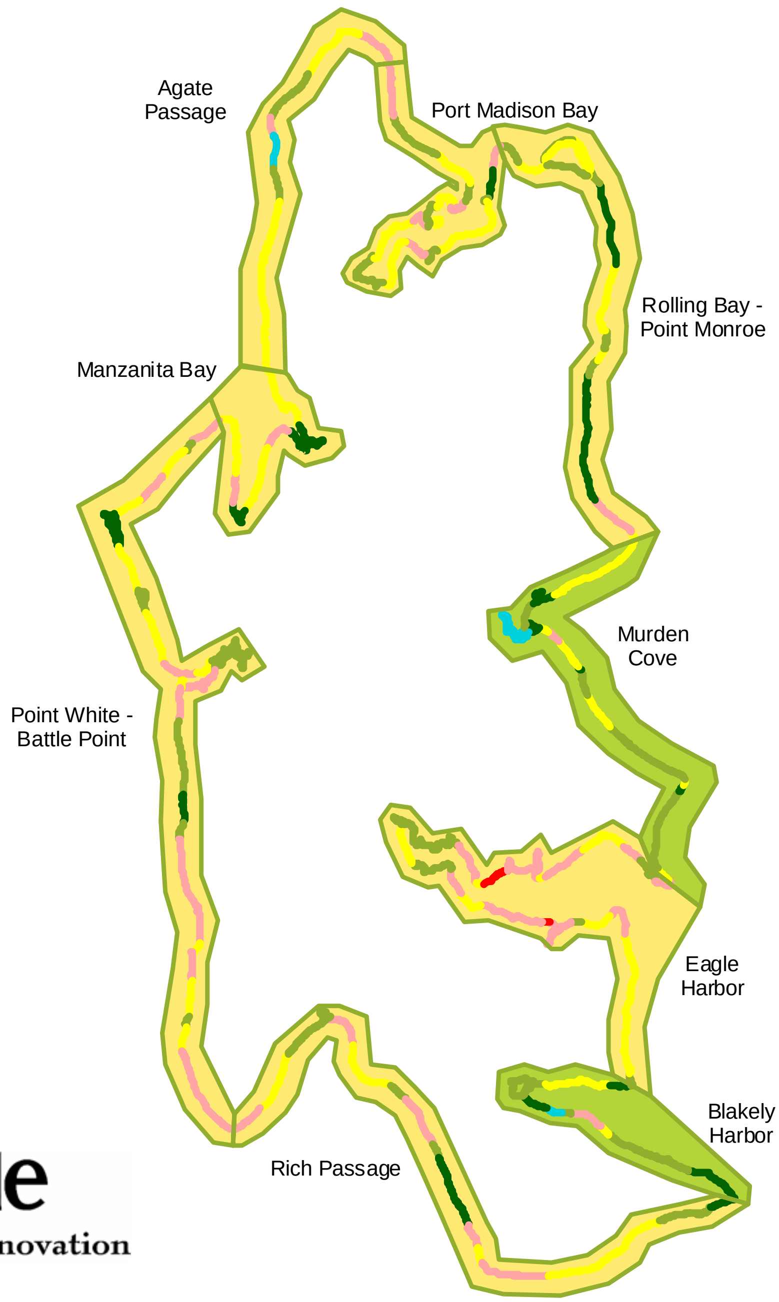
BAINBRIDGE ISLAND NEARSHORE HABITAT CHARACTERIZATION & ASSESSMENT, MANAGEMENT STRATEGY PRIORITIZATION, AND MONITORING RECOMMENDATIONS



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BAINBRIDGE ISLAND NEARSHORE HABITAT CHARACTERIZATION & ASSESSMENT, MANAGEMENT STRATEGY PRIORITIZATION, AND MONITORING RECOMMENDATIONS

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Prepared for
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Preface

The Bainbridge Island Nearshore Assessment was funded by the Salmon Recovery Funding Board (SRFB) as part of its mission to support habitat protection and restoration projects. This project was initiated, in part, as a result of the recent listing of Puget Sound Chinook salmon as “threatened” under the Endangered Species Act and other proposed listings for Puget Sound marine species. The factors contributing to the decline of these species are complex and include, among other factors, the loss and modification of habitat caused by human activities across the region. Some of the early research suggests that the ecological functions and processes which form the habitat that support those species need to be maintained and protected in order to sustain natural populations. While Bainbridge Island does not naturally support freshwater use by Chinook salmon, the City does include approximately 53 miles of saltwater shoreline which plays a critical role in the life-cycle of Puget Sound Chinook and other species of concern. The overarching goal of this project and the City’s Salmon Recovery and Conservation Strategy is to collect and employ critical information to ensure that Bainbridge Island provides and maintains a healthy and functional ecosystem that contributes to sustainable salmonid populations within the region.

The goals of the Nearshore Assessment are to 1) conduct a baseline characterization of the Bainbridge Island nearshore environment and assess its ecological health and function, 2) identify restoration and conservation opportunities and develop a strategy for ranking and prioritizing opportunities, and 3) develop a management framework based on the functions and processes of nearshore ecology. The findings of the project will be used by the City and the Bainbridge Island community to propose, pursue, and make informed decisions about nearshore conservation and restoration opportunities. The knowledge gathered regarding management of nearshore resources will also be integrated into the City’s regulations that govern the development and use of the nearshore.

Management of the Bainbridge Island Nearshore Assessment was provided by the City of Bainbridge Island (COBI) with technical review and support provided by technical representatives of the Salmon Recovery Funding Board and the City’s Environmental Technical Advisory Committee.

Libby Hudson – Project Manager
Peter Namtvedt Best – Editor

City of Bainbridge Island
November 2004

Acronyms

BAS	best available science
CF	controlling factor
COBI	City of Bainbridge Island
EF	ecological function
GIS	geographical information system
IBI	index of biological integrity
MA	management area
OHWM	ordinary high-water mark
WDFW	Washington Department of Fish & Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington State Department of Ecology
WRIA	water resource inventory area
TIA	total impervious area

Acknowledgements

This report is the result of extensive collaboration, information sharing, and discussion involving too many people to name individually. We would first like to acknowledge the enthusiastic support and keen insights of Peter Namtvedt Best of the City of Bainbridge Island, who was responsible for involving us in this challenging project. Peter substantially improved the value of this report at many levels due to his detailed reviews and high standards. We would like to thank members of the Salmon Recovery Funding Board and City of Bainbridge Island technical advisory committees, specifically Jim Brennan, Chris May, Paul Dorn, Kurt Fresh, Doris Small, and Hugh Shipman, for providing beneficial guidance and ideas at various stages in this project. Thanks also go to Cinde Donoghue and Tim Gates from the Washington State Department of Ecology for their reviews and comments. We acknowledge the intangible contributions of our colleagues at Battelle for their support throughout this project.

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1.0 Introduction

The City of Bainbridge Island (COBI) is in need of a tool to inventory and assess the conditions of its marine shorelines. Current data gaps point to a need for a comprehensive assessment of shoreline conditions before decision-making under planning and regulatory programs may proceed effectively. Ultimately, this information will allow planners to assess levels of development impact and resource quality over discrete shoreline management areas (MAs), which will assist with permitting issues and prioritization of areas for conservation and restoration.

1.1 Assessment Need

The Bainbridge Island nearshore ecosystem is characterized by a wide range of conditions, ranging from fairly unmodified stretches of natural shoreline to private residences with associated armoring structures to highly developed industrial areas. Of 2,262 shoreline parcels on Bainbridge Island, over 82% have been developed, with single-family residential use representing the vast majority of these cases (Williams et al. 2003). According to the Bainbridge Island Nearshore Structure Inventory (Best 2003), approximately 49% of the Bainbridge Island shoreline has some type of armoring.

The City of Bainbridge Island is currently required to develop mechanisms to protect and restore nearshore habitat, as well as support reasonable and appropriate shoreline uses. However, detailed information is currently lacking on Bainbridge Island's nearshore habitat characteristics and the associated ecological impacts of land-use development and modifications on these habitats. Specific questions include the following:

- What and where are the nearshore habitat characteristics of Bainbridge Island?
- What and where are the physical processes that drive the nearshore environment of Bainbridge Island?
- What and where are the human stressors in the nearshore environment of Bainbridge Island?
- What is the current quantity and quality of nearshore habitat on Bainbridge Island?
- What high-quality habitat remains to be protected?
- What damaged habitat is most suitable for recovery?
- What damaged habitat is the most difficult to recover?
- What nearshore habitats on Bainbridge Island are essential to salmonids?
- What effects do typical shoreline modifications have on nearshore habitat (especially salmonid habitat)?
- What habitats (or habitat conditions) should be prioritized for protection and restoration?

As with most areas in Puget Sound, the lack of good information on Bainbridge Island shoreline conditions (historic and current) provides a poor basis for making management decisions and inhibits a strategic approach to prioritizing and protecting these habitats. Recent reports have concluded that anthropogenic influences are responsible for habitat loss and species declines in nearshore Puget Sound ecosystems (Williams et al. 2001; PSWQAT 2002). However, the Puget Sound nearshore ecosystem is highly complex and unpredictable. Baseline studies and monitoring programs are limited and, in general, have been inadequate in providing the level of scientific information necessary for informed resource management decisions (Williams et al. 2001). Historic maps of the region, originally surveyed in the

1800s, have only recently been located, digitally scanned, distributed, and interpreted to assess change (Puget Sound River History Project 2003).

1.2 Objectives and Benefits

Based on the needs outlined above, the primary objectives of the Bainbridge Island nearshore habitat assessment effort were to

- Delineate management areas (MAs) and appropriate subareas
- Characterize the ecological features and conditions within those MAs
- Provide a baseline assessment of nearshore ecological functions using repeatable methods
- Consolidate this information into a single, GIS-based database that can be used by planners and resource managers.

In addition to a characterization and assessment of these habitats in the main body of the report, separate documents were also developed that address the following:

- A framework for prioritizing restoration and preservation of nearshore habitats
- Recommendations for a nearshore monitoring plan that may detect changes from current baseline conditions.

Ultimately, this information will form the scientific basis for future conservation, enhancement, and restoration efforts, and will assist in revising the City of Bainbridge Island Shoreline Management Master Program and in supporting future non-regulatory and community-based management actions in the nearshore.

1.3 Assessment Approach

This assessment is based on the general assumption that alteration of shorelines often results in a change in nearshore ecological functions. These changes generally lead to a decline in positive attributes of the nearshore ecosystem, although we acknowledge that alterations do not always result in change, nor are the changes always negative. The role of the assessment in the overall nearshore habitat management process is that of a screening tool which can serve as a basis for prioritizing conservation and restoration efforts in the nearshore, as well as a baseline for future comparison and evaluation. The assessment should be considered a living document, with additional data incorporated as ongoing research clarifies our understanding of nearshore ecological processes and functions and as assessment methods are further refined. It should be emphasized that as a screening tool, this assessment provides only a framework for guiding future action. This tool will be used most effectively by involving the local expertise of scientists who are familiar with the Bainbridge Island shoreline, its ecological resources, and the relationship between alteration and impact.

1.3.1 The Nearshore Conceptual Model

Conceptual models are often incorporated into all types of assessments as a device for describing the causal relationship among land use, stressors, valued ecological resources at risk, and their associated endpoints and indicators (Thom and Wellman 1997, Gentile et al. 2001). Regional assessments that involve conceptual models include May and Peterson’s (2003) Kitsap Salmonid Refugia Study, which integrates conceptual models of watershed function and salmon population dynamics to identify those habitats critical to sustaining remaining native salmonid populations. This nearshore assessment builds upon a summary of the best available science (BAS), which summarizes the existing scientific literature as it relates to the nearshore environment of Bainbridge Island (Williams et al. 2003). As such, the assessment employs the conceptual model of Williams and Thom (2001) to build a scientifically defensible framework for assessing the potential effects of changes to nearshore ecological functions caused by human modifications to nearshore habitats (Figure 1).

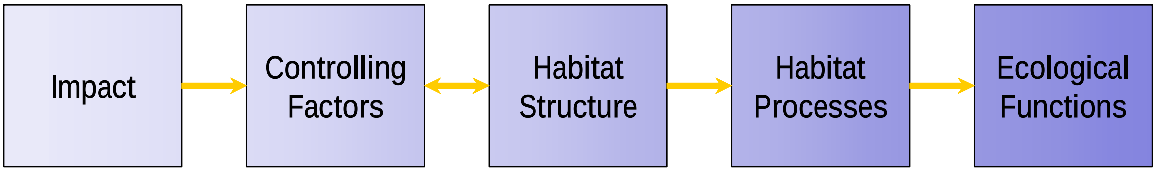


Figure 1. Basis of Conceptual Model (Williams and Thom 2001)

The nearshore conceptual model assumes that shoreline modifications exert effects at varying degrees on an ecosystem's controlling factors (Figure 1; Table 1). Controlling factors (e.g., light level, wave energy) are physical processes or environmental conditions that control local habitat structure and composition (e.g., vegetation, substrate), including where habitat occurs and how much is present. In turn, habitat structure is linked to support processes, such as primary production or landscape connectivity, which influence ecological functions. Thus, impacts that affect controlling factors within an ecosystem are reflected in changes to habitat structure, and ultimately are manifested as changes to functions supported by the habitat. The effect at the functional level depends upon the level of disturbance and the relative sensitivity of the habitat to the disturbance.

Table 1. List of Major Controlling Factor, Habitat Structure, Habitat Process, and Ecological Function Metrics.

Controlling Factors	Habitat Structure	Habitat Processes	Ecological Functions
Wave Energy	Density	Production	Prey Production
Light (Increase)	Biomass	Sediment Flux	Reproduction
Light (Shading)	Length/Size	Nutrient Flux	Refuge
Sediment Supply	Diversity	Carbon Flux	Carbon Sequestration
Substrate	Landscape Position	Landscape Connectivity or Fragmentation	Biodiversity maintenance
Depth/Slope	Patch Shape		
Pollution/Nutrient	Patch Size		Disturbance Regulation
Hydrology			
Physical Disturbance			Migration Corridors

1.3.2 Nearshore Landscape Ecology

Landscape ecology addresses how the spatial extent, heterogeneity, and geometry of landscape elements (e.g., habitats) affect the flow of energy, biota, and materials through the landscape. Human activities are fragmenting natural landscapes into fewer and smaller pieces at an alarming rate, reducing the flow of these materials among habitats and causing local extinction of some populations (Weins 1985; Gonzales et al. 1998; Earn et al. 2000). However, it is clear that most elements of a landscape function best when integrated with all other elements (e.g., watershed approach), and restoration projects are now utilizing the concepts and principles of landscape ecology to improve the functions and success of restoration projects (Kentula 1997).

Of particular relevance to estuarine and marine nearshore ecosystems are the landscape concepts of habitat size, shape, and accessibility (Simenstad and Thom 1992; Shreffler and Thom 1993; Simenstad and Cordell 2000; Bottom et al. 2001). Knowledge of the behavioral patterns of target species or species groups is essential to refining the site selection and design process for management decisions, such as a restoration, for a particular habitat. The National Research Council (1992, 2001) recommends that systems should adopt a dynamic perspective that considers current and future conditions at the site and in the surrounding landscape. A dynamic, landscape oriented approach could mean preserving riparian zones and connectivity to other habitats around a particular site.

On Bainbridge Island, the marine nearshore landscape encompasses the interface between subtidal marine habitats and the upland watershed (including the riparian zone), which is shaped by alongshore processes that affect sediment transport and aquatic species movement patterns. It is apparent that these shoreline processes must continue to function appropriately across the entire landscape to manage shoreline habitats and ecological functions in a long-term, self-sustaining condition (Williams and Thom 2001;Best 2003). With this in mind, the assessment was designed to examine impacts to nearshore processes at two landscape scales. The larger management area (MA) is scaled to encompass aggregations of alongshore cells, analogous to upland watersheds, which define sediment transport processes that form the primary basis for establishing and maintaining habitat structure and function (Figure 1). A management area is comprised of multiple reaches, which are scaled to current or historic geomorphic conditions. Geomorphology often defines or is commonly associated with distinct biological communities (e.g., halophytic plant assemblages in marsh and lagoon settings).

1.3.3 Geomorphology and the Conceptual Model

The nearshore conceptual model (Figure 1) can be refined by a shoreline's geomorphic setting to provide better predictive relationships between nearshore controlling factors and ecological function (Table 2). Table 2 is based on information contained within the nearshore review of the Best Available Science (BAS) (Williams et al. 2003). The refined model addresses each of five geomorphic classes (defined in Section 2.2.3) typically found along the shorelines of Bainbridge Island, and focuses on nine controlling factors used in the assessment framework (described in Section 2.2.4)

1.3.4 Summary

Landscape ecology and geomorphic context were critical tools for applying the conceptual framework to Bainbridge Island shorelines. The assessment was conducted on a "reach-by-reach" scale, fairly small definable landscapes, which were determined by homogeneous stretches of shoreline as defined principally by the WDNR ShoreZone database (WDNR 2001). The advantage of this approach was that most information was preexistent, detailed, relatively current, and widely available. When used in concert with aerial photographs (WDOE 1977, 1992, 2000) and local knowledge, geomorphic context allowed us to refine predictive relationships between shoreline modifications and nearshore functions. Fine-scale, georeferenced data recently collected by COBI (COBI 2002, Best 2003) were used as the basis for quantifying nearshore habitat modifications and habitat structural attributes. This dataset provided detailed information (e.g., extent and number of modifications, encroachment into the intertidal zone, marine riparian vegetation cover and type, stormwater outfalls) that assisted in quantifying impacts to controlling factors within a particular reach of shoreline. Aerial imagery and historic photographs provided additional information for verifying assumptions and completing the picture of nearshore conditions.

Table 2. Conceptual Model Applied to Geomorphic Classes by Each Controlling Factor Metric.

Geomorphic Class	Habitat Structure	Habitat Processes	Ecological Function
Wave Energy			
Rocky	Generally not an issue, but may affect structure of attached macroalgae community.	Only as it affects macroalgal productivity.	May affect biodiversity maintenance.
Marsh/Lagoon	Generally not an issue in these wave protected habitats, though habitat structure of marsh plant community could be affected.	Loss of primary production and altered sediment flux.	
Spit/Barrier/ Backshore	At critical tidal elevations or areas exposed to waves, turbulence may displace rooted aquatic vegetation (e.g., eelgrass), suspend and coarsen fine sediment, reduce LWD retention	Loss of primary production. Increased sediment and carbon flux. Landscape fragmentation.	Loss of associated habitat functions, including salmon prey production and refuge. Loss of eelgrass affects herring spawn; altered sediment composition may affect forage-fish spawning substrate.
Low Bank			
High Bluff			
Loss of Natural Shade			
Rocky	Light increase generally not an issue (little riparian vegetation)	N/A	N/A
Marsh/Lagoon	Loss of riparian vegetation affects habitat complexity. Increased light levels reaching marsh/mudflats increases desiccation and temperature regimes.	Loss of primary productivity from riparian litterfall. Carbon flux alteration and landscape fragmentation.	Loss of biodiversity, prey production (terrestrial insects), and refuge. Increased water temperatures in lagoons may affect herring embryo development.
Spit/Barrier/ Backshore	Same as Rocky (low growing dune vegetation).	N/A	N/A
Low Bank	Same as Marsh/Lagoon.	Same as Marsh/Lagoon.	Same as Marsh/Lagoon. Increased temperatures and desiccation affects beach spawning forage-fish embryos.
High Bluff			

Geomorphic Class	Habitat Structure	Habitat Processes	Ecological Function
Artificial Shade			
Rocky	Total light loss would impact attached macroalgae communities, including patch size, density, and shape.	Loss of primary productivity from macroalgae. Landscape fragmentation.	Loss of associated biodiversity, prey production, and refuge. Darkness may inhibit salmon migration.
Marsh/Lagoon	Total light loss would impact vascular marsh plant, macroalgae, and eelgrass communities, including patch size, density, and shape.	Loss of primary production. Carbon flux alteration. Landscape fragmentation	
Spit/Barrier/ Backshore	Total light loss would impact eelgrass and marine vegetation, including patch size, density, and shape.		
Low Bank			
High Bluff			
Sediment Supply			
Rocky	Generally not an issue, though blockage of alongshore transport may change some substrate characteristics.	Only as it affects sediment flux, if present.	May affect biodiversity.
Marsh/Lagoon	Excessive supply from fluvial sources likely to be issue. May affect beach slope and smother eelgrass beds and marsh vegetation.	Altered sediment flux. Loss of eelgrass and riparian primary production, carbon flux, and landscape connectivity.	Loss of eelgrass associated salmon refuge and prey production. Excessive sediments may smother benthos, reducing biodiversity .
Spit/Barrier/ Backshore	Impoundment of backshore sediments may cause beach erosion, coarsening of sediments, and loss of rooted vegetation.		Loss of eelgrass associated salmon refuge and prey production. Substrate coarsening affects biodiversity. .
Low Bank	Impoundment of backshore sediments may cause foreshore and alongshore beach erosion (due to loss of sediment source), bank steepening, and sediment coarsening. Loss or change of rooted vegetation.		

Geomorphic Class	Habitat Structure	Habitat Processes	Ecological Function
High Bluff	Major issue. Same as Low Bank, but may be more significant along high bluffs, which are often important feeder bluffs.		
Substrate Type			
Rocky	Generally not an issue; modifications are often rock cobble or concrete.	N/A.	N/A
Marsh/Lagoon	Change from soft sediments to novel hard substrates (e.g. rock, concrete, steel, wood) associated with structures. Attached macroalgae and biota (e.g., mussels and barnacles) subsume soft sediment-associated vegetation and animals.	Reduction in sediment flux and alteration of landscape connectivity. Also affects source of primary production and carbon flux.	Alters local biodiversity (especially vegetation and invertebrate communities) in favor of those attaching to hard structures. Also, potential loss of beach spawning habitat for forage fish.
Spit/Barrier/ Backshore			
Low Bank			
High Bluff			
Depth - Slope			
Rocky	May alter distribution of attached macroalgae and biotic (e.g., mussels, barnacles) communities depending upon encroachment. May also simplify habitat complexity.	May reduce landscape connectivity.	May alter biodiversity maintenance and salmon migratory corridors.
Marsh/Lagoon	Change in distribution of eelgrass, salt marsh vegetation, and mudflat channels. Impacts to associated landscape metrics.	Same as above, as well as modification of sediment flux and reduction of primary production.	Same as above, as well as alteration of salmon prey production.
Spit/Barrier/ Backshore	Encroachment and slope increase narrows distribution of eelgrass and other vegetation, simplifying or reducing habitat structure.		
Low Bank			
High Bluff			

Geomorphic Class	Habitat Structure	Habitat Processes	Ecological Function
Pollutants/ Nutrients			
Rocky	Nutrients may initiate nuisance algal blooms and epiphyte growth. Herbicides, contaminants, or water quality impacts may affect kelp vegetation, cause disease outbreaks, and affect growth.	May fragment landscape, affect sediment nutrient, and carbon flux, and reduce habitat connectivity and primary productivity..	Direct toxicity to organisms, especially relevant to herring spawn, juvenile salmon, and their prey. Loss of vegetation causes reduction in salmon prey production and refuge. Affects biodiversity maintenance both in subtidal and riparian settings.
Marsh/Lagoon	Especially relevant in these settings with low flushing rates. Same impacts as noted above, especially as related to eelgrass, marsh, and marine riparian vegetation.		
Spit/Barrier/ Backshore	Same impacts as noted above, especially as related to eelgrass and dune vegetation.		
Low Bank	Same impacts as noted above, especially as related to eelgrass and riparian vegetation.		
High Bluff			
Hydrology			
Rocky	Generally not an issue.	N/A	N/A
Marsh/Lagoon	Constrictions may impact tidal influence and flushing rates, affecting the distribution and diversity of riparian, eelgrass, and marsh vegetation.	Affects primary production, carbon, nutrient, and sediment flux, landscape connectivity	Affects associated plant and animal biodiversity and disturbance regulation. Vegetation change alters migration corridors for birds, mammals, and fishes.
Spit/Barrier/ Backshore	Encroachment into intertidal zone may alter tidal hydrology and displace dune vegetation		Same as Marsh/Lagoon. As well, altered hydrology may affect

Geomorphic Class	Habitat Structure	Habitat Processes	Ecological Function
Low Bank	Alteration of groundwater and surface flows may impact riparian vegetation distribution and slope stability, whereas tidal encroachment by structures and location of outfalls may displace or scour intertidal salt marsh vegetation and eelgrass.		spawning success of forage fish (both via modifications to groundwater seeps and surface flow scour).
High Bluff	Same as Low Bank, though likely greater impacts to slope stability.		
Physical Disturbance			
Rocky	Benthic disturbances alter patch size, shape, and density of attached macroalgae and invertebrates (e.g. barnacles, mussels).	May fragment landscape and affect primary production associated with eelgrass or marsh communities. Altered carbon, nutrient, and sediment flux.	Biodiversity maintenance and natural disturbance regime.
Marsh/Lagoon	Unnatural or frequent disturbance of benthic habitats affects the distribution, size, shape, and density of eelgrass beds, macroalgae, and benthic communities.		Bottom disturbances affect benthic community biodiversity, salmon prey production and refuge, as well as disturbance regulation. May also affect spawn of forage fish. Human noise, activity, and sound may impact nesting and migration corridors of mammals and birds.
Spit/Barrier/ Backshore			
Low Bank	Same as above. Also, vegetation removal affects structure and complexity of riparian cover.	Same as above. Also, reduced contribution of riparian primary production.	
High Bluff			

2.0 Materials and Methods

2.1 Study Area

Bainbridge Island is located within the Central Puget Sound Basin, east of the Kitsap Peninsula and west of the City of Seattle. It has a population of approximately 20,500 people. The Island is approximately five miles wide and ten miles long, encompassing nearly 17,778 acres, or 28 square miles, and is one of the larger islands in Puget Sound. Bainbridge Island shorelines border the main body of Puget Sound, a large protected embayment (Port Orchard Bay), and two high-current passages (Rich Passage and Agate Passage) (Best 2003). The Island is characterized by an irregular coastline of approximately 53 miles, with numerous bays and inlets and a significant diversity of other coastal land forms, including spits, bluffs, dunes, lagoons, cuspate forelands, tombolos, tide flats, stream and tidal deltas, islands, and rocky outcrops (Williams et al. 2003).

2.2 Methods

As described in the Assessment Approach overview (Section 1.3), the methods focus on translating quantitative and qualitative data on shoreline conditions into an assessment of nearshore ecological functions. Described below are the specific data sources and methods used for delineating the spatial scale of the assessment, classifying shorelines into geomorphic classes, defining and scoring assessment metrics within a framework derived from the nearshore conceptual model, and using existing measures of ecological function to validate this assessment.

2.2.1 Data Compilation

Data sources used for all aspects of the assessment are summarized in Table 3. A description of how this information is used is described in Sections 2.2.2, 2.2.3, and 2.2.4, below. All data were georeferenced and assembled into a comprehensive geographical information system (GIS) using ArcView 3.2. This was accomplished in two primary ways: 1) data were initially collected and/or distributed in a geographic file format; or 2) the geographic location of data were estimated from maps or aerial photographs, and the data were then added as an attribute for the reach with which it was associated. Data and GIS files are available by request from the City of Bainbridge Island.

Table 3. Categories of Data and Data Sources Used in Assessment Approach

Data Category	Definition	Assessment Use	Data Source
Drift Cell	Direction of nearshore sediment transport.	Spatial scale (Defines “Management Area”)	Taggart 1984, Schwartz et al. 1991; WA Dept. Ecology 2001
ShoreZone Unit	Areas of relatively homogeneous beach geomorphology.	Spatial scale (Defines “Reach”)	ShoreZone Inventory (WDNR 2001); Oblique photos (WDOE 1977, 1992, 2000)
Geomorphology	Shape of land surface forms and processes producing them	Geomorphic class	Visual interpretation of oblique photos (WDOE 1977, 1992, 2000)
Sediment source	Predominant source of shoreline sediment (e.g. fluvial, backshore)	Geomorphic class; Controlling Factor: Sediment Supply	ShoreZone Inventory (WDNR 2001);
Substrate class	Predominant shoreline substrate	Geomorphic class	ShoreZone Inventory (WDNR 2001);

Data Category	Definition	Assessment Use	Data Source
Slope	Angle of beach/backshore	Geomorphic class	LiDAR data (Puget Sound LiDAR Consortium 2000; Hardy and Berghoff 2000)
Slope stability maps, Feeder bluff locations	Location of eroding backshore landforms (an incomplete inventory)	Geomorphic class, Controlling Factor: Sediment Supply	Small 2001
Historic Geomorphology	Records of land surface forms before substantial human development	Geomorphic class	Topographic sheets (T-sheets) from U.S. Coast and Geodetic Survey; Puget Sound River History Project, UW
Wave Exposure	Relative protection of shore from wave energy	Controlling Factor: Wave Energy	ShoreZone Inventory (WDNR 2001)
% Armoring	Linear percentage of shoreline with armoring structures (e.g., rip-rap, bulkheads)	Controlling Factors: Wave Energy, Sediment Supply, Substrate Type, Depth-Slope	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Armor Material Composition	Armor material (e.g., concrete, rock, wood)	Controlling Factor: Wave Energy	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
% Armoring Encroachment	Linear percentage of shoreline with armoring that encroaches into the intertidal zone	Controlling Factor: Wave Energy, Depth-Slope, Hydrology	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
% Overhanging Vegetation	Linear percentage of shoreline with vegetation overhanging the beach	Controlling Factor: Natural Shade Ecological Function	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Overwater Structure Density	Density of shade causing structures, (docks, piers, boats, buoys, and other overwater structures)	Controlling Factor: Artificial Shade	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Marinas	Piers and floats with more than 5 mooring slips	Controlling Factor: Artificial Shade, Pollution	Oblique photos (WDOE 2000)
Groins	Structure built at angle to shore to intercept alongshore drift	Controlling Factor: Sediment Supply	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Ramps	Sloping platform used as a launch for small watercraft	Controlling Factor: Sediment Supply, Physical Disturbance	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Point Modification Density	Density of all nearshore structures composed of unnatural materials	Controlling Factor: Substrate Type	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Dredged Areas	Areas where substrate has been removed to provide/maintain depth for vessels	Controlling Factor: Depth-Slope	COBI (unpublished)
Areas of Shellfish Closures	Known sources of chemical or biological pollution	Controlling Factor: Pollution	Kitsap County Health District 2003; U.S. EPA 303(d) listed sites
% Total Impervious Area	Percent of land cover classified as impervious surfaces in marine riparian zone	Controlling Factor: Pollution, Hydrology	Kitsap County Aerial Imagery (2001)
Pipe Outfall Density	Density of discharging pipes greater than 8” in diameter	Controlling Factor: Pollution, Hydrology	COBI Nearshore Structure Inventory (COBI 2002, Best 2003)
Artificial Tidal Constrictions	Tide gates, barriers, or culverts	Controlling Factor: Hydrology	COBI (unpublished); Oblique photos (WDOE 2000)
Urban waterfront	Areas with commercial shipping activity or ferry use	Controlling Factor: Physical Disturbance	COBI (unpublished); Oblique photos (WDOE 2000)
Floating /	Density of floating docks, boats, and	Controlling Factor:	COBI Nearshore Structure

Data Category	Definition	Assessment Use	Data Source
Grounding Structure Density	buoys, and boat ramps	Physical Disturbance	Inventory (COBI 2002, Best 2003)
% Total Forested Area	Percent of land cover classified as coniferous, deciduous, meadow-shrub, and wetland in marine riparian zone	Controlling Factor: Physical Disturbance	Kitsap County Aerial Imagery (2001)
Salmon-bearing streams	Streams with documented populations of salmonids	Ecological Function	WRIA 15 Salmon Limiting Factors Analysis (Haring 2000); Kitsap Refugia Study (May and Peterson 2003)
Herring spawning	Documented herring spawning areas	Ecological Function	Priority Habitats and Species (WDFW 2001)
Sandlance spawning	Documented sandlance spawning beaches	Ecological Function	Priority Habitats and Species (WDFW 2001)
Surf smelt spawning	Documented surf smelt spawning beaches	Ecological Function	Priority Habitats and Species (WDFW 2001)
Geoduck presence	Distribution of geoduck beds	Ecological Function	Priority Habitats and Species (WDFW 2001)
Eelgrass	Eelgrass distribution (patchy and continuous)	Ecological Function	Bio-Band Code ZOS from ShoreZone Inventory (WDNR 2001)
Salt marsh	Distribution of salt-tolerant vascular plants	Ecological Function	Bio-Band Codes SAL and TRI from ShoreZone Inventory (WDNR 2001)
Bull kelp	Distribution of canopy forming kelp *Nereocystis*	Ecological Function	Bio-Band Code NER from ShoreZone Inventory (WDNR 2001)
Intertidal seaweed	Distribution of Intertidal Algae	Ecological Function	Bio-Band Codes FUC, LAM, SAR, and LAM from ShoreZone Inventory (WDNR 2001)

2.2.2 Spatial Scale: Defining the Landscape

Landscape principles were used to define two ecologically relevant spatial scales for conducting the assessment along the shoreline. The first scale uses drift cells to define nine mutually exclusive ecological Management Areas (MAs), which may be considered analogous to upland watersheds (Figure 2). Because drift cells "act as closed or nearly closed systems with respect to transport of beach sediment" (Schwartz et al. 1991), they form the basis for establishing and maintaining habitat structure, ecological processes, and ecological functions. Drift cells may converge (e.g., form points) or terminate into areas considered to lack alongshore drift (e.g., back bays), and therefore coalesce to form larger interrelated systems, just as upland watersheds may include aggregations of smaller watersheds or subbasins. Ultimately, the boundaries between shoreline MAs typically fall where drift cells diverge. Drift cells have been delineated through a series of master's theses produced at Western Washington University and later republished in a series of reports by the Washington State Department of Ecology (WDOE). The 21 drift cells mapped around Bainbridge Island were first delineated by Taggart (1984) and later republished by Schwartz (1991) (Table 3; Figure 3).

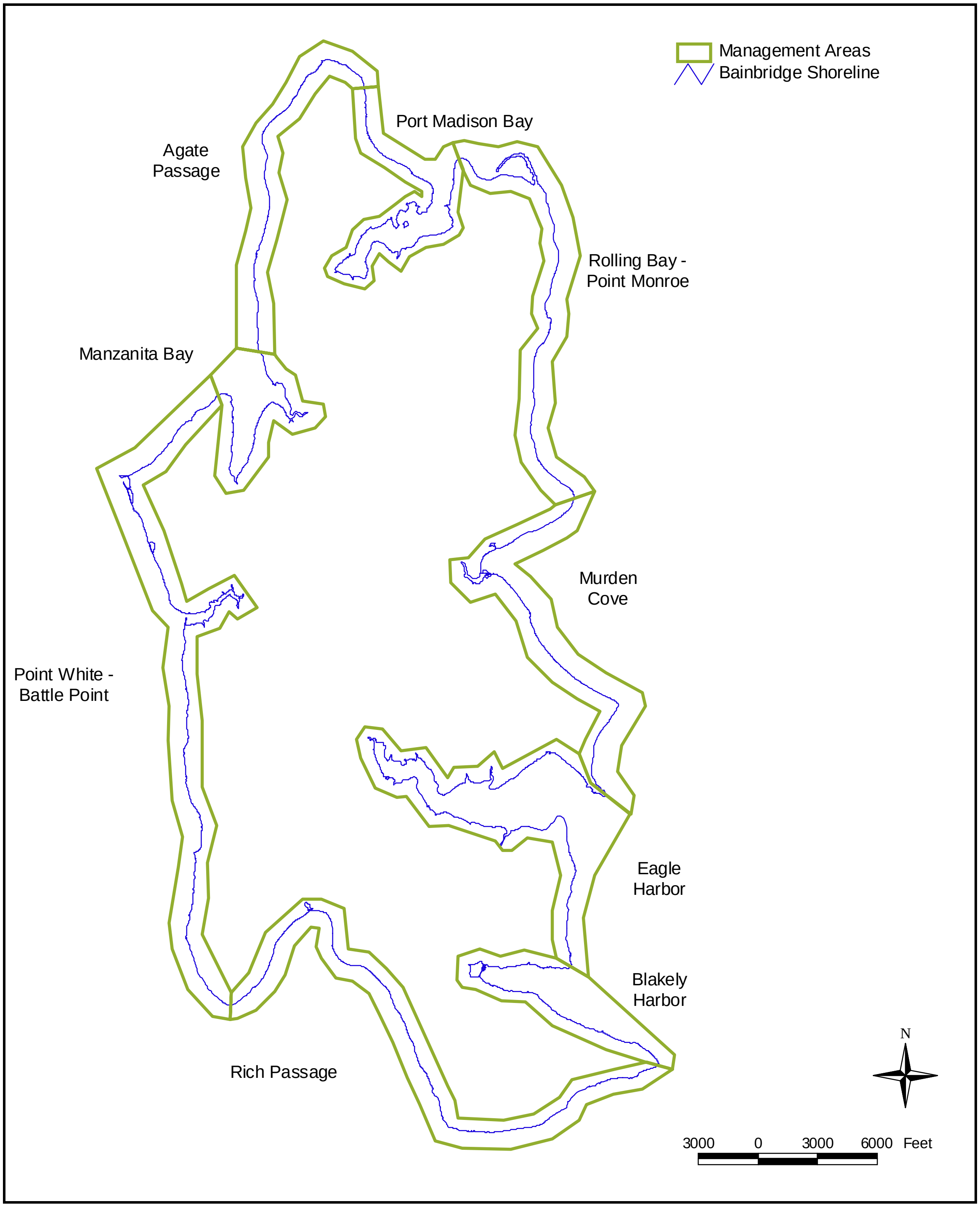


Figure 2. Bainbridge Island Management Areas.

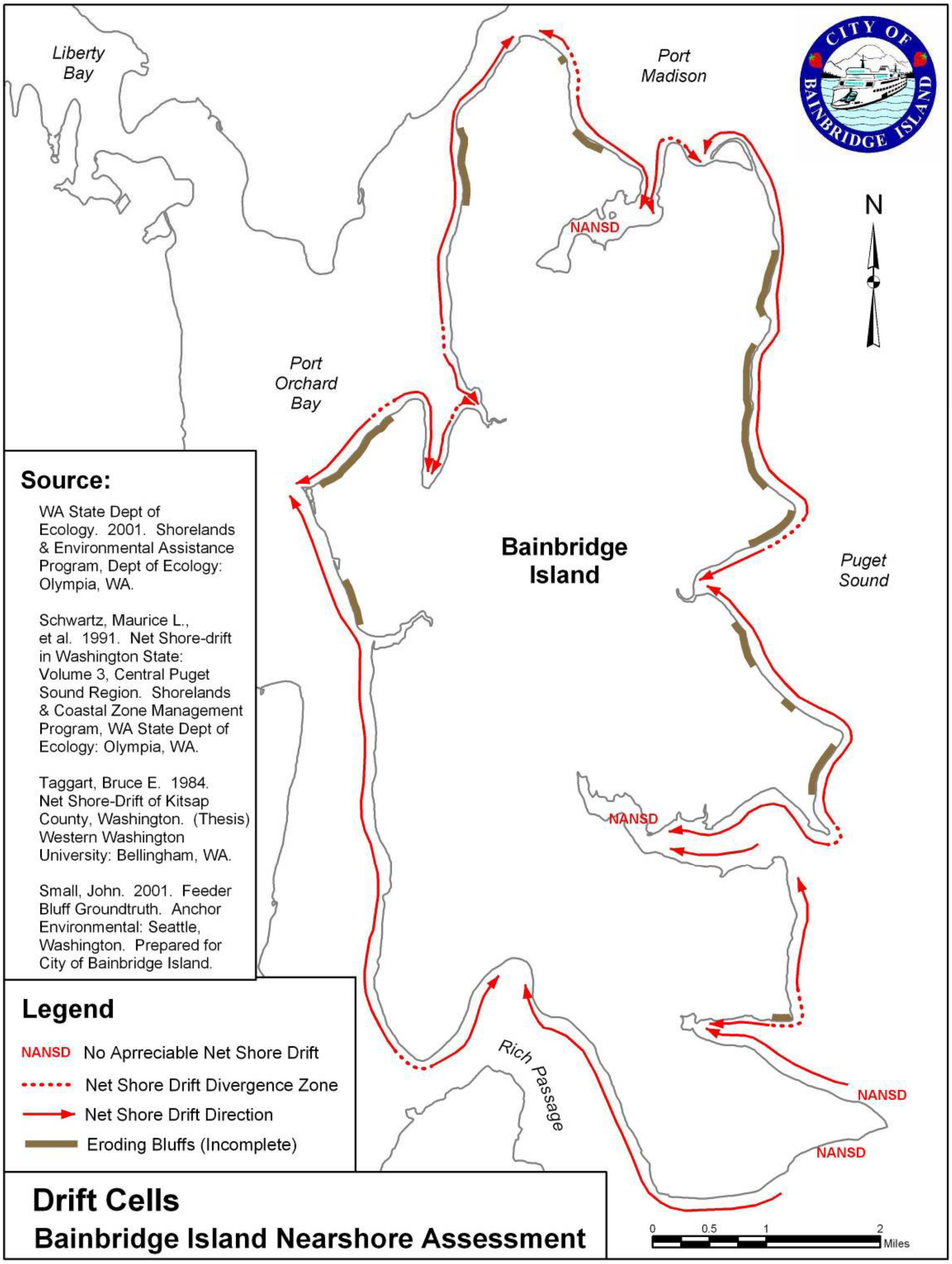


Figure 3. Bainbridge Island Drift Cells.

The COBI, with input from a technical advisory team, used local knowledge to independently review reports for consistency about drift cell direction, and used this information to ultimately define nine MAs (Best 2003). The nine Bainbridge Island MAs are defined as follows:

- MA-1 – Agate Passage
- MA-2 – Port Madison Bay
- MA-3 – Rolling Bay – Point Monroe
- MA-4 – Murden Cove
- MA-5 – Eagle Harbor
- MA-6 – Blakely Harbor
- MA-7 – Rich Passage
- MA-8 – Point White – Battle Point
- MA-9 – Manzanita Bay.

At the second landscape scale, shoreline MAs were further broken into "reaches," which were principally delineated in the ShoreZone Inventory as "ShoreZone Units," i.e., areas of relatively homogeneous beach geomorphology (WDNR 2001). A total of 198 reaches were defined on Bainbridge Island by the ShoreZone inventory, although by necessity, the total number was increased to 201 by delineating two additional reaches: the Schel-Chelb estuary at Lynwood Center off Rich Passage (Reach 6001) and an adjacent stretch of shoreline (Reach 6000), and the high bluff area inside of the lagoon formed by Point Monroe (Reach 6002). The number of reaches within a particular MA ranged from 10 (MA-9) to 38 (MA-8).

Reaches are segments of longer linear shoreline features and are basically analogous to stream reaches within the context of upland watersheds. The distribution of living resources is largely affected by the local environmental conditions that occur at this smaller geographic scale. For example, the local combination of controlling factors, such as slope, depth, hydrology, and wave energy, defines the type of vegetation and substrate (habitat structure) that occurs in that area. Biological communities, which are often spatially constrained by local controlling factors and habitat structure, serve to further define the structure and functions (e.g., refuge, nutrient cycling) of the nearshore ecosystem.

2.2.3 Geomorphic Classification

Understanding a shoreline's geomorphic setting provides not only the basis for deriving consistent comparisons between nearshore structure and function, but also a context for comparing existing conditions with pristine or historical conditions and setting restoration goals. With this in mind, each reach of Bainbridge Island shoreline was classified into one of five major geomorphic categories, following the shore types outlined by Terich (1987):

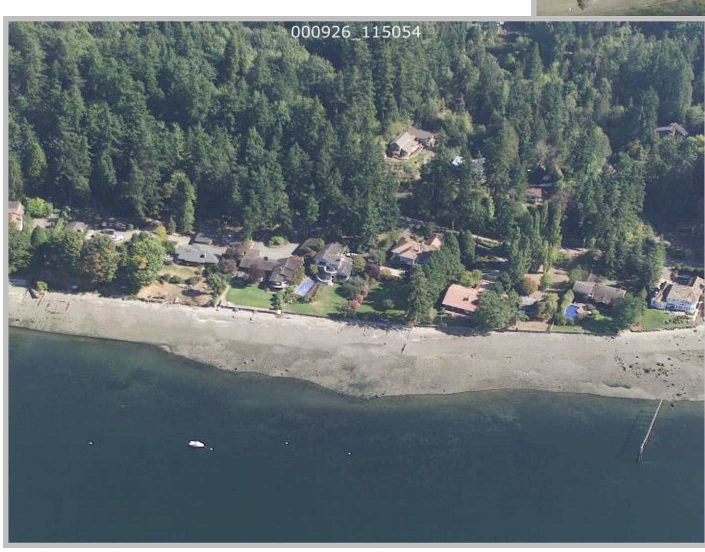
1. Low Bank
2. High Bluff
3. Spit/Barrier/Backshore
4. Marsh/Lagoon
5. Rocky Shore

Large river deltas were perhaps the only category of Puget Sound coastal geomorphology not exhibited on Bainbridge Island, and were not included in the classification scheme.

Geomorphic classes were assigned using data from the ShoreZone inventory (WDNR 2001), which included information on sediment source and substrate class, visual interpretation of aerial photographs (WDOE 1977, 1992, 2000), LiDAR-based slope maps (15+ and 40+ %) (Harding and Berghoff 2000; Puget Sound LiDAR Consortium 2000), slope stability maps (Small 2001), and expert knowledge (Table 3). Historical topographic sheets from the U.S. Coast and Geodetic Survey (Figure 4; Puget Sound River History Project 2003) were used in cases in which shorelines had been modified so extensively that classification into one of the above classes was uncertain (e.g., major fill). The following are some key attributes that were used to assign each class:

- *Low Bank* – (photo example at left) slope often greater than 40% (though not very wide); usually greater than 15%; height less than 5 meters; usually narrow foreshore (beach) with high water line at or on the bank; trees at waterline often indicate low bank rather than beach or wide backshore class; raised bedrock terraces assigned low bank if characterized by a sand and gravel beach; backed by low scarp

- *High Bluff* – (photo example at right) slope greater than 40%; height greater than 5 meters (estimated from aerial photo, GIS verified); often unstable or with visible face (little or no vegetation); sediment source often from backshore; high stairs and setback houses also indicate bluff



- *Spit/Barrier/Backshore* – (photo example at left) wide beach face; slope <15%; wide backshore is key to distinguishing between bank and beach; spits and barrier beaches are generally self-evident

- *Marsh/Lagoon* – (photo example at right) protected embayments, often with fluvial sediment sources; substrate is composed of fines; diagnostic salt marsh vegetation; lagoons may empty completely at low tide (extensive tide flats) and may have a residual basin that holds water at low tide

- *Rocky Shore* – (photo example at left) backshore rocky; foreshore often bedrock with veneer of other substrata on top; raised terraces with bedrock classified as rocky if shoreline characterized by little sediment movement.

The distribution of geomorphic classes over Bainbridge Island is shown in Figure 4. It should be noted that this classification scheme inherently seeks to simplify the habitat continuum, and some reaches may share several geomorphic characteristics because of the scale at which the ShoreZone database distinguished individual reaches. The predominant geomorphic landform class was assigned to those reaches that exhibited a combination of geomorphic traits. For example, if a 1000-ft long reach of shoreline was composed predominantly of high bluffs (75% of linear shoreline), with some smaller proportion composed of low banks, this reach was considered "high bluff."

2.2.4 Assessment Framework

2.2.4.1 - Background: An assessment is the quantitative evaluation of selected ecosystem attributes (Callaway et al. 2001). Proper ecosystem management requires an understanding of patterns and processes in biological systems and the development of assessment and evaluation procedures that ensure the protection of biological resources (Karr 1987). Without an objective, scientifically defensible assessment of current trends, it is impossible to design management strategies to conserve natural resources impacted by human activities or to develop viable hypotheses that can be tested with directed research. Therefore, assessment represents the first step in an ongoing process of compiling and analyzing technical information on ecosystem conditions and the effect of human activities on those conditions.

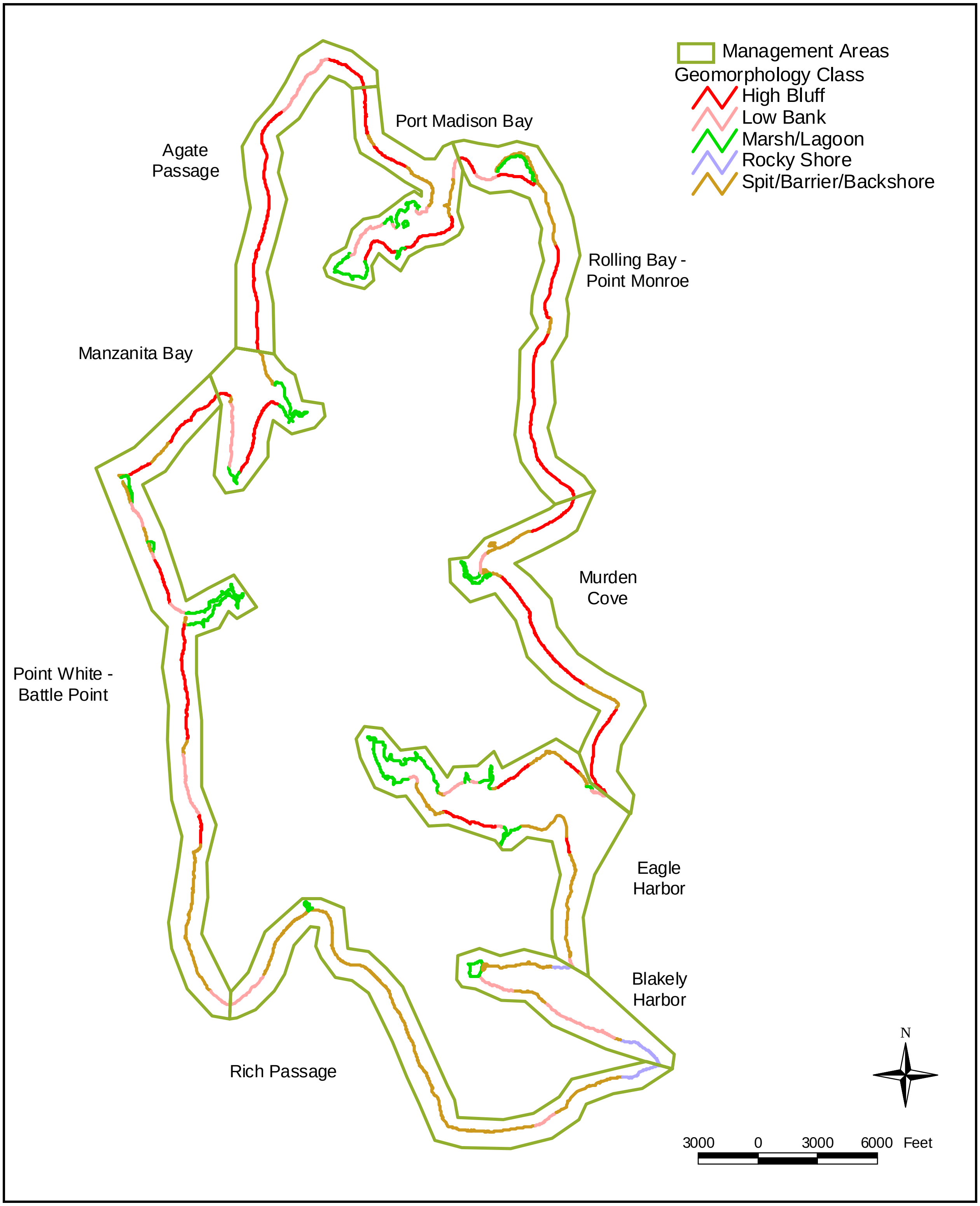


Figure 4. **Bainbridge Island Geomorphic Class Distribution.**

Assessment methods and approaches range widely, based on the question being asked and available knowledge. For example, multi-metric indices of habitat quality and condition are composites of several environmental or biotic variables that have been developed to evaluate aquatic resources and to assess the effects of anthropogenic degradation. One type, the index of biological integrity (IBI), was first developed using fish communities in streams (Karr 1987), and has since been adapted on a regional basis to other well-studied ecosystems (e.g., estuaries), for which considerable biological monitoring data exists (Deegan et al. 1997). A biotic index is calculated based on a set of metrics (measurable biotic variables, such as fish abundance or proportion of diseased individuals) that have been validated as indicators of habitat quality. Critical or threshold metric values are chosen that most efficiently separate high-, medium-, and low-quality habitats from one another (e.g., 10^{th} and 25^{th} percentile of each metric's distribution guided separation of low-quality from medium-quality habitats in Hughes et al. 2002). Scoring of each metric generally ranges from 0 (low quality) to 5 (high quality), with the biotic index computed as the sum of all metric scores. Similar indices have been developed using water-quality parameters (e.g., oxygen saturation, nitrogen) or community structure of benthic communities (Weisberg et al. 1997) to measure ecosystem condition.

In the absence of detailed biological monitoring data, other assessment methods may integrate information on habitat distribution and change, land use, and human activities to guide regional ecosystem management efforts. For example, watershed assessments form the basis for managing water resources and often rely on conceptual models of watershed structure to help determine how well a watershed is functioning and how it responds to natural and human disturbances. GIS-based landscape models have been used increasingly to evaluate ecological conditions in watersheds (e.g., Pess et al. 2002, May and Peterson 2003). These assessments seek to quantify factors, both natural and anthropogenic, that affect the physical, biological, and chemical attributes of a watershed, including hydrologic conditions (e.g., flow regime, water use, land cover, land use), soil erosion and sediment load and sources, natural vegetation patterns and characteristics, habitat conditions within the watershed, biological communities, and water-quality conditions. As with the IBI, GIS-based watershed models convert quantitative factor values into scored metrics, based on expert knowledge, and then integrate and rank these metrics to derive overall scores. Scoring methods vary, although May and Peterson (2003) used a modified additive weighting algorithm to combine the effects of multiple evaluation criteria. Final scores were translated into a percentage scale (relativized) and classified from high quality to degraded, based upon natural breaks and professional judgment.

Regardless of the assessment approach, it is often useful for management purposes to describe conditions in terms of a few qualitative categories, such as low, moderate, and high (Thom 1997). Standard values defining these categories can either be quantitatively derived from reference systems and the literature (e.g., the IBI examples above), predicted through models (e.g., watershed models), or qualitatively assigned in the planning stage. In all cases, a range of values in each category acknowledges the variability of natural systems.

2.2.4.2 - The Bainbridge Island Assessment Method: The method used in this study more closely follows the watershed assessment approach, described above, in that it uses a conceptual model to quantify natural and human-caused factors that affect the physical, biological, and chemical attributes of nearshore marine habitats. The nearshore conceptual model used in this assessment was developed to help predict or understand natural and human-caused effects on Puget Sound nearshore ecological functions (Williams and Thom 2001), as described in Section 1.3. Briefly, this model illustrates the interactions that occur between controlling factors (e.g., depth, wave energy, light), habitat structure, habitat processes, and ultimately, ecological functions in nearshore ecosystems. The model also provides the framework for summarizing the current level of scientific knowledge associated with effects of shoreline modifications to geomorphic classes in the nearshore environment of Bainbridge Island (Table 2). As such, the material presented in this assessment is not only guided by, but also builds upon, the nearshore BAS (Williams et al. 2003), which is strongly recommended as a reference for detailed descriptions and background documentation.

Bainbridge Island nearshore assessment metrics are based on the status of controlling factors in each shoreline reach. In total, nine controlling factor metrics are used, as follows:

1) Wave Energy
2) Light Regime (Loss of Natural Shade)
3) Light Regime (Artificial Shade)
4) Sediment Supply
5) Substrate Type
6) Depth/Slope
7) Pollution (Toxics, Nutrients)
8) Hydrology
9) Physical Disturbance.

Biotic variables, such as fish abundance or benthic community composition, are not used as metrics in the assessment because scale-appropriate information of this type is currently lacking for the study region. Furthermore, little guidance currently exists for biotic indicators of habitat quality in Puget Sound nearshore marine systems (Williams et al. 2003).

The scoring approach uses a five-point scale to assign qualitative categories (0 = no impact, -1 = low impact, -3 = moderate impact, -5 = high impact) of impact to *applicable* shoreline controlling factor metrics within each reach. Specific scoring criteria for each of the nine metrics are detailed in the next section (Assessment Method Scoring). The cumulative reach index score is additive and computed as the sum of all metric scores for each reach.

Scoring of each metric is based on guidance from the BAS document (Williams et al. 2003) to differentiate between high- and low-impact conditions, and often involved balancing the relative weight of several parameters. Whenever possible, critical parameter values were derived from the literature to define categories of impact (e.g., no impact vs. high impact). However, because standardized values rarely existed to define these categories, it was determined in the planning stage to either use even break points for continuous data (e.g., percentage of armoring) or percentile distribution analysis for discrete data (e.g., number of structures) to differentiate between impact categories. For example, it is acknowledged that the extent of shoreline armoring affects the relative level of impact to shoreline controlling factors, and in turn, to ecological functions (Williams and Thom 2001), although few empirical data currently exist to determine how important these cumulative impacts are or how the local conditions most likely affect this relationship. Therefore, a differentiation was made between low, moderate, and high levels of impact associated with shoreline armoring for a particular reach by using even break points in the data (e.g., three categories: 0% to 33%; >33% to 66%; >66% to100%). For situations involving discrete data, such as the number of structures within a particular reach of shoreline, categories were differentiated by percentile distributions that highlighted reaches on Bainbridge Island with the highest and lowest relative density of structures (e.g., three categories separated by 33rd and 66th percentile distribution of the data). Section 2.2.4.4 below. discusses how these statistical categorizations are consistent with BAS and best professional judgment for each controlling factor metric.

Geomorphic context is necessary for properly interpreting potential nearshore impacts under the nearshore conceptual framework. Because some controlling-factor metrics are not necessarily applicable to a particular geomorphic class (e.g., rocky shores were not subject to scoring for five factors: hydrology, substrate type, sediment supply, loss of natural shade, and wave energy; see details below), raw scores are only comparable within each geomorphic class. For example, an increase in reflective wave energy on a rocky shoreline has different consequences to habitat structure and function than on a sandy spit with fringing eelgrass habitat. Table 2 summarizes the relative importance of each controlling factor within a particular geomorphic class, and how impacts to controlling factors can affect habitat structure, nearshore processes, and ecological function. To resolve the discrepancy between raw controlling factor scores for different geomorphic classes, the cumulative reach index scores were normalized on a scale of 0 to -1.0, based on the maximum potential score (Table 6) for that geomorphic class (normalized CF score = raw CF score / maximum potential CF score).

Scores were used in two ways to make comparisons at a broader landscape scale. First, the final normalized scores of each reach (possible range of 0.0 to -1.0) were used to compare the *cumulative* level of impact. This was done by calculating and comparing the average reach score within each management area and across the entire Island. Second, the raw metric scores in each reach (possible range of 0 to -5) were used to tease apart which factors most significantly influenced the final scoring in a negative (or positive) way. This task was done by calculating and comparing the average controlling factor metric scores within each management area, as well as across the entire Island.

To summarize, the conceptual model described in Section 1.3 forms the basis for the Bainbridge Island nearshore assessment method. Assessment metrics are represented by the conceptual model's nine controlling factors, which are considered the primary drivers of nearshore ecological function. Each metric is scored using a five-point scale (-5 to 0), which is modified by the geomorphic context of the reach. The total reach score is additive, but can be scaled up within the landscape. Scoring criteria are based on the BAS, with critical values derived from literature or simple percentile distribution analysis to separate classes of impact.

2.2.4.3 - Data Sources: The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) served as the cornerstone of the assessment, providing recent georeferenced data on the extent and type of shoreline armoring, locations of point structures, and degree of encroachment into the intertidal zone over all of Bainbridge Island shorelines (Table 3). Data were collected during August and September 2001 using a Leica GS50 GPS system with a Leica Laser Locator (Vector IV) range finder or a Trimble Pathfinder Pro XR GPS, either by foot, kayak, or boat. Data were collected as points to speed up field collection, with conversion to line formats using ArcView (version 3.2 or 8.2). In addition to the raw data, point data for individual modifications, such as floating structures, pilings, or piers, were standardized per 1000/ft of shoreline.

Land cover was also an important component in the assessment to determine patterns of land use in the coastal zone. This information was summarized for the coastal strip of marine riparian habitat associated with each reach using preexisting classified aerial imagery from Kitsap County (Kitsap County 2001) (Table 3). A 200-ft marine riparian zone was delineated on the terrestrial side of shorelines, based on guidance from the literature that indicates that functional effectiveness increases substantially with high-quality coastal riparian zone of at least 75 meters (246 ft) in width (Desbonnet et al. 1994; Williams et al. 2003). To identify this demarcation, a 200-ft riparian zone was created in ArcView on the terrestrial side of the shoreline. Kitsap County's 5-meter land-use/land cover raster data (collected by Space Imaging Corporation; post-processed by Marshall and Associates) was converted to pixels (points), grouped into each reach, and summarized as percentage of cover data. Cover classes included eight categories: coniferous, deciduous, meadow-shrub, wetlands, turf, bare ground, impervious, and water. Because of uncertainties about the level of groundtruthing this dataset had been subjected to, a conservative approach was taken in applying information to the assessment. Percentage of total impervious area (%TIA) was derived only from impervious pixels, whereas percentage of naturally vegetated habitats (percentage of forested area) included coniferous, deciduous, meadow-shrub, and wetland pixels.

Other important information used in the assessment of controlling factors included wave exposure and sediment-source data from the ShoreZone inventory (WDNR 2001), recreational shellfish harvest beach closures from the Kitsap County Health District (KCHD) and Washington State Department of Health (KCHD 2003), and feeder bluff activity from a report by Anchor Environmental to the COBI (Small 2001) (Table 3).

2.2.4.4 - Assessment Method Scoring: Below, each of the nine controlling factors is defined, and the available data sources and assumptions used to characterize these parameters (based on the BAS) are summarized. Also provided are specific criteria for assessment scoring (summarized in Table 5). Table 2 outlines the influence of geomorphic context on each controlling factor, following the conceptual model (Figure 1) and the BAS documents (Williams and Thom 2001; Williams et al. 2003). In most cases, best professional judgment was used to determine the relative weighting of multiple scoring criteria within a particular controlling factor category (metric), which is discussed below for each controlling factor.

As discussed in section 2.2.4.2 above, cumulative reach controlling factor (CF) scores were normalized on a scale of 0 to -1.0, based on the maximum potential score (Table 6) for that geomorphic class (i.e. normalized CF score = raw CF score / maximum potential CF score). Since controlling factors are scored using a numerical system that represents a qualitative scale (0 = no impact, -1 = low impact, -3 = moderate impact, -5 = high impact), the normalized CF scores can be converted back to a qualitative CF rating as shown in Table 4.

Table 4. Qualitative Ratings and Normalized Controlling Factor Scores.

Qualitative CF Rating	Qualitative CF Score	Normalized CF Score
High Impact	-5	>=-1 and <-0.800
Moderate/High Impact	-4	>=-0.800 and <-0.600
Moderate Impact	-3	>=-0.600 and <-0.400
Low/Moderate Impact	-2	>=-0.400 and <-0.200
Low Impact	-1	>=-0.200 and <0.000
No Impact	0	=0.000

Table 5. Summary of Controlling Factor Scoring Metrics

Wave Energy
0 if Rocky Shore, Marsh/Lagoon, or Very Protected
otherwise
-3 if linear armoring > 66%, or
-2 if linear armoring > 33%, or
-1 if linear armoring > 0%
and
-1 if concrete/smooth type > rip rap/gabion type
and
-1 if encroachment > 33%

Light - Natural Shade
0 if Rocky Shore or Spit/Barrier/Backshore
otherwise
0 if overhanging veg > 80%, or
-1 if overhanging veg > 60%, or
-2 if overhanging veg > 40%, or
-3 if overhanging veg > 20%, or
-4 if overhanging veg > 0%, or
-5 if overhanging veg = 0%

Light - Artificial Shade
-3 if shading structures density > 18.9/1000 ft, or
-2 if shading structures density > 5.7/1000 ft, or
-1 if shading structures density > 0/1000 ft
and
-2 if marina number >= 2 in reach, or
-1 if marina number = 1 in reach

Sediment Supply
0 if Rocky Shore
otherwise
-3 if linear armoring > 66%, or
-2 if linear armoring > 33%, or
-1 if linear armoring > 0%
and
-2 if armor > 0% and feeder activity = Yes; or
-1 if armor > 0%, feeder = No, but backshore source = Yes; or
-1 if feeder and backshore = No, but alongshore = Yes and groin or drift-intercepting ramps density > 0/1000ft

Substrate Type
0 if Rocky Shore
otherwise
-3 if linear armoring > 66%, or
-2 if linear armoring > 33%, or
-1 if linear armoring > 0%
and
-2 if point mods density > 27.9/1000ft, or
-1 if point mods density > 9.7/1000ft

Depth-Slope
-5 if dredged (e.g., urban harbor)
otherwise
-3 if linear armoring > 66%, or
-2 if linear armoring > 33%, or
-1 if linear armoring > 0%
and
-2 if encroachment > 66%, or
-1 if encroachment > 33%

Pollution
-5 if shellfishing closed
otherwise
-3 if riparian TIA > 60%, or
-2 if riparian TIA > 35%, or
-1 if riparian TIA > 10%
and
-1 if pipe outfall density ≥ 1.9/1000ft
and
-1 if marina or fish farm present

Hydrology
0 if Rocky Shore; or
-5 if Marsh/Lagoon with artificial constriction (e.g. tide gate, culvert)
otherwise
-2 if riparian TIA > 60%, or
-1 if riparian TIA > 35%
and
-2 if encroachment > 66%, or
-1 if encroachment > 33%
and
-1 if pipe outfall density ≥ 1.9/1000 ft

Physical Disturbance
-5 if urban waterfront (e.g., ferry or shipping activity, dry dock)
otherwise
-2 if floating structures > 15.4/1000 ft, or
-1 if floating structures > 4.8/1000 ft
and
-3 if riparian forested < 10%, or
-2 if riparian forested < 25%, or
-1 if riparian forested < 40%

Table 6. Maximum Potential Controlling Factor Score by Geomorphic Class

Geomorphic Class	Max Potential CF Score
Low Bank	45 (40 if "Very Protected" from waves)
High Bluff	45 (40 if "Very Protected" from waves)
Spit/Barrier/Backshore	40 (35 if "Very Protected" from waves)
Marsh/Lagoon	40
Rocky Shore	20

1. Wave Energy

Discussion **-** Wave energy primarily describes the reflective energy of waves, which can be modified by the composition, encroachment, and vertical design of shoreline armoring structures (Table 2). Reaches with a high percentage of shoreline composed of armoring are assumed to have relatively higher reflective wave energy than those with less armoring. Wave reflection forces generally increase as armoring methods intensify, with higher impacts to beach processes in areas with solid vertical or re-curved seawalls, and lower impacts in areas using graded or porous structures (e.g., revetments and rip-rap) or dynamic "soft" solutions (Macdonald et al. 1994; Williams and Thom 2001). Hardened armoring approaches, such as bulkheads and revetments, represent the types of shoreline modifications most likely to affect wave-energy regimes. Encroachment of the structure into the intertidal zone, measured as the vertical distance of the mean high-water line from the toe of the structure, also may increase the reflective energy of waves.

Available data sources most amenable to characterizing the parameters that may amplify reflective wave-energy regime, therefore, include the percentage of armored shoreline, armor material composition, and the degree of encroachment (from the COBI Nearshore Structure Inventory; Best 2003) (Table 3). Grade or angle of a structure also affects wave reflective energy and was considered part of the material composition parameter, because 95% of all shoreline armoring on Bainbridge Island is of vertical design. Jetties and breakwaters, which generally are designed to dissipate wave energy and protect and stabilize navigation channels and harbor areas, are rare to nonexistent along Bainbridge Island shorelines and, therefore, are not addressed here. Wave exposure class, from the ShoreZone Inventory (WDNR 2001) and geomorphic context provide appropriate guidance on reaches more likely to be affected by these shoreline modifications (Table 2).

Criteria and Scoring - Reflective wave energy was not considered an issue for reaches considered "very protected" in the ShoreZone Inventory (WDNR 2001), nor for reaches classified as "rocky" or "marsh/lagoon" (Table 5). For other geomorphic classes, reaches were scored based on percentage of linear armoring using three categories differentiated by equal breaks in the data: **-1** if >0 to 33%; **-2** if >33 to 66%; and **-3** if >66%. To account for the effect of armor material composition, scores were modified by **-1** if the percentage of smooth concrete or wood armoring was greater than the percentage composed of riprap or gabion. As well, encroachment was incorporated into the scoring by adding **-1** if more than one third (33%) of the shoreline was composed of armoring structures that encroached into the intertidal zone.

2. Light Regime (Loss of Natural Shade)

Discussion **-** Light regime (loss of natural shade) primarily describes a loss of shading that affects natural temperature and desiccation rates, especially when anthropogenic alteration removes overhanging marine riparian vegetation. Reaches with intact, relatively undisturbed riparian zones are assumed to have a relatively high percentage of overhanging vegetation (Table 2).

The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on the extent and composition of riparian vegetation overhanging the beach (Table 3). Geomorphic context provides guidance on where overhanging riparian vegetation would historically be an important shoreline feature (i.e., low bank, high bluff, and marsh/lagoon) (Table 2).

Criteria and Scoring **–** Loss of shade was not considered an issue for reaches classified as "rocky" or "spit/barrier/backshore," because these habitats often are exposed, lack overhanging riparian vegetation, or are composed of low dune vegetation (Table 5). Reaches classified as "marsh/lagoon," "low bank," and "high bluff" were scored based on the percentage of overhanging riparian vegetation, using equal breaks in the data: 0 if >80% to 100%; **-1** if >60% to 80%; **-2** if >40% to 60%; **-3** if >20% to 40%; **-4** if >0% to 20%; and **-5** if 0%.

3. Light Regime (Artificial Shade)

Discussion **-** Light regime (artificial shade) describes the diminishment of light, or shading, which is caused by anthropogenic modifications, such as piers, docks, and other floating or overwater structures. The availability of light for aquatic vegetation may be reduced by shoreline structures that are built in the intertidal and shallow subtidal zones and by floating structures that are found closer to the benthos (Table 2). In reaches classified as "marsh/lagoon," structures such as piers or boardwalks built over the backshore zone can also affect light regimes important to dune and marsh vegetation. The orientation, height and composition of a structure affects the level of impact upon light regimes.

The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced point information on the extent and composition of shade-causing structures, defined as docks, piers, boats, buoys, and other overwater structures, including marinas (Table 3). This information has been verified by visual examination of aerial photographs (WDOE 2000). Square footage of overwater structures would provide the best indication of shading area, but was not collected in the field because of sampling limitations; it is recommended that future efforts endeavor to collect this information. However, it can be inferred that some types of shading structures such as marinas, defined as a pier and/or float with more than 5 mooring slips, cast substantially more shade than single-residential docks, mooring buoys, or small boats, and this factor is built into the scoring criteria below. Structure orientation, composition, and approximate tidal elevation are associated with light impacts and will be essential when determining management actions (see Appendix E).

Criteria and Scoring – The relative impact of artificial shading on a particular reach was scored based on the percentile distribution of shade-causing structure density (per 1000 ft of shoreline) within all Bainbridge Island reaches, using three categories differentiated by equal breaks in the data: **-1** if greater than 0 but not more than 33rd percentile of shading structure density on Bainbridge Island ($\leq$5.7 shading structures per 1000 ft of shoreline); **-2** if greater than the 33rd percentile (>5.7/1000 ft) and equal to or less than the 66th percentile (18.9/1000 ft); **-3** if densities were in the top 66th percentile (>18.9/1000 ft) (Table 4). To take into account for larger structures such as marinas, shade scores were further modified by the presence of one (**-1**) or more (**-2**) marinas.

4. Sediment Supply

Discussion **-** Sediment supply, defined as the abundance of sediment within a reach, is substantially affected by shoreline armoring and other stabilization structures. This influence is especially true in situations in which backshore sediment sources, such as feeder bluffs, have been documented, although upland use may also affect this factor (Table 2). Groins, as well as some ramps and other structures built waterward of the OHWM, affect alongshore transport of sediment in a drift cell.

Current feeder bluff activity has been roughly identified through recent mapping (Small 2001) and provides guidance on the reaches where sediment recruitment is very significant (Table 3). Sources of significant backshore and alongshore sediment supply have also been roughly delineated in the ShoreZone Inventory (WDNR 2001). The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provided georeferenced information on shoreline armoring, which confine backshore sediment sources, as well as groins, boat ramps, and other structures that intercept alongshore sediment transport. Wave exposure from the ShoreZone Inventory (WDNR 2001) and geomorphic context provides guidance on the type of reaches for which backshore or alongshore sediment supply is not especially relevant (Table 2).

Criteria and Scoring – Altered sediment supply was not considered an issue for reaches classified as "rocky" according to geomorphic context, nor for reaches classified as "very protected" from wave exposure (including all "marsh/lagoons"), because those reaches do not naturally exhibit the physical processes necessary to recruit and transport significant amounts of sediment (Table 5). For other geomorphic classes, reaches were scored based on percentage of linear armoring using three categories differentiated by equal breaks in the data: **-1** if >0 to 33%; **-2** if >33% to 66%; and **-3** if >66%. To account for the substantial role of feeder bluffs in supplying sediment to the nearshore, scores were modified by **-2** if linear armoring occurred in a reach with feeder bluff activity. In the absence of feeder bluff activity, scores were further modified by **-1** if linear armoring occurred with other documented backshore sediment sources, or if groins or sediment-blocking ramps were present in association with alongshore sediment sources.

5. Substrate Type

Discussion **-** Substrate type represents the direct modification or replacement of natural substrates from the addition of novel structural materials associated with shoreline modifications. An example would include situations in which mixed soft sediment (e.g., gravel and sands) is replaced by solid concrete or large rip-rap materials, or the addition of pilings or other hard structures that provide settlement and attachment substrate for macroalgae and sessile invertebrates (Table 2).

The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on shoreline armoring, including all point modifications, which were defined to include all docks, piers, ramps, groins, freestanding stairs, buoys, pilings, and other overwater structures (e.g., boathouses) composed of unnatural structural materials in the nearshore (Table 2). Geomorphic context provides guidance on the type of reaches in which existing substrates are already "hardened" (i.e., rocky shorelines).

Criteria and Scoring – The direct modification or replacement of natural substrates was not considered an issue for reaches classified as "rocky" according to geomorphic context (Table 3). For other geomorphic classes, reaches were scored based on percentage of linear armoring using three categories differentiated by equal breaks in the data: **-1** if >0 to 33%; **-2** if >33% to 66%; **-3** if >66%. Scores within a reach were further modified based on the percentile distribution of point modification density within all Bainbridge Island reaches using two categories differentiated by three equal breaks in the data: **-1** if greater than the 33^{rd} percentile (>9.7 point modifications/1000 ft of shoreline) and equal to or less than the 66^{th} percentile (27.9/1000 ft) of point modification density on Bainbridge Island; **-2** if point structure density was greater than the 66^{th} percentile (>27.9/1000 ft).

6. Depth or Slope

Discussion **-** Depth or slope reflects the change of natural beach slope, bottom depth, or intertidal zone area, and has associated impacts on the native vegetation and biota using these habitats (Table 2). Structures exhibiting intertidal encroachment, measured as the vertical distance that mean high tide reaches from the toe of an armoring structure, may have an affect on natural beach slope or depth more significantly than would other shoreline modifications.

Bottom depth and slope is significantly changed by dredging, which was incorporated into the assessment where known to have occurred, based on data provided by the COBI (unpublished information) (Table 3). Armoring structures, especially those that encroach into the intertidal zone, also alter the relative size, depth, and slope of nearshore habitats. The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on shoreline armoring and intertidal encroachment (based on the mean high water line on structure).

Criteria and Scoring – Any reach with documented dredging (e.g., for channel maintenance or to maintain docking facilities) was scored as **-5** (Table 3). Change in natural beach slope or bottom depth was considered for all other reaches, which were scored based on percentage of linear armoring using three categories differentiated by equal breaks in the data: **-1** if >0 to 33%; **-2** if >33% to 66%; **-3** if >66%. As well, the effect of encroachment on altering natural beach slope or depth was incorporated into the scoring using two categories differentiated by three equal breaks in the data: **-1** if more than one third (33%) of the shoreline reach length was composed of armoring structures that encroached into the intertidal zone and **-2** if encroaching structures exceeded 66% of the shoreline reach length.

7. Pollution

Discussion **-** Pollution, which includes toxic contaminants, fecal coliform bacteria, excessive nutrients, and altered salinity and temperature regimes, is often associated with proximity to outfalls and stream sources or in association with marinas and fish farms (Williams et al. 2003) (Table 2). Information on historic use (e.g., creosote wood treatment in Eagle Harbor) also provides useful guidance on site and landscape effects, although the definition at this time necessarily excludes creosote or other wood treatments associated with many shoreline structures. Human use may contribute pollutants along heavily armored shorelines adjacent to upland areas with extensive development (e.g., industrial, commercial, residential, agricultural), impervious surfaces, and areas of reduced riparian habitat. Marine riparian vegetation provides functions analogous to freshwater systems that serve to filter nutrients, bacteria, and other pollutants from surface waters (Desbonnet et al. 1994). In the absence of existing data for marine systems, it is assumed that the positive relationship between watershed imperviousness and pollution that exists for stream systems in the region (May et al. 1997) applies to marine nearshore systems as well.

The Washington State Department of Health and Kitsap County Health District summarize known sources of chemical or biological pollution (i.e., U.S. EPA 303(d)-listed sites, near sewer treatment plant outfalls, or areas that periodically experience high levels of nonpoint pollution) with ongoing recreational shellfish closures or warning advisories (Table 3). Land-cover classification from preexisting classified aerial imagery available from Kitsap County (unpublished data, Kitsap County) was used to derive estimates of percent total impervious area (%TIA) in the marine riparian zone, defined conservatively here as 200 ft on the terrestrial side of shorelines; Desbonnet et al. (1994) indicates that functional effectiveness increases substantially with high-quality coastal riparian zones of at least 75 meters (246 ft) in width. Categories derived for urbanization effects for Puget Sound lowland streams (May et al. 1997) and the Kitsap Refugia Study (May and Peterson 2003) were used to differentiate four impervious surface area categories within the riparian zone: commercial (90% TIA), high-intensity residential or urban (60% TIA), medium-intensity residential or suburban (35% TIA), and low intensity residential or rural (10% TIA). The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on marinas and fish farms, which were verified by visual examination of aerial photographs (WDOE 2000), as well as the location of outfalls, defined as discharging pipes greater than 8” in diameter.

Criteria and Scoring **-** Any reach covered by ongoing recreational shellfish closures or warning advisories was scored as **-5** to encompass the vast range of nearshore water bodies impaired by various forms of pollution (Table 3). The potential effect of polluted runoff from other reaches was scored based on %TIA in the 200-ft marine riparian zone using three categories derived for urbanization effects for riparian areas of Puget Sound lowland streams (described above): **-3** if %TIA was greater than 60% (high-intensity residential to commercial), **-2** if %TIA was >35% to 60% (low-intensity residential), and **-1** if %TIA was >10% to 35% (rural residential). Pollution scores in these reaches were also modified by **-1** in reaches with one or more marinas or fish farms, and by **-1** where density of outfalls exceeded the 66th percentile (>1.9/1000 ft) of outfall density on all reaches on Bainbridge Island.

8. Hydrology

Discussion **-** Hydrology refers to whether tidal inundation regimes or patterns of groundwater and surface water flow are impacted. Tidal encroachment by armoring structures, measured as the vertical distance reached by mean high tide from the toe of an armoring structure, displaces intertidal and subtidal vegetation, whereas the placement of outfalls may result in local patterns of sediment scouring (Table 2). Alteration of groundwater and surface flows by development in the marine riparian zone may influence vegetation distribution and slope stability. Marine riparian vegetation provides functions analogous to riparian zones in freshwater systems that serve to moderate the effects of stormwater runoff, soil erosion, and water-level fluctuations (Desbonnet et al. 1994). In the absence of existing data for marine systems, it is assumed that the positive relationship between watershed imperviousness and hydrology that exists for stream systems in the region (May and Peterson 2003) applies to marine nearshore systems as well.

The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on artificial tidal constrictions, such as tide gates or culverts, which were verified by visual examination of aerial photographs (WDOE 2000), as well as the location of outfalls, defined as discharging pipes greater than 8" in diameter (Table 3). Land-cover classification from preexisting classified aerial imagery available from Kitsap County (unpublished data, Kitsap County) was used to derive estimates of hydraulic alteration associated with %TIA in the marine riparian zone (described above). Categories derived for urbanization effects for Puget Sound lowland streams (May et al. 1997; May and Peterson 2003) were used to differentiate four impervious surface area categories within the riparian zone: commercial (90% TIA), high-intensity residential (60% TIA), low-intensity residential (35% TIA), and rural residential (10%). The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on the degree of intertidal encroachment by shoreline armoring (based on the mean high water line on the structure). Geomorphic context provides guidance on the type of reaches in which hydrologic alterations may not be especially relevant (i.e., rocky shorelines), or where tidal constrictions may have disproportionate effects by affecting flushing and inundation rates (i.e., marsh/lagoons) (Table 3).

