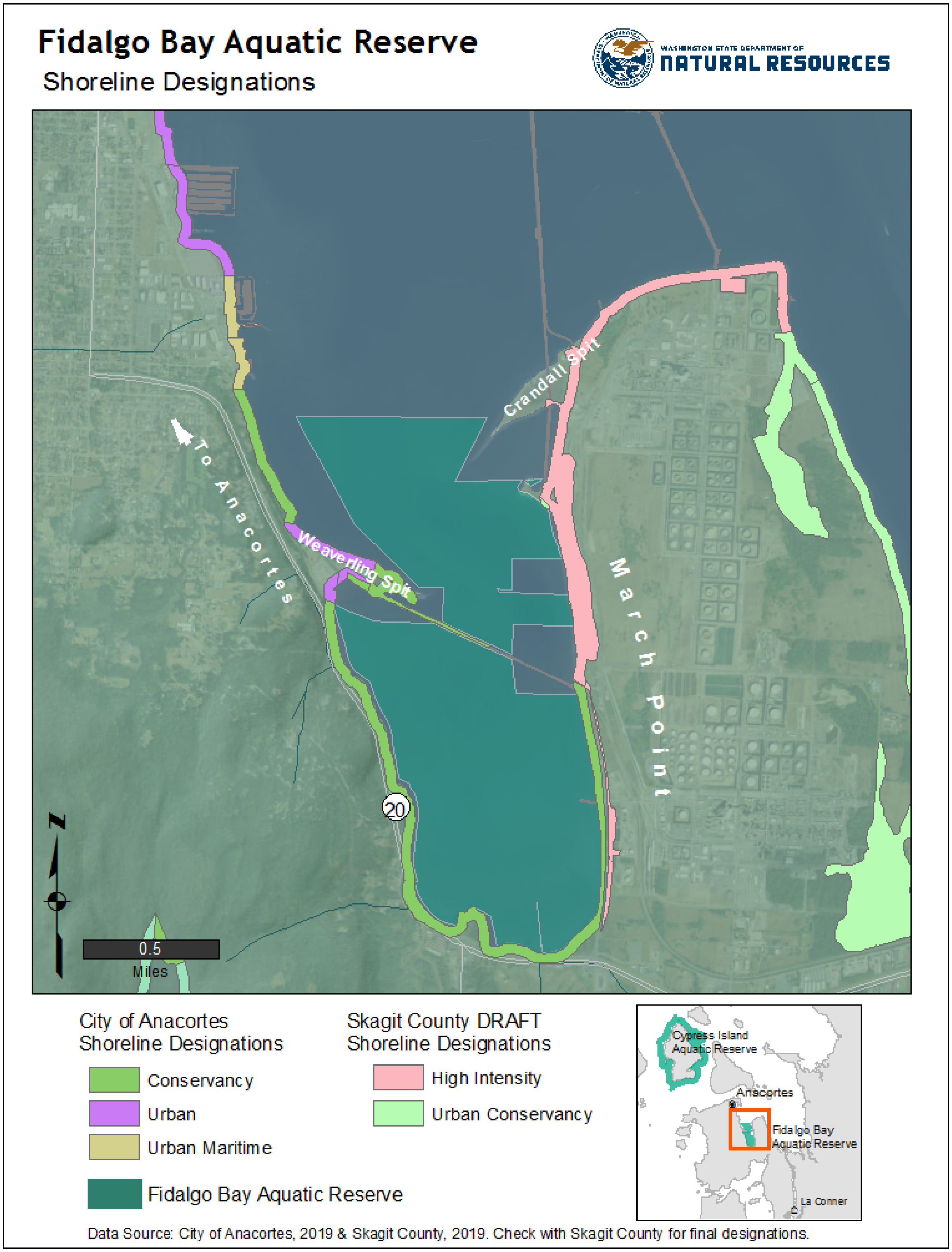


Figure C- 13: Benthic Substrate Types

