Tidal Wetland Prioritization for the Siuslaw River Estuary

Duncan Inlet, Siuslaw River Estuary, July 2004. Photo by L. Brophy.

November 2005

Prepared for:
Siuslaw Watershed Council
Mapleton, Oregon

Prepared by:
Laura Brophy
Green Point Consulting
Corvallis, Oregon

This project was funded by the Oregon Department of Environmental Quality's Non-Point Source Pollution 319 Grant Program.

Green Point Consulting

Corvallis, Oregon
Phone: (541) 752-7671 Fax: (541) 738-0604
E-mail: Laura@GreenPointConsulting.com

Tidal Wetland Prioritization for the Siuslaw River estuary

Please cite this document as follows: Brophy, L.S. (Green Point Consulting). 2005. Tidal Wetland Prioritization for the Siuslaw River Estuary. Prepared for Siuslaw Watershed Council, Mapleton, Oregon. Available from Green Point Consulting, (541) 752-7671, www.GreenPointConsulting.com.

Acknowledgements

I greatly appreciate the interest and participation of the Siuslaw Watershed Council, its staff members, directors, and technical team in this project. Khemarith So of the U.S. Fish and Wildlife Service's Oregon Coastal Program provided valuable assistance in both GIS and field work in the early stages of the project. Justin Mills, Oakridge Institutes for Science and Education fellow at the Northwest Fisheries Science Center, provided valuable GIS assistance. Lori Robertson of the Siuslaw Soil and Water Conservation District, Johan Hogervorst of the Siuslaw National Forest Mapleton District, Tom Kartrude of the Port of Siuslaw, John Spangler of Oregon Department of Fish and Wildlife, Jeff Jones, and Jeff Jackson provided very helpful field orientation, project feedback, and information about the estuary. The U.S. Bureau of Land Management and U.S. Army Corps of Engineers loaned aerial photographs for site characterization. Many others, including landowners, local residents, and resource professionals, provided input into this project, improving the accuracy and usefulness of the results. I thank you all for your dedication and involvement.

Abbreviations

ACOE	U.S. Army Corps of Engineers
BLM	Bureau of Land Management
CRMP	Coastal Resource Management Plan
DLCD	Department of Land Conservation and Development
DMD	Dredged material disposal
DSL	Department of State Lands
EPB	Estuary Plan Book
GIS	Geographic Information Systems
GPC	Green Point Consulting
HGM	Hydrogeomorphic (as in, the HGM method for wetland functional assessment)
LCOG	Lane Council of Governments
NOAA	National Oceanographic and Atmospheric Administration
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
ODA	Oregon Department of Agriculture
ODOT	Oregon Department of Transportation
ONHP	Oregon Natural Heritage Program
OWEB	Oregon Watershed Enhancement Board
SRT	Self-regulating tidegate
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Table of Contents

(This page intentionally left blank)

Introduction

Project goals and approach

Throughout the Pacific Northwest, there is increasing recognition of estuarine contributions to watershed and marine processes. This recognition has generated new interest in tidal wetland conservation and restoration. In Oregon, overall losses of tidal wetlands since the 1850's are estimated at 70% (Christy 2004, Good 2000, Boule and Bierly 1987, Thomas 1983), supporting the need for restoration. Conservation of the small remaining percentage of tidal wetlands is equally important. However, because each estuary offers a wide variety of restoration and conservation opportunities, strategic planning is needed.

This prioritization is designed to provide strategic focus for tidal wetland conservation and restoration actions undertaken in partnership with willing landowners. The study highlights locations in the Siuslaw River estuary where tidal wetland restoration or conservation action may offer the biggest ecological "bang for the buck" **–** that is, those locations that may offer the highest potential to protect or increase estuary functions. The information provided by this study provides a basis for working with interested landowners to develop site-specific action plans.

This study's products are meant for active use. The shapefiles, spreadsheets and maps can be used to organize information about tidal wetlands and estuary conservation activities. The estuary is a dynamic place, so Green Point Consulting (GPC) recommends regular updating of site-specific data, as well as verification of the details in this report before site-specific action planning.

This prioritization uses ecological factors to rank sites for both conservation and restoration actions. Criteria for prioritization included size of site, tidal channel condition, connectivity to other wetlands, salmonid diversity, historic vegetation type, and diversity of current vegetation types. Information on these characteristics was obtained from publicly available data, field reconnaissance (generally offsite observation), and aerial photograph interpretation. Number of landowners, ownership type, land use zoning, and comprehensive land use planning designations are additional factors addressed in this report that can be important in restoration planning.

This study has no regulatory intent or significance; it is intended only to foster conservation and restoration by interested and willing landowners. This project did not delineate wetlands; existing maps were used for site boundaries. This prioritization is not intended to be an assessment of site functions. Assessment of tidal wetland functions is a complex and technical field (Simenstad and others 1991, Adamus 2005a, b, c) and not within the scope of this analysis. However, the criteria used for prioritization were selected because they strongly influence tidal wetland functions.

This study strives for transparent methods and usability. The data sources, data manipulations, scoring methods, and results are thoroughly documented and all analyses are repeatable. All of the data used are stored in the site information tables and can be accessed, checked for accuracy, and updated as needed.

This prioritization is intended to provide a broad perspective and help guide decisions; it should not be used to eliminate any site from consideration for restoration or conservation. Sufficient data are provided for fine-tuning site selection and action planning; these data (and additional new data) can also be used to re-rank sites using alternative methods if desired.

To improve the accuracy and usefulness of this study, **GPC actively sought input from local landowners, residents and resource specialists.** Information gleaned from landowner meetings and other forums has been included in the site characterization and prioritization, the site information table, and this written report.

Study area description

This study included all tidal wetlands in the Siuslaw River Estuary up to the head of tide. Emergent, scrub-shrub and forested tidal wetlands were included, but consistent with statewide methods (Brophy 2005), aquatic beds (eelgrass and algae beds) were excluded. This study also excluded former tidal wetlands that have been completely filled and converted to developed uses such as industrial, commercial and residential sites.

Several definitions of tidal wetlands have been used through the years, but for this study, the following definition is used: "A tidal wetland is a vegetated wetland that is periodically inundated by tidal waters, generally daily at high tide or monthly during spring tides, but at least annually." Since the frequency of tidal inundation could not be directly determined in this study, many data sources were used to create the map of tidal wetlands, including existing data, aerial photographs, field observation, and local knowledge.

Summary of results

Using geospatial data, field observation, and aerial photograph interpretation, this study identified 1202 ha (2970 A) of current and historic tidal wetlands in the Siuslaw River estuary. This figure is a 48% increase over previous estimates of tidal wetland area in the estuary; the increase is primarily due to identification of tidal wetlands further upstream than previous mapping.

Using landscape ecology principles, 70 sites were defined. These sites were then characterized and prioritized. The results show that 38 sites representing about 67% of the former tidal wetland area (809 ha, or about 2000A) have undergone major alterations that greatly restrict tidal flows. Losses have been greater within the tidal swamp habitat type: although the Siuslaw estuary was historically rich in tidal swamp, it has lost about 97% of those swamps to nonwetland, nontidal, or nonforested habitat types. However, considerable tidal wetland restoration is occurring in the basin: Tidal flows are being deliberately restored to about 25% of the highly altered wetlands (192 ha, or 474 A). These results are presented in more detail in **Results and discussion** and in Table 5 below.

Products

The following products are provided with this report:

Written report (paper and PDF formats). Contains background, methods, results, and the following appendices:

Appendix 1. Restoration principles. Principles of tidal wetland restoration.

Appendix 2. Restoration approaches. General recommendations for restoration in Oregon's tidal wetlands south of the Columbia.

Appendix 3. Site ranking tables (excerpted from Excel spreadsheet, Sius_tidalw.xls):

Table 1: Site rankings, sorted by ranking (top down)

Table 2: Site rankings, sorted by site number

Appendix 4. Site information table (site details), including ranking factors and scores (also contained in Excel spreadsheet described below)

Table 1. Key to site information table fields

Table 2. Key to plant species codes used in site information table

Appendix 5. Site maps

1. Total score
2. Site size
3. Tidal channel condition
4. Wetland connectivity
5. Salmonid diversity
6. Historic vegetation
7. Vegetation diversity
8. Site numbers
9. Number of major landowners
10. Land ownership type

Excel spreadsheet of site information (Sius_tidalw.xls)

GIS shapefile of study sites (ArcView shapefile: Sius_tidalw.shp), containing all attributes in Sius_tidalw.xls. Metadata are provided with the shapefile.

All of the report components listed above are necessary for accurate understanding of results. If any of the above products are missing, please contact Laura Brophy at Green Point Consulting, (541) 752-7671 or e-mail Laura@GreenPointConsulting.com for replacements.

Background

Tidal wetlands of the Siuslaw River estuary

The Siuslaw River estuary is classified by the Oregon Department of Land Conservation and Development (DLCD) as a Shallow Draft Development estuary. Other estuaries in this category include Nehalem River, Tillamook Bay, Depoe Bay, Umpqua River, Coquille River, Rogue River, and Chetco River. These estuaries are managed for navigation and other public needs consistent with overall estuary management rules (OR Administrative Rules 660-017-0025).

The Siuslaw watershed supports spawning runs of fall chinook, winter steelhead, coho, and sea-run cutthroat (ODFW 2004). As these fish move through the estuary on their way to the ocean, they all use the estuary to acclimate to ocean salinities. Tidal wetlands in the estuary provide opportunities for this osmotic transition, as well as a rich foraging environment.

Oregon’s tidal wetlands include aquatic bed habitats (eelgrass and algae beds, exposed only briefly during lower low tides), emergent marsh (low and high marsh), scrub-shrub wetlands, and forested wetlands. Tidal scrub-shrub and forested wetlands are collectively known as “tidal swamps.” The Siuslaw River estuary contains all of these tidal wetland habitat types, but consistent with statewide methods (Brophy 2005), this study does not address aquatic bed habitats, for which management issues are quite distinct.

Tidal wetlands are found throughout the full range of salinities, from the marine salinity zone up to the freshwater tidal zone near head of tide. The upper estuary is the least studied, but contains substantial areas of former tidal wetlands that are now diked or tidegated or have other tidal flow restrictions. These areas were converted to agricultural use early in the history of the estuary, because they are at relatively high elevations and have less frequent tidal flooding compared to tidal marshes in the lower estuary.

Tidal wetland functions

Tidal wetlands serve many vital functions in the watershed. Some of the most widely recognized functions are included in the hydrogeomorphic functional assessment method for tidal wetlands of the Oregon coast (Adamus 2005a). These functions include water quality functions (sediment detention and stabilization, nutrient and contaminant stabilization and processing), ecological support functions (food chain support, native vegetation support), and wildlife habitat functions (habitat for fish, birds, invertebrates, mammals).

The value of tidal wetland functions may be enhanced by the position of these wetlands in a critical landscape position -- low in the watershed, in an economically important nursery zone for anadromous and marine organisms, and immediately below concentrations of the agricultural and rural residential land uses that can generate warmed, polluted surface waters.

In Oregon, interest in salmon has brought attention to the salmon habitat functions of tidal wetlands. Tidal wetlands are important to salmon population size, diversity and viability. The health of Pacific Northwest salmon populations depends on a continuum of diverse habitats across freshwater, estuarine and marine zones. Tidal wetlands are considered crucial link in this chain, providing rearing habitat characterized by a highly productive food web, deep meandering channels for shelter from predators and high velocity river flows, cool water temperatures, and a brackish-freshwater interface for physiological adaptation to marine salinities. These tidal wetland features contribute to accelerated juvenile salmon growth during estuarine rearing, in turn supporting increased ocean survival.

The full value of tidal wetland functions is not generally recognized in our economic system. Costanza *et al* (1997) estimated that of all ecosystems on earth, tidal marshes and swamps rate by far the highest in waste treatment (recovery and removal of excess, mobile nutrients), providing a minimum estimated value of $6696/ha/yr for this function. Tidal and freshwater marshes and swamps together form the world's most important environmental "capacitors;" that is, these ecosystems absorb and moderate drastic environmental fluctuations like flooding, storm damage, and drought (estimated value, at least $4539/ha/yr). Tidal marshes are the second-highest ranking ecosystems in the world for food production ($466/ha/yr), habitat and refuge for rare organisms ($169/ha/yr), and recreation ($658/ha/yr). Overall, the ecosystem services valuation of tidal marsh is estimated at a minimum of $9,990/ha/yr, placing it fourth among the highest-valued ecosystems on earth. (The top three are open-water estuarine habitats, freshwater swamps and floodplains, and seagrass and algae beds.)