Criteria and Scoring – Modifications to nearshore hydrology, specifically whether tidal inundation or patterns of groundwater flow are impacted, was not considered an issue for reaches classified as "rocky" (Table 5). Conversely, "marsh/lagoon" reaches with artificial tidal constrictions, such as tide gates or culverts, were scored as **-5**. The potential effect of polluted runoff from other reaches was scored based on %TIA in the 200-ft marine riparian zone using three categories derived for urbanization effects for riparian areas of Puget Sound lowland streams (described above). In other reaches, the potential effect of local hydrology alteration was scored based on the %TIA in the 200-ft marine riparian zone using two categories derived for urbanization effects for Puget Sound lowland streams (see above): **-2** if %TIA was greater than 60% (high-intensity residential to commercial), **-1** if %TIA was >35% to 60% (low-intensity residential). As well, the effect of tidal hydrology by armoring structure encroachment was incorporated into the scoring using two categories differentiated by three equal breaks in the data: **-1** if more than one third (33%) of the shoreline reach length was composed of armoring structures that encroached into the intertidal zone and **-2** if encroaching structures exceeded 66% of the shoreline reach length. Hydrology scores in these reaches were also modified by **-1** where density of outfalls exceeded the 66th percentile (>1.9/1000 ft) of outfall density on all reaches on Bainbridge Island.

9. Physical Disturbances

Discussion – The definition of physical disturbances is limited to recurring physical disturbances associated with human activities in marine and riparian shoreline habitats, but does not include temporary construction impacts associated with various nearshore modifications. Recurring physical disturbances are primarily associated with the grounding of floating docks, mooring buoys (and chains), vessels that are inappropriately located relative to tidal elevation, and various activities associated with boat launch ramps (e.g., prop wash) (Table 2). These regular disturbances physically distress local benthos and vegetation. Physical disturbance in marine riparian habitats can be in the form of noise and light pollution, or from outright vegetation removal, as a consequence of human activities. Riparian zones provide essential habitat for wetland-associated species for use in feeding, roosting, breeding and rearing young, and providing safe cover for mobility and thermal protection (Desbonnet et al. 1994). Intact forested habitats may mitigate human noise and light disturbances in the marine riparian zone, with dense shrub and forested vegetation on steep slopes providing the greatest protection from human disturbance. A variety of human-derived physical disturbances are particularly relevant along urban waterfronts, which are defined to include reaches with commercial shipping or ferry activity.

Ferry use or commercial shipping activity (including marine repair facilities) were determined to constitute "urban" waterfront areas, and were verified by visual examination of aerial photographs (WDOE 2000) and in discussion with the COBI representatives (Peter Namtvedt Best, personal communication) (Table 3). The COBI Nearshore Structure Inventory (COBI 2002, Best 2003) provides georeferenced information on floating structures, defined as floating docks, boats, buoys, and boat ramps, verified by visual examination of aerial photographs (WDOE 2000). Tidal elevation or depth, which further describes the potential for a structure to ground at low tide and cause physical disturbance to the benthos, could be inferred based on nearshore bathymetry profiles and aerial imagery to better provide an indication of likely disturbance impacts. However, the assumptions associated with scoring these impacts from multiple structures within a reach were deemed to be too complex to build into the scoring criteria at this time. It is recommended that this information be used when refining site-specific management actions in the future (see Appendix E). Land-cover classification from preexisting classified aerial imagery available from Kitsap County (unpublished data, Kitsap County) was used to derive estimates of forest cover, defined as intact coniferous, deciduous, meadow-shrub, and wetland habitats, in the 200-ft marine riparian zone (described above). Decreasing levels of riparian forest cover correlate well with increasing %TIA in Puget Sound lowland watersheds (May et al. 1997; May and Peterson 2003), and these relationships were used to differentiate three cover categories most characteristic of the Bainbridge Island landscape: clear cut (<10% total forest cover), high-intensity residential (<25% cover), and low-intensity residential (<40% cover).

Criteria and Scoring **-** Any reach characterized as an urban waterfront (see above) was scored **-5** (Table 5). For all other reaches, the potential for disturbance associated with structures grounding at low tide and boat prop scour (see above) were scored based on the percentile distribution of floating structure density within all Bainbridge Island reaches, using two categories differentiated by three equal breaks in the data: **-1** if greater than the 33rd percentile of floating structure density on Bainbridge Island shorelines (>4.8 point modifications per 1000 ft of shoreline) and equal or less than the 66th percentile (15.4/1000 ft); **-2** if densities were greater than the 66th percentile (>15.4/1000 ft). The potential effect of recurring human disturbance in marine riparian habitats was scored based on the percentage of forested area in the 200-ft riparian zone using three categories derived from Puget Sound lowland watersheds (see above): **-3** if percentage of forested area was less than 10%, **-2** if percentage of forested area was 10% to <25%, **-1** if percentage of forested was 25% to <40%.

2.2.4.5 - Assessment Method Use and Limitations: It is important to note that assessment scores represent a broad estimate of impact to natural controlling factors in the nearshore based on the best data available at this time, and do not necessarily reflect the individual impacts of specific structures or properties. Again, the scoring is a screening tool that serves to highlight situations in which natural shoreline processes have likely been impacted, and as such, need not involve the total complexity of the system being modeled. The aim is to derive a fairly simple index that can be consistently derived using key pieces of information over a broad range of conditions. In all cases, the rationale for the scoring criteria is described, best professional guidance is used, and evidence and justification for these decisions are provided.

Each controlling factor (CF) score is determined separately and, therefore, can be used to highlight situations in which associated shoreline processes have likely been impacted or otherwise altered from the natural condition. In this way, the key factors that may limit ecological functions within a particular reach are highlighted in the results by low (poor) scores (approaching the lowest score of -5) in a specific controlling factor metric. It should be noted that some types of data are used multiple times in the scoring process because they affect many controlling factors. For example, the total percentage of linear armoring within a reach is considered to influence not only reflective wave energy (in some geomorphic settings), but also sediment supply (in some geomorphic settings), substrate type, and depth and slope. Other parameters that are used multiple times for scoring the level of impact to various controlling factor metrics include armoring encroachment, riparian area land use, the presence of marinas, and outfall densities.

That stated, the sum of all controlling factors (CF) scores also provides an index of cumulative impact to nearshore habitat structure, ecological processes, and ecological function (Table 3). Some scoring parameters may appear to be disproportionately weighted in the cumulative score. This reflects that some types of modifications are recognized to have more widespread impacts. However, detailed validation of the model would be necessary to resolve this question. Likewise, an additive index may not recognize the significance of one impaired controlling factor (e.g., pollution) that supercedes all others in a particular stretch of shoreline. However, this additive method balances the need to maintain simplicity in the index, can be consistently applied over a wide variety of shorelines, and represents a proper approach when used as the first step in an assessment process.

2.2.5 Validating Assessment Scores

A preliminary exercise was conducted to validate the assessment scores by evaluating existing ecological functions at the reach level with a simple index of ten potential indicators (listed below), including presence of vegetative habitats, and invertebrate and vertebrate species.

1) Proximity to salmon-bearing stream
2) Herring spawning area
3) Surf smelt spawning beach
4) Pacific sandlance spawning beach
5) Geoduck beds
6) Eelgrass bed (Zostera spp.)
7) Salt marsh (Salicornia, Triglochin, Deschampsia, Distichlis)
8) Bull kelp (Nereocystis)
9) Intertidal seaweed (Fucus, Laminaria, Sargassum, Ulva)
10) Overhanging riparian vegetation

As with the controlling factor assessment, the scoring approach uses a five-point scale to assign qualitative categories of each ecological function metric within each reach, with 1 representing “not present,” 2 through 4 representing “intermediate function” (e.g., patchy habitat distribution or close proximity to some documented functions), and 5 representing “documented functions” or “continuous habitat distribution” (Table 7). The cumulative ecological function (EF) score is additive and computed as the sum of all metric scores in each reach. Therefore, the index assumes that higher ecological functions are present in reaches with a high diversity of habitats and faunal groups. Average reach scores were also computed within each management area and across all of Bainbridge Island to make comparisons at a broader landscape scale.

Scoring criteria for each metric is described below and in Table 6, with data sources summarized in Table 3. For the salmon-bearing stream metric (Haring 2000; May and Peterson 2003), reaches were scored based on proximity to the stream outlet: **1** if more than two reaches away from outlet reach, **2** if two reaches away from outlet reach, **3** if one reach away from outlet reach, **4** if adjacent to outlet reach, and **5** if outlet reach. For the forage-fish spawning (herring, surf smelt, and sandlance) and geoduck metrics (WDFW 2001), reaches were scored based on presence or absence of these resources using two categories: **1** if not present; **5** if present. For most of the habitat metrics (eelgrass, saltmarsh, bull kelp, and intertidal seaweed) (WDNR 2001), reaches were scored based on the extent of habitat present in the reach using three categories: **1** if not present, **3** if patchy distribution, and **5** if continuous distribution. Finally, the overhanging riparian vegetation metric (COBI 2002, Best 2003) was scored for each reach based on percentage of shoreline coverage using three categories differentiated by equal breaks in the data: **1** if >0 to 33%; **3** if >33% to 66%; and **5** if >66%.

After the ecological function (EF) scores were tabulated, these values were paired with corresponding controlling factor (CF) assessment scores for each reach, graphed in an X-Y plot, and visually examined to discern patterns and relationships (Figures B-72 through B-76). These preliminary results show that the relationships between ecological functions and controlling factors are generally weak, but they do suggest that low (poor) CF scores are generally correlated with reduced habitat diversity and other indicators of ecological function. This appears to be the case in some geomorphic settings more than others. Future refinements to the validation methodology would be desirable, and could include refining the list of potential indicators and modifying the scoring based on geomorphic setting.

It must also be noted, that several of the metrics used did not benefit from comprehensive and geographically complete data sets. For example, herring, surf smelt, and sandlance spawning surveys have not been comprehensive over all of Bainbridge Island. Filling in these data gaps or finding interim surrogates (i.e. suitable spawning substrate) may be important to future refinements of the validation process. Given the limited scale-specific information available at this time, it is emphasized that ecological function scores serve as a rough surrogate for habitat function that can serve both as a tool to validate a more detailed controlling factors assessment, as well as a guide for improving management action prioritization (Appendix E). Ultimately, only ongoing research and monitoring conducted at an appropriate scale can clarify our conceptual understanding of nearshore ecological relationships, which can be used to validate the most appropriate indicators of habitat function (Appendix F).

Table 7. Summary of Ecological Function Scoring

Fish Bearing Stream Proximity
5 if stream within the reach, or
4 if stream 1 reach away, or
3 if stream 2 reaches away, or
2 if stream 3 reaches away, or
1 if stream 4 or more reaches away

Herring Spawning
5 if present, or
1 if not present

Surf Smelt Spawning
5 if present, or
1 if not present

Sandlance Spawning
5 if present, or
1 if not present

Geoducks
5 if present, or
1 if not present

Eelgrass
5 if continuous, or
3 if patchy
1 if not present

Saltmarsh
5 if continuous, or
3 if patchy
1 if not present

Bull Kelp
5 if continuous, or
3 if patchy, or
1 if not present

Intertidal Seaweed
5 if continuous, or
3 if patchy, or
1 if not present

Overhanging Vegetation
5 if overhanging veg > 66%, or
3 if overhanging veg > 33%, or
1 if overhanging veg <=33%

3.0 Results and Discussion

3.1 Bainbridge Island

A brief overview of Bainbridge Island shoreline conditions is summarized below, with some discussion of the factors that most significantly influenced scoring. Individual management area (MA) and reach results are reported separately in Section 3.2 of the report. To facilitate readability, tables referred to in this section are collected in Appendix A; maps, charts, and figures can be found in Appendix B. Raw controlling factor (CF) scores and ecological function (EF) scores for each reach are included in Appendix C and Appendix D, respectively.

Number of MAs = 9
Mean MA CF Score (Normalized) = -0.44 (Range: -0.56 to -0.30)
Median MA CF Score (Normalized) = -0.47

Number of Reaches = 201
Island-Wide Qualitative Rating: Moderate Impact
Mean Reach CF Score (Normalized) = -0.45 (Range: -0.87 to 0.00)
Median Reach CF Score (Normalized) = -0.48

Mean Reach EF Score = 20.2 (Range: 10 to 36)
Median Reach EF Score = 20

3.1.1 Description

Bainbridge Island comprises 281,574 linear ft of shoreline (Table A-1). A total of 21 alongshore cells were used to define nine Management Areas (MAs), composed of 201 individual shoreline reaches around the Island (Figure 3). Shoreline reaches are distributed by geomorphic class as follows: spit/backshore (76), high bluff (54), low bank (33), marsh/lagoon (33), and rocky shore (5) (Figure 4). The smallest management area on Bainbridge Island is Manzanita Bay (MA-9; 10 reaches, 18,879 linear ft), and the longest is Point White – Battle Point (MA-8; 38 reaches, 51,650 ft). Sediment sources and wave exposure classes are shown in Figure B-1.

Overhanging riparian vegetation covers approximately 27% (76,399 linear ft) of the entire Bainbridge Island shoreline (Table A-1, Figure B-2). Within the Island's 200-ft riparian zone (over 50 million ft^2), naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 54% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent 23% of the riparian zone land cover (Table A-1, Figure B-3).

Overall, 82% of Bainbridge Island shorelines are currently in residential, recreational, commercial, or industrial use (Best 2003). The development pattern is dominated by single-family residences, although the Island's shorelines host two state parks and many local parks, a fish-pen aquaculture operation, a ferry terminal, a ferry maintenance and repair facility, marinas, mixed-use development, and a Superfund site (a former creosote wood treatment plant and ship yard) (Best 2003). Related impacts are shown in Figure B-4.

Approximately 48% of Bainbridge Island's shoreline is modified by armoring, with most of this represented by vertical rip rap or vertical concrete structures (Table A-1, Figure B-5). In total, 25% of the shoreline has armoring that encroaches into the intertidal zone. A total of 2,931 point modifications were recorded along Bainbridge Island shorelines (unpublished data, COBI 2002), at an average density of 10.4

structures per 1,000 ft (Table A-1, Figure B-6). The most common structures were stairs (526), followed by buoys (495), upland structures at the waterline (341), and docks (330).

The Island-wide distributions of subtidal/intertidal marine vegetation, forage-fish spawning areas, salmon-bearing streams, and geoduck and clam resources are shown in Figures B-7, B-8, and B-9.

3.1.2 Limiting Factors and Opportunities

The average normalized controlling factor (CF) score of all reaches Island-wide was -0.45 (median -0.48, range: -0.87 to 0.00), whereas the average of all normalized MA scores was -0.44, (median -0.47, range: -0.56 to -0.30) (Table A-2; Figure B-10). The values above represent baseline scores over all of Bainbridge Island for relative comparison with individual MAs and reaches, which are discussed in detail below. The most highly impacted MA on Bainbridge Island is Eagle Harbor (MA-5; CF Score -0.56), which also included some of the most highly disturbed reaches over the study area (Figure B-12, Figure B-13, Appendix C). The least-impacted MAs are Murden Cove (MA-4; normalized CF Score -0.33) and Blakely Harbor (MA-6; normalized CF Score -0.30). Scores of documented ecological functions (EF) were highest in Manzanita Bay (MA-9; EF Score 23.9), Agate Passage (MA-1; EF Score 28.4), and Port Madison Bay (MA-2; EF Score 23.0), the northern portion of Bainbridge Island (Figure B-11, Appendix D). In contrast, the lowest EF Scores were observed in Eagle Harbor (MA-5; EF Score 17.9), Blakely Harbor (MA-6; EF Score 17.6), and Rich Passage (MA-7; EF Score 16.1). Prioritization methods for best determining management options based on these results is discussed in Appendix E; Figure B-14 provides a graphical display for reference.

Because the analysis involved only data from Bainbridge Island (the population of interest), it is currently inappropriate to make comparisons relative to all of Puget Sound. Bainbridge Island's diverse shoreline conditions range from polluted urban waterfronts to moderate-density residential development, to fairly undisturbed stretches of shoreline with intact riparian habitats. Therefore, Bainbridge Island represents a microcosm of Puget Sound, with on average, moderate levels of impacts to nearshore resources, but extreme examples of high and low impacts as well (Figures B-12, B-13, and B-14).

On average, the mean raw reach score for individual controlling factor metrics over all Bainbridge Island was -2.10, which provides some basis for distinguishing specific metrics which influenced cumulative scores in a positive or negative direction (Table A-3). Substrate type (-2.90) and depth/slope (-2.61) metrics had the lowest (worst) average scores and represented the most impacted controlling factors over the entire Island (Figure B-15, Figure B-16). Scoring of both metrics was influenced by percentage of shoreline armoring data. As well, the substrate metric reflected the density of all point modifications, whereas depth-slope reflected the relative amount of dredging and armoring encroachment. In summary, the low (poor) scores in these metrics suggest that high rates of shoreline armoring (48% of shoreline), armoring encroachment (25% of shoreline), and point modifications (10.4 structures per 1000 ft shoreline) have significantly changed the historic composition of substrate and depth-slope contours along Bainbridge Island shorelines.

Hydrology (-1.23) and physical disturbance (-1.60) raw controlling factor metrics scored highest (best) and represented the least-impacted controlling factors over all Bainbridge Island reaches (Table A-3; Figure B-15). Scores of both metrics were highly influenced by land cover. As well, the hydrology metric reflects the presence of unnatural tidal constrictions along the shoreline, armoring encroachment, and outfall density. The physical disturbance metric characterized recurring human activities along the shoreline and was also influenced by the presence of urban waterfront activity and the density of floating structures and boat ramps. The relatively higher scores in these metrics suggest that low-to-moderate density residential land use within the marine riparian zone (54% naturally vegetated surfaces, 23%

impervious surfaces) has likely helped to sustain some historic level of hydrology function and protection from physical disturbance along many of Bainbridge Island shorelines.

3.2 Management Areas

A brief description of each Bainbridge Island management area (MA) is summarized below, with some discussion of the predominant limiting factors that negatively influenced scoring, as well as suggestions of opportunities for improvement. Individual reach results are reported separately as a subheading under the corresponding MA and in Appendix C.

3.2.1 Agate Passage Management Area (MA-1) (Reaches 3217 – 3223; 3487 – 3491)

MA CF Qualitative Rating = Moderate Impact
Mean Reach CF Score (Normalized) = -0.47 (Reach score range: -0.69 to 0.00)
Median Reach CF Score (Normalized) = -0.54
Number of Reaches = 12

Mean Reach EF Score = 28.4 (Range: 22 to 32)
Median Reach EF Score = 29

<u>Description</u>
Agate Passage (MA-1) comprises 19,495 ft of shoreline along Agate Passage and around Agate Point (Table A-1). It comprises 12 reaches, most of which are classified as high bluff (9) and the remainder classified as low bank (3) (Figure B-17). MA-1 comprises two drift cells with northerly alongshore drift that converge at Agate Point. The southern boundary of the first drift cell begins at a divergence zone north of Manzanita Bay and moves along the western shoreline along Agate Passage, encompassing a long stretch of shoreline with eroding feeder bluffs (Figure 3). The smaller second cell begins at a divergence zone located just southeast of Agate Point on the western shore of Port Madison, and also includes a small area with unstable feeder bluff activity. Relative to wave exposure, shorelines are considered “semi-protected” along Agate Passage to “protected” along Port Madison (Figure B-18). There are no major watersheds in MA-1, with all runoff considered coastal sheetflow.

Overhanging riparian vegetation covers approximately 36% of the MA-1 shoreline, the highest value observed of any MA (Table A-1, Figure B-23). Similarly, within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 71% of land cover (Figure B-22). Impervious surfaces (e.g., roads, roofs) represent 17% of the riparian zone land cover. As such, riparian zone land-cover class values in Agate Passage represent one of the best ratios of percentage of natural vegetation to %TIA on Bainbridge Island.

Shoreline development in MA-1 is primarily residential in nature. Approximately 57% of shoreline is modified by armoring and 21% of the shoreline has armoring that encroaches into the intertidal zone (Table A-1; Figure B-19). A total of 235 point modifications were recorded along MA-1 shorelines, at an average of 12.1 modifications per 1000 ft, among the highest densities on Bainbridge Island (Figure B-20). The most common structures were stairs (64), a common feature for shoreline access along high bluffs, followed by overwater structures, such as docks or piers (32).

<u>Limiting Factors</u>
The average normalized CF score within MA-1 was -0.47, well within the middle range of MA scores on Bainbridge Island (Table A-2; Figure B-10, Figure B-13). Consequently, the Agate Passage MA was rated “moderate” in terms of relative impact to shoreline controlling factors on Bainbridge Island.

Relative to other areas, MA-1 scored particularly low (poor) in the following controlling factor metrics: loss of natural shade, sediment supply, pollution, and hydrology (Table A-3; Figure B-16). The fact that MA-1 had the lowest (worst) average natural shade score (-2.75) while also having the highest total percentage (36%) of shoreline with overhanging riparian vegetation was puzzling. Closer examination of the data revealed that most short reaches in the MA exhibited relatively low vegetation scores, whereas some longer reaches had riparian cover exceeding 90%. While still useful, this suggests that a simple, additive index alone may prove misleading when average assessment scores are scaled up within a larger landscape. Alternative measures, such as using median and upper/lower quartiles may characterize the cumulative landscape scores better than simply using the average. Sediment supply scores were influenced primarily by the high percentage of armoring in front of important feeder bluffs and backshore sediment sources. Pollution scores were low in MA-1 because of recreational shellfish closures and warnings in five of twelve reaches associated with proximity to a sewer treatment plant outfall. High %TIA in the marine riparian zone and outfall densities along the shoreline in some reaches further influenced low pollution and hydrology metric scores.

On a positive note, MA-1 exhibited high (good) scores in the physical disturbance metric relative to other MAs (Table A-3, Figure B-16). This value is primarily attributed to the residential nature of the shoreline, high forested cover, and relatively moderate number of docks, mooring buoys, and ramps due to poor shoreline access afforded by the high bluff geomorphology of most reaches.

<u>Opportunities</u>
The most obvious opportunities for improving scoring of controlling factor metrics include removal of armoring structures in front of feeder bluffs to allow natural sediment processes. This approach will yield obvious results at down-drift reaches dependent upon alongshore sediment sources. Some high-bluff reaches in this MA were in particularly good condition, including Reach 3488, one of the least-impacted, high-bluff reaches on Bainbridge Island. This reach exhibits natural feeder bluff activity, large woody debris (LWD) recruitment, downed trees and overhanging riparian vegetation at the base of the bluffs, high forest cover in the landward riparian zone, and no linear or point modifications along the shoreline.

The EF scores are particularly high in MA-1 relative to the rest of Bainbridge Island because of the prevalence of forage-fish (herring, sandlance, and surf smelt) spawning areas documented along most reaches (Table A-4; Figure B-11, Figures B-24, B-25, B-26, Appendix D). Eelgrass beds and geoduck resources are also abundant along most shorelines.

<u>Individual Reaches Within MA-1</u> (Figure B-27, Appendix C, Appendix D)

Reach 3217
- CF Rating = Moderate/High Impact; Normalized score = -0.689
- Most impacted CF metrics: sediment supply, pollution
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1658 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 24.1%; Riparian zone land use: No data on %TIA; No data on %forested
- Total shoreline armoring: 86.9%; Total encroaching: 61.6%
- Total point modifications: 14; Density: 8.4/1000 ft; most common is stairs, with 3/1000 ft
- Other: shellfish closure present
- EF Score: 32

Reach 3218
- CF Rating = Moderate/High Impact; Normalized score = -0.622
- Most impacted CF metric: pollution

- Least impacted CF metric: depth/slope, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 349 ft
- Sediment source: Backshore; Wave exposure: semi-protected
- Overhanging vegetation: 16.4%; Riparian zone land use: No data on %TIA, No data on %forested
- Total shoreline armoring: 39.3%; Total encroaching: 0%
- Total point modifications: 9; Density: 25.8/1000 ft; most common is pilings, with 11.5/1000 ft
- Other: shellfish closure present
- EF Score: 32

Reach 3219
- CF Rating = Moderate Impact; Normalized score = -0.578
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, sediment supply, depth/slope, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 541 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 29.4%; Riparian zone land use: No data on %TIA, No data on %forested
- Total shoreline armoring: 45%; Total encroaching: 0%
- Total point modifications: 11; Density: 20.3/1000 ft; most common is overwater structures, with 5.5/1000 ft
- Other: shellfish closure present
- EF Score: 30

Reach 3220
- CF Rating = Moderate Impact; Normalized score = -0.556
- Most impacted CF metric: pollution
- Least impacted CF metric: physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 624 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 7.7%; Riparian zone land use: No data on %TIA, No data on %forested
- Total shoreline armoring: 61.8%; Total encroaching: 0%
- Total point modifications: 10; Density: 16/1000 ft; most common is stairs, with 6.4/1000 ft
- Other: shellfish closure present
- EF Score: 30

Reach 3221
- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metric: pollution
- Least impacted CF metric: physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 2161 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 14.8%; Riparian zone land use: No data on %TIA, No data on %forested
- Total shoreline armoring: 60%; Total encroaching: 0%
- Total point modifications: 31; Density: 14.3/1000 ft; most common is upland structures at waterline, with 3.2/1000 ft
- Other: shellfish closure present
- EF Score: 26

Reach 3222
- CF Rating = Low/Moderate Impact; Normalized score = -0.378
- Most impacted CF metric: substrate type
- Least impacted CF metric: hydrology, physical disturbance

- Geomorphic class: Low Bank; Shoreline length: 1019 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 46.5%; Riparian zone land use: 20% TIA, 72.6% forested
- Total shoreline armoring: 49.3%; Total encroaching: 0%
- Total point modifications: 13; Density: 12.8/1000 ft; most common is upland structures at waterline, with 4.9/1000 ft
- Other:
- EF Score: 30

Reach 3223

- CF Rating = Low/Moderate Impact; Normalized score = -0.333
- Most impacted CF metrics: natural shade, substrate type
- Least impacted CF metric: hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1591 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 36.6%; Riparian zone land use: 10.4% TIA, 82.7% forested
- Total shoreline armoring: 53.9%; Total encroaching: 8.3%
- Total point modifications: 12; Density: 7.5/1000 ft; most common is stairs, with 3.8/1000 ft
- Other: next to Agate Pass bridge
- EF Score: 26

Reach 3487

- CF Rating = Moderate/High Impact; Normalized score = -0.622
- Most impacted CF metrics: sediment supply, substrate type
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 810 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 18.6%; Riparian zone land use: 44% TIA, 50.6% forested
- Total shoreline armoring: 68.9%; Total encroaching: 11.7%
- Total point modifications: 17; Density: 21/1000 ft; most common is groins, with 7.4/1000 ft
- Other: heavily cleared for homes, lawns, views; lots of rock engineering
- EF Score: 22

Reach 3488

- CF Rating = No Impact, Normalized score = 0
- Most impacted CF metrics:
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1439 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 90.2%; Riparian zone land use: 8.8% TIA, 84.2% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0
- Other: nice tidal flats, downed trees, feeder bluff in good shape
- EF Score: 28

Reach 3489

- CF Rating = Low/Moderate Impact, Normalized score = -0.222
- Most impacted CF metric: sediment supply
- Least impacted CF metric: natural shade, artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1504 ft

- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 97.1%; Riparian zone land use: 11.1% TIA, 83.6% forested
- Total shoreline armoring: 5.7%; Total encroaching: 0%
- Total point modifications: 8; Density: 5.3/1000 ft; most common is outfalls, with 3.3/1000 ft
- Other: shoreline heavily covered with downed trees (LWD) from slope
- EF Score: 28

Reach 3490
- CF Rating = Moderate Impact; Normalized score = -0.511
- Most impacted CF metric: sediment supply
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 3453 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 31.5%; Riparian zone land use: 10.2% TIA, 77.7% forested
- Total shoreline armoring: 63.9%; Total encroaching: 61.4%
- Total point modifications: 39; Density: 11.3/1000 ft; most common is upland structures at waterline, with 3.5/1000 ft
- Other: riprap at base of cliff, little LWD retention
- EF Score: 30

Reach 3491
- CF Rating = Moderate Impact; Normalized score = -0.533
- Most impacted CF metric: substrate type
- Least impacted CF metric: hydrology
- Geomorphic class: High Bluff; Shoreline length: 4347 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 24.5%; Riparian zone land use: 22% TIA, 58.7% forested
- Total shoreline armoring: 78.7%; Total encroaching: 16.9%
- Total point modifications: 71; Density: 16.3/1000 ft; most common is stairs, with 5.1/1000 ft
- Other:
- EF Score: 27

3.2.2 Port Madison Bay Management Area (MA-2) (Reaches 3193 – 3216)

Qualitative Rating = Moderate Impact
Mean CF Score (Normalized) = -0.47 (Range: -0.70 to -0.03)
Median CF Score (Normalized) = -0.48
Number of Reaches = 24

Mean EF Score = 23.1 (Range: 16 to 36)
Median EF Score = 20

Description
MA-2 comprises 32,037 ft of shoreline that encompasses much of Port Madison and the entirety of Port Madison Bay (Table A-1). MA-2 comprises 24 reaches, most of which are classified as marsh/lagoon (8), followed by high bluff (6), spit/backshore (6), and low bank (4) (Figure B-17). MA-2 is defined by two drift cells with southerly alongshore drift that terminate into Port Madison Bay, an area that lacks appreciable alongshore drift (Figure 3). The northern boundary of the first drift cell begins at a divergence zone located just southeast of Agate Point on the western shore of Port Madison and moves south into Port Madison Bay, encompassing a short stretch of shoreline with eroding feeder bluffs. The smaller second cell begins at a divergence zone located on the eastern shore of Port Madison. Relative to

wave exposure, shorelines are considered “semi-protected” to “protected” along Port Madison, and “very protected” within Port Madison Bay (Figure B-18). MA-2 receives upland flows from Coho Creek (WRIA 15.0319A), as well as from several other small coastal streams.

Overhanging riparian vegetation covers approximately 26% of the MA-2 shoreline (Table A-1, Figure B-23). However, within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 66% of land cover (Figure B-22). Impervious surfaces (e.g., roads, roofs) represent 14% of the riparian zone land cover.

Shoreline development in MA-2 is primarily residential in nature, with a large number of structures for accessing and mooring watercraft in this protected anchorage. Approximately 61% of the shoreline is modified by armoring, and 35% of the shoreline has armoring that encroaches into the intertidal zone, in both categories the highest percentage of all MAs on Bainbridge Island (Table A-1, Figure B-19). Much of this armoring is characterized as fill or land-building, as opposed to erosion protection that might be observed in a more exposed section of shoreline.

A total of 445 point modifications were recorded along MA-2 shorelines, at an average of 14 modifications per 1000 ft (Table A-1, Figure B-20). As previously noted, most of these structures are for accessing boats, with the most common structure being mooring buoys (96), followed by overwater structures (e.g., boat houses) (31), docks (88), and piers (69). At least eight marinas, defined as a pier/float with more than five mooring slips, were present within MA-2 (Figure B-21). A total of 22 outfalls were also recorded in MA-2. The Washington Department of Fish & Wildlife (WDFW) has also reported the chronic mortality of herring embryos in Hidden Cove, though the cause is still under investigation.

<u>Limiting Factors</u>

The average normalized CF score within MA-2 was -0.47, again well within the middle range of MA scores on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). Relative to other areas, MA-2 scored particularly low (poor) in the artificial shade and substrate-type metrics (Table A-3, Figure B-16). Artificial shade scores were influenced primarily by the high density of shade-causing structures such as docks, piers, boats, buoys, and other overwater structures, and the relatively high number of marinas. High densities of these types of structures, combined with heavily armored shorelines, also combined to low (poor) scores in the substrate metric.

Even though reaches had relatively high rates of shoreline armoring, the wave-energy metric in MA-2 scored high (good) relative to other MAs, primarily because much of the shoreline is considered “very protected” from wave energy (Figure B-16). Thus, shorelines would be less likely to experience the detrimental effects of reflective wave energy in this “very protected” setting.

<u>Opportunities</u>

One of the least impacted spit/barrier/backshore reaches on Bainbridge Island is Reach 3194 in Port Madison Bay (MA-2), which has few linear or point modifications along shorelines, some low backshore/dune or riparian vegetation, and LWD accumulation on the backshore (Appendix C, Figure B-27).

Scoring of controlling factor metrics in MA-2 would improve by removing or maximizing light penetration under existing shade-causing structures, especially those that occur over or near eelgrass resources. One of the most obvious opportunities for improving scores in a number of metrics would be to minimize and remove shoreline armoring in this MA, especially since this is not a high wave energy area.

As well, EF scores are particularly high in MA-2 relative to the rest of Bainbridge Island as a result of the prevalence of documented forage-fish (herring, sandlance, and surf smelt) spawning areas (Table A-4, Figure B-11, Figures B-24, B-25, B-26, Appendix D). Current investigations of herring embryo mortality by WDFW may guide related management options in this MA in the future. Coho salmon are also documented to spawn in the single large tributary found within the bay (Coho Creek, WRIA 15.0319A), and efforts should be made to maximize functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats (Haring 2000). Eelgrass is abundant along the semi-protected shorelines of Port Madison, although the historic extent of eelgrass within the very protected confines of Port Madison Bay is unclear. Geoduck and clam resources are also abundant along this part of Bainbridge Island.

Individual Reaches within MA-2 (Figure B-27, Appendix C, Appendix D)

Reach 3193

- CF Rating = Moderate/High Impact; Normalized score = -0.622
- Most impacted CF metric: substrate type
- Least impacted CF metric: pollution
- Geomorphic class: Low Bank; Shoreline length: 1159 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 4.5%; Riparian zone land use: 8.5% TIA, 67.6% forested
- Total shoreline armoring: 87%; Total encroaching: 62.9%
- Total point modifications: 22; Density: 19/1000 ft; most common is stairs, with 4.3/1000 ft
- Other:
- EF Score: 22

Reach 3194

- CF Rating = Low Impact, Normalized score = -0.025
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, hydrology, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1218 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 9.4%; Riparian zone land use: 10.6% TIA, 50.1% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0
- Other:
- EF Score: 32

Reach 3195

- CF Rating = Low/Moderate Impact; Normalized score = -0.371
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: wave energy, natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 473 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 19.1% TIA, 14.2% forested
- Total shoreline armoring: 9.6%; Total encroaching: 0%
- Total point modifications: 5; Density: 10.6/1000 ft; most common is buoys, with 4.2/1000 ft
- Other:
- EF Score: 27

Reach 3196

- CF Rating = Moderate Impact; Normalized score = -0.486

- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 627 ft
- Sediment source: Backshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 13.2% TIA, 55.5% forested
- Total shoreline armoring: 35.7%; Total encroaching: 0%
- Total point modifications: 17; Density: 27.1/1000 ft; most common is buoys, with 14.4/1000 ft
- Other:
- EF Score: 30

Reach 3197
- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metrics: artificial shade, substrate type
- Least impacted CF metric: wave energy
- Geomorphic class: High Bluff; Shoreline length: 3344 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 43.7%; Riparian zone land use: 10.9% TIA, 66.9% forested
- Total shoreline armoring: 83.8%; Total encroaching: 0%
- Total point modifications: 77; Density: 23/1000 ft; most common is buoys, with 8.4/1000 ft
- Other: 4 marina(s) present
- EF Score: 21

Reach 3198
- CF Rating = Low/Moderate Impact; Normalized score = -0.375
- Most impacted CF metrics: artificial shade, substrate type
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1236 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 58.9%; Riparian zone land use: 12.3% TIA, 80.5% forested
- Total shoreline armoring: 48.3%; Total encroaching: 0%
- Total point modifications: 9; Density: 7.3/1000 ft; most common is pilings, with 1.6/1000 ft
- Other: 1 marina(s) present
- EF Score: 24

Reach 3199
- CF Rating = Moderate/High Impact; Normalized score = -0.625
- Most impacted CF metrics: artificial shade, substrate type
- Least impacted CF metric: wave energy
- Geomorphic class: High Bluff; Shoreline length: 1126 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 1.5%; Riparian zone land use: 8.5% TIA, 76.6% forested
- Total shoreline armoring: 78.3%; Total encroaching: 64.3%
- Total point modifications: 21; Density: 18.6/1000 ft; most common is buoys, with 5.3/1000 ft
- Other: 2 marina(s) present
- EF Score: 19

Reach 3200
- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: High Bluff; Shoreline length: 1338 ft

- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 25.8%; Riparian zone land use: 24.1% TIA, 67.8% forested
- Total shoreline armoring: 88.3%; Total encroaching: 88.3%
- Total point modifications: 20; Density: 15/1000 ft; most common is piers, with 4.5/1000 ft
- Other:
- EF Score: 18

Reach 3201
- CF Rating = Moderate Impact; Normalized score = -0.425
- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1302 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 34%; Riparian zone land use: 10.7% TIA, 82.6% forested
- Total shoreline armoring: 65%; Total encroaching: 3.6%
- Total point modifications: 27; Density: 20.7/1000 ft; most common is floating docks, with 5.4/1000 ft
- Other:
- EF Score: 19

Reach 3202
- CF Rating = Low/Moderate Impact; Normalized score = -0.325
- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 907 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 43.1%; Riparian zone land use: 15.3% TIA, 81.5% forested
- Total shoreline armoring: 43.5%; Total encroaching: 25.2%
- Total point modifications: 7; Density: 7.7/1000 ft; most common is railways, with 2.2/1000 ft
- Other:
- EF Score: 16

Reach 3203
- CF Rating = Low/Moderate Impact; Normalized score = -0.3
- Most impacted CF metrics: natural shade, artificial shade
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2168 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 20.6%; Riparian zone land use: 20.3% TIA, 56% forested
- Total shoreline armoring: 32.2%; Total encroaching: 2.6%
- Total point modifications: 27; Density: 12.5/1000 ft; most common is floating docks, with 4.2/1000 ft
- Other:
- EF Score: 16

Reach 3204
- CF Rating = Moderate Impact; Normalized score = -0.475
- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy
- Geomorphic class: Low Bank; Shoreline length: 2790 ft
- Sediment source: Don't Know; Wave exposure: very protected

- Overhanging vegetation: 33.6%; Riparian zone land use: 18.9% TIA, 59.2% forested
- Total shoreline armoring: 52%; Total encroaching: 50.8%
- Total point modifications: 55; Density: 19.7/1000 ft; most common is floating docks, with 5.7/1000 ft
- Other:
- EF Score: 18

Reach 3205

- CF Rating = Moderate/High Impact; Normalized score = -0.65
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 864 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 10.9%; Riparian zone land use: 25.2% TIA, 33% forested
- Total shoreline armoring: 87.4%; Total encroaching: 74.3%
- Total point modifications: 16; Density: 18.5/1000 ft; most common is stairs, with 3.5/1000 ft
- Other:
- EF Score: 16

Reach 3206

- CF Rating = Moderate/High Impact; Normalized score = -0.65
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: Low Bank; Shoreline length: 298 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 29.7%; Riparian zone land use: 18% TIA, 69.9% forested
- Total shoreline armoring: 98.6%; Total encroaching: 98.6%
- Total point modifications: 16; Density: 53.7/1000 ft; most common is buoys, with 20.2/1000 ft
- Other: 1 marina(s) present
- EF Score: 16

Reach 3207

- CF Rating = Moderate Impact; Normalized score = -0.5
- Most impacted CF metrics: natural shade, substrate type
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 875 ft
- Sediment source: Unknown; Wave exposure: very protected
- Overhanging vegetation: 13.8%; Riparian zone land use: 16.7% TIA, 47.8% forested
- Total shoreline armoring: 66.2%; Total encroaching: 17.6%
- Total point modifications: 10; Density: 11.4/1000 ft; most common is upland structures at waterline, with 2.3/1000 ft
- Other: Treasure Island
- EF Score: 20

Reach 3208

- CF Rating = Low/Moderate Impact; Normalized score = -0.25
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1275 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 38.4%; Riparian zone land use: 12.2% TIA, 71.4% forested

- Total shoreline armoring: 25.3%; Total encroaching: 15%
- Total point modifications: 5; Density: 3.9/1000 ft; most common is overwater structures, with 0.8/1000 ft
- Other: includes pier which serves as access to island
- EF Score: 20

Reach 3209
- CF Rating = Moderate Impact; Normalized score = -0.425
- Most impacted CF metrics: natural shade, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1940 ft
- Sediment source: Don't Know; Wave exposure: very protected
- Overhanging vegetation: 20.2%; Riparian zone land use: 16.4% TIA, 59.7% forested
- Total shoreline armoring: 61%; Total encroaching: 51.2%
- Total point modifications: 5; Density: 2.6/1000 ft; most common is floating docks, with 1/1000 ft
- Other:
- EF Score: 18

Reach 3210
- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: Low Bank; Shoreline length: 950 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 16.7%; Riparian zone land use: 25.2% TIA, 33.2% forested
- Total shoreline armoring: 93.5%; Total encroaching: 85.4%
- Total point modifications: 17; Density: 17.9/1000 ft; most common is buoys, with 7.4/1000 ft
- Other:
- EF Score: 18

Reach 3211
- CF Rating = Low/Moderate Impact; Normalized score = -0.375
- Most impacted CF metrics: wave energy, artificial shade, substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 838 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 16.1%; Riparian zone land use: 11.4% TIA, 53.8% forested
- Total shoreline armoring: 43.7%; Total encroaching: 0%
- Total point modifications: 7; Density: 8.4/1000 ft; most common is stairs, with 2.4/1000 ft
- Other:
- EF Score: 20

Reach 3212
- CF Rating = Moderate Impact; Normalized score = -0.525
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2098 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 19.8% TIA, 51.6% forested
- Total shoreline armoring: 90.4%; Total encroaching: 28%
- Total point modifications: 34; Density: 16.2/1000 ft; most common is piers, with 2.9/1000 ft

- Other:
- EF Score: 30

Reach 3213
- CF Rating = Low/Moderate Impact; Normalized score = -0.356
- Most impacted CF metric: sediment supply
- Least impacted CF metric: pollution
- Geomorphic class: High Bluff; Shoreline length: 2010 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 64.3%; Riparian zone land use: 6.1% TIA, 84.4% forested
- Total shoreline armoring: 37.1%; Total encroaching: 37.1%
- Total point modifications: 6; Density: 3/1000 ft; most common is stairs, with 0.5/1000 ft
- Other:
- EF Score: 36

Reach 3214
- CF Rating = Low/Moderate Impact; Normalized score = -0.35
- Most impacted CF metrics: wave energy, artificial shade, sediment supply, substrate type, pollution, physical disturbance
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 686 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 17.9%; Riparian zone land use: 14% TIA, 80.7% forested
- Total shoreline armoring: 14.2%; Total encroaching: 0%
- Total point modifications: 6; Density: 8.7/1000 ft; most common is floating docks, with 2.9/1000 ft
- Other: encompasses Bloedel Reserve
- EF Score: 32

Reach 3215
- CF Rating = Moderate/High Impact; Normalized score = -0.622
- Most impacted CF metric: depth/slope
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1507 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 12.8%; Riparian zone land use: 11.2% TIA, 76.7% forested
- Total shoreline armoring: 98.8%; Total encroaching: 98.8%
- Total point modifications: 17; Density: 11.3/1000 ft; most common is stairs, with 6/1000 ft
- Other:
- EF Score: 34

Reach 3216
- CF Rating = Moderate/High Impact; Normalized score = -0.667
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: pollution
- Geomorphic class: High Bluff; Shoreline length: 1009 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 23.5%; Riparian zone land use: 5.4% TIA, 92.9% forested
- Total shoreline armoring: 91.6%; Total encroaching: 82.9%
- Total point modifications: 19; Density: 18.8/1000 ft; most common is stairs, with 5.9/1000 ft
- Other:
- EF Score: 32

3.2.3 Rolling Bay-Point Monroe Management Area (MA-3) (Reaches 3176 – 3192, plus Reach 6002)

Qualitative Rating = Moderate Impact
Mean CF Score (Normalized) = -0.42 (Range: -0.8 to -0.13)
Median CF Score (Normalized) = -0.43
Number of Reaches = 18

Mean EF Score = 22.7 (Range: 18 to 26)
Median EF Score = 23.5

Description
Rolling Bay-Point Monroe (MA-3) comprises 29,707 ft of shoreline that encompasses Point Monroe, Point Monroe Lagoon, as well as Rolling Bay to Skiff Point (Table A-1, Figure 2). Rolling Bay-Point Monroe (MA-3) comprises 18 reaches broken into the following categories: high bluff (11), spit/backshore (5), low bank (1), and a large marsh/lagoon (1) (Figure B-28). Much of MA-3 contains extensive tideflats. MA-3 is defined by two drift cells that converge at Point Monroe (Figure 3). The smaller drift cell begins at a divergence zone located on the eastern shore of Port Madison and moves southeast into Point Monroe Lagoon; high bluffs on the landward margin of the lagoon have exhibited some recent instability. The larger second cell begins to the south at a divergence zone located near Skiff Point, with northerly alongshore drift that terminates at the end of Point Monroe. Relative to wave exposure, shorelines along the eastern shore facing Puget Sound are considered “semi-protected,” with “very protected” shorelines within Point Monroe Lagoon (Figure B29). MA-3 receives most upland flows from Dripping Water Creek (WRIA 15.0320) and unnumbered 28, which drain upland areas with low levels of land use (1% TIA).

Overhanging riparian vegetation covers approximately 29% of the MA-3 shoreline (Table A-1, Figure B-34). However, within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 57% of land cover (Figure B-33). Impervious surfaces (e.g., roads, roofs) represent 17% of the riparian zone land cover.

Shoreline development in MA-3 is primarily residential in nature. Many of the homes built along the spit at Point Monroe are built on fill that directly abuts the shoreline, where encroachment is likely underestimated. However, MA-3 shorelines also include Fay Bainbridge State park, which is a stretch of relatively undeveloped sandy beach with shoreline access for recreation. Approximately 38% of shoreline is modified by armoring and 27% of the shoreline has armoring that encroaches into the intertidal zone (Table A-1, Figure B-30).

A total of 291 point modifications were recorded along MA-3 shorelines, at an average of 10 modifications per 1000 ft (Table A-1, Figure B-31). Most of these modifications are structures at the waterline (112), as well as docks (33) and overwater structures (28). A total of 8 outfalls were also recorded in MA-3.

Limiting Factors
The average normalized CF score within MA-3 was -0.42, within the middle range of MA scores on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). The wave-energy metric for MA-3 scored particularly low (poor) relative to all other MAs (Table A-3, Figure B-16). Low (poor) wave-energy scores were influenced not only by extent of shoreline armoring within each reach, but also by the

prevalence of vertical concrete-type bulkheads that encroached into the intertidal zone along shorelines with higher wave exposure.

Conversely, the artificial shade and hydrology metrics in MA-3 scored high (good) relative to other MAs (Table A-3, Figure B-16). Artificial shade scores were high (good) primarily because of the low density of shading structures, such as docks and piers, present along MA-3 shorelines. In part, the poor shoreline access (high bluffs) and higher relative wave exposure of this MA is not conducive to mooring and accessing boats. The only multi-boat pier (marina) along this stretch of shoreline was located in the lagoon behind Point Monroe (Figure B-32). Hydrology scores were also relatively high (good), despite the influence of impaired tidal hydrology as a result of armoring encroachment. Much of this can be attributed to low TIA (17%) within the marine riparian zone, the lack of artificial tidal constrictions along the shoreline, and relatively low density of outfalls.

Two of the most highly affected high-bluff reaches on Bainbridge Island (Reaches 3177 and 3178) are located within Rolling Bay (MA-3) (Figure B-38). These reaches are feeder bluffs (at least historically); however, each has homes and bulkheads built at the base of the bluffs, with high rates of armoring (>90%), high densities of point modifications, no overhanging riparian vegetation, and a relatively high %TIA in marine riparian zone.

<u>Opportunities</u>
One of the least-impacted spit/barrier/backshore reaches on Bainbridge Island (Reach 3186) encompasses Fay Bainbridge State Park, which has no linear or point modifications along the shoreline, low backshore/dune or riparian vegetation, and LWD accumulation on the backshore (Figure B-38).

The most obvious opportunities for improving scoring of controlling factors metrics include removal or modification of unnecessary armoring structures, especially those that encroach into the intertidal zone. These actions may reduce reflective wave energy, allow resumption of natural sediment processes, preserve intertidal and subtidal vegetated habitats such as eelgrass, and enhance forage-fish spawning functions (Figure B-14).

The EF scores were moderate-to-high in MA-3 relative to the rest of Bainbridge Island (Table A-4, Figure B-11, Appendix D) because of the prevalence of documented herring and sandlance spawning areas, principally in the northern region near Point Monroe (Figure B-34). Cutthroat trout are also documented to spawn in Dripping Water Creek (WRIA 15.0320), and efforts should be made to maximize functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats. Continuous-to-patchy eelgrass beds are found along much of the shoreline, as are geoduck resources (Figures B-35, B-37).

<u>Individual Reaches within MA-3</u> (Figure B-38, Appendix C, Appendix D)

Reach 3176
- CF Rating = Moderate Impact; Normalized score = -0.467
- Most impacted CF metric: pollution
- Least impacted CF metric: hydrology
- Geomorphic class: High Bluff; Shoreline length: 427 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 12.3%; Riparian zone land use: 22.6% TIA, 34.1% forested
- Total shoreline armoring: 52.2%; Total encroaching: 0%
- Total point modifications: 2; Density: 4.7/1000 ft; most common is upland structures at waterline, with 2.3/1000 ft
- Other: shellfish closure present
- EF Score: 20

Reach 3177

- CF Rating = Moderate/High Impact, Normalized score = -0.8
- Most impacted CF metrics: wave energy, natural shade, substrate type, depth/slope, pollution
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1311 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 39.2% TIA, 36.8% forested
- Total shoreline armoring: 89.1%; Total encroaching: 89.1%
- Total point modifications: 24; Density: 18.3/1000 ft; most common is upland structures at waterline, with 12.2/1000 ft
- Other: shellfish closure present
- EF Score: 18

Reach 3178

- CF Rating = Moderate/High Impact, Normalized score = -0.756
- Most impacted CF metrics: wave energy, natural shade, sediment supply, depth/slope, pollution
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 852 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 25.4% TIA, 48.3% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 6; Density: 7/1000 ft; most common is upland structures at waterline, with 2.3/1000 ft
- Other: shellfish closure present
- EF Score: 20

Reach 3179

- CF Rating = Low Impact, Normalized score = -0.178
- Most impacted CF metric: sediment supply
- Least impacted CF metric: natural shade, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 5675 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 81.4%; Riparian zone land use: 13.6% TIA, 81.8% forested
- Total shoreline armoring: 26.5%; Total encroaching: 18.4%
- Total point modifications: 10; Density: 1.8/1000 ft; most common is upland structures at waterline, with 0.7/1000 ft
- Other:
- EF Score: 25

Reach 3180

- CF Rating = Low/Moderate Impact; Normalized score = -0.4
- Most impacted CF metrics: natural shade, sediment supply
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 905 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 8%; Riparian zone land use: 14.1% TIA, 74.3% forested
- Total shoreline armoring: 34.2%; Total encroaching: 34.2%
- Total point modifications: 1; Density: 1.1/1000 ft; most common is outfalls, with 1.1/1000 ft
- Other:
- EF Score: 22

Reach 3181
- CF Rating = Moderate Impact; Normalized score = -0.578
- Most impacted CF metrics: wave energy, depth/slope
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 583 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 10.7%; Riparian zone land use: 36.6% TIA, 44.5% forested
- Total shoreline armoring: 99.9%; Total encroaching: 99.9%
- Total point modifications: 3; Density: 5.1/1000 ft; most common is upland structures at waterline, with 5.1/1000 ft
- Other:
- EF Score: 23

Reach 3182
- CF Rating = Low/Moderate Impact; Normalized score = -0.325
- Most impacted CF metrics: wave energy, sediment supply, depth/slope
- Least impacted CF metric: natural shade, artificial shade, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 944 ft
- Sediment source: Foreshore; Wave exposure: semi-protected
- Overhanging vegetation: 6.6%; Riparian zone land use: 29.2% TIA, 51.3% forested
- Total shoreline armoring: 42.8%; Total encroaching: 42.8%
- Total point modifications: 3; Density: 3.2/1000 ft; most common is upland structures at waterline, with 1.1/1000 ft
- Other:
- EF Score: 22

Reach 3183
- CF Rating = Moderate Impact; Normalized score = -0.533
- Most impacted CF metrics: wave energy, sediment supply
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 616 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 11.6%; Riparian zone land use: 19.4% TIA, 65.8% forested
- Total shoreline armoring: 68.8%; Total encroaching: 63.8%
- Total point modifications: 4; Density: 6.5/1000 ft; most common is upland structures at waterline, with 4.9/1000 ft
- Other:
- EF Score: 21

Reach 3184
- CF Rating = Moderate Impact; Normalized score = -0.511
- Most impacted CF metrics: sediment supply, depth/slope
- Least impacted CF metric: artificial shade, pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 2485 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 17%; Riparian zone land use: 7.6% TIA, 64.8% forested
- Total shoreline armoring: 66.4%; Total encroaching: 66.4%
- Total point modifications: 1; Density: 0.4/1000 ft; most common is stairs, with 0.4/1000 ft
- Other:
- EF Score: 24

Reach 3185
- CF Rating = Low Impact, Normalized score = -0.178
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, sediment supply, substrate type, depth/slope, hydrology
- Geomorphic class: High Bluff; Shoreline length: 915 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 9.2%; Riparian zone land use: 22.3% TIA, 47% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 4; Density: 4.4/1000 ft; most common is buoys, with 2.2/1000 ft
- Other: LWD on beach backshore
- EF Score: 25

Reach 3186
- CF Rating = Low Impact, Normalized score = -0.125
- Most impacted CF metrics: artificial shade, physical disturbance
- Least impacted CF metric: wave energy, natural shade, sediment supply, substrate type, depth/slope, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2782 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 20.8% TIA, 35.6% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 12; Density: 4.3/1000 ft; most common is upland structures at waterline, with 2.5/1000 ft
- Other: borders Fay Bainbridge State Park,
- EF Score: 24

Reach 3187
- CF Rating = Low/Moderate Impact, Normalized score = -0.225
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: natural shade, artificial shade, pollution, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 712 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 1.7% TIA, 0% forested
- Total shoreline armoring: 13.7%; Total encroaching: 0%
- Total point modifications: 3; Density: 4.2/1000 ft; most common is upland structures at waterline, with 2.8/1000 ft
- Other: Fay Bainbridge State Park, backshore dunes and LWD
- EF Score: 20

Reach 3188
- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1711 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 30.6% TIA, 0% forested
- Total shoreline armoring: 87.4%; Total encroaching: 66.5%
- Total point modifications: 47; Density: 27.5/1000 ft; most common is upland structures at waterline, with 17.5/1000 ft
- Other: Point Monroe

- EF Score: 26

Reach 3189

- CF Rating = Low/Moderate Impact; Normalized score = -0.325
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1764 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 26% TIA, 1.2% forested
- Total shoreline armoring: 15.5%; Total encroaching: 7%
- Total point modifications: 17; Density: 9.6/1000 ft; most common is buoys, with 5.1/1000 ft
- Other: outer half of Point Monroe
- EF Score: 24

Reach 3190

- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metrics: natural shade, physical disturbance
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 3447 ft
- Sediment source: Unknown; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 29.2% TIA, 2.3% forested
- Total shoreline armoring: 36.6%; Total encroaching: 0%
- Total point modifications: 109; Density: 31.6/1000 ft; most common is upland structures at waterline, with 9.3/1000 ft
- Other: 1 marina(s) present; inside of Point Monroe, encroachment likely underestimated
- EF Score: 22

Reach 6002

- CF Rating = Low/Moderate Impact, Normalized score = -0.225
- Most impacted CF metrics: artificial shade, substrate type
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: High Bluff; Shoreline length: 1976 ft
- Sediment source: Unknown; Wave exposure: very protected
- Overhanging vegetation: 92.7%; Riparian zone land use: 2.8% TIA, 82.9% forested
- Total shoreline armoring: 8.3%; Total encroaching: 0%
- Total point modifications: 16; Density: 8.1/1000 ft; most common is floating docks, with 3/1000 ft
- Other: High bluffs inside Point Monroe
- EF Score: 24

Reach 3191

- CF Rating = Moderate Impact; Normalized score = -0.467
- Most impacted CF metric: substrate type
- Least impacted CF metric: pollution, hydrology
- Geomorphic class: Low Bank; Shoreline length: 1432 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 29.8%; Riparian zone land use: 6.3% TIA, 71.7% forested
- Total shoreline armoring: 36.3%; Total encroaching: 8%
- Total point modifications: 21; Density: 14.7/1000 ft; most common is piers, with 2.1/1000 ft
- Other: broad beach in shallow bay
- EF Score: 24

Reach 3192

- CF Rating = Low/Moderate Impact; Normalized score = -0.289
- Most impacted CF metrics: sediment supply, substrate type
- Least impacted CF metric: hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1168 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 66.2%; Riparian zone land use: 16.3% TIA, 61.7% forested
- Total shoreline armoring: 39.7%; Total encroaching: 17.6%
- Total point modifications: 8; Density: 6.9/1000 ft; most common is stairs, with 2.6/1000 ft
- Other:
- EF Score: 24

3.2.4 Murden Cove Management Area (MA-4) (Reaches 3156 – 3175)

Qualitative Rating = Low/Moderate Impact
Mean CF Score (Normalized) = -0.33 (Range: -0.64 to 0.00)
Median CF Score (Normalized) = -0.34
Number of Reaches = 20

Mean EF Score = 20.2 (Range: 13 to 26)
Median EF Score = 20.5

Description

Murden Cove (MA-4) comprises 28,843 ft of shoreline that encompasses all of Murden Cove, as well as Yeomalt Point and part of Wing Point (Table A-1, Figure 2). Murden Cove comprises 20 reaches broken into the following categories: high bluff (11), spit/backshore (6), marsh/lagoon (2), and low bank (1) (Figure B-39). Most of MA-4 also contains extensive tideflats. MA-4 is defined by two drift cells that converge at the head of Murden Cove, forming the Murden Cove Creek subestuary (a spit and marsh/lagoon area) that lacks appreciable alongshore drift (Figure 3). The northern end of the first drift cell begins at a divergence zone located at Skiff Point and moves south into Murden Cove, encompassing high feeder bluffs south of Skiff Point. The second cell begins to the south at a divergence zone located near Wing Point and moves in a northerly direction, encompassing a number of feeder bluff areas below Yeomalt Point and southern Murden Cove (Figure B-40). Relative to wave exposure, almost all shorelines along the eastern shore facing Puget Sound are considered “semi-protected,” with a small stretch of “protected” and “very protected” shorelines within Murden Cove (Figure B-40). Murden Cove receives upland flows from Murden Cove Creek (WRIA 15.0321), which drains upland areas with low-to-moderate levels of land use (6% TIA), as well as a number of small coastal streams.

Overhanging riparian vegetation covers approximately 36% of the MA-4 shoreline, tying it with MA-1 for the highest value observed of any MA (Table A-1, Figure B-45). Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 58% of land cover (Figure B-44). Impervious surfaces (e.g., roads, roofs) represent 18% of the riparian zone land cover.

Shoreline development in MA-4 is primarily residential in nature, with some shoreline backed by public roads. Only 34% of the shoreline is modified by armoring and 19% of the shoreline has armoring that encroaches into the intertidal zone, both values that compare favorably with all other MAs on Bainbridge Island (Table A-1, Figure B-41). Most of the homes along this stretch of shoreline are built on the high bluffs, which generally make the shoreline inaccessible; armoring is generally composed of rip-rap at the toe of bluffs.

A total of 86 point modifications were recorded along MA-4 shorelines (unpublished data, COBI 2002), at an average of three modifications per 1000 ft, by far the lowest density of all MAs on the Island (Table A-1, Figure B-42). Most of these modifications are stairs (29) and structures at the waterline (14). A total of 10 outfalls were also recorded along MA-4 shorelines.

Limiting Factors

The average normalized CF score within MA-4 was -0.33, the second highest (best) MA score on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). MA-4 had no particularly low (poor) scores relative to other MAs, but rather, had among the highest (best) scores in four metric categories: artificial shade, substrate type, depth/slope, and physical disturbance (Table A-3, Figure B-16). Artificial shade scores rated well primarily because of the low density of shading structures, such as docks and piers, along MA-4 shorelines. As was seen in MA-3, poor shoreline access (predominance of high bluffs and extensive tide flats) and higher relative wave exposure of this MA is not conducive to mooring and accessing boats. In addition, no marinas or multi-boat piers were documented along this stretch of shoreline (Figure B-43). Substrate type and depth/slope scores were also good because the percentage of shoreline armoring was fairly low in this MA. As well, the substrate metric reflected the relatively low density of point modifications, whereas depth-slope reflected the lack of dredging activity and moderately low level of armoring encroachment. Finally, physical disturbance scores were high (good) primarily because of the low-density residential setting, high-forested cover in the marine riparian zone, and low number of docks, mooring buoys, and ramp densities of most reaches.

Opportunities

Murden Cove (MA-4) encompasses one of the least-altered high bluff reaches (Reach 3165) and two of the least-altered marsh/lagoon reaches (Reaches 3170 and 3171) on Bainbridge Island (Figure B-49, Appendix C). Reach 3165 is a feeder bluff, with downed trees at the based of the bluffs, high forest cover in the landward riparian zone, and no linear or point modifications along shoreline. Reaches 3170 and 3171 are located near the outlet of Murden Cove Creek and have abundant LWD accumulation, intact tidal flats, abundant overhanging and marsh vegetation, and no point or linear modifications along the shoreline.

At an MA level, the most obvious opportunities for improving scoring would be to enhance processes and functions at reaches with particularly low (poor) scores (Figure B-14). This may include targeting removal of encroaching armoring structures in front of feeder bluffs or backshore sediment sources to allow natural sediment processes, modifying or softening armoring structures in front of roads, and removal of constrictions to remnant tidal marshes in Reach 3173 (Figure B-49). Additionally, historic maps and photographs show an extensive backshore marsh along Manitou Beach, which is now fragmented and impacted by development (Peter Namtvedt Best, personal communications). Restoring and reconnecting this marsh to Murden Cove would provide additional functional benefit.

The EF scores were moderate in MA-4 relative to the rest of Bainbridge Island (Figure B-11, Appendix D). There are some small documented areas of surf smelt and sandlance spawning (Figure B-47). Cutthroat trout, coho, and chum salmon are also documented to spawn in Murden Cove Creek (WRIA 15.0321) (Haring 2000), and efforts should be made to preserve spawning access and functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats. Continuous-to-patchy eelgrass beds are found in parts of Murden Cove, and geoduck resources are abundant throughout the MA (Figure B-46 and B-48).

Individual Reaches within MA-4 (Figure B-49, Appendix C, Appendix D)

Reach 3156

- CF Rating = Moderate/High Impact; Normalized score = -0.622

- Most impacted CF metrics: natural shade, depth/slope, pollution
- Least impacted CF metric: artificial shade
- Geomorphic class: High Bluff; Shoreline length: 267 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 14.8% TIA, 39.3% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 0
- Other: shellfish closure present; Wing Point
- EF Score: 18

Reach 3157

- CF Rating = Moderate Impact; Normalized score = -0.422
- Most impacted CF metrics: natural shade, pollution
- Least impacted CF metric: artificial shade, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 717 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 27.2% TIA, 43.7% forested
- Total shoreline armoring: 37%; Total encroaching: 14.5%
- Total point modifications: 4; Density: 5.6/1000 ft; most common is stairs, with 5.6/1000 ft
- Other: shellfish closure present; broad backshore with LWD recruitment
- EF Score: 18

Reach 3158

- CF Rating = Low/Moderate Impact; Normalized score = -0.311
- Most impacted CF metric: pollution
- Least impacted CF metric: hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 3639 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 57.3%; Riparian zone land use: 17.2% TIA, 59.5% forested
- Total shoreline armoring: 17.2%; Total encroaching: 13.1%
- Total point modifications: 12; Density: 3.3/1000 ft; most common is stairs, with 2.2/1000 ft
- Other: shellfish closure present; LWD recruitment on beach from bluffs
- EF Score: 26

Reach 3159

- CF Rating = Low Impact, Normalized score = -0.133
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, artificial shade, sediment supply, depth/slope, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 387 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 6.3%; Riparian zone land use: 13.3% TIA, 61% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 2; Density: 5.2/1000 ft; most common is upland structures at waterline, with 5.2/1000 ft
- Other:
- EF Score: 24

Reach 3160

- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metric: depth/slope

- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 287 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 44% TIA, 9.6% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 1; Density: 3.5/1000 ft; most common is boat ramps, with 3.5/1000 ft
- Other:
- EF Score: 26

Reach 3161
- CF Rating = Low/Moderate Impact; Normalized score = -0.325
- Most impacted CF metrics: wave energy, artificial shade, substrate type, pollution, physical disturbance
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2013 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 10.5%; Riparian zone land use: 38% TIA, 25% forested
- Total shoreline armoring: 14.3%; Total encroaching: 3.1%
- Total point modifications: 16; Density: 7.9/1000 ft; most common is upland structures at waterline, with 2/1000 ft
- Other:
- EF Score: 20

Reach 3162
- CF Rating = Low/Moderate Impact; Normalized score = -0.244
- Most impacted CF metric: sediment supply
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1980 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 47.6%; Riparian zone land use: 11.2% TIA, 66.2% forested
- Total shoreline armoring: 22.8%; Total encroaching: 14.6%
- Total point modifications: 4; Density: 2/1000 ft; most common is stairs, with 1/1000 ft
- Other:
- EF Score: 24

Reach 3163
- CF Rating = Moderate Impact; Normalized score = -0.578
- Most impacted CF metric: sediment supply
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1730 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 13.6%; Riparian zone land use: 18.6% TIA, 59.4% forested
- Total shoreline armoring: 86.5%; Total encroaching: 39.5%
- Total point modifications: 10; Density: 5.8/1000 ft; most common is outfalls, with 2.3/1000 ft
- Other:
- EF Score: 22

Reach 3164
- CF Rating = Low/Moderate Impact; Normalized score = -0.356
- Most impacted CF metric: sediment supply
- Least impacted CF metric: pollution, physical disturbance

- Geomorphic class: High Bluff; Shoreline length: 1208 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 77.8%; Riparian zone land use: 5.6% TIA, 76.5% forested
- Total shoreline armoring: 57%; Total encroaching: 51.9%
- Total point modifications: 7; Density: 5.8/1000 ft; most common is stairs, with 3.3/1000 ft
- Other:
- EF Score: 26

Reach 3165
- CF Rating = Low Impact, Normalized score = -0.067
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, artificial shade, sediment supply, substrate type, depth/slope, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 182 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 43.8%; Riparian zone land use: 18.2% TIA, 66.2% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0
- Other:
- EF Score: 22

Reach 3166
- CF Rating = Moderate; Normalized score = -0.467
- Most impacted CF metrics: sediment supply, depth/slope
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1434 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 67%; Riparian zone land use: 13.7% TIA, 66% forested
- Total shoreline armoring: 89.1%; Total encroaching: 89.1%
- Total point modifications: 3; Density: 2.1/1000 ft; most common is pilings, with 2.1/1000 ft
- Other:
- EF Score: 22

Reach 3167
- CF Rating = Moderate/High Impact; Normalized score = -0.644
- Most impacted CF metrics: substrate type, depth/slope
- Least impacted CF metric: pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 636 ft
- Sediment source: Backshore; Wave exposure: semi-protected
- Overhanging vegetation: 14.2%; Riparian zone land use: 15.5% TIA, 53.6% forested
- Total shoreline armoring: 100%; Total encroaching: 72.4%
- Total point modifications: 10; Density: 15.7/1000 ft; most common is upland structures at waterline, with 3.1/1000 ft
- Other: large shallow tide flats
- EF Score: 14

Reach 3168
- CF Rating = Moderate Impact; Normalized score = -0.425
- Most impacted CF metrics: wave energy, sediment supply, substrate type
- Least impacted CF metric: natural shade, artificial shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 438 ft

- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 17.5% TIA, 58.2% forested
- Total shoreline armoring: 78.6%; Total encroaching: 19.9%
- Total point modifications: 3; Density: 6.9/1000 ft; most common is boat ramps, with 4.6/1000 ft
- Other:
- EF Score: 13

Reach 3169
- CF Rating = Low Impact, Normalized score = -0.125
- Most impacted CF metric: wave energy
- Least impacted CF metric: natural shade, artificial shade, pollution, hydrology, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1483 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 7.2% TIA, 80.8% forested
- Total shoreline armoring: 4.8%; Total encroaching: 0%
- Total point modifications: 0
- Other: LWD accumulation on spit
- EF Score: 16

Reach 3170
- CF Rating = Low Impact, Normalized score = -0.05
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, artificial shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 760 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 56.3%; Riparian zone land use: 5.3% TIA, 88.3% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0
- Other:
- EF Score: 21

Reach 3171
- CF Rating = No Impact, Normalized score = 0
- Most impacted CF metrics:
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 3929 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 95.7%; Riparian zone land use: 5% TIA, 88.4% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 2; Density: 0.5/1000 ft; most common is outfalls, with 0.3/1000 ft
- Other:
- EF Score: 24

Reach 3172
- CF Rating = Low/Moderate Impact, Normalized score = -0.222
- Most impacted CF metric: natural shade
- Least impacted CF metric: artificial shade, hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 1173 ft
- Sediment source: Alongshore; Wave exposure: protected

- Overhanging vegetation: 4%; Riparian zone land use: 10.2% TIA, 54.8% forested
- Total shoreline armoring: 6.7%; Total encroaching: 0%
- Total point modifications: 1; Density: 0.9/1000 ft; most common is upland structures at waterline, with 0.9/1000 ft
- Other: small shallow embayment
- EF Score: 17

Reach 3173

- CF Rating = Low Impact, Normalized score = -0.175
- Most impacted CF metric: hydrology
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2150 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 10.8% TIA, 50.3% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 2; Density: 0.9/1000 ft; most common is outfalls, with 0.9/1000 ft
- Other: tidal constriction (culvert) to remnant tidal marsh; backshore is taken up by road, LWD recruitment along entire shoreline
- EF Score: 16

Reach 3174

- CF Rating = Moderate Impact; Normalized score = -0.5
- Most impacted CF metric: sediment supply
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1632 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 1.5%; Riparian zone land use: 37% TIA, 29.2% forested
- Total shoreline armoring: 80.3%; Total encroaching: 6.4%
- Total point modifications: 4; Density: 2.5/1000 ft; most common is overwater structures, with 0.6/1000 ft
- Other: backshore dominated by road, LWD recruitment good
- EF Score: 17

Reach 3175

- CF Rating = Moderate Impact; Normalized score = -0.422
- Most impacted CF metric: pollution
- Least impacted CF metric: artificial shade, hydrology
- Geomorphic class: High Bluff; Shoreline length: 2799 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 22.4%; Riparian zone land use: 31.7% TIA, 35.3% forested
- Total shoreline armoring: 60.5%; Total encroaching: 24.7%
- Total point modifications: 5; Density: 1.8/1000 ft; most common is pilings, with 1.4/1000 ft
- Other: shellfish closure present
- EF Score: 18

3.2.5 Eagle Harbor Management Area (MA-5) (Reaches 3121 – 3155)

Qualitative Rating = Moderate/High Impact
Mean CF Score (Normalized) = -0.56 (Range: -0.87 to -0.25)
Median CF Score (Normalized) = -0.58
Number of Reaches = 35

Mean EF Score = 17.9 (Range: 12 to 24)
Median EF Score = 18

Description
Eagle Harbor (MA-5) comprises 46,054 ft of shoreline that encompasses all of Rockaway Beach and Eagle Harbor, including all of Bill Point and part of Wing Point (Table A-1, Figure 2). This diverse MA comprises 35 reaches broken into the following categories: marsh/lagoon (10), spit/backshore (8), low bank (8), and high bluff (4) (Figure B-39). MA-5 is defined by three major drift cells (Figure 3). Two of them begin at the outer margins of Eagle Harbor (Wing Point and Bill Point) and move westward, terminating in the middle of Eagle Harbor, an area that lacks appreciable alongshore drift. The third drift cell begins at a divergence zone located just to the north of Blakely Harbor and moves north along Rockaway beach to Bill Point. Relative to wave exposure, all shorelines along the eastern shore, facing Puget Sound, are considered "semi-protected," whereas the inner portion of Eagle Harbor is considered "very protected"(Figure B-40)). Eagle Harbor receives upland flows from six watersheds with moderate-to-high levels of land use: WRIA 15.0330 (TIA 3%), WRIA 15.0329 (TIA 4%), Sportsman's Club Pond Creek (WRIA 15.0325; TIA 10%), WRIA unnumbered 48 (TIA 60%), Ravine Creek (WRIA 15.0324; TIA 40%), and WRIA unnumbered 22 (TIA 18%).

Overhanging riparian vegetation covers approximately 23% of the MA-5 shoreline, among the lowest values for this characteristic among MAs on Bainbridge Island (Table A-1, Figure B-45). Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose only 36% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent 45% of land cover (Figure B-44). Eagle Harbor was the only MA on Bainbridge Island where the %TIA exceeded the percentage of natural vegetation in the marine riparian zone.

Eagle Harbor (MA-5) is the commercial and industrial heart of Bainbridge Island, and includes the City's downtown, a Washington State Ferry terminal and repair facility, multiple commercial marinas, and a Superfund site at Bill Point, throughout portions of the outer harbor, and at the mouth of the Ravine Creek. There is also the City's Waterfront Park in Eagle Harbor that provides shoreline access, boat launch facilities, and visitor moorage (Figure B-43). The remainder of MA-5 shoreline has typical single-family residential development, with some shoreline backed by public roads. Almost 53% of the shoreline is modified by armoring and 30% of the shoreline has armoring that encroaches into the intertidal zone, high values when compared with all other MAs on Bainbridge Island (Table A-1, Figure B-41).

A total of 506 point modifications were recorded along MA-5 shorelines, at an average of 11 modifications per 1000 ft (Table A-1, Figure B-42). Most of these modifications are associated with boat facilities, including pilings (89), moored boats (78), mooring buoys (66), and docks (60). At least 17 marinas, defined as a dock with more than five mooring slips, were present along the shoreline of MA-5. A total of 38 outfalls were also recorded along MA-5 shorelines.

Limiting Factors
The average normalized CF score within MA-5 was -0.56, the lowest (worst) MA score on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). Eagle Harbor (MA-5) had among the lowest (poorest)

scores of all MAs in four of the nine metrics: depth slope, pollution, hydrology, and physical disturbance; no metrics placed among the high (good) scores (Table A-3, Figure B-16). Depth and slope scores were low (poor), in part, because dredging activity occurred in at least seven reaches within the MA. As well, depth and slope scores reflected the relatively high rate of armoring encroachment (30%) along Eagle Harbor shorelines. Pollution scores were low (poor) in MA-5 because of recreational shellfish closures/warnings throughout all reaches in and around Eagle Harbor from contaminated runoff, marinas, the Eagle Harbor/Wyckoff Superfund Site, and the sewage treatment plant outfall at Wing Point. High %TIA in the marine riparian zone (45%), high outfall densities, and impaired tidal hydrology due to the high rate of armoring encroachment influenced the low (poor) hydrology metric score. Finally, physical disturbance scores were low (poor) primarily because of the "urban" setting (ferry activity) of some reaches, low forested cover in the marine riparian zone (36%), and relatively high number of docks, mooring buoys, and ramp densities within most reaches.

Some of the most highly impacted reaches on Bainbridge Island were located in Eagle Harbor (MA-5), including reaches 3131, 3141, 3143, and 3144 as well as reaches 3125 and 3126 associated with the Eagle Harbor/Wyckoff Superfund site on Bill Point (Figure B-49, Appendix C). In all cases, these reaches were characterized by exceptional amounts of fill and armoring, most of which encroached into the intertidal zone, high levels of point modifications, including docks and piers, and a high %TIA in the marine riparian zone.

Opportunities

Numerous opportunities exist for improving scoring of CF metrics at the individual reach level and perhaps on a sub area basis within MA-5, although the net improvement to the entire Eagle Harbor MA would likely be a significant challenge considering the current level of alterations (Figure B-14). The best opportunities for improvement should be sought before opportunities are lost or significantly limited further, especially opportunities to improve water quality and remove fill that can help restore some of the marsh/lagoon habitat permanently lost due to Superfund remediation. Regardless, best management practices would recommend actions that improve CF scores, such as minimizing and removing shoreline armoring in areas where erosion does not place structures at risk (e.g., Waterfront Park), maximizing light penetration in overwater structures, and improving the relative percentage of forested-to-impervious surface area in the marine riparian zone. Redevelopment may occur in an urban area at a faster rate than elsewhere, opportunities for restoration or enhancement might arise during the redevelopment of properties and infrastructure.

The EF scores were low (17.9) in MA-5 relative to the rest of Bainbridge Island (Figure B-11), despite the presence of at least three fish-bearing streams and some areas of documented sand lance and surf smelt spawn (Table A-4, Figure B-47). Low EF scores can be attributed to the low levels of overhanging vegetation, patchy distribution of eelgrass, and the paucity of geoduck resources in Eagle Harbor (Figures B-46 and B-48). Historic records document that herring once spawned in Eagle Harbor, but give no indication as to the reason for population declines (Chapman et al. 1941). Currently, high pollution levels prohibit the harvest and consumption of fish and shellfish from these waters.