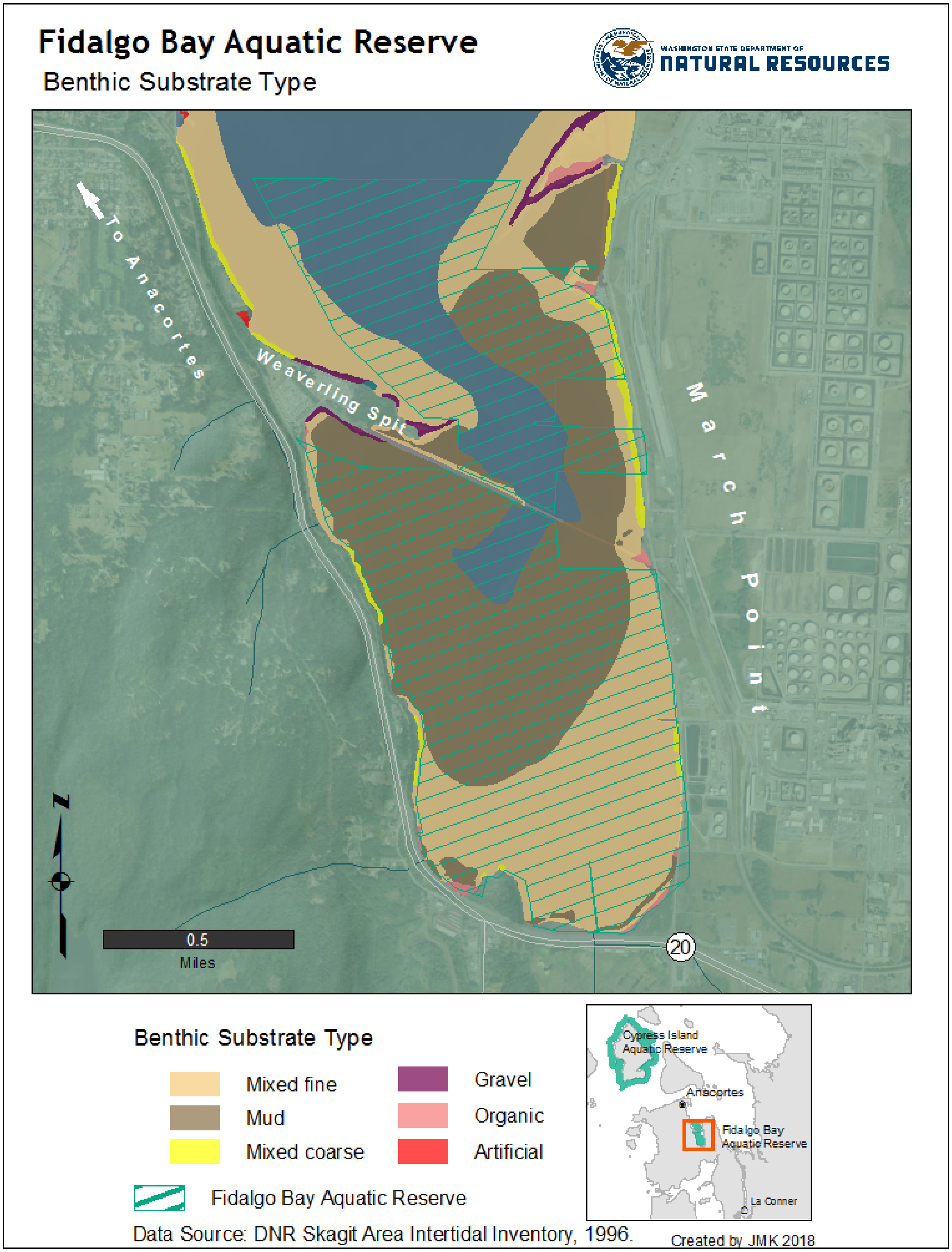


Figure C- 14: Littoral Drift Cells