Human uses and alteration types

People have always used Oregon's estuaries intensively. Native Americans built villages on the lowlands near the sea, where easy-to-access waters with abundant fish and shellfish provided food, shelter, and transportation. After European settlement, many estuary lands were filled for towns and industrial sites, diked and converted to agriculture, dredged for navigation, or otherwise altered. Grassy tidal marshes were diked early for pasture. In the tidal swamp zone, trees were harvested and tidal channels blocked so that the lands could be converted to pasture or homesites. Estimates by several experts show that about 70 to 90% of Oregon's tidal wetlands have been converted to other human uses (Christy 2004, Good 2000, Boule and Bierly 1987) during the past 150 years. However, the rate of change has slowed in recent years. Estuary zoning and wetland protection regulations have helped reduce human impacts to tidal wetlands (Good 1997). Today, many groups are attempting to restore tidal wetlands to their original functions.

Estuary-wide alteration types

Alterations to estuaries can be site-specific (diking, ditching, etc.) or estuary-wide. Estuary-wide alterations can affect all tidal wetlands in an estuary, even those with no site-specific changes. Examples of estuary-wide alterations include altered sediment deposition patterns; changed peak flows, water circulation patterns, and flooding regimes; water and sediment contamination; impermeable surfaces like urban areas and road systems; and invasive species. Quantifying the effect of such large-scale changes on individual tidal wetland sites is difficult. Consistent with statewide methods (Brophy 2005), this study addresses only site-specific alterations, but estuary-wide factors should be considered when planning a site-specific restoration project.

Site-specific alteration types and their effects on tidal wetland functions

The main types of site-specific tidal wetland alterations on the Oregon coast are dikes, tidegates, ditches, restrictive culverts, fill (including dredged material disposal), road and railroad crossings and embankments, dams, channel armor, excavation, tillage, grazing, driftwood removal, and logging and brush clearing in tidal swamps. Invasive species are another type of alteration, though generally not a deliberate one.

Alterations that remove, reduce or redirect tidal flows (***dikes, tidegates, and restrictive culverts)*** cause the broadest impacts to wetland functions. By definition, tidal flows create the unique functions of tidal wetlands, so these three types of alterations reduce, alter or eliminate all tidal wetland functions. Wetland changes due to altered tidal flow can include a decrease in tidal channel complexity, shift in the composition and distribution of vegetation communities, changes in soil biology and chemistry, altered salinity, and altered patterns of sediment erosion and deposition. In many cases, sites where tidal flows have been reduced or eliminated undergo soil subsidence. This is a gradual lowering of the soil surface elevation caused by soil compaction, decomposition (oxidation) of organic plant material in the soil, and loss of buoyancy when tidal influence is removed (Frenkel and Morlan 1991). Many of Oregon's diked tidelands have undergone 2 to 4 feet of subsidence.

Sites that are no longer tidally influenced because of human alteration may still be wetlands, and may still perform many wetland functions. Freshwater wetlands often develop in diked areas after many years, due to soil subsidence and impeded freshwater drainage. However, many of the original functions (such as salmonid habitat and osmotic transition zones) may be greatly reduced or completely lost.

Even where tidal flows are still present, human alterations can strongly affect tidal wetland functions. ***Ditches*** change tidal flow patterns and channel morphology, affecting nearly all tidal wetland functions. For example, ditches are usually shallower and broader than natural tidal wetland channels, creating warmer water conditions that reduce habitat value for juvenile salmon. Ditches speed water flow off a site, reducing duration of inundation and diminishing wetland area. ***Road and railroad crossings*** can greatly affect water flow patterns by blocking channels and redirecting or impeding both subsurface flows and "sheet flow" (nonchannelized surface flow). ***Tillage*** and ***grazing*** compact soils, contribute to erosion of channel banks, and reduce vegetation diversity and wildlife habitat. ***Channel armor*** and ***riprap*** reduce vegetation diversity and channel shading, eliminate "edge" foraging for aquatic organisms including salmon, and can cause erosion in adjacent areas. ***Excavation, fill*** and ***dredged material disposal*** change site elevations, water flow patterns, and soil biology, altering the many wetland functions that depend on these basic physical characteristics of tidal wetlands. ***Logging*** and ***driftwood removal*** directly reduce wildlife habitat, alter productivity and food webs, and reduce channel shading. ***Invasive species*** can completely alter the character of a tidal wetland. For example, smooth cordgrass can convert a former mud flat into a low marsh, greatly reducing shorebird habitat functions.

Restoring tidal wetland functions

Tidal wetland restoration generally focuses on removal of human alterations. Dikes can be breached or removed; tidegates replaced with fish-friendly models or self-regulating gates which remain open except during extreme high tides. Restrictive culverts can be upgraded to allow free exchange of tidal flow. Ditches can be filled, and meandering channel remnants reconnected. Removal of human alterations is the most practical restoration approach, often the most economical, and generally the approach with the highest chances of success (Simenstad and Bottom 2004, Mitsch 2000).

Once human alterations are removed, the natural forces that create tidal wetlands can generally become re-established. These natural forces (tidal flows, sediment deposition, and so on) are necessary for the return of tidal wetland functions over time (see **Restoration Principles,** Appendix 1).

Restoration of tidal flow is the most important component of tidal wetland restoration design. Other restoration techniques may be needed, such as restoration of freshwater flow, removal of invasive species, planting of woody (tidal swamp) species, and meander restoration to carry tidal flow throughout a site. Table 7 in **Restoration recommendations** at the end of this report shows potential restoration actions corresponding to site alterations. Other details are provided in Appendix 2, **Restoration approaches.**

Methods

This study prioritized tidal wetland sites for conservation and restoration, using existing data, aerial photograph interpretation, field reconnaissance, and local knowledge.

Information sources

Tidal wetland sites were located and characterized using publicly accessible data, local knowledge, and new information from aerial photograph interpretation and field reconnaissance. Table 1 below summarizes the existing data sources used; further details on data sources and methods are found in the **Prioritization** section below.

This project's map of tidal wetland sites was based on a map developed by Scranton (2004) for the Hydrogeomorphic Guidebook for Tidal Wetlands of the Oregon Coast (Adamus 2005c). Using the information described above, GPC modified the Scranton map (referred to as the "HGM map" in this report) to meet this project's needs (see **Site definition** below). Some of the HGM map areas were omitted from this analysis, because based on the evidence gathered they did not appear to be current or former tidal wetlands. Other HGM map areas were merged or split to form sites appropriate for action planning.

Geographic information systems (GIS) software was used to organize, analyze and display data for this study. GIS data came from a variety of publicly available sources (Table 1). The GIS database included landforms, elevation, wetland inventories, soil type, historic vegetation, habitat type, salmon distribution, hydrography, salinity, land ownership, and urban areas mapping. Generalized land use zoning data and county land-use planning documents were used to identify current land uses and planning overlays for sites and adjacent areas.

Aerial photographs were analyzed to define and characterize sites. True color, 1:12,000 scale photos taken in June 2000 were obtained from the U.S. Department of Interior, Bureau of Land Management. Color infrared 1:24,000 scale photos taken in May 2001 were obtained from the U.S. Army Corps of Engineers.

Interviews with local residents and other regional experts provided a historical context and other details for each site. The Siuslaw Watershed Council organized several meetings for landowners and the public, at which GPC presented information about this project and gathered input from local residents. Input included both information about the estuary, and concerns about watershed issues. The information gathered is contained in this report.

To determine current site conditions, field observations of sites were made from publicly accessible vantage points. A few sites were visited with landowner permission.

Table 1. Data sources and descriptions

Title	Source	Data type	Scale	Metadata Availability? (Y/N)	Complete? (Y/N)
Digital Ortho Quadrangles (digital aerial photographs)	USGS	Raster	1:24,000	Yes	Yes
Digital Raster Graphics (digitized USGS quadrangle maps)	USGS	Raster	1:24,000	Yes	Yes
June 2000 True Color aerial photography http://www.or.blm.gov/or957/mapping/aerialphotography/index.asp	BLM	Hardcopy	1:12,000	No	Yes
May 2001 Infrared aerial photography https://www.nwp.usace.army.mil/ec/ts/aerial.htm	ACOE	Hardcopy	1:24,000	No	No
Head of tide for the mainstem river and for all tributaries http://statelands.dsl.state.or.us/tidally.htm	OR DSL	Tabular	Scale independent	No	No
National Wetlands Inventory http://wetlands.fws.gov/downloads.htm	USFWS	Coverage	1:24,000	Yes	Yes
HGM base layer: Tidal wetlands of Oregon's Coastal Watersheds (Scranton 2004) http://www.coastalatlas.net/download/shapes/tidal_marsh.zip	Russell Scranton, OSU	Shapefile and geodatabase	Unknown	Yes	Yes
SSURGO soil survey http://www.or.nrcs.usda.gov/pnw_soil/or_data.html	NRCS	Coverage and Tabular	1:24,000	Yes	Yes
Historic vegetation	ONHP	Shapefile	1:24,000	No	No
Oregon Estuary Plan Book: base shoreline, habitat types, mitigation sites, shoreline mgmt units, estuary mgmt units, vectorized shorelines (1:5000) http://www.inforain.org/mapsatwork/oregonestuary/	OR DSL	Shapefile	1:1000 unless noted	Yes	Yes
Salmon distribution and habitat use types http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm	ODFW	Coverage	Generally 1:100,000	Yes	Yes
Hydrography http://rainbow.dfw.state.or.us/nrimp/information/index.htm	ODFW	Coverage	1:100,000	Yes	Yes
3-Zone Average Annual Salinity	NOAA	Shapefile	unknown	Yes	Yes
Urban Growth Boundary http://www.gis.state.or.us/data/index.html	ODOT/DLCD	Shapefile	1:24,000	Yes	Yes
Lane Council of Governments tax lot maps	LCOG	Shapefile	varies	No	Yes

Site definition

To provide strategic guidance for tidal wetland restoration and conservation, this study defined analysis units called “sites.” In general, a site is a contiguous wetland area with strong internal hydrologic connectivity, a homogeneous level of alteration, and consistent land use history. The goal of site definition was to provide an action planning tool that recognizes the ecological importance of large contiguous blocks of wetland, while still providing units of small enough size to be practical for taking action. Land ownership in itself was generally not used to define sites, but since different landowners often use the land differently, site boundaries often approximate ownership boundaries.

The HGM map was used as the base layer for this project (see Table 1 and **Data sources** above). The HGM map divides the landscape according to HGM class, which is partly based on elevation and degree of tidal influence (e.g., low marsh, high marsh, and swamp are mapped separately). But, in this assessment, a major goal is to recognize interconnected, contiguous tidal wetland areas as a single site where possible, *particularly* if that site incorporates a range of elevations and plant communities. Such a continuum of plant communities has very high ecological value, as it allows movement of animals from one wetland zone to another in response to their needs or changing environmental conditions. So, most of the this project’s sites were formed by merging polygons of different HGM classes.

The HGM map contained many areas classified as “Restoration consideration areas” (RCAs). The HGM guidebook describes these areas as “non-tidal wetlands at about the same elevation as tidal waters and which, in some cases, might have been tidal wetlands prior to blockage by dikes, roads, etc.” Field observations, aerial photograph interpretation, discussions with local experts and residents, and other information sources were used to either include these RCAs in the current study (if they appeared to be current or former tidal wetlands), or to reject them (if not). However, as shown in the site information tables (INFO_NEEDS and NEXT_STEP), further information on tidal status is still needed for many of these areas. Guidance on how to determine tidal status can be found in Brophy (2005).

Site numbering

In general, sites are numbered from the river mouth upwards to the highest portion of the estuary. Sites 1-50 and Site 70 are on the mainstem; Sites 51 through 69 are on the North Fork.

Prioritization method

The prioritization method used in this has been extensively reviewed and tested and follows statewide standards. GPC refined and tested the method in the Nehalem, Yaquina, Alsea, and Umpqua River estuaries (Brophy 1999; Brophy and So 2005a, 2005b, 2005c). The Siuslaw Watershed Council’s technical team reviewed the method during its implementation in the Siuslaw estuary to ensure it met local needs. This prioritization uses the methods contained in the

Estuary Assessment Module of the Oregon Watershed Assessment Manual (Brophy 2005). The OWEB manual method was developed through extensive field experience, literature review and peer review by a team of regional experts in tidal wetland ecology and restoration.

Restoration sites vs. conservation sites and joint prioritization

This study, like the statewide method (Brophy 2005), prioritizes restoration sites and conservation sites jointly. Sites are prioritized by analyzing broad indicators of current and potential tidal wetland function. Although prioritizing conservation and restoration sites separately might seem advisable, in reality every estuary presents a continuous spectrum of degree of alteration. Many sites are altered and offer restoration opportunities, but also currently provide substantial wetland functions. Many relatively undisturbed sites offer some restoration opportunities, such as improved culverts on the upslope side, removal of introduced non-indigenous species, or creation of native vegetation buffers.