Individual Reaches within MA-5 (Figure B-49, Appendix C, Appendix D)

Reach 3121

- CF Rating = Low/Moderate Impact; Normalized score = -0.267
- Most impacted CF metric: natural shade
- Least impacted CF metric: hydrology
- Geomorphic class: Low Bank; Shoreline length: 644 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 17.4%; Riparian zone land use: 15.2% TIA, 57% forested

- Total shoreline armoring: 23.8%; Total encroaching: 17.8%
- Total point modifications: 2; Density: 3.1/1000 ft; most common is buoys, with 3.1/1000 ft
- Other:
- EF Score: 19

Reach 3122
- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1770 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 58.4% TIA, 35.4% forested
- Total shoreline armoring: 63.5%; Total encroaching: 29%
- Total point modifications: 25; Density: 14.1/1000 ft; most common is stairs, with 6.2/1000 ft
- Other:
- EF Score: 20

Reach 3123
- CF Rating = Moderate Impact ; Normalized score = -0.575
- Most impacted CF metric: wave energy
- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 4019 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 3.8%; Riparian zone land use: 44.6% TIA, 30.8% forested
- Total shoreline armoring: 82.3%; Total encroaching: 49.5%
- Total point modifications: 46; Density: 11.4/1000 ft; most common is upland structures at waterline, with 5/1000 ft
- Other: homes at base of bluff
- EF Score: 18

Reach 3124
- CF Rating = Moderate Impact ; Normalized score = -0.578
- Most impacted CF metrics: wave energy, depth/slope, pollution
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 836 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 29%; Riparian zone land use: 32.2% TIA, 49.7% forested
- Total shoreline armoring: 69.4%; Total encroaching: 69.4%
- Total point modifications: 0Other: shellfish closure present
- EF Score: 24

Reach 3125
- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: wave energy, depth/slope, pollution
- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1244 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 4%; Riparian zone land use: 74.5% TIA, 5.6% forested
- Total shoreline armoring: 99.6%; Total encroaching: 99.6%
- Total point modifications: 4; Density: 3.2/1000 ft; most common is pilings, with 3.2/1000 ft
- Other: shellfish closure present; Creosote (Bill) Point

- EF Score: 20

Reach 3126

- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: wave energy, depth/slope, pollution
- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 402 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 84.7% TIA, 0% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 0
- Other: shellfish closure present; Creosote (Bill) Point
- EF Score: 14

Reach 3127

- CF Rating = Moderate Impact ; Normalized score = -0.575
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, artificial shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1141 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 57.7% TIA, 23.5% forested
- Total shoreline armoring: 100%; Total encroaching: 41.4%
- Total point modifications: 0
- Other: shellfish closure present; inside of Creosote (Bill) Point
- EF Score: 12

Reach 3128

- CF Rating = Moderate Impact ; Normalized score = -0.425
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, artificial shade, hydrology, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 374 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 22.7% TIA, 71.2% forested
- Total shoreline armoring: 100%; Total encroaching: 0%
- Total point modifications: 1; Density: 2.7/1000 ft; most common is pilings, with 2.7/1000 ft
- Other: shellfish closure present; inside of Creosote (Bill) Point
- EF Score: 12

Reach 3129

- CF Rating = Low/Moderate Impact ; Normalized score = -0.325
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, artificial shade, hydrology, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 446 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 70.5%; Riparian zone land use: 13.6% TIA, 80.6% forested
- Total shoreline armoring: 64.7%; Total encroaching: 0%
- Total point modifications: 1; Density: 2.2/1000 ft; most common is pilings, with 2.2/1000 ft
- Other: shellfish closure present
- EF Score: 16

Reach 3130

- CF Rating = Moderate/High Impact ; Normalized score = -0.625
- Most impacted CF metrics: depth/slope, pollution
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2871 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 34.3%; Riparian zone land use: 42% TIA, 52% forested
- Total shoreline armoring: 33.8%; Total encroaching: 24.1%
- Total point modifications: 17; Density: 5.9/1000 ft; most common is overwater structures, with 2.1/1000 ft
- Other: dredged regions, 4 marina(s), and shellfish closure present
- EF Score: 14

Reach 3131

- CF Rating = High Impact, Normalized score = -0.844
- Most impacted CF metrics: natural shade, substrate type, depth/slope, pollution
- Least impacted CF metric: sediment supply, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 386 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 61.3% TIA, 31% forested
- Total shoreline armoring: 97.8%; Total encroaching: 53.1%
- Total point modifications: 9; Density: 23.3/1000 ft; most common is outfalls, with 7.8/1000 ft
- Other: dredged regions, 1 marina(s), and shellfish closure present
- EF Score: 14

Reach 3132

- CF Rating = Moderate/High Impact ; Normalized score = -0.644
- Most impacted CF metrics: substrate type, pollution
- Least impacted CF metric: hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 2959 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 32.2%; Riparian zone land use: 42.7% TIA, 41.5% forested
- Total shoreline armoring: 71.6%; Total encroaching: 27.9%
- Total point modifications: 114; Density: 38.5/1000 ft; most common is boats, with 14.2/1000 ft
- Other: shellfish closure present
- EF Score: 24

Reach 3133

- CF Rating = Moderate Impact ; Normalized score = -0.55
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1318 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 18.7%; Riparian zone land use: 40.1% TIA, 51.7% forested
- Total shoreline armoring: 61.9%; Total encroaching: 8.3%
- Total point modifications: 17; Density: 12.9/1000 ft; most common is floating docks, with 3.8/1000 ft
- Other: shellfish closure present; broad shallow mudflat
- EF Score: 18

Reach 3134
- CF Rating = Moderate/High Impact ; Normalized score = -0.686
- Most impacted CF metrics: substrate type, pollution
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1230 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 19.6%; Riparian zone land use: 33.7% TIA, 53.2% forested
- Total shoreline armoring: 74.1%; Total encroaching: 34.1%
- Total point modifications: 19; Density: 15.4/1000 ft; most common is floating docks, with 6.5/1000 ft
- Other: shellfish closure present; broad tidal flat
- EF Score: 18

Reach 3135
- CF Rating = Low/Moderate Impact ; Normalized score = -0.4
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: Low Bank; Shoreline length: 689 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 85.3%; Riparian zone land use: 41.5% TIA, 37.2% forested
- Total shoreline armoring: 63.8%; Total encroaching: 18.1%
- Total point modifications: 1; Density: 1.5/1000 ft; most common is buoys, with 1.5/1000 ft
- Other: shellfish closure present; point of land
- EF Score: 19

Reach 3136
- CF Rating = Low/Moderate Impact ; Normalized score = -0.325
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2214 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 21.6%; Riparian zone land use: 39.9% TIA, 41.1% forested
- Total shoreline armoring: 22.5%; Total encroaching: 19.7%
- Total point modifications: 9; Density: 4.1/1000 ft; most common is pilings, with 2.7/1000 ft
- Other: shellfish closure present; extensive tide flats
- EF Score: 18

Reach 3137
- CF Rating = Moderate Impact ; Normalized score = -0.5
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1816 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 38.7%; Riparian zone land use: 19.3% TIA, 56% forested
- Total shoreline armoring: 46.1%; Total encroaching: 33.2%
- Total point modifications: 19; Density: 10.5/1000 ft; most common is pilings, with 6.1/1000 ft
- Other: shellfish closure present; extensive mudflats, fronts road
- EF Score: 19

Reach 3138
- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2682 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 28.5%; Riparian zone land use: 11.1% TIA, 57.1% forested
- Total shoreline armoring: 13.5%; Total encroaching: 9.1%
- Total point modifications: 13; Density: 4.8/1000 ft; most common is upland structures at waterline, with 1.1/1000 ft
- Other: shellfish closure present; extensive mudflats, saltmarsh
- EF Score: 20

Reach 3139
- CF Rating = Low/Moderate Impact ; Normalized score = -0.25
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, sediment supply, substrate type, depth/slope
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1515 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 65.2%; Riparian zone land use: 22.5% TIA, 50% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 5; Density: 3.3/1000 ft; most common is outfalls, with 1.3/1000 ft
- Other: shellfish closure present; outlet for Sportsman's Club Creek
- EF Score: 22

Reach 3140
- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2035 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 43.6%; Riparian zone land use: 29.7% TIA, 36.7% forested
- Total shoreline armoring: 8.5%; Total encroaching: 8.5%
- Total point modifications: 3; Density: 1.5/1000 ft; most common is outfalls, with 1/1000 ft
- Other: shellfish closure present; clearing for parking lots
- EF Score: 21

Reach 3141
- CF Rating = Moderate/High Impact, Normalized score = -0.725
- Most impacted CF metrics: depth/slope, pollution
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2012 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 33.9%; Riparian zone land use: 61.2% TIA, 17.5% forested
- Total shoreline armoring: 56.1%; Total encroaching: 23.3%
- Total point modifications: 21; Density: 10.4/1000 ft; most common is floating docks, with 3/1000 ft
- Other: dredged regions, 1 marina(s), and shellfish closure present
- EF Score: 20

Reach 3142

- CF Rating = Moderate Impact ; Normalized score = -0.571
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 305 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 49.4% TIA, 34.9% forested
- Total shoreline armoring: 34.7%; Total encroaching: 0%
- Total point modifications: 5; Density: 16.4/1000 ft; most common is pilings, with 3.3/1000 ft
- Other: shellfish closure present; dune vegetation, no clearing, spit not included in COBI database
- EF Score: 19

Reach 3143

- CF Rating = High Impact, Normalized score = -0.867
- Most impacted CF metrics: artificial shade, substrate type, depth/slope, pollution, physical disturbance
- Least impacted CF metric: sediment supply, hydrology
- Geomorphic class: Low Bank; Shoreline length: 708 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 12.6%; Riparian zone land use: 82.2% TIA, 5.1% forested
- Total shoreline armoring: 87.5%; Total encroaching: 0%
- Total point modifications: 20; Density: 28.2/1000 ft; most common is floating docks, with 7.1/1000 ft
- Other: dredged regions, 3 marina(s), and shellfish closure present
- EF Score: 14

Reach 3144

- CF Rating = High Impact, Normalized score = -0.822
- Most impacted CF metrics: natural shade, depth/slope, pollution, physical disturbance
- Least impacted CF metric: sediment supply
- Geomorphic class: Low Bank; Shoreline length: 536 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 93.9% TIA, 2.2% forested
- Total shoreline armoring: 63.6%; Total encroaching: 63.6%
- Total point modifications: 11; Density: 20.5/1000 ft; most common is outfalls, with 7.5/1000 ft
- Other: dredged regions, 1 marina(s), and shellfish closure present
- EF Score: 13

Reach 3145

- CF Rating = Moderate/High Impact ; Normalized score = -0.675
- Most impacted CF metrics: pollution, physical disturbance
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 927 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 42.8%; Riparian zone land use: 88.3% TIA, 0.6% forested
- Total shoreline armoring: 54.4%; Total encroaching: 32.8%
- Total point modifications: 14; Density: 15.1/1000 ft; most common is buoys, with 4.3/1000 ft
- Other: 1 marina(s), and shellfish closure present
- EF Score: 16

Reach 3146

- CF Rating = Moderate/High Impact, Normalized score = -0.733
- Most impacted CF metrics: natural shade, artificial shade, pollution, physical disturbance
- Least impacted CF metric: wave energy, depth/slope, hydrology
- Geomorphic class: Low Bank; Shoreline length: 471 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 86.4% TIA, 0% forested
- Total shoreline armoring: 62.4%; Total encroaching: 12.3%
- Total point modifications: 15; Density: 31.9/1000 ft; most common is boats, with 10.6/1000 ft
- Other: 2 marina(s), and shellfish closure present; part of Waterfront Park with public boat launch, moorage and recreational facilities
- EF Score: 17

Reach 3147

- CF Rating = Moderate/High Impact ; Normalized score = -0.65
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2718 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 39.5%; Riparian zone land use: 70.7% TIA, 21.1% forested
- Total shoreline armoring: 55.6%; Total encroaching: 55.6%
- Total point modifications: 23; Density: 8.5/1000 ft; most common is boats, with 3.3/1000 ft
- Other: 1 marina(s), and shellfish closure present; part of Waterfront Park
- EF Score: 18

Reach 3148

- CF Rating = Moderate Impact ; Normalized score = -0.6
- Most impacted CF metrics: artificial shade, depth/slope, pollution, physical disturbance
- Least impacted CF metric: wave energy, natural shade, sediment supply
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 233 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 98.7% TIA, 0% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 15; Density: 64.3/1000 ft; most common is pilings, with 51.5/1000 ft
- Other: dredged regions, urban waterfront, 2 marina(s), and shellfish closure present; WSDOT repair facility covers entire shoreline; extensive fill
- EF Score: 13

Reach 3149

- CF Rating = Moderate/High Impact ; Normalized score = -0.622
- Most impacted CF metrics: depth/slope, pollution, physical disturbance
- Least impacted CF metric: wave energy, sediment supply
- Geomorphic class: High Bluff; Shoreline length: 2031 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 29.9%; Riparian zone land use: 62.6% TIA, 18.1% forested
- Total shoreline armoring: 31.5%; Total encroaching: 21.3%
- Total point modifications: 35; Density: 17.2/1000 ft; most common is pilings, with 13.3/1000 ft
- Other: dredged regions, urban waterfront, 1 marina(s), and shellfish closure present; includes WSDOT ferry terminal
- EF Score: 18

Reach 3150
- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2455 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 1.5%; Riparian zone land use: 28.6% TIA, 39.6% forested
- Total shoreline armoring: 58.8%; Total encroaching: 24.1%
- Total point modifications: 16; Density: 6.5/1000 ft; most common is stairs, with 2/1000 ft
- Other: shellfish closure present; large intertidal beach, backed by marsh and LWD
- EF Score: 21

Reach 3151
- CF Rating = Moderate/High Impact ; Normalized score = -0.622
- Most impacted CF metric: pollution
- Least impacted CF metric: hydrology
- Geomorphic class: High Bluff; Shoreline length: 944 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 3%; Riparian zone land use: 27% TIA, 44.4% forested
- Total shoreline armoring: 71.1%; Total encroaching: 20.4%
- Total point modifications: 11; Density: 11.7/1000 ft; most common is buoys, with 4.2/1000 ft
- Other: shellfish closure present
- EF Score: 20

Reach 3152
- CF Rating = Low/Moderate Impact ; Normalized score = -0.4
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 815 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 22.8% TIA, 50% forested
- Total shoreline armoring: 17.9%; Total encroaching: 0%
- Total point modifications: 8; Density: 9.8/1000 ft; most common is buoys, with 4.9/1000 ft
- Other: shellfish closure present; wide backshore with dune vegetation and LWD accumulation
- EF Score: 16

Reach 3153
- CF Rating = Low/Moderate Impact ; Normalized score = -0.4
- Most impacted CF metrics: natural shade, pollution
- Least impacted CF metric: wave energy, artificial shade, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 463 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 33.9% TIA, 45.5% forested
- Total shoreline armoring: 39.5%; Total encroaching: 0%
- Total point modifications: 2; Density: 4.3/1000 ft; most common is pilings, with 4.3/1000 ft
- Other: shellfish closure present; barrier beach with lagoon
- EF Score: 20

Reach 3154

- CF Rating = Moderate/High Impact ; Normalized score = -0.644
- Most impacted CF metrics: natural shade, depth/slope, pollution
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 726 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 21.6% TIA, 48.8% forested
- Total shoreline armoring: 92.3%; Total encroaching: 81.4%
- Total point modifications: 5; Density: 6.9/1000 ft; most common is groins, with 5.5/1000 ft
- Other: shellfish closure present
- EF Score: 20

Reach 3155

- CF Rating = Moderate/High Impact ; Normalized score = -0.644
- Most impacted CF metrics: natural shade, depth/slope, pollution
- Least impacted CF metric: artificial shade
- Geomorphic class: Low Bank; Shoreline length: 116 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 48% TIA, 28% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 0
- Other: shellfish closure present; part of Wing Point
- EF Score: 20

3.2.6 Blakely Harbor Management Area (MA-6) (Reaches 3105 – 3120)

Qualitative Rating = Low/Moderate Impact
Mean CF Score (Normalized) = -0.30 (Range: -0.68 to 0.00)
Median CF Score (Normalized) = -0.33
Number of Reaches = 16

Mean EF Score = 17.6 (Range: 10 to 27)
Median EF Score = 17

Description

MA-6 comprises 20,345 ft of shoreline that encompasses all of Blakely Harbor, including part of Restoration Point (Table A-1, Figure 2). Blakely Harbor is an embayment comprising 16 reaches broken into the following categories: spit/backshore (7), low bank (6), rocky shore (2), and marsh/lagoon (1) (Figure B-50). MA-6 is defined by two drift cells with westerly alongshore drift that terminate at the head of Blakely Harbor, with the log pond area lacking appreciable alongshore drift (Figure 3). The first drift cell begins at a divergence zone located at a point on the northern margin of Blakely Harbor and moves west into the harbor; this short stretch of shoreline has scarce sediment abundance and encompasses a small reach with rocky shore (Figure B-51). The second drift cell begins at Restoration Point, a rocky headland with scarce sediment abundance and no appreciable alongshore drift, and moves northwest into Blakely Harbor. Relative to wave exposure, shorelines along the southern stretch of MA-6 are considered “semi-protected,” whereas the interior of Blakely Harbor is considered “protected” to “very protected” (Figure B-51). Blakely Harbor receives upland flows from five watersheds with low levels of land use and high forest cover: WRIA unnumbered 56 (TIA 1%), WRIA unnumbered 77 (TIA 2%), WRIA 15.0332 (TIA <1%), Macs Dam Creek (WRIA 15.0331; TIA <1%), and unnumbered 65 (TIA <1%).

Overhanging riparian vegetation covers approximately 29% of the MA-6 shoreline (Table A-1, Figure B-56). Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 59% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent 19% of land cover (Figure B-55).

Historically, Blakely Harbor was the home of a large commercial sawmill, which included a log rafting pond in the upper reaches of the bay that was constructed with a large stone jetty that constricted tidal flows (Figure B-54). This area is now parkland with public shoreline access, recreational trails, and plans for an interpretive center. The remainder of MA-6 shoreline has single-family residential development. Only 22% of the shoreline is modified by armoring and 17% of the shoreline has armoring that encroaches into the intertidal zone, the lowest values for any MA on Bainbridge Island (Table A-1, Figure B-52).

A total of 132 point modifications were recorded along MA-6 shorelines (unpublished data, COBI 2002), at an average of 6.5 modifications per 1000 ft, among the lowest on Bainbridge Island (Table A-1, Figure B-53). Most of these modifications were composed of mooring buoys (32), pilings (19), stairs (15), groins (14), and docks (14). The rock jetty built in the upper bay to create the historic log pond represents an unnatural tidal constriction in upper Blakely Harbor (Figure B-54). As well, a total of 8 outfalls were recorded along MA-6 shorelines.

<u>Limiting Factors</u>
The average normalized CF score within MA-6 was -0.33, the highest (best) MA score on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). MA-6 had no particularly low (poor) scores relative to other MAs, but rather, had among the best scores in seven of the nine metric categories: wave energy, natural shade, sediment supply, substrate type, depth/slope, pollution, and hydrology (Table A-3, Figure B-16). High (good) wave-energy scores were influenced primarily by the relatively low rate of shoreline armoring (22%) and low rate of armor encroachment (17%) into the intertidal zone. Natural shade scores were low (poor) despite a fairly average total percentage (29%) of total shoreline with overhanging riparian vegetation. Much of this can be attributed to the prevalence of spit/backshore geomorphic class reaches (7 of 16 reaches), where natural shade is not considered an issue because these habitats often are exposed, lack overhanging riparian vegetation, or are composed of low dune vegetation. As well, a number of other reaches in the Blakely Harbor MA also had riparian cover exceeding 90%.

Sediment supply scores were high (good) primarily because of the combination of low shoreline armoring rates combined with the lack of feeder bluffs and backshore sediment sources. However, groins (14) were a somewhat conspicuous feature along this stretch of shoreline with alongshore sediment transport and scarce-to-moderate sediment abundance, which lowered (worsened) sediment supply scores. High (good) substrate-type scores were influenced by low rates of shoreline armoring in this MA, as well as the relatively low density of point modifications (6.5/1000 ft shoreline). Low armoring and armoring encroachment rates also contributed to high (good) scores in the depth/slope metric, despite two reaches with a likely history of dredging activity. Pollution scores were high in MA-6 because of a lack of recreational shellfish closures or warnings, marinas and fish farms. Relatively low %TIA in the marine riparian zone and outfall densities along the shoreline in some reaches further influenced high (good) pollution metric scores. Finally, hydrology scores were also relatively high (good), despite the influence of an artificial tidal constriction in reach 3116, because of low %TIA scores (19%) within the marine riparian zone, low rates of armoring encroachment into the intertidal zone, and relatively low outfall densities.

<u>Opportunities</u>
Three of the least-impacted, low-bank reaches on Bainbridge Island are located in Blakely Harbor (MA-6), including Reaches 3112, 3113, and 3114 (Figure B-60, Appendix C). In all cases, the marine riparian

zone of these reaches is composed of fairly intact forest, with no linear modifications and few point modifications present along the shoreline.

At an MA level, the most obvious opportunities for improving scoring would be to enhance processes and functions at reaches with particularly high scores (Figure B-14). This effort may include targeting removal or modification of encroaching armoring structures or groin structures, and modifying/removing the rock jetty that constricts tidal exchange to back-bay habitats in Reach 3115 (Figure B-60).

The EF scores were low (poor) in MA-6 relative to the rest of Bainbridge Island despite high CF scores (Table A-4, Figure B-11, Appendix D). This difference may be attributed to the relatively small documented area of surf-smelt spawning habitat, limited extent of eelgrass in the bay, as well as the lack of geoduck resources found therein (Figures B-57, B-58, and B-59). However, cutthroat trout, and coho salmon are also documented to spawn in two streams, Macs Dam Creek (WRIA 15.0331) and WRIA 15.0332, and efforts should be made to preserve spawning access and functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats (Haring 2000). Blakely Harbor also provides additional support as a non-natal rearing area to juvenile salmon, including chinook and pink salmon; these functions were not quantified in the index.

<u>Individual Reaches Within MA-6</u> (Figure B-60, Appendix C, Appendix D)

Reach 3105

- CF Rating = Low Impact, Normalized score = -0.15
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, pollution, hydrology
- Geomorphic class: Rocky Shore; Shoreline length: 2700 ft
- Sediment source: Don't Know; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 9.5% TIA, 14.8% forested
- Total shoreline armoring: 1.2%; Total encroaching: 0%
- Total point modifications: 1; Density: 0.4/1000 ft; most common is groins, with 0.4/1000 ft
- Other: fronts golf course
- EF Score: 14

Reach 3106

- CF Rating = Low/Moderate Impact; Normalized score = -0.4
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 352 ft
- Sediment source: Don't Know; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 28.4% TIA, 10.6% forested
- Total shoreline armoring: 24.6%; Total encroaching: 0%
- Total point modifications: 10; Density: 28.4/1000 ft; most common is buoys, with 17.1/1000 ft
- Other:
- EF Score: 10

Reach 3107

- CF Rating = Low/Moderate Impact, Normalized score = -0.222
- Most impacted CF metric: natural shade
- Least impacted CF metric: hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 2358 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 17.3%; Riparian zone land use: 20.7% TIA, 65.7% forested
- Total shoreline armoring: 14.2%; Total encroaching: 14.2%
- Total point modifications: 1; Density: 0.4/1000 ft; most common is buoys, with 0.4/1000 ft
- Other: some clearing of vegetation for road
- EF Score: 18

Reach 3108

- CF Rating = Low/Moderate Impact ; Normalized score = -0.333
- Most impacted CF metrics: wave energy, depth/slope
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 1402 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 43.6%; Riparian zone land use: 9% TIA, 85.5% forested
- Total shoreline armoring: 51.5%; Total encroaching: 45.7%
- Total point modifications: 2; Density: 1.4/1000 ft; most common is outfalls, with 1.4/1000 ft
- Other: some clearing of vegetation for road
- EF Score: 16

Reach 3109

- CF Rating = Moderate Impact ; Normalized score = -0.422
- Most impacted CF metric: wave energy
- Least impacted CF metric: artificial shade
- Geomorphic class: Low Bank; Shoreline length: 522 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 20.7%; Riparian zone land use: 14.2% TIA, 50.3% forested
- Total shoreline armoring: 63.1%; Total encroaching: 59%
- Total point modifications: 7; Density: 13.4/1000 ft; most common is groins, with 7.7/1000 ft
- Other:
- EF Score: 14

Reach 3110

- CF Rating = Moderate/High Impact ; Normalized score = -0.675
- Most impacted CF metrics: wave energy, substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1522 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 16.4% TIA, 41.4% forested
- Total shoreline armoring: 87.5%; Total encroaching: 63%
- Total point modifications: 33; Density: 21.7/1000 ft; most common is stairs, with 4.6/1000 ft
- Other:
- EF Score: 16

Reach 3111

- CF Rating = Low/Moderate Impact ; Normalized score = -0.325
- Most impacted CF metric: wave energy

- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 394 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 24.4%; Riparian zone land use: 13.7% TIA, 51.5% forested
- Total shoreline armoring: 55.3%; Total encroaching: 0%
- Total point modifications: 1; Density: 2.5/1000 ft; most common is floating docks, with 2.5/1000 ft
- Other:
- EF Score: 14

Reach 3112

- CF Rating = No Impact Normalized score = 0
- Most impacted CF metrics:
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 373 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 100.1%; Riparian zone land use: 2.8% TIA, 92.9% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 1; Density: 2.7/1000 ft; most common is outfalls, with 2.7/1000 ft
- Other:
- EF Score: 19

Reach 3113

- CF Rating = No Impact, Normalized score = 0
- Most impacted CF metrics:
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 331 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 98.4%; Riparian zone land use: 2.8% TIA, 96.5% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0Other:
- EF Score: 22

Reach 3114

- CF Rating = Low Impact, Normalized score = -0.089
- Most impacted CF metric: artificial shade
- Least impacted CF metric: wave energy, sediment supply, substrate type, depth/slope, pollution, hydrology
- Geomorphic class: Low Bank; Shoreline length: 1291 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 70.4%; Riparian zone land use: 10% TIA, 88.5% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 3; Density: 2.3/1000 ft; most common is outfalls, with 0.8/1000 ft
- Other:
- EF Score: 27

Reach 3115

- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metric: hydrology
- Least impacted CF metric: wave energy, physical disturbance

- Geomorphic class: Marsh/Lagoon; Shoreline length: 3018 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 48.3%; Riparian zone land use: 17.6% TIA, 77% forested
- Total shoreline armoring: 16.1%; Total encroaching: 16.1%
- Total point modifications: 4; Density: 1.3/1000 ft; most common is pilings, with 0.7/1000 ft
- Other: tidal constriction present
- EF Score: 20

Reach 3116
- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metric: depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2032 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 5.5%; Riparian zone land use: 37.3% TIA, 53.4% forested
- Total shoreline armoring: 4.3%; Total encroaching: 4.3%
- Total point modifications: 13; Density: 6.4/1000 ft; most common is pilings, with 3/1000 ft
- Other: dredged regions present
- EF Score: 17

Reach 3117
- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metric: depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1477 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 18.9%; Riparian zone land use: 46.7% TIA, 45.2% forested
- Total shoreline armoring: 13.4%; Total encroaching: 5.6%
- Total point modifications: 20; Density: 13.5/1000 ft; most common is buoys, with 3.4/1000 ft
- Other: dredged regions present
- EF Score: 17

Reach 3118
- CF Rating = Moderate Impact ; Normalized score = -0.425
- Most impacted CF metrics: wave energy, artificial shade, substrate type, depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 543 ft
- Sediment source: Foreshore; Wave exposure: protected
- Overhanging vegetation: 18%; Riparian zone land use: 26.3% TIA, 72.9% forested
- Total shoreline armoring: 56.8%; Total encroaching: 56.8%
- Total point modifications: 6; Density: 11.1/1000 ft; most common is floating docks, with 3.7/1000 ft
- Other:
- EF Score: 16

Reach 3119
- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1098 ft
- Sediment source: Alongshore; Wave exposure: protected

- Overhanging vegetation: 15.7%; Riparian zone land use: 44.6% TIA, 49.1% forested
- Total shoreline armoring: 36.3%; Total encroaching: 27.5%
- Total point modifications: 29; Density: 26.4/1000 ft; most common is buoys, with 6.4/1000 ft
- Other:
- EF Score: 17

Reach 3120
- CF Rating = Low Impact, Normalized score = -0.05
- Most impacted CF metric: artificial shade
- Least impacted CF metric: wave energy, natural shade, sediment supply, substrate type, depth/slope, pollution, hydrology, physical disturbance
- Geomorphic class: Rocky Shore; Shoreline length: 932 ft
- Sediment source: Alongshore, with feeder bluff activity; Wave exposure: semi-protected
- Overhanging vegetation: 97.9%; Riparian zone land use: 0.6% TIA, 96.2% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 1; Density: 1.1/1000 ft; most common is buoys, with 1.1/1000 ft
- Other: good home setbacks
- EF Score: 24

3.2.7 Rich Passage Management Area (MA-7) (Reaches 3540; 3080 – 3104, plus Reaches 6000-6001)

Qualitative Rating = Moderate Impact
Mean CF Score (Normalized) = -0.47 (Range: -0.78 to -0.05)
Median CF Score (Normalized) = -0.46
Number of Reaches = 28

Mean EF Score = 16.1 (Range: 12 to 22)
Median EF Score = 15.5

Description
Rich Passage (MA-7) comprises 34,565 ft of shoreline that encompasses most of Rich Passage, from Restoration Point to Point White, including Pleasant Beach and South Beach (Table A-1, Figure 2). Rich Passage (MA-7) encompasses a long stretch of shoreline made up of 28 reaches composed primarily of spit/backshore (21) and low bank (3) geomorphic classes; it also includes rocky shores (3) near Restoration Point and one marsh/lagoon reach at the restored Schel-Chelb estuary (Figure B-50). MA-7 is defined by two drift cells that converge in the embayment near the outlet of Schel-Chelb estuary (Figure 3). The first drift cell begins at Restoration Point, a rocky headland with scarce sediment abundance and no appreciable alongshore drift, and moves westward (Figure B-51). The second drift cell begins at a divergence zone located at Point White and moves eastward. Relative to wave exposure, shorelines along the eastern stretch of MA-7 near Restoration Point are considered “semi-protected,” whereas the interior of Rich Passage is considered “protected” (Figure B-51). Rich Passage receives upland runoff from direct coastal sheetflow, as well as several small watersheds with moderate-to-low levels of land use and high forest cover: WRIA 15.0337 (TIA 2%), WRIA 15.0335 (TIA 2%), WRIA 15.0334 (TIA 3%), WRIA 15.0333 (TIA <1%), and Schel-Chelb Creek (WRIA 15.0325).

Overhanging riparian vegetation covers approximately 8% of the MA-7 shoreline, by far the lowest such value over Bainbridge Island (Table A-1, Figure B-56). However, low overhanging riparian cover is expected because of the relatively high percentage of reaches classified as spit/backshore that typically do not have this type of vegetation. Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 42% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent 26% of land cover (Figure B-55). Besides Eagle Harbor (MA-5), riparian zone land-cover class values in Rich Passage represent the worst ratios of percentage of natural vegetation to %TIA on Bainbridge Island (Table A-1).

Most of the MA-7 shoreline is backed by single-family residential development, with highly accessible beaches afforded by the typical regional geomorphology (i.e., low bank to spit/backshore). Shorelines within the Rich Passage MA include road frontage, a state park, restored estuary, commercial fish farm, and a sewage treatment outfall. Fort Ward State Park is a waterfront park with a boat launch, shoreline access, and trails (Figure B-54). Schel-Chelb estuary, near Lynwood Center, is a 2-acre wetland that was constructed to restore tidal flushing and fish access to the Pleasant Beach Watershed[1]. A commercial aquaculture facility for Atlantic salmon exists in the waters off of South Beach. As well, the Kitsap County Sewer District #7 treatment facility discharges into Rich Passage, just east of Fort Ward State Park. Approximately 52% of the MA-7 shoreline is modified by armoring, and 21% of the shoreline has armoring that encroaches into the intertidal zone (Table A-1, Figure B-52).

A total of 402 point modifications were recorded along MA-7 shorelines (unpublished data, COBI 2002), at an average of 11.6 modifications per 1000 ft (Table A-1, Figure B-53). Most of the modifications along this residentially developed shoreline are represented by stairs (110), mooring buoys (94), groins (43), structures at the waterline (42), and overwater structures such as docks (10) and piers (2). A total of 29 outfalls were also recorded.

Limiting Factors

The average normalized CF score within Rich Passage (MA-7) was -0.47, within the middle range of scores on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). MA-6 had among the lowest (worst) scores in the wave energy and physical disturbance metrics relative to other MAs (Table A-3, Figure B-16). Low (bad) wave-energy scores were influenced primarily by the relatively high rate of shoreline armoring (52%), especially by vertical concrete structures that may enhance reflected wave energy. Physical disturbance scores were low (poor) primarily because of the low percentage of forested cover in the marine riparian zone (42%), and the relatively high number of dock, mooring buoy, and ramp densities within most reaches in this MA, where shorelines are highly accessible and residential development is high.

Two of the most highly altered spit/barrier/backshore reaches on Bainbridge Island (Reaches 3093 and 3088) were found in Rich Passage (MA-7) (Figure B-60, Appendix C). These reaches were characterized by exceptional amounts of armoring, most of which encroach into the intertidal zone, high levels of point modifications, including groins and upland structures at the waterline, and greater than 30% TIA in the marine riparian zone. As well, Reach 3083 is located close to the salmon net pen aquaculture facility and in a zone where high pollution levels associated with the Fort Ward sewage discharge have led to advisories against the harvest and consumption of shellfish.

Rich Passage had among the best (highest) scores in natural shade and sediment supply metrics (Table A-3, Figure B-16). Natural shade scores were the highest (best) despite being the MA with the lowest total percentage (8%) of shoreline with overhanging riparian vegetation on Bainbridge Island. This discrepancy is attributed to the fact that 75% (21 of 28) of the reaches are classified as spit/backshore geomorphic classes, where natural shade was not considered an issue because these habitats often are exposed, lack overhanging riparian vegetation, or are composed of low dune vegetation. Similarly, sediment supply scores were high (good) primarily because of the absence of feeder bluffs and backshore sediment sources that would magnify the negative influence of armoring along this stretch of shoreline.

[1] Schel-Chelb was constructed as mitigation for construction activities associated with the capping of contaminated sediments at the Eagle Harbor ship yard as part of the Eagle Harbor/Wyckoff Superfund Cleanup.

Groins (42) were a highly conspicuous feature along MA-7 shorelines, and did reduce sediment supply scores slightly. These results suggest that the scoring scheme might be modified to better balance the negative effects of armoring rates in areas with backshore sediment supply against the influence of groins in areas with alongshore transport and scarce-to-moderate sediment abundance.

Opportunities

Two of the least-impacted spit/barrier/backshore reaches on Bainbridge Island included Reaches 3091 and 3092, part of Fort Ward State Park in Rich Passage (MA-7) (Appendix C). Both reaches have few linear or point modifications along shorelines and high rates of overhanging riparian vegetation along the shoreline.

Numerous opportunities exist for improving scoring of CF metrics at the individual reach level, as well as at the MA level. Some of the most effective actions would seek to minimize and remove armoring, especially armoring that encroaches into the intertidal zone, maximize light penetration of overwater structures, and improve the relative percentage of forested-to-impervious surface area in the marine riparian zone. As well, groins should be removed if possible, and the tidal constriction at the mouth of Schel-Chelb estuary could possibly be further improved by replacing existing culverts with a small bridge.

The EF scores were lower (worse) in MA-7 (16.1) than in any other MA on Bainbridge Island (Table A-4, Figure B-11, Appendix D). This may be attributed to the relatively limited extent of documented forage-fish spawning (sand lance spawning has been noted near Reach 3083), sparse-to-patchy extent of eelgrass throughout the MA, and minimal geoduck resources (Figures B-57, B-58, and B-59). Cutthroat trout and coho salmon are also documented to spawn in one tributary, Schel-Chelb Creek (WRIA 15.0028X), within MA-7. Efforts should be made to improve spawning access and functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats.

Individual Reaches within MA-7 (Figure B-60, Appendix C, Appendix D)

Reach 3540

- CF Rating = Moderate/High Impact, Normalized score = -0.778
- Most impacted CF metrics: wave energy, natural shade, substrate type, depth/slope
- Least impacted CF metric: artificial shade, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 1501 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 41.3% TIA, 33.1% forested
- Total shoreline armoring: 94.9%; Total encroaching: 82.4%
- Total point modifications: 27; Density: 18/1000 ft; most common is stairs, with 5.3/1000 ft
- Other:
- EF Score: 14

Reach 3080

- CF Rating = Moderate Impact; Normalized score = -0.6
- Most impacted CF metrics: natural shade, depth/slope
- Least impacted CF metric: physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 901 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 29.3% TIA, 40.5% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 7; Density: 7.8/1000 ft; most common is upland structures at waterline, with 2.2/1000 ft

- Other: heavy encroachment and signs of erosion
- EF Score: 15

Reach 3081

- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metrics: sediment supply, substrate type, pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1938 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 1.7%; Riparian zone land use: 39% TIA, 30% forested
- Total shoreline armoring: 43.8%; Total encroaching: 31.6%
- Total point modifications: 24; Density: 12.4/1000 ft; most common is upland structures at waterline, with 3.1/1000 ft
- Other: heavily residential
- EF Score: 16

Reach 3082

- CF Rating = Low/Moderate Impact ; Normalized score = -0.35
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade, depth/slope
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1668 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 44.4% TIA, 14.7% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 16; Density: 9.6/1000 ft; most common is buoys, with 3/1000 ft
- Other: shellfish closure present
- EF Score: 15

Reach 6000

- CF Rating = Low/Moderate Impact ; Normalized score = -0.325
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade, depth/slope, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 507 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 22% TIA, 39.8% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 4; Density: 7.9/1000 ft; most common is buoys, with 3.9/1000 ft
- Other: shellfish closure present
- EF Score: 21

Reach 6001

- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metrics: natural shade, pollution, hydrology
- Least impacted CF metric: wave energy, artificial shade, sediment supply, substrate type, depth/slope, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1468 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 9.7% TIA, 66% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 4; Density: 2.7/1000 ft; most common is outfalls, with 2.7/1000 ft
- Other: tidal constriction, and shellfish closure present; Schel-chelb Estuary

- EF Score: 22

Reach 3083
- CF Rating = Moderate/High Impact ; Normalized score = -0.65
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1961 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 1.9%; Riparian zone land use: 45.3% TIA, 31.3% forested
- Total shoreline armoring: 47.4%; Total encroaching: 33%
- Total point modifications: 37; Density: 18.9/1000 ft; most common is upland structures at waterline, with 6.1/1000 ft
- Other: shellfish closure present; clearing associated with road fronting beach
- EF Score: 21

Reach 3084
- CF Rating = Moderate Impact ; Normalized score = -0.6
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1165 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 27.2%; Riparian zone land use: 29.4% TIA, 43% forested
- Total shoreline armoring: 93.2%; Total encroaching: 0%
- Total point modifications: 46; Density: 39.5/1000 ft; most common is stairs, with 10.3/1000 ft
- Other:
- EF Score: 17

Reach 3085
- CF Rating = Moderate Impact ; Normalized score = -0.525
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 499 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 24.4% TIA, 58.6% forested
- Total shoreline armoring: 100%; Total encroaching: 0%
- Total point modifications: 7; Density: 14/1000 ft; most common is stairs, with 4/1000 ft
- Other: extensive intertidal zone
- EF Score: 18

Reach 3086
- CF Rating = Moderate Impact ; Normalized score = -0.45
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1230 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 49.8% TIA, 23.5% forested
- Total shoreline armoring: 15.4%; Total encroaching: 0%
- Total point modifications: 10; Density: 8.1/1000 ft; most common is buoys, with 3.3/1000 ft
- Other: high LWD retention
- EF Score: 15

Reach 3087

- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metrics: wave energy, artificial shade, sediment supply, substrate type, physical disturbance
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 877 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 23.3% TIA, 47.6% forested
- Total shoreline armoring: 6.7%; Total encroaching: 0%
- Total point modifications: 7; Density: 8/1000 ft; most common is buoys, with 3.4/1000 ft
- Other: high LWD retention
- EF Score: 14

Reach 3088

- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: wave energy, substrate type, depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 855 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 28.9% TIA, 48.6% forested
- Total shoreline armoring: 91.4%; Total encroaching: 88.3%
- Total point modifications: 21; Density: 24.6/1000 ft; most common is stairs, with 8.2/1000 ft
- Other:
- EF Score: 12

Reach 3089

- CF Rating = Moderate/High Impact ; Normalized score = -0.675
- Most impacted CF metrics: wave energy, substrate type, depth/slope
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1464 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 4.9%; Riparian zone land use: 39.8% TIA, 41.6% forested
- Total shoreline armoring: 67.5%; Total encroaching: 67.5%
- Total point modifications: 21; Density: 14.3/1000 ft; most common is groins, with 5.5/1000 ft
- Other:
- EF Score: 14

Reach 3090

- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metrics: wave energy, sediment supply, depth/slope
- Least impacted CF metric: natural shade, pollution
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 674 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 53.8%; Riparian zone land use: 9.5% TIA, 76.9% forested
- Total shoreline armoring: 34.6%; Total encroaching: 34.6%
- Total point modifications: 2; Density: 3/1000 ft; most common is boat ramps, with 1.5/1000 ft
- Other:
- EF Score: 16

Reach 3091

- CF Rating = Low Impact, Normalized score = -0.05

- Most impacted CF metrics: pollution, hydrology
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 923 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 99.8%; Riparian zone land use: 0.4% TIA, 97.6% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 1; Density: 1.1/1000 ft; most common is outfalls, with 1.1/1000 ft
- Other: Fort Ward State Park
- EF Score: 18

Reach 3092
- CF Rating = Low Impact, Normalized score = -0.05
- Most impacted CF metrics: artificial shade, pollution
- Least impacted CF metric: wave energy, natural shade, sediment supply, substrate type, depth/slope, hydrology, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2363 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 27.4%; Riparian zone land use: 14.5% TIA, 61.6% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 2; Density: 0.8/1000 ft; most common is pilings, with 0.4/1000 ft
- Other: Fort Ward State Park
- EF Score: 16

Reach 3093
- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: pollution, physical disturbance
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 746 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 52.8% TIA, 6.7% forested
- Total shoreline armoring: 100%; Total encroaching: 0%
- Total point modifications: 8; Density: 10.7/1000 ft; most common is buoys, with 4/1000 ft
- Other: fish farm, and shellfish closure present; encroachment by new development likely underestimated
- EF Score: 18

Reach 3094
- CF Rating = Moderate/High Impact ; Normalized score = -0.65
- Most impacted CF metrics: pollution, physical disturbance
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 421 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 40.2% TIA, 0.9% forested
- Total shoreline armoring: 55.6%; Total encroaching: 0%
- Total point modifications: 13; Density: 30.9/1000 ft; most common is buoys, with 21.4/1000 ft
- Other: 1 marina(s), fish farm, and shellfish closure present
- EF Score: 14

Reach 3095
- CF Rating = Moderate Impact ; Normalized score = -0.425

- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 703 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 6.5% TIA, 46.9% forested
- Total shoreline armoring: 20.1%; Total encroaching: 0%
- Total point modifications: 10; Density: 14.2/1000 ft; most common is buoys, with 8.5/1000 ft
- Other: fish farm, and shellfish closure present; bedrock terrace in foreshore
- EF Score: 14

Reach 3096

- CF Rating = Moderate/High Impact ; Normalized score = -0.625
- Most impacted CF metrics: substrate type, pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 3262 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0.5%; Riparian zone land use: 17.8% TIA, 36% forested
- Total shoreline armoring: 67.4%; Total encroaching: 13.8%
- Total point modifications: 50; Density: 15.3/1000 ft; most common is stairs, with 7.1/1000 ft
- Other: fish farm, and shellfish closure present; bedrock terrace in foreshore
- EF Score: 14

Reach 3097

- CF Rating = Moderate Impact ; Normalized score = -0.6
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1810 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 13.7%; Riparian zone land use: 19.4% TIA, 49.5% forested
- Total shoreline armoring: 83.6%; Total encroaching: 1.4%
- Total point modifications: 28; Density: 15.5/1000 ft; most common is stairs, with 5.5/1000 ft
- Other: road in backshore
- EF Score: 20

Reach 3098

- CF Rating = Moderate Impact ; Normalized score = -0.511
- Most impacted CF metric: natural shade
- Least impacted CF metric: pollution, hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 1263 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 3.9% TIA, 72.6% forested
- Total shoreline armoring: 96%; Total encroaching: 17.6%
- Total point modifications: 8; Density: 6.3/1000 ft; most common is stairs, with 4/1000 ft
- Other: rock terrace in foreshore
- EF Score: 18

Reach 3099

- CF Rating = Moderate Impact ; Normalized score = -0.45
- Most impacted CF metrics: wave energy, substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1229 ft

- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 20.4% TIA, 56.2% forested
- Total shoreline armoring: 94.3%; Total encroaching: 0%
- Total point modifications: 13; Density: 10.6/1000 ft; most common is stairs, with 4.1/1000 ft
- Other: rock terrace in foreshore
- EF Score: 16

Reach 3100
- CF Rating = Moderate Impact ; Normalized score = -0.55
- Most impacted CF metric: wave energy
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1572 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 1.3%; Riparian zone land use: 28.4% TIA, 60.8% forested
- Total shoreline armoring: 95.2%; Total encroaching: 45.3%
- Total point modifications: 21; Density: 13.4/1000 ft; most common is stairs, with 5.7/1000 ft
- Other: rock terrace in foreshore
- EF Score: 14

Reach 3101
- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metrics: wave energy, sediment supply, substrate type
- Least impacted CF metric: natural shade, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1414 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 14.7% TIA, 41.5% forested
- Total shoreline armoring: 40.2%; Total encroaching: 0%
- Total point modifications: 13; Density: 9.2/1000 ft; most common is stairs, with 2.8/1000 ft
- Other: bedrock terrace in foreshore, start of golf course
- EF Score: 16

Reach 3102
- CF Rating = Low/Moderate Impact ; Normalized score = -0.35
- Most impacted CF metrics: depth/slope, physical disturbance
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, hydrology
- Geomorphic class: Rocky Shore; Shoreline length: 903 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 12.9% TIA, 3.5% forested
- Total shoreline armoring: 42.8%; Total encroaching: 38.3%
- Total point modifications: 1; Density: 1.1/1000 ft; most common is upland structures at waterline, with 1.1/1000 ft
- Other: bedrock terrace in foreshore, golf course
- EF Score: 14

Reach 3103
- CF Rating = Low/Moderate Impact ; Normalized score = -0.4
- Most impacted CF metrics: depth/slope, physical disturbance
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, hydrology
- Geomorphic class: Rocky Shore; Shoreline length: 236 ft

- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 45.9% TIA, 3.5% forested
- Total shoreline armoring: 91.8%; Total encroaching: 0%
- Total point modifications: 1; Density: 4.2/1000 ft; most common is stairs, with 4.2/1000 ft
- Other: golf course
- EF Score: 14

Reach 3104

- CF Rating = Low Impact, Normalized score = -0.2
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, pollution, hydrology
- Geomorphic class: Rocky Shore; Shoreline length: 1013 ft
- Sediment source: Alongshore; Wave exposure: semi-protected
- Overhanging vegetation: 0%; Riparian zone land use: 1.9% TIA, 0% forested
- Total shoreline armoring: 9.6%; Total encroaching: 0%
- Total point modifications: 0
- Other: Restoration Point, golf course
- EF Score: 14

3.2.8 Point White – Battle Point Management Area (MA-8) (Reaches 3502 – 3539)

Qualitative Rating = Moderate Impact
Mean CF Score (Normalized) = -0.47 (Range: -0.75 to -0.10)
Median CF Score (Normalized) = -0.48
Number of Reaches = 38

Mean EF Score = 19.8 (Range: 13 to 30)
Median EF Score = 18.5

Description

The Point White to Battle Point management area (MA-8) comprises 54,650 ft, the longest MA on Bainbridge Island (Table A-1, Figure 2). It fronts Port Orchard Bay and includes Battle Point, Battle Point Lagoon, Fletcher Bay, Tolo Lagoon, and part of Point White. MA-8 comprises 38 reaches composed of the following geomorphic classes: spit/backshore (16), high bluff (10), marsh/lagoon (7), and low bank (5) (Figure B-61). MA-8 is defined by two major drift cells that converge at Battle Point (Figure 3). The larger drift cell begins at a divergence zone located at Point White and moves north past Fletcher Bay and a nearby reach with eroding feeder bluffs (Figure B-62)). The second drift cell begins at a divergence zone located just south of Arrow Point and moves south to Battle Point; most of this drift cell encompasses a large stretch of eroding feeder bluffs. Relative to wave exposure, all west-facing shorelines are considered "protected," whereas the interior of small embayments and estuaries is considered "very-protected" (Figure B-62). MA-8 receives upland flows from five watersheds with low levels of land use: WRIA unnumbered 73 (TIA 2%), Fletcher/Springbrook Creek (WRIA 15.0340; TIA 1%), WRIA unnumbered 72 (TIA 1%), WRIA 15.0339 (TIA 0%), WRIA 15.0338 (TIA 2%).

Overhanging riparian vegetation covers approximately 32% of the MA-8 shoreline (Table A-1, Figure B-67). Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 56% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent 22% of land cover (Figure B-66).

Shoreline development in MA-1 is primarily residential in nature. Approximately 50% of the MA-7 shoreline is modified by armoring, and 22% of the shoreline has armoring that encroaches into the intertidal zone (Table A-1, Figure B-63). A total of 616 point modifications were recorded along MA-8 shorelines (unpublished data, COBI 2002) at an average of 11.9 modifications per 1000 ft (Figure B-64). Most of the modifications along this residentially developed shoreline were represented by stairs (132), mooring buoys (113), docks (73), upland structures at the waterline (61), overwater structures (57), groins (37), and piers (24). A total of 32 outfalls were also recorded along MA-8 shorelines.

Limiting Factors

The average normalized CF score within MA-8 was -0.47, within the middle range of MA scores on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). Individual metric scores for MA-8 did not rank among the best or worst in any metric category compared with other MAs (Table A-3, Figure B-16). However, metric scores within the Point White - Battle Point MA very closely mirrored the pattern observed over all of Bainbridge Island (Figure B-15), with substrate type and depth and slope metrics exhibiting lower (worse) average scores and hydrology and physical disturbance metrics exhibiting higher (better) average scores.

Some of the most highly altered spit/backshore and marsh/lagoon reaches on Bainbridge Island were located in the Point White - Battle Point MA (Figure B-71, Appendix C). Backshore Reaches 3533 and 3505 were characterized by exceptional amounts of armoring (>80%), most of which encroached into the intertidal zone, high levels of point modifications, and either shellfish closures due to pollution or a high %TIA in the marine riparian zone. Marsh/lagoon Reaches 3518 and 3522 near the mouth of Fletcher Bay were also characterized by high armoring rates, most of which encroached into the intertidal zone, high numbers of docks and piers, loss of overhanging riparian vegetation, subtidal dredging for channel maintenance, and shellfish closures due to pollution (Figure B-65).

Opportunities

Opportunities for improving scoring of CF metrics in MA-8 would target a variety of approaches to limiting impairment of controlling factors (Figure B-14). Action items might include minimizing and removing shoreline armoring and intertidal encroachment in areas where wave erosion is not an issue (e.g., Fletcher Bay) or in front of feeder bluffs, maximizing light penetration of overwater structures, checking and upgrading septic systems to improve water quality in Fletcher Bay, and reducing the amount of impervious surfaces in the marine riparian zone.

The EF scores were moderate in MA-8 (19.8) when compared with all other MAs on Bainbridge Island (Table A-4, Figure B-11, Appendix D). Spawning by forage fish, such as herring, sandlance, and surf smelt, has been documented within some reaches of MA-8, especially in the north near Battle Point (Figures B-69). Cutthroat trout, steelhead, chum, and coho salmon are also documented to spawn in Fletcher Creek (WRIA 15.0340) and other streams in Fletcher Bay. Efforts should be made to improve spawning access and functions of juvenile rearing areas, both in-stream and in nearby shoreline habitats. Geoduck beds have been documented throughout the MA-8 shoreline, although eelgrass is sparse-to-patchy along these shorelines (Figure B-68 and B-70).

Individual Reaches within MA-8 (Figure B-71, Appendix C, Appendix D)

Reach 3502

- CF Rating = Moderate/High Impact; Normalized score = -0.667
- Most impacted CF metrics: sediment supply, substrate type, depth/slope
- Least impacted CF metric: pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1640 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected

- Overhanging vegetation: 17.3%; Riparian zone land use: 24.1% TIA, 61.2% forested
- Total shoreline armoring: 94.4%; Total encroaching: 88.6%
- Total point modifications: 29; Density: 17.7/1000 ft; most common is stairs, with 5.5/1000 ft
- Other:
- EF Score: 24

Reach 3503
- CF Rating = Low/Moderate Impact ; Normalized score = -0.289
- Most impacted CF metric: sediment supply
- Least impacted CF metric: natural shade, artificial shade, pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 547 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 82.1%; Riparian zone land use: 8.2% TIA, 72% forested
- Total shoreline armoring: 33.8%; Total encroaching: 33.8%
- Total point modifications: 1; Density: 1.8/1000 ft; most common is outfalls, with 1.8/1000 ft
- Other:
- EF Score: 24

Reach 3504
- CF Rating = Moderate Impact ; Normalized score = -0.489
- Most impacted CF metric: sediment supply
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1524 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 59%; Riparian zone land use: 13.5% TIA, 54.8% forested
- Total shoreline armoring: 65.5%; Total encroaching: 57.4%
- Total point modifications: 19; Density: 12.5/1000 ft; most common is stairs, with 3.9/1000 ft
- Other:
- EF Score: 22

Reach 3505
- CF Rating = Moderate/High Impact, Normalized score = -0.725
- Most impacted CF metrics: sediment supply, substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1451 ft
- Sediment source: Unknown, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 11.1%; Riparian zone land use: 23.2% TIA, 21.8% forested
- Total shoreline armoring: 92.6%; Total encroaching: 61.2%
- Total point modifications: 35; Density: 24.1/1000 ft; most common is stairs, with 6.2/1000 ft
- Other: broad shallow foreshore
- EF Score: 20

Reach 3506
- CF Rating = Moderate Impact ; Normalized score = -0.467
- Most impacted CF metrics: natural shade, sediment supply
- Least impacted CF metric: pollution
- Geomorphic class: High Bluff; Shoreline length: 1237 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 19.4%; Riparian zone land use: 8.6% TIA, 83.2% forested
- Total shoreline armoring: 35.4%; Total encroaching: 35.4%
- Total point modifications: 7; Density: 5.7/1000 ft; most common is floating docks, with 1.6/1000 ft

- Other: natural LWD recruitment from cliff at south end
- EF Score: 24

Reach 3507
- CF Rating = Low Impact, Normalized score = -0.15
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: wave energy, natural shade, sediment supply, substrate type, depth/slope, pollution, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 501 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 5.5% TIA, 0% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 1; Density: 2/1000 ft; most common is buoys, with 2/1000 ft
- Other: Battle Point
- EF Score: 26

Reach 3508
- CF Rating = Low Impact, Normalized score = -0.2
- Most impacted CF metrics: pollution, physical disturbance
- Least impacted CF metric: wave energy, natural shade, artificial shade, sediment supply, substrate type, depth/slope
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 141 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 66.7% TIA, 0% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 0
- Other: Battle Point
- EF Score: 24

Reach 3509
- CF Rating = Low Impact, Normalized score = -0.15
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy, substrate type, depth/slope, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 3166 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 31.9%; Riparian zone land use: 11.1% TIA, 65.3% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 2; Density: 0.6/1000 ft; most common is piers, with 0.3/1000 ft
- Other: inside Battle Point
- EF Score: 18

Reach 3510
- CF Rating = Low Impact, Normalized score = -0.1
- Most impacted CF metric: artificial shade
- Least impacted CF metric: wave energy, natural shade, sediment supply, substrate type, depth/slope, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1210 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 3.5%; Riparian zone land use: 12.6% TIA, 45.5% forested
- Total shoreline armoring: 0%; Total encroaching: 0%

- Total point modifications: 3; Density: 2.5/1000 ft; most common is pilings, with 0.8/1000 ft
- Other:
- EF Score: 24

Reach 3511
- CF Rating = Moderate Impact ; Normalized score = -0.533
- Most impacted CF metrics: natural shade, sediment supply, substrate type
- Least impacted CF metric: hydrology
- Geomorphic class: Low Bank; Shoreline length: 1481 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 6.1%; Riparian zone land use: 23.3% TIA, 47.9% forested
- Total shoreline armoring: 70%; Total encroaching: 0%
- Total point modifications: 15; Density: 10.1/1000 ft; most common is stairs, with 2.7/1000 ft
- Other: encroachment appears to be underestimated
- EF Score: 30

Reach 3512
- CF Rating = Moderate Impact ; Normalized score = -0.55
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 718 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 39.5% TIA, 37% forested
- Total shoreline armoring: 51.8%; Total encroaching: 0%
- Total point modifications: 16; Density: 22.3/1000 ft; most common is upland structures at waterline, with 9.8/1000 ft
- Other:
- EF Score: 24

Reach 3513
- CF Rating = Low/Moderate Impact ; Normalized score = -0.325
- Most impacted CF metric: natural shade
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1421 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 6.8%; Riparian zone land use: 42.1% TIA, 33% forested
- Total shoreline armoring: 19.3%; Total encroaching: 0%
- Total point modifications: 3; Density: 2.1/1000 ft; most common is piers, with 2.1/1000 ft
- Other: heavy accumulation of LWD
- EF Score: 18

Reach 3514
- CF Rating = Low/Moderate Impact ; Normalized score = -0.375
- Most impacted CF metric: physical disturbance
- Least impacted CF metric: wave energy, natural shade, sediment supply, depth/slope
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 531 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 100% TIA, 0% forested
- Total shoreline armoring: 0%; Total encroaching: 0%
- Total point modifications: 8; Density: 15.1/1000 ft; most common is buoys, with 9.4/1000 ft
- Other: barrier beach in front of lagoon

- EF Score: 20

Reach 3515

- CF Rating = Low/Moderate Impact ; Normalized score = -0.4
- Most impacted CF metric: substrate type
- Least impacted CF metric: hydrology
- Geomorphic class: Low Bank; Shoreline length: 363 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 65.9%; Riparian zone land use: 29.6% TIA, 51.2% forested
- Total shoreline armoring: 59.5%; Total encroaching: 0%
- Total point modifications: 19; Density: 52.4/1000 ft; most common is upland structures at waterline, with 19.3/1000 ft
- Other:
- EF Score: 24

Reach 3516

- CF Rating = Moderate Impact ; Normalized score = -0.422
- Most impacted CF metric: sediment supply
- Least impacted CF metric: hydrology
- Geomorphic class: High Bluff; Shoreline length: 2377 ft
- Sediment source: Backshore, with feeder bluff activity; Wave exposure: protected
- Overhanging vegetation: 50.7%; Riparian zone land use: 19.3% TIA, 62.1% forested
- Total shoreline armoring: 62.7%; Total encroaching: 0%
- Total point modifications: 27; Density: 11.4/1000 ft; most common is stairs, with 3.8/1000 ft
- Other: downed trees and LWD recruitment from bluffs
- EF Score: 24

Reach 3517

- CF Rating = Moderate/High Impact ; Normalized score = -0.667
- Most impacted CF metrics: natural shade, depth/slope
- Least impacted CF metric: hydrology
- Geomorphic class: Low Bank; Shoreline length: 984 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 45.1% TIA, 35.9% forested
- Total shoreline armoring: 91.3%; Total encroaching: 29.6%
- Total point modifications: 13; Density: 13.2/1000 ft; most common is stairs, with 4.1/1000 ft
- Other: dredged regions present
- EF Score: 18

Reach 3518

- CF Rating = Moderate/High Impact, Normalized score = -0.7
- Most impacted CF metrics: natural shade, substrate type, depth/slope, pollution
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 763 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 16.5% TIA, 47.8% forested
- Total shoreline armoring: 99.3%; Total encroaching: 24.2%
- Total point modifications: 14; Density: 18.4/1000 ft; most common is stairs, with 7.9/1000 ft
- Other: dredged regions, and shellfish closure present; large tide flats, mouth of Fletcher Bay
- EF Score: 15

Reach 3519

- CF Rating = Moderate Impact ; Normalized score = -0.575
- Most impacted CF metrics: substrate type, pollution
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 664 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 47.7%; Riparian zone land use: 27% TIA, 50.2% forested
- Total shoreline armoring: 82.2%; Total encroaching: 0%
- Total point modifications: 16; Density: 24.1/1000 ft; most common is floating docks, with 7.5/1000 ft
- Other: shellfish closure present; inside Fletcher Bay
- EF Score: 16

Reach 3520

- CF Rating = Moderate Impact ; Normalized score = -0.6
- Most impacted CF metrics: substrate type, pollution
- Least impacted CF metric: wave energy, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 388 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 23%; Riparian zone land use: 15.6% TIA, 58.4% forested
- Total shoreline armoring: 89.5%; Total encroaching: 0%
- Total point modifications: 7; Density: 18/1000 ft; most common is floating docks, with 7.7/1000 ft
- Other: shellfish closure present; small inlet in Fletcher Bay
- EF Score: 13

Reach 3521

- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metric: pollution
- Least impacted CF metric: wave energy, natural shade, hydrology
- Geomorphic class: Marsh/Lagoon; Shoreline length: 6268 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 84.4%; Riparian zone land use: 16.1% TIA, 63.8% forested
- Total shoreline armoring: 11.5%; Total encroaching: 4.6%
- Total point modifications: 34; Density: 5.4/1000 ft; most common is floating docks, with 2.1/1000 ft
- Other: shellfish closure present
- EF Score: 20

Reach 3522

- CF Rating = Moderate/High Impact ; Normalized score = -0.675
- Most impacted CF metrics: depth/slope, pollution
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 2373 ft
- Sediment source: Backshore; Wave exposure: very protected
- Overhanging vegetation: 37.1%; Riparian zone land use: 31.2% TIA, 55.8% forested
- Total shoreline armoring: 57.5%; Total encroaching: 47.3%
- Total point modifications: 56; Density: 23.6/1000 ft; most common is floating docks, with 6.7/1000 ft
- Other: dredged regions, 1 marina(s), and shellfish closure present, high bluffs in backshore
- EF Score: 21

Reach 3523

- CF Rating = Moderate Impact ; Normalized score = -0.429
- Most impacted CF metrics: depth/slope, pollution
- Least impacted CF metric: wave energy, natural shade, artificial shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 402 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 31.6% TIA, 0% forested
- Total shoreline armoring: 3.9%; Total encroaching: 3.9%
- Total point modifications: 0
- Other: dredged regions, and shellfish closure present; inside southern spit of Fletcher Bay
- EF Score: 18

Reach 3524

- CF Rating = Moderate Impact ; Normalized score = -0.425
- Most impacted CF metric: depth/slope
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 401 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 33.3% TIA, 0% forested
- Total shoreline armoring: 10.1%; Total encroaching: 10.1%
- Total point modifications: 2; Density: 5/1000 ft; most common is buoys, with 5/1000 ft
- Other: dredged regions present; southern barrier to Fletcher Bay
- EF Score: 19

Reach 3525

- CF Rating = Moderate/High Impact, Normalized score = -0.733
- Most impacted CF metrics: wave energy, natural shade, substrate type, depth/slope
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1525 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 38.6% TIA, 48.5% forested
- Total shoreline armoring: 91.3%; Total encroaching: 84%
- Total point modifications: 30; Density: 19.7/1000 ft; most common is stairs, with 6.6/1000 ft
- Other:
- EF Score: 16

Reach 3526

- CF Rating = Low/Moderate Impact, Normalized score = -0.222
- Most impacted CF metrics: artificial shade, sediment supply, substrate type
- Least impacted CF metric: pollution, hydrology
- Geomorphic class: High Bluff; Shoreline length: 2324 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 76.1%; Riparian zone land use: 7.7% TIA, 90.2% forested
- Total shoreline armoring: 22.8%; Total encroaching: 11.6%
- Total point modifications: 17; Density: 7.3/1000 ft; most common is stairs, with 2.6/1000 ft
- Other: good setbacks, much LWD accumulation on beach
- EF Score: 24

Reach 3527

- CF Rating = Low/Moderate Impact ; Normalized score = -0.289
- Most impacted CF metrics: artificial shade, sediment supply, substrate type, pollution

- Least impacted CF metric: wave energy, natural shade, depth/slope, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1004 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 62%; Riparian zone land use: 14.5% TIA, 82.3% forested
- Total shoreline armoring: 28.5%; Total encroaching: 6.5%
- Total point modifications: 5; Density: 5/1000 ft; most common is floating docks, with 2/1000 ft
- Other:
- EF Score: 22

Reach 3528
- CF Rating = Low Impact, Normalized score = -0.111
- Most impacted CF metrics: wave energy, natural shade, sediment supply, substrate type, depth/slope
- Least impacted CF metric: artificial shade, pollution, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1256 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 73.7%; Riparian zone land use: 3.3% TIA, 93% forested
- Total shoreline armoring: 11.5%; Total encroaching: 2.4%
- Total point modifications: 4; Density: 3.2/1000 ft; most common is stairs, with 1.6/1000 ft
- Other: lots of LWD accumulation
- EF Score: 22

Reach 3529
- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metrics: artificial shade, substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 755 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 33.6% TIA, 53% forested
- Total shoreline armoring: 29%; Total encroaching: 0%
- Total point modifications: 13; Density: 17.2/1000 ft; most common is upland structures at waterline, with 4/1000 ft
- Other: broad beach on small spit of land
- EF Score: 16

Reach 3530
- CF Rating = Moderate/High Impact ; Normalized score = -0.689
- Most impacted CF metrics: wave energy, substrate type
- Least impacted CF metric: pollution, hydrology, physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 3301 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 15.9%; Riparian zone land use: 16.7% TIA, 67.8% forested
- Total shoreline armoring: 83.2%; Total encroaching: 44.4%
- Total point modifications: 73; Density: 22.1/1000 ft; most common is buoys, with 5.1/1000 ft
- Other:
- EF Score: 18

Reach 3531
- CF Rating = Moderate/High Impact ; Normalized score = -0.667
- Most impacted CF metrics: substrate type, depth/slope

- Least impacted CF metric: artificial shade, pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1562 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 31.5%; Riparian zone land use: 12.8% TIA, 68.8% forested
- Total shoreline armoring: 90.5%; Total encroaching: 81.1%
- Total point modifications: 28; Density: 17.9/1000 ft; most common is groins, with 5.1/1000 ft
- Other:
- EF Score: 16

Reach 3532
- CF Rating = Moderate Impact ; Normalized score = -0.475
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 564 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 24.3% TIA, 57.8% forested
- Total shoreline armoring: 51.8%; Total encroaching: 38.1%
- Total point modifications: 8; Density: 14.2/1000 ft; most common is stairs, with 3.5/1000 ft
- Other:
- EF Score: 16

Reach 3533
- CF Rating = Moderate/High Impact, Normalized score = -0.75
- Most impacted CF metrics: wave energy, substrate type, pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1279 ft
- Sediment source: Unknown; Wave exposure: protected
- Overhanging vegetation: 12.8%; Riparian zone land use: 35.6% TIA, 41.4% forested
- Total shoreline armoring: 80.3%; Total encroaching: 43.3%
- Total point modifications: 29; Density: 22.7/1000 ft; most common is stairs, with 5.5/1000 ft
- Other: shellfish closure present
- EF Score: 18

Reach 3534
- CF Rating = Moderate Impact ; Normalized score = -0.575
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 622 ft
- Sediment source: Unknown; Wave exposure: protected
- Overhanging vegetation: 12.3%; Riparian zone land use: 7.8% TIA, 46.9% forested
- Total shoreline armoring: 83.8%; Total encroaching: 0%
- Total point modifications: 4; Density: 6.4/1000 ft; most common is outfalls, with 3.2/1000 ft
- Other: shellfish closure present; cleared for road
- EF Score: 18

Reach 3535
- CF Rating = Moderate Impact ; Normalized score = -0.575
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 987 ft
- Sediment source: Backshore; Wave exposure: protected

- Overhanging vegetation: 30.5%; Riparian zone land use: 35.9% TIA, 41.6% forested
- Total shoreline armoring: 53.4%; Total encroaching: 0%
- Total point modifications: 22; Density: 22.3/1000 ft; most common is buoys, with 5.1/1000 ft
- Other: shellfish closure present; road fronts shoreline
- EF Score: 18

Reach 3536
- CF Rating = Low/Moderate Impact ; Normalized score = -0.3
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade, artificial shade, physical disturbance
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 565 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: No data on %TIA, No data on %forested
- Total shoreline armoring: 15.1%; Total encroaching: 0%
- Total point modifications: 0
- Other: shellfish closure present, some encroachment by waterfront homes
- EF Score: 18

Reach 3537
- CF Rating = Moderate Impact ; Normalized score = -0.5
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 1080 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 8.5%; Riparian zone land use: 20.7% TIA, 38.8% forested
- Total shoreline armoring: 12.2%; Total encroaching: 0%
- Total point modifications: 20; Density: 18.5/1000 ft; most common is buoys, with 6.5/1000 ft
- Other: shellfish closure present; road fronts shoreline
- EF Score: 16

Reach 3538
- CF Rating = Moderate/High Impact ; Normalized score = -0.625
- Most impacted CF metric: pollution
- Least impacted CF metric: natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 3031 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 32.3% TIA, 20.2% forested
- Total shoreline armoring: 93.4%; Total encroaching: 3.3%
- Total point modifications: 30; Density: 9.9/1000 ft; most common is stairs, with 3.6/1000 ft
- Other: shellfish closure present; road fronts shoreline
- EF Score: 14

Reach 3539
- CF Rating = Moderate/High Impact ; Normalized score = -0.667
- Most impacted CF metric: pollution
- Least impacted CF metric: physical disturbance
- Geomorphic class: Low Bank; Shoreline length: 1243 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 10.8%; Riparian zone land use: 37.9% TIA, 47.1% forested
- Total shoreline armoring: 94%; Total encroaching: 38.9%

- Total point modifications: 6; Density: 4.8/1000 ft; most common is overwater structures, with 1.6/1000 ft
- Other: shellfish closure present; road fronts shoreline
- EF Score: 14

3.2.9 Manzanita Bay Management Area (MA-9) (Reaches 3492 – 3501)

Qualitative Rating = Moderate Impact
Mean CF Score (Normalized) = -0.49 (Range: -0.71 to -0.13)
Median CF Score (Normalized) = -0.54
Number of Reaches = 10

Mean EF Score = 23.9 (Range: 20 to 33)
Median EF Score = 22.5

Description
Manzanita Bay (MA-9) is the smallest management area on Bainbridge Island, comprising 18,879 linear feet of shoreline that encompass all of Manzanita Bay and Arrow Point (Table A-1, Figure 2). MA-9 comprises only 10 reaches composed of the following geomorphic classes: marsh/lagoon (3), high bluff (3), spit/backshore (2), and low bluff (2) (Figure B-61). MA-9 is basically defined by four drift cells (Figure 3). The first drift cell begins at a divergence zone located outside the northern margin of Manzanita Bay and moves south into Little Manzanita Bay. The second drift cell is quite small and moves eastward into Little Manzanita Bay along its south shore. The third and fourth drift cells move south from divergence zones near Arrow Point and south of Little Manzanita Bay and converge at the head of Big Manzanita Bay. Relative to wave exposure, shorelines of MA-9 are considered "very-protected" in upper embayment reaches, or "protected" (Figure B-62). No feeder bluffs have been documented in MA-9. Manzanita Bay receives upland flows from two watersheds with low to moderate levels of land use: Manzanita Creek (WRIA 15.0344; TIA 5%) and WRIA unnumbered 29 (TIA <1%).

Overhanging riparian vegetation covers approximately 35% of the MA-9 shoreline, ranking this MA among the best on Bainbridge Island in this category (Table A-1, Figure B-67). Within the 200-ft riparian zone, naturally vegetated surfaces (coniferous and deciduous trees, shrubs, and wetlands) compose 70% of land cover, whereas impervious surfaces (e.g., roads, roofs) represent only 12% of land cover (Figure B-66). As such, riparian zone land-cover in Manzanita Bay is among the best of all Bainbridge Island MAs.

Shoreline development in MA-9 is primarily residential. Approximately 57% of the shoreline is modified by armoring, and 29% of the shoreline has armoring that encroaches into the intertidal zone, among the highest rates for any MA on Bainbridge Island (Table A-1, Figure B-63). A total of 218 point modifications were recorded along MA-9 shorelines, at an average of 11.5 modifications per 1000 ft (Figure B-64). Most of the modifications along this protected embayment were represented by stairs (63), docks (42), overwater structures (12), groins (7), and piers (9). A total of 9 outfalls were also recorded along MA-9 shorelines.

Limiting Factors
The average normalized controlling factor (CF) score within MA-9 was -0.49, within the middle range of MA scores on Bainbridge Island (Table A-2, Figure B-10, Figure B-13). However, Manzanita Bay (MA-9) had among the lowest (worst) scores of all MAs in five of the nine metrics: natural shade, artificial shade, sediment supply, substrate type, and depth/slope (Table A-3, Figure B-16). As was seen in MA-1, the Manzanita Bay MA scored low (bad) on the natural shade metric despite having a relatively high total percentage (35%) of shoreline with overhanging riparian vegetation. Closer examination of the data

revealed that the shoreline along most reaches in MA-9 displayed relatively low coverage of overhanging vegetation (0% to 18%), whereas a few long marsh/lagoon reaches had cover exceeding 50%. Artificial shade scores were influenced primarily by the high density of shade-causing structures such as docks, piers, boats, buoys, and other overwater structures found in this protected anchorage. Sediment supply scores were affected primarily by the high percentage of armoring (57%), especially in front of areas with documented backshore sediment sources, combined with multiple groins (7) and drift-intercepting ramps in areas with alongshore sediment sources. The substrate type metric was similarly influenced by heavily armored shorelines combined with relatively high densities of point modifications. Low (poor) depth and slope scores also reflected the relatively high rate of armoring, combined with encroachment rates (29%), along Manzanita Bay shorelines.

Manzanita Bay (MA-9) had one of the best (highest) scores of all MAs in the pollution metric (Table A-3, Figure B-16). This is partly because of the absence of recreational shellfish closures and warnings, though it should be noted that Manzanita Bay has not been classified by the WA Department of Health. Low pollution metric scores were further aided by few marinas, low outfall densities, and a relatively low %TIA (12%) in the marine riparian zone.

<u>Opportunities</u>
One of the most obvious opportunities for improving scores in a number of MA-9 metrics would be to minimize and remove shoreline armoring, especially since this is not a high wave-energy area. Scores would also improve by removing or maximizing light penetration under existing shade-causing structures, or reducing the number of docks and overwater structures.

The EF scores are particularly high in MA-9 (23.9) relative to other MAs on Bainbridge Island (Table A-4, Figure B-11, Appendix D). This was likely due to the prevalence of documented spawning by all three forage-fish species (herring, sandlance, and surf smelt) (Figures B-69). Cutthroat trout, chum, and coho salmon are also documented to spawn in the Manzanita Creek (WRIA 15.0344), and efforts should be made to maximize adult passage and juvenile rearing functions, both in-stream and in nearby shoreline habitats. Eelgrass is fairly sparse along most Manzanita Bay shorelines, although geoduck and clam resources are abundant (Figure B-68, Figure B-70).

<u>Individual Reaches within MA-9</u> (Figure B-71, Appendix C, Appendix D)

Reach 3492
- CF Rating = Moderate Impact; Normalized score = -0.525
- Most impacted CF metric: substrate type
- Least impacted CF metric: natural shade, hydrology
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 2034 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 2.6%; Riparian zone land use: 22.6% TIA, 61.1% forested
- Total shoreline armoring: 95.6%; Total encroaching: 5%
- Total point modifications: 39; Density: 19.2/1000 ft; most common is stairs, with 5.9/1000 ft
- Other:
- EF Score: 22

Reach 3493
- CF Rating = Moderate Impact ; Normalized score = -0.425
- Most impacted CF metrics: artificial shade, substrate type, depth/slope
- Least impacted CF metric: wave energy
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1209 ft
- Sediment source: Alongshore; Wave exposure: protected

- Overhanging vegetation: 57.3%; Riparian zone land use: 13% TIA, 72.2% forested
- Total shoreline armoring: 38.7%; Total encroaching: 33.8%
- Total point modifications: 11; Density: 9.1/1000 ft; most common is buoys, with 3.3/1000 ft
- Other: small embayment, some fronting road
- EF Score: 23

Reach 3494
- CF Rating = Low Impact, Normalized score = -0.125
- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy, natural shade, pollution, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 4804 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 81.3%; Riparian zone land use: 7.5% TIA, 75.9% forested
- Total shoreline armoring: 18%; Total encroaching: 4.5%
- Total point modifications: 25; Density: 5.2/1000 ft; most common is stairs, with 2.5/1000 ft
- Other:
- EF Score: 26

Reach 3495
- CF Rating = Moderate/High Impact ; Normalized score = -0.622
- Most impacted CF metrics: natural shade, depth/slope
- Least impacted CF metric: pollution, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 1470 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 11.6% TIA, 81.3% forested
- Total shoreline armoring: 99.9%; Total encroaching: 76.9%
- Total point modifications: 16; Density: 10.9/1000 ft; most common is stairs, with 4.1/1000 ft
- Other:
- EF Score: 33

Reach 3496
- CF Rating = Moderate Impact ; Normalized score = -0.556
- Most impacted CF metric: substrate type
- Least impacted CF metric: pollution, hydrology, physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 3076 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 29.9%; Riparian zone land use: 14.4% TIA, 58.8% forested
- Total shoreline armoring: 52.8%; Total encroaching: 36.6%
- Total point modifications: 50; Density: 16.3/1000 ft; most common is floating docks, with 4.9/1000 ft
- Other:
- EF Score: 30

Reach 3497
- CF Rating = Low Impact, Normalized score = -0.2
- Most impacted CF metrics: natural shade, artificial shade, sediment supply
- Least impacted CF metric: wave energy, pollution, hydrology, physical disturbance
- Geomorphic class: Marsh/Lagoon; Shoreline length: 1698 ft
- Sediment source: Foreshore; Wave exposure: very protected
- Overhanging vegetation: 50.1%; Riparian zone land use: 8.2% TIA, 64.9% forested
- Total shoreline armoring: 6.3%; Total encroaching: 6.3%

- Total point modifications: 8; Density: 4.7/1000 ft; most common is stairs, with 1.2/1000 ft
- Other:
- EF Score: 23

Reach 3498
- CF Rating = Moderate/High Impact, Normalized score = -0.711
- Most impacted CF metrics: natural shade, substrate type, depth/slope
- Least impacted CF metric: pollution
- Geomorphic class: Low Bank; Shoreline length: 1414 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 8.3% TIA, 73.9% forested
- Total shoreline armoring: 90.1%; Total encroaching: 74.8%
- Total point modifications: 24; Density: 17/1000 ft; most common is stairs, with 4.2/1000 ft
- Other:
- EF Score: 20

Reach 3499
- CF Rating = Moderate Impact ; Normalized score = -0.6
- Most impacted CF metrics: natural shade, substrate type
- Least impacted CF metric: hydrology
- Geomorphic class: Low Bank; Shoreline length: 2080 ft
- Sediment source: Alongshore; Wave exposure: protected
- Overhanging vegetation: 0%; Riparian zone land use: 12.6% TIA, 73.2% forested
- Total shoreline armoring: 91.8%; Total encroaching: 16.8%
- Total point modifications: 32; Density: 15.4/1000 ft; most common is stairs, with 4.8/1000 ft
- Other: 1 marina(s) present
- EF Score: 20

Reach 3500
- CF Rating = Moderate Impact ; Normalized score = -0.514
- Most impacted CF metric: substrate type
- Least impacted CF metric: wave energy, natural shade
- Geomorphic class: Spit/Barrier/Backshore; Shoreline length: 427 ft
- Sediment source: Alongshore; Wave exposure: very protected
- Overhanging vegetation: 0%; Riparian zone land use: 20.8% TIA, 65.4% forested
- Total shoreline armoring: 99.5%; Total encroaching: 53%
- Total point modifications: 6; Density: 14.1/1000 ft; most common is upland structures at waterline, with 4.7/1000 ft
- Other:
- EF Score: 22

Reach 3501
- CF Rating = Moderate Impact ; Normalized score = -0.578
- Most impacted CF metric: depth/slope
- Least impacted CF metric: physical disturbance
- Geomorphic class: High Bluff; Shoreline length: 668 ft
- Sediment source: Backshore; Wave exposure: protected
- Overhanging vegetation: 17.7%; Riparian zone land use: 14% TIA, 79% forested
- Total shoreline armoring: 100%; Total encroaching: 100%
- Total point modifications: 7; Density: 10.5/1000 ft; most common is stairs, with 4.5/1000 ft
- Other:

- EF Score: 20

3.3 Validating Assessment Scores

Graphs of the controlling factor and ecological function metric scores paired by reach suggest a slight correlation between impaired controlling factors and reduced ecological function (Figure B-72). In other words, when assessments suggest impairment of controlling factors within a particular shoreline reach (low score), habitat diversity and other indicators of ecological function (e.g., forage-fish spawning) are often reduced (low score). This relationship appears to be more pronounced in some geomorphic settings, such as low bank, marsh/lagoon, and spit/barrier/backshore habitats (Figures B-74, B-75, B-76), than in others (e.g., high bluffs; Figure B-73). Additional examination of reaches where this relationship does not hold may be useful for refining assessment techniques. As well, these graphical relationships only provide a first step at describing trends. Future efforts should use this information to design studies that address links between individual and cumulative impacts to specific ecological functions. More detailed analysis and discussion of this topic as it relates to prioritizing management actions is included in Appendix E.

3.4 Summary Conclusions and Recommendations

Although Bainbridge Island is generally considered semi-rural, over 82% of shoreline parcels are developed to densities only second to the Islands urban centers, and 52% of the shoreline is armored or otherwise modified. Its nearshore ecosystems provide support for a vast number of marine plants and animals and are vital to sustaining endangered species such as salmon, although in many cases these biological functions remain unquantified. The present report outlines a science-based framework for assessing the status of nearshore ecological conditions on Bainbridge Island.

This assessment is intended as a screening tool for prioritizing management actions Island-wide, and should be considered a living document that can be continuously refined as our knowledge base increases. The assessment framework is comprised of the following components:

- A conceptual model that is based on the best available science for the nearshore ecosystem. This model organizes the linkages between human impacts/actions, controlling factors, habitat structure, and ecological functions.
- Two ecologically- relevant spatial scales: reach and management area;
- Geomorphic context at the reach level;
- A scoring system based on the status of nine controlling factors metrics;
- An attempt to validate the scoring with limited existing data on ecological functions.

Key findings of the nearshore assessment were as follows:

- Bainbridge Island's shoreline represents a microcosm of what is generally found in Puget Sound, with moderate levels of impacts to nearshore resources, but extreme examples of high and low impacts as well. Most management areas were considered moderately impacted by human activities.
- Of nine MAs on Bainbridge Island, only Eagle Harbor (MA-5) was considered highly impacted; this MA included some of the most highly disturbed reaches found around the Island. Two MAs stood out as relatively undisturbed or least impacted: Murden Cove (MA-4) and Blakely Harbor (MA-6).

- At a reach level, assessment scoring did identify some stretches of shoreline commonly acknowledged as highly impacted or modified by human actions (e.g., reaches associated with the Wyckoff Superfund site on Bill Point and below feeder bluffs in Rolling Bay), as well as the more pristine reaches with minimal human impacts.
- The substrate type and depth/slope metrics represented the most impacted controlling factors over the entire Island. Low (poor) scores in these metrics suggest that high rates of shoreline armoring, armoring encroachment, and point modifications have significantly changed the historic composition of substrate and depth-slope contours along Bainbridge Island shorelines. Impacts to these controlling factors have likely caused significant affects to the nearshore ecosystem. Most nearshore organisms and habitats assemblages are dependent on specific substrate characteristics (e.g. rocky or sandy) and are limited to particular tidal elevations due to light availability and sensitivity to exposure out of water. Changes in substrate type or depth/slope may have caused habitat shifts or reduced the available area suitable for the formation of habitats and the processes necessary to sustain habitats.
- The hydrology and physical disturbance metrics represented the least-impacted controlling factors Island-wide. The relatively higher (better) scores in these metrics suggest that low-to-moderate intensity residential land use (as opposed to high-intensity urban or industrial land use) along many of the Island's shorelines has likely helped keep impacts to hydrology low and limited physical disturbances. These controlling factors can be sustained by maintaining forested marine riparian zones as well as avoiding and reducing intertidal/subtidal fill, tidal constrictions, and encroaching armoring. The discharge of untreated stormwater should be avoided and reduced. Floats, boats and mooring buoys should be located in deep water where they will not ground. Boats and boating facilities, including docks, buoys, and boat ramps, should be located to avoid and operated to minimize impacts to kelp, eelgrass, and other sensitive habitats.
- Scoring of some cumulative landscape (MA) controlling factor metrics might be improved in future updates of the assessment. For example, average cumulative MA scores associated with the natural shade metric were sometimes negatively associated with conditions at the landscape scale. High (good) scores were observed in MAs with a low total percentage of overhanging riparian vegetation along shorelines, and vice-versa. This discrepancy can largely be attributed to geomorphic factors (i.e., natural shade was not considered an issue in exposed beach/backshore/spit habitats) but may also indicate a weakness in the method for calculating cumulative landscape (MA) assessment scores. Refining the methods used to calculate cumulative landscape (MA) assessment scores (such as including reach length as a means of standardization) and to characterize the cumulative landscape (MA) assessment scoring (such as using median and highest/lowest quartiles) could improve the accuracy of cumulative landscape (MA) assessment results.
- Scoring of some ecological function might be improved in future updates of the assessment. Scores of documented ecological functions were highest (best) in the northern portions of Bainbridge Island, including Manzanita Bay (MA-9), Agate Passage (MA-1), and Port Madison Bay (MA-2). In contrast, the lowest (worst) EF scores were observed in Eagle Harbor (MA-5), Blakely Harbor (MA-6), and Rich Passage (MA-7). However, these scores were highly influenced by the presence of forage fish spawning habitats, one of the few ecological functions that has not been thoroughly and consistently quantified across all reaches, therefore possibly depressing scores where spawning has not yet been evaluated. Predictive mapping of spawning substrate based on sediment characteristics may prove a useful intermediate tool to assess forage fish metrics until field surveys are conducted. EF scoring might be further refined in future updates of the assessment, with distinctions drawn based on geomorphic context, similar to how CF scores where modified in this assessment.