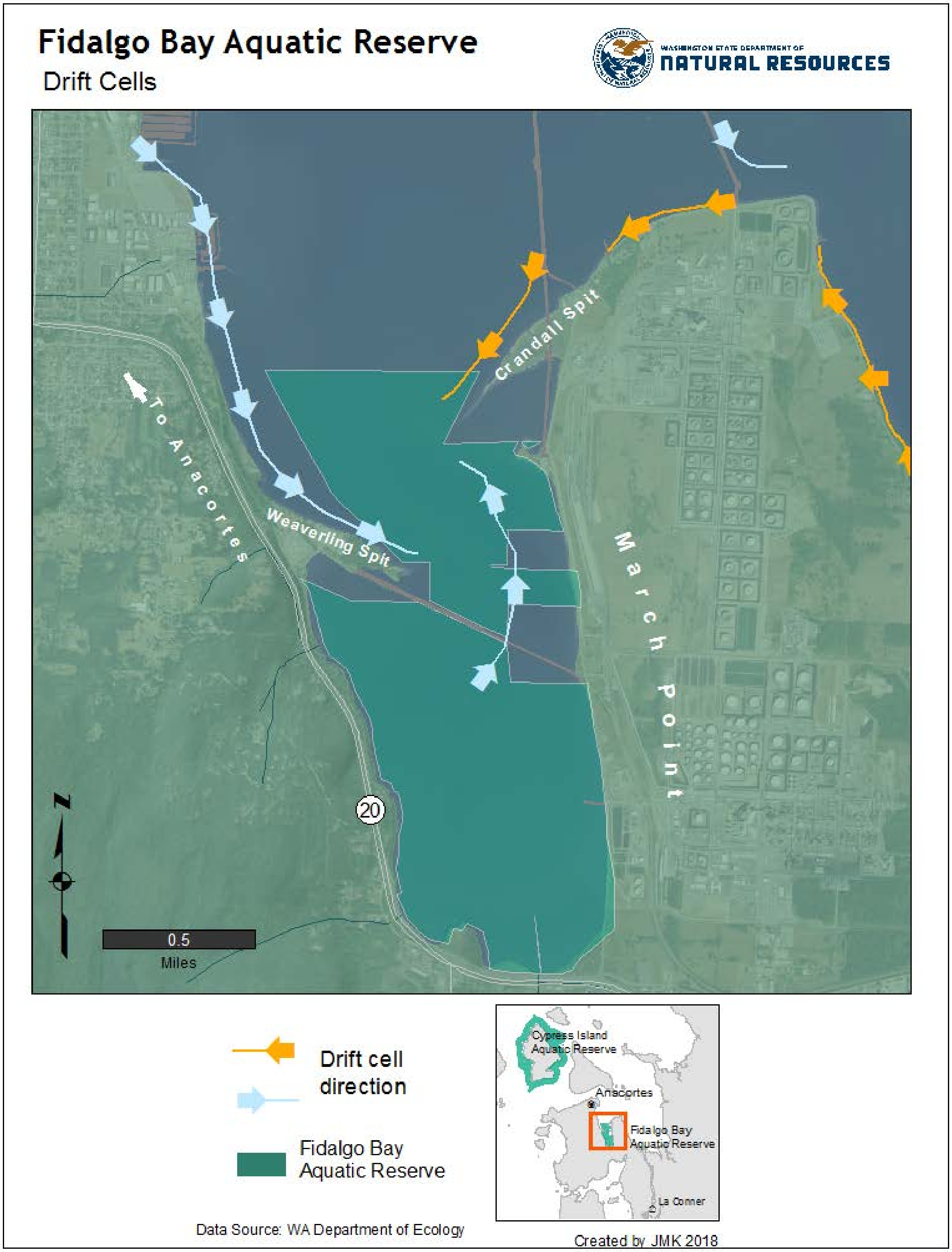


Figure C- 15: Eelgrass Distribution - 2016