Despite this continuum of degree of alteration, GPC recognizes the desire to view restoratoin opportunities separately from conservation ("protection") opportunities. Therefore, each study site has been characterized as either a restoration site or a conservation site based on its degree of alteration and restoration potential. This information is recorded in the field **REST_CON** in the site information table (Appendix 4). This designation can be used can be used to develop action plans tailored specifically to restoration or conservation activities. For example, to develop an action plan for conservation of existing high-functioning tidal wetlands, select the highest-scoring wetlands that are classified as conservation sites ("con" in field REST_CON in site information table). To develop a restoration action plan, select the highest-scoring wetlands characterized as restoration sites ("rest" in field REST_CON).

Prioritization criteria

The following ecological criteria were used to prioritize sites:

1. Size of site
2. Tidal channel condition
3. Wetland connectivity
4. Salmonid diversity
5. Historic wetland type
6. Diversity of vegetation classes

Each site was scored for each of these criteria, and the criterion scores were summed for a total site score (Map 1). The resulting total score represents a site's likelihood of contributing to tidal wetland functions in its current or restored state. After scoring, the sites were grouped into five priority categories (high, medium-high, medium, medium-low, and low). These rankings are intended to provide a broad perspective and help guide decisions. **The rankings should not be used to eliminate any site from consideration for restoration or conservation actions. In**

other words, all tidal wetlands are important; prioritization is simply a way to focus action planning on sites where the return for that effort may be the greatest.

Non-ecological criteria, such as number of landowners, landowner type, and land use zoning also affect restoration decision-making. These factors are addressed in the sections **Land ownership**, **Land use zoning**, and **Comprehensive Plan Overlays** below.

Table 2 shows a summary of the criteria used to prioritize sites, the data sources, and the scoring levels for each criterion.

Table 2. Summary of prioritization criteria

Factor	Data source	Description	Levels
Size of site	Map of sites	Size in hectares. Threshold size for including a site is 1 ha.	Convert full range of values for study area to scores of 1 (smallest) to 5 (largest).
Tidal channel condition	Aerial photograph interpretation	Observe aerial photographs for visible tidal flow restrictions, ditching, and dikes.	Scale of 1 to 5 (1= poor channel condition/tidal exchange; 5=good condition, full tidal exchange). See scoring matrix below.
Wetland connectivity	National Wetland Inventory, Estuary Plan Book Habitat types mapping	Total area of other wetlands (emergent, scrub-shrub, and forested wetlands, plus EPB-mapped eelgrass and algae beds) outside site and within 1 mile buffer around site perimeter.	Convert full range of values for study area to scores of 1 (smallest area) to 5 (largest area).
Salmonid diversity	ODFW salmonid distribution data	Number of salmon stocks spawning in river or tributary upstream of site, not including cutthroat.	Number of stocks rescaled to scale of 1 to 5 (score of 1 = 0 stocks; score of 5 = 3 stocks).
Historic wetland type	Oregon Natural Heritage Program historic vegetation mapping	Proportion of site that was historically swamp (either forested or shrub swamp)	Full range of values for study area rescaled to scores of 1 (smallest proportion) to 5 (largest proportion).
Diversity of current vegetation types	National Wetland Inventory/Aerial photograph interpretation	Number of Cowardin vegetation classes (emergent, scrub-shrub, forested wetlands) mapped on site.	One Cowardin class = score of 1 Two Cowardin classes = 3 Three Cowardin classes = 5
TOTAL SCORE			Add all 6 criteria scores, double-weighting the channel condition score. Maximum possible score = 35; minimum possible score = 7)

Map 1 and Appendix 3 contain the results of the prioritization; see **Results and discussion** for details and interpretation.

Size of site

Site size is recognized as an important factor in wetland prioritization methods (White and others 1998; Schreffler and Thom 1993; Lebovitz 1992; Brophy 1999; Costa and others 2002). The size of a wetland is closely related to the level of functions it provides. All other factors being equal, bigger is simply better when it comes to providing ecosystem services. The science of biogeography (McArthur and Wilson, 1967) has established that larger sites are more self-sustaining, have higher diversity of plant and animal species, and have greater ability to buffer against outside pressures and disturbances such as pollution and invasive species. Larger sites can also present an efficiency of scale, reducing the per-acre cost of restoration.

Site size in hectares was calculated using the site maps. The threshold for including a site in this study was one hectare. The site size used in the prioritization is the area of vegetated tidal wetland and former tidal wetland; it does not include tidal channels, mud flats or aquatic beds. Site size was rescaled to obtain a size score ranging from 1 (smallest site in study area) to 5 (largest site in study area). Map 2 shows the results of the site size scoring.

Tidal channel condition

Channel morphology and tidal connectivity are important indicators of tidal wetland function and overall hydrologic condition. Site alterations such as ditching, diking, tidegates, restrictive culverts, and roads impede or prevent tidal flow and alter tidal channel structure, resulting in lower channel complexity and shorter total channel length. Highly altered channels and blocked tidal flow reduce tidal wetland functions, and also make restoration more difficult and more expensive.

Tidal channel condition was evaluated using aerial photographs, field reconnaissance, and local knowledge. Each site was scored using the scoring matrix shown in Table 3. Four subfactors contributing to tidal channel condition were evaluated: tidal exchange, tidegate location, ditching, and remnant channels. Each of these subfactors was assigned a score ranging from 1 (highly altered condition) to 5 (low alteration). The four subfactor scores were averaged to obtain a tidal channel condition score ranging from 1 (highly altered/low tidal connectivity) to 5 (relatively unaltered/intact tidal connectivity).

Table 3. Tidal channel condition scoring matrix

Subfactor	**Highly- altered condition**		**Medium alteration**		**Least-altered condition**	
	Description	**Score**	**Description**	**Score**	**Description**	**Score**
Tidal exchange	None	1	Restricted	3	Full	5
Tidegate location	Offsite	1	Onsite	3	No tidegate	5
Ditching	Heavy	1	Some	3	None	5
Remnant channels	None	1	Some	3	Many*	5

*or, channels are undisturbed

Map 3 shows the results of the classification of tidal channel condition.

Wetland connectivity

In landscape ecology terms, connectivity (spatial connection of habitats to one another) is the opposite of fragmentation (isolation of habitats). Wetlands with good connectivity – those located near other wetlands and connected via stream or narrow wetland corridors – can perform many of their functions better, compared to isolated wetlands (Amezaga *et al* 2002, Adamus 2005a, Adamus and Field 2001). If a particular wetland is disturbed, the creatures that depend on it for shelter and livelihood may need to move to another nearby wetland. Mobile species such as anadromous fish, shorebirds, waterfowl, and native landbirds and mammals often feed and rest in several wetlands, so a single isolated wetland does not serve their needs. Interconnected salt marsh, brackish marsh and freshwater wetlands offer juvenile salmon the opportunity to gradually adjust to ocean salinities before migrating to the sea.

Wetland connectivity also buffers environmental change. Each type of tidal wetland occupies a specific elevation range relative to sea level – but sea level itself is slowly changing. Land uplift and subsidence due to tectonic activity are fairly rapid in places; for example, Cape Blanco is estimated to be rising at a rate of about a foot every 100 years (Komar 1998). At the same time, the world's sea level is also rising, though land uplift is generally keeping up in Oregon. However, periodic earthquakes can change this relationship radically; the earthquake of 1700 caused a subsidence of about 3 feet in the land surface across much of the Oregon coast. Adding to these geologic scale changes, human activities may also have caused major changes in the location of head of tide in some estuaries. For example, head of tide in the Coquille estuary appears to have shifted about 4 miles downstream since the 1850's (Benner 1992). Because of these current and potential changes, wetlands that are well-connected to a range of other wetland types at different elevations were prioritized in this study.

NWI-mapped wetlands in the emergent, scrub-shrub, and forested wetland classes were considered together with Estuary Plan Book mapped eelgrass and algae beds (attributes 1.3.9, 1.3.10, 2.3.9 and 2.3.10) for this analysis. Eelgrass and algae beds were included in the connectivity criterion because of their importance as habitat for invertebrates, anadromous and other fish, shorebirds, and waterfowl (Phillips 1984, Rozas and Odum 1987). To determine connectivity, the total area of EPB- and NWI-mapped wetlands within a one-mile buffer around the perimeter of each site was calculated.

Map 4 shows the results of the wetland connectivity analysis.

Salmonid diversity

The Siuslaw watershed currently supports spawning runs of four salmonid species: Coho, winter steelhead, fall chinook, and sea-run cutthroat. In addition, chum were historically present in the lower watershed (ODFW 2004), and chum may currently be present in low numbers (Ecotrust 2002). All of these anadromous fish must migrate through the estuary, so all tidal wetland sites in the Siuslaw estuary could potentially provide salmonid habitat functions. However, some sites are located along the migration corridors for all four of these species, whereas other sites are located on tributaries that support spawning populations of only one or two salmonid species.

Sites located along migration corridors for a larger number of salmon species were given priority in this study.

Ideally, a prioritization like this one would rank sites by using precise and high-resolution data on abundance and distribution of juvenile salmonids in tidal channels and streams. However, no such comprehensive, consistent, and appropriate-scale data were available for this study. Therefore, sites were scored by using salmon distribution data without regard to the population condition or size. This was considered acceptable, since the remainder of the prioritization criteria also address factors that strongly affect salmon habitat functions (site size, channel condition, wetland connectivity, historic wetland type, and vegetation diversity).

Scoring for salmonid diversity used the Oregon Department of Fish and Wildlife 1:100,000 scale salmon distribution mapping (ODFW 2004). The total number of salmonid stocks using the river or stream on which the site was located was determined using the ODFW data. The number of stocks was then rescaled to derive the salmon habitat connectivity score ranging from 1 (0 stocks) to 5 (all 3 stocks).

This score is not intended to evaluate actual use levels; data on fish use of tidal wetlands are only beginning to be developed for Oregon (Bottom, Fleming, Jones and Simenstad, 2004). Equivalent distribution maps were not available for cutthroat, so that species was not considered in this analysis. Chum were not included in the analysis because no current chum use was mapped (ODFW 2004), and because nearly all sites in the study area were located along historic chum migration routes, so using the historic chum data would not have distinguished among sites. Although juvenile salmon can move both downstream and upstream in their rearing period (Miller and Sadro 2003), this analysis looks only at upstream spawning because the general movement of salmon populations during their development is downstream towards the ocean, and upstream movements are likely to be small compared to the total migration distance for most species.

Map 5 shows the results of the salmonid diversity analysis.

Historic wetland type

A major goal of estuarine restoration is to re-establish the full suite of habitat types that were historically present within the planning area. Simenstad and Bottom (2004) state that "Restoration plans should be designed to restore ecosystem complexity, diversity, and riparian-flood plain connectivity based on the historic estuarine landscape structure." Of all tidal wetland types in Oregon, tidal swamps have been the most heavily affected by development and agricultural conversion. Estimates of tidal swamp losses on the Oregon coast since the 1850's range from 90 to 95% (Thomas, 1983; Brophy, unpublished), compared to about 70% for tidal marshes.

Tidal forested and scrub-shrub wetlands (tidal swamps) have unique characteristics supporting salmonid habitat functions. In addition to providing the usual benefits of brackish-to-freshwater tidal wetlands -- an osmotic transition zone, a rich foraging environment, and deep, cool channels with overhanging banks for shelter from predators -- tidal forests also have trees and shrubs that provide additional shade, physical shelter and large woody debris. Woody vegetation, leaf fall, and root masses provide habitat structure and detrital contributions to the food web. Because of these characteristics, and because of their disproportionate losses to development, former tidal swamps were prioritized within this study.

Most of the tidal swamp historically found in Oregon was spruce swamp or tideland spruce meadow, with Sitka spruce (*Picea sitchensis*) as the dominant tree species (Jefferson 1975, Thomas 1983). Crabapple swamp and shore pine swamp were also found in the Siuslaw estuary (Christy et al 2001; Hawes *et al* 2002). Regardless of the tree or shrub species present, nearly all of these swamp areas were cleared early in this century. Therefore, historic vegetation mapping (Hawes et al 2002, Christy et al 2001) was used to locate areas of former swamp within the tidal wetland zone. The historic vegetation layer covered the estuary from ocean to River Mile 14. This layer was intersected with the sites layer to determine the proportion of each site that was historically swamp. This proportion was then rescaled to derive the historic vegetation score ranging from 1 (0% swamp) to 5 (100% swamp). Sites without historic vegetation data (above river mile 14) were given a score of 3 (neutral).

The results of the historic wetland type analysis are shown in Map 6.

Diversity of current vegetation types

Many wetland functional assessment methods use diversity and interspersion of vegetation cover classes as an indicator of functional level (Roth and others 1996, Adamus 2005a, Adamus and Field 2001). A diversity of cover classes provides a variety of habitat types, resulting in more ecological niches and presumably higher animal species diversity. Cowardin cover classes (Cowardin 1992) were used to define vegetation diversity for this project. The three Cowardin classes included in this study are emergent (dominated by grass, sedges, or other herbaceous vegetation), scrub-shrub (dominated by shrubs), or forested (dominated by trees). To obtain a vegetation diversity score, the NWI layer was intersected with the sites layer. The proportion of each Cowardin cover class within each site was calculated by dividing the area of each cover class by the total area of the site. The total number of cover classes on a site was rescaled to obtain each site’s score, ranging from 1 (1 cover class) to 5 (3 cover classes).