- Preliminary validation efforts suggest that low (poor) controlling factors scores are often correlated with reduced habitat diversity and other indicators of ecological function (e.g., forage-fish spawning), especially in some geomorphic settings. Closer examination of outliers may assist in refining assessment techniques and selecting a more appropriate suite of parameters for monitoring.
- The current assessment methodology primarily focuses on aquatic habitats and functions. Future updates to the assessment should add focus to backshore and marine riparian habitats and functions.
- Improved mapping of feeder bluffs and other sediment sources should be conducted.
- In general, the assessment appeared to offer the right balance of detail and consistency when used as the first step in a screening process for management options.

Appendix E outlines management strategies that are appropriate for Bainbridge Island nearshore habitats, based on the following points:

- Management strategies are applied, in part, based on geomorphic conditions at the reach (site) and management area (landscape) levels. Five fundamental strategies for improving ecosystem functions of nearshore systems include habitat creation, enhancement, restoration, conservation, and preservation.
- Landscape ecology considerations were included in defining management strategies. Management strategy recommendations are assigned according to the level of disturbance at both the management area and reach scales (Figure B-14). If damages are great at both scales, fewer management strategies are likely to be successful. Conversely, if damage is relatively low on both scales, there is a broader array of management options. For example, it would make little sense to restore the ecosystem at a heavily damaged nearshore site (reach) if the landscape (management area) upon which this site depends is also heavily damaged. A more appropriate strategy would be restoration or enhancement of selected attributes of the reach.
- To better refine management actions for a particular site (reach or portion of a reach), eight criteria can be used to enhance ecosystem structure and function based on landscape ecology and restoration ecology principles. The criteria include site size, habitat complexity, accessibility, connectance, potential to conform to natural conditions, potential for self-maintenance, potential benefit to nearshore dependent threatened and endangered species, and potential to improve ecosystem functions (e.g., forage fish spawning areas) within a particular reach or management area.
- The assessment and prioritization framework will be most effective when it involves the local expertise of scientists and resource managers who are familiar with the Bainbridge Island shoreline and its ecological resources.

Assessing the results of management actions requires a monitoring program (Appendix F), which will assist in determining not only whether the actions are successful, but how to adaptively modify or adjust management actions to make them more successful. Other key points that are discussed and considered in the monitoring recommendations include:

- Consideration of monitoring goals, scale (effort in time and space), timing, sampling design and replication, reference site designation, attribute selection, sampling methods, and costs.
- Focus on monitoring that provides data for key attributes within the conceptual framework. In this way, monitoring will link processes to the nearshore habitat structure, integrate a multitude of nearshore habitats that support a variety of functions, establish relationships between structure and function, and ultimately can scale local processes to the broader Puget Sound ecosystem. Suggested key monitoring attributes include: controlling factors (e.g., water quality, sediment processes,

shoreline modifications), habitat structure (e.g., land use-land cover assessment, nearshore riparian cover, shallow water aquatic habitats), and ecological functions (e.g., fish assemblages, exotic species).

- To opportunistically fulfill a range of monitoring goals using rigorous methods under the limited resources (both funding and personnel) available at a local level, we recommend: 1) selectively monitoring several key nearshore parameters; 2) focusing monitoring efforts at ongoing local monitoring and assessment activities; 3) using consistent and standardized protocols; 4) forging partnerships and involving other stakeholders; and 5) leveraging opportunities with existing resources unique to Bainbridge Island.

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Appendix A

Tables

Table A-1. Shoreline Modifications and Land Use Information by Management Area.

Management Area	Total Shore length	Armor	Encroach	Point Modifications	Overhanging Veg.	Total Riparian Zone Area	Natural Vegetated Area	Total Impervious Area
	ft	ft	ft	Total	ft	ft^2	ft^2	ft^2
Agate Passage (1)	19,495	11,136	4,101	235	7,098.61	2,765,779	1,981,630	457,196
Port Madison Bay (2)	32,037	19,669	11,128	445	8,264.83	5,927,938	3,895,986	848,732
Rolling Bay-Pt Monroe (3)	29,707	11,408	8,001	291	8,476.87	4,850,204	2,741,291	832,855
Murden Cove (4)	28,843	9,782	5,419	86	10,457.85	5,235,820	3,026,803	924,348
Eagle Harbor (5)	46,054	24,376	13,750	506	10,626.11	8,608,682	3,108,878	3,842,974
Blakely Harbor (6)	20,345	4,534	3,509	132	5,863.43	3,546,429	2,109,451	682,699
Rich Passage (7)	34,565	17,982	7,134	402	2,674.87	6,618,710	2,788,114	1,696,926
Pt Whie-Battle Pt (8)	51,650	25,907	11,508	616	16,395.04	8,887,467	4,992,018	1,942,880
Manzanita Bay (9)	18,879	10,752	5,389	218	6,541.83	3,578,452	2,502,064	428,941
All	**281,574**	**135,546**	**69,937**	**2,931**	**76,399.44**	**50,019,481**	**27,146,236**	**11,657,551**
		% Length	% Length	Per 1000ft	% Length		% Riparian Zone	% Riparian Zone
Agate Passage (1)		57%	21%	12.1	36%		72%	17%
Port Madison Bay (2)		61%	35%	13.9	26%		66%	14%
Rolling Bay-Pt Monroe (3)		38%	27%	9.8	29%		57%	17%
Murden Cove (4)		34%	19%	3.0	36%		58%	18%
Eagle Harbor (5)		53%	30%	11.0	23%		36%	45%
Blakely Harbor (6)		22%	17%	6.5	29%		59%	19%
Rich Passage (7)		52%	21%	11.6	8%		42%	26%
Pt Whie-Battle Pt (8)		50%	22%	11.9	32%		56%	22%
Manzanita Bay (9)		57%	29%	11.5	35%		70%	12%
All		**48%**	**25%**	**10.4**	**27%**		**54%**	**23%**

Table A-2. Summary Statistics of Normalized Reach Controlling Factors Scores by Management Area.

Management Area	Qualitative Impact Rating	Average	Median	Worst	Best	n
Agate Passage (1)	Moderate	-0.470	-0.544	-0.689	0.000	12
Port Madison Bay (2)	Moderate	-0.471	-0.480	-0.700	-0.025	24
Rolling Bay-Pt Monroe (3)	Moderate	-0.421	-0.433	-0.800	-0.125	18
Murden Cove (4)	Low/Moderate	-0.334	-0.340	-0.644	0.000	20
Eagle Harbor (5)	Moderate	-0.559	-0.578	-0.867	-0.250	35
Blakely Harbor (6)	Low/Moderate	-0.295	-0.329	-0.675	0.000	16
Rich Passage (7)	Moderate	-0.468	-0.463	-0.778	-0.050	28
Pt White-Battle Pt (8)	Moderate	-0.466	-0.482	-0.750	-0.100	38
Manzanita Bay (9)	Moderate	-0.486	-0.540	-0.711	-0.125	10
ALL Reaches	**Moderate**	**-0.454**	**-0.475**	**-0.867**	**0.000**	**201**
ALL MA Scores	**Moderate**	**-0.441**	**-0.468**	**-0.559**	**-0.295**	**9**

Table A-3. Raw Controlling Factors Scores by Management Area and Metric.
(Font Color Indicates Two Worst (Red) and Best (Green) Scores in Each Metric. Range from 0 to -5)

Management Area	**Wave Energy**	**Natural Shade**	**Artificial Shade**	**Sediment Supply**	**Substrate Type**	**Depth-Slope**	**Pollut.**	**Hydrol.**	**Phys. Disturb.**	Average
Agate Passage (1)	-2.42	**-2.75**	-1.92	**-2.92**	-3.42	-2.17	**-3.00**	**-1.58**	**-1.00**	-2.35
Port Madison Bay (2)	**-0.96**	-2.29	**-2.79**	-2.50	**-3.54**	-2.92	-1.33	-1.04	-1.75	-2.13
Rolling Bay-Pt Monroe (3)	**-2.50**	-2.39	**-1.33**	-2.61	-2.67	-2.61	-1.67	**-1.00**	-1.50	-2.03
Murden Cove (4)	-2.10	-1.95	**-0.45**	-2.35	**-2.00**	**-2.10**	-1.95	-1.05	**-0.55**	-1.61
Eagle Harbor (5)	-1.94	-2.11	-2.09	-2.29	-3.03	**-3.14**	**-4.74**	**-1.74**	**-2.14**	-2.58
Blakely Harbor (6)	**-1.63**	**-0.75**	-1.50	**-1.44**	**-1.75**	**-1.94**	-0.94	**-0.88**	-1.06	-1.32
Rich Passage (7)	**-2.43**	**-0.71**	-1.86	**-2.32**	-2.86	-2.39	-2.50	-1.36	**-1.96**	-2.04
Pt Whie-Battle Pt (8)	-2.00	-1.61	-2.24	-2.53	-3.05	-2.61	-2.61	-1.05	-1.84	-2.17
Manzanita Bay (9)	-2.10	**-2.60**	**-2.50**	**-3.10**	**-3.80**	**-3.30**	**-1.00**	-1.10	-1.20	-2.30
All	**-1.98**	**-1.81**	**-1.90**	**-2.41**	**-2.90**	**-2.61**	**-2.47**	**-1.23**	**-1.60**	**-2.10**

Table A-4. Ecological Functional Scores by Management Area and Metric.
(Shading Highlights Management Areas with Lowest (Red) and Highest (Green) Quantified Functions. Range from 0 to 50)

Management Area	Reach Average	Median	Max	Min	n
Agate Passage (1)	**28.42**	29.00	32.00	22.00	12
Port Madison Bay (2)	23.08	20.00	36.00	16.00	24
Rolling Bay-Pt Monroe (3)	22.67	23.50	26.00	18.00	18
Murden Cove (4)	20.20	20.50	26.00	13.00	20
Eagle Harbor (5)	17.91	18.00	24.00	12.00	35
Blakely Harbor (6)	17.56	17.00	27.00	10.00	16
Rich Passage (7)	**16.07**	15.50	22.00	12.00	28
Pt White-Battle Pt (8)	19.79	18.50	30.00	13.00	38
Manzanita Bay (9)	23.90	22.50	33.00	20.00	10
ALL Reach Scores	**20.18**	**20.00**	**36.00**	**10.00**	**201**
ALL MA Scores	**21.07**	**20.20**	**28.42**	**16.07**	**9**

Note: Ecological function scores, in many cases, were developed from geographically incomplete data sets and should be used in the context that not all reaches and MAs have been evaluated for specific functional indicators – this means that functional indicators (e.g. forage fish spawning) may exist in some reaches and MAs, but have not been mapped or identified in an existing database and therefore the ecological function scores may be artificially low.

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Appendix B

Figures

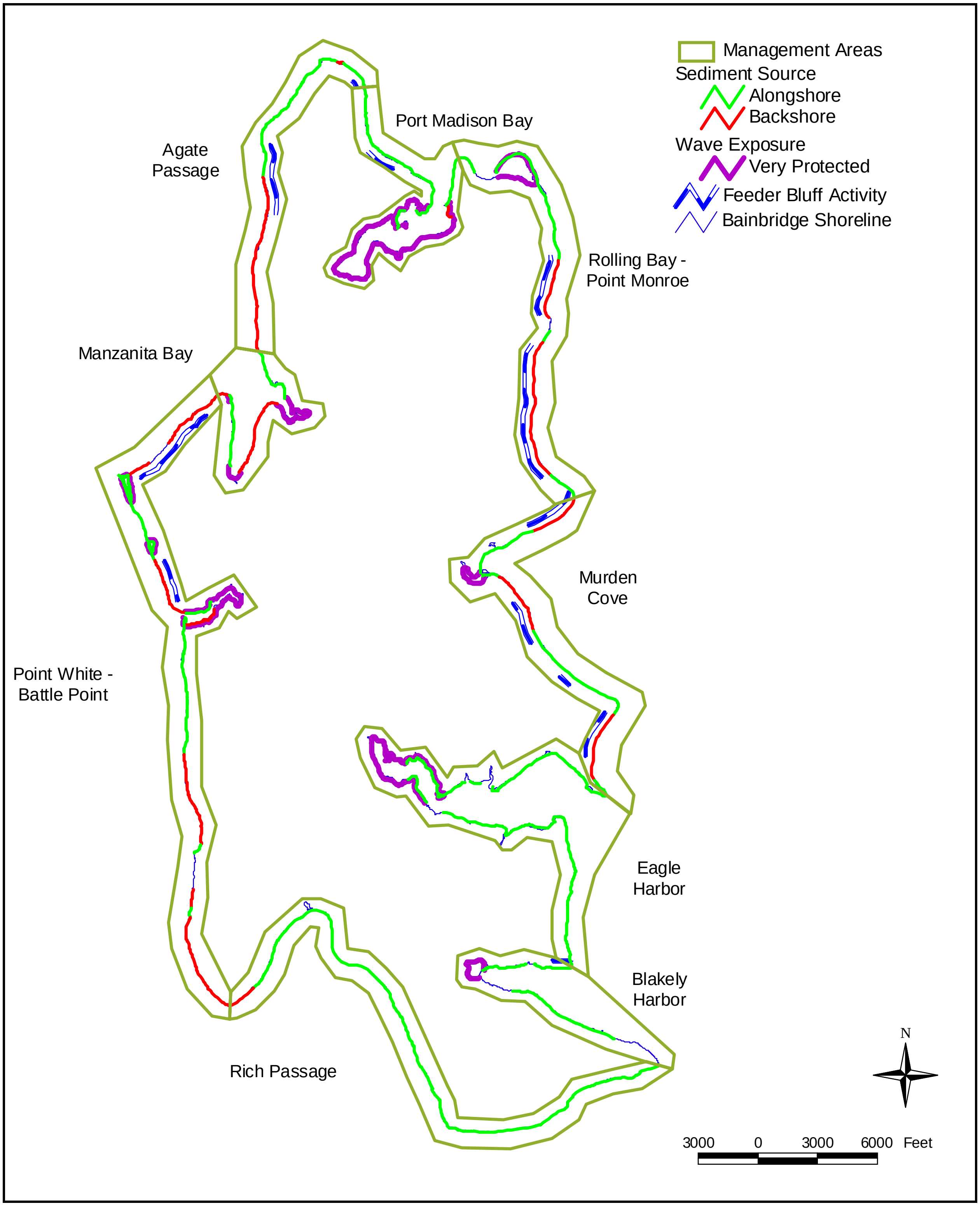

Figure B-1. Bainbridge Island Sediment Sources and Wave Exposure Classes.

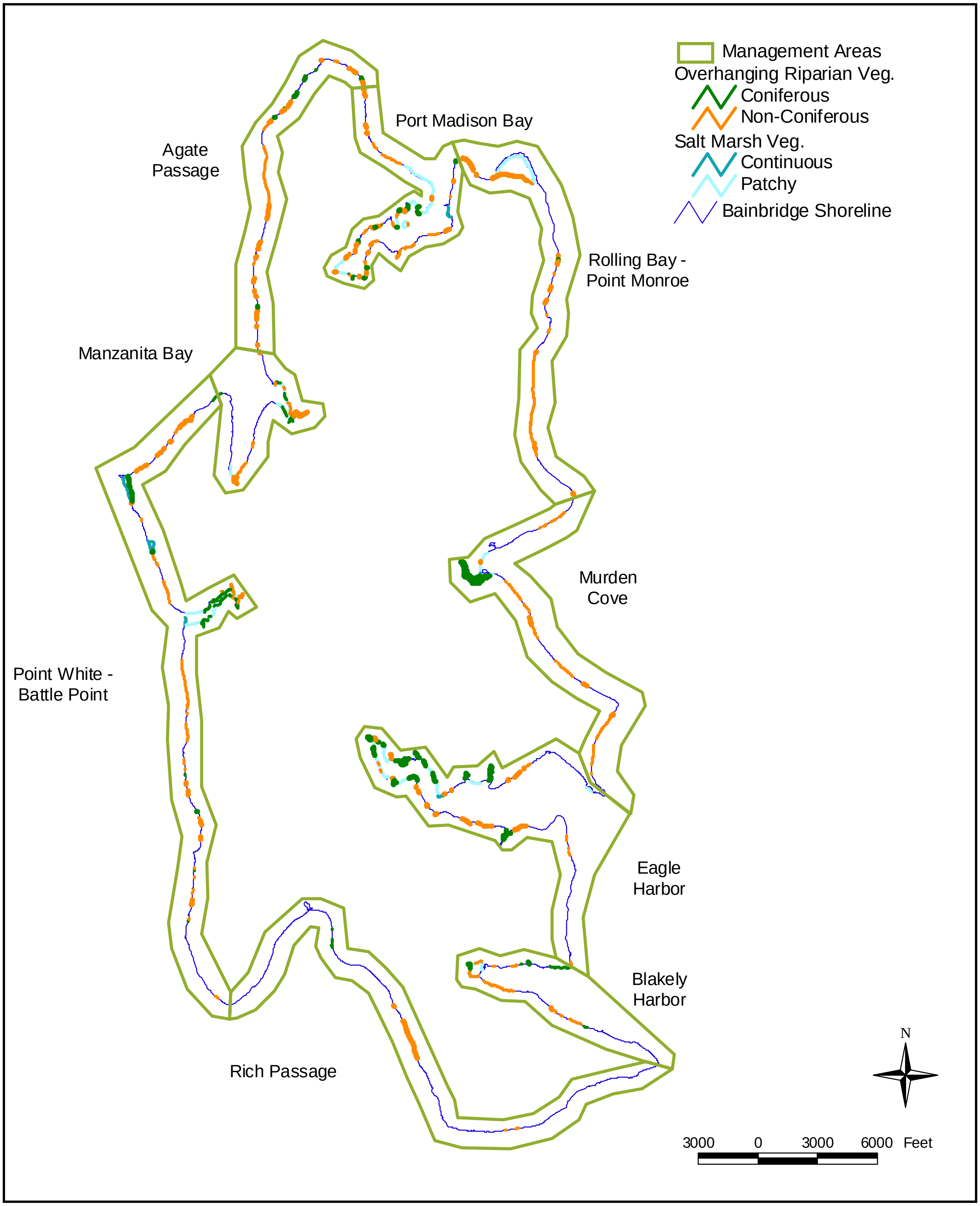

Figure B-2. Bainbridge Island Overhanging Riparian and Saltmarsh Vegetation.

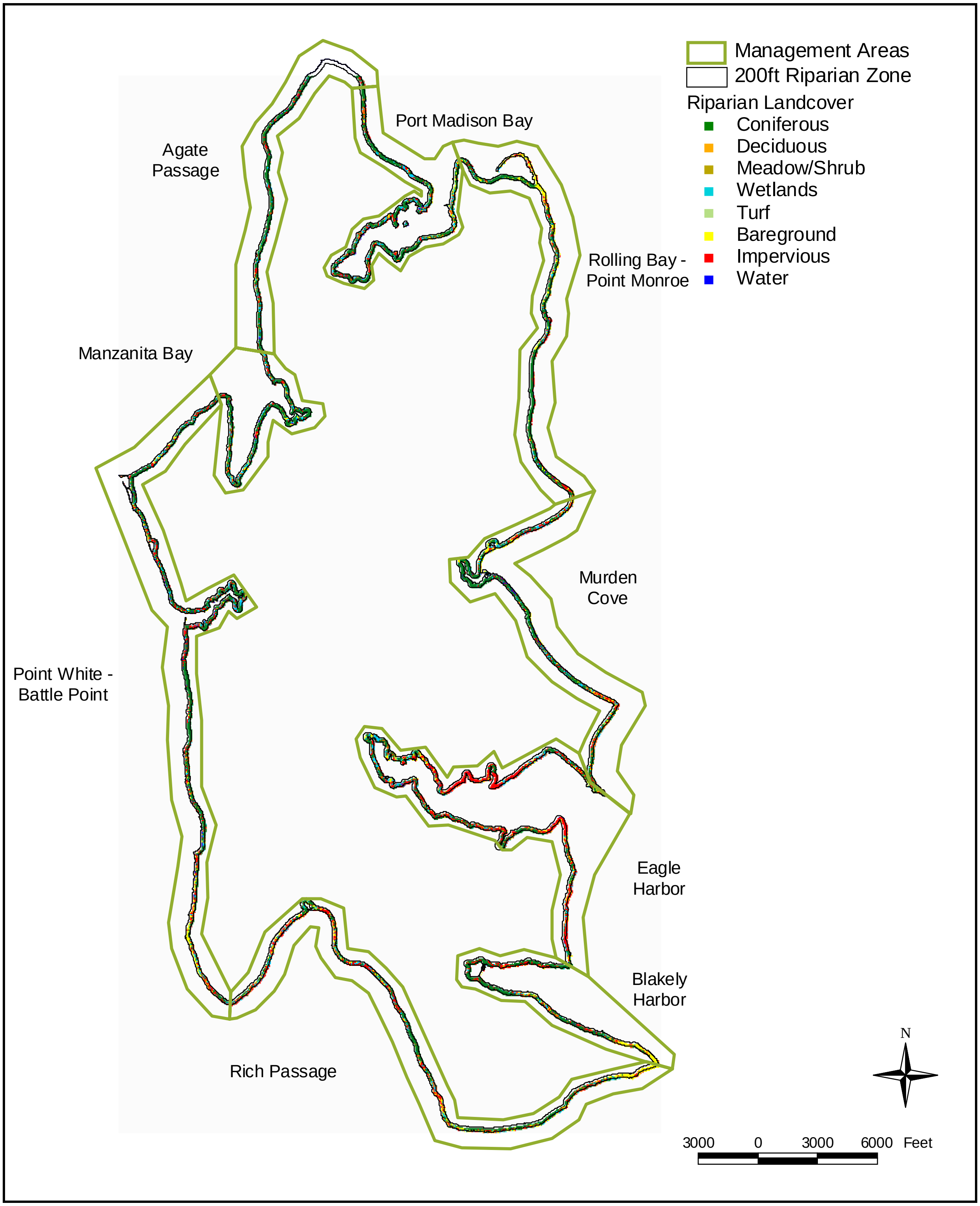

Figure B-3. Bainbridge Island Marine Riparian Zone Land Cover Classes

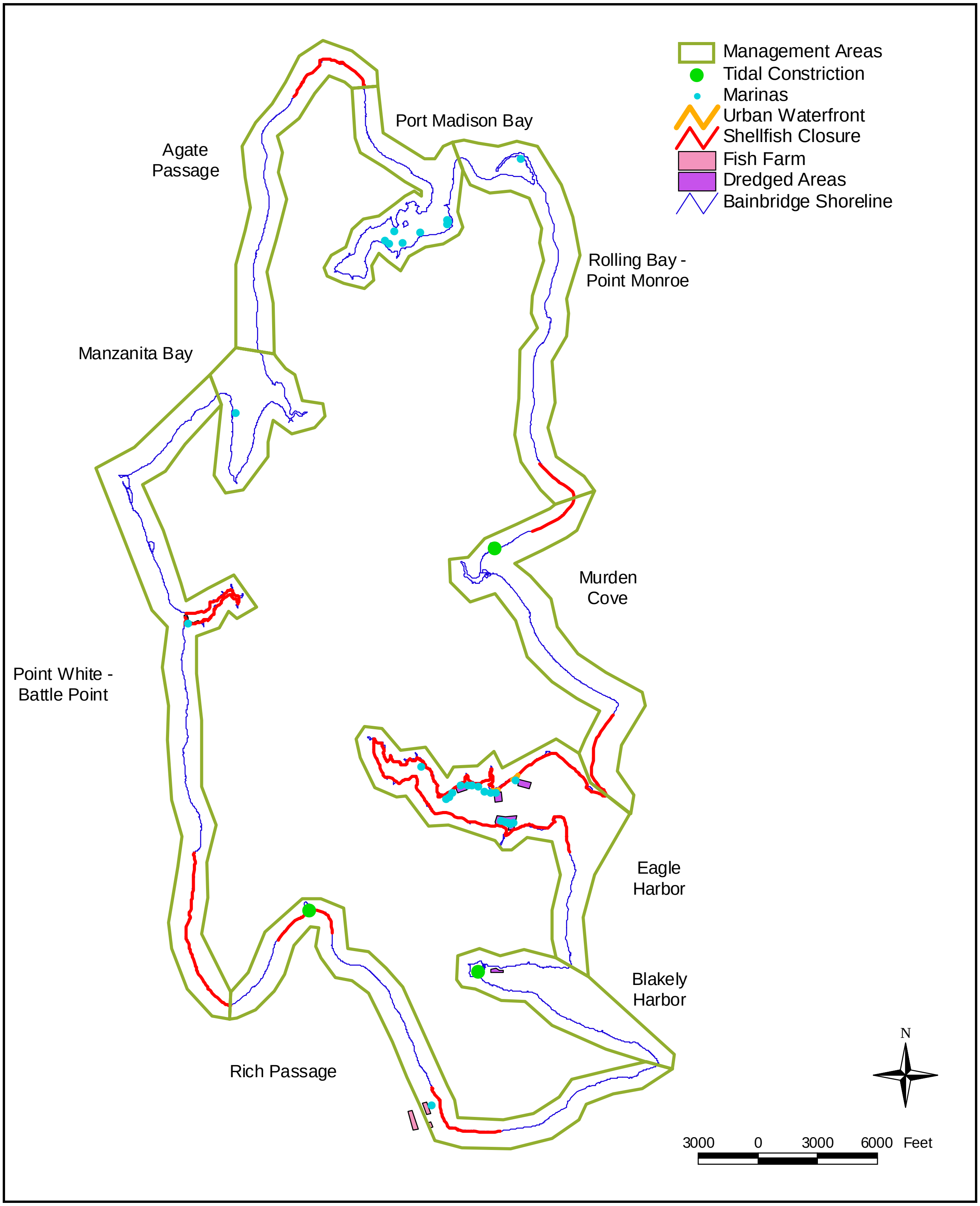

Figure B-4. Bainbridge Island Shellfish Closures, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

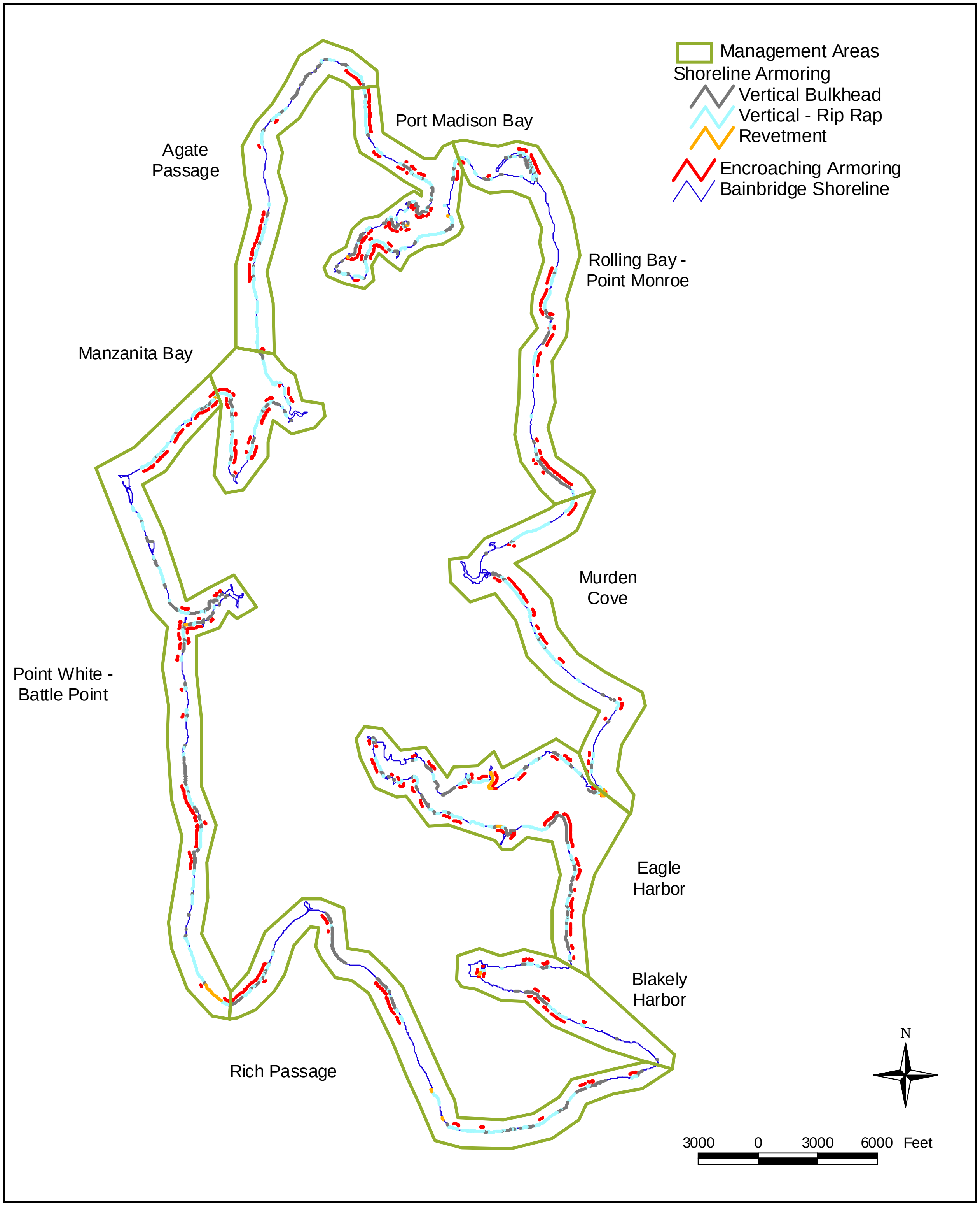

Figure B-5. Bainbridge Island Shoreline Armoring and Armoring Encroachment.

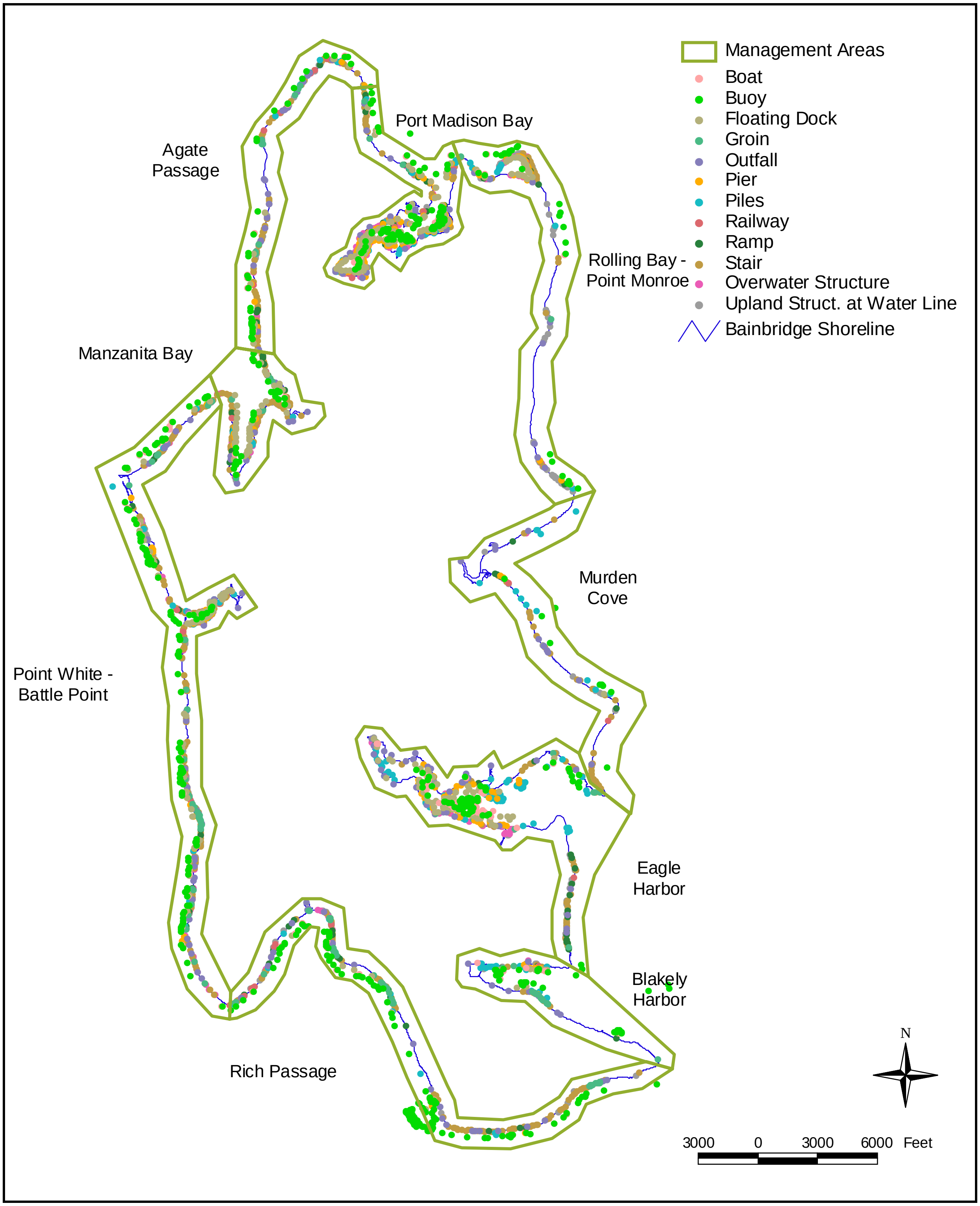

Figure B-6. Bainbridge Island Point Modifications.

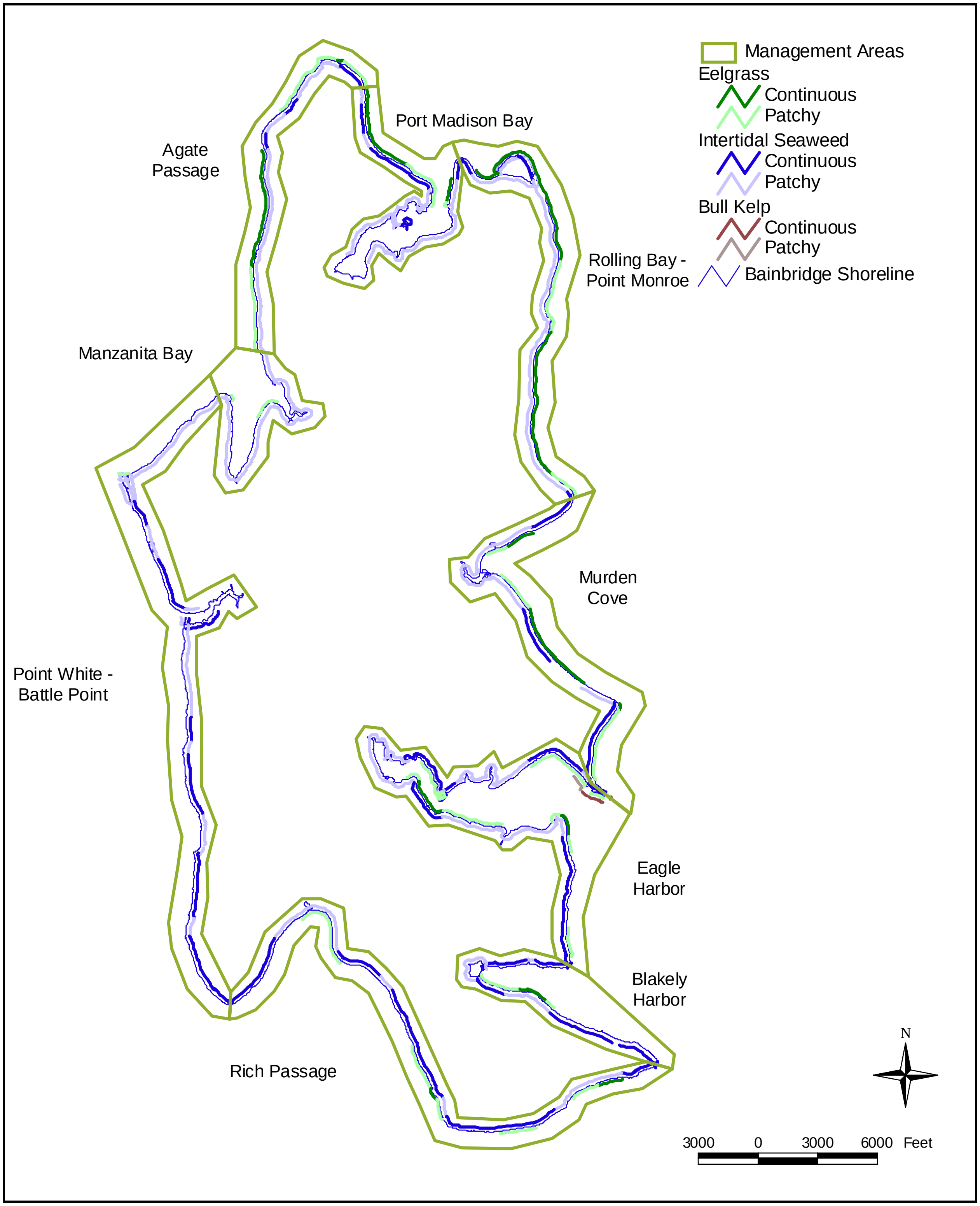

Figure B-7. Bainbridge Island Eelgrass, Kelp, and Seaweed Distribution.

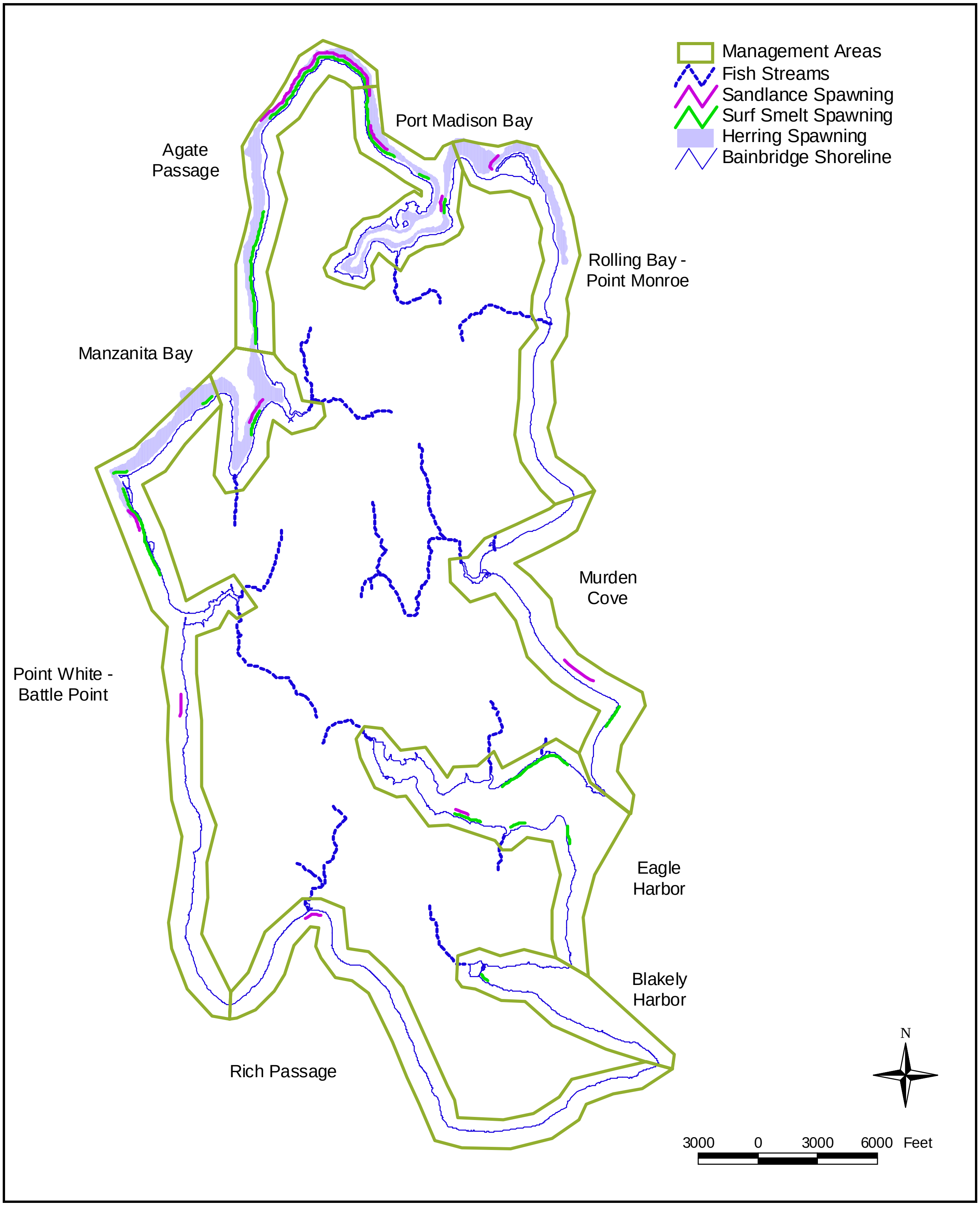

Figure B-8. Bainbridge Island Forage Fish Spawning Areas and Salmon-Bearing Streams.

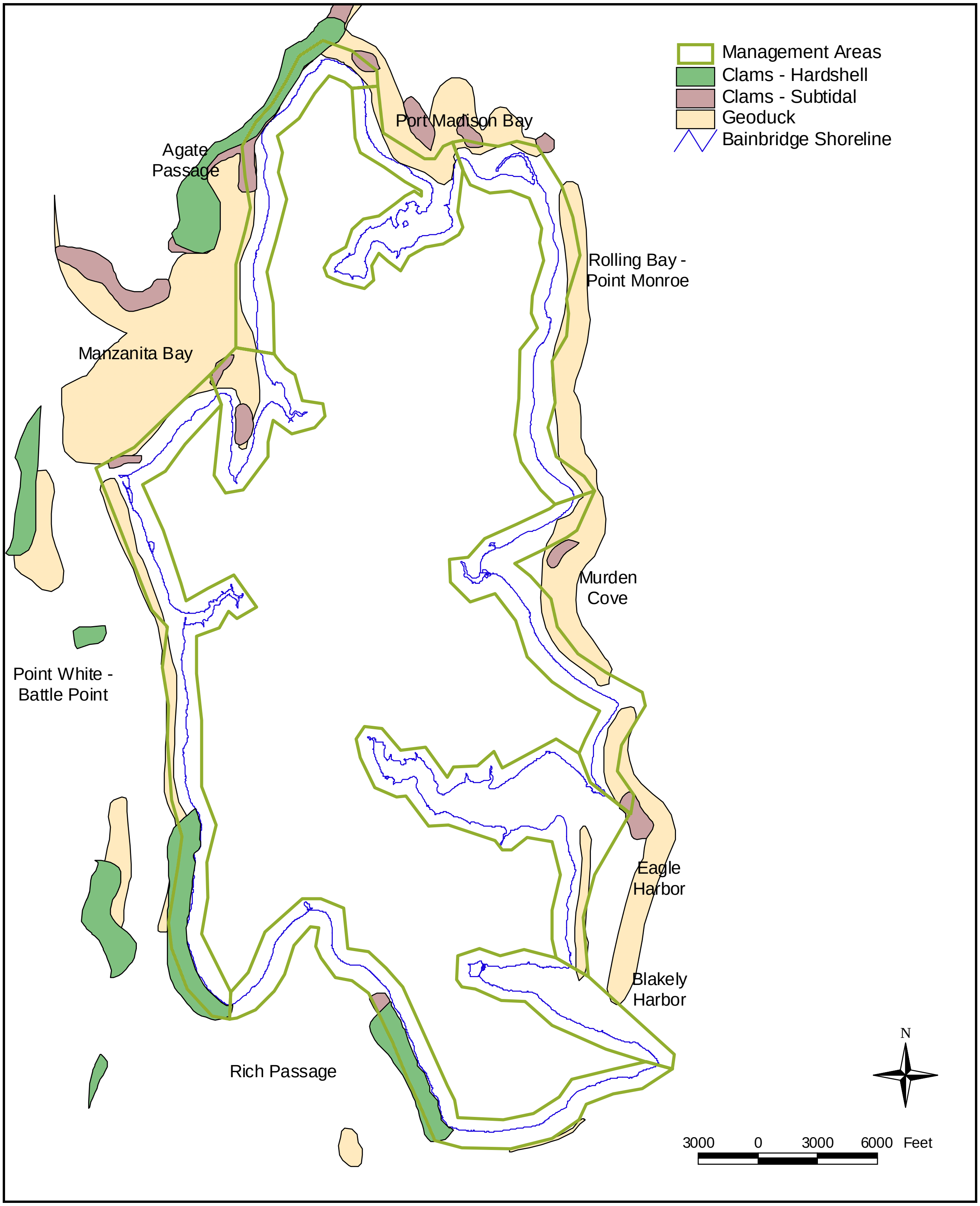

Figure B-9. Bainbridge Island Clam and Geoduck Distribution.

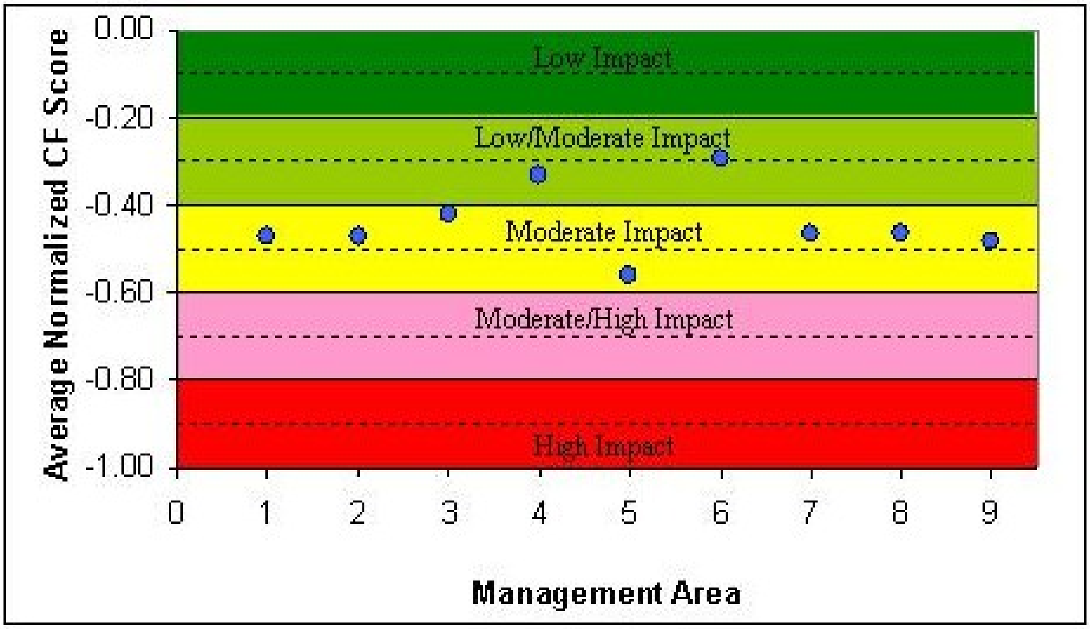

Figure B-10. Average (Normalized) Controlling Factors Scores by Management Area.

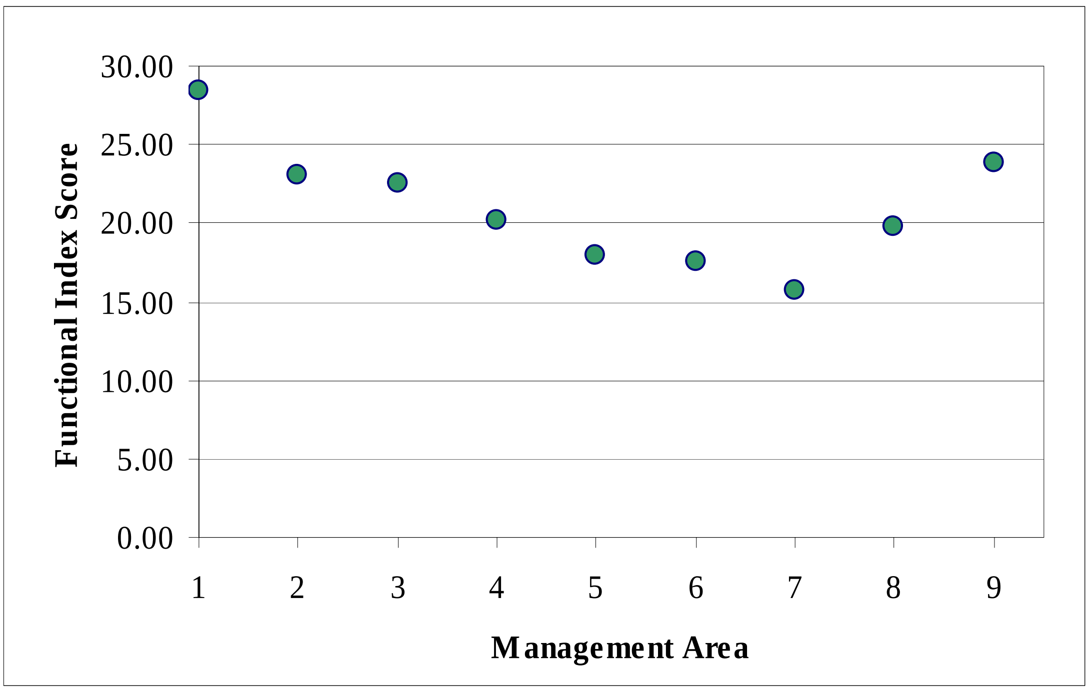

Figure B-11. Functional Index Scores by Management Area.

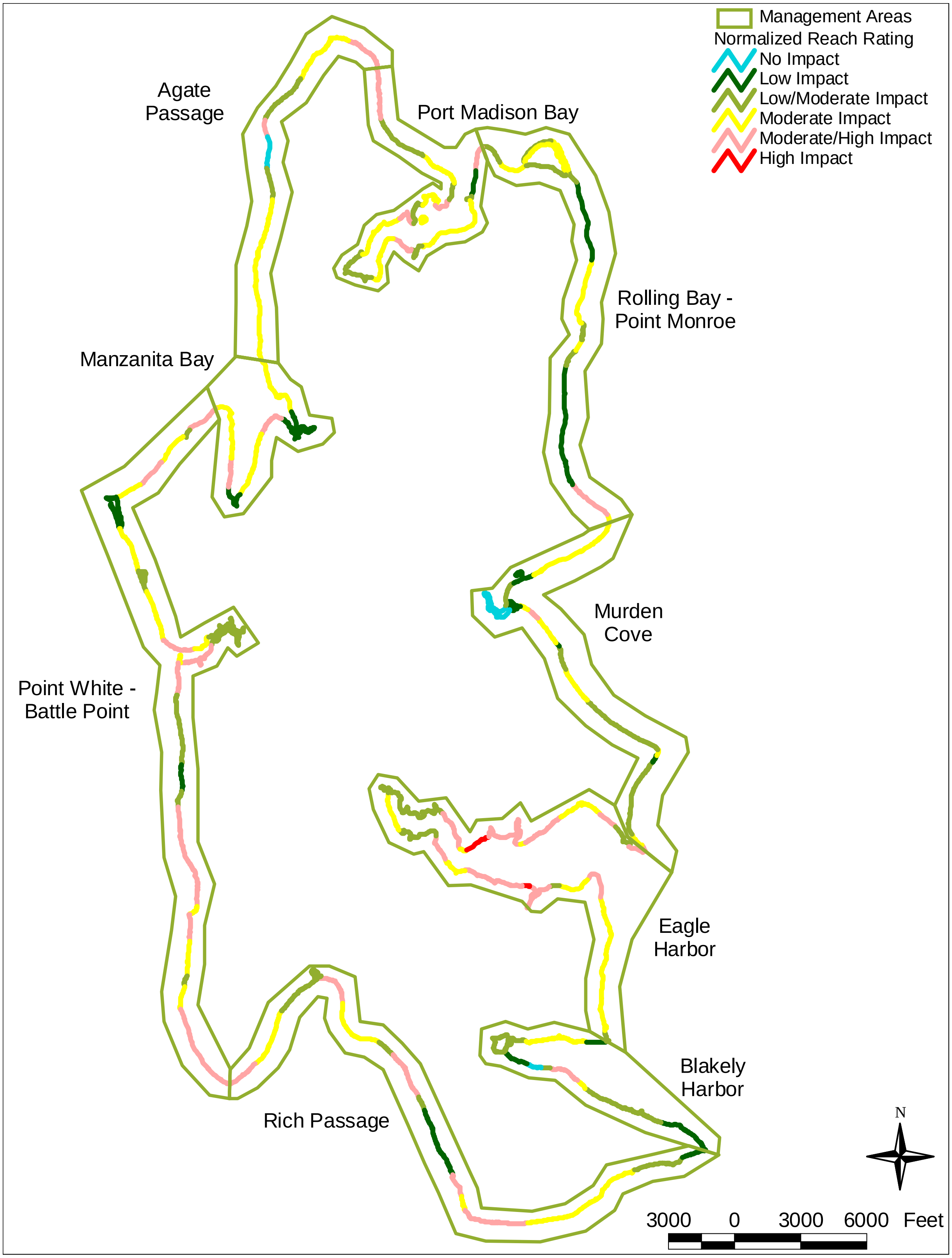

Figure B-12. Bainbridge Island Reach Scores (Normalized).

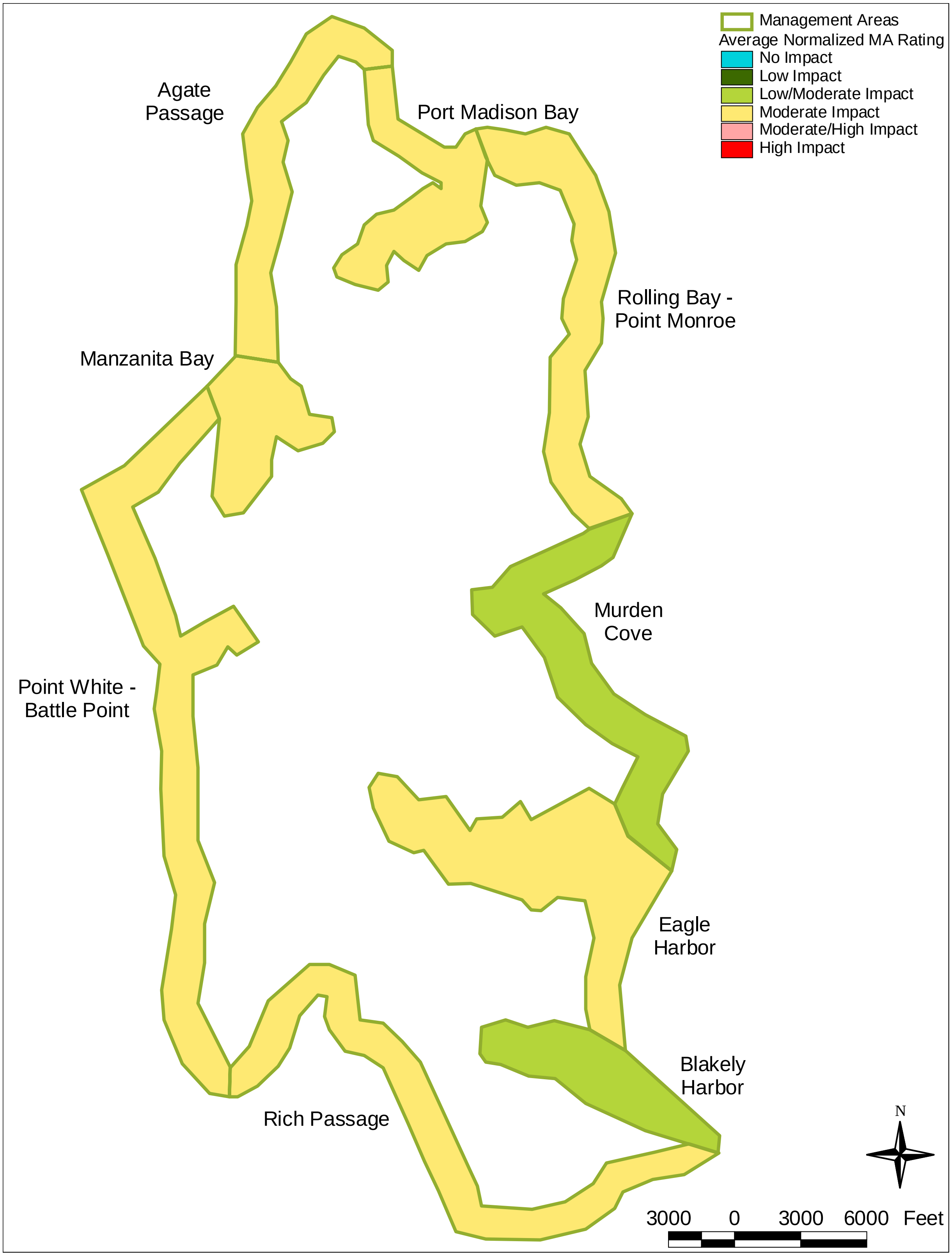

Figure B-13. Bainbridge Island Average Reach Scores by Management Area.

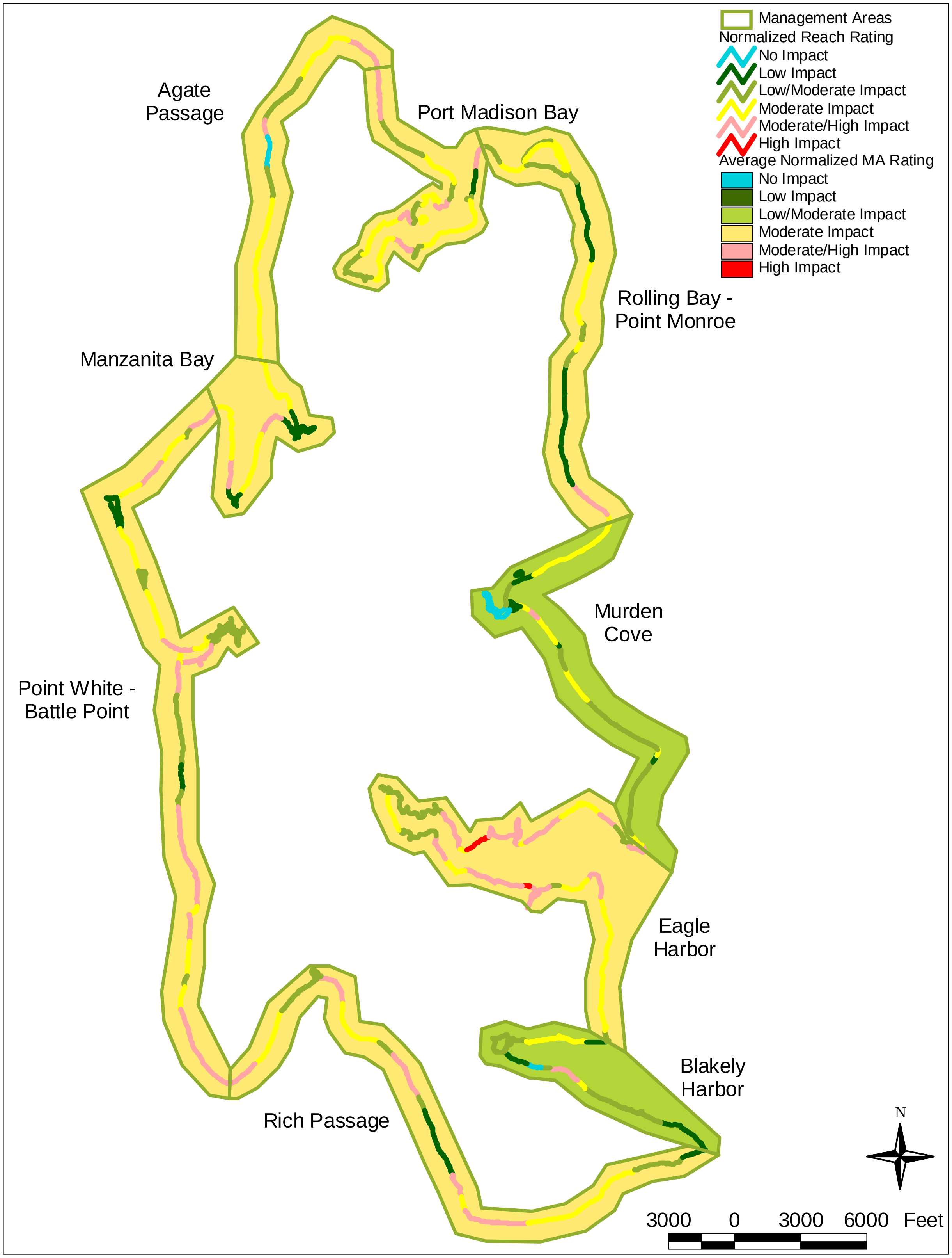

Figure B-14. Bainbridge Island Qualitative Rating of Reach and Management Areas.

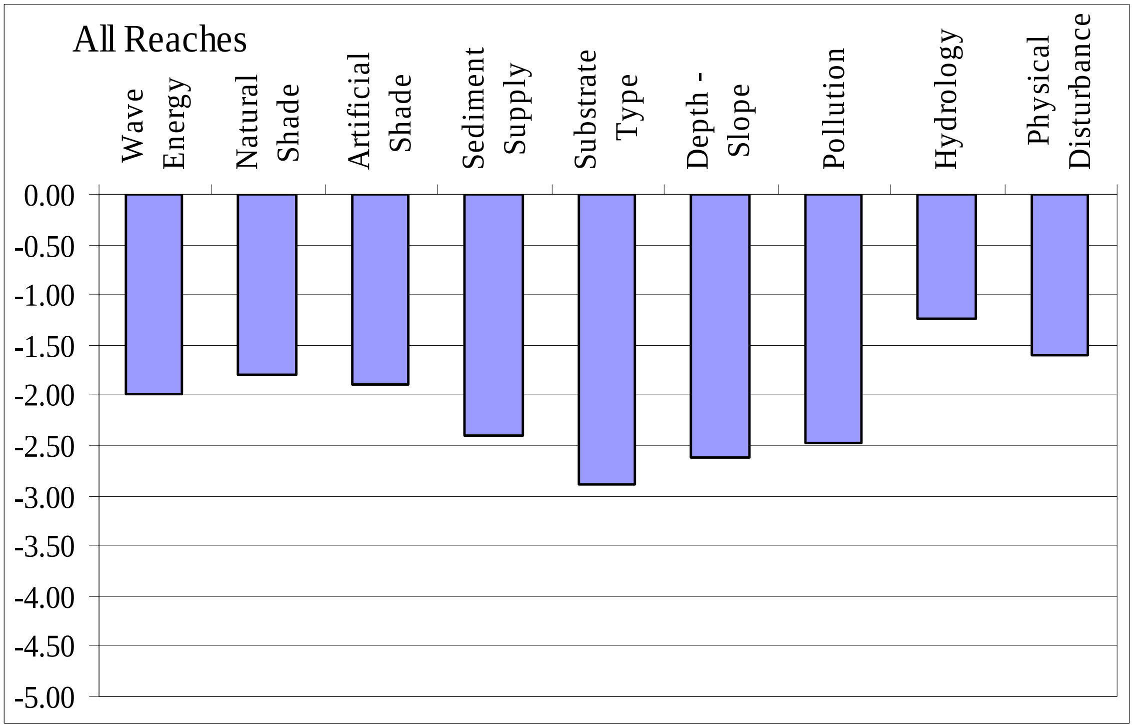

Figure B-15. Average Controlling Factor Metric Scores For All Reaches on Bainbridge Island.

Figure B-16. Average Individual Controlling Factor Metric Scores by Management Area.

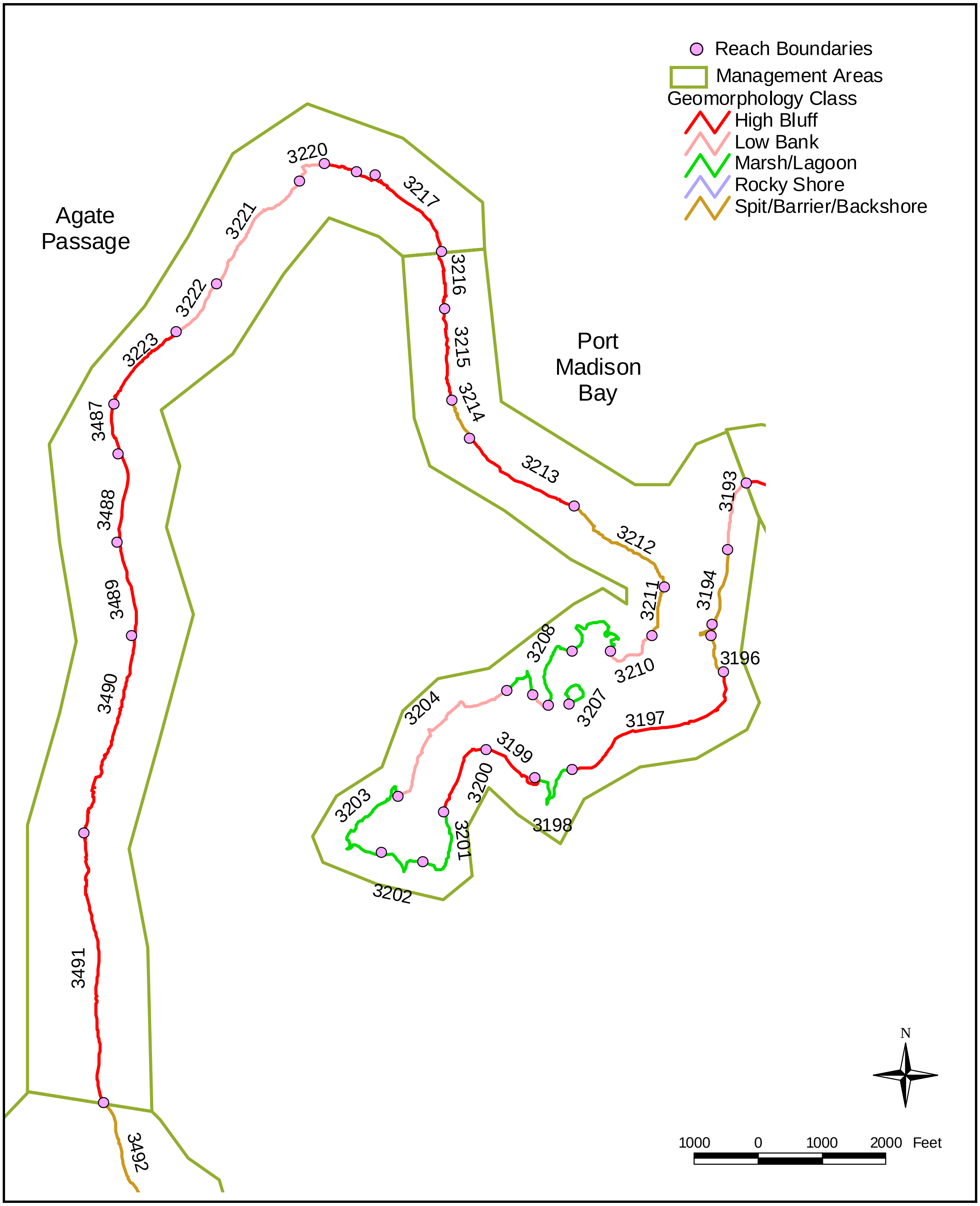

Figure B-17. Management Areas 1 and 2 Geomorphic Class Distribution

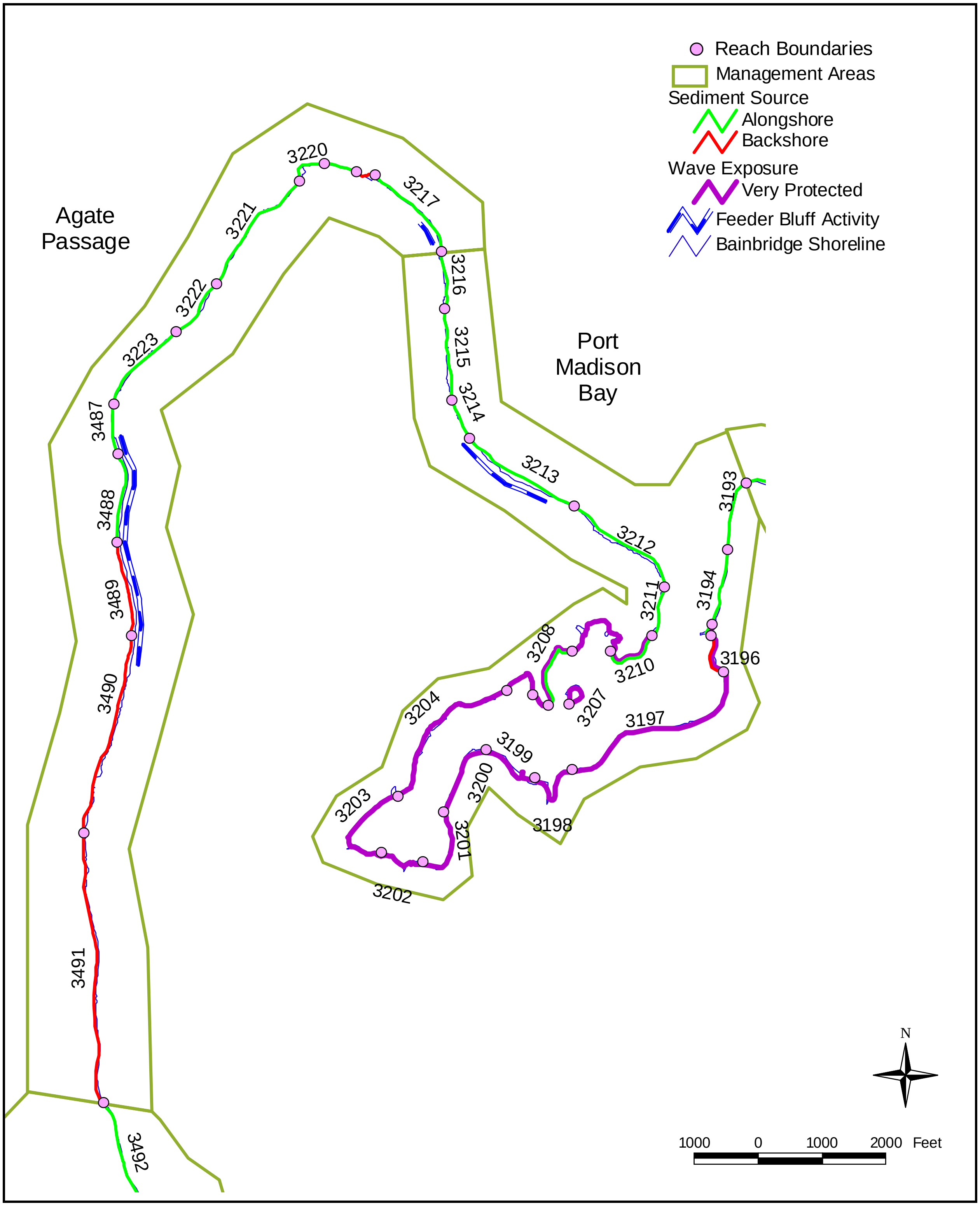

Figure B-18. Management Areas 1 and 2 Sediment Sources and Wave Exposure Classes.

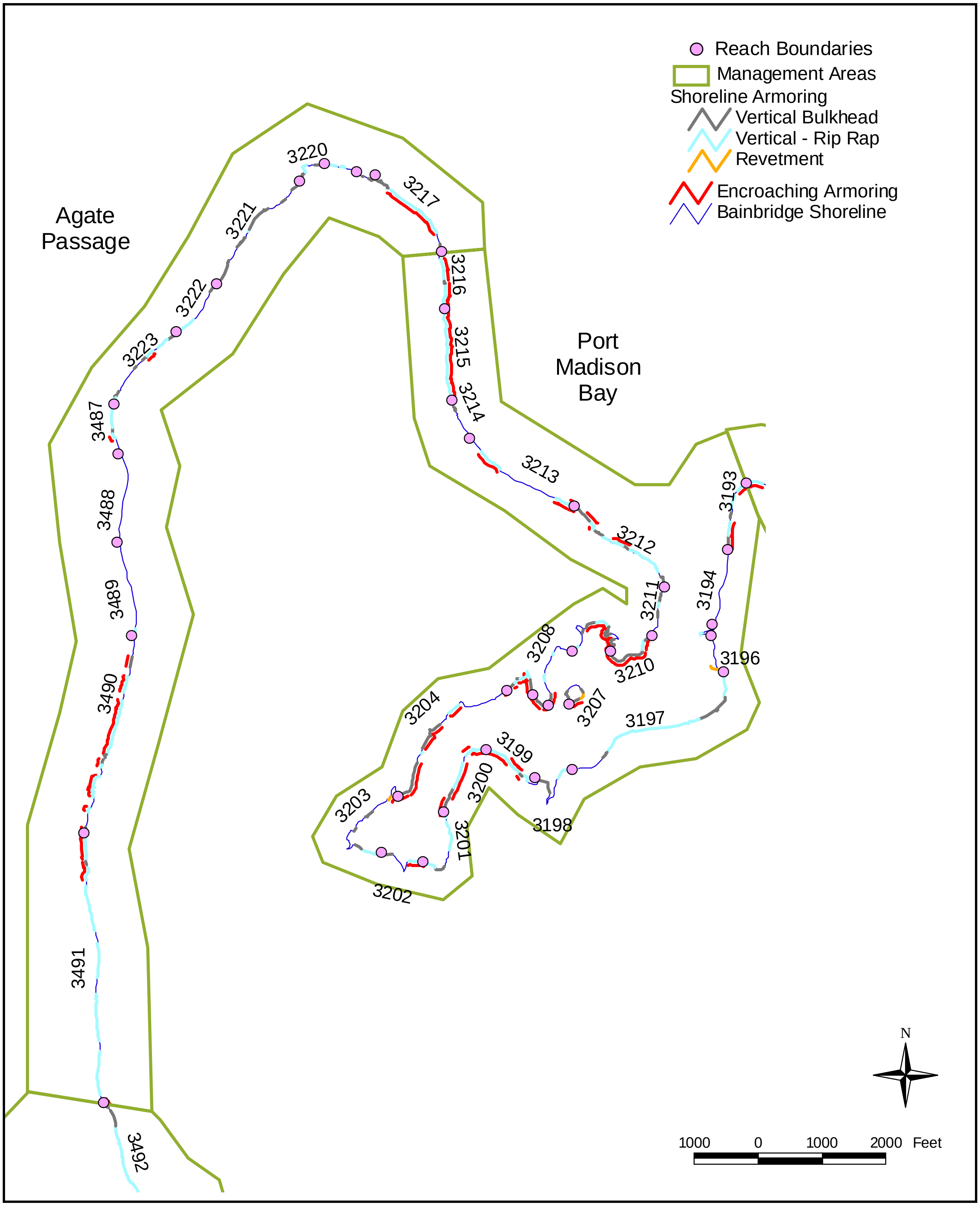

Figure B-19. Management Areas 1 and 2 Shoreline Armoring and Armoring Encroachment.

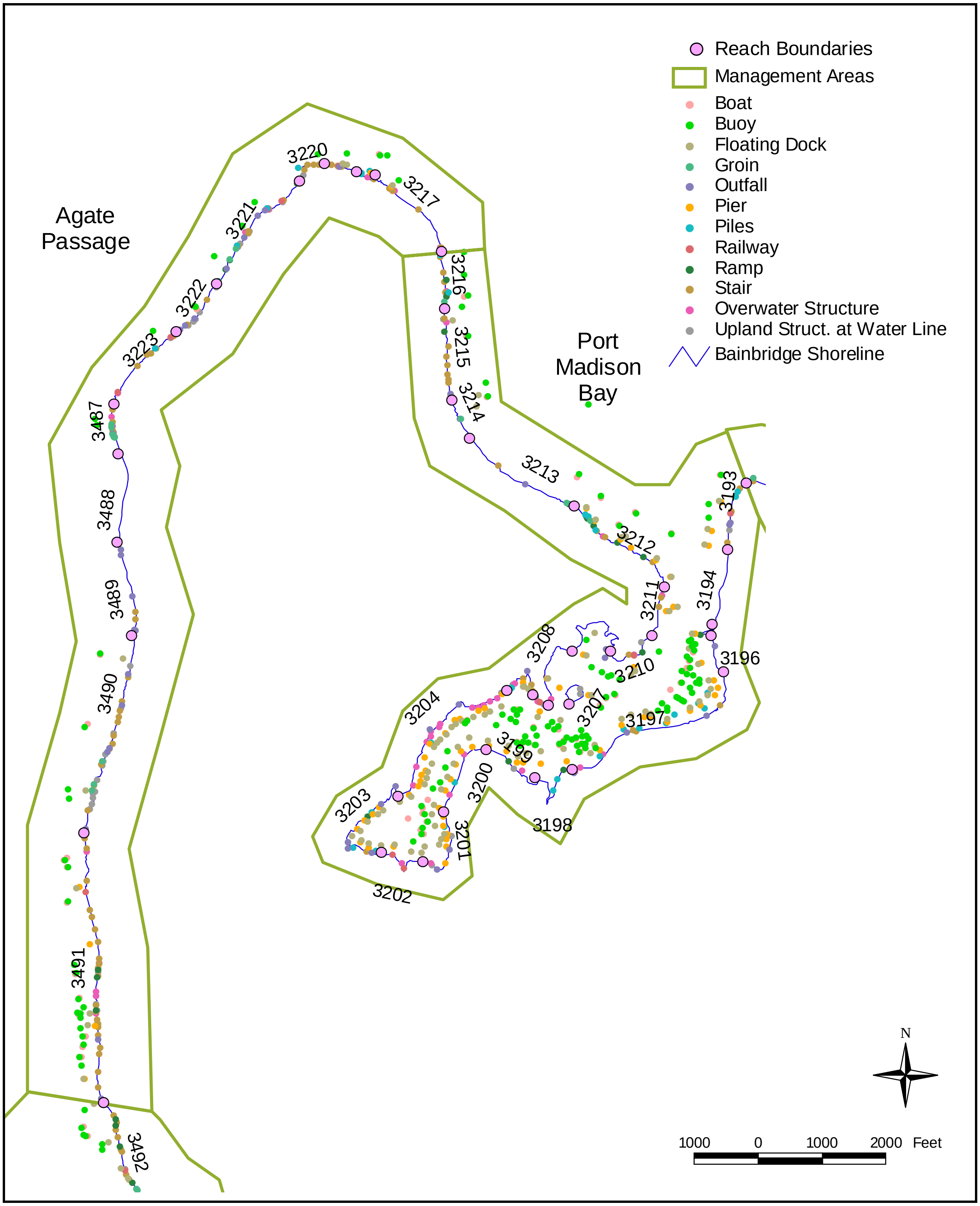

Figure B-20. Management Areas 1 and 2 Point Modifications.