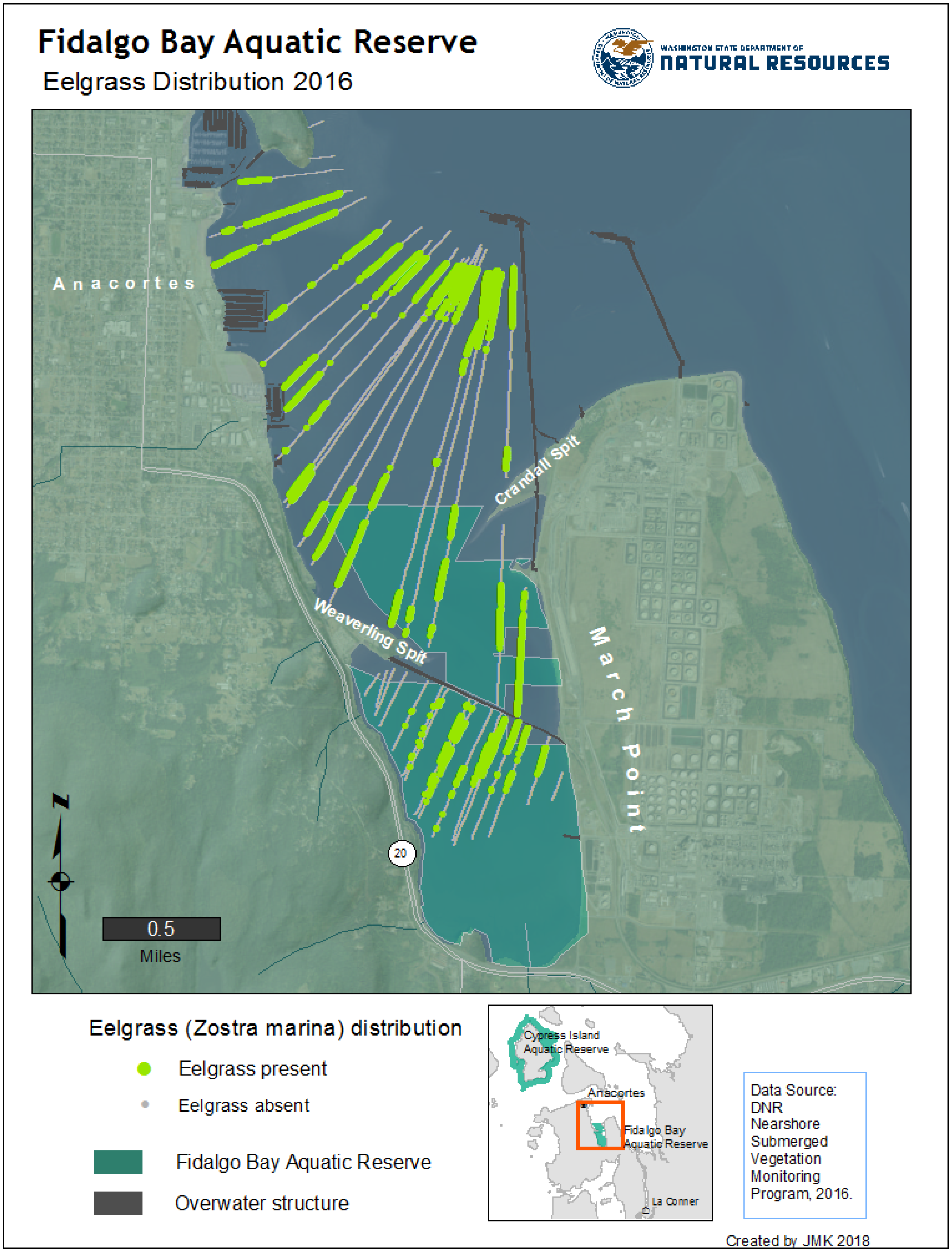


Figure C- 16: Restoration Projects