Map 7 shows the results of the vegetation diversity analysis.

Scoring method

Each prioritization factor (criterion) was scored for each individual site on a scale of 1 to 5. On the scoring scale, 1 represents relatively poor condition and 5 corresponds to the best condition based on this study’s prioritization factors (i.e., large size, good channel condition, high wetland connectivity, high number of salmon species, high percent swamp, high vegetation type diversity). For the total score, all six scores were added to get a total score (TOT_SCO in the site information table), with the tidal channel condition score double-weighted because this factor is considered particularly important in site functions and restorability (Simenstad 2005). The formula for the total score is:

TOT_SCO = [SIZE_SCO] +(2* [TCC_SCO])+ [WLCN_SCO] + [NTYP_SCO] + [SWMP_SCO] + [CWDN_SCO]

(Abbreviations are explained in Appendix 4, Table 1.)

After scoring, the sites were separated into the “ranking groups” shown in Map 1 and in Tables 1 and 2 of Appendix 3. These groups provide an easy way of visualizing scores on a map. Five ranking groups were created, with an equal number of sites assigned to each group. Differences of one group (e.g., medium versus medium-low or medium versus medium-high) should not be considered significant, because sites on both sides of the boundary may have very similar scores. Scores for each ranking criterion and the total score can be found in both the ranking tables (Appendix 3) and the site information table (Appendix 4).

It is important to note that the priority groups and the underlying scores should be used as a **general guide** for action planning, not a final arbiter of the absolute priority or ecological value of each site. To fine-tune action planning decisions, GPC recommends reviewing the details contained in the site information table, as well as the supplemental data contained in the next section of this report.

Land ownership

Land ownership for tidal wetland sites was analyzed to assist in the decision-making and action planning process. Both the number of major landowners (over 5% of site area) and the type of ownership were recorded for each site. The number of landowners at a site can affect the ease of restoration, because the more landowners are involved, the more difficult it can be to coordinate restoration activities. The type of ownership of a site affects decision-making in two different ways. Ownership type (private *versus* public) may influence the potential for loss of a wetland since it influences the likelihood of development. Ownership type may also influence the cost of restoration and the appropriate avenues and strategies for restoration.

Other site ranking protocols (Lebovitz 1992, Dean and others 2000) have included ownership type as a ranking criterion. However, discussions with the Siuslaw Watershed Council as well as previous prioritizations (Brophy and So, 2005a, 2005b, 2005c) determined that land ownership data are best provided as supplemental data, rather than incorporated into site scoring. The primary reason for omitting land ownership type from the scoring is that this prioritization focuses on ecological factors, and land ownership, in itself, is not an ecological factor. Of course, land ownership is closely correlated to land use and intensity of alteration, but those factors are reflected in the tidal channel condition, vegetation diversity, and wetland connectivity metrics.

Some authors (Lebovitz 1992, Dean and others 2000) have theorized that land ownership type relates directly to cost or logistical complexity of acquisition and/or restoration. However, in GPC experience, there is actually a complex, multidimensional relationship between land ownership type, restoration potential, cost, and other factors. Privately owned sites (particularly those near urban areas) may be under high development pressure, increasing the urgency of both conservation and restoration. Private lands may present greater challenges, but also more diverse opportunities for conservation and restoration, compared to public lands. Many funding sources are limited to use on private lands. Conservation actions accomplished through work with willing private landowners can open doors to community involvement and education. Projects on public lands present very different opportunities and challenges. These projects may involve longer timelines due to public review, and more complex administrative hurdles. Given the complexity of these issues, it was apparent that land ownership category was not an appropriate prioritization factor.

During the early stages of this project, the USFWS Coastal Program obtained and provided GIS land ownership data from the Lane Council of Governments (LCOG). The layer did not register well with other GIS data, so it was adjusted for better registration. Many parcels in this layer did not show any owner; these blank parcels were not considered in the analysis. To obtain the number of landowners and land ownership type for each site, the LCOG layer was intersected with the sites layer. Because of registration problems, the intersection produced many small "slivers" of tax parcels that probably do not in fact intersect with site boundaries. To eliminate the "slivers," data were processed in Excel to remove land ownerships that occupied less than 5% of each site (considered minor landowners).

The number of major landowners (>5%) for each site is shown in Map 9. Land ownership types are listed in Table 4 below and mapped in Map 10.

Because of the landowner layer registration problems, GPC recommends verifying landowner information before developing any site-specific action plans. Also, where roads or railroads cross sites, the landowner layer did not show ownership for the road/railroad right-of-way. It is important to contact appropriate authorities before planning conservation or restoration actions that could affect roads and railroads.

Table 4. Ownership categories

Factor	Data source	Levels	Description
Ownership category	Land ownership data from Lane County Council of Governments (LCOG) GIS data	Tribe Federal State Port County City	Specific categories of public ownership
		Private non-industrial	Private ownership, not industrial timber
		Private industrial	Industrial timber ownership or a mixture of
		Mixed	Mixed ownership types

Some high-priority restoration sites have multiple landowners. If not all landowners want to participate in restoration or conservation of the site, it may be possible to begin restoration on sub-areas of the site without affecting other areas. The feasibility of such partial restoration depends on the particular characteristics of the site, and should be considered during restoration design.

Land use planning

Land use planning affects estuary lands in many ways. All cities and counties in Oregon have local comprehensive plans, and land use regulations that implement the plans. The City of Florence and Lane County comprehensive plans are highly relevant to this study. These plans contain resource inventories, analyses and priorities which are used in the development of local land use policies. Local comprehensive plans are generally implemented through local zoning or land use regulations. Before restoration or other actions can begin on tidal wetland sites, local land use plans and regulations must be reviewed.

Three simple analyses of land use planning were conducted for this study. Generalized land use zoning was analyzed both for sites and areas adjacent to sites, and special designations for mitigation sites and dredged material disposal sites within the Lane County Rural Comprehensive Plan were reviewed. The methods and results are described below.

The land use planning analyses presented below address only a small part of the planning context within the estuary. Thus, one of the first steps that should be taken in site-specific action planning is to consult directly with local (City and County) planning staff. See Appendix 2 (**Permits and regulatory coordination**), and the Oregon Watershed Assessment Manual's Estuary module (Brophy 2005) for further details.

Zoning

To determine current land use for each site, a generalized land use zoning layer was downloaded from the Oregon Geospatial Data Clearinghouse. Sites were intersected with the zoning layer and the proportion of each zoning category on each site was calculated. Zoning categories occupying less than 20% of the site were disregarded. The top two zoning classes for each site are shown in the site information tables in the columns "Zone_top" and "Zone_2nd." See **Results and discussion** below for details.

To determine land use adjacent to sites, a 500m buffer was drawn around the perimeter of each site. This buffer was then intersected with the zoning layer and the proportion of each zoning category in each site's buffer was determined. Zoning categories occupying less than 20% of the buffer were disregarded. The results are shown in the site information table and in **Results and discussion** below.

Dredged material disposal (DMD) sites

Designated dredged material disposal (DMD) areas are described in the area Coastal Resources Management Plan (CRMP), part of the Lane County Rural Comprehensive Plan (Lane County Public Works 1991). The CRMP describes a list of DMD areas that was slightly modified from the plan prepared by Wilsey and Hamm (1978). The more detailed maps in Wilsey and Hamm were used to locate the CRMP areas. The study sites which contain DMD areas are marked in the site information table (field: CRMP_DMD). See **Results and discussion: Dredged material disposal sites** below for details.

Mitigation sites

The Coastal Resources Management Plan (CRMP), part of the Lane County Rural Comprehensive Plan (Lane County Public Works 1991), was reviewed for designated mitigation sites. Only one mitigation site is described in the plan; this site is discussed in **Results and discussion: Mitigation sites** below.

Historic aerial photograph analysis

A series of historic aerial photographs (1939-1953) were analyzed to determine the first date of alteration for each site in the estuary. This analysis was helpful in understanding site changes over time, and the site narratives below include some of the most pertinent information gathered. However, the historic airphotos were not useful for prioritizing sites or for making restoration decisions, because nearly all sites with major alterations had already been altered in the earliest photo set (1939). Therefore, the earliest date of alteration was not included in the site information table, as it differs little from site to site.

Data limitations

The accuracy of scoring in this study depends on the quality of the source data. Errors in the original data could have been carried forward through data processing steps, resulting in some inaccuracies in the final results. Positional and registration errors were apparent in some GIS analyses. For instance, as described above, the land ownership layer did not register well with other data sources. However, the processing methods used in this study reduced the potential for errors, because the broad conclusions drawn (i.e., ranking groups) are not dependent on highly accurate data. In other words, the data used appear to be adequate for the analyses conducted.

This study used aerial photograph interpretation, existing data, and field investigation (usually observation from offsite) to characterize the sites in this study. Such “remote” data are inherently less accurate than data collected onsite in the field. Therefore, landowner contacts and site visits are recommended early in the restoration or conservation planning process, to verify the data presented in this report.

Although this prioritization uses criteria that are strongly related to wetland functions, the prioritization is not intended to assess specific site functions. Assessment of tidal wetland functions requires onsite field work for each site assessed (Adamus 2005a, Simenstad and others 1991) and is not within the scope of this study.

The study area included the full historic extent of tidal wetlands in the estuary. However, it may not be possible to restore the full historic range of tidal influence at every site. (See Appendix 1, **Restoration Principles** for details.) Factors such as subsidence, agricultural activities (e.g., cultivation, ditching, draining, and channeling), remaining dikes and other obstructions (e.g., roads), and basin-wide hydrologic changes all affect the potential to restore tidal exchange on a site. Field investigation is needed at any site where restoration is planned. Field investigation should include elevation surveys, water level (tidal range) measurements, plant community analysis, and other measurements as needed to determine the feasibility of restoring tidal influence and tidal wetland habitats at the site.

Notes on site information table fields

A key to fields in the site information table is provided at the beginning of Appendix 4. Additional notes about specific fields are found below.

ALT_TYP (alteration types)

The field "ALT_TYP" shows the types of alterations present on each site, based on aerial photograph interpretation, field reconnaissance (generally offsite observation), and other data sources. Abbreviations used for the alteration types are shown in Table 7. Grazing is not listed as an alteration unless the site is free of structural alterations like dikes, ditches, tidegates and restrictive culverts. Current or fairly recent past grazing can be assumed for sites where the field VEG_TYP includes the description "pasture."

Logging and driftwood removal were widespread in the accessible tidal forests and marshes of the estuary, but very few site-specific accounts of these activities are available, and widespread logging predated the earliest available aerial photos (1939). Therefore, logging and driftwood removal are not listed as alterations for specific sites, but can be assumed for most of the sites in this study. See **Estuary geomorphology: Large woody debris** below for details.

Many sites in the study are bordered by roads, homesites, railroads, or other developments. These are commonly located at the base of an adjacent hillslope. In many cases, these developments involved fill material placed in the margins of the wetland, so many of the tidal wetlands are currently smaller than they were historically, and some small tidal wetlands have been completely filled. However, as explained in **Study area** above, completely filled and developed areas were not included in this study, so fill is not listed as an alteration type.

Notes fields

The last eight columns in the site information table are 80-character text fields which store detailed information about sites. The titles of the notes fields are GPC_NOTES, INFO_NEEDS, NXT_STEP, VEG_TYP, PLANT_SPP, REST_OPT, LIMITS, and EXIST_REST. Since long text fields are sometimes accidentally truncated during database manipulations, each text string ends with the bracketed word "[end]." If that word is missing, the text field has been truncated and should be restored from the original file. However, notes were not entered in all 8 fields for all sites; those which were deliberately left blank contain the text "[blank]."

GPC_NOTES

This column contains notes about the characteristics of sites, based on aerial photograph interpretation, field reconnaissance (generally from offsite), and local knowledge.

INFO_NEEDS (site-specific information needs)

This column records site-specific information needs and suggestions. For most sites, investigation of tidal status (whether or not tidal exchange is occurring) and the condition of the tidal connection point (restrictive culvert? functioning or malfunctioning tidegate?) is a primary information need, as these details could not be determined for many sites during the course of this study. Recommended methods for evaluating tidal influence and tidal restrictions are found in the Oregon Watershed Assessment Manual's Estuary Module (Brophy 2005).