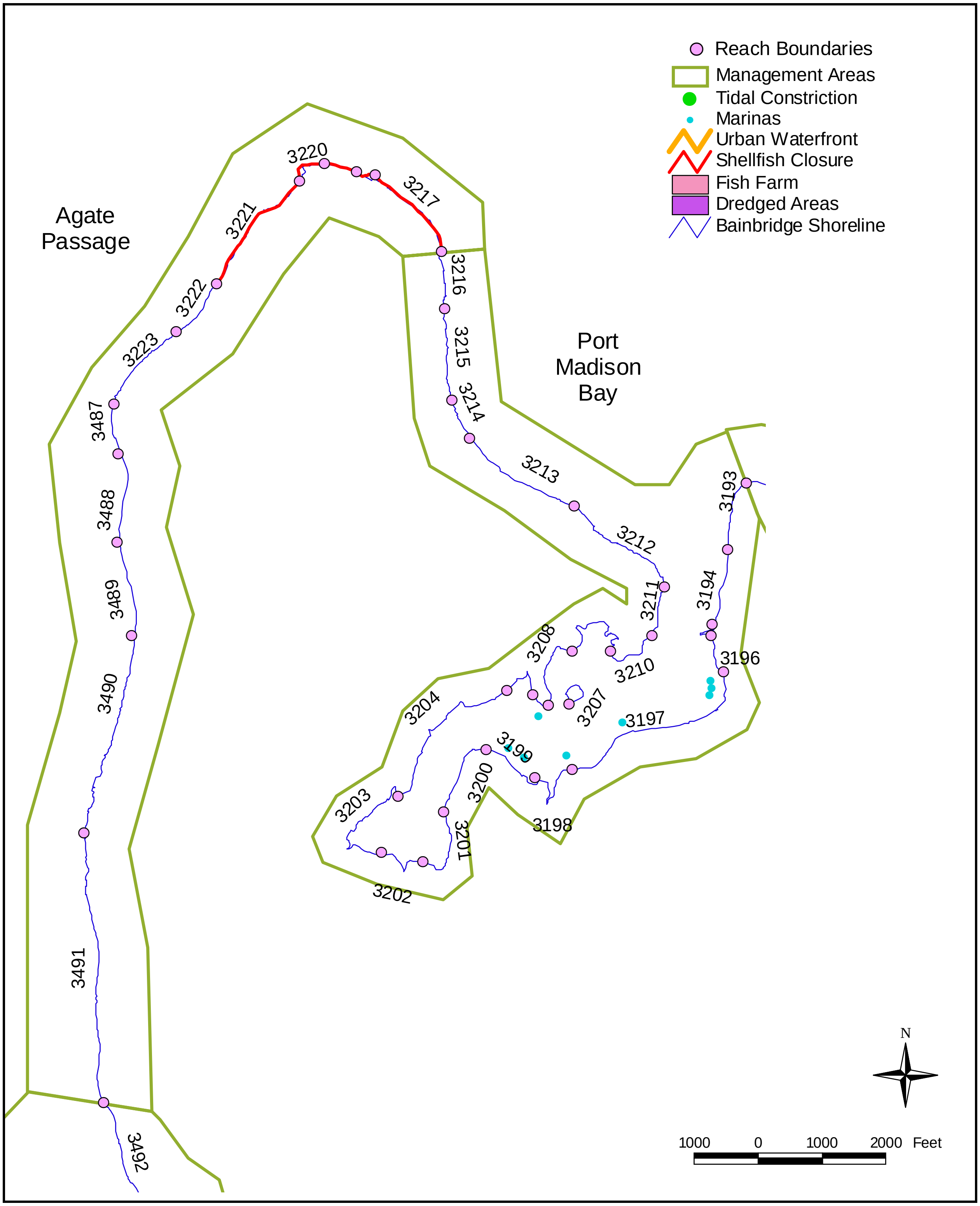

Figure B-21. Management Areas 1 and 2 Shellfish Closures, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

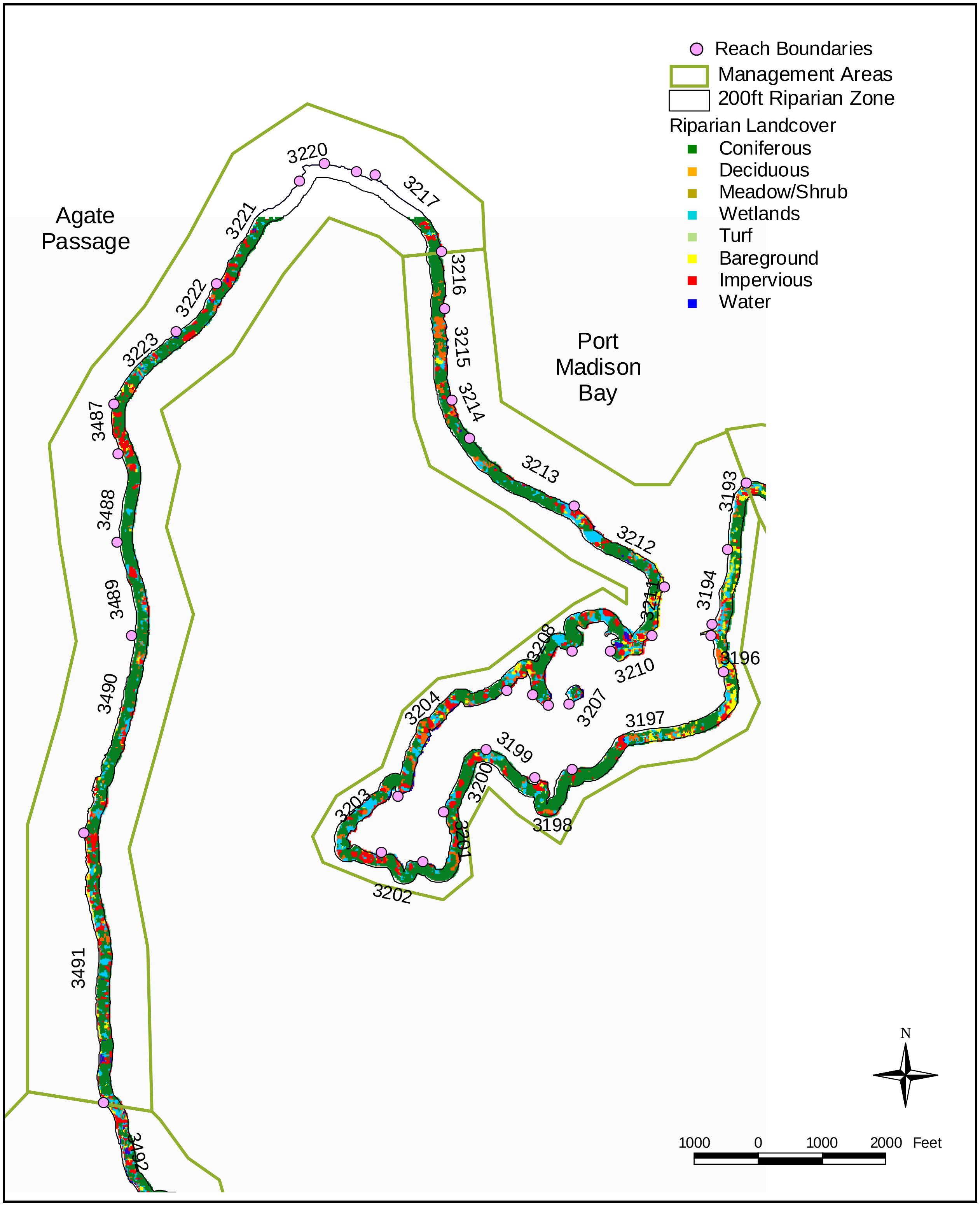

Figure B-22. Management Areas 1 and 2 Marine Riparian Zone Land Cover Classes.

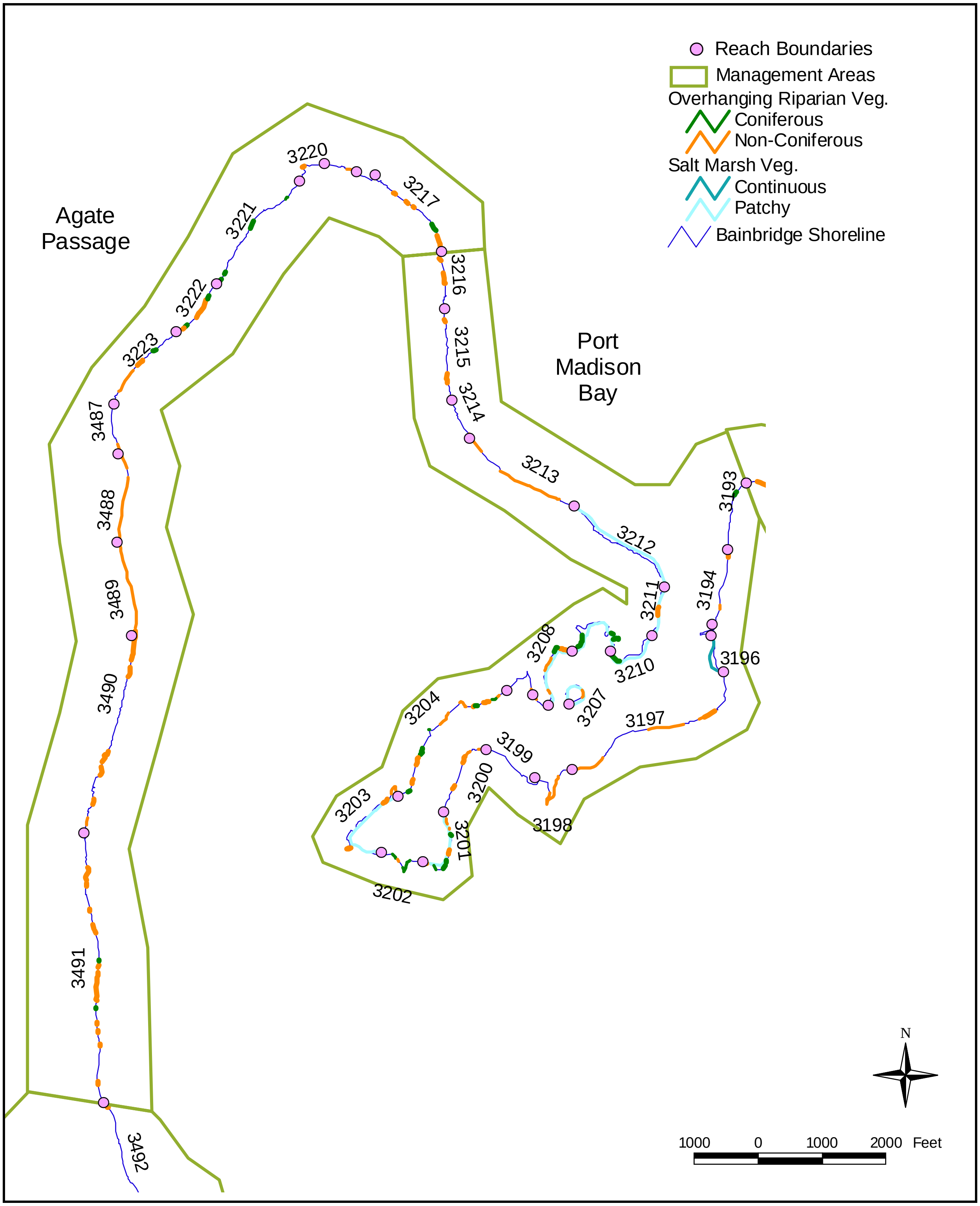

Figure B-23. Management Areas 1 and 2 Overhanging Riparian and Saltmarsh Vegetation.

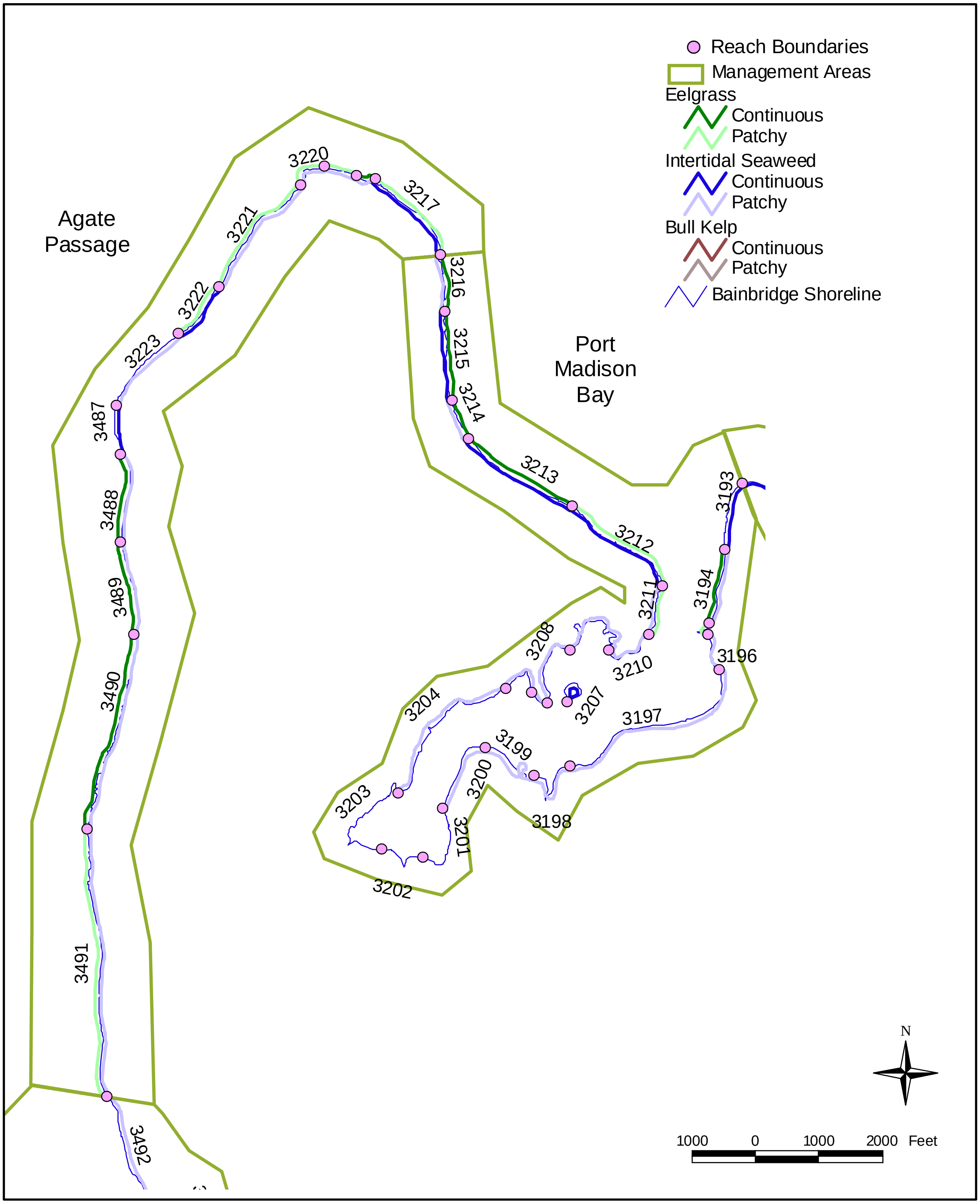

Figure B-24. Management Areas 1 and 2 Eelgrass, Kelp, and Seaweed Distribution.

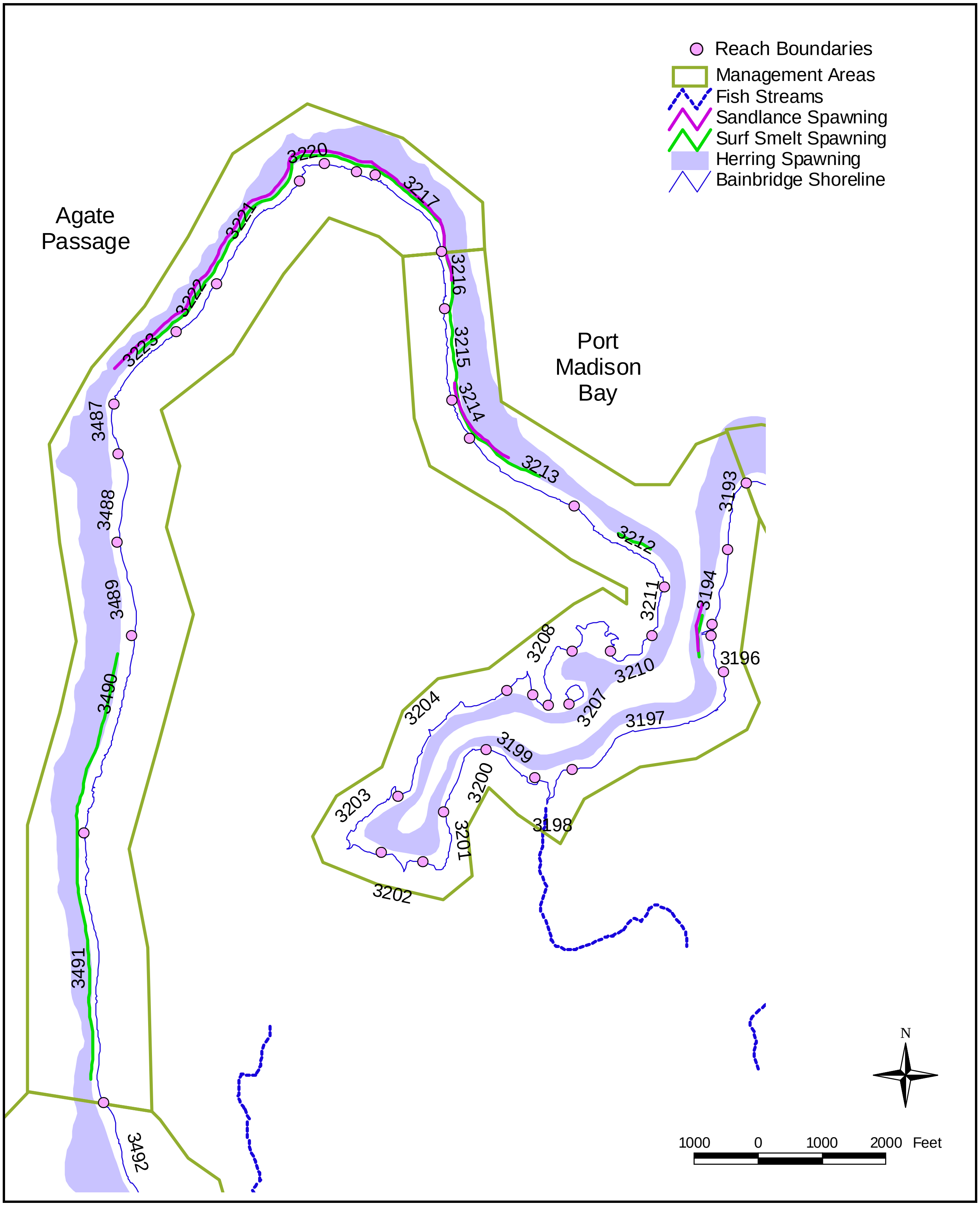

Figure B-25. Management Areas 1 and 2 Forage Fish Spawning Areas and Salmon-Bearing Streams.

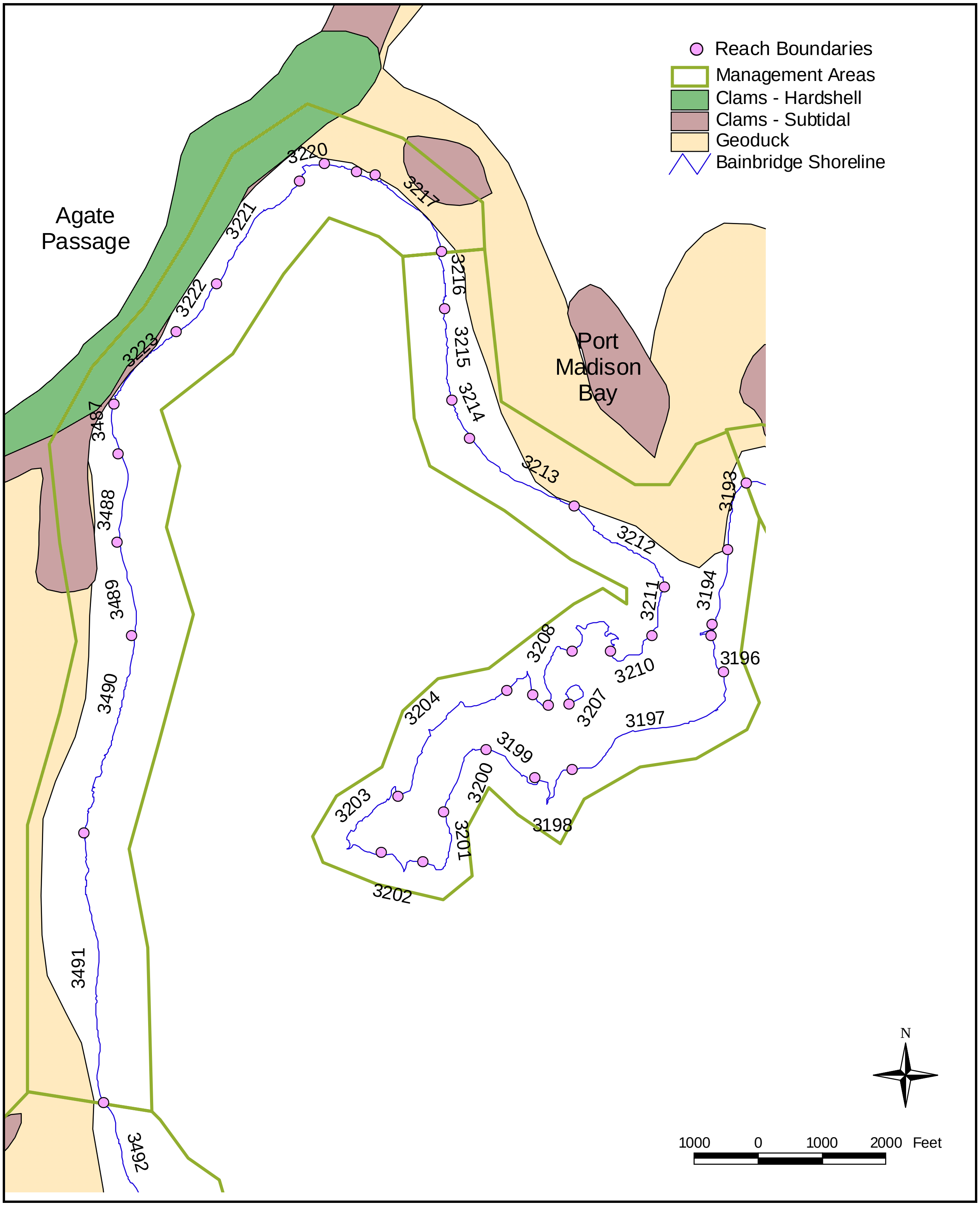

Figure B-26. Management Areas 1 and 2 Clam and Geoduck Distribution

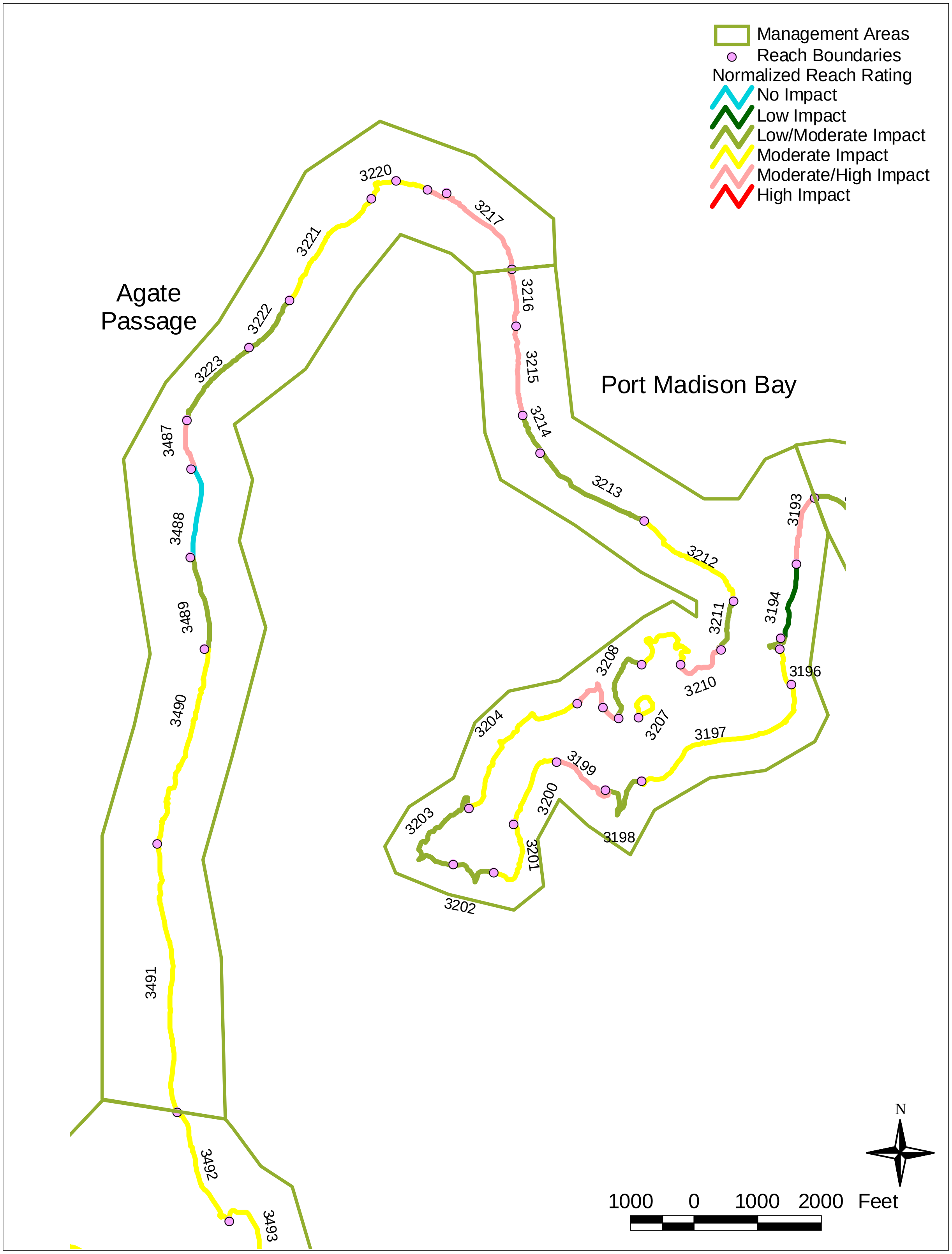

Figure B-27. Management Areas 1 and 2 Reach Scores (Normalized).

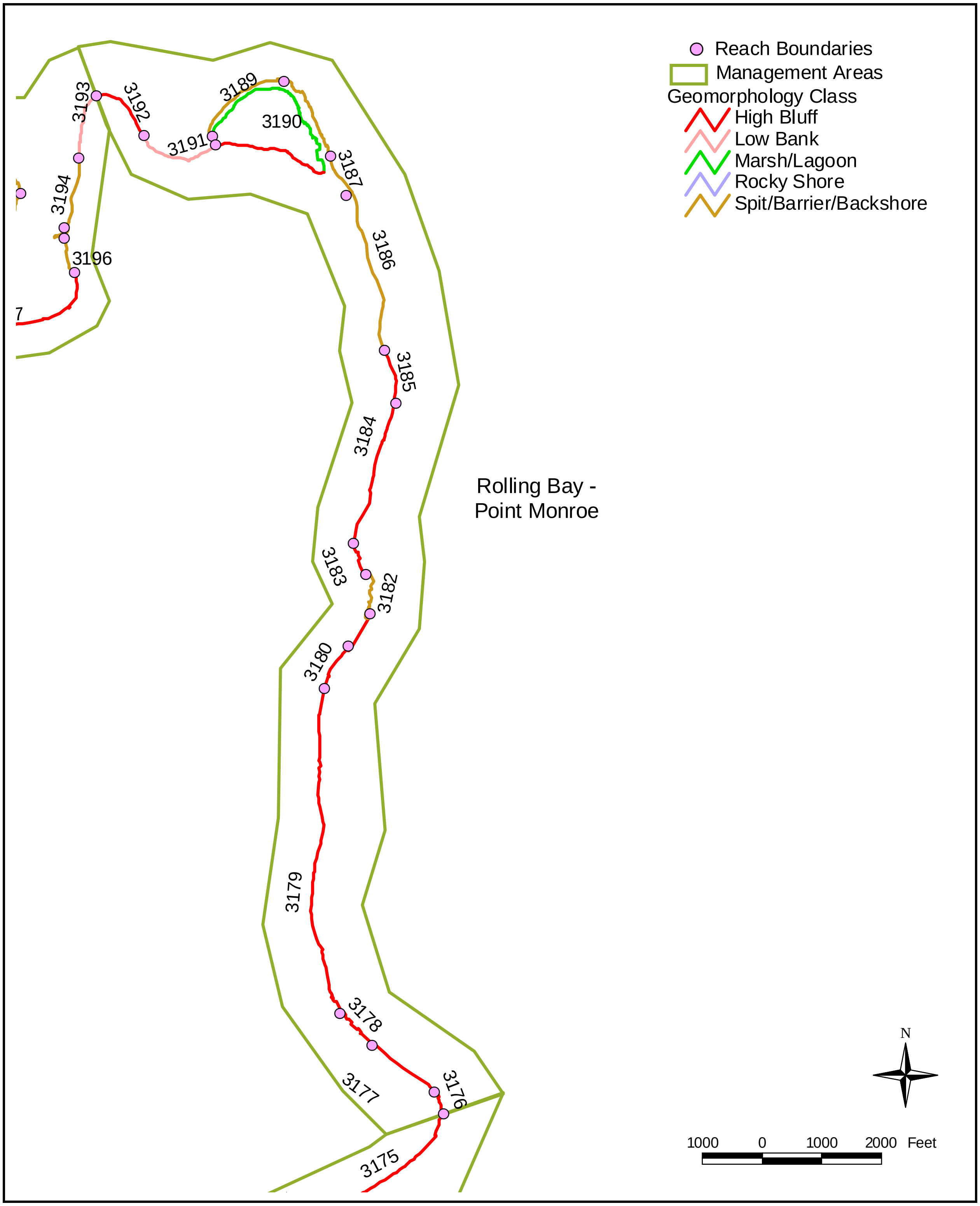

Figure B-28. Management Area 3 Geomorphic Class Distribution

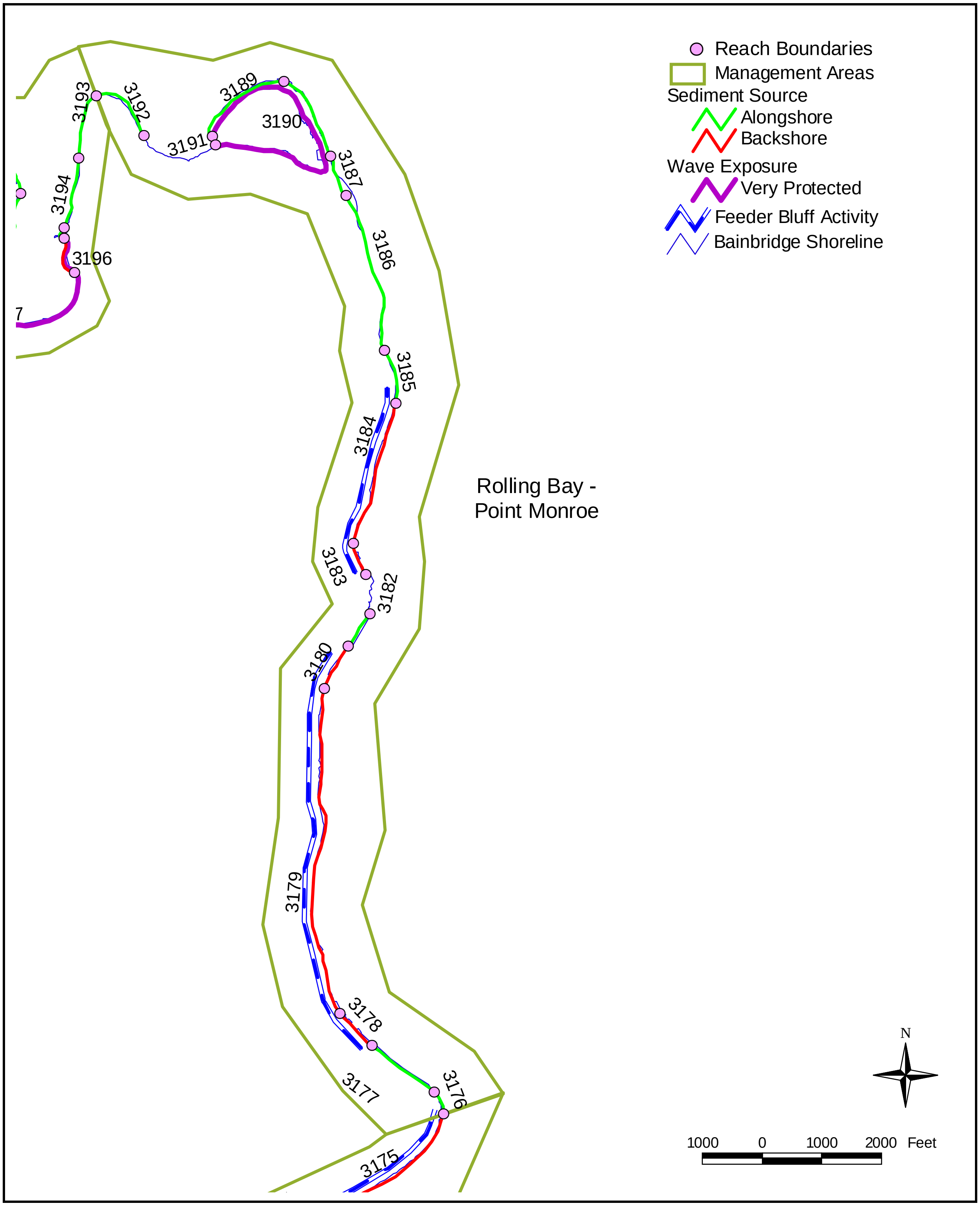

Figure B-29. Management Area 3 Sediment Sources and Wave Exposure Classes.

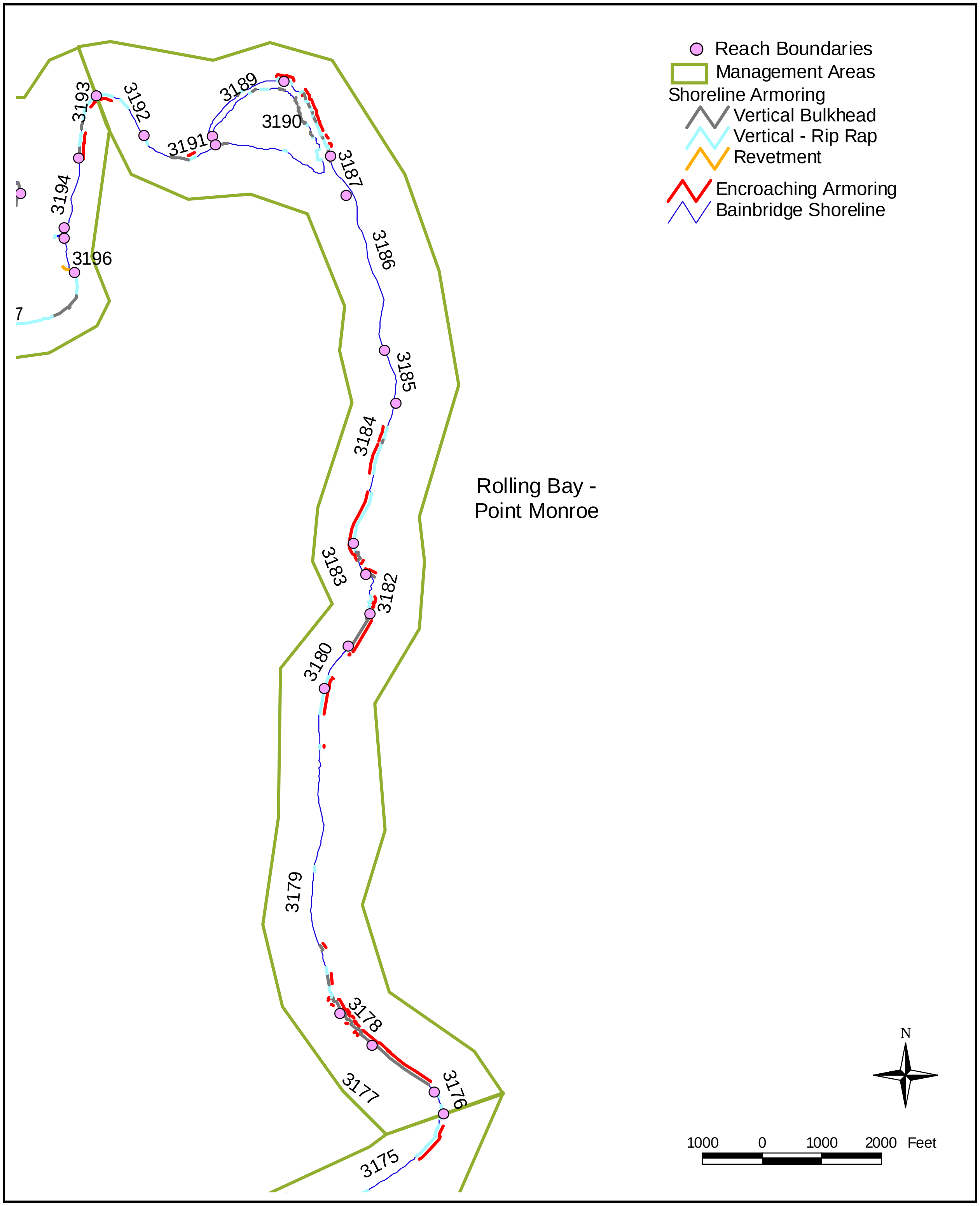

Figure B-30. Management Area 3 Shoreline Armoring and Armoring Encroachment.

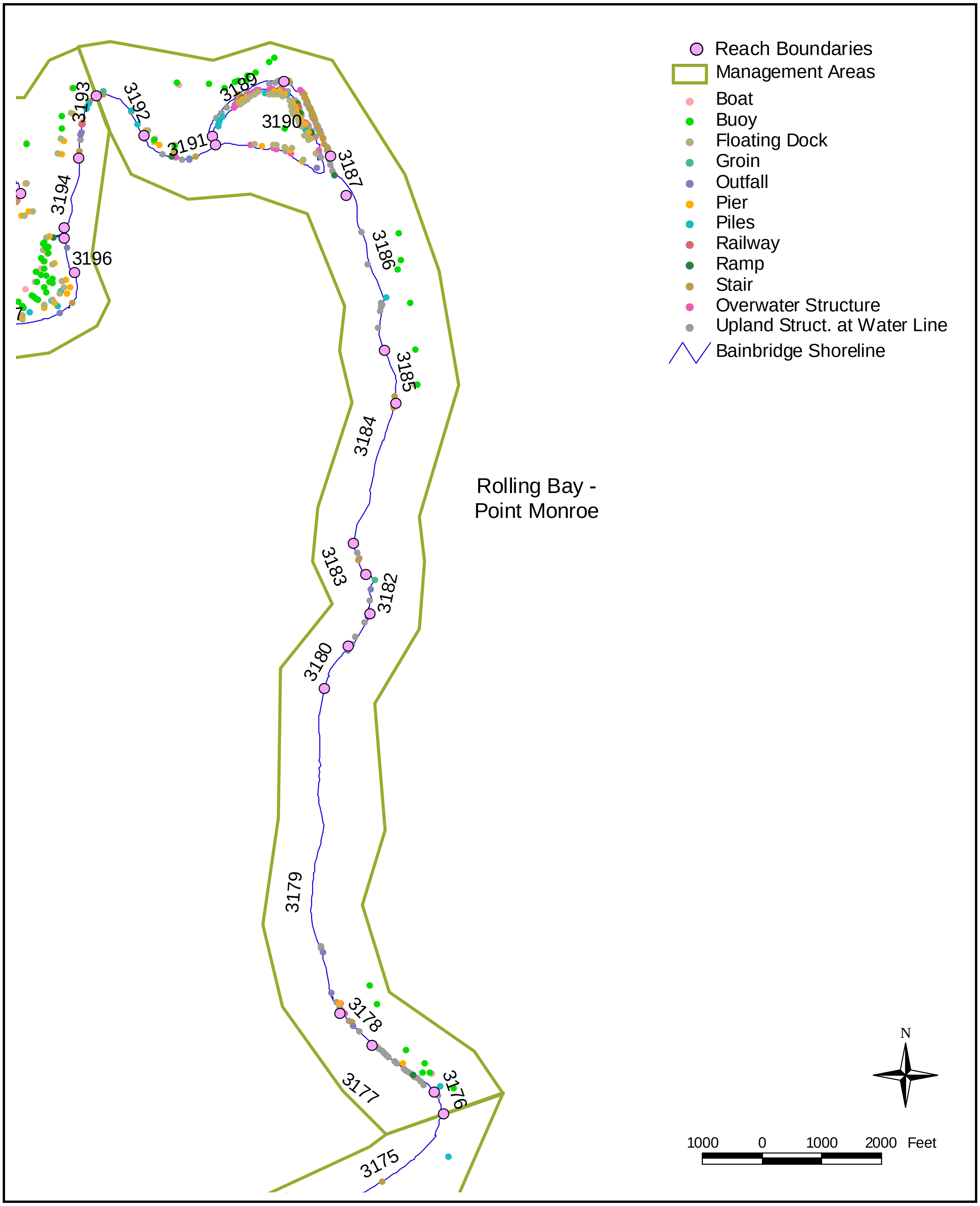

Figure B-31. Management Area 3 Point Modifications.

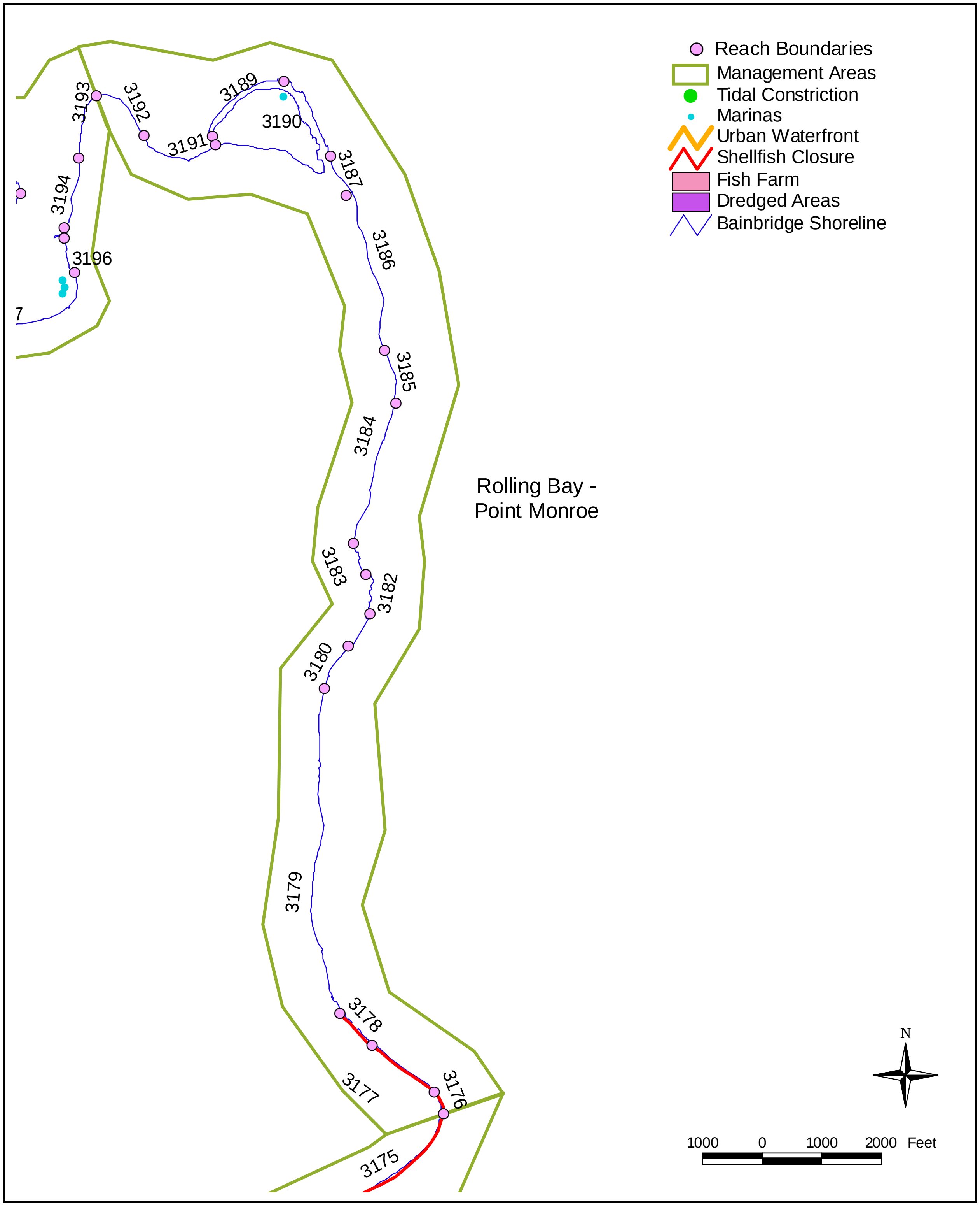

Figure B-32. Management Area 3 Shellfish Closures, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

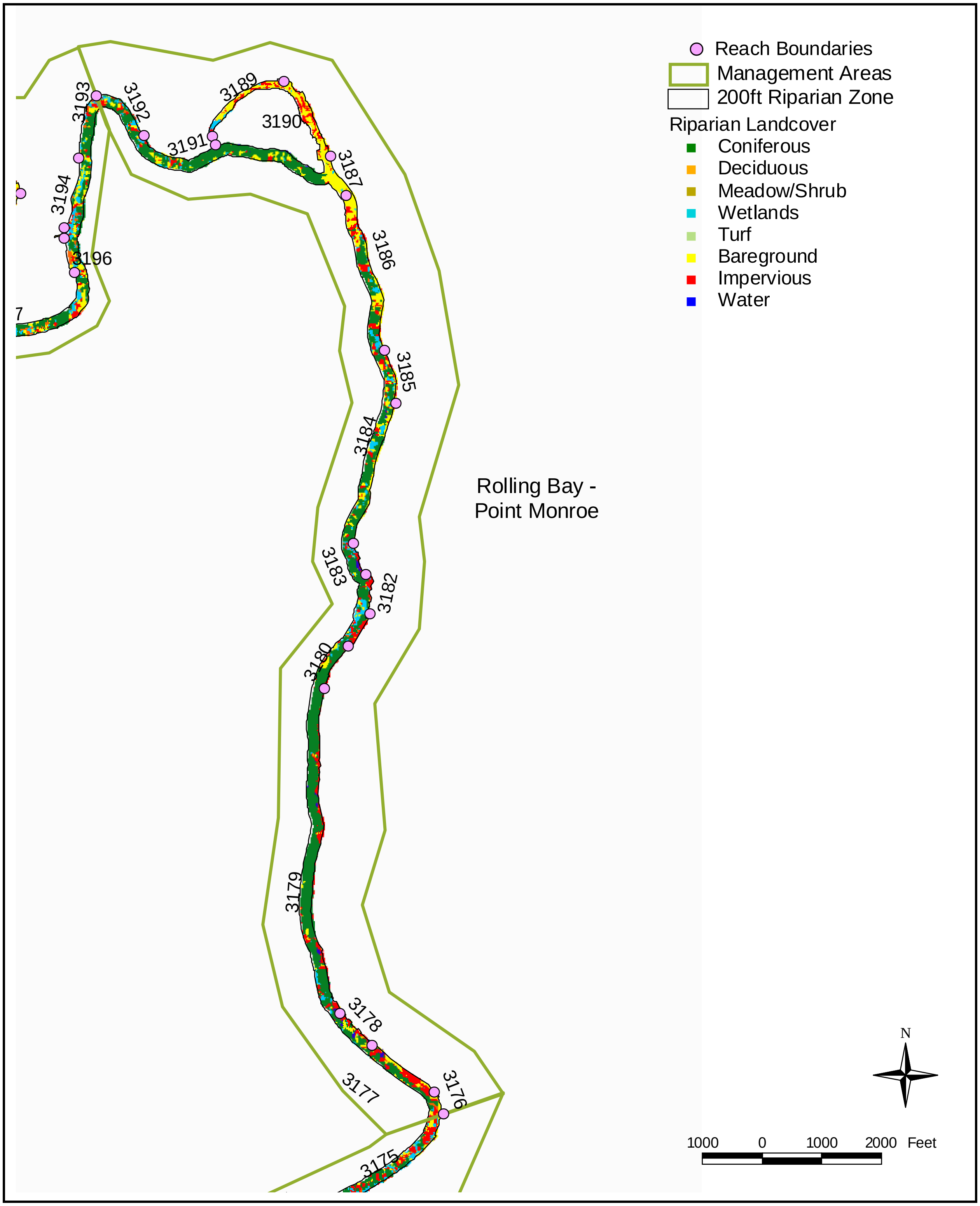

Figure B-33. Management Area 3 Marine Riparian Zone Land Cover Classes.

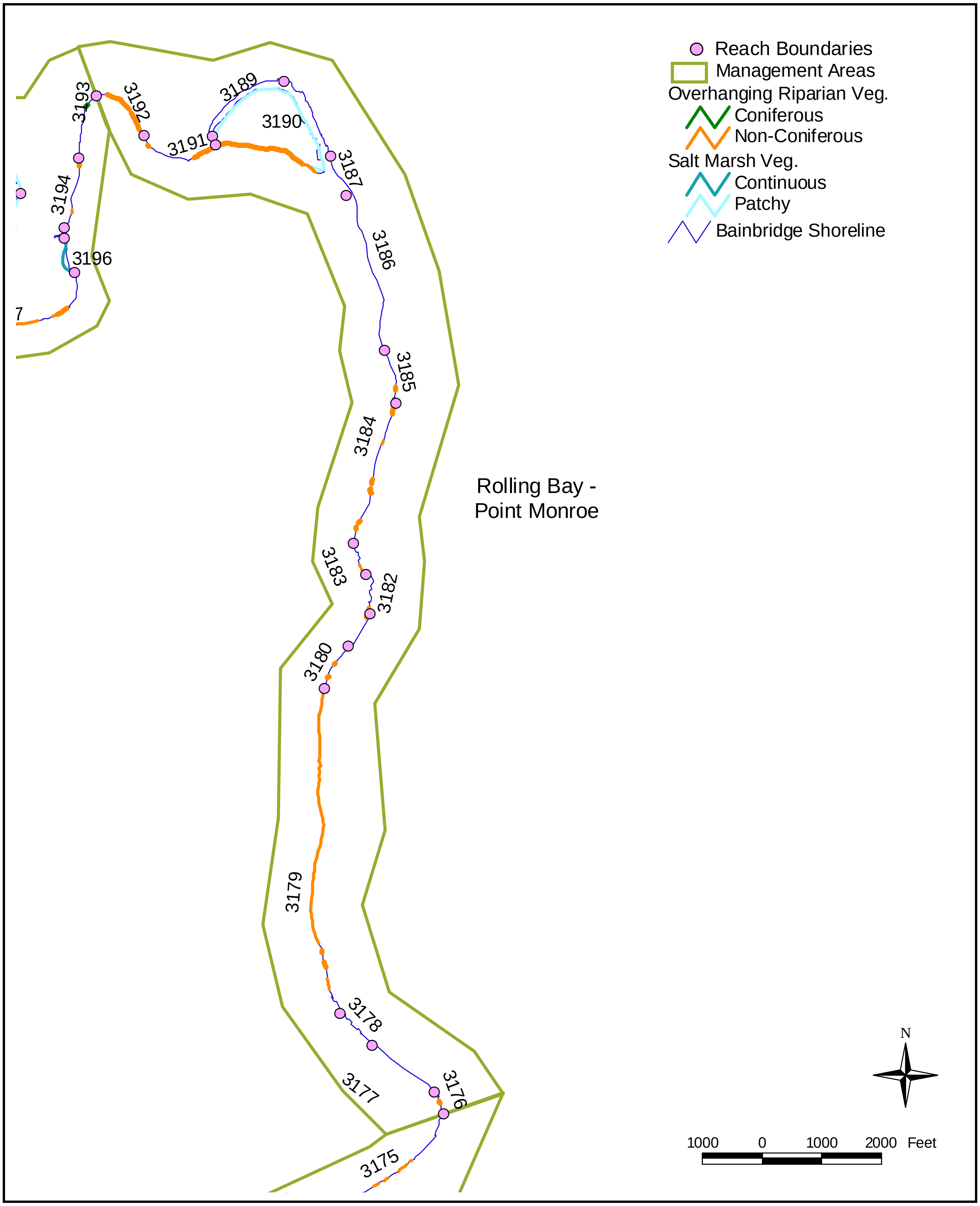

Figure B-34. Management Area 3 Overhanging Riparian and Saltmarsh Vegetation.

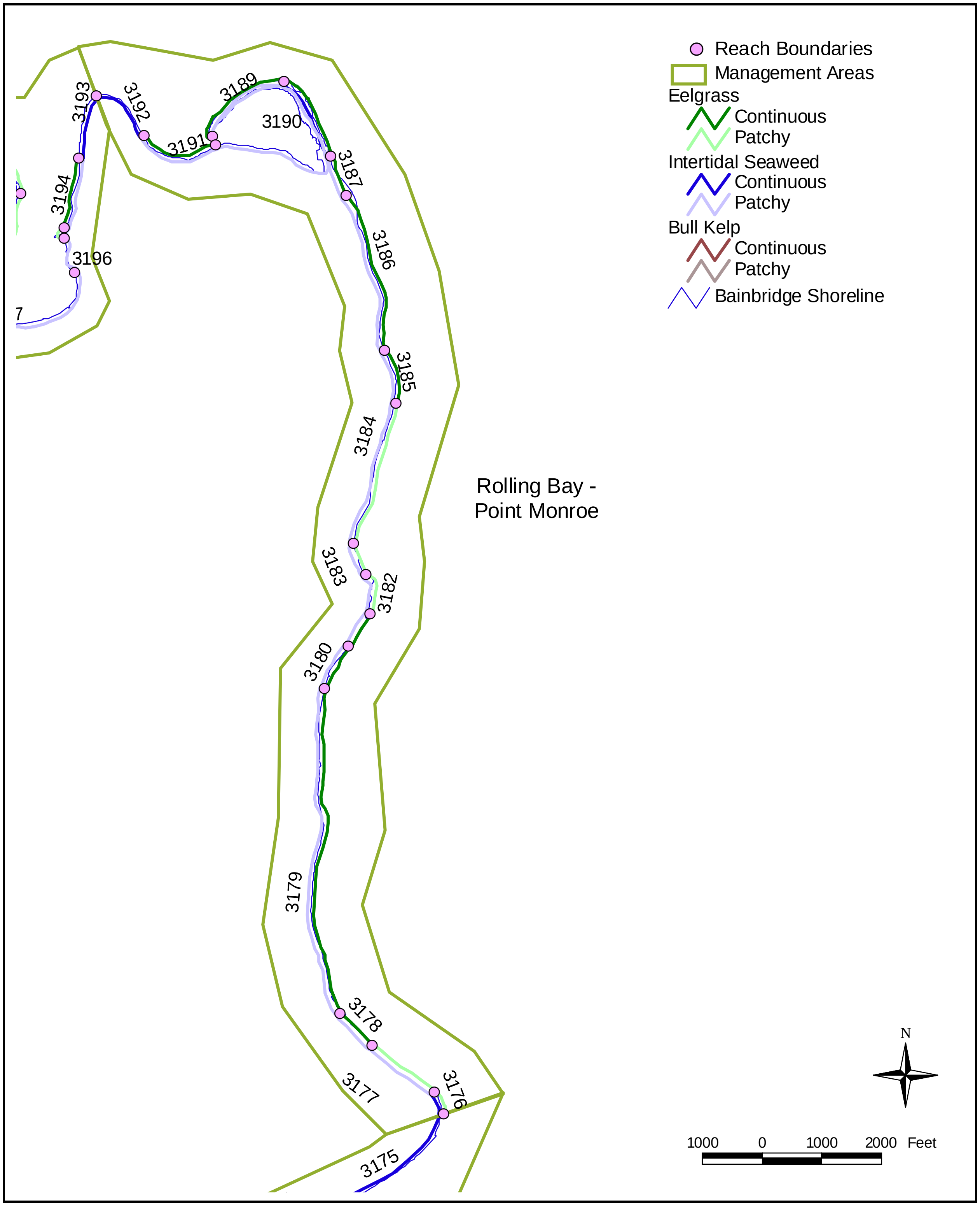

Figure B-35. Management Area 3 Eelgrass, Kelp, and Seaweed Distribution.

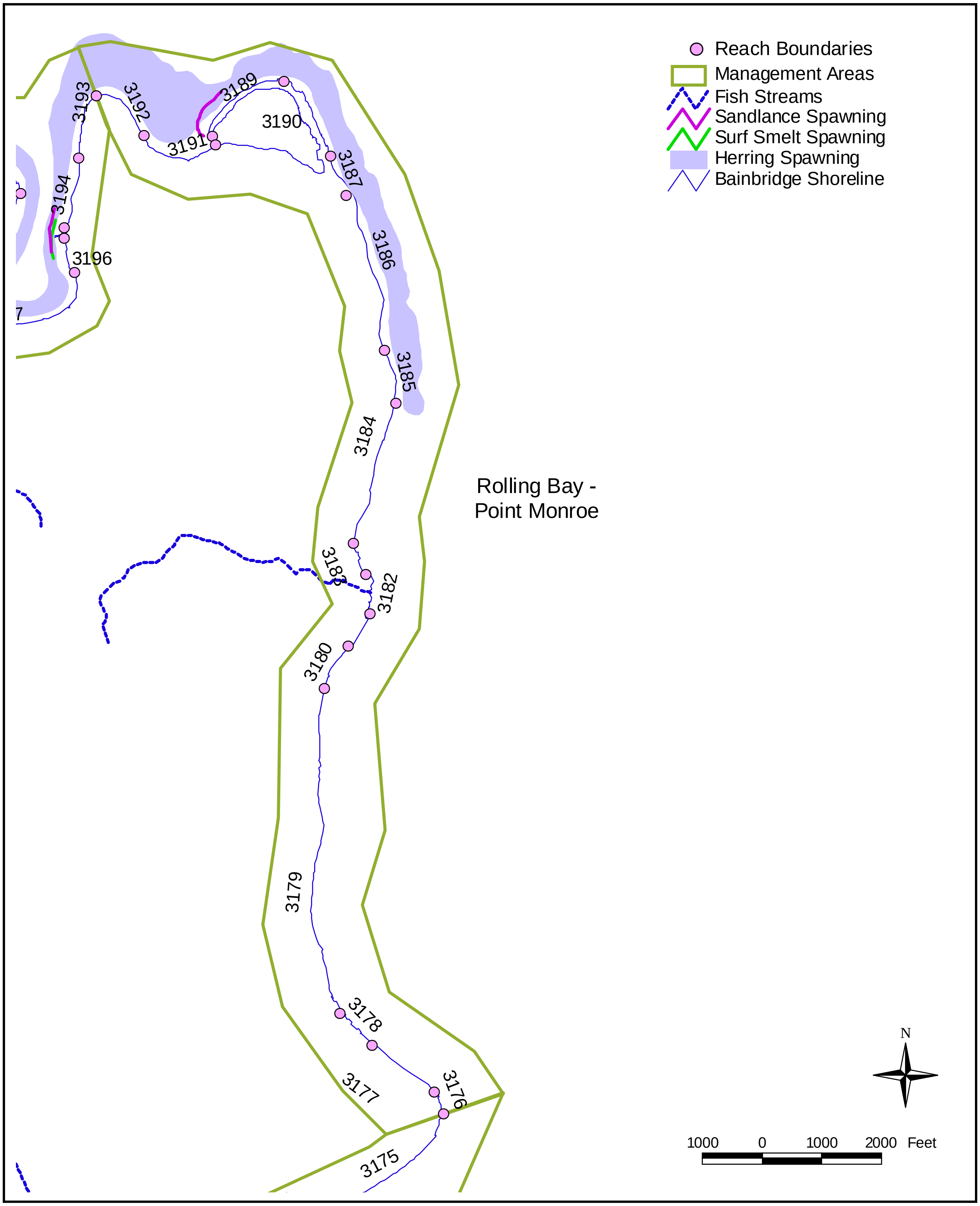

Figure B-36. Management Area 3 Forage Fish Spawning Areas and Salmon-Bearing Streams.

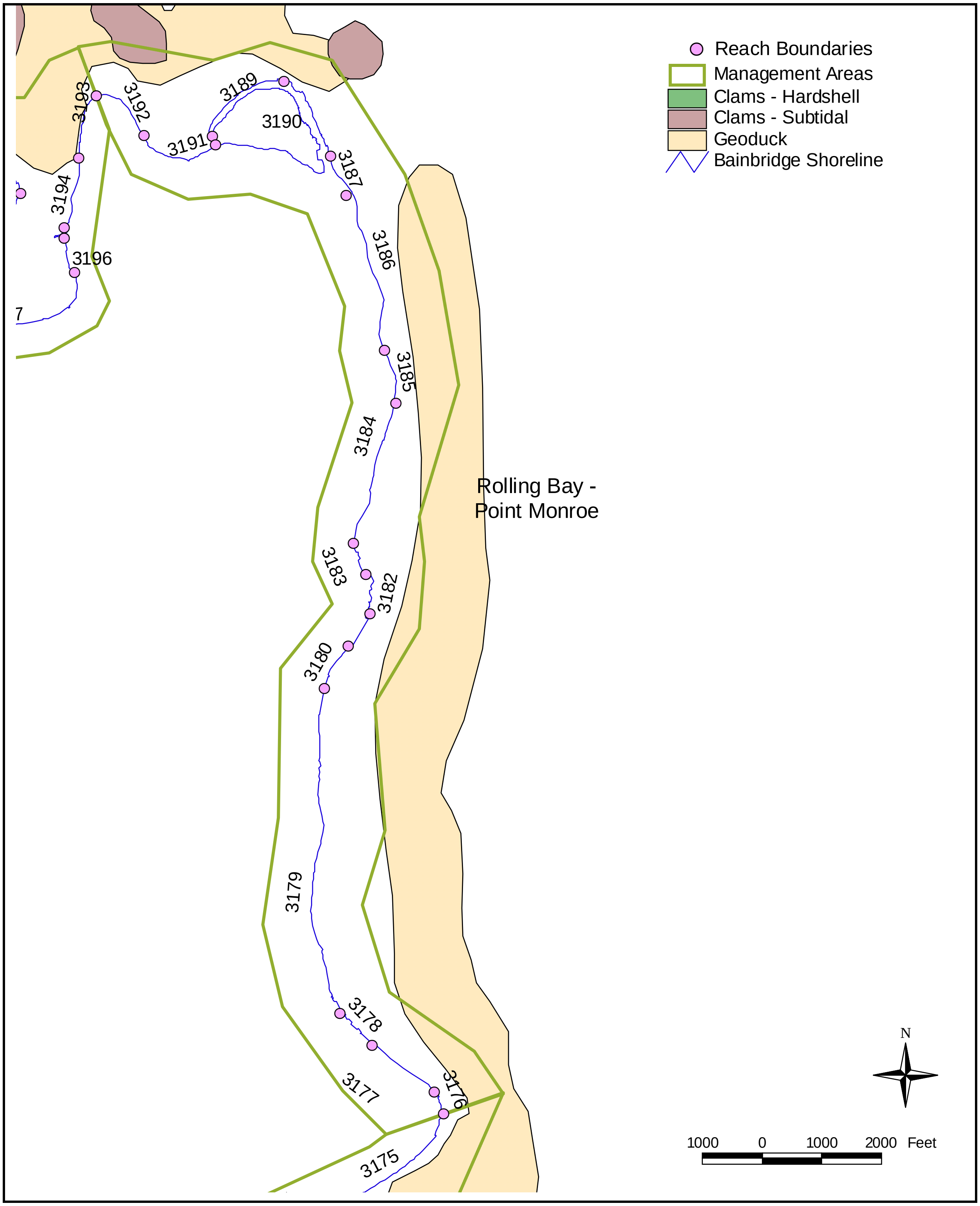

Figure B-37. Management Area 3 Clam and Geoduck Distribution.

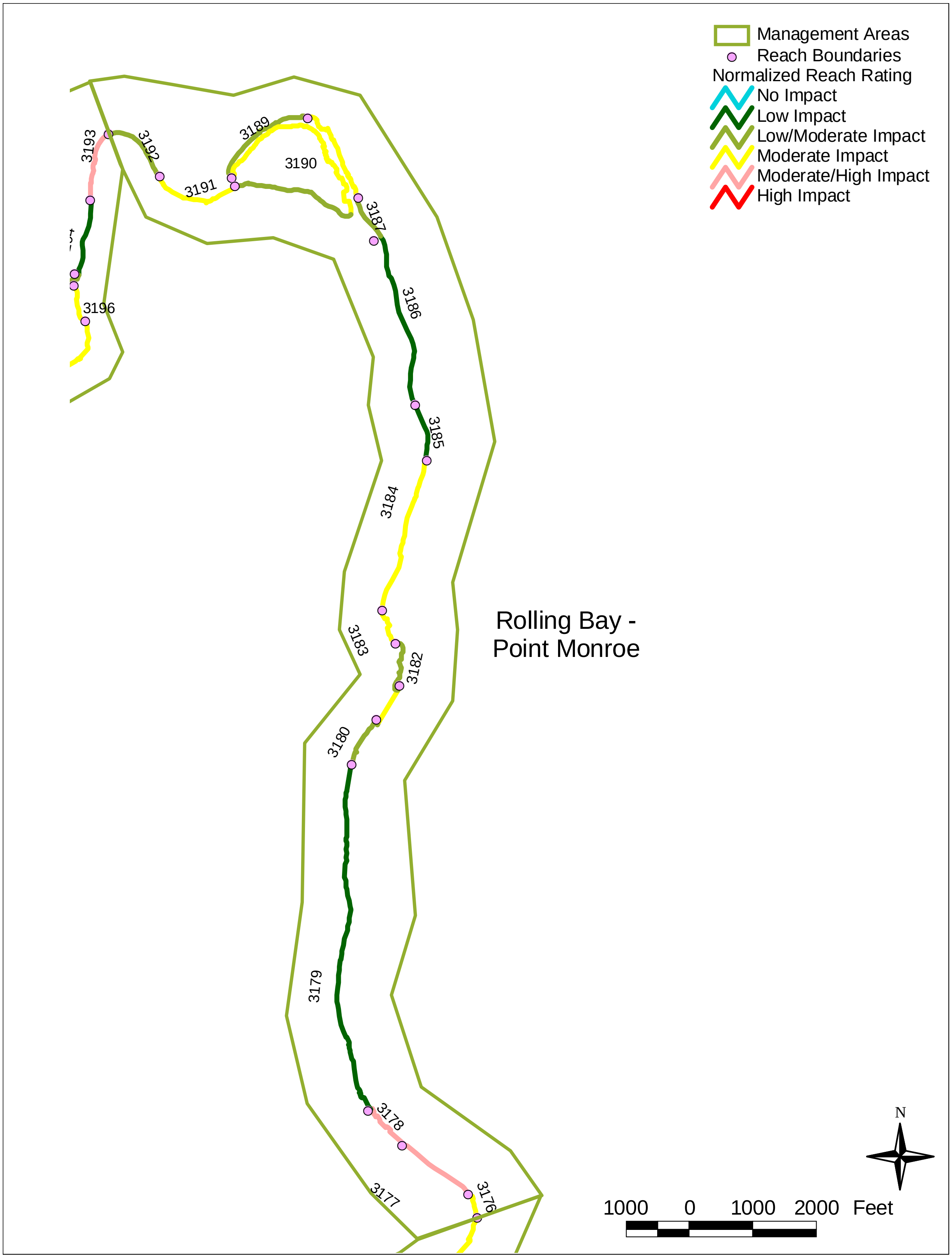

Figure B-38. Management Area 3 Reach Scores (Normalized).

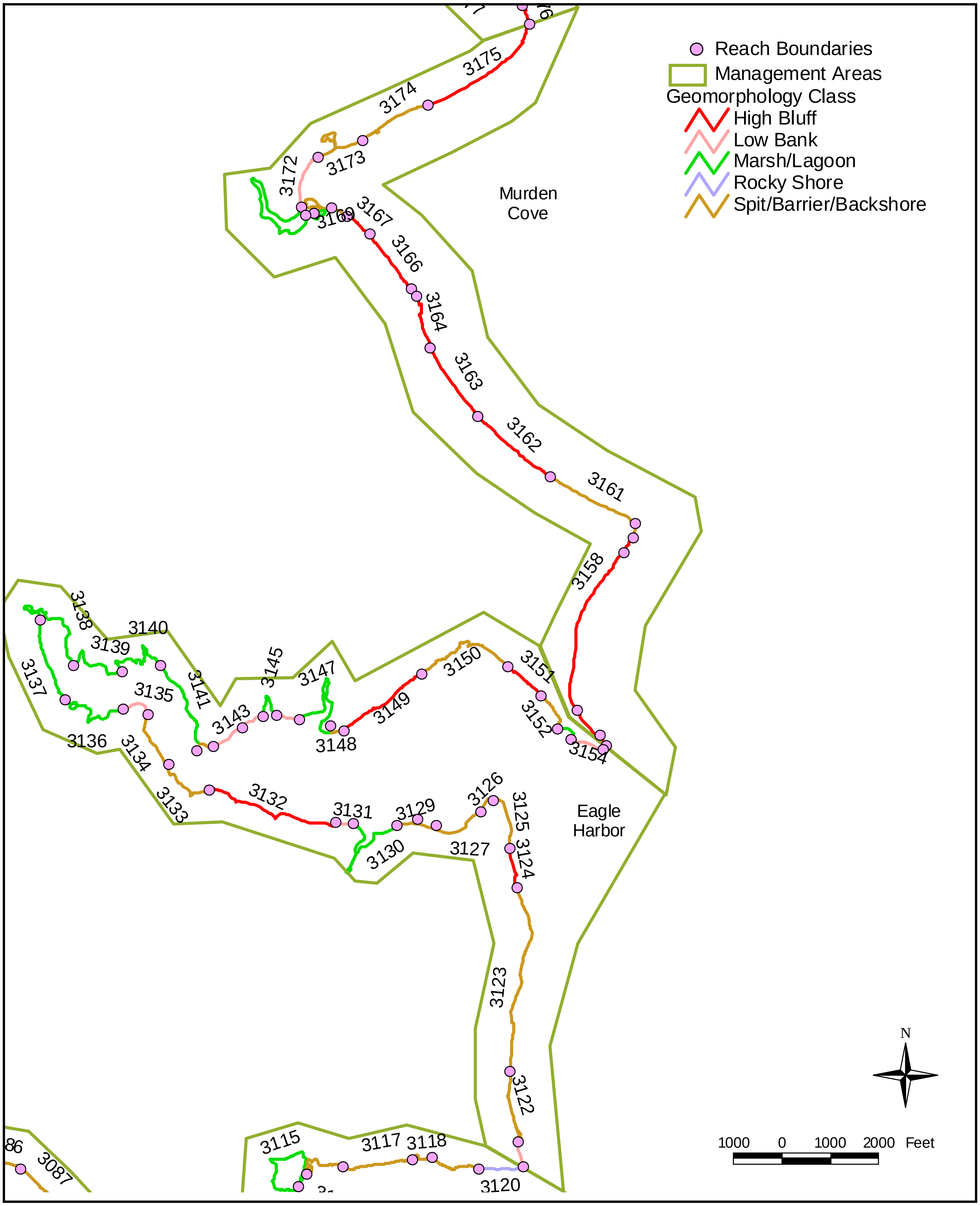

Figure B-39. Management Areas 4 and 5 Geomorphic Class Distribution

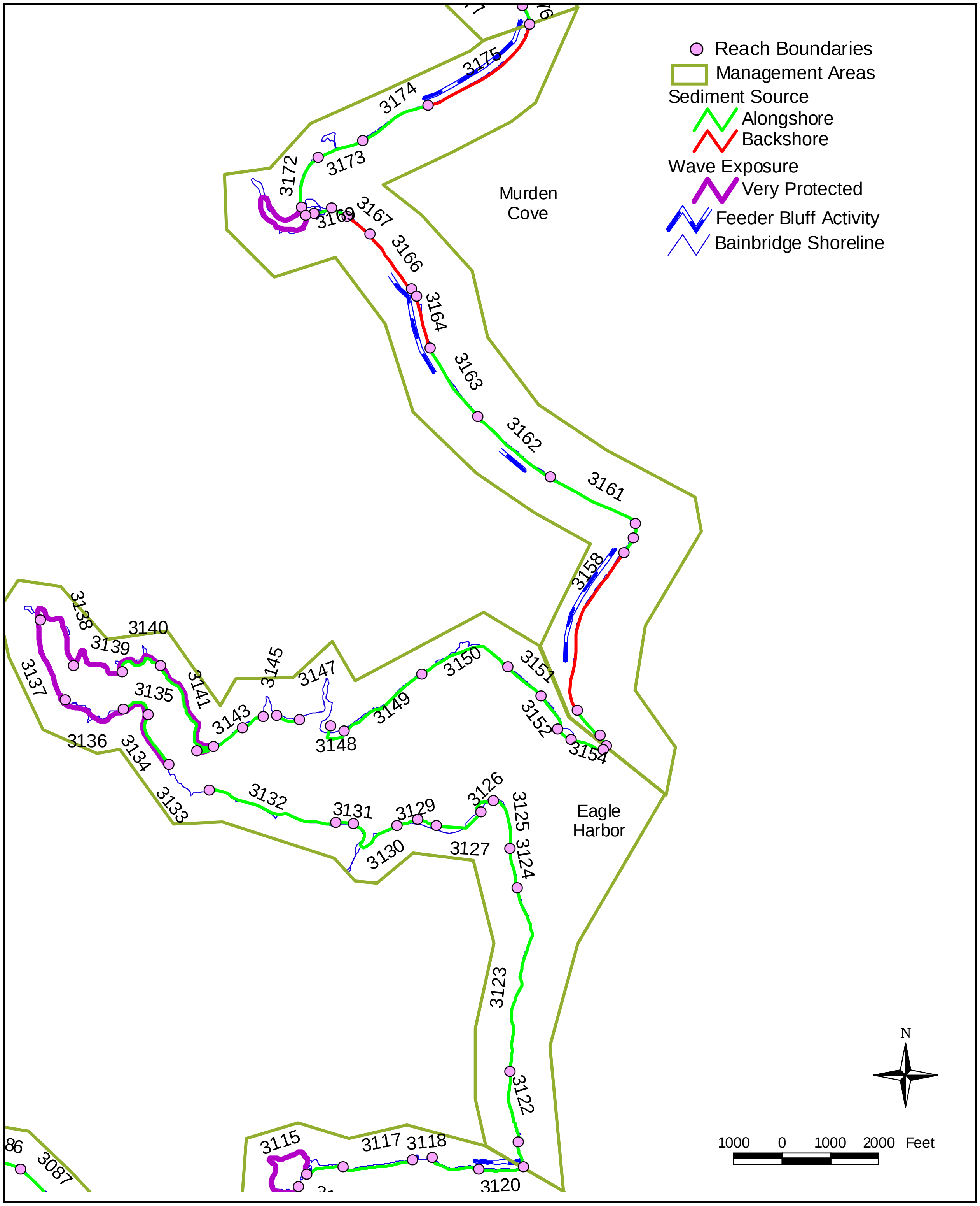

Figure B-40. Management Areas 4 and 5 Sediment Sources and Wave Exposure Classes.

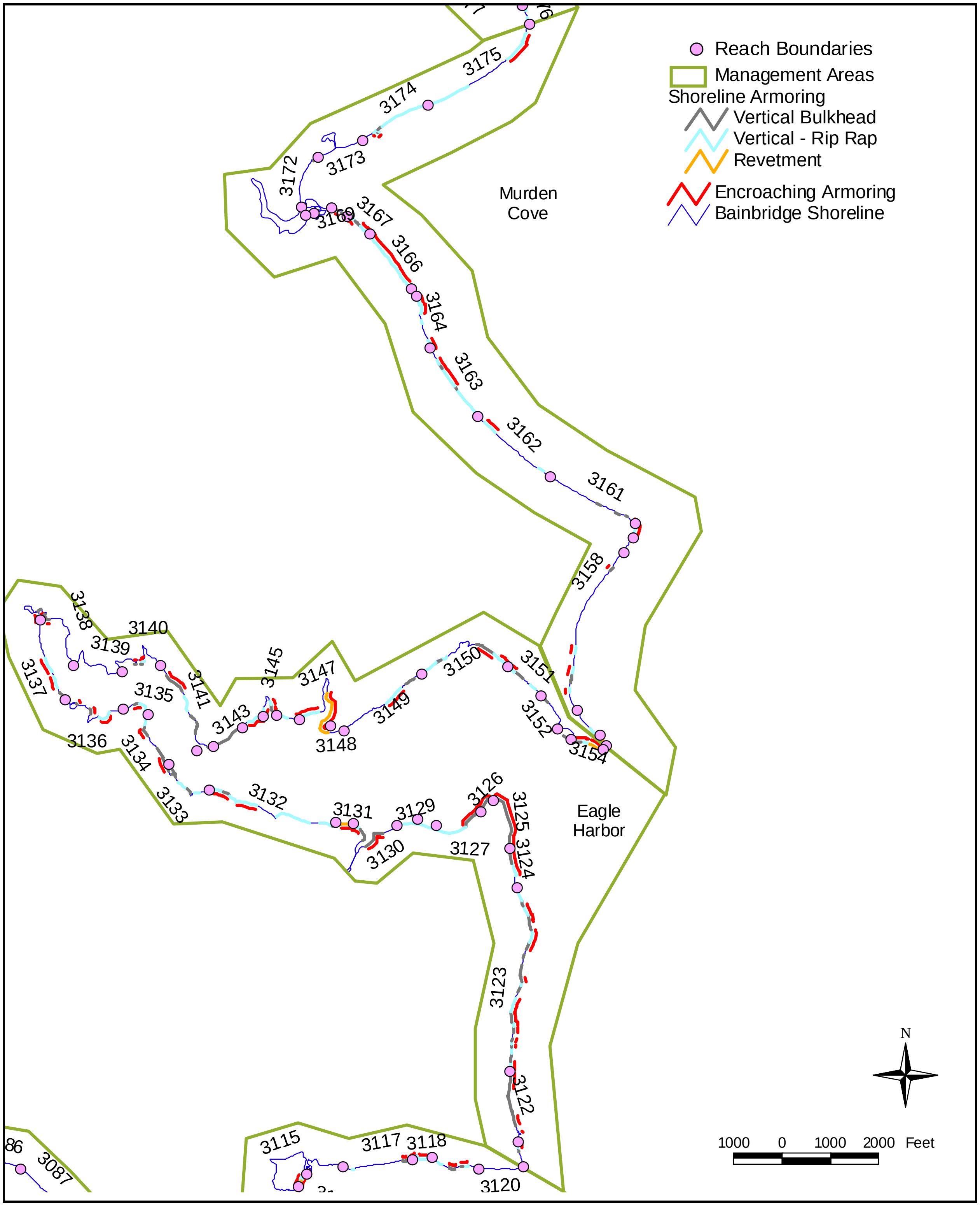

Figure B-41. Management Areas 4 and 5 Shoreline Armoring and Armoring Encroachment.

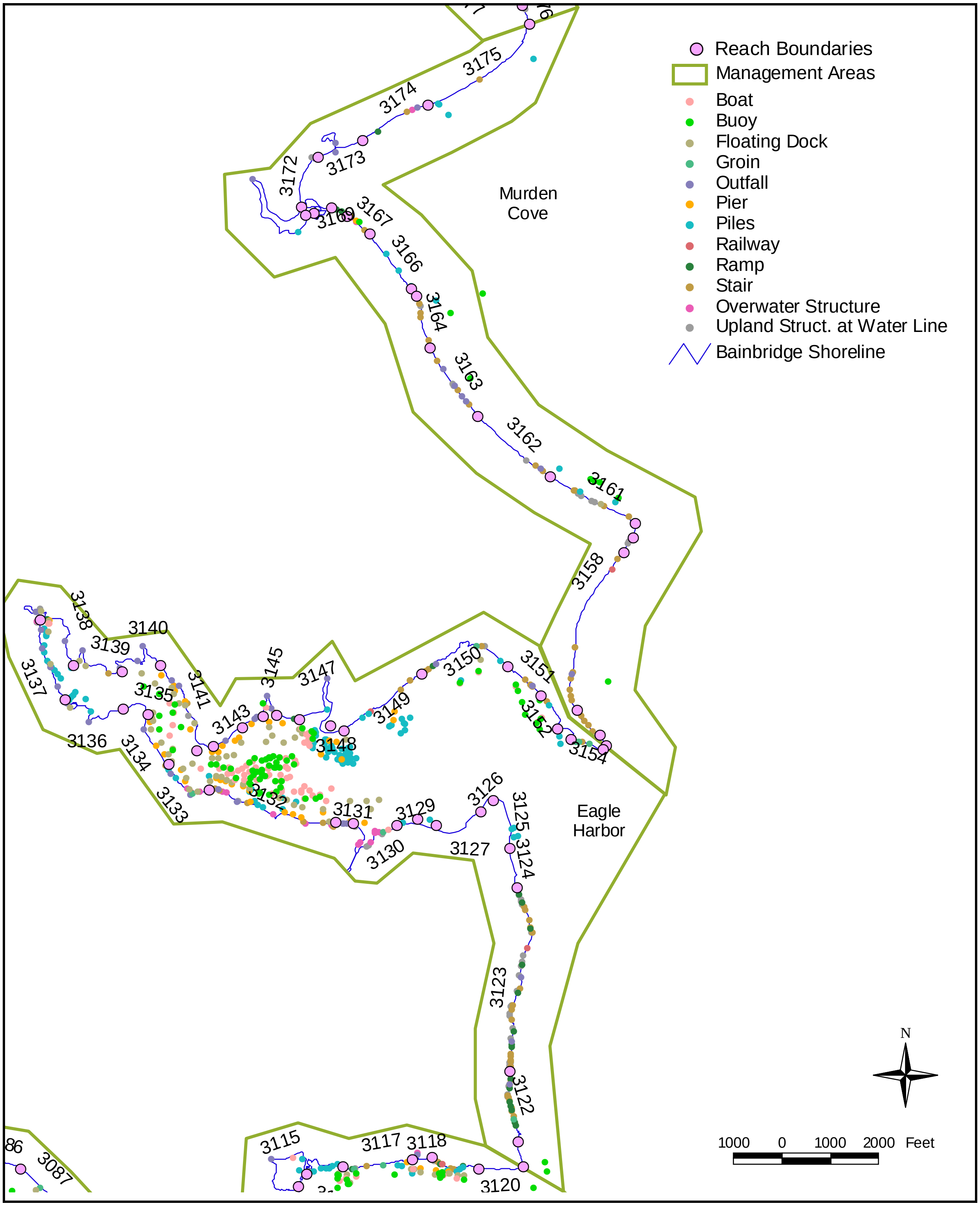

Figure B-42. Management Areas 4 and 5 Point Modifications.