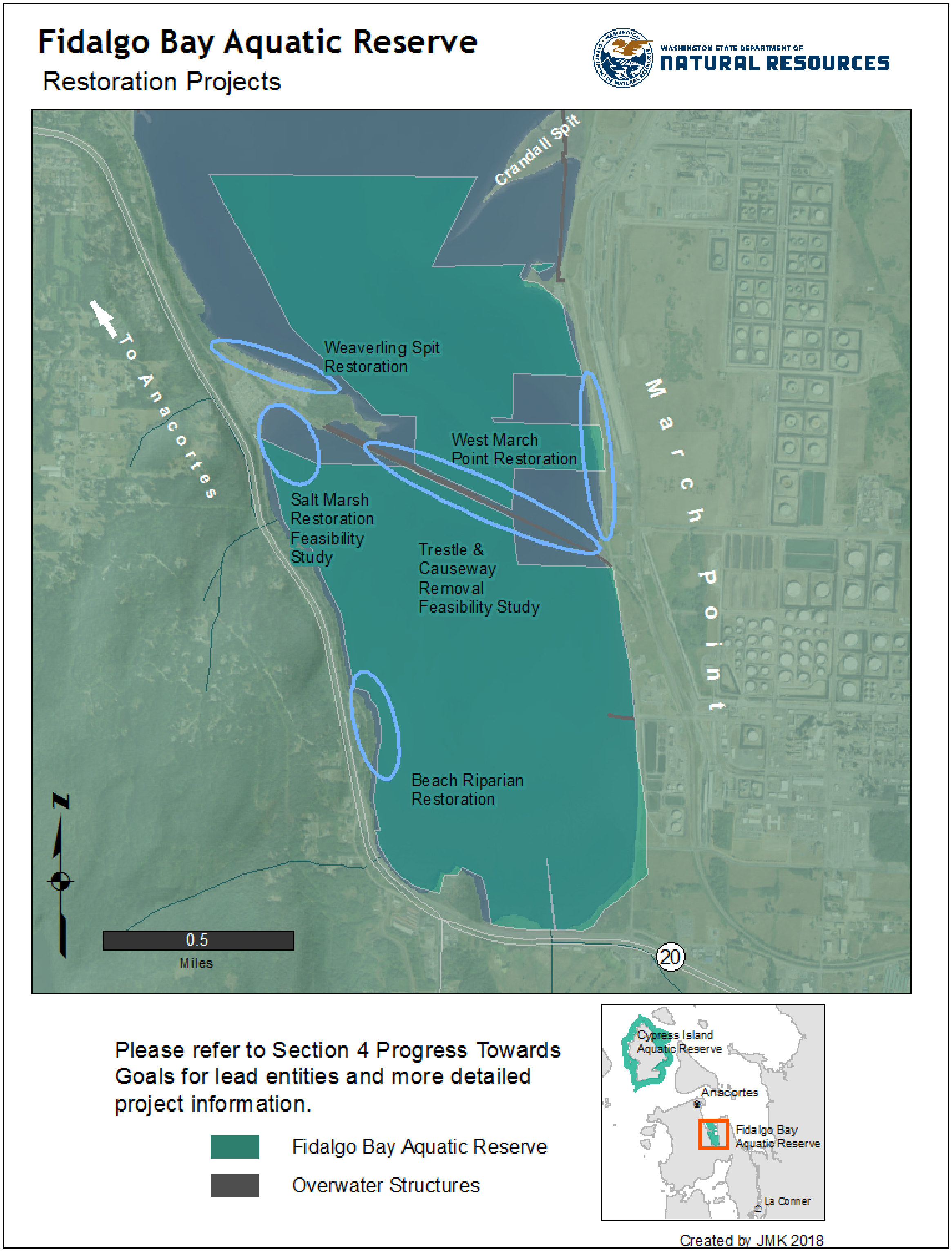


Figure C- 17: Intertidal Biota and Avian Monitoring Sites