NXT_STEP (recommended next step)

This field describes the recommended next step in action planning for sites with specific issues or information needs. For all sites (including those where this field is blank), the appropriate "next step" is to contact the landowner and discuss their interest in possible wetland conservation or restoration. If the landowner is interested, a site visit is recommended to further assess site conditions. For diked sites and sites with restrictive culverts or tidegates, an initial site visit should focus on determining the nature and condition of the tidal connections. Site changes and development activities on or near the site should be recorded, because restoration actions must be compatible with existing land uses (see **Restoration Approaches**, Appendix 2). Further recommendations for onsite assessment are found in the Oregon Watershed Assessment Manual's Estuary Module (Brophy 2005).

VEG_TYP (vegetation type)

This field describes the tidal status and type of wetland present on the site, based on aerial photograph interpretation, field reconnaissance (generally offsite observation), and other data sources. The term "fully tidal" means the site has no obvious tidal barriers, but does not indicate that the site has frequent tidal inundation. Fully tidal sites high in the estuary may have infrequent tidal flooding.

PLANT_SPP (dominant plant species)

Plant species which appear to be dominant on the site are listed here. This information was gained from offsite observation, and sometimes only part of the site could be seen. Therefore, it should not be considered an accurate description of plant communities. Onsite evaluation of plant communities is recommended for every site before any site-specific planning is begun.

REST_OPT (restoration options)

This field describes restoration options, generally listed from more intensive to less intensive. Due to space limitations, only some restoration options are listed in the site information table. Further options are described in **Restoration recommendations** below, and in **Site narratives**.

LIMITS (limits to restoration potential)

In this field, special considerations or limits to restoration potential are listed. This is not a complete list; onsite assessment is needed to more completely address this question. Restoration approaches (Appendix 2) lists many issues to consider when beginning onsite assessment.

EXIST_REST (existing restoration activities)

Several sites in the study area are currently being restored to tidal wetland through active removal of tidal flow barriers. Information provided to GPC about such deliberate tidal barrier removal is listed here. This column does not list natural deterioration of dikes and tidegates, abandonment of pastures, and other unplanned events which can also result in restoration of tidal wetlands.

Deliberate restoration efforts unrelated to tidal flow restoration (such as riparian plantings and grazing setasides) are not listed in this column, but these are also important to site recovery and function.

Results and discussion

Site prioritization is summarized in Map 1 and Appendix 3. A detailed site information table is provided in Appendix 4. Individual criterion scores are illustrated in Maps 2 through 7. Narrative descriptions of high-ranked sites are provided later in the Results section. A general discussion of results follows.

Total historic tidal wetland area

About 1,202 ha (2970 A) of historic tidal wetlands were identified in the Siuslaw River estuary in this study. This figure is about 48% larger than the previous estimate of total historic tidal wetland area (Good 2000). The increase is primarily due to the new data generated during this study through the use of aerial photograph analysis, local knowledge, and field reconnaissance. The Oregon Estuary Plan Book (EPB) (Cortright *et al* 1987) was the most comprehensive tidal wetland mapping previously available. The EPB tidal wetland mapping extends only up to Siuslaw River Mile 13, but this study identified tidal wetlands up to River Mile 19. (Head of tide is considerably further upstream at River Mile 23, but this project's analysis did not identify tidal wetlands over 1 ha in size above Mile 19.) Similarly, the Estuary Plan Book tidal wetland mapping stops at River Mile 3 on the North Fork Siuslaw River, but this project located tidal wetlands up to River Mile 6. (Head of tide on the North Fork is at River Mile 10.5).

Alterations to Siuslaw tidal wetlands

This study found that about 2/3 (67%, or 809 ha = 2000 A) of former tidal wetlands in the Siuslaw estuary have undergone major alterations that block or greatly reduce tidal flows, such as dikes, tidegates, and restrictive culverts. However, substantial restoration is also occurring in the estuary, with about one quarter of those highly-altered sites (192 ha = 474A) currently in active restoration status. Table 5 shows these results.

Table 5. Summary of Siuslaw tidal wetland alterations and restoration activities

Alteration level	Description	# of sites	Hectares	% of total hectares
Relatively unaltered	Relatively undisturbed tidal wetlands	26	331.2	27.6
Minor alteration	Wetlands with mostly intact tidal flow, but other site alterations like road crossing, ditching or grazing	6	61.9	5.2
Major alteration – active restoration	Wetlands with tidal flow restrictions (dikes, tidegates, restrictive culverts), but tidal flow is being actively restored	3	192.0	16.0
Major alteration – no active restoration	Wetlands that have dikes, ditching, and/or restrictive culverts; no active restoration of tidal flow	35	616.6	51.3
Total		**70**	**1201.6**	**100.0**

Some specific types of tidal wetlands in the Siuslaw River estuary have been disproportionately affected by human alterations. The Siuslaw estuary was historically rich in tidal swamp (shrub and forested tidal wetlands); in the 1850's, about 70% of the wetlands within the tidal zone were swamps, and the total area of tidal swamps was the fourth-highest of all estuaries in the state (461 ha = 1139 A). 97% of these historic tidal swamps are now gone, mostly converted to agricultural lands. By comparison, about 40% of the estuary's historic tidal marsh area has been converted to other uses. The tidal swamp losses in the Siuslaw parallel the 96-100% losses of tidal swamps in the most heavily impacted, brackish-water zone of the Columbia River estuary (Thomas 1983).

The alterations shown in Table 5 were determined through aerial photograph interpretation, field reconnaissance and discussions with local experts and residents. The specific alterations observed at each site are listed in the site information table (Appendix 4). As described in **Methods** above, this study did not attempt to determine whether sites had been altered by logging or driftwood removal, and did not specifically list grazing as an alteration type unless it the site was free of structural alterations like dikes, ditches, tidegates and restrictive culverts.

During field reconnaissance, plant communities were observed from offsite (see **Notes on site information table fields:** VEG_TYP and PLANT_SPP above). Since plant communities respond to disturbance and changes in tidal flow, this information helped determine the alteration status of each site observed. Plant communities at the actively restoring sites (29, 36 and 59) are already dominated by native tidal marsh species. The most recently breached site (site 59) appears the most dynamic, with colonizing species spreading onto bare mud.

About 5% (62 ha) of identified tidal wetlands are affected by site alterations like culverted drainages, road crossings, and grazing, but still have some tidal exchange. Some of these sites have plant communities dominated by native species, but in other areas, the disturbance has led to dominance by non-native invasive species like reed canarygrass. Vegetation information is found in the site information table (Appendix 4).

It is important to remember that all tidal wetlands -- even the “relatively unaltered” sites -- are affected by overall estuary changes such as sediment regime changes, water contamination, and hydrologic changes including flow pattern alterations caused by major fills, dredging, and shoreline armoring. Due to lack of detailed, site-specific data and information on how such changes affect wetland functions, and in accordance with statewide methods (Brophy 2005), this study did not address estuary-wide alterations.

Prioritized sites

Map 1 shows the study sites divided into five categories of priority: High, medium-high, medium, medium-low, and low. The ranking groups were obtained by dividing the total number of sites into five equal-sized groups. As described in **Methods** above, these ranking groups can be used as general guides for planning conservation and restoration actions in the estuary, but it is important to consider site details as well. Many site details are found in the site information table (Appendix 4) and in the **Site narratives** below. Other information must be obtained through further investigations, including onsite assessments.

This prioritization is a first step in strategic planning for conservation and restoration in the Siuslaw estuary. In general, the next step in action planning involves outreach to find those landowners interested in restoring or conserving the identified sites. Once willing and interested landowners are located, a variety of site-specific activities can begin, including preliminary onsite assessment visits, monitoring to determine current conditions, verification of land ownership boundaries, regulatory contacts to determine required permits, archaeological investigations, and many other steps to maximize the chances of successful action.

In the Siuslaw River estuary, many high-priority sites are located on the lower mainstem, lower North Fork, and Duncan Island. Large areas of tidal swamp were historically located here, and wetlands in this zone have large size, good connectivity to other wetlands, and good connectivity to salmon migration corridors. Other high priority sites are located on Sweet Creek, and east of Duncan Island. Some of the high-priority sites are described in **Site narratives** below.

Lower-priority sites are important, too

Although this study prioritizes sites to assist in conservation and restoration planning, **no tidal wetland is unimportant**. Conservation of all existing tidal wetlands is recommended, because the majority of tidal wetlands in the estuary have been converted to other uses, and those being restored may take decades or more to recover their original functions (Frenkel and Morlan 1991). Similarly, restoration of all tidal wetlands is important. A “low” priority ranking in this project does not mean that the low-ranked wetland is ecologically unimportant, nor does it imply that the site should be given reduced protection in a regulatory context. As discussed above, this study has no regulatory significance or intent. It is intended only to provide a strategic approach to conservation and restoration of tidal wetlands in the estuary.

Land use planning

Zoning

The predominant zoning on study sites is agricultural (44%), with "resource use" second at 29% and forest lands occupying about 21% (Table 6). About 6% of total site area is located in industrial, residential or urban areas. The top two zoning classes for each site are shown in the site information tables in the columns "Zone_top" and "Zone_2nd."

Within the 500m buffer zones around sites, most land (54%) is zoned for forestry, with agricultural land second (18%), resource use third (15%), and urban, residential and industrial lands together occupying about 11% of the buffer zones (Table 6). The top three zoning classes (and the percent of the buffer they occupy) are shown in the site information table in the columns "Bufzn_1" (zoning class occupying largest area within buffer zone), "Bfzn1pct" (percent of buffer zone occupied by top zoning class), "Bufzn_2" (2nd highest zoning class), "Bfzn2pct" (% of buffer occupied by 2nd zoning class), "Bufzn_3", and "Bufzn3pct."

Table 6. Land use zoning classes found on study sites

Zoning label	Description	Area (ha)	% of total site area	% of all site buffer zones
LAA1	Exclusive Farm Use Zone	523.4	43.6	18.1
LAF1	Non Impacted Forest Lands	93.7	7.8	27.4
LAF2	Impacted Forest Lands	157.0	13.1	26.2
LAI1	Rural Industrial Zone	6.4	0.5	1.4
LAN1	Resource Use Zone	345.5	28.8	14.7
LAR1	Various Rural Residential Zones	39.4	3.3	5.0
LAU11	Florence UGB	24.6	2.1	4.6
WATER	Water	11.7	1.0	2.6

Dredged material disposal (DMD) sites

Dredged material disposal sites (DMD sites) listed in the Lane County Rural Comprehensive Plan are marked in the site information table (column "CRMP_DMD"). Many of the designated DMD areas are at least partially wetlands (mostly diked wet pastures) at the present time. Twelve of the restoration sites identified in this study are designated DMD sites, including the majority (6 out of 9) of the potential restoration sites above Duncan Island. While recognizing the need to retain existing planning designations, GPC recommends disposal of dredged material on uplands, not on existing wetlands. A planned revision of the DMD plan may offer an opportunity to redesignate DMD sites to avoid disposal in wetlands. Even diked wet pastures provide wetland functions that are valuable for fish and wildlife, and filling diked pastures with dredged material limits future restoration opportunities.

Mitigation sites

Only one mitigation site is described in the area Coastal Resources Management Plan (Lane County Public Works 1991). The mitigation area overlaps this study's sites 5 and 6, which are fully tidal high marsh islands near the mouth of the North Fork Siuslaw. The mitigation area also includes another small island (upland) near Sites 5 and 6. (The small islands near sites 5 and 6 were not included as sites in this study, due to their apparent upland status and apparent origin as DMD sites.)

The comprehensive plan states that the mitigation area consists of "dredged material disposal islands." The type of mitigation activity recommended in the plan is excavation of the existing islands to convert the high marsh or upland to tide flat. However, even if sites 5 and 6 were created from dredged material, they are currently functioning tidal wetlands. Conversion of one fully tidal wetland type to another as mitigation for tidal wetland fill creates a net loss of wetlands; net loss is counter to the goals of mitigation. To achieve "no net loss," mitigation for loss of tidal wetlands should generally consist of restoration of tidal flow to formerly tidal (but currently nontidal) areas like diked pastures. Many such opportunities exist in the Siuslaw estuary.

Restoration recommendations

Planning restoration for altered sites is a technically demanding task. Some principles and general recommendations are provided in Appendices 1 and 2, **Restoration Principles** and **Restoration Approaches**. Additional guidance is found in the Oregon Watershed Assessment Manual's estuary module (Brophy 2005) and in other resources listed there.

This study does not provide site-specific restoration design recommendations, because additional data from field monitoring are needed to develop restoration plans. However, Table 7 below shows some potential restoration actions for each alteration type.

For all sites, the top priority for site action is protection of existing wetlands. After that is accomplished, further action may be taken to restore resources as described in Table 7 and in the site information table (column labeled "REST_OPT)."