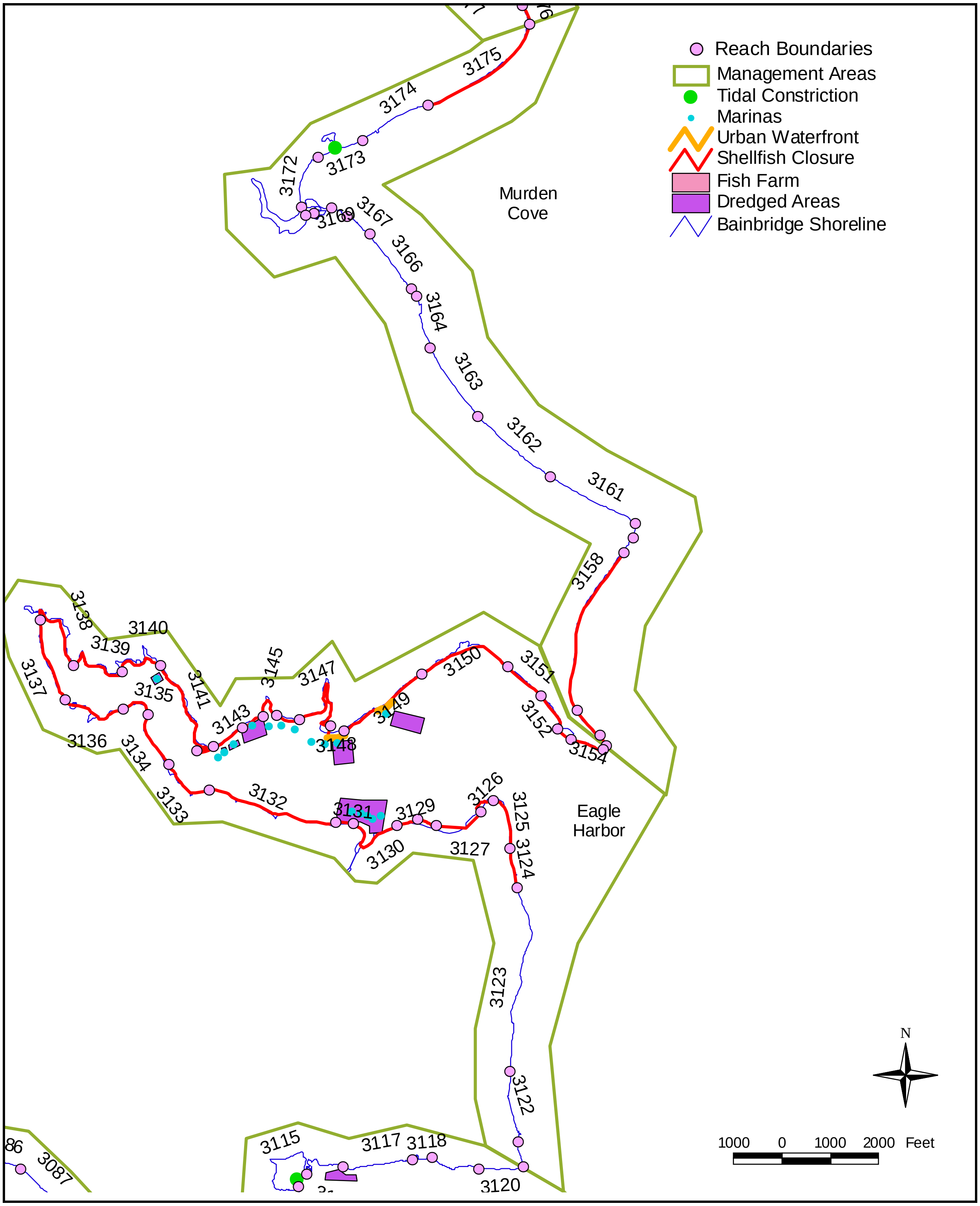

Figure B-43. Management Areas 4 and 5 Shellfish Closures, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

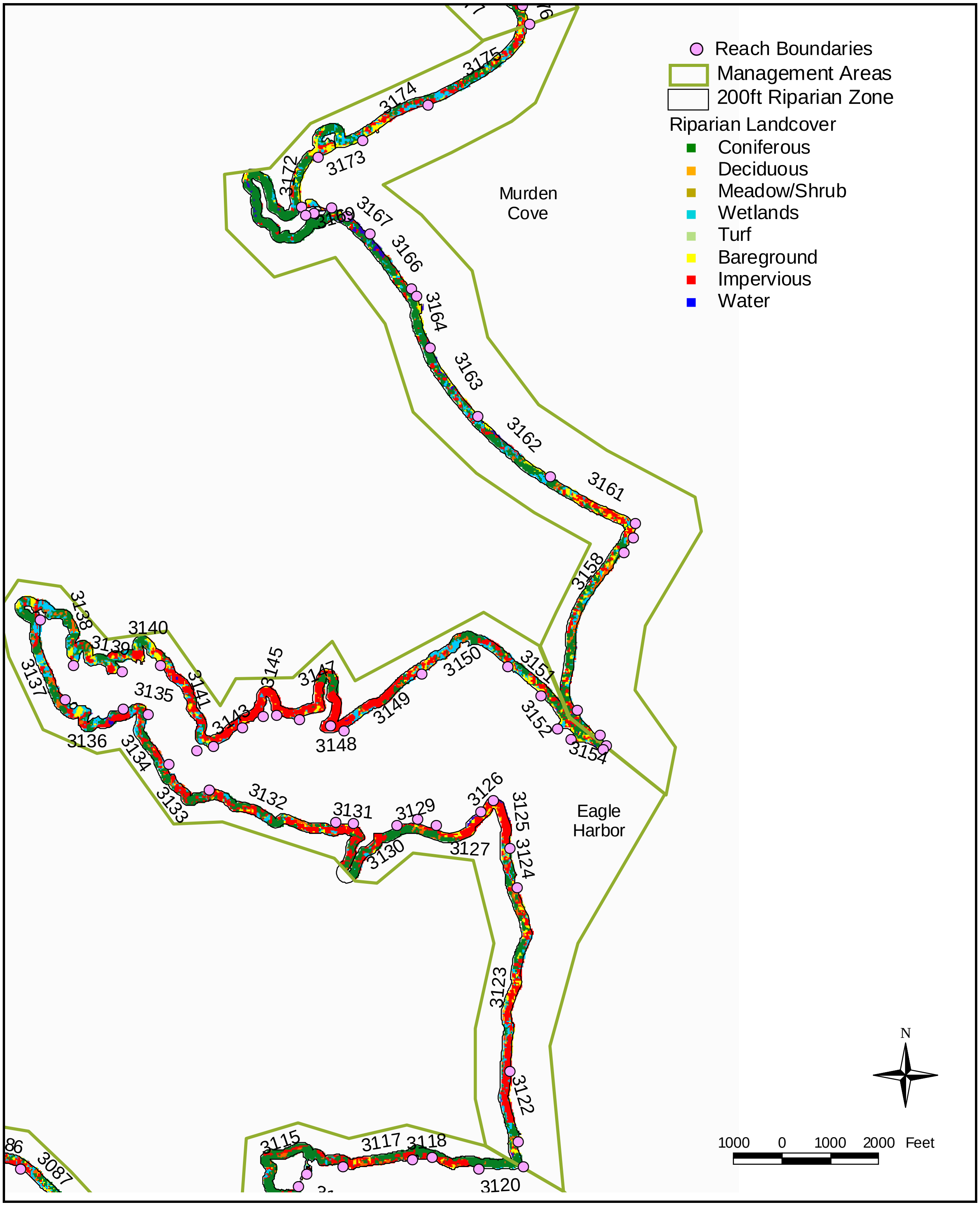

Figure B-44. Management Areas 4 and 5 Marine Riparian Zone Land Cover Classes.

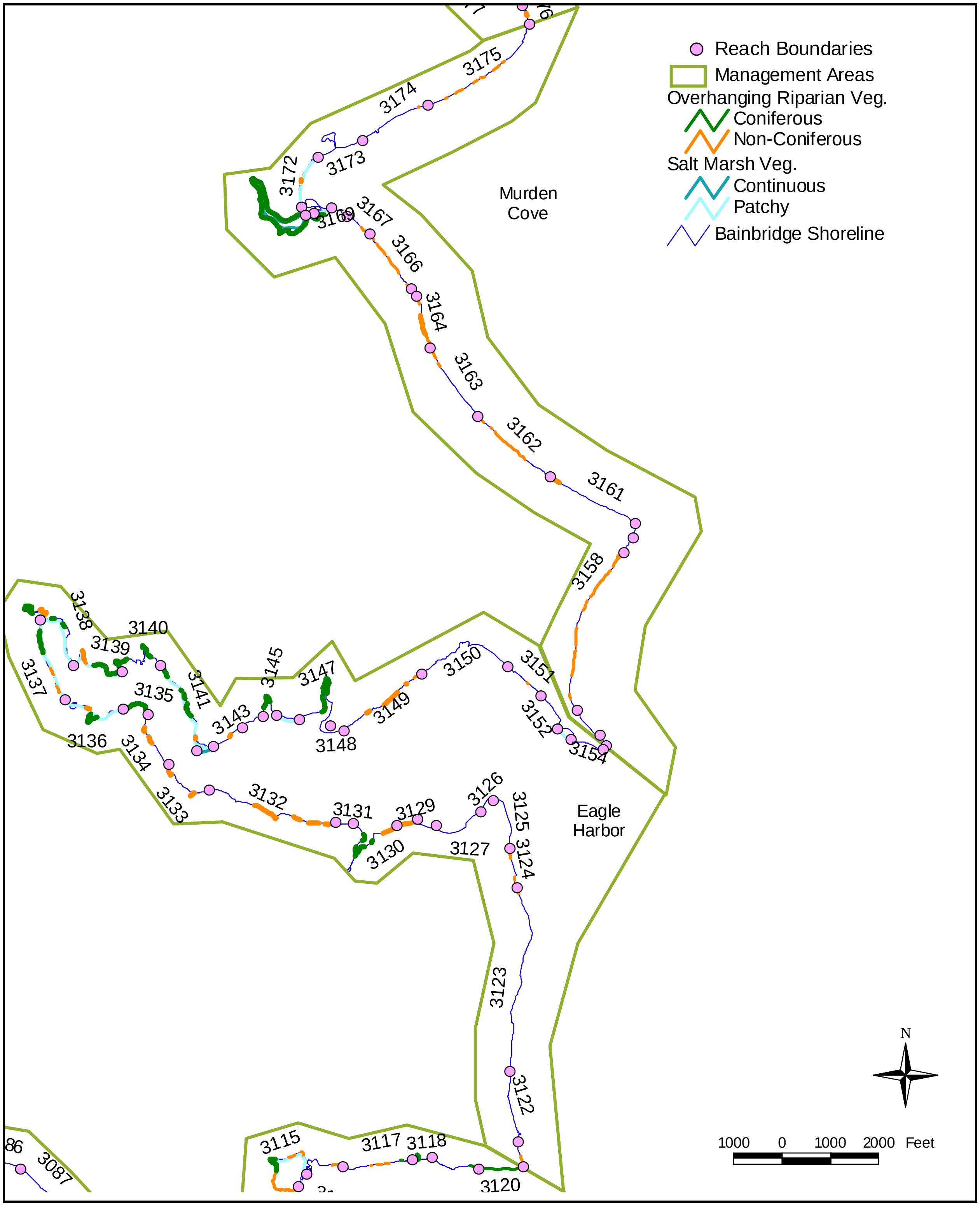

Figure B-45. Management Areas 4 and 5 Overhanging Riparian and Saltmarsh Vegetation.

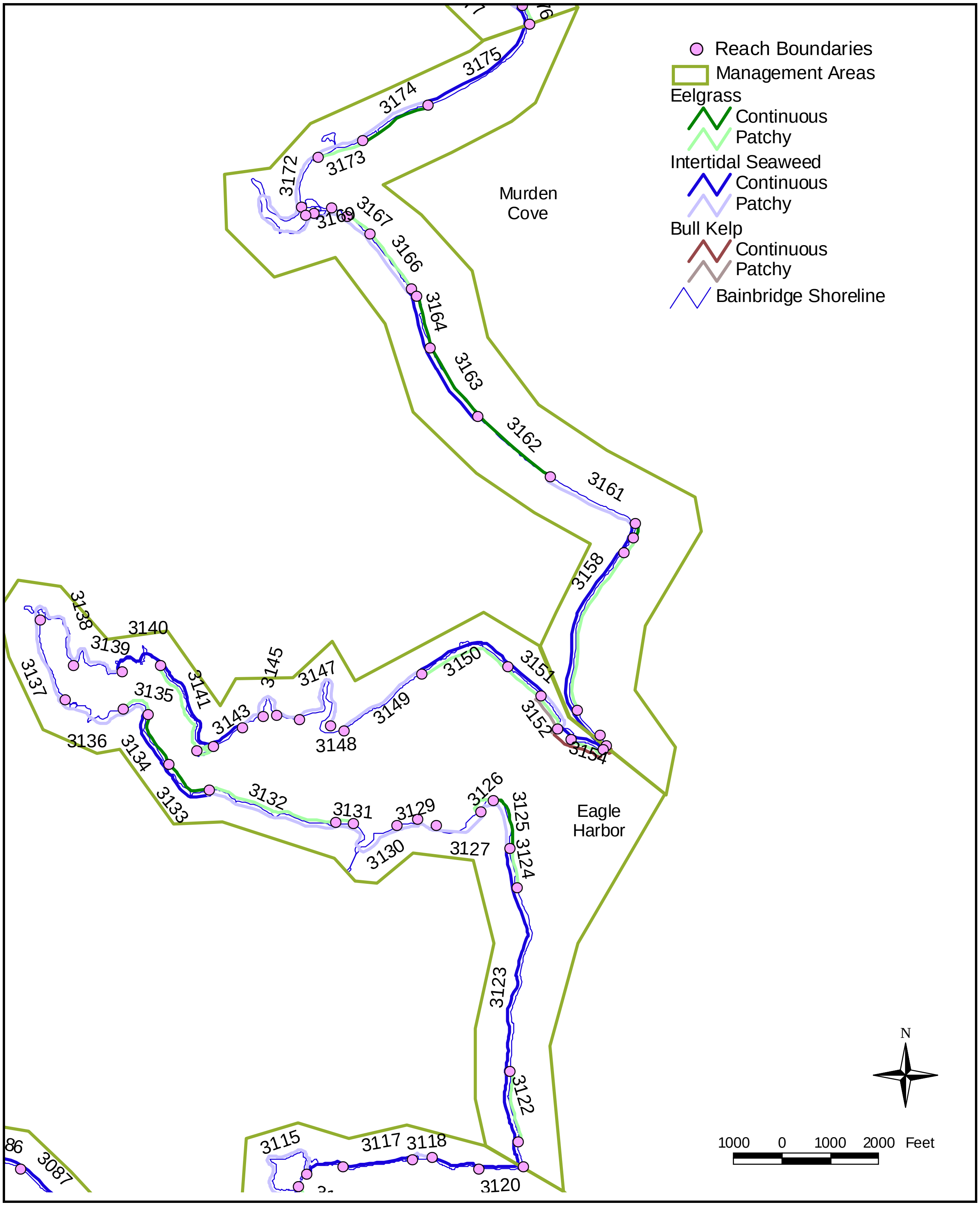

Figure B-46. Management Areas 4 and 5 Eelgrass, Kelp, and Seaweed Distribution.

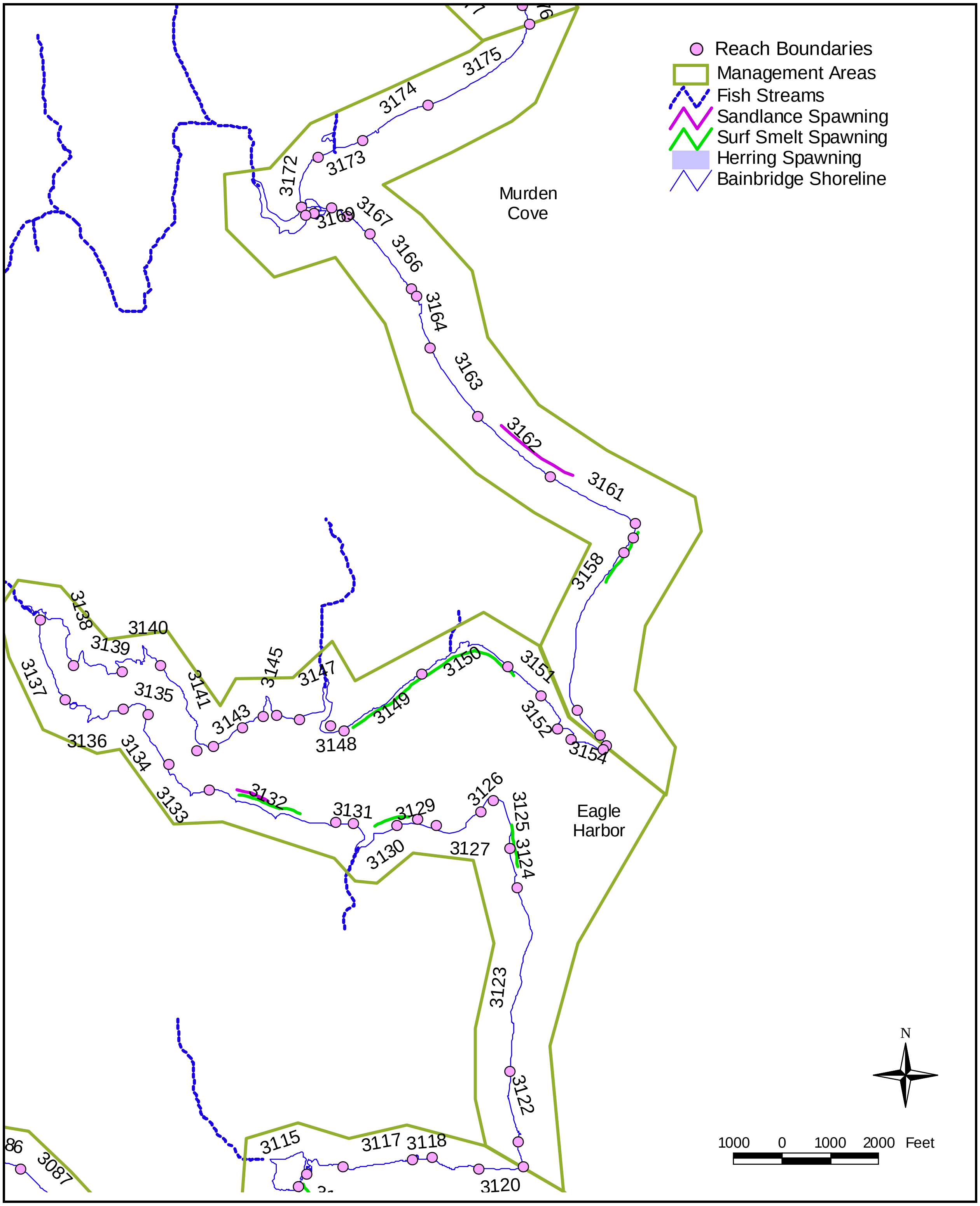

Figure B-47. Management Areas 4 and 5 Forage Fish Spawning Areas and Salmon-Bearing Streams.

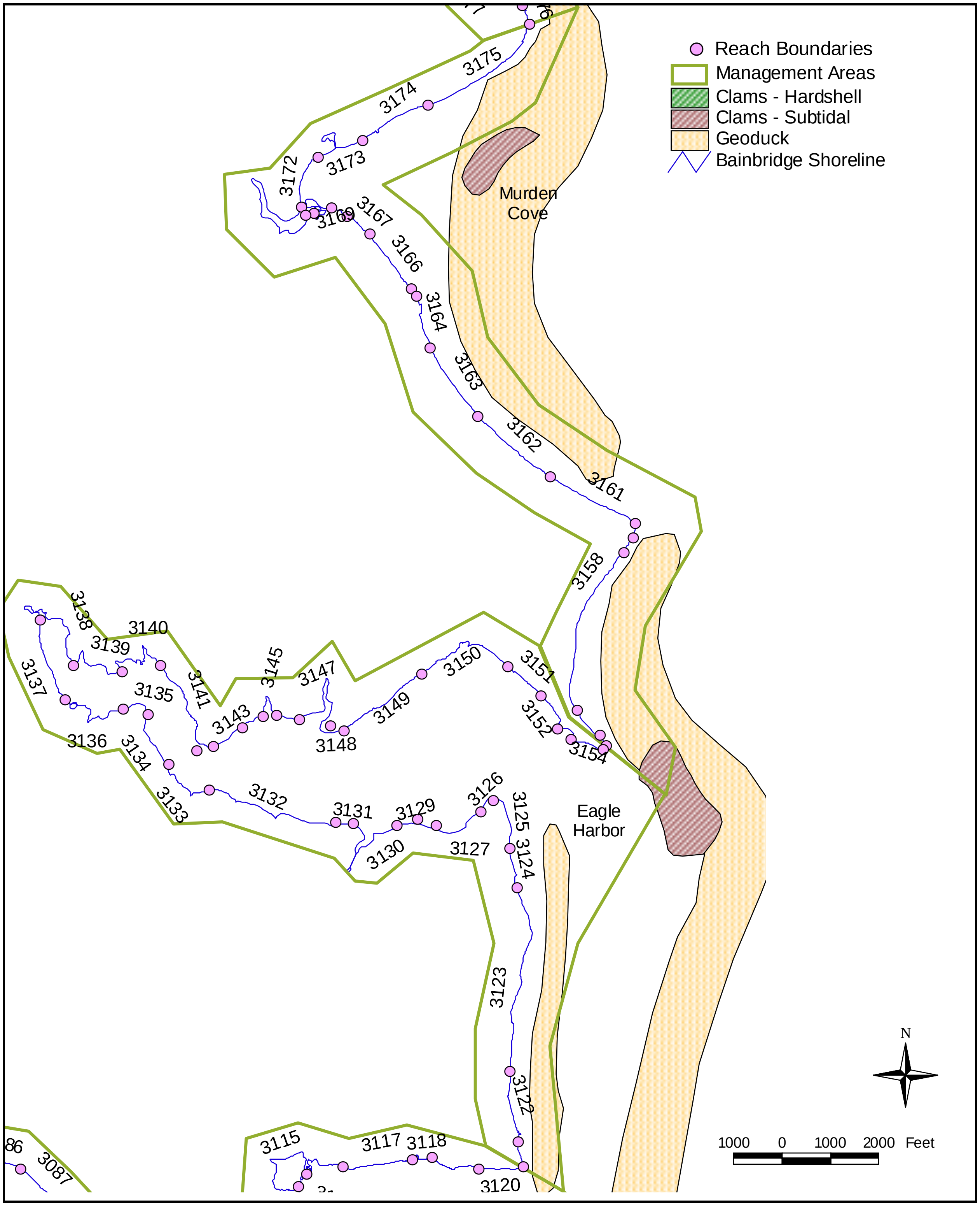

Figure B-48. Management Areas 4 and 5 Clam and Geoduck Distribution.

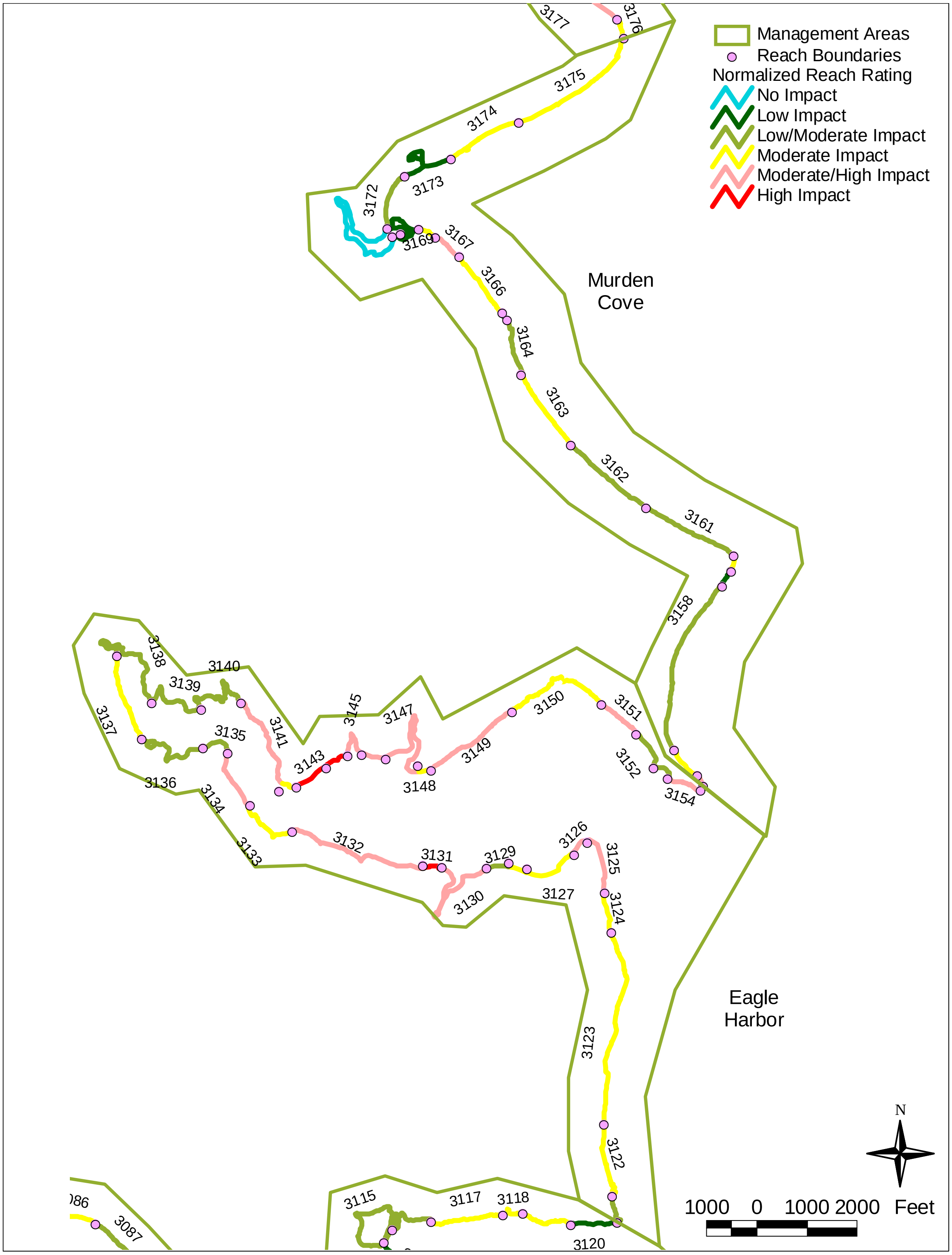

Figure B-49. Management Areas 4 and 5 Reach Scores (Normalized).

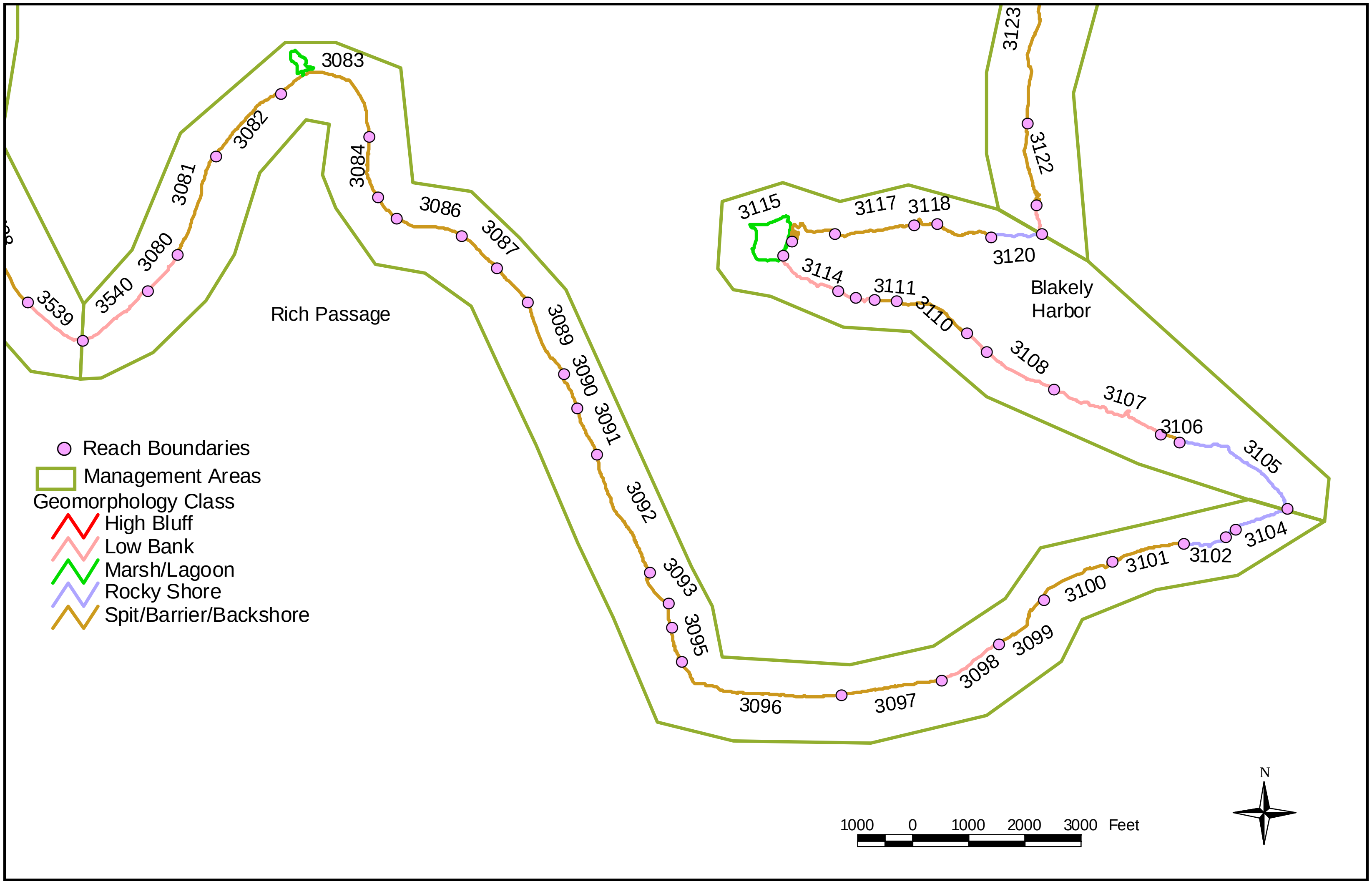

Figure B-50. Management Areas 6 and 7 Geomorphic Class Distribution

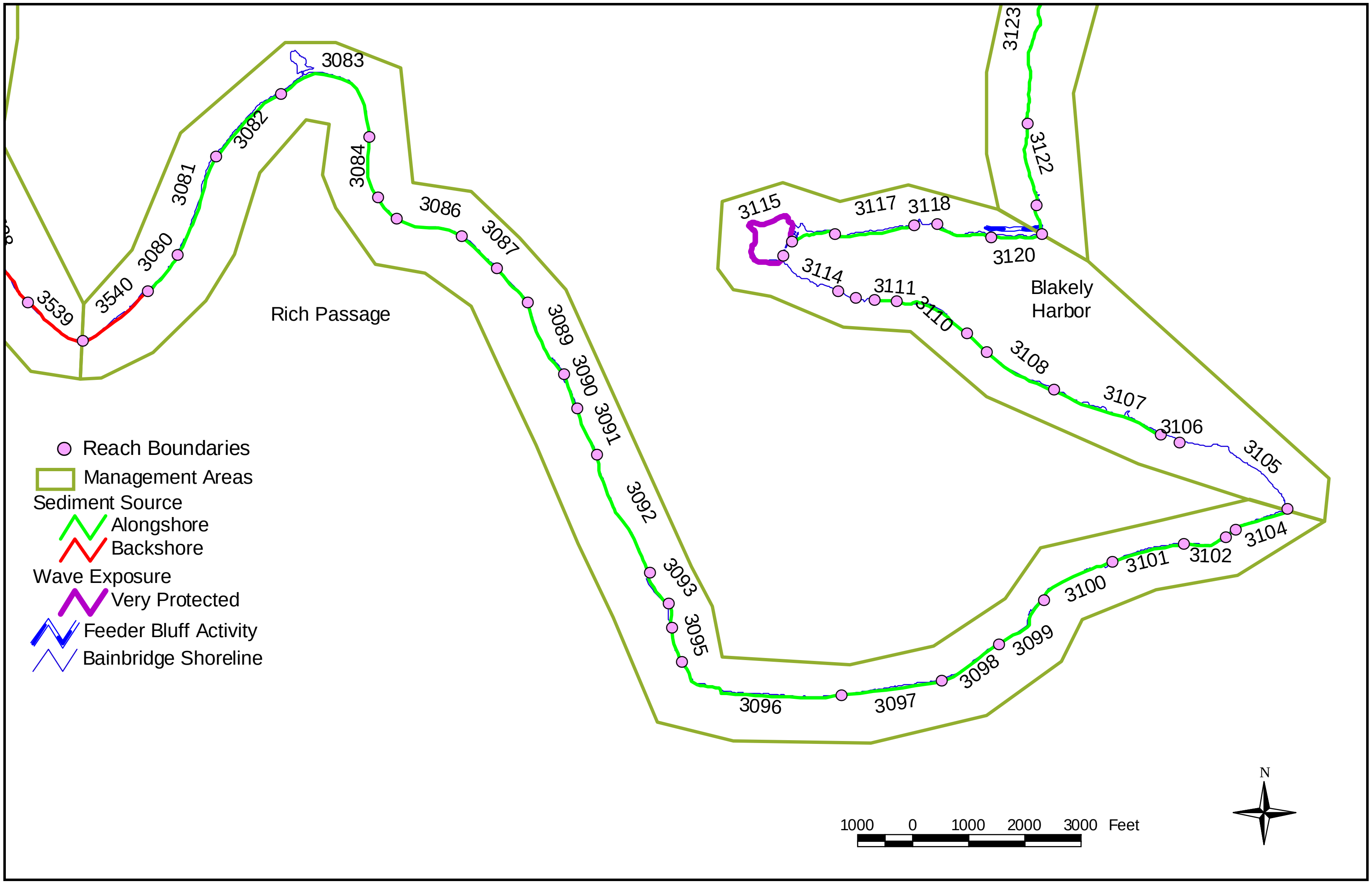

Figure B-51. Management Areas 6 and 7 Sediment Sources and Wave Exposure Classes.

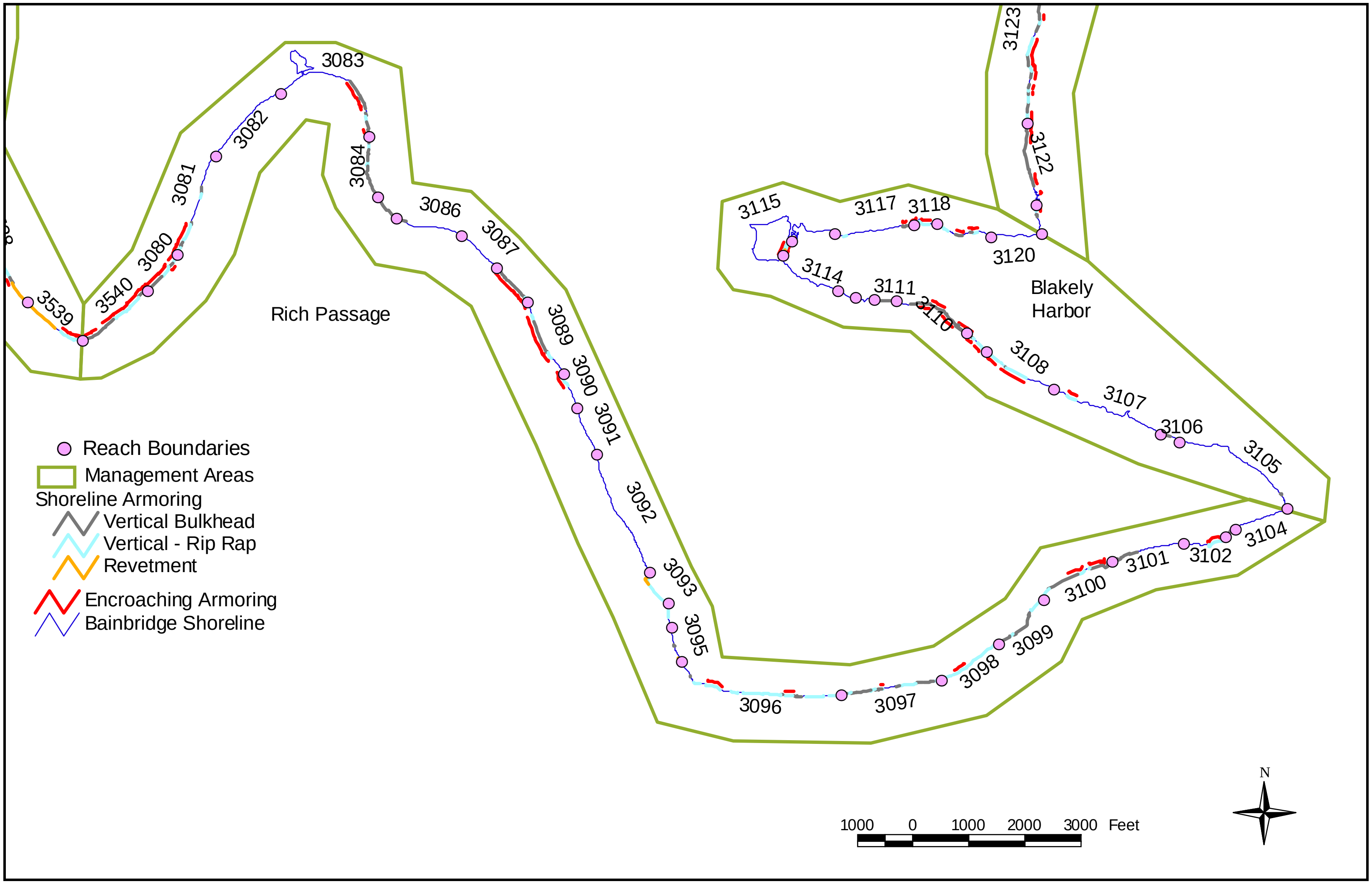

Figure B-52. Management Areas 6 and 7 Shoreline Armoring and Armoring Encroachment.

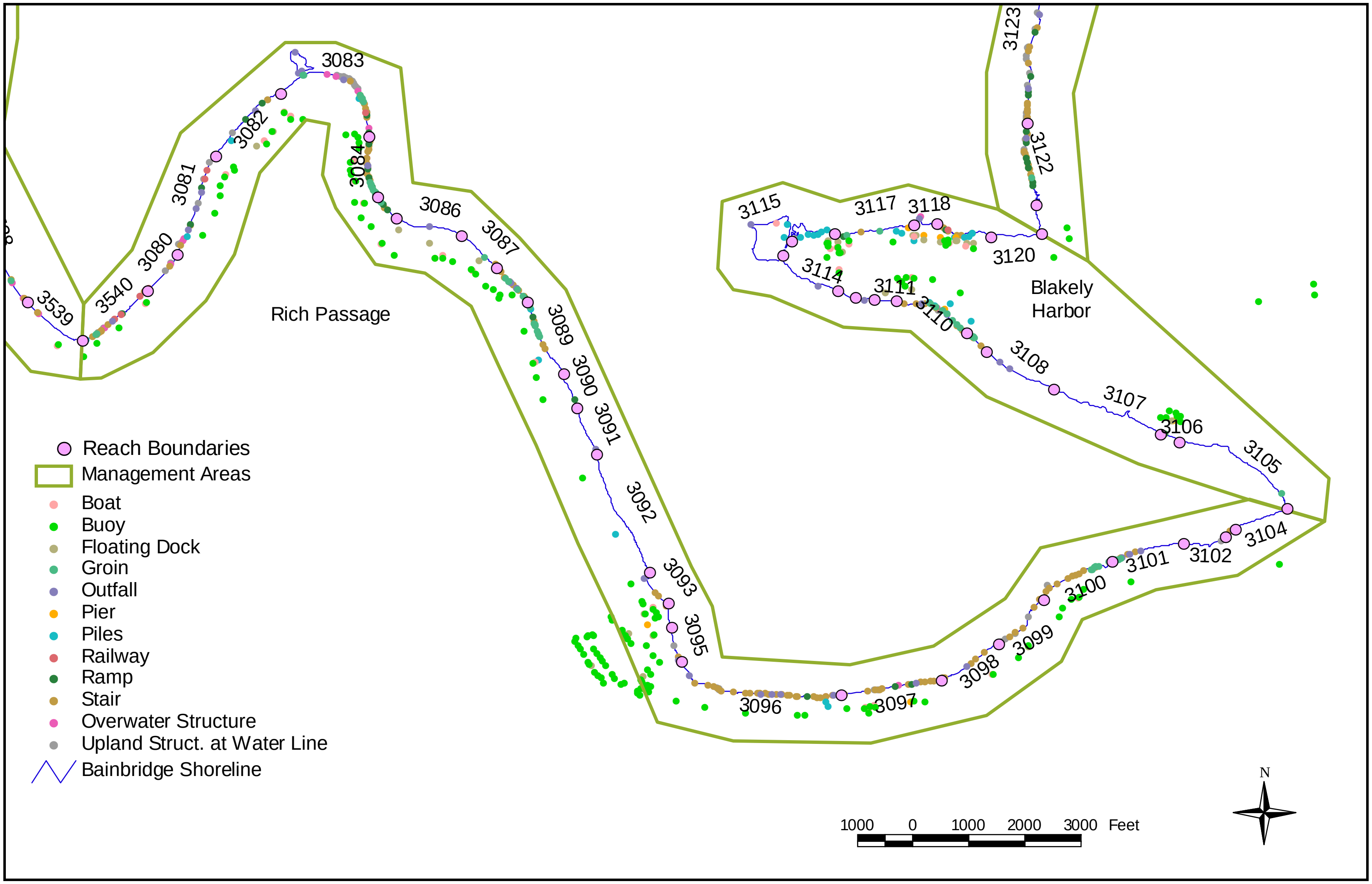

Figure B-53. Management Areas 6 and 7 Point Modifications.

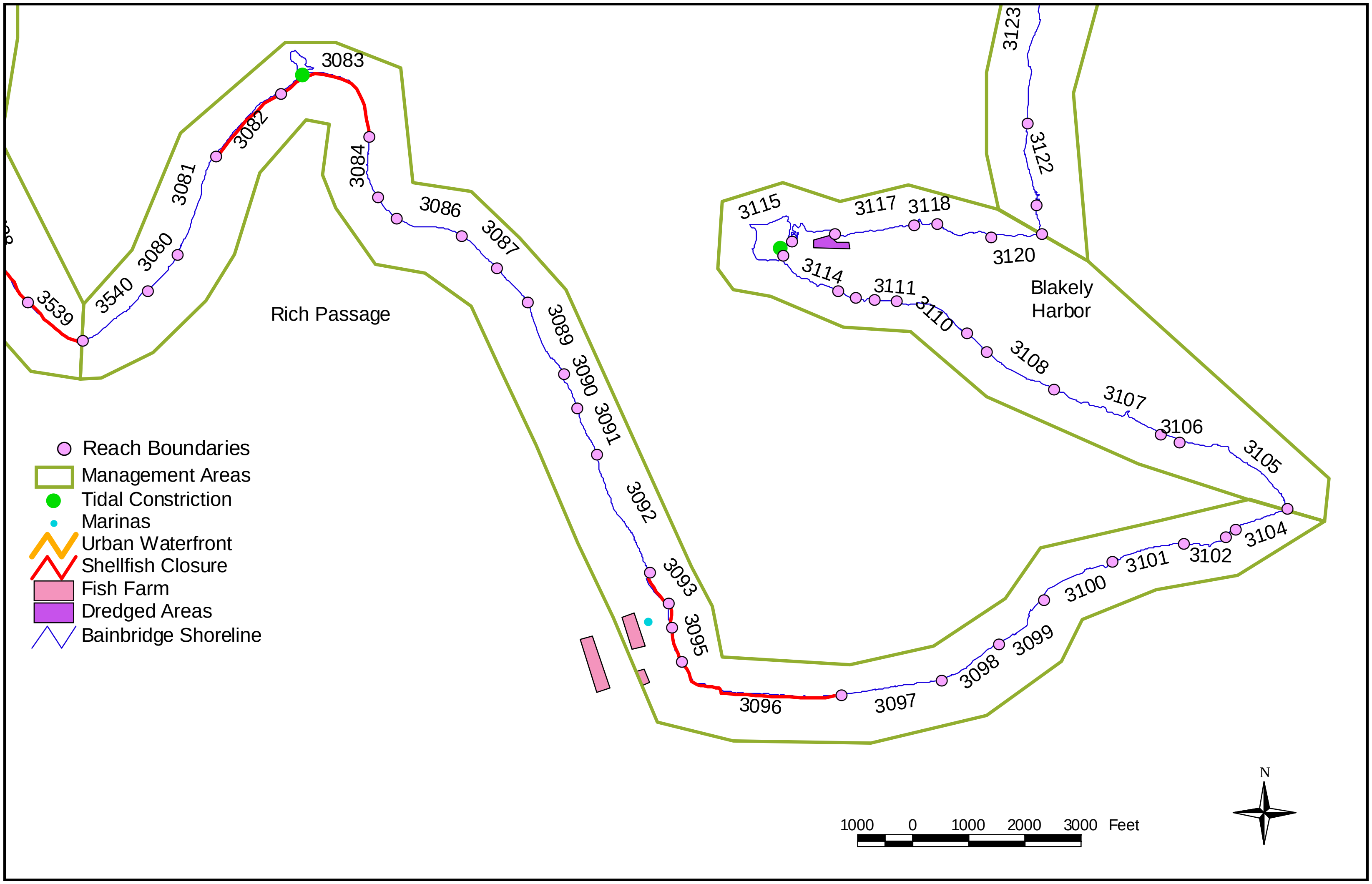

Figure B-54. Management Areas 6 and 7 Shellfish Closures, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

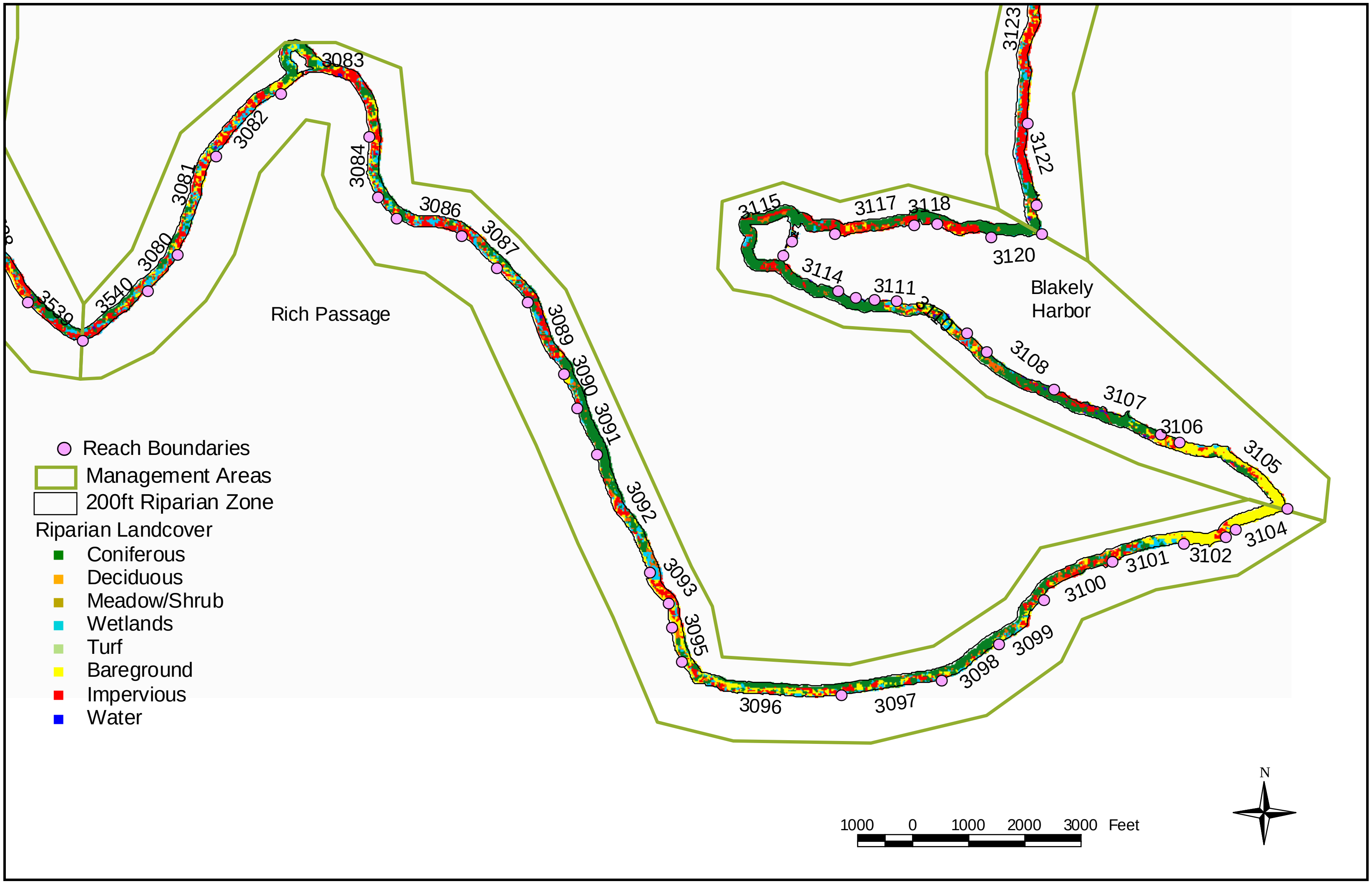

Figure B-55. Management Areas 6 and 7 Marine Riparian Zone Land Cover Classes.

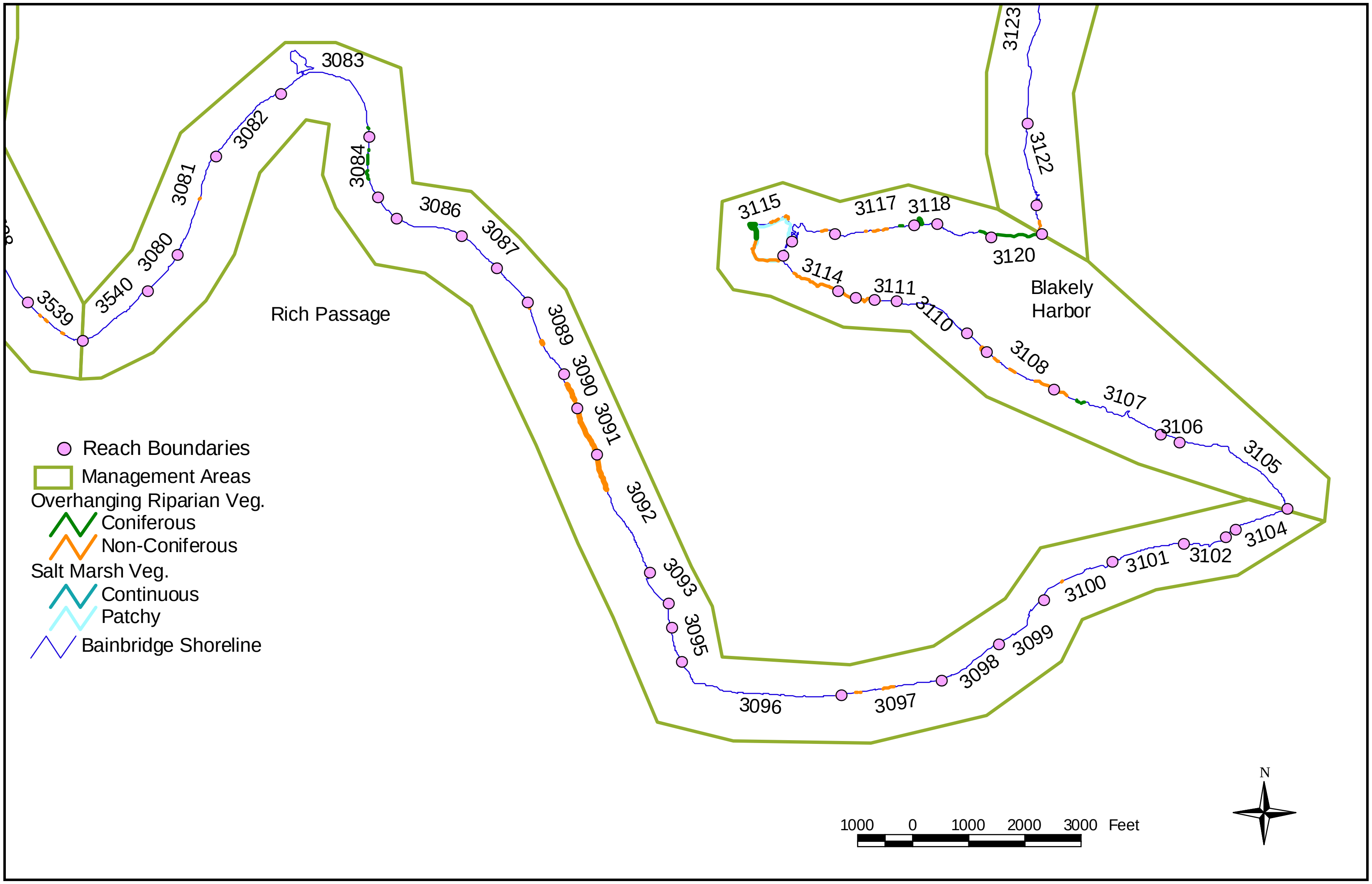

Figure B-56. Management Areas 6 and 7 Overhanging Riparian and Saltmarsh Vegetation.

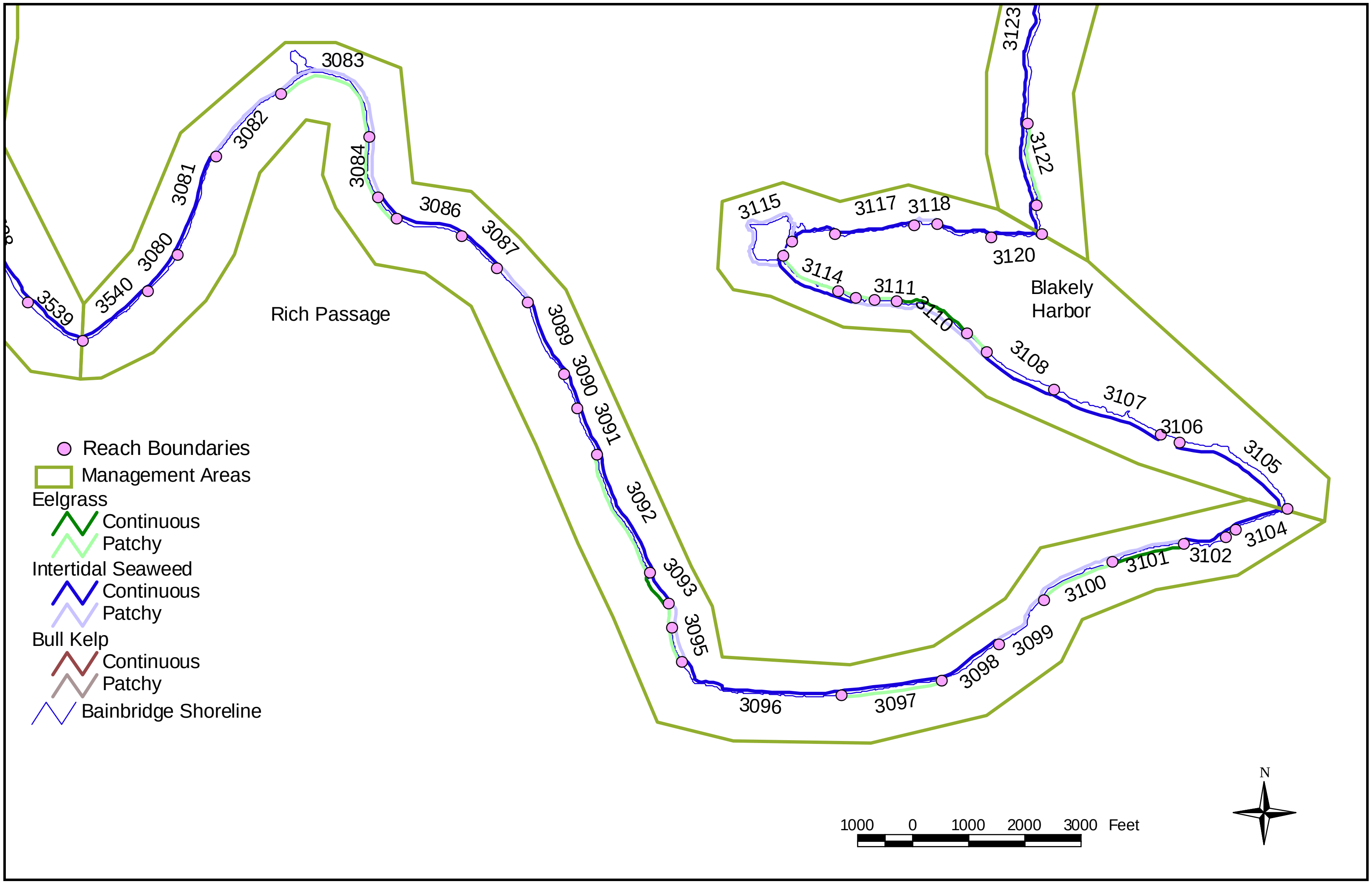

Figure B-57. Management Areas 6 and 7 Eelgrass, Kelp, and Seaweed Distribution.

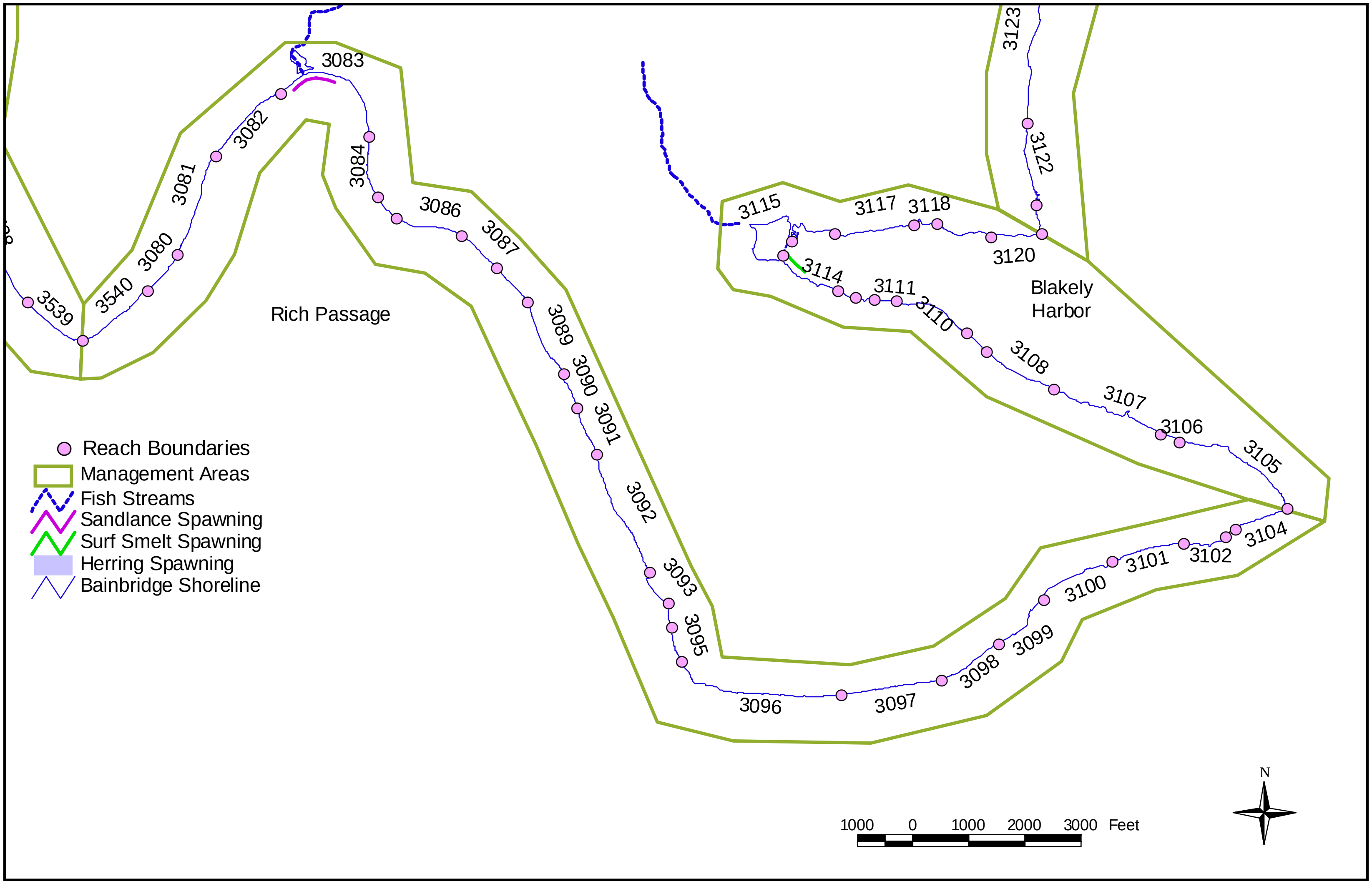

Figure B-58. Management Areas 6 and 7 Forage Fish Spawning Areas and Salmon-Bearing Streams.

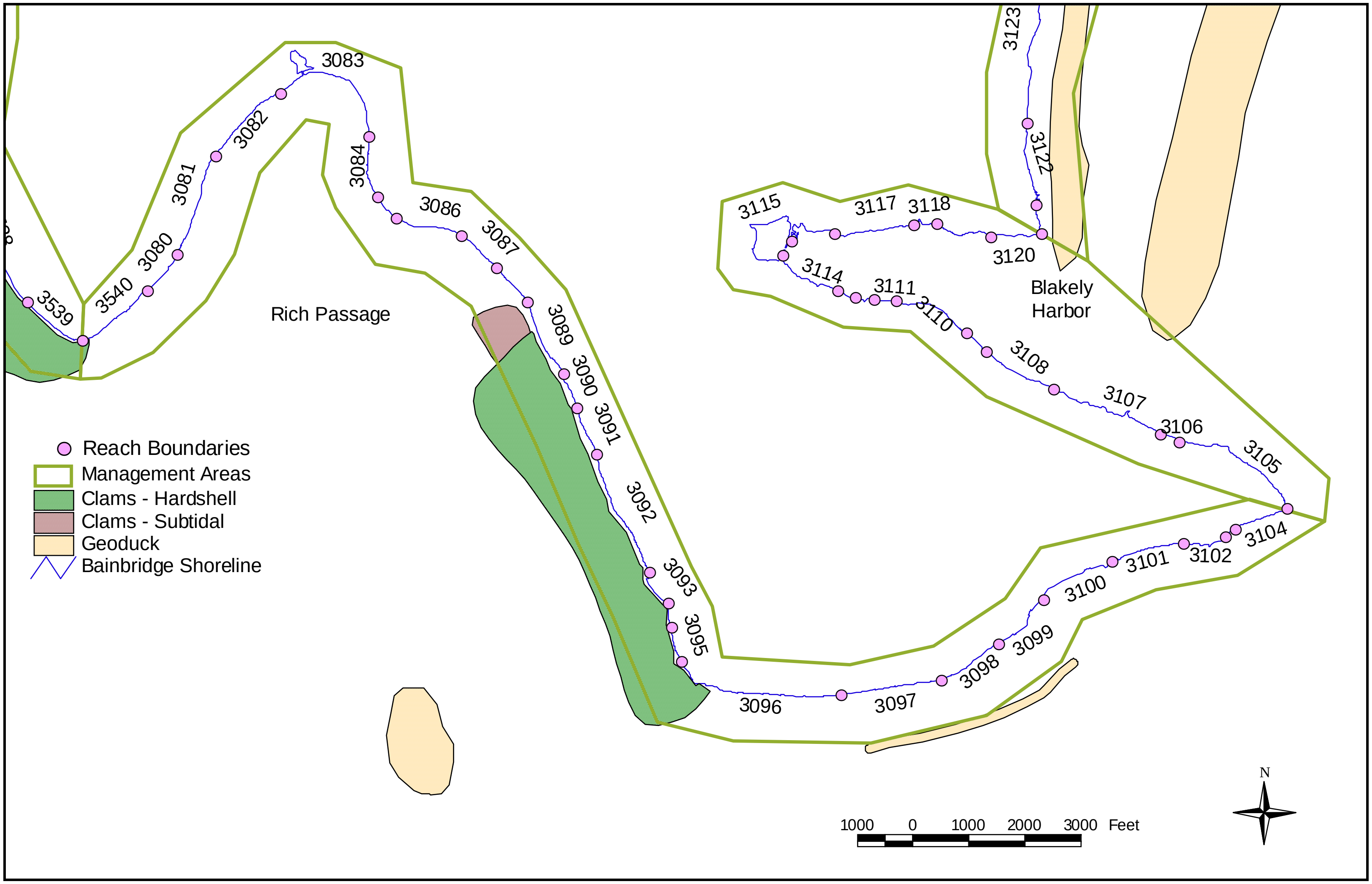

Figure B-59. Management Areas 6 and 7 Clam and Geoduck Distribution.

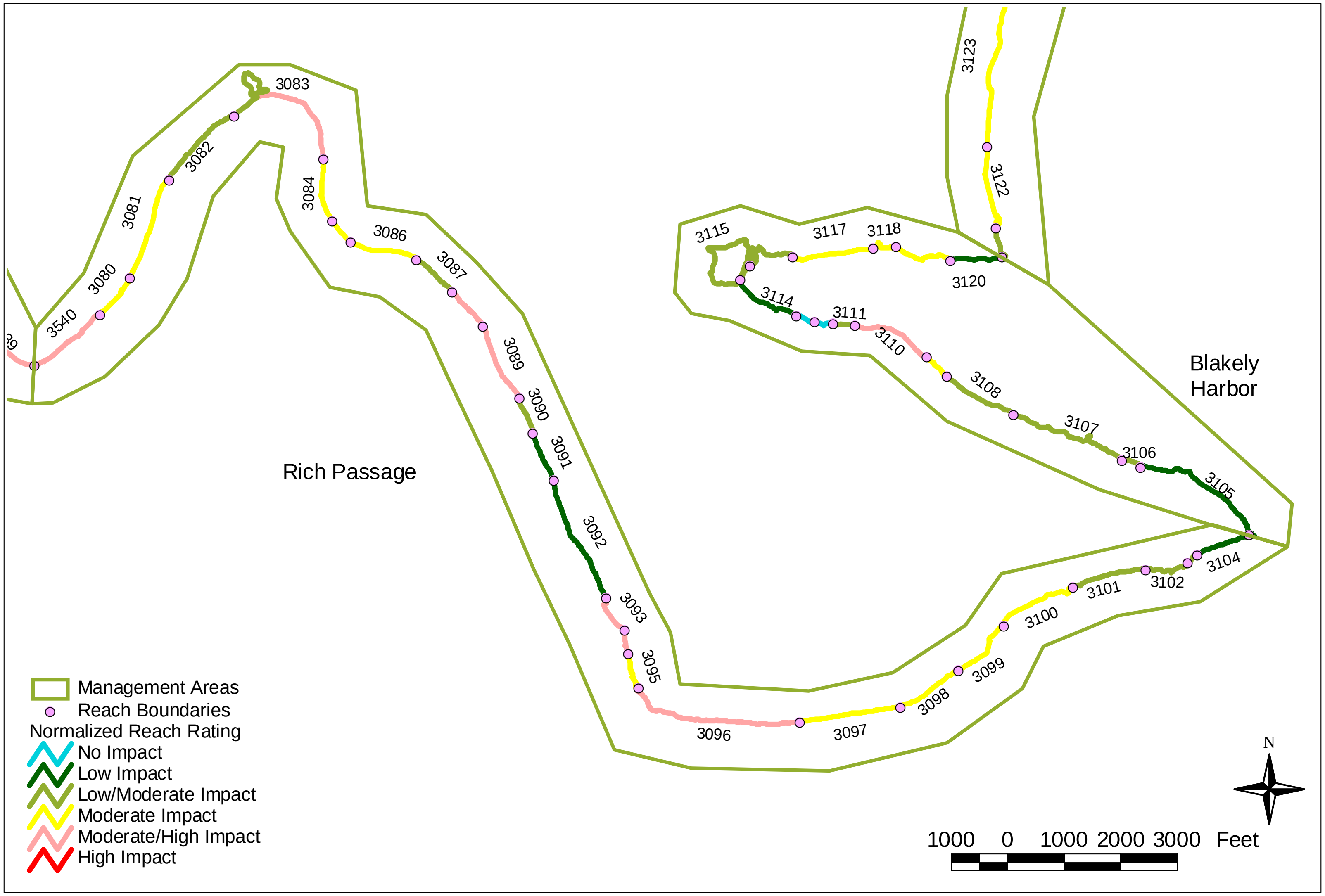

Figure B-60. Management Areas 6 and 7 Reach Scores (Normalized).

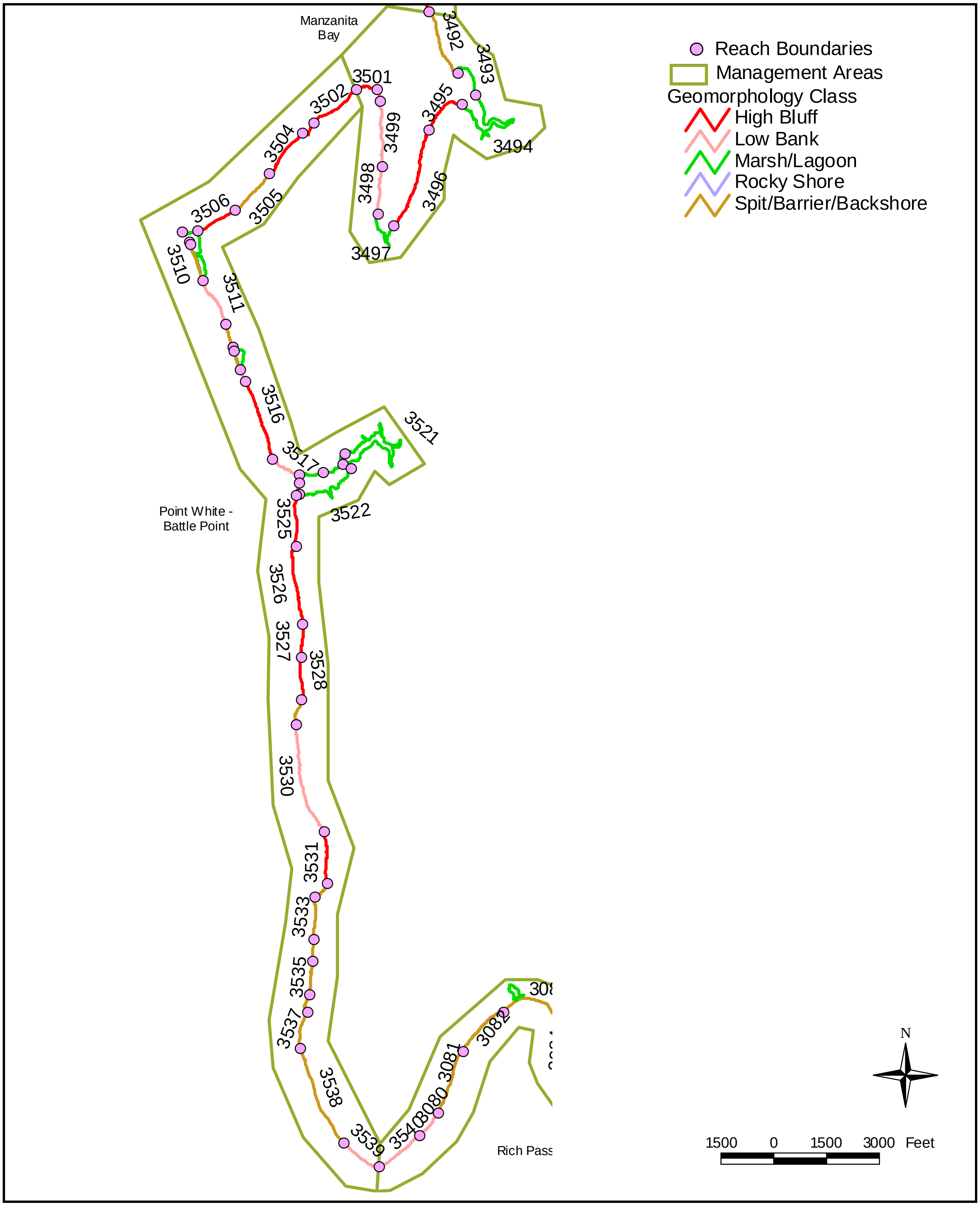

Figure B-61. Management Areas 8 and 9 Geomorphic Class Distribution

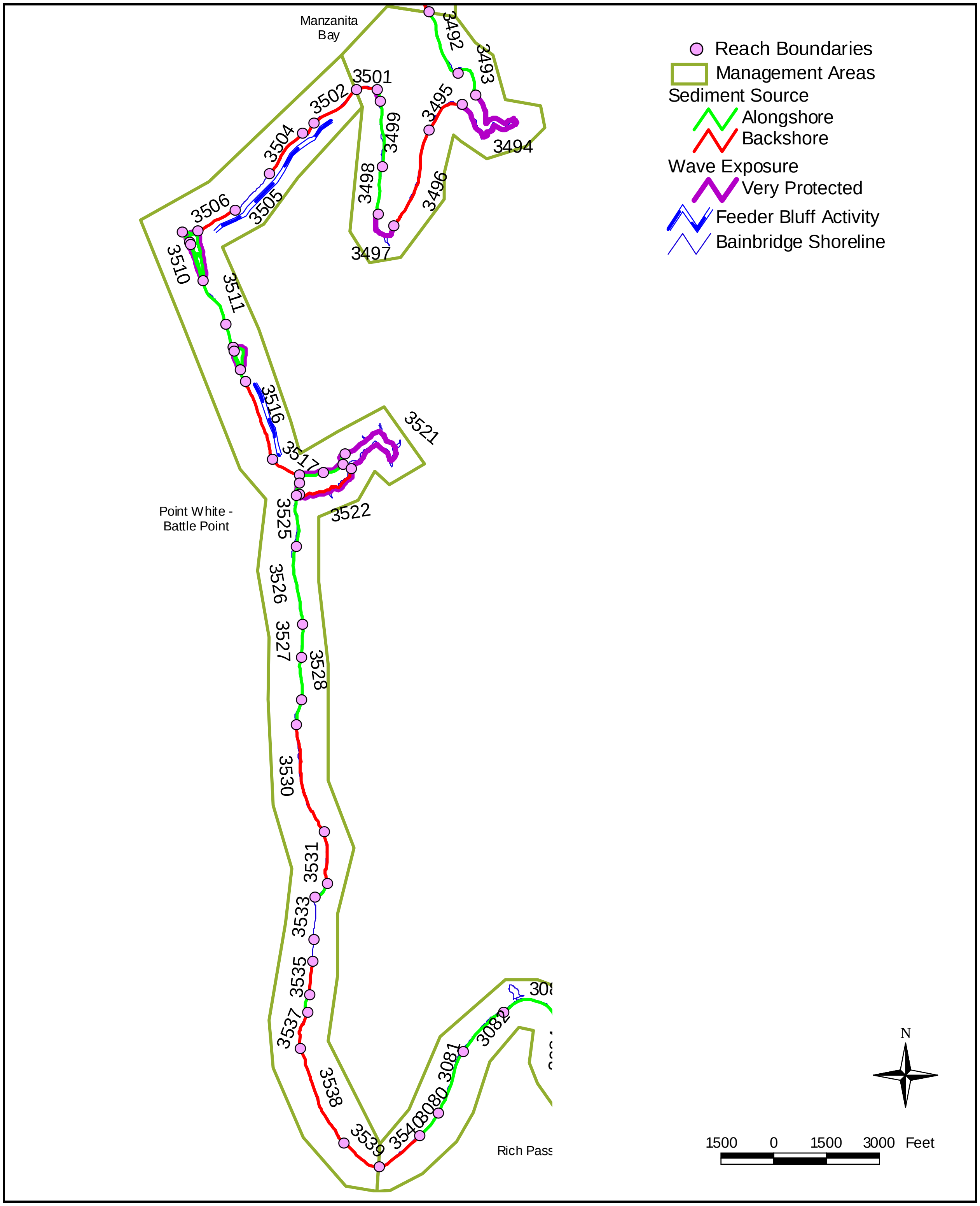

Figure B-62. Management Areas 8 and 9 Sediment Sources and Wave Exposure Classes.

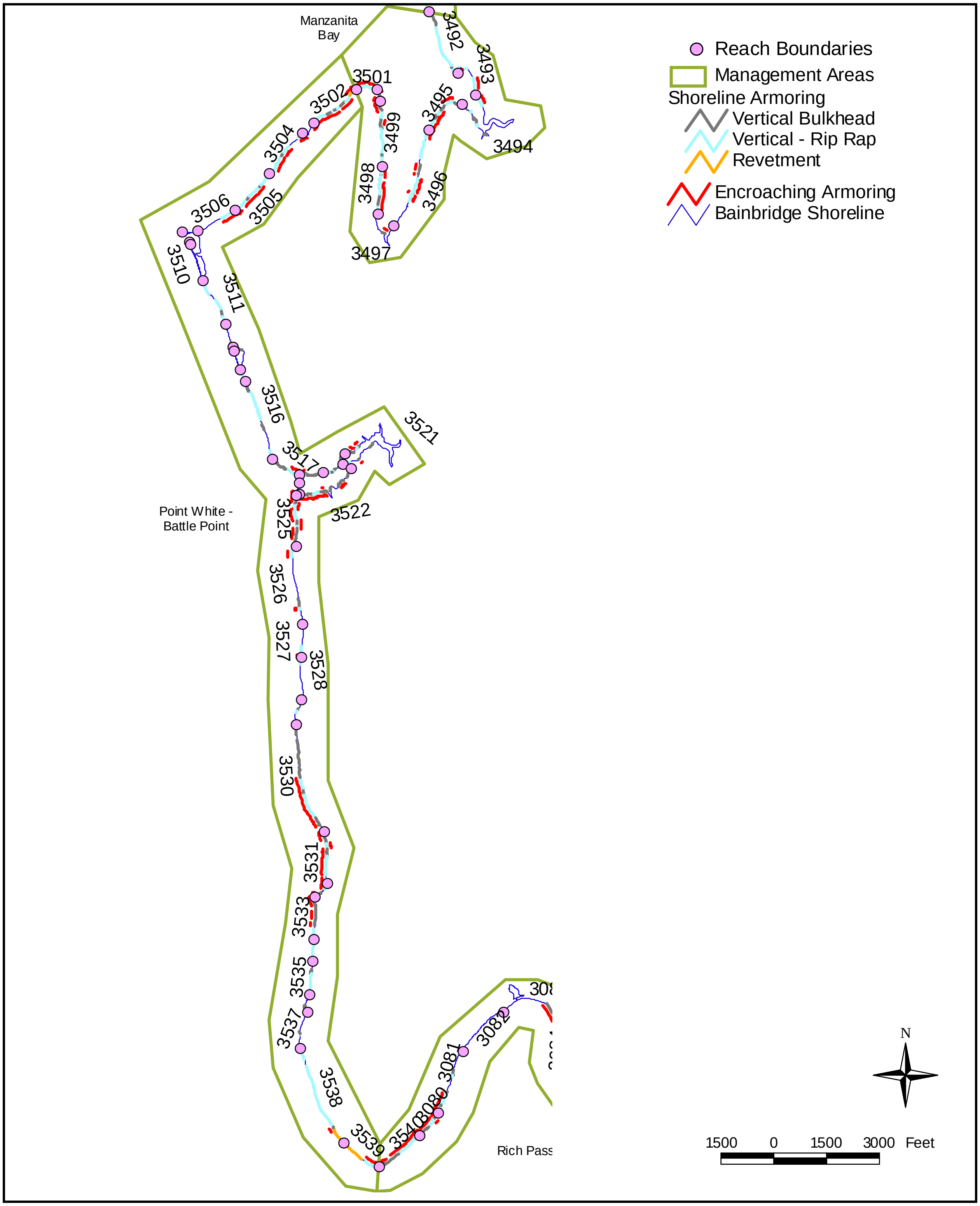

Figure B-63. Management Areas 8 and 9 Shoreline Armoring and Armoring Encroachment.