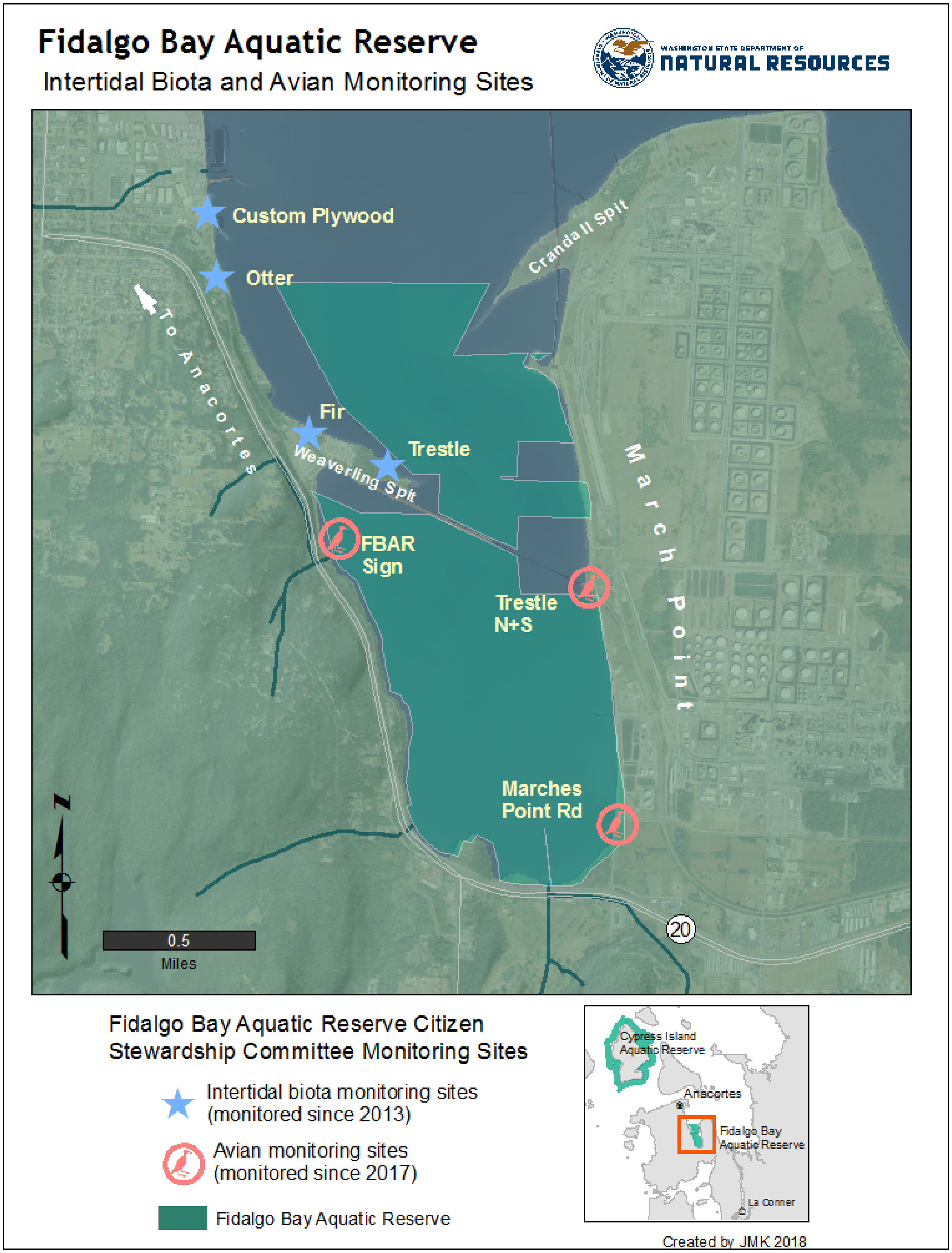


Figure C- 18: Herring Spawn Distribution