Tidal wetland restoration options generally focus on restoring tidal flow, because this is the highest priority action for sites where tidal flow is restricted. For grazed sites, an important restoration option to consider is simply removal of grazing or setback of grazing from the wettest areas (including channels). For every site, riparian plantings should be considered in portions of the site where the elevation is appropriate for growth of shrubs or trees. Woody plantings are often appropriate on natural levees, along tidal channels (which often have their own natural levees), and along the upland edge of the site. All sites would also benefit from protection or establishment of a native vegetated buffer around the margins of the site. Many sites in the study area already have such a buffer, but some do not.

Alterations observed in the Siuslaw estuary are listed in the column “ALT_TYPES” in the site information table (Appendix 4). Alterations are coded as follows: Y=dike, D=ditch, C=restrictive culvert or tidegate; R=road or railroad crossing. “N” indicates no obvious or substantial alterations, other than logging or shrub removal on sites that once had woody vegetation.

Examples of some potential restoration actions for each type of alteration are listed in Table 7 below. Specific decisions among these options (and others) will require careful consideration of site characteristics and restoration goals. Some of the listed restoration actions may be inappropriate for particular sites; only careful onsite assessment can determine the appropriate actions.

Table 7. Restoration options for specific site alterations

Alteration type	Abbreviation	Potential restoration alternatives, from least to most intensive (not a complete list)
Diking	Y	Dike breaching; dike removal; dike setbacks
Ditching	D	Channel meander reconnection; ditch filling; meander restoration
Restrictive culvert/tidegate	C	Tidegate removal; culvert upgrade; installation of tidegate allowing fish passage; installation of self-regulating tidegate for controlled tidal exchange; replace restrictive culvert with bridge
Road/railroad crossing	R	Culvert upgrade; install bridge; raise road/railroad on causeway; realign road/railroad and remove fill
Grazing	G	Pasture management; riparian fencing and plantings; remove livestock (Note: Grazing is listed as an alteration only if the site lacks major structural alterations like dikes, tidegates, and restrictive culverts)
None	N	No restoration action needed, but protect existing wetland, establish buffers, plant trees/shrubs where appropriate in former swamp areas or on natural levees

Beyond the site-specific actions listed above, it is important to consider conservation and restoration of nontidal wetlands and other habitats near the tidal sites in this study. The most effective conservation and restoration projects are those which protect or restore habitat linkages and connections (see Appendix 1, **Restoration Principles**). The slightly-brackish to freshwater tidal zone of the estuary may offer particularly high habitat values (Simenstad and Bottom 2004), so linking these sites to adjacent nontidal wetlands may offer great benefits.

During the course of this study, questions arose about some sites. If possible, these questions should be answered before planning site-specific actions at those sites. The questions and other information needs are briefly described in the site information table (Appendix 4), column "INFO_NEEDS."

Archaeological sites

Before European settlement, Oregon's estuaries were widely used by Native American peoples for dwelling and gathering places and a source of livelihood. Therefore, every estuary restoration project should be conducted with awareness that there may be archaeological sites within or near the project area. State and federal laws prohibit destruction or disturbance of known archaeological sites. In the case of inadvertent discovery of cultural resources, state and federal laws require that the project be halted and the appropriate Tribe be contacted immediately. To understand the historic and cultural context of each site, and to avoid possible impacts to cultural resources in the Siuslaw River estuary, GPC highly recommends consultation with the Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians before beginning project planning. Contact Lisa Morris, Cultural Resource Protection Coordinator for the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians, lmorris@ctclusi.org, 541-888-9577.

Estuary geomorphology

Estuary type and historic changes

The Siuslaw River estuary has been described in several documents, including the Siuslaw Watershed Assessment (Ecotrust 2002) and a 1975 assessment by the U.S. Army Corps of Enginners (US ACE 1979). Like many of Oregon's estuaries, the Siuslaw River estuary is a "drowned river mouth" estuary, with broad tide flats located low in the system. Sediment deposition on these flats during high river flows has led to some expansion of tidal marsh in the lower estuary since the 1850's. For example, a historic vegetation map shows open water throughout the area now occupied by sites 3, 5, 6, 7, 52, and 54. Sites 5 and 6 are reported to have been constructed from dredged material (Lane County Public Works 1991), but shoaling in the area probably contributed to the amount of material to be removed. Sites 11 (Cox Island) and 12 appear to have expanded their marsh area since the 1850's.

Large woody debris

Logging and driftwood removal have radically reduced the availability of large woody debris in Oregon estuaries, and this is probably also true for Siuslaw tidal wetlands. Most Oregon tidal swamps dominated by Sitka spruce were logged early during European settlement, because these sites were very accessible and log transport was easy on the adjacent rivers. Driftwood removal for lumber and firewood has also been widespread in Oregon tidal marshes and swamps. Changes in large wood volumes may have caused major changes in channel dynamics and hydrology. Therefore, large wood placement may be an appropriate restoration strategy for tidal marshes and swamps, along with efforts to increase the general supply of large wood to the basin.

Dredging and dredged material disposal

Dredging in the Siuslaw estuary has altered channel configurations in several areas. Local residents reported that the channel between Cox Island (Site 11) and Site 12 was dredged to allow easier log transportation (see **Site narratives** below). Duncan Inlet was dredged to improve its use for log storage, and the eastern connection of the Inlet to the mainstem river was excavated or deepened. Some local residents state that this connection did not exist prior to the excavation; if this is true, the hydrology of Duncan Inlet has probably changed considerably due to this connection.

Designated dredged material disposal sites are described below.

Natural levees and sediment deposition

Sediment deposition during high river flows has also led to the formation of "natural levees" along riverbanks. Natural levees are common features of many tidal wetlands; they are created gradually through repeated sediment deposition each time a flooding river overtops its bank. The sudden decrease in velocity as the flow crosses the bank causes deposition of coarse sediments on the top of the riverbank. Natural levees are further described in Brophy (2005). Natural levees are easily confused with dikes or filled areas, as they often adjoin tidal or freshwater wetlands.

This study attempted to distinguish between manmade dikes and natural levees, because tidal wetland restoration often involves removal or breaching of manmade dikes, but natural levees should generally be left in place. Field experience and aerial photograph interpretation skills were used to identify dikes as site alterations and distinguish them from natural levees. A combination of slope profile, vegetation, and apparent disturbance were used to distinguish the two types of features. The distinction is sometimes made difficult by the fact that dikes may be built up on top of natural levees. The information gleaned from field observation, aerial photograph interpretation, and local knowledge is noted in the site information table (Appendix 4).

Where a dike appears to have been built atop a high natural levee (e.g., sites 46, 48 and 50), restoration of tidal flow may not need to include dike removal -- the dike can simply be breached. Dikes atop high natural levees do not greatly restrict tidal flows, because most tides do not overtop the pre-existing natural levees. However, lower natural levees may be frequently overtopped, so it may be important to remove or breach dikes built on these lower natural levees. Monitoring of local tidal range is recommended before finalizing restoration plans. If dike removal is to be attempted on a built-up natural levee, careful onsite assessment is recommended, because removal of the natural levee is not desirable. Soil cores can show the depth at which the natural levee meets the added-on dike material.

Riverbank erosion

Erosion of riverbanks is a major concern for landowners in the Siuslaw estuary. Possible causes include basin wide changes in hydrology (peak flows), boat traffic, and loss of riparian vegetation. On Duncan Island, landowners whose homes are located on the mainstem riverbank are particularly concerned over the loss of large trees which are undercut by bank erosion and fall into the river. Measures to reduce erosion, such as reduced boat speeds, riverbank plantings of trees and shrubs, and bioengineered bank stabilization, are recommended to address this concern.

Invasive species

Consistent with statewide protocol (Brophy 2005), this study addressed invasive plant species, but not invasive animal species. Five invasive plant species are of special concern in the Siuslaw estuary: Smooth cordgrass (*Spartina alterniflora*), saltmeadow cordgrass (*Spartina patens*), common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canarygrass (*Phalaris arundinacea*). Many other invasive plants (such as Japanese knotweed, giant knotweed, Scots broom, and Himalayan blackberry) are present within the estuary, but the five species addressed in this section are particularly important in the estuary for several reasons: 1) They are already present in the Siuslaw River estuary, or have been tentatively identified in the estuary; 2) They are wetland plants which can occupy large areas of tidal and formerly tidal marsh sites, to the exclusion of native species; 3) Three of the five (cordgrasses and loosestrife) are on the Oregon Department of Agriculture's "T" list, indicating they are considered economic threats to the state; 4) Four of the five are tolerant of brackish water (all but reed canarygrass), making them particular threats in the estuary.

ODA asks individuals who observe "T" list weed species to call 1-800-INVADER to report the observations. The Siuslaw occurrences of the cordgrass species have already been reported to ODA in the past, but the purple loosestrife has not been reported, as it has not been confirmed. Similarly, the occurrence of the common reed should be reported to ODA when confirmed.

Plant species information is contained in the site information table (Appendix 4); these five invasive species are listed in the column "Plant_spp" for sites where others have documented their presence, or where they were observed or tentatively identified during this project.

Both species of cordgrass are listed by the Oregon State Weed Board as priority noxious weeds, as are other cordgrass species. Smooth cordgrass is considered a particular threat to Oregon estuaries because it colonizes mudflats, forming dense, single-species clones. According to the Oregon Department of Agriculture's website, "Mono-cultures of [smooth] cordgrass alter estuary hydrology and ecosystem functions through increased sedimentation and accretion, raising the elevation of infested areas several feet" (Oregon Department of Agriculture 2005). Such infestations could render thousands of acres of mudflats unsuitable for important economic activities (oyster production), recreational activities (clam harvest), and migratory waterfowl use.

Smooth cordgrass was originally transplanted to Site 3 and nearby areas in the 1970's, before the species was determined to be a noxious weed. It was controlled during the 1990's and was considered eradicated by 1997. However, regrowth from buried rhizomes apparently occurred, and this species was once more observed on Site 3 in 2005. The 2005 sighting (http://web.pdx.edu/~h2mp/spartina.doc) found smooth cordgrass growing amid dense high marsh vegetation of tufted hairgrass, Oregon gumweed, and seashore saltgrass. Active control measures and continued monitoring are once more in place to prevent further spread of this species.

Saltmeadow cordgrass is found on the Cox Island Preserve. This species grows in low to high tidal marsh; like smooth cordgrass, it forms dense clones which exclude native species. Control efforts have been ongoing for a number of years and the populations have been greatly reduced. However, monitoring for this species is important to prevent its further spread and establishment in new areas.

Common reed: During the field work for this project, a tall grass tentatively identified as common reed was observed growing in tidal marsh along upper Duncan Inlet. On the east coast of the U.S., both native and non-native genotypes of this species are present (http://www.invasiveplants.net/phragmites/phrag/morph.htm). The non-native genotypes are considered a major threat to the integrity of east coast tidal marsh. This species has not yet been perceived as such a threat in Oregon tidal marsh, and it is not listed as a noxious weed in Oregon. Its presence in the Siuslaw estuary is not documented in the Oregon Plant Atlas (http://www.oregonflora.org/oregonplantatlas.html). The tentative identification of this species was based on vegetative characteristics only; GPC recommends analysis of specimens that are blooming to verify species identification. Further analysis may be needed to determine whether it is native or non-native, and development of a control strategy is recommended if the plants are determined to be a non-native genotype.

Purple loosestrife is an invasive, non-native wetland plant that is considered a serious risk to freshwater and brackish wetlands throughout the Pacific Northwest. It has not yet been reported from the Siuslaw estuary (http://www.weedmapper.org/lysa2_lane.html) and if present here, it should be controlled as soon as possible. A few plants of this species may have been seen in the upper estuary, but identification could not be verified from the offsite observation points. Landowners should be informed of the possible presence of loosestrife in the estuary, and control efforts should be undertaken as soon as possible if its presence is confirmed.

Reed canarygrass is common in the freshwater tidal portion of the estuary, particularly in disturbed areas and along streambanks. This species not tolerant of brackish water, so it is also common in altered tidal wetlands where brackish tidal water has been excluded by diking, tidegates, or restrictive culverts. Its native or non-native status has been disputed; currently, it is considered to be native, but the invasive populations may be a non-native genotype (Antieau 1993). Regardless of its native or non-native status, it is considered undesirable and is generally invasive, forming dense single-species stands in disturbed sites. At sites where reed canarygrass is dominant, restoration plans should include methods for reed canarygrass control or suppression.

Site narratives

In this section, narrative descriptions are provided for sites in the high and medium-high ranking groups which have particular characteristics of interest. This information may be important for decision-making, and should be reviewed before contacting landowners or taking other actions in the estuary. **For all of these sites, the highest priority action is conservation of the existing wetlands.** Other potential actions are described below and in **Restoration recommendations** above.