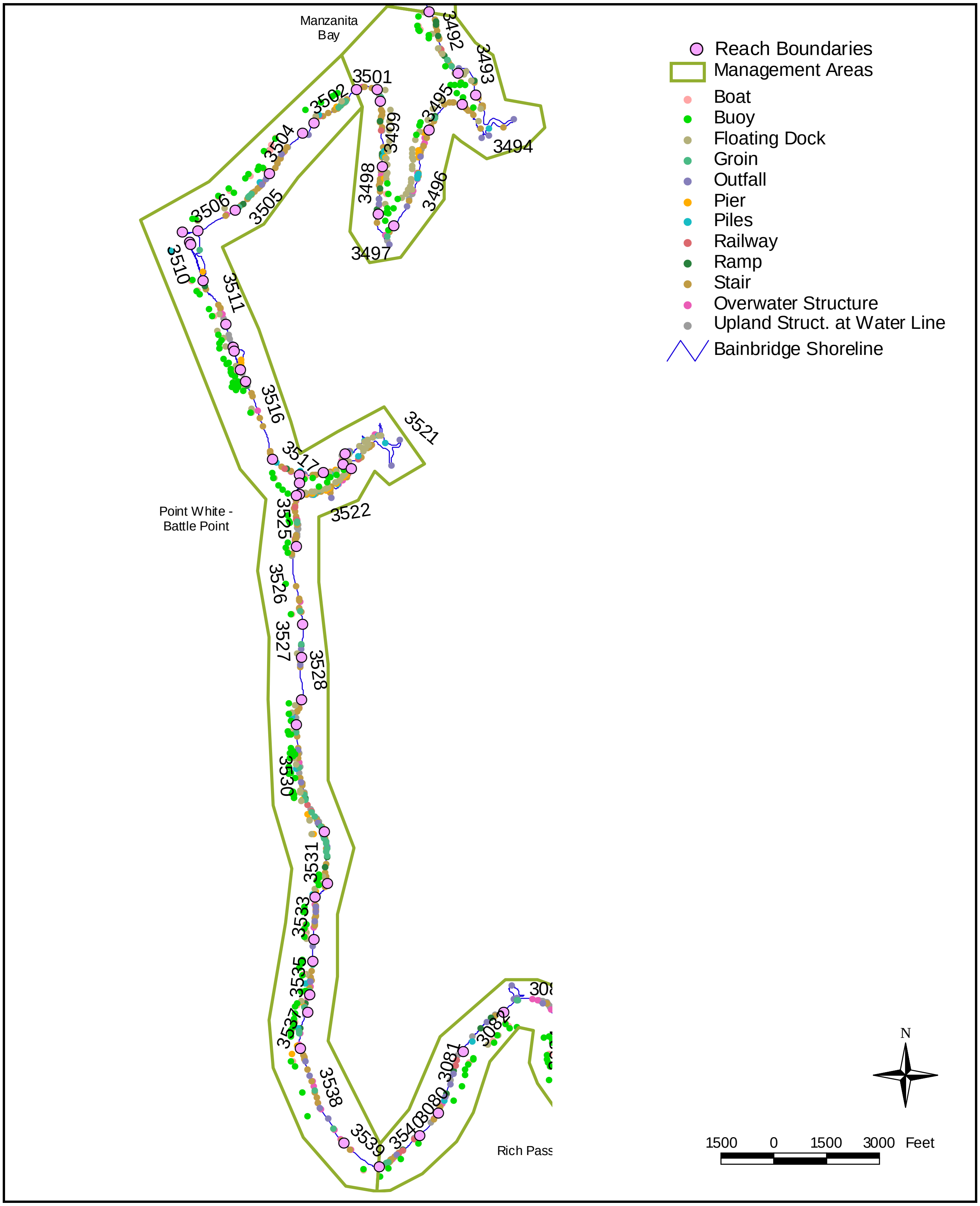

Figure B-64. Management Areas 8 and 9 Point Modifications.

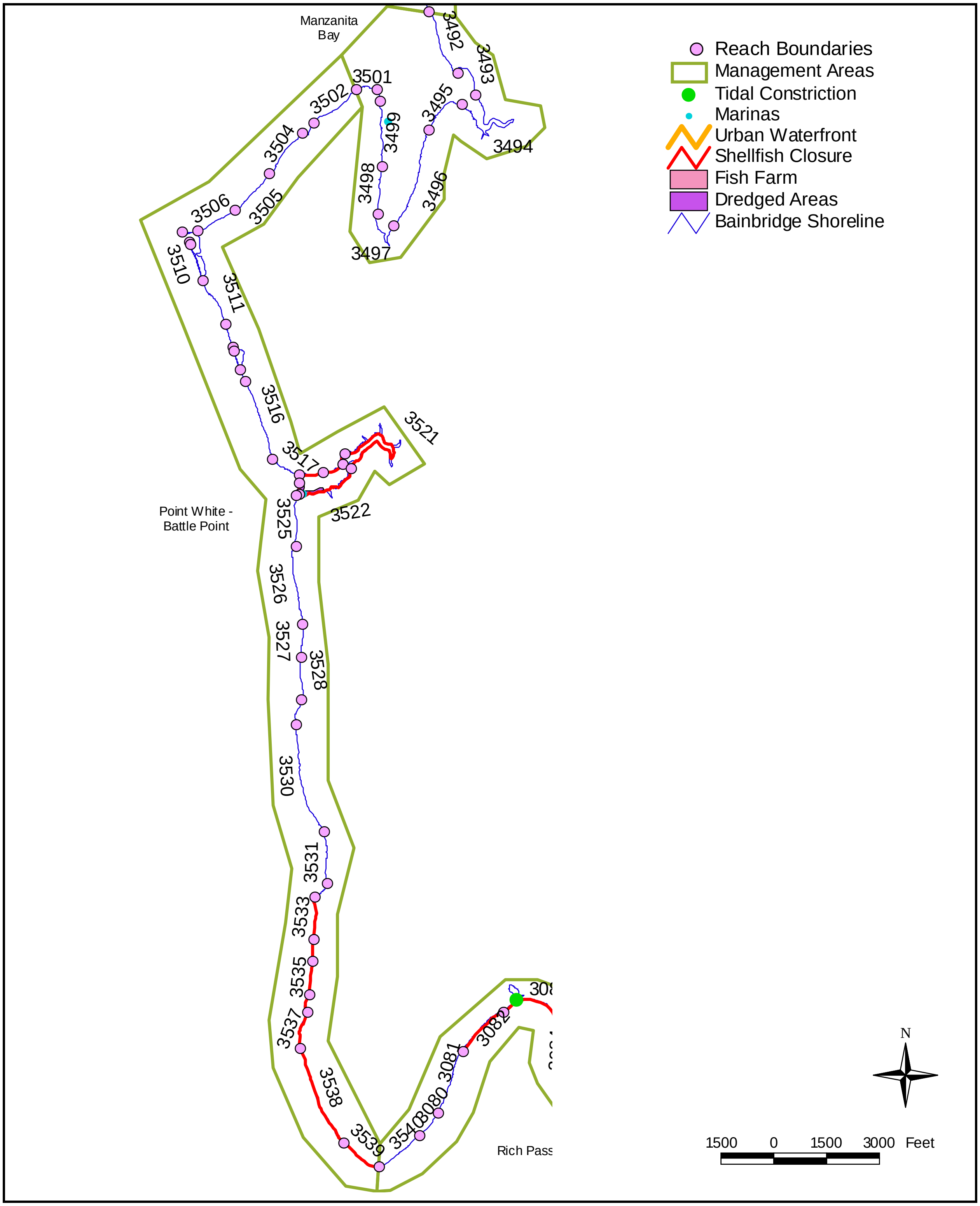

Figure B-65. Management Areas 8 and 9 Shellfish Closure, Dredging, Tidal Constrictions, Urban Waterfront, Fish Farms, and Marina Locations.

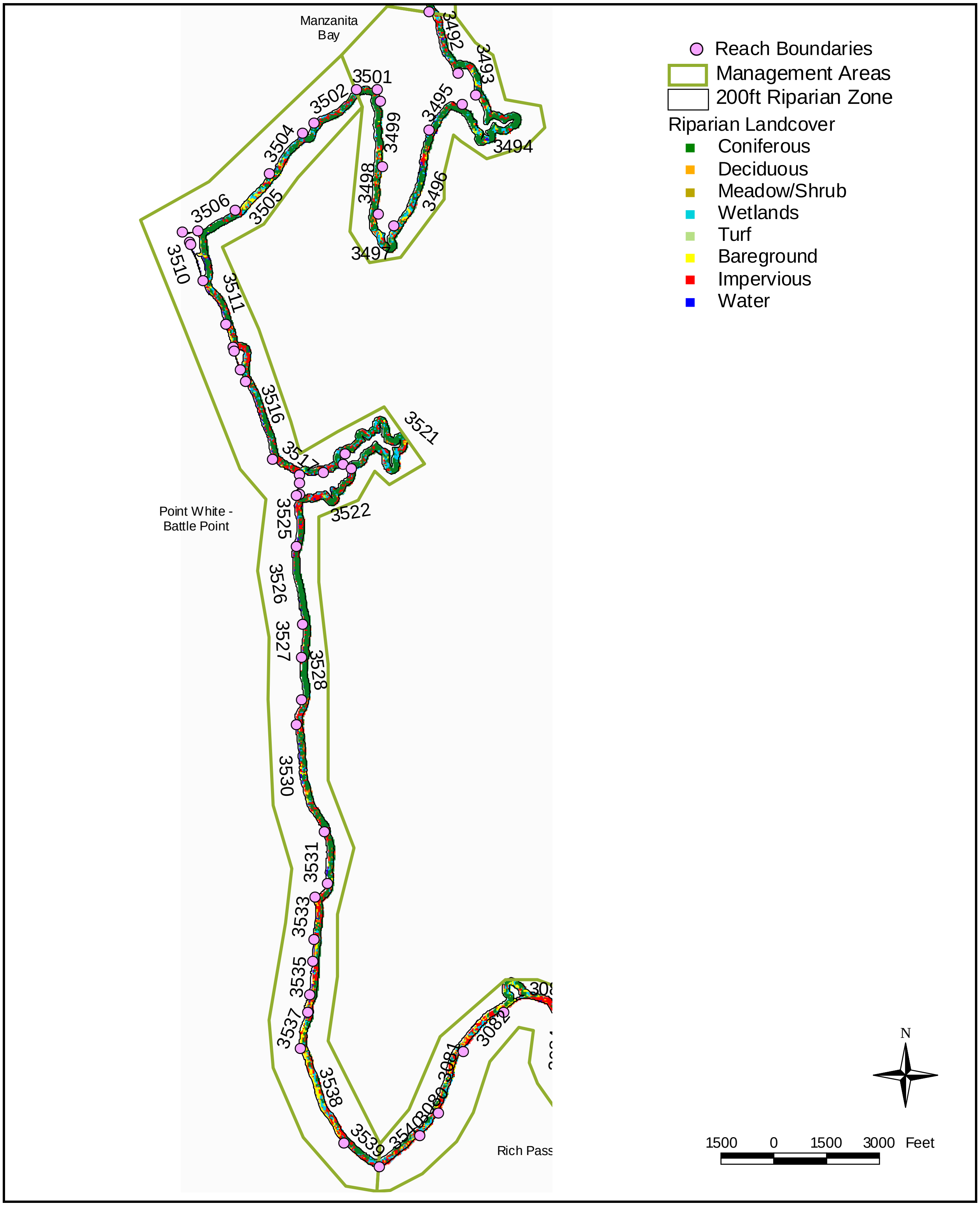

Figure B-66. Management Areas 8 and 9 Marine Riparian Zone Land Cover Classes.

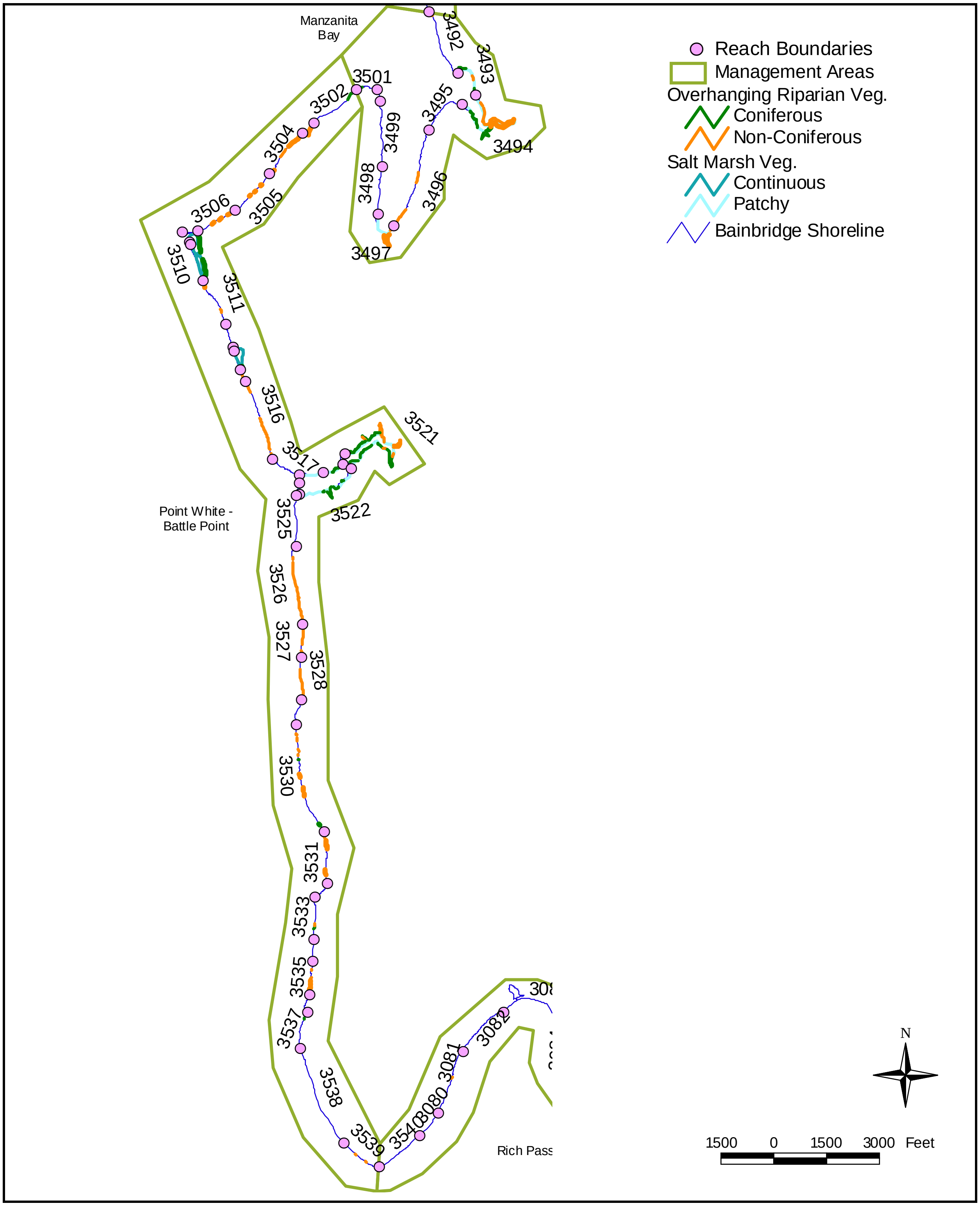

Figure B-67. Management Areas 8 and 9 Overhanging Riparian and Saltmarsh Vegetation.

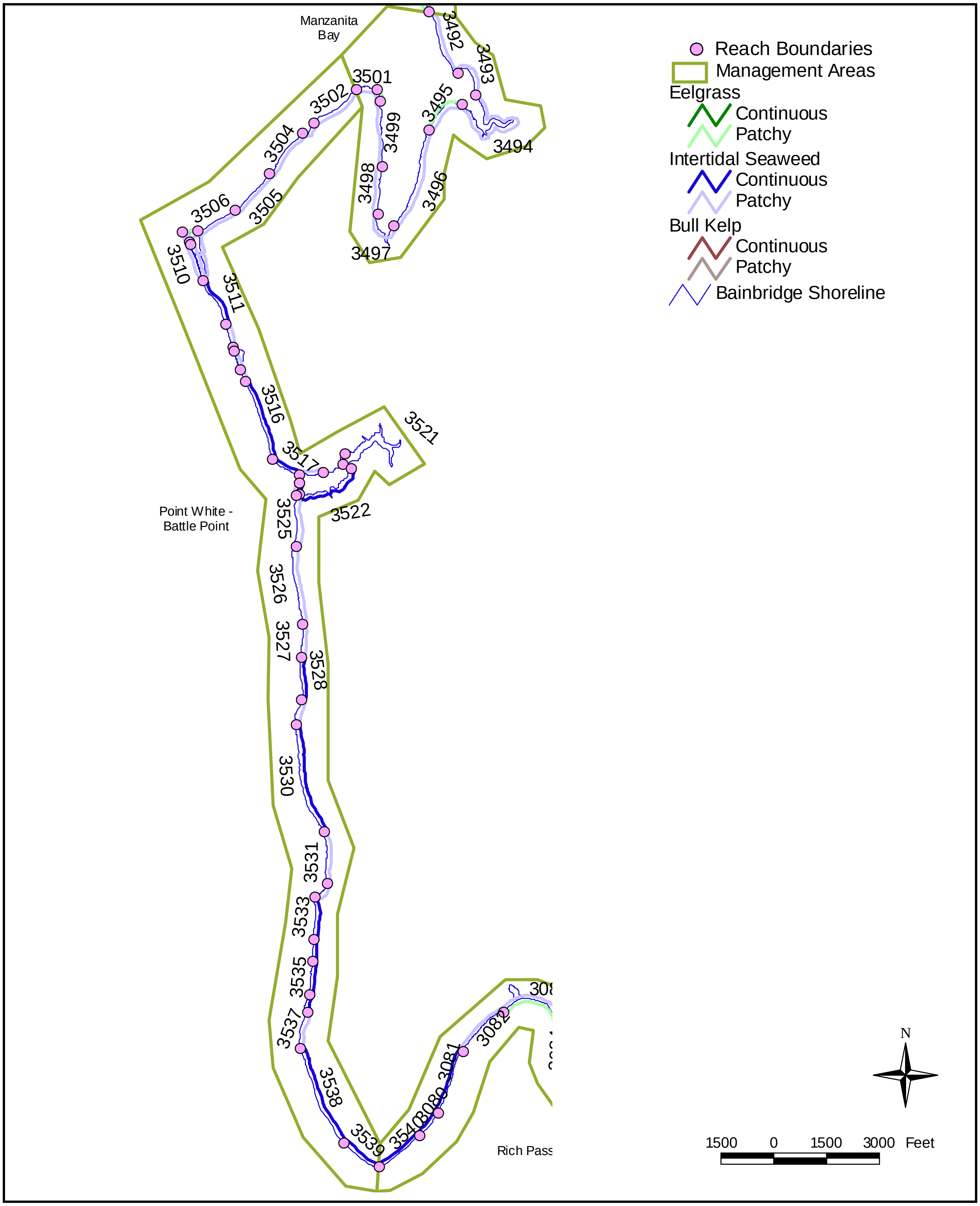

Figure B-68. Management Areas 8 and 9 Eelgrass, Kelp, and Seaweed Distribution.

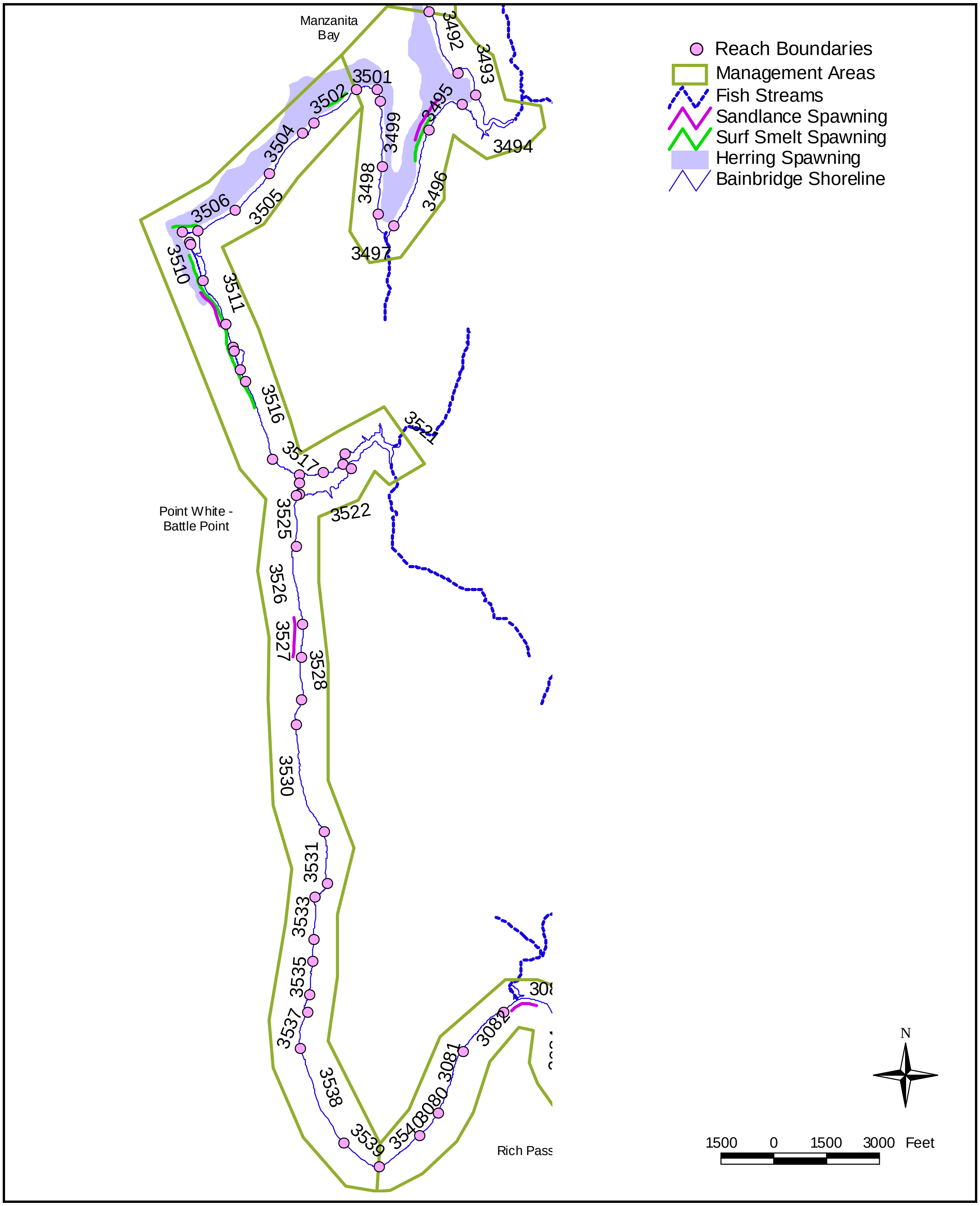

Figure B-69. Management Areas 8 and 9 Forage Fish Spawning Areas and Salmon-Bearing Streams.

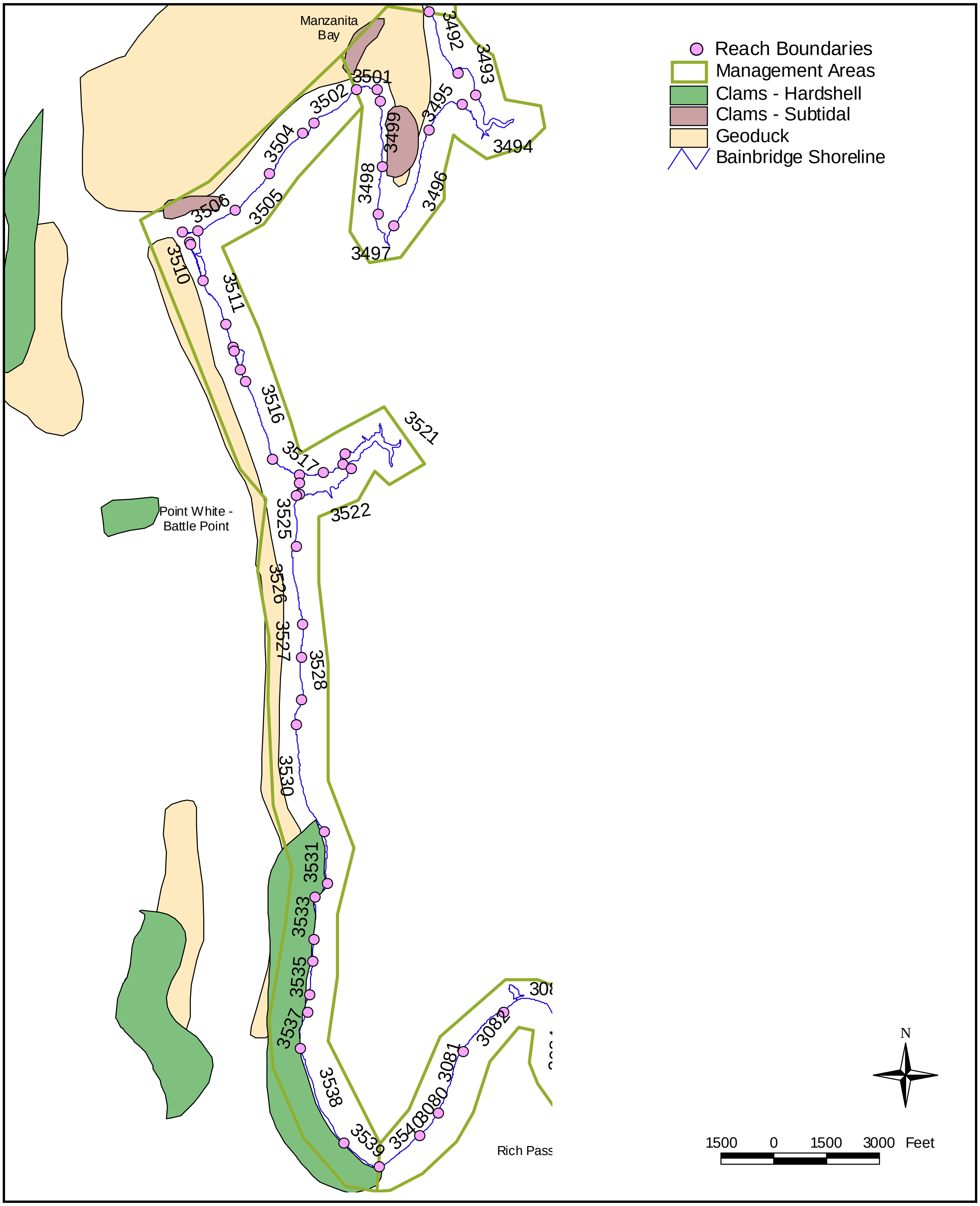

Figure B-70. Management Areas 8 and 9 Clam and Geoduck Distribution.

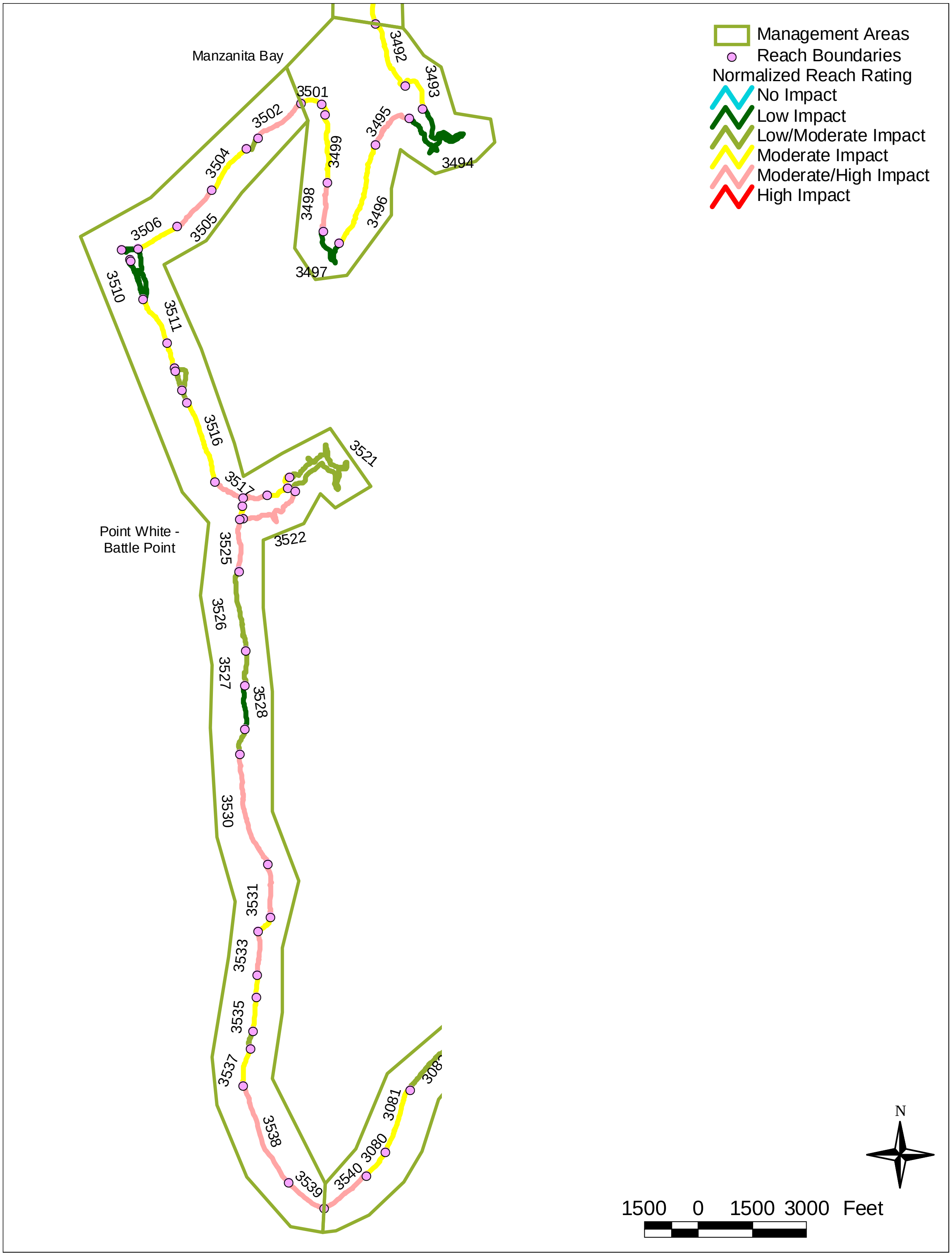

Figure B-71. Management Areas 8 and 9 Reach Scores (Normalized).

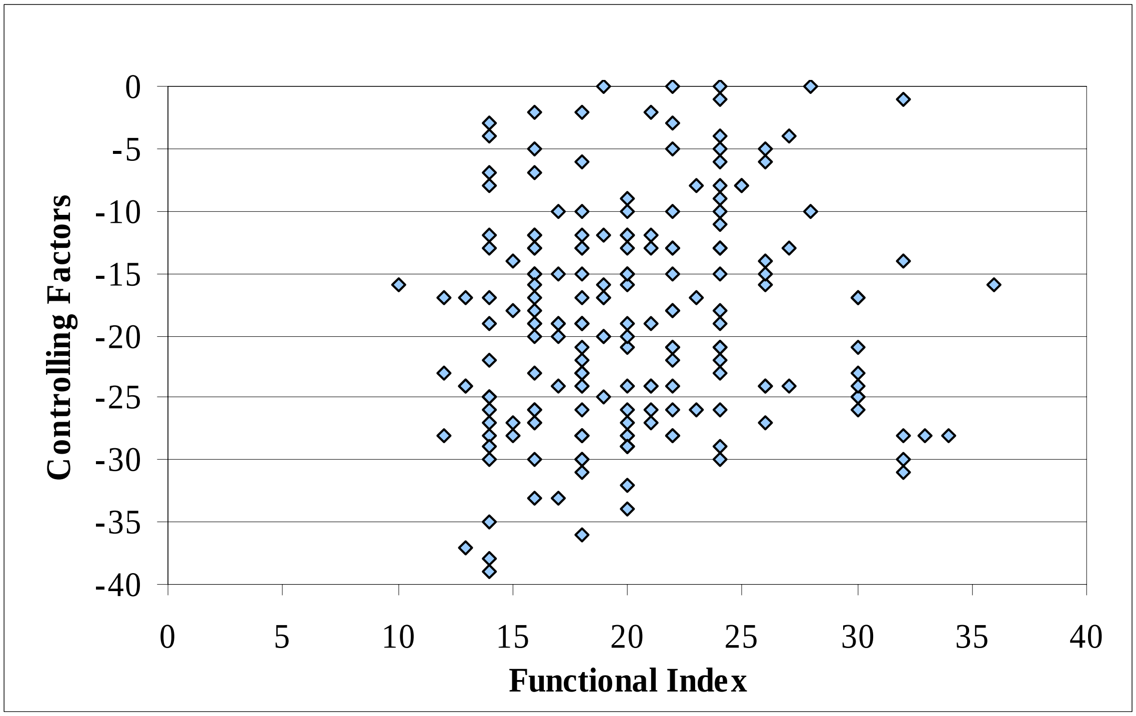

Figure B-72. Controlling Factors versus Functional Index Scores, All Geomorphic Types.

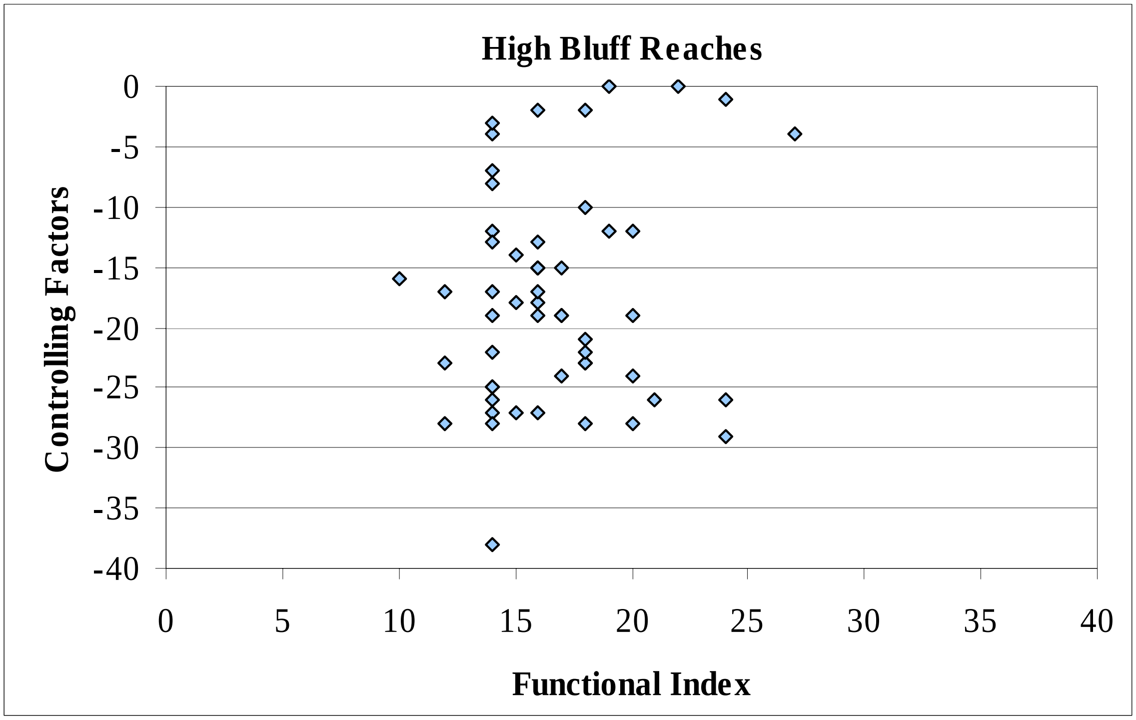

Figure B-73. Controlling Factors versus Functional Index Scores, High Bluff.

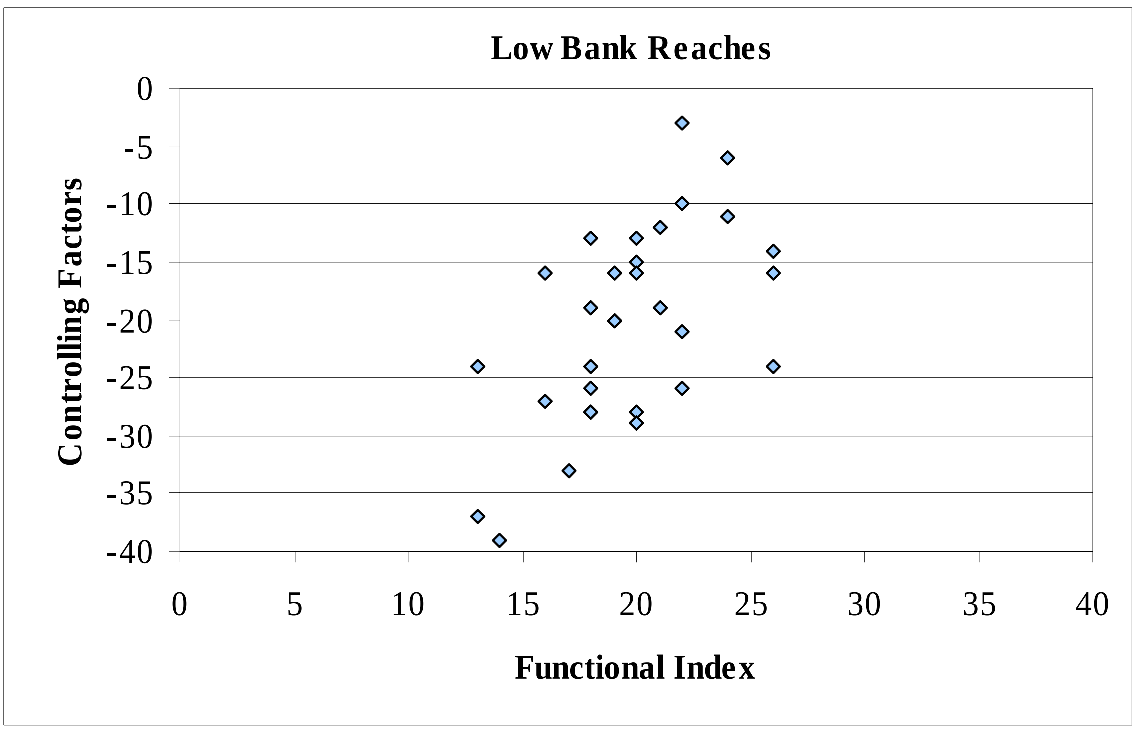

Figure B-74. Controlling Factors versus Functional Index Scores, Low Bank.

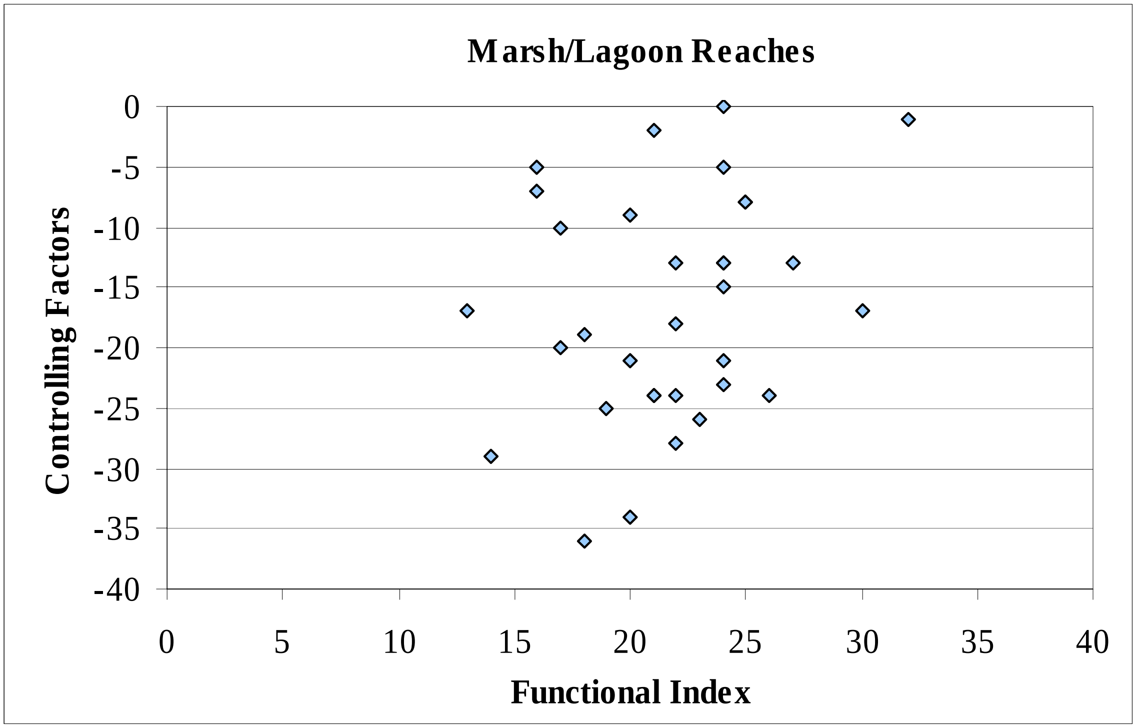

Figure B-75. Controlling Factors versus Functional Index Scores, Marsh/Lagoon.

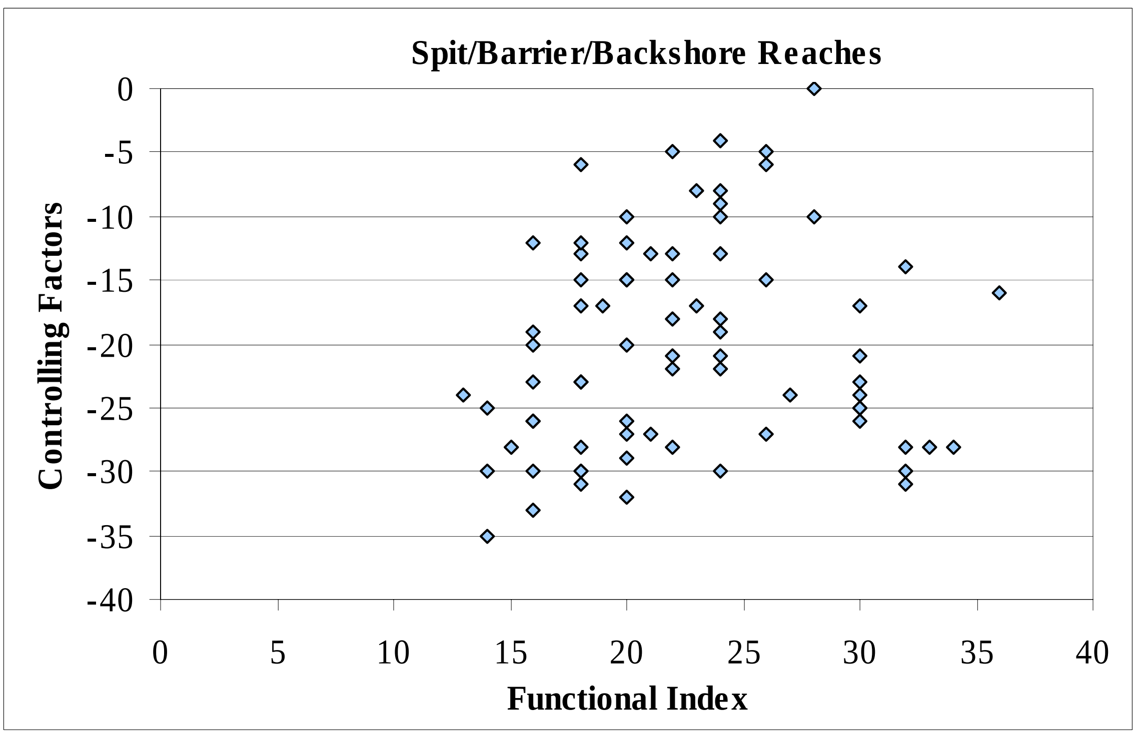

Figure B-76. Controlling Factors versus Functional Index Scores, Spit/Barrier/Backshore.

Appendix C

Controlling Factors Scoring

Table C-1. Controlling Factors Scoring

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3080	-3	0	-1	-4	-5	-5	-2	0	-2	-3	0	0	-1	-4	-3	-1	-4
3081	-2	0	0	-2	-4	0	-2	0	-2	-2	0	0	-1	-3	-2	-1	-3
3082	0	0	0	0	-5	0	-2	0	-2	0	0	0	-1	-1	0	-1	-1
3083	-2	-1	-1	-4	-4	0	-2	0	-2	-2	0	0	-1	-3	-2	-2	-4
3084	-3	-1	0	-4	-3	0	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3085	-3	-1	0	-4	-5	0	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3086	-1	-1	0	-2	-5	0	-3	0	-3	-1	0	0	0	-1	-1	-1	-2
3087	-1	-1	0	-2	-5	0	-2	0	-2	-1	0	0	-1	-2	-1	-1	-2
3088	-3	-1	-1	-5	-5	0	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3089	-3	-1	-1	-5	-4	0	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3090	-2	0	-1	-3	-2	0	-2	0	-2	-2	0	0	-1	-3	-2	0	-2
3091	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3092	0	0	0	0	-3	0	-1	0	-1	0	0	0	0	0	0	0	0
3093	-3	0	0	-3	-5	0	-3	0	-3	-3	0	0	0	-3	-3	-1	-4
3094	-2	0	0	-2	-5	0	-3	-1	-4	-2	0	0	0	-2	-2	-2	-4
3095	-1	0	0	-1	-5	0	-3	0	-3	-1	0	0	0	-1	-1	-2	-3
3096	-3	0	0	-3	-4	0	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3097	-3	-1	0	-4	-4	0	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3098	-3	0	0	-3	-5	-5	-2	0	-2	-3	0	0	0	-3	-3	-1	-4
3099	-3	-1	0	-4	-5	0	-2	0	-2	-3	0	0	0	-3	-3	-1	-4
3100	-3	-1	-1	-5	-4	0	-2	0	-2	-3	0	0	-1	-4	-3	-1	-4
3101	-2	-1	0	-3	-5	0	-1	0	-1	-2	0	0	-1	-3	-2	-1	-3
3102	-2	0	-1	0	-5	0	0	0	0	-2	0	0	0	0	-2	0	0
3103	-3	-1	0	0	-5	0	0	0	0	-3	0	0	0	0	-3	0	0
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3105	-1	-1	0	0	-5	0	0	0	0	-1	0	0	-1	0	-1	0	0
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3110	-3	-1	-1	-5	-5	0	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
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3112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3114	0	0	0	0	-1	-1	-2	0	-2	0	0	0	0	0	0	0	0
3115	-1	0	0	0	-2	-2	-1	0	-1	-1	0	0	0	-1	-1	0	-1
3116	-1	0	0	-1	-4	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3117	-1	-1	0	-2	-4	0	-3	0	-3	-1	0	0	-1	-2	-1	-1	-2

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3118	-2	0	-1	-3	-4	0	-3	0	-3	-2	0	0	0	-2	-2	-1	-3
3119	-2	0	0	-2	-4	0	-3	0	-3	-2	0	0	-1	-3	-2	-2	-4
3120	0	0	0	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0
3121	-1	0	0	-1	-4	-4	-2	0	-2	-1	0	0	0	-1	-1	0	-1
3122	-2	-1	0	-3	-5	0	0	0	0	-2	0	0	-1	-3	-2	-2	-4
3123	-3	-1	-1	-5	-4	0	0	0	0	-3	0	0	-1	-4	-3	-1	-4
3124	-3	-1	-1	-5	-3	-3	0	0	0	-3	0	0	0	-3	-3	0	-3
3125	-3	-1	-1	-5	-4	0	0	0	0	-3	0	0	0	-3	-3	0	-3
3126	-3	-1	-1	-5	-5	0	0	0	0	-3	0	0	0	-3	-3	0	-3
3127	-3	0	-1	-4	-5	0	0	0	0	-3	0	0	0	-3	-3	0	-3
3128	-3	0	0	-3	-5	0	0	0	0	-3	0	0	0	-3	-3	0	-3
3129	-2	0	0	-2	-1	0	0	0	0	-2	0	0	0	-2	-2	0	-2
3130	-2	-1	0	0	-3	-3	-2	-2	-4	-2	0	0	-1	-3	-2	-1	-3
3131	-3	0	-1	-4	-5	-5	-3	-1	-4	-3	0	0	0	-3	-3	-2	-5
3132	-3	0	0	-3	-3	-3	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
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3134	-3	-1	-1	0	-4	0	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3135	-2	0	0	0	0	0	-2	0	-2	-2	0	0	0	-2	-2	0	-2
3136	-1	0	0	0	-3	-3	-1	0	-1	-1	0	0	0	-1	-1	0	-1
3137	-2	0	-1	0	-3	-3	-2	0	-2	-2	0	0	0	-2	-2	-1	-3
3138	-1	-1	0	0	-3	-3	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3139	0	0	0	0	-1	-1	-2	0	-2	0	0	0	0	0	0	0	0
3140	-1	-1	0	0	-2	-2	-1	0	-1	-1	0	0	0	-1	-1	0	-1
3141	-2	-1	0	0	-3	-3	-3	-1	-4	-2	0	0	0	-2	-2	-1	-3
3142	-2	-1	0	0	-5	0	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3143	-3	-1	0	-4	-4	-4	-3	-2	-5	-3	0	0	0	-3	-3	-2	-5
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3145	-2	0	0	0	-2	-2	-3	-1	-4	-2	0	0	0	-2	-2	-2	-4
3146	-2	0	0	-2	-5	-5	-3	-2	-5	-2	0	0	-1	-3	-2	-2	-4
3147	-2	0	-1	0	-3	-3	-2	-1	-3	-2	0	0	0	-2	-2	-1	-3
3148	0	0	0	0	-5	0	-3	-2	-5	0	0	0	0	0	0	-2	-2
3149	-1	0	0	-1	-3	-3	-2	-1	-3	-1	0	0	0	-1	-1	-2	-3
3150	-2	0	0	-2	-4	0	-2	0	-2	-2	0	0	-1	-3	-2	-1	-3
3151	-3	0	0	-3	-4	-4	-3	0	-3	-3	0	0	0	-3	-3	-1	-4
3152	-1	-1	0	-2	-5	0	-3	0	-3	-1	0	0	0	-1	-1	-1	-2
3153	-2	-1	0	0	-5	-5	0	0	0	-2	0	0	0	-2	-2	0	-2
3154	-3	0	-1	-4	-5	-5	0	0	0	-3	0	0	-1	-4	-3	-1	-4
3155	-3	0	-1	-4	-5	-5	0	0	0	-3	0	0	0	-3	-3	0	-3
3156	-3	0	-1	-4	-5	-5	0	0	0	-3	0	0	0	-3	-3	0	-3

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3157	-2	0	0	-2	-5	-5	0	0	0	-2	0	0	0	-2	-2	-1	-3
3158	-1	0	0	-1	-2	-2	-1	0	-1	-1	-2	0	0	-3	-1	0	-1
3159	0	0	0	0	-4	-4	0	0	0	0	0	0	0	0	0	-1	-1
3160	-3	0	-1	-4	-5	0	0	0	0	-3	0	0	0	-3	-3	0	-3
3161	-1	-1	0	-2	-4	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3162	-1	0	0	-1	-2	-2	0	0	0	-1	-2	0	0	-3	-1	0	-1
3163	-3	0	-1	-4	-4	-4	-1	0	-1	-3	-2	0	0	-5	-3	-1	-4
3164	-2	0	-1	-3	-1	-1	-1	0	-1	-2	-2	0	0	-4	-2	-1	-3
3165	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0
3166	-3	0	-1	-4	-1	-1	0	0	0	-3	-2	0	0	-5	-3	0	-3
3167	-3	0	-1	-4	-4	-4	-3	0	-3	-3	0	-1	0	-4	-3	-2	-5
3168	-3	-1	0	-4	-5	0	0	0	0	-3	0	0	-1	-4	-3	-1	-4
3169	-1	-1	0	-2	-5	0	0	0	0	-1	0	0	0	-1	-1	0	-1
3170	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0
3171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3172	-1	-1	0	-2	-4	-4	0	0	0	-1	0	0	0	-1	-1	0	-1
3173	0	0	0	0	-5	0	0	0	0	0	0	0	0	0	0	0	0
3174	-3	0	0	-3	-4	0	-1	0	-1	-3	0	0	-1	-4	-3	0	-3
3175	-2	0	0	-2	-3	-3	0	0	0	-2	-2	0	0	-4	-2	0	-2
3176	-2	0	0	-2	-4	-4	-2	0	-2	-2	0	0	0	-2	-2	0	-2
3177	-3	-1	-1	-5	-5	-5	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3178	-3	-1	-1	-5	-5	-5	-2	0	-2	-3	-2	0	0	-5	-3	-1	-4
3179	-1	0	0	-1	0	0	-1	0	-1	-1	-2	0	0	-3	-1	0	-1
3180	-2	0	-1	-3	-4	-4	0	0	0	-2	-2	0	0	-4	-2	0	-2
3181	-3	-1	-1	-5	-4	-4	0	0	0	-3	0	0	0	-3	-3	-1	-4
3182	-2	0	-1	-3	-4	0	0	0	0	-2	0	0	-1	-3	-2	0	-2
3183	-3	-1	-1	-5	-4	-4	0	0	0	-3	-2	0	0	-5	-3	-1	-4
3184	-3	0	-1	-4	-4	-4	0	0	0	-3	-2	0	0	-5	-3	0	-3
3185	0	0	0	0	-4	-4	-2	0	-2	0	0	0	0	0	0	0	0
3186	0	0	0	0	-5	0	-2	0	-2	0	0	0	0	0	0	0	0
3187	-1	-1	0	-2	-5	0	0	0	0	-1	0	0	0	-1	-1	0	-1
3188	-3	0	-1	-4	-5	0	-1	0	-1	-3	0	0	0	-3	-3	-2	-5
3189	-1	0	0	-1	-5	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3190	-2	-1	0	0	-5	-5	-3	-1	-4	-2	0	0	0	-2	-2	-2	-4
3191	-2	-1	0	-3	-3	-3	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3192	-2	0	0	-2	-1	-1	-1	0	-1	-2	0	0	-1	-3	-2	-1	-3
3193	-3	0	-1	-4	-4	-4	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3194	0	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	0
3195	-1	0	0	0	-5	0	-3	0	-3	-1	0	0	-1	-2	-1	-1	-2

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3196	-2	0	0	0	-5	0	-3	0	-3	-2	0	-1	0	-3	-2	-2	-4
3197	-3	0	0	0	-2	-2	-3	-2	-5	-3	0	0	0	-3	-3	-2	-5
3198	-2	0	0	0	-2	-2	-2	-1	-3	-2	0	0	0	-2	-2	-1	-3
3199	-3	0	-1	0	-4	-4	-3	-2	-5	-3	0	0	0	-3	-3	-2	-5
3200	-3	0	-1	0	-3	-3	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3201	-2	0	0	0	-3	-3	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3202	-2	0	0	0	-2	-2	-2	0	-2	-2	0	0	0	-2	-2	-1	-3
3203	-1	0	0	0	-3	-3	-3	0	-3	-1	0	0	0	-1	-1	-1	-2
3204	-2	-1	-1	0	-3	-3	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3205	-3	0	-1	0	-4	-4	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3206	-3	-1	-1	0	-3	-3	-3	-1	-4	-3	0	0	0	-3	-3	-2	-5
3207	-3	-1	0	0	-4	-4	-3	0	-3	-3	0	0	0	-3	-3	-1	-4
3208	-1	-1	0	0	-3	-3	-2	0	-2	-1	0	0	0	-1	-1	0	-1
3209	-2	-1	-1	0	-3	-3	-2	0	-2	-2	0	0	0	-2	-2	0	-2
3210	-3	-1	-1	0	-4	-4	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3211	-2	-1	0	-3	-4	0	-3	0	-3	-2	0	0	0	-2	-2	-1	-3
3212	-3	0	0	-3	-5	0	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3213	-2	0	-1	-3	-1	-1	-1	0	-1	-2	-2	0	0	-4	-2	0	-2
3214	-1	-1	0	-2	-4	0	-2	0	-2	-1	0	0	-1	-2	-1	-1	-2
3215	-3	0	-1	-4	-4	-4	-2	0	-2	-3	0	0	0	-3	-3	-1	-4
3216	-3	0	-1	-4	-3	-3	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3217	-3	0	-1	-4	-3	-3	-2	0	-2	-3	-2	0	0	-5	-3	-1	-4
3218	-2	-1	0	-3	-4	-4	-3	0	-3	-2	0	-1	0	-3	-2	-2	-4
3219	-2	0	0	-2	-3	-3	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3220	-2	-1	0	-3	-4	-4	-2	0	-2	-2	0	0	0	-2	-2	-2	-4
3221	-2	-1	0	-3	-4	-4	-2	0	-2	-2	0	0	-1	-3	-2	-2	-4
3222	-2	0	0	-2	-2	-2	-2	0	-2	-2	0	0	0	-2	-2	-1	-3
3223	-2	0	0	-2	-3	-3	-2	0	-2	-2	0	0	0	-2	-2	-1	-3
3487	-3	0	0	-3	-4	-4	-2	0	-2	-3	-2	0	0	-5	-3	-2	-5
3488	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3489	-1	0	0	-1	0	0	0	0	0	-1	-2	0	0	-3	-1	-1	-2
3490	-2	0	-1	-3	-3	-3	-2	0	-2	-2	-2	0	0	-4	-2	-1	-3
3491	-3	0	0	-3	-3	-3	-3	0	-3	-3	0	-1	0	-4	-3	-2	-5
3492	-3	0	0	-3	-4	0	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3493	-2	0	-1	0	-2	-2	-3	0	-3	-2	0	0	0	-2	-2	-1	-3
3494	-1	-1	0	0	0	0	-1	0	-1	-1	0	0	0	-1	-1	-1	-2
3495	-3	0	-1	-4	-5	-5	-2	0	-2	-3	0	-1	0	-4	-3	-1	-4
3496	-2	0	-1	-3	-3	-3	-3	0	-3	-2	0	-1	0	-3	-2	-2	-4
3497	-1	-1	0	0	-2	-2	-2	0	-2	-1	0	0	-1	-2	-1	0	-1

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3498	-3	0	-1	-4	-5	-5	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3499	-3	0	0	-3	-5	-5	-3	-1	-4	-3	0	0	0	-3	-3	-2	-5
3500	-3	-1	-1	0	-5	0	-2	0	-2	-3	0	0	-1	-4	-3	-2	-5
3501	-3	0	-1	-4	-4	-4	-2	0	-2	-3	0	-1	0	-4	-3	-1	-4
3502	-3	0	-1	-4	-4	-4	-3	0	-3	-3	-2	0	0	-5	-3	-2	-5
3503	-2	0	-1	-3	0	0	0	0	0	-2	-2	0	0	-4	-2	0	-2
3504	-2	0	-1	-3	-2	-2	-2	0	-2	-2	-2	0	0	-4	-2	-1	-3
3505	-3	0	-1	-4	-4	0	-3	0	-3	-3	-2	0	0	-5	-3	-2	-5
3506	-2	0	-1	-3	-4	-4	-2	0	-2	-2	-2	0	0	-4	-2	-1	-3
3507	0	0	0	0	-5	0	-2	0	-2	0	0	0	0	0	0	0	0
3508	0	0	0	0	-5	0	0	0	0	0	0	0	0	0	0	0	0
3509	0	0	0	0	-3	-3	-1	0	-1	0	0	0	-1	-1	0	0	0
3510	0	0	0	0	-4	0	-2	0	-2	0	0	0	0	0	0	0	0
3511	-3	0	0	-3	-4	-4	-3	0	-3	-3	0	0	-1	-4	-3	-1	-4
3512	-2	-1	0	-3	-5	0	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3513	-1	-1	0	0	-4	-4	-2	0	-2	-1	0	0	0	-1	-1	0	-1
3514	0	0	0	0	-5	0	-3	0	-3	0	0	0	0	0	0	-2	-2
3515	-2	-1	0	-3	-1	-1	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3516	-2	0	0	-2	-2	-2	-3	0	-3	-2	-2	0	0	-4	-2	-1	-3
3517	-3	-1	0	-4	-5	-5	-3	0	-3	-3	0	-1	0	-4	-3	-1	-4
3518	-3	-1	0	0	-5	-5	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3519	-3	-1	0	0	-2	-2	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3520	-3	-1	0	0	-3	-3	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3521	-1	-1	0	0	0	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3522	-2	-1	-1	0	-3	-3	-3	-1	-4	-2	0	-1	0	-3	-2	-2	-4
3523	-1	0	0	0	-5	0	0	0	0	-1	0	0	0	-1	-1	0	-1
3524	-1	-1	0	-2	-5	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2
3525	-3	-1	-1	-5	-5	-5	-3	0	-3	-3	0	0	-1	-4	-3	-2	-5
3526	-1	0	0	-1	-1	-1	-2	0	-2	-1	0	0	-1	-2	-1	-1	-2
3527	-1	0	0	-1	-1	-1	-2	0	-2	-1	0	0	-1	-2	-1	-1	-2
3528	-1	0	0	-1	-1	-1	0	0	0	-1	0	0	0	-1	-1	0	-1
3529	-1	0	0	-1	-5	0	-3	0	-3	-1	0	0	0	-1	-1	-2	-3
3530	-3	-1	-1	-5	-4	-4	-3	0	-3	-3	0	-1	0	-4	-3	-2	-5
3531	-3	0	-1	-4	-3	-3	-2	0	-2	-3	0	-1	0	-4	-3	-2	-5
3532	-2	0	-1	-3	-5	0	-3	0	-3	-2	0	0	0	-2	-2	-2	-4
3533	-3	-1	-1	-5	-4	0	-3	0	-3	-3	0	0	0	-3	-3	-2	-5
3534	-3	0	0	-3	-4	0	-2	0	-2	-3	0	0	-1	-4	-3	-1	-4
3535	-2	0	0	-2	-3	0	-3	0	-3	-2	0	-1	0	-3	-2	-2	-4
3536	-1	-1	0	-2	-5	0	0	0	0	-1	0	0	0	-1	-1	0	-1

Reach	Wave Energy				Natural Shade		Artificial Shade			Sediment Supply					Substrate Type		
	Armor	Concrete vs. Rip Rap	Encroach	**Sum**	Overhanging Vegetation	**Sum**	Shading Structures	Marinas	**Sum**	Armor	Feeder Bluff	Backshore Source	Alongshore Source	**Sum**	Armor	Point Mods Density	**Sum**
3537	-1	-1	0	-2	-4	0	-3	0	-3	-1	0	-1	0	-2	-1	-2	-3
3538	-3	0	0	-3	-5	0	-2	0	-2	-3	0	-1	0	-4	-3	-1	-4
3539	-3	0	-1	-4	-4	-4	-2	0	-2	-3	0	-1	0	-4	-3	-1	-4
3540	-3	-1	-1	-5	-5	-5	-2	0	-2	-3	0	-1	0	-4	-3	-2	-5
6000	0	0	0	0	-5	0	-3	0	-3	0	0	0	-1	-1	0	-1	-1
6001	0	0	0	0	-5	-5	0	0	0	0	0	0	0	0	0	0	0
6002	-1	-1	0	0	0	0	-2	0	-2	-1	0	0	0	-1	-1	-1	-2

Controlling Factors Scores, continued

Reach	**Depth - Slope**				**Pollution**					**Hydrology**					**Physical Disturbance**				**Controlling Factors Total Score**	
	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3080	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	0	0	0	-27	-0.600
3081	0	-2	0	-2	0	-2	-1	0	-3	0	-1	0	-1	-2	0	-1	-1	-2	-19	-0.475
3082	0	0	0	0	-5	-2	0	0	-5	0	-1	0	0	-1	0	-2	-2	-4	-14	-0.350
3083	0	-2	-1	-3	-5	-2	-1	0	-5	0	-1	-1	-1	-3	0	-1	-1	-2	-26	-0.650
3084	0	-3	0	-3	0	-1	-1	0	-2	0	0	0	-1	-1	0	-2	0	-2	-24	-0.600
3085	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-21	-0.525
3086	0	-1	0	-1	0	-2	-1	0	-3	0	-1	0	-1	-2	0	-2	-2	-4	-18	-0.450
3087	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-12	-0.300
3088	0	-3	-2	-5	0	-1	-1	0	-2	0	0	-2	-1	-3	0	-2	0	-2	-28	-0.700
3089	0	-3	-2	-5	0	-2	0	0	-2	0	-1	-2	0	-3	0	-1	0	-1	-27	-0.675
3090	0	-2	-1	-3	0	0	0	0	0	0	0	-1	0	-1	0	-1	0	-1	-15	-0.375
3091	0	0	0	0	0	0	-1	0	-1	0	0	0	-1	-1	0	0	0	0	-2	-0.050
3092	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-2	-0.050
3093	0	-3	0	-3	-5	-2	-1	-1	-5	0	-1	0	-1	-2	0	-2	-3	-5	-28	-0.700
3094	0	-2	0	-2	-5	-2	-1	-1	-5	0	-1	0	-1	-2	0	-2	-3	-5	-26	-0.650
3095	0	-1	0	-1	-5	0	-1	-1	-5	0	0	0	-1	-1	0	-2	0	-2	-17	-0.425
3096	0	-3	0	-3	-5	-1	-1	-1	-5	0	0	0	-1	-1	0	-1	-1	-2	-25	-0.625
3097	0	-3	0	-3	0	-1	-1	0	-2	0	0	0	-1	-1	0	-2	0	-2	-24	-0.600
3098	0	-3	0	-3	0	0	-1	0	-1	0	0	0	-1	-1	0	-1	0	-1	-23	-0.511
3099	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-18	-0.450
3100	0	-3	-1	-4	0	-1	0	0	-1	0	0	-1	0	-1	0	-1	0	-1	-22	-0.550
3101	0	-2	0	-2	0	-1	-1	0	-2	0	0	0	-1	-1	0	0	0	0	-15	-0.375
3102	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	0	0	0	-3	-3	-7	-0.350
3103	0	-3	0	-3	0	-2	0	0	-2	0	-1	0	0	0	0	0	-3	-3	-8	-0.400
3104	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	-3	-3	-4	-0.200
3105	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-3	-0.150
3106	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-2	-2	-4	-16	-0.400
3107	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-10	-0.222
3108	0	-2	-1	-3	0	0	-1	0	-1	0	0	-1	-1	-2	0	0	0	0	-15	-0.333
3109	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	-1	0	-1	-19	-0.422
3110	0	-3	-1	-4	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-2	0	-2	-27	-0.675
3111	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-13	-0.325
3112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
3113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
3114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	-4	-0.089
3115	0	-1	0	-1	0	-1	0	0	-1	-5	0	0	0	-5	0	0	0	0	-12	-0.300

Reach	Depth - Slope				Pollution					Hydrology					Physical Disturbance				Controlling Factors Total Score	
	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3116	-5	-1	0	-5	0	-2	0	0	-2	0	-1	0	0	-1	0	-1	0	-1	-15	-0.375
3117	-5	-1	0	-5	0	-2	0	0	-2	0	-1	0	0	-1	0	-2	0	-2	-19	-0.475
3118	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	-1	0	-1	-17	-0.425
3119	0	-2	0	-2	0	-2	0	0	-2	0	-1	0	0	-1	0	-2	0	-2	-19	-0.475
3120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-0.050
3121	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-12	-0.267
3122	0	-2	0	-2	0	-2	-1	0	-3	0	-1	0	-1	-2	0	-1	-1	-2	-19	-0.475
3123	0	-3	-1	-4	0	-2	0	0	-2	0	-1	-1	0	-2	0	-1	-1	-2	-23	-0.575
3124	0	-3	-2	-5	-5	-1	0	0	-5	0	0	-2	0	-2	0	0	0	0	-26	-0.578
3125	0	-3	-2	-5	-5	-3	0	0	-5	0	-2	-2	0	-4	0	0	-3	-3	-28	-0.700
3126	0	-3	-2	-5	-5	-3	0	0	-5	0	-2	-2	0	-4	0	0	-3	-3	-28	-0.700
3127	0	-3	-1	-4	-5	-2	0	0	-5	0	-1	-1	0	-2	0	0	-2	-2	-23	-0.575
3128	0	-3	0	-3	-5	-1	0	0	-5	0	0	0	0	0	0	0	0	0	-17	-0.425
3129	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	0	0	0	-13	-0.325
3130	-5	-2	0	-5	-5	-2	0	-1	-5	0	-1	0	0	-1	0	-1	0	-1	-25	-0.625
3131	-5	-3	-1	-5	-5	-3	-1	-1	-5	0	-2	-1	-1	-4	0	-2	-1	-3	-38	-0.844
3132	0	-3	0	-3	-5	-2	-1	0	-5	0	-1	0	-1	-2	0	-2	0	-2	-29	-0.644
3133	0	-2	0	-2	-5	-2	-1	0	-5	0	-1	0	-1	-2	0	-1	0	-1	-22	-0.550
3134	0	-3	-1	-4	-5	-1	-1	0	-5	0	0	-1	-1	-2	0	-2	0	-2	-24	-0.686
3135	0	-2	0	-2	-5	-2	0	0	-5	0	-1	0	0	-1	0	-1	-1	-2	-16	-0.400
3136	0	-1	0	-1	-5	-2	0	0	-5	0	-1	0	0	-1	0	0	0	0	-13	-0.325
3137	0	-2	-1	-3	-5	-1	-1	0	-5	0	0	-1	-1	-2	0	0	0	0	-20	-0.500
3138	0	-1	0	-1	-5	-1	0	0	-5	0	0	0	0	0	0	-1	0	-1	-15	-0.375
3139	0	0	0	0	-5	-1	-1	0	-5	0	0	0	-1	-1	0	-1	0	-1	-10	-0.250
3140	0	-1	0	-1	-5	-1	0	0	-5	0	0	0	0	0	0	0	-1	-1	-12	-0.300
3141	-5	-2	0	-5	-5	-3	-1	-1	-5	0	-2	0	-1	-3	0	-2	-2	-4	-29	-0.725
3142	0	-2	0	-2	-5	-2	0	0	-5	0	-1	0	0	-1	0	-2	-1	-3	-20	-0.571
3143	-5	-3	0	-5	-5	-3	-1	-1	-5	0	-2	0	-1	-3	0	-2	-3	-5	-39	-0.867
3144	-5	-2	-1	-5	-5	-3	-1	-1	-5	0	-2	-1	-1	-4	0	-2	-3	-5	-37	-0.822
3145	0	-2	0	-2	-5	-3	-1	-1	-5	0	-2	0	-1	-3	0	-2	-3	-5	-27	-0.675
3146	0	-2	0	-2	-5	-3	0	-1	-5	0	-2	0	0	-2	0	-2	-3	-5	-33	-0.733
3147	0	-2	-1	-3	-5	-3	0	-1	-5	0	-2	-1	0	-3	0	-2	-2	-4	-26	-0.650
3148	-5	0	0	-5	-5	-3	0	-1	-5	0	-2	0	0	-2	-5	0	-3	-5	-24	-0.600
3149	-5	-1	0	-5	-5	-3	0	-1	-5	0	-2	0	0	-2	-5	0	-2	-5	-28	-0.622
3150	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	-1	-1	-2	-19	-0.475
3151	0	-3	0	-3	-5	-1	-1	0	-5	0	0	0	-1	-1	0	-2	0	-2	-28	-0.622
3152	0	-1	0	-1	-5	-1	0	0	-5	0	0	0	0	0	0	-2	0	-2	-16	-0.400

Reach	**Depth - Slope**				**Pollution**					**Hydrology**					**Physical Disturbance**				**Controlling Factors Total Score**	
	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3153	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	0	0	0	-16	-0.400
3154	0	-3	-2	-5	-5	-1	0	0	-5	0	0	-2	0	-2	0	0	0	0	-29	-0.644
3155	0	-3	-2	-5	-5	-2	0	0	-5	0	-1	-2	0	-3	0	0	-1	-1	-29	-0.644
3156	0	-3	-2	-5	-5	-1	0	0	-5	0	0	-2	0	-2	0	0	-1	-1	-28	-0.622
3157	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	0	0	0	-19	-0.422
3158	0	-1	0	-1	-5	-1	0	0	-5	0	0	0	0	0	0	0	0	0	-14	-0.311
3159	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-6	-0.133
3160	0	-3	-2	-5	0	-2	0	0	-2	0	-1	-2	0	-3	0	-1	-3	-4	-24	-0.600
3161	0	-1	0	-1	0	-2	0	0	-2	0	-1	0	0	-1	0	-1	-1	-2	-13	-0.325
3162	0	-1	0	-1	0	-1	-1	0	-2	0	0	0	-1	-1	0	0	0	0	-11	-0.244
3163	0	-3	-1	-4	0	-1	-1	0	-2	0	0	-1	-1	-2	0	0	0	0	-26	-0.578
3164	0	-2	-1	-3	0	0	0	0	0	0	0	-1	0	-1	0	0	0	0	-16	-0.356
3165	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-3	-0.067
3166	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	0	0	0	-21	-0.467
3167	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	-1	0	-1	-29	-0.644
3168	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-17	-0.425
3169	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-0.125
3170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	-0.050
3171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
3172	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-10	-0.222
3173	0	0	0	0	0	-1	-1	0	-2	-5	0	0	-1	-5	0	0	0	0	-7	-0.175
3174	0	-3	0	-3	0	-2	-1	0	-3	0	-1	0	-1	-2	0	0	-1	-1	-20	-0.500
3175	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	0	-1	-1	-19	-0.422
3176	0	-2	0	-2	-5	-1	0	0	-5	0	0	0	0	0	0	-1	-1	-2	-21	-0.467
3177	0	-3	-2	-5	-5	-2	0	0	-5	0	-1	-2	0	-3	0	-1	-1	-2	-36	-0.800
3178	0	-3	-2	-5	-5	-1	-1	0	-5	0	0	-2	-1	-3	0	0	0	0	-34	-0.756
3179	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-8	-0.178
3180	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	0	0	0	-18	-0.400
3181	0	-3	-2	-5	0	-2	0	0	-2	0	-1	-2	0	-3	0	0	0	0	-26	-0.578
3182	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	0	0	0	-13	-0.325
3183	0	-3	-1	-4	0	-1	0	0	-1	0	0	-1	0	-1	0	0	0	0	-24	-0.533
3184	0	-3	-2	-5	0	0	0	0	0	0	0	-2	0	-2	0	0	0	0	-23	-0.511
3185	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-8	-0.178
3186	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	-1	-1	-2	-5	-0.125
3187	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	-1	-3	-4	-9	-0.225
3188	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	0	-3	-3	-24	-0.600
3189	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-2	-3	-5	-13	-0.325

Reach	Depth - Slope				Pollution					Hydrology					Physical Disturbance				Controlling Factors Total Score	
	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3190	0	-2	0	-2	0	-1	0	-1	-2	0	0	0	0	0	0	-2	-3	-5	-24	-0.600
3191	0	-2	0	-2	0	0	-1	0	-1	0	0	0	-1	-1	0	-2	0	-2	-21	-0.467
3192	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-13	-0.289
3193	0	-3	-1	-4	0	0	-1	0	-1	0	0	-1	-1	-2	0	-2	0	-2	-28	-0.622
3194	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-1	-0.025
3195	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-2	-2	-4	-13	-0.371
3196	0	-2	0	-2	0	-1	-1	0	-2	0	0	0	-1	-1	0	-2	0	-2	-17	-0.486
3197	0	-3	0	-3	0	-1	-1	-1	-3	0	0	0	-1	-1	0	-2	0	-2	-24	-0.600
3198	0	-2	0	-2	0	-1	0	-1	-2	0	0	0	0	0	0	-1	0	-1	-15	-0.375
3199	0	-3	-1	-4	0	0	0	-1	-1	0	0	-1	0	-1	0	-2	0	-2	-25	-0.625
3200	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	-2	0	-2	-24	-0.600
3201	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-17	-0.425
3202	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-13	-0.325
3203	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-12	-0.300
3204	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	-2	0	-2	-19	-0.475
3205	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	-2	-1	-3	-26	-0.650
3206	0	-3	-2	-5	0	-1	0	-1	-2	0	0	-2	0	-2	0	-2	0	-2	-26	-0.650
3207	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-20	-0.500
3208	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-10	-0.250
3209	0	-2	-1	-3	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-1	0	-1	-17	-0.425
3210	0	-3	-2	-5	0	-1	-1	0	-2	0	0	-2	-1	-3	0	-2	-1	-3	-28	-0.700
3211	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-15	-0.375
3212	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-21	-0.525
3213	0	-2	-1	-3	0	0	0	0	0	0	0	-1	0	-1	0	-1	0	-1	-16	-0.356
3214	0	-1	0	-1	0	-1	-1	0	-2	0	0	0	-1	-1	0	-2	0	-2	-14	-0.350
3215	0	-3	-2	-5	0	-1	-1	0	-2	0	0	-2	-1	-3	0	-1	0	-1	-28	-0.622
3216	0	-3	-2	-5	0	0	-1	0	-1	0	0	-2	-1	-3	0	-2	0	-2	-30	-0.667
3217	0	-3	-1	-4	-5	-3	0	0	-5	0	-2	-1	0	-3	0	-1	0	-1	-31	-0.689
3218	0	-2	0	-2	-5	-3	0	0	-5	0	-2	0	0	-2	0	-2	0	-2	-28	-0.622
3219	0	-2	0	-2	-5	-3	-1	0	-5	0	-2	0	-1	-3	0	-2	0	-2	-26	-0.578
3220	0	-2	0	-2	-5	-3	0	0	-5	0	-2	0	0	-2	0	-1	0	-1	-25	-0.556
3221	0	-2	0	-2	-5	-3	-1	0	-5	0	-2	0	-1	-3	0	-1	0	-1	-27	-0.600
3222	0	-2	0	-2	0	-1	-1	0	-2	0	0	0	-1	-1	0	-1	0	-1	-17	-0.378
3223	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-15	-0.333
3487	0	-3	0	-3	0	-2	-1	0	-3	0	-1	0	-1	-2	0	-1	0	-1	-28	-0.622
3488	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
3489	0	-1	0	-1	0	-1	-1	0	-2	0	0	0	-1	-1	0	0	0	0	-10	-0.222

Reach	Depth - Slope				Pollution					Hydrology					Physical Disturbance				Controlling Factors Total Score	
	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3490	0	-2	-1	-3	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-1	0	-1	-23	-0.511
3491	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-24	-0.533
3492	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-21	-0.525
3493	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	-2	0	-2	-17	-0.425
3494	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-0.125
3495	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	-1	0	-1	-28	-0.622
3496	0	-2	-1	-3	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-2	0	-2	-25	-0.556
3497	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-8	-0.200
3498	0	-3	-2	-5	0	0	-1	0	-1	0	0	-2	-1	-3	0	-2	0	-2	-32	-0.711
3499	0	-3	0	-3	0	-1	0	-1	-2	0	0	0	0	0	0	-2	0	-2	-27	-0.600
3500	0	-3	-1	-4	0	-1	0	0	-1	0	0	-1	0	-1	0	-1	0	-1	-18	-0.514
3501	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	0	0	0	-26	-0.578
3502	0	-3	-2	-5	0	-1	0	0	-1	0	0	-2	0	-2	0	-1	0	-1	-30	-0.667
3503	0	-2	-1	-3	0	0	0	0	0	0	0	-1	0	-1	0	0	0	0	-13	-0.289
3504	0	-2	-1	-3	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-1	0	-1	-22	-0.489
3505	0	-3	-1	-4	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-2	-2	-4	-29	-0.725
3506	0	-2	-1	-3	0	0	0	0	0	0	0	-1	0	-1	0	-1	0	-1	-21	-0.467
3507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3	-4	-6	-0.150
3508	0	0	0	0	0	-3	0	0	-3	0	-2	0	0	-2	0	0	-3	-3	-8	-0.200
3509	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-6	-0.150
3510	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	-1	0	-1	-4	-0.100
3511	0	-3	0	-3	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-24	-0.533
3512	0	-2	0	-2	0	-2	-1	0	-3	0	-1	0	-1	-2	0	-2	-1	-3	-22	-0.550
3513	0	-1	0	-1	0	-2	0	0	-2	0	-1	0	0	-1	0	0	-1	-1	-13	-0.325
3514	0	0	0	0	0	-3	0	0	-3	0	-2	0	0	-2	0	-2	-3	-5	-15	-0.375
3515	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-18	-0.400
3516	0	-2	0	-2	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-19	-0.422
3517	-5	-3	0	-5	0	-2	0	0	-2	0	-1	0	0	-1	0	-1	-1	-2	-30	-0.667
3518	-5	-3	0	-5	-5	-1	-1	0	-5	0	0	0	-1	-1	0	-1	0	-1	-28	-0.700
3519	0	-3	0	-3	-5	-1	0	0	-5	0	0	0	0	0	0	-2	0	-2	-23	-0.575
3520	0	-3	0	-3	-5	-1	0	0	-5	0	0	0	0	0	0	-2	0	-2	-24	-0.600
3521	0	-1	0	-1	-5	-1	0	0	-5	0	0	0	0	0	0	-1	0	-1	-12	-0.300
3522	-5	-2	-1	-5	-5	-1	0	-1	-5	0	0	-1	0	-1	0	-2	0	-2	-27	-0.675
3523	-5	-1	0	-5	-5	-1	0	0	-5	0	0	0	0	0	0	0	-3	-3	-15	-0.429
3524	-5	-1	0	-5	0	-1	0	0	-1	0	0	0	0	0	0	-1	-3	-4	-17	-0.425
3525	0	-3	-2	-5	0	-2	0	0	-2	0	-1	-2	0	-3	0	-1	0	-1	-33	-0.733
3526	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	-10	-0.222