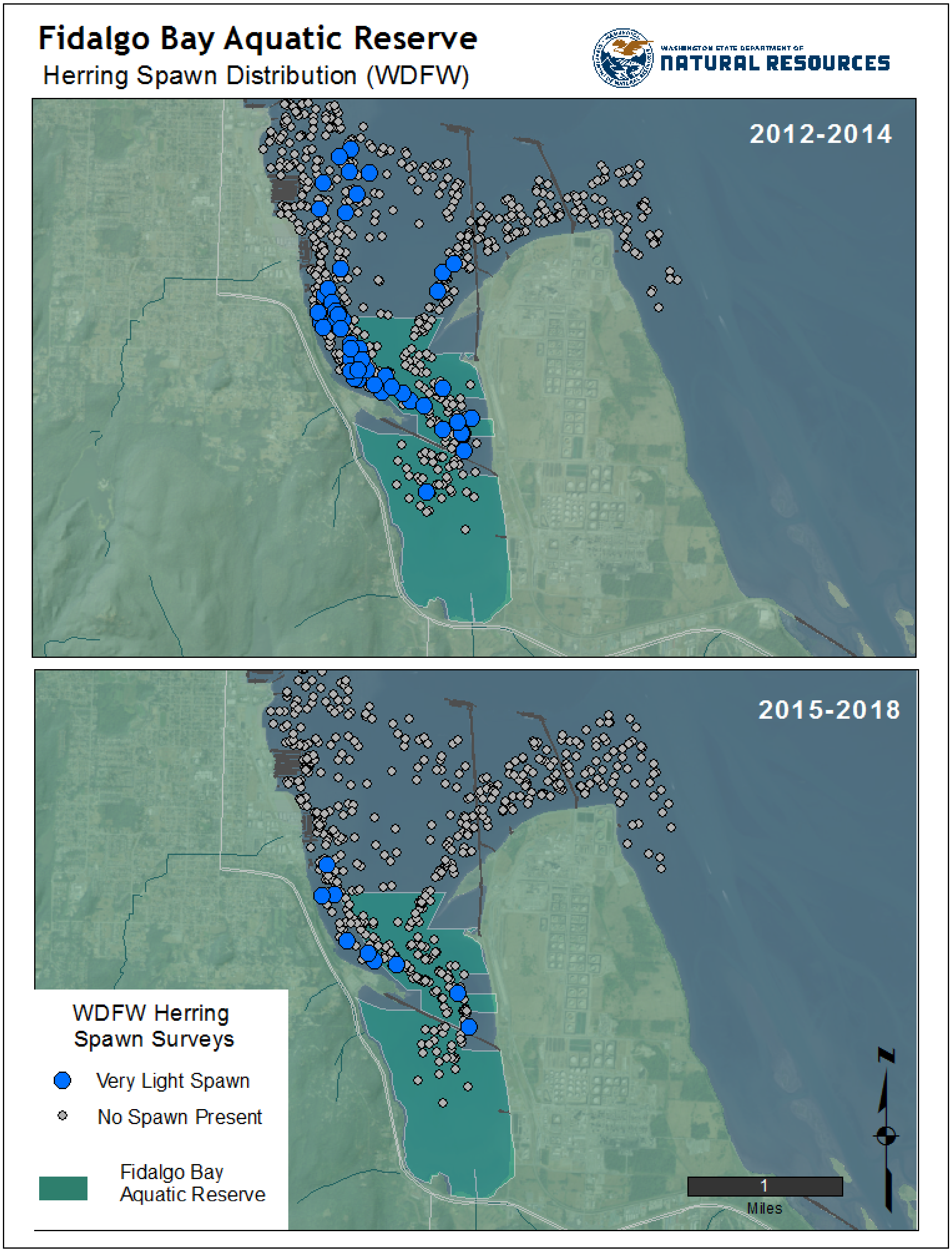


Figure C- 19: Forage Fish Spawning Habitat