Site 1 is a restoration site located near the mouth of the Siuslaw River, behind the North Jetty. This site was probably strongly affected (and perhaps formed) by the rapid accretion of beach sands behind the North Jetty after the jetty's construction in the late 1800's (Komar 1998). The current degree of tidal influence at the site appears low; the North Jetty mutes tidal flow to the site. Plant species observed at the site's south end (north of the North Jetty Road) were freshwater wetland species, and considering the site's location in the marine salinity zone, this suggests tidal flows are indeed very muted. This site may be somewhat impounded by the North Jetty Road and/or the dunes formed after the jetty's construction. However, there is a large and recent culvert under the North Jetty Road, so any impoundment does not appear to be due to an undersized culvert. Elevation measurements could determine how much of the site would be tidally influenced if the North Jetty were lowered or removed; but since jetty alterations are unlikely, this site is most likely to remain a freshwater wetland. Therefore, the highest-priority action for this site is to protect the existing wetlands and surrounding vegetated buffers.

Site 3 is a conservation site, immediately adjacent to a designated DMD site. The site boundaries actually overlap the EPB GIS layer of DMD sites. However, based on the Wilsey and Hamm plan maps (Wilsey and Hamm 1978) the DMD area appears to be south of the tidal marsh, so this site is not shown as a DMD site in the site information table. A mitigation project to removed dredge spoils and restore tidal marsh was conducted on the south edge of this site recently. Also, according to recent ODA reports, smooth cordgrass (*Spartina alterniflora*) was planted on this site in the late 1970's, and its regrowth was documented in 2005 (see **Invasive species** above). Smooth cordgrass removal and annual monitoring are underway to ensure this species does not recur at this site.

Site 11 (Cox Island) is a conservation site and a Nature Conservancy preserve located in the mainstem Siuslaw River just east of Florence. This site is the largest undiked, unditched, fully tidal wetland site in the estuary. This site has no major alterations except for possible hydrologic effects caused by dredging or cutting of the channel that separates it from site 12 just upstream. According to local landowners, the channel between sites 11 and 12 was cut to facilitate log transport from the Siboco facility located at the north end of South Inlet. Cox Island has a number of clones of saltmeadow cordgrass (*Spartina patens*), an invasive species of concern in the Siuslaw estuary. Control of this species is ongoing and has been successful in reducing the area infested, but control and monitoring to prevent re-establishment or spread of the cordgrass will need to continue well into the future. Although this site is essentially unaltered, some Scots broom (*Cytisus scoparius*) was observed on the natural levee on the site's east end; control of this invasive upland species (and any others present) is recommended.

Site 12 is a conservation site, a large undiked tidal marsh site adjacent to Cox Island. It has characteristics similar to Cox Island and the notes for Site 11 apply to this site. This site is the second largest undisturbed tidal marsh in Siuslaw estuary.

Site 13 is a restoration site, but restoration of tidal flows to this site is not currently recommended due to the potential for flooding of low-lying homes adjacent to the site. This site was a muted tidal wetland when observed in summer 2004, with native tidal marsh vegetation dominant in the lower portion. Tidal flows to the site are blocked by a tidegated culvert under Highway 126, and by the highway embankment. According to a local landowner, the tidegate was replaced recently; it had been malfunctioning in recent years, and homes located on low ground near the wetland had been flooding during high tides. Because of the risk of flooding homes, and because of the recent expenditures and efforts to replace the tidegate, restoration of this site by tidegate removal is unlikely and not recommended at this time.

Site 23 is a restoration site just upstream of site 12. This is a diked pasture with a fairly complex dike system. The lower (west) portion of the site has a dike breach that has re-introduced tidal flows to that area, but tidal influence remains muted in that portion due to remaining dikes and channel alterations. The upper (east) portion of the site has intact dikes and is currently nontidal. A proposal to establish a wetland mitigation bank at this site is currently being considered by the Oregon Department of State Lands.

Site 25 (Cushman Slough) is a restoration site; it is a long, narrow wetland located on the north side of Highway 126 just upstream of Cushman. This site was historically connected to tidal channels on site 26 on the other side of the highway. With construction of the highway, the site's channel system was converted to a linear drainage. Despite this hydrologic alteration, the site remains tidally connected to the river under the bridge at the site's west end. The site ranks high in this study due to its good tidal connection, good wetland connectivity, high salmonid diversity, historic swamp status, and high level of vegetation diversity. If restoration of tidal flow to site 26 were to occur, a logical (but expensive) restoration action benefiting both sites would be to reconnect tidal flow under Highway 126 between the two sites, so that site 25 receives tidal flow through the tidal channels on site 26, as it did historically. See site 26 below for further discussion.

Site 26 is the highest-priority restoration site in the study area, and by far the largest and highest-priority single-owner restoration site. The site was historically a tidally-influenced crabapple swamp, an unusual wetland type that has been heavily impacted by coastal development. If the landowner is interested, tidal influence would be readily restorable to this site by modifications or removal of the tidegate at the west end of the site. Other less-intensive restoration options are described below.

Site 26 has a very slight slope upwards from the low ground on the west end (historic tidal channel mouth) up to the higher east end, as well as from the north edge near Highway 126 upwards out to the dike and high natural levee. The dike is most prominent on the west end of the site, and grades into the natural levee on the center and east end of the site. The site's slight natural slope means that a full range of tidal wetland habitat types (from tidal marsh up into tidal swamp) could be re-established without artificial grading.

There are buildings on the east end of site 26 and on its high natural levee. The dike itself forms an access road for the buildings on the natural levee. If the landowner is interested in restoration of tidal flows, a onsite assessment and baseline monitoring should carefully check the elevation of the access road and buildings relative to the local tidal range. This data should be gathered using elevation survey equipment and a locally installed tide gauge. If the elevation data indicate a risk of a high storm surge flooding buildings, a self-regulating tidegate (SRT) could be installed. SRTs can be set to be open at all times except during a storm surge (high water event), when they close. The site may currently experience occasional river flooding over the natural levee; the history of such flooding should also be taken into account in site planning.

Any tidal flow restoration plan for site 26 should address the historic position of the tidal channel and its relationship to Highway 126. The historic vegetation map shows the tidal channel directly under Highway 126. The former tidal channel is currently split between two channels that are now essentially ditches, one north of the highway and one south. The north side channel is on site 25, which appears to have nearly full tidal influence under the bridge at its west end. The south side channel is the tidegated ditch on site 26. Careful monitoring of tidal elevations on site 25 will help reveal the potential range of tidal elevations near the highway and on site 26, particularly since site 26 does not have any freshwater input from hillslope drainage.

Besides restoration of tidal flow, many less-intensive restoration opportunities exist for site 26. Cattle could be moved off the wettest parts of the property, allowing vegetation to regrow. This would improve wildlife habitat and help shade the ditch, cooling the water. Riparian/wetland tree and shrub plantings are also an option for areas at appropriate elevations, particularly on the natural levee/dike.

Site 29 is a large restoring tidal marsh on Duncan Island. This site was a diked pasture during most of the 20th century, with extensive dikes, dams and tidegates to keep tidal flows out of the site. Active restoration is occurring on this site; previous landowners breached one of its dikes and opened a breach in an earthen dam on a major tidal channel. As a result of these restoration actions, most of the site now has muted tidal influence, with some areas nearly fully tidal and others probably muted tidal compared to their historic condition. During field work for this project in 2004, livestock grazing was still active on the higher portions of the site. Those areas continue to be dominated by non-native pasture grasses, but native tidal marsh vegetation is returning to most of the site. Ongoing restoration at this site would improve its functions. Restoration options include further reductions in grazing, riparian and wetland plantings, additional dike breaches, dike removal, and removal or upgrades of any remaining tidegates or restrictive culverts.

Site 36 is the tidal portion of Karnowsky Creek. This site has undergone major restoration in the past few years (Siuslaw National Forest 2005), including dike breaching in 1997 and restoration of the valley’s wetlands and stream channels. Vegetation in the tidal portion is dominated by a mix of native tidal marsh species (softstem bulrush, common cattail, Lyngbye’s sedge, Pacific silverweed, and others), with non-native reed canarygrass dominant in parts of the freshwater tidal area.

Site 41 is a conservation site. Field observation from the road south of Duncan Inlet suggested that this site (and site 42) may have a population of common reed (*Phragmites australis*); its identity should be confirmed if possible. Non-native genotypes of this species are considered a threat to east coast tidal marshes because they form dense monocultures that displace native species. Non-native genotypes of this species may present a threat to Oregon tidal marsh as well. Although site 41 is considered a conservation site because of its relatively undisturbed condition, one restoration option for the site is control of the common reed, should its identity be confirmed. See **Invasive species** above for details.

Site 45 is a restoration site found along Sweet Creek and the tidal slough just north of the mouth of Sweet Creek. Some restoration efforts have already been undertaken here, including riparian plantings. Although tidal flows here currently appear to be unrestricted, Site 45 is classified in this study as a restoration site, because further plantings would help re-establish the tidal swamp conditions that probably characterized this site historically. Control of reed canarygrass will probably be necessary to allow establishment and growth of appropriate woody species.

The water flow connection to the willow swamp area in the east end of site 45 should be checked. Aerial photos seemed to indicate the connection is not currently restricted, but an onsite assessment could verify conditions. If the connection is restricted, opening the connection could improve tidal connectivity.

Site 53 is a conservation site located in a historic swamp area near the mouth of the North Fork Siuslaw River. Historic vegetation mapping describes the site as an "unmappable mixture of shore pine swamp and undifferentiated marsh." Field observations showed spruce, not shore pine, on the upper portions of the site, but this relatively undisturbed site is indeed a mixture of tidal swamp and marsh. Some of the wooded area along the west edge of the site appears to be upland forest; the scope of work for this project did not include determination of the location of wetland boundaries.

Restoration options for site 53 include culvert upgrades to reconnect two small, muted tidal swamps in small valleys northwest of the North Fork Road. These areas were not retained as sites because they were under 1 ha in size, but they should be considered as restoration options for Site 53. Each has a restrictive culvert (no tidegate) under the North Fork Road; in addition, the road embankment probably acts as a dam, blocking diffuse flow. Despite the restrictive culverts, the muted tidal swamp areas still show native tidal swamp vegetation. They also show some vegetation changes due to the elevated water levels caused by impoundment by the restrictive culverts, as well as some exotic species due to disturbance.

Site 56 is a restoration site, a diked pasture that is currently nontidal. A full suite of restoration options exist for this site, including dike removal or breaching, tidegate and restrictive culvert removals or upgrades, reductions in grazing, grazing setbacks from tidal channels, riparian plantings, etc. (see Table 7 and restoration options listed in the site information table, Appendix 4). The dike along the site's northwest edge also serves as an access road for homes north of the site. Any breaches in that portion of the dike would have to be bridged for road access. However, the main tidal channel mouth appears to be at the south end of the site, where there is no road crossing, so a breach there would be more appropriate and logistically easier.

Site 59 is a restoring tidal marsh where two dike breaches were opened recently. Tidal exchange on the site appears to be good, and the site's vegetation appears to be developing on a trajectory towards native tidal marsh. Lyngbye's sedge and tufted hairgrass, both typical native tidal marsh species, are becoming established on the site. If further restoration is desired here, sheet flow across the site could be improved by removing more of the dike and opening one additional breach between the two existing breaches (at the location of a third historic tidal channel).

Site 63 is conservation site, a tidal swamp that currently has muted tidal influence. Historically, this site's primary tidal channel flowed across site 62. Site 62 was diked and tidegated prior to 1939, so the main tidal channel that connected to site 63 has been blocked for decades. However, vegetation on the site seems to indicate that some tidal influence is still present, probably via small tidal channels connecting to the North Fork at the east edge of the site.

Literature cited

Adamus, P.R. 2005a. Rapid Assessment Method for Tidal Wetlands of the Oregon Coast. Volume 1 of a Hydrogeomorphic Guidebook for Tidal Wetlands of the Oregon Coast. Report to Coos Watershed Association, Oregon Department of State Lands, and US Environmental Protection Agency.

Adamus, P.R. 2005b. Scientific Review and Data Analysis Results for Tidal Wetlands of the Oregon Coast. Volume 2 of a Hydrogeomorphic Guidebook for Tidal Wetlands of the Oregon Coast. Report to Coos Watershed Association, Oregon Department of State Lands, and US Environmental Protection Agency.

Adamus, P.R. 2005c. Wetland Profiles of Oregon's Coastal Watersheds and Estuaries. Volume 3 of a Hydrogeomorphic Guidebook for Tidal Wetlands of the Oregon Coast. Report to Coos Watershed Association, Oregon Department of State Lands, and US Environmental Protection Agency.

Adamus, P.R., and D. Field. 2001. Guidebook for Hydrogeomorphic (HGM)-based assessment of Oregon Wetland and Riparian Sites. Oregon Division of State Lands, Salem, OR.

Amezaga, J.M., L. Santamaría, and A.J. Green. 2002. Biotic wetland connectivity—supporting a new approach for wetland policy. Acta Oecologica 23: 213–222.

Antieau, C. J. 1993. Biology and management of reed canarygrass, and implications for ecological restoration. Washington State Department of Transportation, Seattle. Available on the web at http://216.119.67.178/rcgrass/rc_docs.htm.