	Depth - Slope				**Pollution**					**Hydrology**					**Physical Disturbance**				**Controlling Factors Total Score**	
Reach	Dredge	Armor	Encroach	**Sum**	Shellfish Closed	TIA	Outfall Density	Marina or Fish Farm	**Sum**	Tidal Constrict.	TIA	Encroach	Outfall Density	**Sum**	Urban Waterfront	Floating Struct., Ramps	% Forest of Riparian Zone	**Sum**	**Sum**	**Geomorph Normalized Score**
3527	0	-1	0	-1	0	-1	-1	0	-2	0	0	0	-1	-1	0	-1	0	-1	-13	-0.289
3528	0	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-0.111
3529	0	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	-2	0	-2	-12	-0.300
3530	0	-3	-1	-4	0	-1	-1	0	-2	0	0	-1	-1	-2	0	-2	0	-2	-31	-0.689
3531	0	-3	-2	-5	0	-1	-1	0	-2	0	0	-2	-1	-3	0	-2	0	-2	-30	-0.667
3532	0	-2	-1	-3	0	-1	0	0	-1	0	0	-1	0	-1	0	-2	0	-2	-19	-0.475
3533	0	-3	-1	-4	-5	-2	-1	0	-5	0	-1	-1	-1	-3	0	-2	0	-2	-30	-0.750
3534	0	-3	0	-3	-5	0	-1	0	-5	0	0	0	-1	-1	0	-1	0	-1	-23	-0.575
3535	0	-2	0	-2	-5	-2	-1	0	-5	0	-1	0	-1	-2	0	-2	0	-2	-23	-0.575
3536	0	-1	0	-1	-5	-3	0	0	-5	0	-2	0	0	-2	0	0	0	0	-12	-0.300
3537	0	-1	0	-1	-5	-1	-1	0	-5	0	0	0	-1	-1	0	-2	-1	-3	-20	-0.500
3538	0	-3	0	-3	-5	-1	-1	0	-5	0	0	0	-1	-1	0	-1	-2	-3	-25	-0.625
3539	0	-3	-1	-4	-5	-2	0	0	-5	0	-1	-1	0	-2	0	-1	0	-1	-30	-0.667
3540	0	-3	-2	-5	0	-2	-1	0	-3	0	-1	-2	-1	-4	0	-1	-1	-2	-35	-0.778
6000	0	0	0	0	-5	-1	0	0	-5	0	0	0	0	0	0	-2	-1	-3	-13	-0.325
6001	0	0	0	0	-5	0	-1	0	-5	-5	0	0	-1	-5	0	0	0	0	-15	-0.375
6002	0	-1	0	-1	0	0	-1	0	-1	0	0	0	-1	-1	0	-1	0	-1	-9	-0.225

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Appendix D

Ecological Functions Scoring

Table D-1. Ecological Functions Scoring

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3080	2	1	1	1	1	1	1	1	5	1	15
3081	3	1	1	1	1	1	1	1	5	1	16
3082	4	1	1	1	1	1	1	1	3	1	15
3083	4	1	1	5	1	3	1	1	3	1	21
3084	4	1	1	1	1	3	1	1	3	1	17
3085	3	1	1	1	1	3	1	1	5	1	18
3086	2	1	1	1	1	1	1	1	5	1	15
3087	1	1	1	1	1	1	1	1	5	1	14
3088	1	1	1	1	1	1	1	1	3	1	12
3089	1	1	1	1	1	1	1	1	5	1	14
3090	1	1	1	1	1	1	1	1	5	3	16
3091	1	1	1	1	1	1	1	1	5	5	18
3092	1	1	1	1	1	3	1	1	5	1	16
3093	1	1	1	1	1	5	1	1	5	1	18
3094	1	1	1	1	1	3	1	1	3	1	14
3095	1	1	1	1	1	3	1	1	3	1	14
3096	1	1	1	1	1	1	1	1	5	1	14
3097	1	1	1	1	5	3	1	1	5	1	20
3098	1	1	1	1	5	1	1	1	5	1	18
3099	1	1	1	1	5	1	1	1	3	1	16
3100	1	1	1	1	1	3	1	1	3	1	14
3101	1	1	1	1	1	5	1	1	3	1	16
3102	1	1	1	1	1	1	1	1	5	1	14
3103	1	1	1	1	1	1	1	1	5	1	14
3104	1	1	1	1	1	1	1	1	5	1	14
3105	1	1	1	1	1	1	1	1	5	1	14
3106	1	1	1	1	1	1	1	1	1	1	10
3107	1	1	1	1	5	1	1	1	5	1	18
3108	1	1	1	1	1	1	1	1	5	3	16
3109	1	1	1	1	1	3	1	1	3	1	14
3110	1	1	1	1	1	5	1	1	3	1	16
3111	1	1	1	1	1	3	1	1	3	1	14
3112	2	1	1	1	1	3	1	1	3	5	19

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3113	3	1	1	1	1	3	1	1	5	5	22
3114	4	1	5	1	1	3	1	1	5	5	27
3115	5	1	1	1	1	1	3	1	3	3	20
3116	4	1	1	1	1	1	1	1	5	1	17
3117	4	1	1	1	1	1	1	1	5	1	17
3118	5	1	1	1	1	1	1	1	3	1	16
3119	4	1	1	1	1	1	1	1	5	1	17
3120	3	1	1	1	5	1	1	1	5	5	24
3121	2	1	1	1	5	1	1	1	5	1	19
3122	1	1	1	1	5	3	1	1	5	1	20
3123	1	1	1	1	5	1	1	1	5	1	18
3124	1	1	5	1	5	3	1	1	5	1	24
3125	1	1	5	1	1	5	1	1	3	1	20
3126	1	1	1	1	1	3	1	1	3	1	14
3127	1	1	1	1	1	1	1	1	3	1	12
3128	1	1	1	1	1	1	1	1	3	1	12
3129	1	1	1	1	1	1	1	1	3	5	16
3130	1	1	1	1	1	1	1	1	3	3	14
3131	1	1	1	1	1	3	1	1	3	1	14
3132	1	1	5	5	1	3	1	1	3	3	24
3133	1	1	1	1	1	5	1	1	5	1	18
3134	1	1	1	1	1	5	1	1	5	1	18
3135	2	1	1	1	1	3	1	1	3	5	19
3136	3	1	1	1	1	1	3	1	3	3	18
3137	4	1	1	1	1	1	3	1	3	3	19
3138	5	1	1	1	1	1	3	1	3	3	20
3139	5	1	1	1	1	1	3	1	3	5	22
3140	4	1	1	1	1	1	1	1	5	5	21
3141	3	1	1	1	1	3	3	1	5	1	20
3142	2	1	1	1	1	3	5	1	3	1	19
3143	1	1	1	1	1	1	1	1	5	1	14
3144	2	1	1	1	1	1	1	1	3	1	13
3145	3	1	1	1	1	1	1	1	3	3	16
3146	4	1	1	1	1	1	3	1	3	1	17

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3147	5	1	1	1	1	1	1	1	3	3	18
3148	4	1	1	1	1	1	1	1	1	1	13
3149	3	1	5	1	1	1	1	1	3	1	18
3150	2	1	5	1	1	3	1	1	5	1	21
3151	1	1	5	1	1	3	1	1	5	1	20
3152	1	1	1	1	1	3	1	3	3	1	16
3153	1	1	1	1	1	1	3	5	5	1	20
3154	1	1	1	1	1	3	1	5	5	1	20
3155	1	1	1	1	1	3	1	5	5	1	20
3156	1	1	1	1	5	1	1	1	5	1	18
3157	1	1	1	1	5	1	1	1	5	1	18
3158	1	1	5	1	5	3	1	1	5	3	26
3159	1	1	5	1	5	3	1	1	5	1	24
3160	1	1	5	1	5	5	1	1	5	1	26
3161	1	1	1	5	5	1	1	1	3	1	20
3162	1	1	1	5	5	5	1	1	1	3	24
3163	1	1	1	1	5	5	1	1	5	1	22
3164	1	1	1	1	5	5	1	1	5	5	26
3165	1	1	1	1	5	3	1	1	5	3	22
3166	1	1	1	1	5	3	1	1	3	5	22
3167	1	1	1	1	1	3	1	1	3	1	14
3168	2	1	1	1	1	1	1	1	3	1	13
3169	3	1	1	1	1	1	3	1	3	1	16
3170	4	1	1	1	1	1	3	1	3	5	21
3171	5	1	1	1	1	1	5	1	3	5	24
3172	4	1	1	1	1	1	3	1	3	1	17
3173	3	1	1	1	1	3	1	1	3	1	16
3174	2	1	1	1	1	5	1	1	3	1	17
3175	1	1	1	1	5	1	1	1	5	1	18
3176	1	1	1	1	5	3	1	1	5	1	20
3177	1	1	1	1	5	3	1	1	3	1	18
3178	1	1	1	1	5	5	1	1	3	1	20
3179	2	1	1	1	5	5	1	1	3	5	25
3180	3	1	1	1	5	5	1	1	3	1	22

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3181	4	1	1	1	5	5	1	1	3	1	23
3182	5	1	1	1	5	3	1	1	3	1	22
3183	4	1	1	1	5	3	1	1	3	1	21
3184	3	5	1	1	5	3	1	1	3	1	24
3185	2	5	1	1	5	5	1	1	3	1	25
3186	1	5	1	1	5	5	1	1	3	1	24
3187	1	5	1	1	1	5	1	1	3	1	20
3188	1	5	1	1	5	5	1	1	5	1	26
3189	1	5	1	1	5	5	1	1	3	1	24
3190	1	5	1	5	1	1	3	1	3	1	22
3191	1	5	1	1	5	5	1	1	3	1	24
3192	1	5	1	1	5	1	1	1	5	3	24
3193	1	5	1	1	5	1	1	1	5	1	22
3194	1	5	5	5	5	5	1	1	3	1	32
3195	2	5	5	5	1	3	1	1	3	1	27
3196	3	5	5	5	1	1	5	1	3	1	30
3197	4	5	1	1	1	1	1	1	3	3	21
3198	5	5	1	1	1	1	1	1	3	5	24
3199	4	5	1	1	1	1	1	1	3	1	19
3200	3	5	1	1	1	1	1	1	3	1	18
3201	2	5	1	1	1	1	3	1	1	3	19
3202	1	5	1	1	1	1	1	1	1	3	16
3203	1	5	1	1	1	1	3	1	1	1	16
3204	1	5	1	1	1	1	1	1	3	3	18
3205	1	5	1	1	1	1	1	1	3	1	16
3206	1	5	1	1	1	1	1	1	3	1	16
3207	1	5	1	1	1	1	3	1	5	1	20
3208	1	5	1	1	1	1	3	1	3	3	20
3209	1	5	1	1	1	1	3	1	3	1	18
3210	1	5	1	1	1	1	3	1	3	1	18
3211	1	5	1	1	1	3	3	1	3	1	20
3212	1	5	5	1	5	3	3	1	5	1	30
3213	1	5	5	5	5	5	1	1	5	3	36
3214	1	5	5	5	5	5	1	1	3	1	32

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3215	1	5	5	5	5	5	1	1	5	1	34
3216	1	5	5	5	5	5	1	1	3	1	32
3217	1	5	5	5	5	3	1	1	5	1	32
3218	1	5	5	5	5	5	1	1	3	1	32
3219	1	5	5	5	5	3	1	1	3	1	30
3220	1	5	5	5	5	3	1	1	3	1	30
3221	1	5	5	5	1	3	1	1	3	1	26
3222	1	5	5	5	1	3	1	1	5	3	30
3223	1	5	5	5	1	1	1	1	3	3	26
3487	1	5	1	1	5	1	1	1	5	1	22
3488	1	5	1	1	5	5	1	1	3	5	28
3489	1	5	1	1	5	5	1	1	3	5	28
3490	1	5	5	1	5	5	1	1	3	3	30
3491	2	5	5	1	5	3	1	1	3	1	27
3492	3	5	1	1	5	1	1	1	3	1	22
3493	4	5	1	1	1	1	3	1	3	3	23
3494	5	5	1	1	1	1	3	1	3	5	26
3495	4	5	5	5	5	3	1	1	3	1	33
3496	3	5	5	5	5	1	1	1	3	1	30
3497	2	5	1	1	1	1	3	1	3	5	23
3498	1	5	1	1	5	1	1	1	3	1	20
3499	1	5	1	1	5	1	1	1	3	1	20
3500	1	5	1	1	5	3	1	1	3	1	22
3501	1	5	1	1	5	1	1	1	3	1	20
3502	1	5	5	1	5	1	1	1	3	1	24
3503	1	5	1	1	5	1	1	1	3	5	24
3504	1	5	1	1	5	1	1	1	3	3	22
3505	1	5	1	1	5	1	1	1	3	1	20
3506	1	5	5	1	5	1	1	1	3	1	24
3507	1	5	5	1	5	3	1	1	3	1	26
3508	1	5	5	1	5	1	1	1	3	1	24
3509	1	1	1	1	1	1	5	1	3	3	18
3510	1	5	5	1	5	1	1	1	3	1	24
3511	1	5	5	5	5	1	1	1	5	1	30

Reach	Fish Bearing Stream Proximity	Herring Spawning	Surf Smelt Spawning	Sandlance Spawning	Geoducks	Eelgrass	Salt Marsh	Bull Kelp	Intertidal Seaweed	Overhanging Veg Total	**Functional Index Sum Score**
3512	1	1	5	5	5	1	1	1	3	1	24
3513	1	1	5	1	1	1	5	1	1	1	18
3514	1	1	5	1	5	1	1	1	3	1	20
3515	1	1	5	1	5	1	1	1	3	5	24
3516	1	1	5	1	5	1	1	1	5	3	24
3517	1	1	1	1	5	1	1	1	5	1	18
3518	2	1	1	1	1	1	3	1	3	1	15
3519	3	1	1	1	1	1	3	1	1	3	16
3520	4	1	1	1	1	1	1	1	1	1	13
3521	5	1	1	1	1	1	3	1	1	5	20
3522	4	1	1	1	1	1	3	1	5	3	21
3523	3	1	1	1	1	1	5	1	3	1	18
3524	2	1	1	1	5	1	1	1	5	1	19
3525	1	1	1	1	5	1	1	1	3	1	16
3526	1	1	1	5	5	1	1	1	3	5	24
3527	1	1	1	5	5	1	1	1	3	3	22
3528	1	1	1	1	5	1	1	1	5	5	22
3529	1	1	1	1	5	1	1	1	3	1	16
3530	1	1	1	1	5	1	1	1	5	1	18
3531	1	1	1	1	5	1	1	1	3	1	16
3532	1	1	1	1	5	1	1	1	3	1	16
3533	1	1	1	1	5	1	1	1	5	1	18
3534	1	1	1	1	5	1	1	1	5	1	18
3535	1	1	1	1	5	1	1	1	5	1	18
3536	1	1	1	1	5	1	1	1	5	1	18
3537	1	1	1	1	5	1	1	1	3	1	16
3538	1	1	1	1	1	1	1	1	5	1	14
3539	1	1	1	1	1	1	1	1	5	1	14
3540	1	1	1	1	1	1	1	1	5	1	14
6000	4	1	1	5	1	3	1	1	3	1	21
6001	5	1	1	5	1	3	1	1	3	1	22
6002	1	5	1	5	1	1	3	1	3	3	24

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Appendix E

Prioritization of Management Options

Prioritization of Management Options

The objective of the prioritization process is to develop a science-based protocol for determining priorities and strategies for improving nearshore ecosystem functions on Bainbridge Island. The process links output from the Nearshore Characterization and Assessment with the prioritization process. The process draws from the fields of restoration ecology, landscape ecology, and conservation biology. The input to the approach is based on expert opinion founded in the best available science (BAS) for the region. A companion report developed for Bainbridge Island (Williams et al., 2003) provides a discussion of the BAS for Bainbridge Island nearshore.

Nearshore Management Strategies

Five fundamental strategies for improving ecosystem functions of nearshore systems (listed in no particular order) are included in the process and form the basis for management decisions:

- Creation – Creation involves bringing into being a new ecosystem that previously did not exist on the site (NRC 1992). In contrast to restoration, creation involves the conversion of one habitat type or ecosystem into another.
- Enhancement – Enhancement means any improvement of a structural or functional attribute (NRC 1992). As noted by Lewis (1990), enhancement and restoration are often confused. Enhancement is the intentional alteration of an existing habitat to provide conditions that previously did not exist and which by consensus increase one or more attributes. Shreffler and Thom (1993) found that, for estuarine systems, enhancement often meant *enhancement of selected attributes* of the ecosystem, such as improving the quality or size of a tidal marsh or eelgrass meadow.
- Restoration – As defined in the scientific literature, restoration means the return of an ecosystem to a close approximation of its previously existing condition (e.g., Lewis 1990, NRC 1992). We use the term restoration to refer to any form of human intervention with the intent of improving upon the existing condition of the ecosystem or habitat. Restoration involves doing *something* to increase the rate of recovery over the rate of natural recovery occurring without human intervention.
- Conservation – Conservation, as defined by Meffe et al. (1994), refers to the maintenance of biodiversity. Conservation Biology is a synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy and other theoretically based disciplines to the maintenance of biological diversity. Conservation can allow development to occur as long as biodiversity and the structure and processes to maintain it are not affected.
- Preservation – Preservation refers to the formal exclusion of activities that may negatively affect the structure and/or functioning of habitats or ecosystems. It can also refer to preservation of a species or group of species through management actions, such as elimination of harm to a species directly or indirectly through damage of its habitat. Marine protected areas (MPAs) can fit within this strategy. Marine protected areas are receiving growing attention as a viable way to preserve fish populations threatened by over-fishing and habitat loss (e.g., Roberts et al. 2001). They are typically established in habitats known to be important for function, such as reproduction or rearing.

Influence of Disturbance on Management Actions

The prioritization process considers the level of disturbance affecting the nearshore systems of Bainbridge Island. The success of any strategy varies depending on the level of disturbance of the site and the landscape within which the site resides (NRC 1992). Using the findings of the National Research Council (NRC) and a review of the literature on estuarine habitat restoration, Shreffler and Thom (1993) concluded that the strategies of restoration, enhancement, and creation should be applied depending on the degree of disturbance of the site and the landscape (Figure E-1). It is assumed that the historical conditions represent the optimal habitat conditions for a particular site. In general, restoration to historical conditions is best accomplished where the sites and the landscape are not heavily altered (Shreffler and Thom 1993; NRC 1992). Creation of new habitat (i.e., habitat not historically present) at a site is done when the site and the landscape are heavily damaged. Because the nearshore and adjacent uplands of the Island have typically not been heavily urbanized, the goal of restoring the nearshore habitats to historical conditions is viable over much of the Island. However, in some areas of the Island, other alternative actions are more appropriate (see below). For example, sites with a high degree of disturbance on the landscape (management area) and site (reach) scales (Figure E-1), in general, have a low probability for restoration, and creation of a new habitat or ecosystem or perhaps enhancement of selected attributes would be the only viable strategies to apply in these situations. In contrast, where the site and landscape are essentially intact, restoration to historical (i.e., humans present, but insignificant disturbance) or predisturbance (i.e., before man) conditions would be viable options and the probability of success would be high.

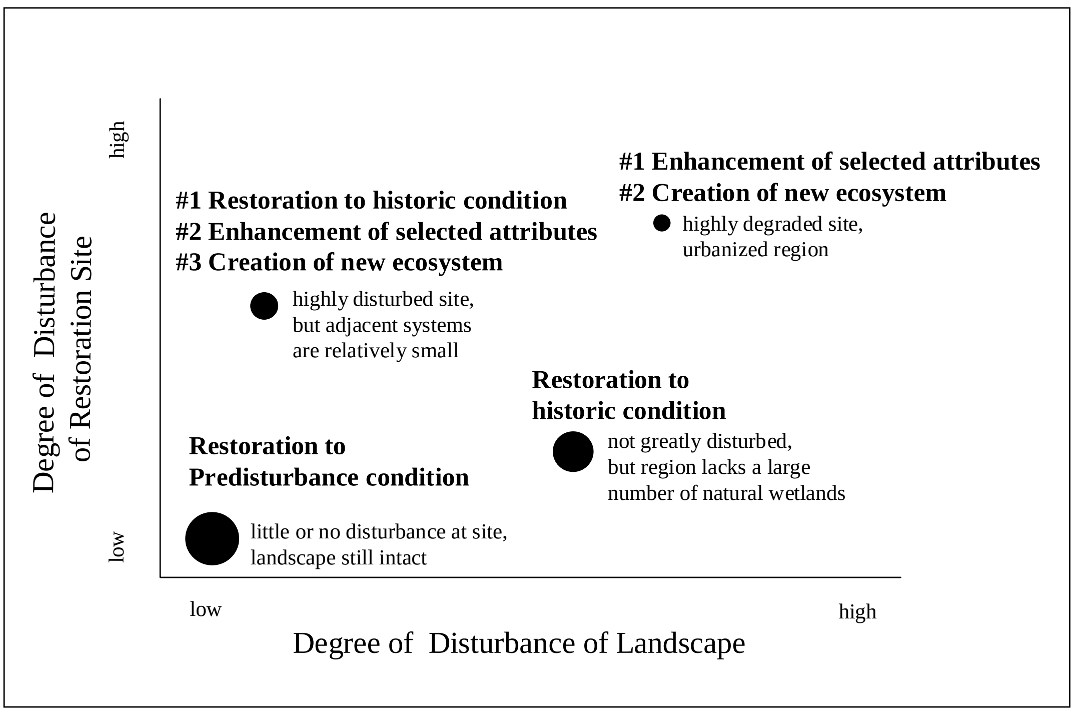

Figure E-1. The restoration strategies for nearshore systems relative to disturbance levels on the site and in the landscape (from Shreffler and Thom 1993).
(The relative chance of success increases with the size of the dot.)

Conservation strategy is related to another strategy common in the literature: *sustainable development*. *Development* here means the qualitative change in a systems complexity and configuration as opposed to (sustainable) *growth* which refers to a quantitative increase the size of the system (Meffe et al. 1994). Basically, this means that society conducts itself in a manner that preserves ecosystems for the future by encouraging actions that conserve what exists and that restore what has been damaged or lost (Meffe et al. 1994). Hence, the fields of conservation biology and restoration ecology merge under sustainable development, and, furthermore, are interdependent upon one another.

Some of the practical steps in sustainable development include the following:

- Avoid and minimize damages from any development project through thorough review and refinement of the project–base this on sound understanding of the individual and cumulative effects of the project on the ecosystem. By knowing the sources of stress, one can better provide advice on how to avoid these stresses through engineering and project modifications.
- Devote a strong effort in the planning phase for the restoration project to maximize the assurance of success.
- Execute the restoration project effectively and comprehensively.
- Monitor and adjust the project as needed to better meet the goals.

Finally, effectively achieving the goal may require that several strategies be employed at a site and in the landscape. It is possible that preservation of landscape features, enhancement of selected nearshore attributes, and conservation in the nearshore may be highly effective in restoring the controlling factors that affect historical structure, functions, and processes to the system.

Background to Prioritization Process

There is no universally accepted method for prioritizing nearshore sites for restoration or for determining what strategies are best applied to each site. At a national level, the U.S. Army Corps of Engineers (2000) has the most developed planning process for projects under their civil works mission (i.e., navigation, flood control), and they are adapting this process to ecosystem restoration projects (Thom et al., in press). Once the site is selected, the Corps process evaluates alternative plans relative to environmental planning objectives and cost. Through what is termed incremental analysis, they arrive at a point where there is a rapidly diminishing return on investment in the project. The process therefore highlights the action that provides the most benefit per unit of investment. The Corps utilizes environmental indices (e.g., habitat suitability indices; hydrogeomorphic indices; Shafer and Yozzo 1998; Thom et al., in press) as metrics to evaluate environmental outcomes from alternative restoration plans.

In the northwest, several approaches have been applied to prioritizing restoration projects. The approaches have several aspects in common: a goal statement, a site assessment to ascertain changes in conditions from the historical condition, a set of selection criteria, and a qualitative or semi-quantitative scoring protocol. The overall driver for these programs is to determine where and what needs to be done to result in improved conditions relative to the goal. Improvement in the landscape (management area) (e.g., limiting factor analysis), or simply the opportunity for restoration (e.g., sites made easily available, Bloch et al., 2002) at least partially drives the process of site prioritization. In highly urbanized and developed areas such as ports, site selection and prioritization is strongly driven by the cost for the site and its restoration relative the chance for restoration to be successful (Shreffler and Thom 1993). The chief drawback with all approaches has been the need to rely heavily on subjective (i.e., expert opinion) information in the face of a lack of critical data on key relationships. For example, it would be ideal to develop a metric that indicates the increase in fitness of juvenile salmon relative to various manipulations of the nearshore ecosystem. Because this is not possible with our present understanding, surrogates are utilized, such as area of selected habitats, juvenile salmon prey densities produced by habitats, area covered by exotic plants, and area of intact riparian zone.

Multi-criteria methods use data on the physical and chemical requirements (i.e., the *controlling factors* as used in this study) of a selected nearshore habitat (e.g., eelgrass), along with data on past restoration experience for that habitat to parameterize a model or index that evaluates the restoration potential for sites in a region (e.g., Store and Kangas 2001; Short 2003). Recent work with multi-criteria methods link results directly to a Geographic Information System (GIS), where the results of the analysis can be displayed on maps of the region (Store and Kangas 2001). The advantage of these habitat suitability models (HSM) is that quantitative data on habitat requirements are used along with information on existing conditions at sites. If data on habitat requirements are available and used, this type of analysis is generally more objective than other methods relying on expert opinion. However, expert opinion can also be incorporated when quantitative data are not available, which increases susceptibility to bias and decreases repeatability.

For analysis of sites, the method not only requires information on the needs of a particular habitat type, but also on the historic and present conditions of sites in the region. For example, a site with appropriate conditions prior to development may not presently be suitable for a particular habitat. Therefore, careful examination of the potential site needs to incorporate past (historical undisturbed) and present conditions, and the degree of change that needs to take place to reestablish the habitat. This method deals only with habitats where there is a large amount of information on their requirements as well as on their restoration potential. A separate model would be required for each habitat within a system.

The Index of Biological Integrity (IBI) is a multi-metric index of habitat quality and condition that composite several environmental or biotic variables to evaluate aquatic resources and to assess the effects of anthropogenic degradation (Karr 1993; Hughes et al. 2002). A biotic index is calculated based on a set of measurable biotic variables that are known to be indicative of habitat quality. For example, the following set of variables was used by Hughes et al. (2000) for evaluating estuarine quality on the east coast:

- Fish abundance or biomass
- Total fish species per trawl
- Species dominance
- Number of resident species
- Number of estuarine nursery species
- Number of in-estuary spawning species entering the estuary as adults to spawn
- Proportion of benthic-associated, or demersal, species
- Proportion of diseased fish.

The eight variables are compared with critical values indicating low habitat quality, and assigned a score. Often an independent set of data on water quality or other environmental variables are collected, computed as an index similar to the IBI, and compared with the IBI scores. If the IBI is a valid indicator of habitat conditions, the IBI score will correlate with the index based on environmental variables. Through analysis, the environmental factors most responsible for site-to-site variation in the IBI can be identified, and these can guide actions at the site that would lead to an improved IBI. For the IBI analysis to be most informative and defensible, critical values for the biotic and environmental variables need to be known.

In developing ecological assessment criteria for restoring anadromous salmon habitat, Simenstad and Cordell (2000) advocated the use of measures directly relatable to the ecological and physiological responses of juvenile salmonids to restored habitats. They proposed the use of three categories: *capacity*, *opportunity*, and *realized functions* (Table E-1). Capacity metrics include habitat attributes that promote juvenile salmon production through promotion of foraging, growth, and growth efficiency, and/or decreased mortality. The capacity category is an extension of the ecological concept of carrying capacity.

Examples of capacity metrics include the productivity and density of prey, physical and chemical conditions that promote high assimilation efficiencies, and structural conditions that provide protection from predation. Opportunity metrics appraise the ability of salmon to access and benefit from the habitat's capacity (Simenstad and Cordell 2000). Opportunity incorporates the principles of landscape ecology (Forman and Godron 1986). Examples of metrics include tidal elevation of feeding habitats, extent of morphometric features such as habitat edge length, as well as refugia (such as low-tide, deep-water refuges) from predation. Finally, realized function metrics include any direct measures of physiological or behavioral responses that can be attributable to fish occupation of the habitat and that promote fitness and survival (Simenstad and Cordell 2000). Survival is the ultimate metric, but related metrics include habitat-specific residence time, foraging success, and growth.

Table E-1. Capacity, Opportunity, and Realized Functions as Measures of Ecological and Physiological Responses of Juvenile Salmonids to Restored Habitats (Simenstad and Cordell 2000)

Category	Potential Armoring Impact	Potential Impact to Salmon
Capacity	Altered habitat type Altered habitat forming processes Altered habitat production	Change in prey species Change in prey production Change in prey abundance Change in prey distribution Change in predator abundance
Opportunity	Altered access Altered migration route Altered habitat size Altered habitat location Altered refugia from predators	Change in ability to find prey Change in rate of migration Change in predation rate
Realized Function	Altered residence time Altered foraging success	Change in growth rate and survival

Relevance to Bainbridge Island Nearshore

On Bainbridge Island, a numerical multi-criteria assessment of habitat suitability could be developed for eelgrass and tidal marshes. Quantitative information on physical and chemical requirements for these habitats would drive assessments of the appropriateness of sites for restoring these habitats. Other potential habitats include tidal flats and cobble and rocky shores, although these have not been evaluated rigorously. To accomplish this evaluation, the classification system developed by Dethier (1990) would be an important source for the physical "setting" for the various nearshore habitats found on Bainbridge Island. Dethier's classification is descriptive, however, and linking physical conditions to habitat types is qualitative. The IBI multi-metric analysis, as described for other estuarine systems, may be appropriate for evaluating the functionality of restoration projects carried out on the Island. An IBI approach could also be employed to compare conditions before and after site restoration.

The process developed here relies as much as possible on solid ecological principles, coupled with the best available scientific understanding of the nearshore ecosystems of Puget Sound (Williams et al., 2003), and the best information available on the biophyscial conditions of the nearshore on Bainbridge Island (this report). Specifically, the process developed here relies on *restoration of controlling factors as the key to successful and long-term sustainability*. We have not done an analysis of historical conditions on the Island. Historical information on reaches on the Island should be examined to fully evaluate the appropriate strategy and potential for a strategy to work for those reaches. In the present analysis, we assumed that the "historical" conditions are present within other similar geomorphic settings in Puget Sound or relatively undisturbed sites on Bainbridge Island.

The Prioritization Method for Bainbridge Island Nearshore

The prioritization for Bainbridge Island nearshore involves an initial assessment of which strategies would have the highest priority of working within each reach, followed by a site (reach) specific assessment to refine the strategy and priority. This approach uses landscape ecology and conservation biology principles, and national recommendations on the most applicable restoration strategies as the fundamental underpinnings for prioritization (see above and NRC 1992; Shreffler and Thom 1993). These principles are well established in the ecological literature, and are highly useful in providing comprehensive, larger-scale guidance.

Analysis of the Most Applicable Management Strategies

A national assessment showed that the degree of impact on the landscape and site scales affected the probability of restoration success, and that the most appropriate restoration strategies varied according to disturbance on these two scales (Figure E-1). Restoration of natural aquatic systems can be uncertain (NRC 1992; Thom 2000). Prioritization of sites and management action strategies for these sites are presented here using information designed to reduce this uncertainty as much as possible. For Bainbridge Island, reach is equated to site-scale, and management area is equated to landscape scale. Actual sites on Bainbridge Island may be smaller than a reach, and should be evaluated at the actual scale when developing strategies for that site. Because the shoreline management area is based on drift cells, a major contributor to habitat-forming processes in reaches, shoreline management areas encompass appropriate landscape-scale processes. Because some sites may be located at the convergence or divergence between two drift cells, these sites should be evaluated relative to their unique position.

The matrix in Figure E-2 identifies the strategies most appropriate under the different states of combined reach and management area impact. Figure E-2 integrates the restoration strategies in Figure E-1 and the two additional strategies of conservation and preservation discussed above. The strategies most likely to work are indicated, as well as where each strategy might also be applied with a somewhat lower probability of working.

As seen in the matrix (Figure E-2), multiple strategies are potentially viable under any one of the states. This matrix provides general guidance as a first approximation of specific management actions that could be evaluated within a reach or management area. In developing the matrix in Figure E-2, the following logic was used:

- The lower the disturbance on both scales, the greater reliance on preservation, conservation, and restoration
- The greater the disturbance on both scales, the greater reliance on enhancement
- Under the greatest levels of disturbance, greater is the reliance on creation.

Low Reach Impact	Restore Enhance	Preserve Conserve Restore Enhance	Preserve Conserve Restore
↕	Restore Enhance Create	Conserve Restore Enhance Create	Conserve Restore Enhance
High Reach Impact	Restore Enhance Create	Restore Enhance Create	Restore Enhance
	High Management Area Impact	↔	**Low Management Area Impact**

Figure E-2. Matrix of management action strategies most appropriate for a reach based on the degree of disturbance of the management area and the reach (not listed in any particular order).

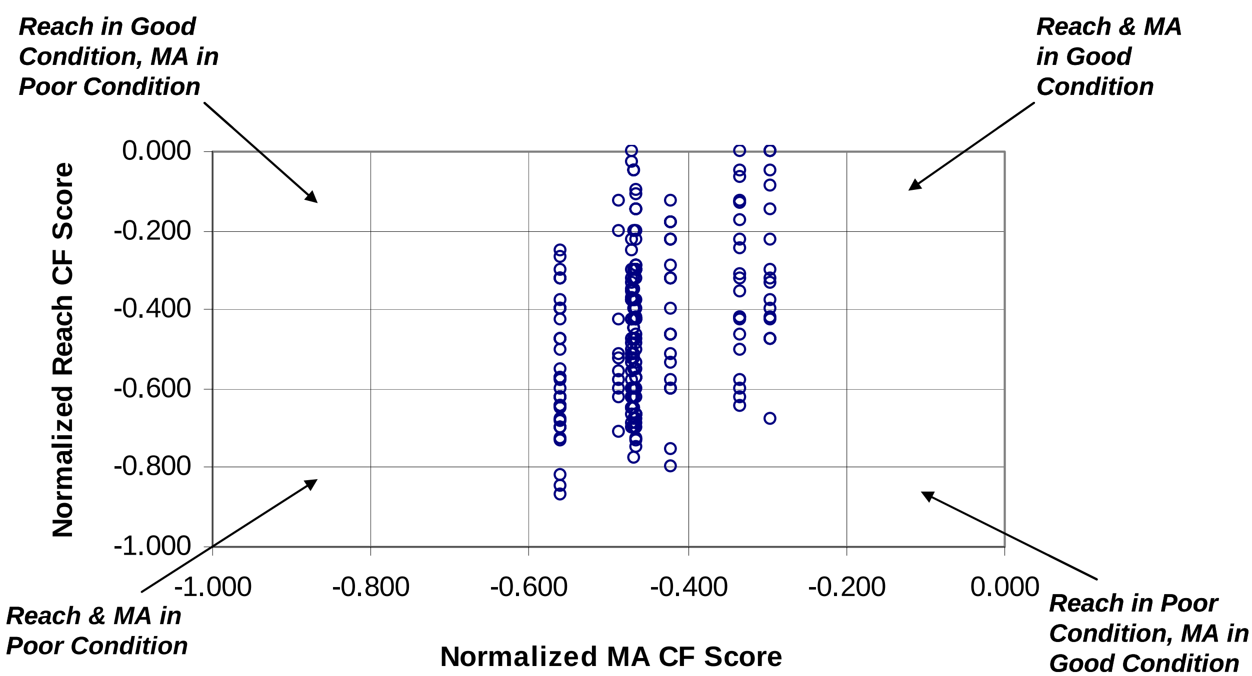

Figure E-3. Shoreline Management Area average normalized controlling factor disturbance score versus reach normalized controlling factor disturbance score.

To develop this prioritization specifically for the Bainbridge Island nearshore, the average controlling factor score (based on normalized reach scores) for each shoreline management area is plotted against the normalized controlling factor score for reaches (Figure E-3). Each point in Figure E-3 represents a reach. The rationale for using average controlling factor scores within each management area is that the average score indicates the relative degree of disturbances of the management area, which corresponds to the degree of disturbance of the landscape in Figure E-1. The degree of disturbance on the site scale is represented by the reach scale controlling factor score.

Figure E-3 corresponds to the matrix of management action strategies in Figure E-2 above, and can be used to *prioritize appropriate management action strategies for those reaches*. For example, for reaches with low controlling-factor disturbance scores on both axes, the most appropriate management action strategies would be to conserve, preserve, and restore (to pre-disturbance or pre-historical conditions). Whereas, reaches where controlling-factor disturbance scores are high on both axes, management action strategies of enhancement of selected habitat attributes or creation of new ecosystems are most appropriate. Areas where shoreline management area controlling factor scores are low (good), but reach scores are high (poor), the reach is in relatively good condition; however, any strategy for restoration needs to be considered relative to the ability of processes afforded by a relatively disturbed landscape to maintain the restored reach in the long term. Because the points are continuously distributed (at least on the reach scale) and there is a high degree of variability, the management action strategy most appropriate for a particular reach needs further reach-specific analysis. This degree of variation in the application of strategies is reflected in the general zones illustrated in Figure E-4. The scores and categories for each reach and management area are provided in Table E-2.

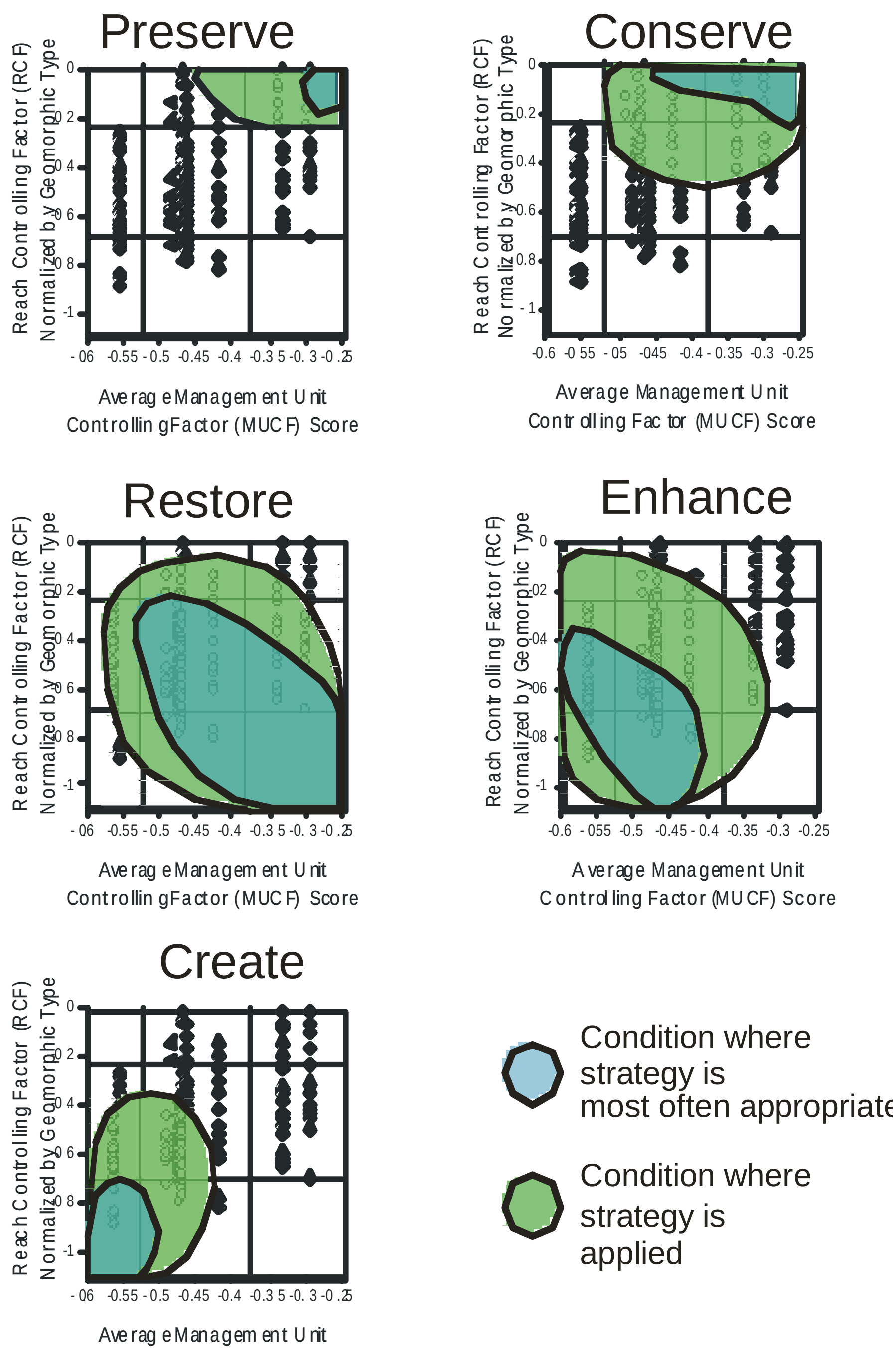

Figure E-4. Generalized zones of application of management strategies relative to management area and reach disturbance.

Table E-2. Controlling factors scores for reaches and management areas, along with their relative qualitative ranking.

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
1	3217	-0.689	Mod/High	-0.470	Mod	32
1	3218	-0.622	Mod/High	-0.470	Mod	32
1	3219	-0.578	Mod	-0.470	Mod	30
1	3220	-0.556	Mod	-0.470	Mod	30
1	3221	-0.600	Mod	-0.470	Mod	26
1	3222	-0.378	Low/Mod	-0.470	Mod	30
1	3223	-0.333	Low/Mod	-0.470	Mod	26
1	3487	-0.622	Mod/High	-0.470	Mod	22
1	3488	0.000	No	-0.470	Mod	28
1	3489	-0.222	Low/Mod	-0.470	Mod	28
1	3490	-0.511	Mod	-0.470	Mod	28
1	3491	-0.533	Mod	-0.470	Mod	27
2	3193	-0.622	Mod/High	-0.471	Mod	22
2	3194	-0.025	Low	-0.471	Mod	32
2	3195	-0.371	Low/Mod	-0.471	Mod	27
2	3196	-0.486	Mod	-0.471	Mod	30
2	3197	-0.600	Mod	-0.471	Mod	21
2	3198	-0.375	Low/Mod	-0.471	Mod	22
2	3199	-0.625	Mod/High	-0.471	Mod	19
2	3200	-0.600	Mod	-0.471	Mod	18
2	3201	-0.425	Mod	-0.471	Mod	19
2	3202	-0.325	Low/Mod	-0.471	Mod	16
2	3203	-0.300	Low/Mod	-0.471	Mod	16
2	3204	-0.475	Mod	-0.471	Mod	18
2	3205	-0.650	Mod/High	-0.471	Mod	16
2	3206	-0.650	Mod/High	-0.471	Mod	16
2	3207	-0.500	Mod	-0.471	Mod	20
2	3208	-0.250	Low/Mod	-0.471	Mod	20
2	3209	-0.425	Mod	-0.471	Mod	18
2	3210	-0.700	Mod/High	-0.471	Mod	18
2	3211	-0.375	Low/Mod	-0.471	Mod	20
2	3212	-0.525	Mod	-0.471	Mod	30
2	3213	-0.356	Low/Mod	-0.471	Mod	36
2	3214	-0.350	Low/Mod	-0.471	Mod	32
2	3215	-0.622	Mod/High	-0.471	Mod	34
2	3216	-0.667	Mod/High	-0.471	Mod	32
3	3176	-0.467	Mod	-0.421	Mod	20
3	3177	-0.800	Mod/High	-0.421	Mod	18
3	3178	-0.756	Mod/High	-0.421	Mod	20
3	3179	-0.178	Low	-0.421	Mod	25
3	3180	-0.400	Low/Mod	-0.421	Mod	22
3	3181	-0.578	Mod	-0.421	Mod	23
3	3182	-0.325	Low/Mod	-0.421	Mod	22

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
3	3183	-0.533	Mod	-0.421	Mod	21
3	3184	-0.511	Mod	-0.421	Mod	24
3	3185	-0.178	Low	-0.421	Mod	25
3	3186	-0.125	Low	-0.421	Mod	24
3	3187	-0.225	Low/Mod	-0.421	Mod	20
3	3188	-0.600	Mod	-0.421	Mod	26
3	3189	-0.325	Low/Mod	-0.421	Mod	24
3	3190	-0.600	Mod	-0.421	Mod	22
3	3191	-0.467	Mod	-0.421	Mod	24
3	3192	-0.289	Low/Mod	-0.421	Mod	26
3	6002	-0.225	Low/Mod	-0.421	Mod	26
4	3156	-0.622	Mod/High	-0.334	Low/Mod	18
4	3157	-0.422	Mod	-0.334	Low/Mod	18
4	3158	-0.311	Low/Mod	-0.334	Low/Mod	26
4	3159	-0.133	Low	-0.334	Low/Mod	24
4	3160	-0.600	Mod	-0.334	Low/Mod	26
4	3161	-0.325	Low/Mod	-0.334	Low/Mod	20
4	3162	-0.244	Low/Mod	-0.334	Low/Mod	24
4	3163	-0.578	Mod	-0.334	Low/Mod	22
4	3164	-0.356	Low/Mod	-0.334	Low/Mod	26
4	3165	-0.067	Low	-0.334	Low/Mod	22
4	3166	-0.467	Mod	-0.334	Low/Mod	22
4	3167	-0.644	Mod/High	-0.334	Low/Mod	14
4	3168	-0.425	Mod	-0.334	Low/Mod	13
4	3169	-0.125	Low	-0.334	Low/Mod	16
4	3170	-0.050	Low	-0.334	Low/Mod	19
4	3171	0.000	No	-0.334	Low/Mod	24
4	3172	-0.222	Low/Mod	-0.334	Low/Mod	17
4	3173	-0.175	Low	-0.334	Low/Mod	16
4	3174	-0.500	Mod	-0.334	Low/Mod	17
4	3175	-0.422	Mod	-0.334	Low/Mod	18
5	3121	-0.267	Low/Mod	-0.559	Mod	19
5	3122	-0.475	Mod	-0.559	Mod	20
5	3123	-0.575	Mod	-0.559	Mod	18
5	3124	-0.578	Mod	-0.559	Mod	24
5	3125	-0.700	Mod/High	-0.559	Mod	20
5	3126	-0.700	Mod/High	-0.559	Mod	14
5	3127	-0.575	Mod	-0.559	Mod	12
5	3128	-0.425	Mod	-0.559	Mod	12
5	3129	-0.325	Low/Mod	-0.559	Mod	16
5	3130	-0.625	Mod/High	-0.559	Mod	14
5	3131	-0.844	High	-0.559	Mod	14
5	3132	-0.644	Mod/High	-0.559	Mod	22
5	3133	-0.550	Mod	-0.559	Mod	18
5	3134	-0.686	Mod/High	-0.559	Mod	18
5	3135	-0.400	Low/Mod	-0.559	Mod	19

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
5	3136	-0.325	Low/Mod	-0.559	Mod	16
5	3137	-0.500	Mod	-0.559	Mod	19
5	3138	-0.375	Low/Mod	-0.559	Mod	18
5	3139	-0.250	Low/Mod	-0.559	Mod	20
5	3140	-0.300	Low/Mod	-0.559	Mod	19
5	3141	-0.725	Mod/High	-0.559	Mod	22
5	3142	-0.571	Mod	-0.559	Mod	19
5	3143	-0.867	High	-0.559	Mod	14
5	3144	-0.822	High	-0.559	Mod	13
5	3145	-0.675	Mod/High	-0.559	Mod	16
5	3146	-0.733	Mod/High	-0.559	Mod	17
5	3147	-0.650	Mod/High	-0.559	Mod	18
5	3148	-0.600	Mod	-0.559	Mod	13
5	3149	-0.622	Mod/High	-0.559	Mod	18
5	3150	-0.475	Mod	-0.559	Mod	21
5	3151	-0.622	Mod/High	-0.559	Mod	20
5	3152	-0.400	Low/Mod	-0.559	Mod	16
5	3153	-0.400	Low/Mod	-0.559	Mod	20
5	3154	-0.644	Mod/High	-0.559	Mod	20
5	3155	-0.644	Mod/High	-0.559	Mod	20
6	3105	-0.150	Low	-0.295	Low/Mod	14
6	3106	-0.400	Low/Mod	-0.295	Low/Mod	10
6	3107	-0.222	Low/Mod	-0.295	Low/Mod	18
6	3108	-0.333	Low/Mod	-0.295	Low/Mod	16
6	3109	-0.422	Mod	-0.295	Low/Mod	14
6	3110	-0.675	Mod/High	-0.295	Low/Mod	16
6	3111	-0.325	Low/Mod	-0.295	Low/Mod	14
6	3112	0.000	No	-0.295	Low/Mod	19
6	3113	0.000	No	-0.295	Low/Mod	22
6	3114	-0.089	Low	-0.295	Low/Mod	27
6	3115	-0.300	Low/Mod	-0.295	Low/Mod	20
6	3116	-0.375	Low/Mod	-0.295	Low/Mod	17
6	3117	-0.475	Mod	-0.295	Low/Mod	17
6	3118	-0.425	Mod	-0.295	Low/Mod	16
6	3119	-0.475	Mod	-0.295	Low/Mod	17
6	3120	-0.050	Low	-0.295	Low/Mod	24
7	3080	-0.600	Mod	-0.468	Mod	15
7	3081	-0.475	Mod	-0.468	Mod	16
7	3082	-0.350	Low/Mod	-0.468	Mod	15
7	3083	-0.650	Mod/High	-0.468	Mod	21
7	3084	-0.600	Mod	-0.468	Mod	17
7	3085	-0.525	Mod	-0.468	Mod	18
7	3086	-0.450	Mod	-0.468	Mod	15
7	3087	-0.300	Low/Mod	-0.468	Mod	14
7	3088	-0.700	Mod/High	-0.468	Mod	12
7	3089	-0.675	Mod/High	-0.468	Mod	14

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
7	3090	-0.375	Low/Mod	-0.468	Mod	16
7	3091	-0.050	Low	-0.468	Mod	18
7	3092	-0.050	Low	-0.468	Mod	16
7	3093	-0.700	Mod/High	-0.468	Mod	18
7	3094	-0.650	Mod/High	-0.468	Mod	14
7	3095	-0.425	Mod	-0.468	Mod	14
7	3096	-0.625	Mod/High	-0.468	Mod	14
7	3097	-0.600	Mod	-0.468	Mod	20
7	3098	-0.511	Mod	-0.468	Mod	18
7	3099	-0.450	Mod	-0.468	Mod	16
7	3100	-0.550	Mod	-0.468	Mod	14
7	3101	-0.375	Low/Mod	-0.468	Mod	16
7	3102	-0.350	Low/Mod	-0.468	Mod	14
7	3103	-0.400	Low/Mod	-0.468	Mod	14
7	3104	-0.200	Low	-0.468	Mod	14
7	3540	-0.778	Mod/High	-0.468	Mod	14
7	6000	-0.325	Low/Mod	-0.468	Mod	21
7	6001	-0.375	Low/Mod	-0.468	Mod	22
8	3502	-0.667	Mod/High	-0.466	Mod	24
8	3503	-0.289	Low/Mod	-0.466	Mod	24
8	3504	-0.489	Mod	-0.466	Mod	22
8	3505	-0.725	Mod/High	-0.466	Mod	20
8	3506	-0.467	Mod	-0.466	Mod	24
8	3507	-0.150	Low	-0.466	Mod	26
8	3508	-0.200	Low	-0.466	Mod	24
8	3509	-0.150	Low	-0.466	Mod	16
8	3510	-0.100	Low	-0.466	Mod	24
8	3511	-0.533	Mod	-0.466	Mod	30
8	3512	-0.550	Mod	-0.466	Mod	24
8	3513	-0.325	Low/Mod	-0.466	Mod	18
8	3514	-0.375	Low/Mod	-0.466	Mod	20
8	3515	-0.400	Low/Mod	-0.466	Mod	22
8	3516	-0.422	Mod	-0.466	Mod	24
8	3517	-0.667	Mod/High	-0.466	Mod	18
8	3518	-0.700	Mod/High	-0.466	Mod	15
8	3519	-0.575	Mod	-0.466	Mod	16
8	3520	-0.600	Mod	-0.466	Mod	13
8	3521	-0.300	Low/Mod	-0.466	Mod	20
8	3522	-0.675	Mod/High	-0.466	Mod	21
8	3523	-0.429	Mod	-0.466	Mod	18
8	3524	-0.425	Mod	-0.466	Mod	19
8	3525	-0.733	Mod/High	-0.466	Mod	16
8	3526	-0.222	Low/Mod	-0.466	Mod	24
8	3527	-0.289	Low/Mod	-0.466	Mod	22
8	3528	-0.111	Low	-0.466	Mod	22
8	3529	-0.300	Low/Mod	-0.466	Mod	16

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
8	3530	-0.689	Mod/High	-0.466	Mod	18
8	3531	-0.667	Mod/High	-0.466	Mod	16
8	3532	-0.475	Mod	-0.466	Mod	16
8	3533	-0.750	Mod/High	-0.466	Mod	18
8	3534	-0.575	Mod	-0.466	Mod	18
8	3535	-0.575	Mod	-0.466	Mod	18
8	3536	-0.300	Low/Mod	-0.466	Mod	18
8	3537	-0.500	Mod	-0.466	Mod	16
8	3538	-0.625	Mod/High	-0.466	Mod	14
8	3539	-0.667	Mod/High	-0.466	Mod	14
9	3492	-0.525	Mod	-0.486	Mod	22
9	3493	-0.425	Mod	-0.486	Mod	23
9	3494	-0.125	Low	-0.486	Mod	26
9	3495	-0.622	Mod/High	-0.486	Mod	33
9	3496	-0.556	Mod	-0.486	Mod	30
9	3497	-0.200	Low	-0.486	Mod	21
9	3498	-0.711	Mod/High	-0.486	Mod	20
9	3499	-0.600	Mod	-0.486	Mod	20
9	3500	-0.514	Mod	-0.486	Mod	22
9	3501	-0.578	Mod	-0.486	Mod	20

Refining Management Actions

A further analysis may be needed to refine the best management action for each site (i.e., reach or a portion of a reach where a management decision is required). Eight criteria guide the development of management actions. The first four are based on landscape ecology and conservation biology principles, and indicate the *existing environmental quality of the site*. The latter four are based on restoration ecology and reflect the *potential environmental quality of the* site following implementation of a management action strategy. The primary emphasis in these latter criteria is on potential for controlling factors to be reestablished or enhanced at the site to eventually result in a structurally and functionally enhanced and sustainable ecosystem. These criteria can help in development of a site design plan.

1. *Size* – Size refers to reach length and the size of the potential management action within a site. In general, larger size enhances habitat stability, increases the number of species that can potentially use the site, is easier to identify by migratory species, and increases within-habitat complexity. On Bainbridge Island, specific sites located with a single reach would be considered small because they potentially contain only a subset of the habitats naturally occurring over a larger area. A site that covers most or all of a reach would be considered large, since it contains all habitats that naturally occur within the reach. A site that covers more than one reach would be considered very large, because it covers areas where two or more suites of habitat types are naturally found, and the animals using them benefit from being adjacent to one another.

2. *Complexity* – This criterion refers to the numbers of different types of habitats within a reach. As the number of habitat types increases, so does the number of different species that can

occupy an area, and the number of functions supported by the area. Higher complexity results in greater biodiversity. For Bainbridge Island, sites and reaches that have more natural habitats will generally have more associated species. Adjacent reaches that differ in their habitat types would cumulatively contain greater complexity.

3. *Accessibility* – Accessibility refers to unencumbered access by nearshore-dependent aquatic, avian, and terrestrial species. Projects that would allow or enhance access of these species to important nearshore habitats would potentially enhance the feeding, rearing, and refuge functions of the site. For example, opening a system to fish access appears to have resulted in utilization of the system by fish.

4. *Connectance* – This criterion refers to the degree of natural connection and pathways between adjacent habitats or migratory corridors. Connectance means that an animal can move between adjacent habitats to derive the benefits of each habitat. It also refers to the flow of material such as organic matter between areas of production (e.g., a salt marsh) and areas of deposition (e.g., tidal channels and creek bottom) where the materials are utilized by the ecosystem. On Bainbridge Island, connectance can be interrupted by overwater structures, armoring, boat activity, and other features.

5. *Potential to conform to natural habitat structure, processes, and functions* – This criterion expresses the relative probability that a site can return some or all of the natural habitat structure, function and processes found on the site historically. As mentioned above, the level of impact to the site (reach) and landscape (management area) is important.

6. *Potential for self-maintenance* – Self-maintenance addresses the desire for a site to be able to persist and evolve toward a natural (historical) habitat condition without significant human intervention. As a pre-requisite for this to occur, conditions for controlling factors in the reach and in the management area must be appropriately developed and maintained. Self-maintenance means that the habitat can persist and develop under natural climatic variation, and that the system has a natural degree of resilience to natural perturbations. This criterion also takes into account the need to know the probable historical conditions, and the factors that produced the present conditions.

7. *Potential benefit to nearshore-dependent threatened and endangered species* – This criterion is specifically directed at those species whose populations are at precariously low numbers, and who might benefit from improved nearshore habitat conditions. At present, wild Chinook salmon would be one of the major species driving the decision process.

8. *Potential to substantially improve ecosystem functions* – This criterion acknowledges that some actions can result in greater enhancement of ecosystem functions than others, and that these projects may not be the largest or most complex systems. For example, the location may be more important than the size of a project. A medium-sized project done in a location where an endangered species can directly benefit because of the proximity to its normal migratory pathway would be more important than a project done far outside of the pathway.

The eight criteria are for the most part, qualitative. They can be applied directly to evaluate the benefit of management action alternatives for a particular site. A simple application of these criteria would be a checklist. For example, with the exception of size (which can be stated as aerial extent of habitat types within a reach or site), each of the remaining seven criteria can simply be assessed as being present or absent, with a qualifying statement as to degree. This evaluation can be done with existing data as well as with a site visit. In cases where aspects (e.g., the number of habitat types) may be uncertain, new data may be required.

Criteria 5 and 6 can be assessed relative to the level or degree of disturbance on the management area scale. An appropriate question would be, "Are the natural habitat forming processes healthy enough to allow for the development and maintenance of natural habitat structure and functions, and will the site be maintained through time?" Multi-criteria methods available but still untested in Puget Sound could also be used for specific habitat recommendations addressing Criteria 5 and 6. The method developed by Short et al. (2002) provides an excellent example of a multi-criteria protocol to assess the potential for a site to support eelgrass.

To address Criterion 7 relative to salmon, the criteria of Simenstad and Cordell (2000) can be applied (Table E-1). Will the management action potentially provide enhanced capacity, opportunity, and realized function in support of juvenile salmon? In the example cited in Table E-1, armoring of a shoreline can affect all three of these criteria, and removal of armoring may result in improvement to one or more of the criteria. Criterion 8 can be evaluated by examining the present reach ecological function (Table E-2), and whether this ecological function can be enhanced. In some cases, the ecological function is high for reaches with a moderate controlling factor score, and improvement in ecological function may not be expected even with improved conditions in the reach controlling factors. Specific elements contributing to the summed controlling factor level for a site need to be examined to make this assessment. For example, planting riparian vegetation may improve a reach controlling factor score, and also substantially improve the ecological function.

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Appendix F

Monitoring Recommendations and Approach

The Bainbridge Island Monitoring Program

Background

While assessment is the quantitative evaluation of selected ecosystem attributes, monitoring can be defined as the systematic repetition of the assessment process. That is, monitoring is the systematic and objective measurement of the same attributes on a regular schedule over time (Callaway et al. 2001). Monitoring can serve two primary roles: evaluation of the quality of existing conditions of an area (e.g., site, reach, management area), and assessment of the development of an area following implementation of a management action (e.g., permit approval for shoreline development; habitat restoration, creation, or protection). In the latter case, the monitoring shows whether or not the management action has any effect on the quality of the area. In either role, monitoring provides valuable and sometime critical information for making accurate and cost-effective management decisions. Without objective quantitative information, decisions are driven by guesswork, which may lead to further degradation of an area and inefficient use of funds, resources, and effort.

In nearshore ecosystems, monitoring provides the basis for understanding existing conditions, and can be integral to determining the extent of improvement or degradation of a particular site, reach, or management area. For example, in evaluating the appropriateness of a particular site for restoring eelgrass, it would be useful to monitor light, temperature and sediment quality metrics to indicate conditions that are appropriate relative to eelgrass growth requirements. In addition, monitoring is critical to documenting the functioning of an ecosystem following implementation of management actions. It is at the heart of adaptive management by providing feedback required to determine progress and forming the basis for making mid-course corrections (Thom 1997).

For the purposes of this document, we use definitions that are consistent with Simenstad et al. (1991) and Williams et al. (2003). The nearshore ecosystem is defined as the area encompassing the marine riparian zone, across the beach, to the lower limit of the photic zone (water layer that is penetrated by sufficient sunlight for photosynthesis) (Williams et al. 2003). An “attribute” describes a distinct component or characteristic of the ecosystem or habitat, e.g., sediment, rooted vascular plants, or motile fishes. A “parameter”, frequently called a metric, is a specific variable that can be measured to describe an attribute or adequately assess its status, e.g. grain size, percent cover, or survival.

Monitoring involves sampling attribute parameters that are direct or indirect indicators of the health or quality of the environment. Environmental or physical monitoring parameters that relate to “controlling factors”, under the nearshore conceptual framework of Williams and Thom (2001), include water properties (e.g., temperature, dissolved oxygen [DO] levels), turbidity, toxic contaminants, light levels, sediment composition, depth, and inorganic nutrient concentrations. Habitat structure is often monitored in aquatic ecosystems by quantifying parameters such as substrate type, vegetation type and cover, shoot density and length, biomass, and plant species composition. Ecological function parameters include animal (i.e., invertebrate, fish, bird, mammal) species composition, density, standing stock, population structure, diet, reproductive state, growth rate, and activity patterns.

Issues to Consider

In any monitoring program, a number of issues must be carefully considered before data are collected, including monitoring goals, scale (effort in time and space), timing, sampling design and replication, reference site designation, attribute selection, sampling methods, and costs. Although it is beyond the scope of this chapter to provide a thorough exploration of each of these issues, we provide a brief overview and refer to several technical guidance documents (Simenstad et al. 1991, Fonseca et al. 1998, Callaway et al. 2001, Thayer et al. 2003) that may be consulted for more detail. We consider these issues relative to both long-term ecosystem monitoring and more specific site assessment goals.

Goal formulation plays a critical role in the restoration and assessment planning process, involving development of a vision that leads to specific performance criteria or objectives (Thom and Wellman 1997, Thom 1997). As such, goal formulation dictates the level of monitoring required for any project by defining major attributes of the system, as well as the parameters of interest. A common goal associated with long-term ambient monitoring programs is often to detect broad changes in ecosystem health and function, whereas site specific monitoring often seeks to measure improvement in particular ecosystem attributes relative to a particular management action.

The essence of monitoring should be consistency, although at the same time, monitoring procedures must be able to evolve, using knowledge gained to determine whether sampling can be streamlined, increased, or additional attributes considered (Callaway et al. 2001). Monitoring should be conducted at a frequency and duration most appropriate for the study, depending on the parameter being measured and the question being asked (NRC 1990, Kentula et al. 1992). For long-term ambient monitoring programs, the duration is assumed to be infinite whereas the frequency is driven by the characteristics of key ecosystem parameters. Site specific monitoring should generally be conducted most intensely immediately following a management action, with measurements becoming less frequent as habitats mature. Five years should be considered a minimum for monitoring projects with physical goals such as the restoration of tidal hydrology, with a longer monitoring time period recommended for any project including goals for ecological function (Thayer et al. 2003).

An adequate sampling design always incorporates three principal components of scientific quality: *repeatability* in terms of the potential to be exactly repeated, *reliability* as the quality to sustain scientific confidence, and *validity* because it is based on precedence and evidence (National Academy of Sciences 1989). The Estuarine Habitat Assessment Protocol (EHAP; Simenstad et al. 1991) describes and recommends techniques that meet these standards for quantitatively measuring attributes of estuarine habitats that characterize the potential ecological function of that habitat for fish and wildlife. All of these methods are recognized and accepted by the scientific community as appropriate for nearshore habitats in Puget Sound. The EHAP also provides a review of habitat descriptions, sampling theory, sampling strategies, sample replication, and statistical structure issues, as well as recommendations for sample preservation, processing and reporting. Callaway et al. (2001) provides a similarly useful overview of assessment and monitoring procedures appropriate for tidal wetlands.

Placement and timing of samples should be tailored to spatial and temporal variability of the parameter of interest, including species' phenology (periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions) and population dynamics (Callaway et al. 2001). As an example, vegetation mapping and cover assessment are often conducted annually during the season of peak biomass (generally summer). In contrast, parameters that may change temporally (over time) or in response to major events (e.g., storms) should be evaluated with these issues in mind. For instance, efforts to monitor the rate and direction of nearshore sediment transport must take into account the seasonal influence of winds, waves, and currents as well as periodic events like landslides.

A broad goal applicable to monitoring programs is to compare existing conditions to pristine or historical conditions in order to gauge impairment and assess change. Wherever possible, background information should be gained from historical data or existing local sites to describe ecosystem structure and function (Zedler 2001). Long-term ambient monitoring programs that seek to detect changes in ecosystem health often seek to establish a contemporary baseline condition, especially in the absence of good historical data. This baseline becomes a point from which assessments of future conditions may be determined. With site-specific monitoring projects, initial baseline conditions at the project site and a reference site should be measured before management actions occur. It is of paramount importance that reference sites be selected with similar habitat, geomorphology, and landscape features (Callaway et al. 2001).

Thereafter, monitoring is conducted simultaneously at the project site and reference site(s) to evaluate progress toward reaching goals.

Under optimal conditions, a monitoring program would assess all attributes relevant to the habitat of concern. However, funding and the availability of qualified personnel often limit the number of measurements that can be taken and the number of samples that can be processed. Most monitoring programs seek to balance monitoring goals with these constraints by limiting the range of attributes that are monitored. Simenstad et al. (1991) provide a hierarchical organization of parameter attributes that should guide the decision process. Callaway et al. (2001) also include a list of minimal requirements and priorities for site monitoring.

Existing Monitoring Programs and Protocols

Ongoing aquatic monitoring programs in the region include the Puget Sound Ambient Monitoring Program (PSAMP), which brings together local, state, and federal agencies to monitor trends in environmental quality of the Puget Sound ecosystem. Through this program, data on marine and fresh waters, fish, sediments, and shellfish have been collected since 1989, surveys of nearshore habitat (e.g., eelgrass abundance) have been conducted since 1991, and marine bird populations have been surveyed since 1992. For example, the Washington Department of Natural Resources maps aquatic vegetation and physical shoreline conditions (Washington State ShoreZone Inventory), and established a program in 2000 to monitor long-term changes in eelgrass abundance and distribution in Puget Sound. PSAMP findings are coordinated by the Puget Sound Action Team and disseminated through a variety of articles, presentations, and reports, including an annual update on the condition of Puget Sound (Puget Sound Water Quality Action Team 2002).

It should also be noted that monitoring of nearshore "health" and research linking nearshore processes to ecological functions will intensify as the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) begins to develop, select, and evaluate actions that will help protect and restore the Puget Sound nearshore ecosystem. PSNERP is a cooperative effort among U.S. Army Corps of Engineers (Corps) and local sponsors that include state and other federal government organizations, tribes, industries and environmental organizations. The Washington Department of Fish and Wildlife represents the local sponsors of the project.

PSAMP utilizes a variety of standardized protocols for monitoring the general conditions of Puget Sound, although the broad spatial scale of the PSAMP sampling effort may not adequately characterize regional or local conditions. For example, sites where monitoring occurs may not be located in areas of interest, or sites may be so few or so infrequently sampled as to provide only very limited information about the area of interest to local communities. In order to comprehensively assess nearshore conditions within a locality such as Bainbridge Island, a region-specific monitoring program is required. Such a program may involve expanding the scale of PSAMP monitoring in the region of interest through agency partnerships, and may involve local and PSNERP sponsorship. As well, it would involve supplemental sampling of habitats and ecological function using appropriate regional protocols (Simenstad et al. 1991) while integrating ongoing local monitoring and assessment activities, such as the City of Bainbridge Island Nearshore Structure Inventory (Best 2003).

Bainbridge Island Monitoring Recommendations

Monitoring efforts should serve the two primary goals outlined at the beginning of this document: evaluation of existing conditions, and assessment following implementation of a management action. Management actions recently highlighted by PSAMP as central to restoring Puget Sound nearshore processes focus on shoreline armoring, sediment processes, and aquatic vegetation. These actions include: 1. providing marshes, mudflats, and beaches with essential sand and gravel materials; 2.

removing, moving and modifying artificial structures (bulkheads, rip rap, dikes, tide gates, etc.); 3. using alternative measures to protect shorelines from erosion and flooding; and; 4. restoring estuaries and nearshore habitat such as eelgrass beds and kelp beds.

Monitoring of Bainbridge Island's nearshore ecosystem should also build upon the findings, recommendations, and data gaps established in this report and previous studies. The summary of the Best Available Science (BAS) (Williams et al. 2003) outlines the ecological functions of the Bainbridge Island nearshore environment and provides a conceptual framework for understanding the linkages between human actions, physical processes (controlling factors), habitats, and biological components of the nearshore. The BAS also highlights specific impacts to Bainbridge Island nearshore and estuarine habitats due to various types of human shoreline modifications. The nearshore characterization and assessment (the main body of this document) uses the conceptual model to consistently quantify the most highly impacted and least impaired shorelines of Bainbridge Island with an approach that can be scaled to various landscape scales. Finally, the protocol for prioritizing management decisions (Appendix 1 of this document) provides specific guidelines for prioritizing restoration or conservation strategies on particular shorelines based on assessment results. Therefore, we recommend monitoring the following key attributes that encompass each level of the conceptual framework. In this way, monitoring will link processes to the nearshore habitat structure, integrate a multitude of nearshore habitats that support a variety of functions, establish relationships between structure and function, and ultimately can scale local processes to the broader Puget Sound ecosystem.

Controlling Factors

Water quality – Nearshore water quality affects the health of fish and invertebrates, as well as human health and recreation. Standard measures of water quality include water temperature, dissolved oxygen, nutrients (organic and inorganic nitrogen), water clarity/turbidity, and indicators of potential contamination, such as fecal coliforms. In order to establish and monitor baseline conditions, permanent stations representative of "typical" habitats or geomorphic settings (e.g., lagoons) should be established and sampled biweekly to monthly at the water surface and bottom to measure seasonal and annual patterns. Water bodies recognized to have impaired hydrology (i.e., with tide gates, culverts), altered circulation, or poor water quality should be identified and subjected to more intensive (e.g., hourly) water quality sampling with automatic dataloggers and sensors, especially during extreme events.

Sediment processes – Sediment processes are the foundation of nearshore habitat formation and variability. Monitoring of sediment supply potential, transport, and connectivity therefore are critical to the long-term evaluation of habitat structure and function, as well for planning and assessing management actions. For both long-term and site-specific project monitoring, sediment supply analysis should be undertaken to establish current baseline conditions, understand seasonal trends, verify potential problem areas, and model effects of extreme storm events. General guidance on recommended protocols for monitoring sediment processes in coastal and estuarine habitats can be obtained in Komar (1998) and Cahoon, et al (1999).

Shoreline Modifications – The type, extent, and relative impact of human modifications to the shoreline can have a range of effects to nearshore processes and functions (Williams and Thom 2001). Quantification of parameters (e.g., armoring extent, encroachment into intertidal zone) associated with this attribute provides a relative measure of human impacts over time, and can be especially useful when conducted in tandem with other environmental monitoring activities. Quantitative, geo-referenced ground surveys should be completed at multi-year intervals (e.g., every 5 years).

Habitat Structure

Land use-land cover – Land cover assessment is typically conducted using remotely sensed data (e.g., aerial imagery, satellite images, aerial photographs) and quantifies distribution of the distribution of primary habitats and how watersheds and shoreline habitats are altered by human activities and development. Land use and land cover changes are often tightly linked to changes in loadings of nutrients, sediments, and contaminants to streams and rivers that eventually end up in the shallow nearshore waters. Standard aerial photography is a useful tool for visually identifying broad changes in land cover over time, and annual records often are available from state or federal agency archives (e.g. Washington State Department of Transportation). Other remote sensing techniques, such as digital aerial photography, provides a georeferenced measure of ground reflectance to detect the extent and location of habitats, their patch characteristics, or vegetation structure and condition (standard protocols described in Dobson et al. 1995, Phinn and Stow in Zedler 1996, Finkbeiner 2001). This information should be collected during peak summer growth (greenness) at multi-year (1-10 year) intervals, with concomitant data classification, ground-truthing, and analysis. Land use assessment often focuses on total impervious area (TIA), a commonly used metric that reflects land use practices and watershed condition (May and Peterson 2003).

Nearshore riparian cover – Nearshore riparian habitats describe the upland vegetation bordering, and often overhanging, marine aquatic environments. Although understood as an extremely important ecological component in freshwater systems (i.e., forested watersheds), the functions of marine riparian cover have only recently been recognized, and are believed to represent an important factor in shading baitfish spawning areas, organic matter and prey production to nearshore aquatic habitats, and habitat for birds, reptiles, and mammals. This is also the area where development is often heaviest. Nearshore riparian cover can be assessed using remote sensing, in combination with ground-truthing, at multi-year intervals (see recommended methods in land use-land cover section). Large woody debris recruitment may also be a useful cover class to quantify using these remote sensing techniques in combination with groundtruthing.

Shallow water aquatic habitats – Vegetated habitats like tidal marshes, eelgrass, and kelp beds have been greatly impacted by humans over the past 150 years, and these structurally complex habitats are critical for the functions of many aquatic and fisheries resources, and well as for improving water quality. The distribution and health of these vegetated habitats should be monitored every 1-3 years to document changes. Monitoring of subtidal resources such as eelgrass should be stratified by habitat ("flats" and "fringing beds") using underwater video and diver methods established by WDNR and WDFW, with sampling effort appropriately scaled to determine local trends (Berry et al. 2003). Remote sensing techniques can also be used to monitor kelp beds, intertidal eelgrass, and tidal saltmarshes at multi-year intervals (see land-cover section). Comprehensive nearshore mapping of both subtidal and intertidal resources have been developed using a combination of aerial imagery and underwater video techniques described above (Woodruff et al. 2002). Side-scan sonar technology also offers some opportunities for efficiently mapping submerged habitats. Water properties, including temperature, salinity, dissolved oxygen, light attenuation, and nutrients should be monitored coincident with vegetated habitat sampling (see water quality section).

Ecological Functions

Fish Assemblages – Fishes (i.e., forage fish, juvenile salmon, flatfish) are highly mobile animals that use nearshore habitats over a variety of scales for refuge, reproduction, feeding, and other functions. In turn, they serve as vehicles for nutrient cycling and energy transfer across habitats at a number of levels in the food web. Habitat quality may be reflected by community structure, including species richness, diversity of feeding types and life histories, specific abundance and biomass, and tissue health. Long term records can also provide information on the relative impact of invasive species, long-term climate change or cyclic phenomena (e.g. El Nino Southern Oscillation), harvest, trends related to freshwater inputs or water quality impairment, and nursery habitat value. Monitoring that would be useful at the local level includes annual assessment and verification of forage fish spawning areas using methods established by WDFW (2003). To derive an understanding of juvenile salmon distribution and abundance around Bainbridge Island, beach seine collections may be done following methods outlined by WDFW and Simenstad et al. (1991). Survey timing should coincide with species' peak outmigration, with frequency guided by project requirements and limitations; annual monitoring would be preferred to derive a long-term understanding of trends. Water properties, including temperature, salinity, and dissolved oxygen should be monitored coincident with fish community sampling.

Exotic Species – Exotic, or non-native, plant and animal species have been recognized as an increasing threat to global ecosystems, where they have altered basic ecosystem processes, habitat structure, and food webs. Exotics are more likely to become successfully established in aquatic ecosystems modified by humans. Monitoring facilitates the early detection of new invasions within a window of opportunity that eradication may be successful. Rapid assessment surveys of exotic species should be conducted at multi-year intervals following the methods of Cohen et al. (2001), with more intensive surveys conducted on a site-specific basis.

To summarize, our monitoring recommendations cover a range of key attributes that may be realistically collected at a local level to fill existing data gaps. Monitoring of toxic contaminants in sediment, water or biota is beyond the scope of this document. Regulation and/or cleanup of contaminants is addressed under both state and federal regulations, including Section 303(d) of the Clean Water Act and the Washington State Model Toxics Control Act (MTCA). It should not be assumed, however, that the existence of these federal and state regulations provide sufficient protection to sensitive species in all nearshore areas, since unregulated point and non-point source pollution continues to occur in Puget Sound. Further, the cumulative, sublethal effects of multiple contaminants or environmental stressors associated with nearshore communities are not clearly understood, and are not addressed in current environmental regulations. However, contaminant concentrations in tissues of some fishes (e.g., English sole) collected under the Bainbridge Island fish sampling effort could be evaluated on a site-specific basis in cooperation with PSAMP and WDFW. As well, we selected fish assemblages rather than subtidal macroinvertebrates as a measure of nearshore ecological function because of the cost-prohibitive sample processing time and expertise associated with identification of some invertebrate taxa, as well as the inherent value of having some discrete measure of salmon habitat use for Bainbridge Island. In the absence of funding constraints, another useful indicator of nearshore ecological function would be animal (bird, mammal, reptile, and amphibian) use of riparian habitats.

As previously discussed, a region-specific monitoring program would be required to comprehensively assess nearshore conditions of Bainbridge Island and inform an effective adaptive-management program. We assume this monitoring would serve two goals at different scales: 1. evaluate existing conditions for Bainbridge Island as a whole (comparable to annual Puget Sound Reports under PSAMP) to guide management decisions, and 2. assess site conditions following implementation of a particular management action to gauge its effectiveness. Given the current level of uncertainty typical at the planning stage, we provide summary guidance that can form the basis for a range of nearshore monitoring efforts on Bainbridge Island. Most of these recommendations address how Bainbridge Island can opportunistically fulfill a range of monitoring goals using rigorous methods under the limited resources (both funding and personnel) available at a local level.

Selectively monitor key nearshore parameters. Previous documents have summarized the critical linkages in Bainbridge Island nearshore ecosystems (Williams et al. 2003) and developed a conceptual framework for understanding these interactions (Williams and Thom 2001). We recommend focusing monitoring efforts on key parameters listed in the previous section that integrate the health of nearshore habitats. For example, eelgrass is used as an indicator of estuary health because it responds to many natural and human caused environmental variables. Changes in abundance or distribution of this resource are likely to reflect changes in environmental conditions, while likely affecting many other eelgrass-dependent species.

Focus monitoring efforts on ongoing local monitoring and assessment activities. The Bainbridge Island monitoring program should focus on sustaining established monitoring inventories, such as the City of Bainbridge Island Nearshore Structure Inventory (Best 2003). This project provides exceptionally detailed, georeferenced information on the number and extent of human modifications to the shoreline, and serves as a 2001 baseline that can be revisited to assess future change. As well, Bainbridge Island should seek to incorporate elements of other Puget Sound-wide monitoring programs, such as PSAMP, at a sampling effort appropriately scaled to determine local trends. For example, marine water sampling stations near Bainbridge Island could be selected and monitored in collaboration with the Washington State Department of Ecology. Similar monitoring surveys could be developed to better determine local trends in eelgrass habitat and the current extent of forage fish spawning areas, in collaboration with the Washington State Departments of Natural Resources and Fish and Wildlife, respectively. Site selection should prioritize the use of historically monitored sites wherever possible.

Use consistent and standardized protocols. Consistent and standardized protocols allow comparison of local data with other regional efforts, thereby allowing for scaled analysis of region-wide trends and increasing the relative value of the information collected. Sampling protocols of most ongoing programs (e.g., PSAMP) are well-documented, freely available (http://www.psat.wa.gov/Programs/Monitor.htm), and provide specific contact information. Other regionally appropriate protocols (e.g., Simenstad et al. 1991) should be used in the absence of ongoing efforts.

Forge partnerships and involve other stakeholders – Partnerships with agencies and other stakeholders in existing monitoring programs, such as PSAMP, are likely the best way for Bainbridge Island to develop a successful monitoring program. Not only would this lend consistent methods and appropriate technical knowledge to the local monitoring effort, but it takes advantage of existing resources and may lead to broader sponsorship by groups such as PSNERP. Besides the consortium of agency personnel involved in PSAMP, other stakeholder groups that may be interested in partnering include local Tribes, Kitsap County, local health districts and conservation districts, the Corps of Engineers, and the US Environmental Protection Agency. Organizations such as People for Puget Sound may also be enlisted to recruit volunteers with unique local knowledge and abilities to assist in monitoring efforts.

Leverage opportunities with existing resources unique to Bainbridge Island. The City of Bainbridge Island is uniquely situated to leverage its existing resources into additional opportunities for nearshore monitoring and research. A number of good relationships have already been established with regional stakeholders and the scientific community. Furthermore, the City of Bainbridge Island has developed a unique baseline inventory of nearshore structures (Best 2003), and has been exceptionally proactive in acquiring the knowledge for managing the local nearshore ecosystem (Williams et al. 2003, this document). These efforts put Bainbridge Island at a regional advantage for acquiring additional funding for nearshore monitoring, restoration, and research. For example, PSNERP will likely prioritize restoration and research efforts for sites with a well-established management framework for employing these actions. Furthermore, Bainbridge Island's quantitative inventory of nearshore structures, combined with this assessment document, provides excellent background justification for future funding proposals that seek to fill data gaps, such as linking and scaling land-use patterns to nearshore ecological functions. We recommend further attempts to involve researchers and graduate students from local universities in these efforts.

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