Benner, P.A. 1992. Historical reconstruction of the Coquille River and surrounding landscape. Sections 3.2, 3.3 in: The action plan for Oregon coastal watersheds, estuaries, and ocean waters. Near Coastal Waters National Pilot Project, Environmental Protection Agency, 1988-1991. Portland, Oregon: Conducted by the Oregon Department of Environmental Quality.

Boule, M.E., and K.F. Bierly. 1987. History of estuarine wetland development and alteration: what have we wrought? Northwest Envir. J. 3(1): 43-61.

Brophy, L.S. (Green Point Consulting). 2005. Estuary Assessment: Component Module of the Oregon Watershed Assessment Manual. Prepared for the Oregon Watershed Enhancement Board, Salem, Oregon. 108 pp.

Brophy, L.S. (Green Point Consulting). 2004. Yaquina estuarine restoration project: Final report. Prepared for the MidCoast Watersheds Council, Newport, OR.

Brophy, L.S. (Green Point Consulting). 1999. Yaquina and Alsea River basins estuarine wetland site prioritization project: Final report. Prepared for the MidCoast Watersheds Council, Newport, OR.

Brophy, L.S. (Green Point Consulting), and K. So. 2005a. Tidal wetland prioritization for the Nehalem River Estuary. Prepared for USFWS Coastal Program, Newport Field Office.

Brophy, L.S. (Green Point Consulting), and K. So. 2005b. Tidal wetland prioritization for the Smith River (Umpqua) Estuary. Prepared for USFWS Coastal Program, Newport Field Office. Prepared by Green Point Consulting, Corvallis, OR.

Brophy, L.S. (Green Point Consulting), and K. So. 2005c. Tidal wetland prioritization for the Umpqua River Estuary. Prepared for USFWS Coastal Program, Newport Field Office. Prepared by Green Point Consulting, Corvallis, OR.

Christy, J.A. 2004. Estimated Loss of Salt Marsh and Freshwater Wetlands within the Oregon Coastal Coho ESU. Oregon Natural Heritage Information Center, Oregon State University. December 2004.

Christy, J. C., E. R. Alverson, M. P. Dougherty, S. C. Kolar, C. W. Alton, S. M. Hawes, J. A. Hiebler, and E. M. Nielsen. 2001. Classification of historic vegetation in Oregon, as recorded by General Land Office surveyors. Oregon Natural Heritage Program, 9 May 2001.

Cornu, C.E. 2005. Restoring Cox, Dalton and Fredrickson Creek Marshes. South Slough NERR Coastal Resource Management Series. CRMS-2005-2. Coos Bay, Oregon.

Costa, J, J. Rockwell and S. Wilkes. 2002. Atlas of Tidally Restricted Salt Marshes in Buzzards Bay Watershed. Buzzards Bay Project National Estuary Program / Massachusetts Office of Coastal Zone Management. Wareham, MA. Available online at http://www.buzzardsbay.org/smatlasmain.htm.

Cortright, R., J. Weber, and R. Bailey. 1987. The Oregon estuary plan book. Oregon Dept. of Land Conservation and Development, Salem, OR. Available online at http://www.inforain.org/mapsatwork/oregonestuary

Costanza, R, R. d'Arge, R. de Groot, S. Farberk, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, & M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253-260.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Performed for Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Dean, T., Z. Ferdana, J. White, and C. Tanner. 2000. Skagit Estuary Restoration Assessment. People for Puget Sound and U.S. Fish and Wildlife Service. May 2000. Available online at http://pugetsound.org/index/pubs#habitat

Ecotrust. 2002. A Watershed Assessment for the Siuslaw Basin. Prepared by Ecotrust, Portland Oregon. Prepared for the Siuslaw Watershed Council. Available at http://www.inforain.org/siuslaw/. Accessed November 2005.

Frenkel, R.E., and J.C. Morlan. 1991. Can we restore our salt marshes? Lessons from the Salmon River, Oregon. The Northwest Environmental Journal 7:119-135.

Good, J.W. 2000. Summary and current status of Oregon's estuarine ecosystems. Section 3.3 in Oregon State of the Environment: Full Report. Oregon Progress Board, Salem, OR. Available online at http://egov.oregon.gov/DAS/OPB/soer2000index.shtml

Good, J. W. 1997. Oregon CZM Profile: Protection of Estuaries and Coastal Wetlands. Unpublished report prepared as part of the National Coastal Zone Effectiveness Study. Corvallis, Oregon: Oregon Sea Grant and Marine Resource Management Program, College of Oceanic and Atmospheric Sciences, Oregon State University.

Gwin, S.E., M.E. Kentula, and P.W. Shaffer. 1999. Evaluating the Effects of Wetland Regulation through Hydrogeomorphic Classification and Landscape Profiles. Wetlands 19(3): 477-489.

Hawes, S.M., J.A. Hiebler, E.M. Nielsen, C.W. Alton & J. A. Christy. 2002. Historic vegetation of the Pacific Coast, Oregon, 1851-1910. ArcView coverage, Version 1.0. Oregon Natural Heritage Information Center, Oregon State University.

Jefferson, C.A. 1975. Plant communities and succession in Oregon coastal salt marshes. Ph.D. thesis, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR. 192 pp.

Komar, P.D. 1998. The Pacific Northwest Coast: Living with the shores of Oregon and Washington. Duke University Press, Durham and London.

Lane County Public Works. 1991. Lane County Rural Comprehensive Plan: Coastal Resources Management Plan. Adopted 1980, revised 1982, 1983, and 1991. Lane County Land Management Division.

Lebovitz, A. 1992. Oregon estuarine conservation and restoration priority evaluation: Opportunities for salmonid habitat and wetlands functional enhancement in Oregon's estuaries. Technical report to Oregon Trout, Portland, Oregon.

McArthur, R.H., and E.O. Wilson. 1967. The theory of island biogeography. Princeton University Press, Princeton, N.J.

Mitsch, W.J. 2000. Self-design applied to coastal restoration. *In* Weinstein, M.P., and D.A. Kreeger. 2000. Concepts and Controversies in Tidal Marsh Ecology. Kluwer, Boston.

Mitsch, W.J. and Gosselink, J.G. 1993. Wetlands (2nd ed.). Van Nostrand Reinhold Co., New York Odum, E.P. 1971. Fundamentals of ecology. W.B. Saunders Co. Philadelphia, PA. 544pp.

National Research Council. 1992. Restoration of aquatic ecosystems: Science, technology and public policy. National Academy Press, Washington, DC.

Oregon Department of Agriculture. 2005. Smooth cordgrass species profile. Available online at http://www.oregon.gov/ODA/PLANT/weed_profile_smoothcordgrass.shtml. Accessed October 2005.

ODFW (Oregon Department of Fish and Wildlife). 2004. Fish distribution/habitat GIS data. Available online at http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm. Accessed 27 December 2004.

Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: A community profile. U.S. Fish Wildl. Serv. FWS/OBS-84/24.

Rozas, L.P., and W.E. Odum. 1988. Occupation of submerged aquatic vegetation by fishes: testing the roles of food and refuge. Oecologia 77: 101-106.

Roth, E., R. Olsen, P. Snow, and R. Sumner. 1996. Oregon Freshwater Wetland Assessment Method. Wetlands Program, Oregon Division of State Lands, Salem, OR.

Scranton, R. 2004. The application of Geographic Information Systems for delineation and classification of tidal wetlands for resource management of Oregon's coastal watersheds. Thesis, Marine Resource Management Program, Oregon State Univ., Corvallis.

Shreffler, D. K. and R. M. Thom. 1993. Restoration of Urban Estuaries; New Approaches for Site Location and Design. Washington Department of Natural Resources, Olympia, WA.

Simenstad, C.A. 2005. Personal communication.

Simenstad, C.A. 1983. The ecology of estuarine channels of the Pacific Northwest coast: A community profile. U.S. Fish Wild. Serv. FWS/OBS-83/05. 181 pp.

Simenstad, C.A., and D.L. Bottom. 2004. Guiding Ecological Principles for Restoration of Salmon Habitat in the Columbia River Estuary. Available online at http://www.fish.washington.edu/research/wet/publications/ecol_principles.doc. Accessed December 21, 2004.

Simenstad, C.A., and B.E. Feist. 1996. Restoration potential of diked estuarine wetlands: Inferring fate and recovery rate of historically-breached sites. University of Washington, School of Fisheries, Wetland Ecosystem Team and U.S. Environmental Protection Agency-Region 10. Subtask 93C8 Phase I Report. EPA publication 910/R96-005. May 1996.

Simenstad, C.A., C.D. Tanner, R.M. Thom, and L.D. Conquest. 1991. Estuarine Habitat Assessment Protocol. EPA/910/9-91-037. U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

Siuslaw National Forest. 2005. Karnowsky Creek Restoration website. http://www.fs.fed.us/r6/siuslaw/projects/restoration/karnowsky. Accessed November 2005.

Thayer, Gordon W., Teresa A. McTigue, Ronald J. Salz, David H. Merkey, Felicity M. Burrows, and Perry F. Gayaldo, (eds.). 2005. Science-Based Restoration Monitoring of Coastal Habitats, Volume Two: Tools for Monitoring Coastal Habitats. NOAA Coastal Ocean Program Decision Analysis Series No. 23. NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. 628 pp. plus appendices.

Thomas, Duncan W. 1983. Changes in Columbia River Estuary habitat types over the past century. Astoria, Or. Columbia River Estuary Data Development Program, Columbia River Estuary Study Taskforce. 98 p.

U.S. Army Corps of Engineers. 1975. The Siuslaw Estuary and the Umpqua Estuary, including the Smith River. Prepared by U.S. Army Engineer District, Portland, Oregon.

White, J., T. Dean, Z. Schwartz, and C. Tanner. 1998. Site selection for estuarine habitat restoration: A model criteria. People for Puget Sound, Seattle, WA. 9 pp.

Wilsey and Ham. 1978. Siuslaw River Dredged Material Disposal Plan. Prepared for Lane County, Oregon.

Zedler, Joy B. 2001. Handbook for restoring tidal wetlands. CRC Press, Boca Raton, FL.

Appendix 1. Restoration principles

Tidal wetland restoration is most likely to be successful if it follows basic principles of restoration design. The titles of the following principles are taken directly from the document, “Guiding ecological principles for restoration of salmon habitat in the Columbia River Estuary” (Simenstad and Bottom, 2004). The discussion of each principle is tailored to reflect concerns specific to Oregon estuaries south of the Columbia River. These principles should be carefully incorporated into every restoration project.

Protect first – restore second

The most immediate need for every current and former tidal wetland site in Oregon is protection of existing wetlands. This is particularly true for unaltered sites, but must also be considered for every altered site. Many former tidal wetlands are currently freshwater wetlands, and many are partially tidal (“muted tidal”) wetlands. Restoration should not result in a net loss of wetland area or functions.

To conserve existing wetlands, the water sources, flow restrictions, and potential hydrologic effects of restoration actions must be carefully considered. In particular, freshwater wetlands formed by impoundment behind a tidal flow restriction (tidegate or restrictive culvert) should be carefully analyzed to determine the likely effects of removing the tidegate or upgrading the culvert. Tidal range outside the restriction must be compared to site elevations within the freshwater wetland, to ensure that restoration will in fact restore tidal wetland and not merely drain the current freshwater wetland.

Do no harm

In this assessment, restoration is defined as "return of an ecosystem to a close approximation of its condition prior to disturbance. ... Restoration is ... a holistic process not achieved through the isolated manipulation of individual elements” (National Research Council 1992). It is important to avoid manipulations that may harm existing wetland functions or prevent recovery of original functions. For example, some tidal wetland restoration projects have included construction of features (such as excavated ponds) that would not have been found in the original, pre-disturbance wetland. Pond excavation may provide more waterfowl habitat (a valued function), but may decrease foraging habitat and protective shelter for juvenile salmon. Excavation of ponds may also prevent recovery of the original site hydrology and associated functions such as nutrient processing and water temperature moderation.

Use natural processes to restore and maintain structure

Tidal wetlands are created by natural processes. The most distinctive and basic of these is tidal flow; others include freshwater input, sediment and detritus deposition. The goal of restoration is to re-establish these natural processes where they have been altered by human disturbance. Restoration is generally more successful, more sustainable, and more cost-effective when it uses natural processes rather than engineered solutions (Simenstad and Bottom 2004; Mitsch 2000).

Restore rather than enhance or create

Enhancement is "the modification of specific structural features of an existing wetland to increase one or more functions based on management objectives, typically done by modifying site elevations or the proportion of open water" (Gwin *et al* 1999). Gwin goes on to state that "Although this term [enhancement] implies gain or improvement, a positive change in one wetland function may negatively affect other wetland functions." Enhancement should not be implemented if it results in a net loss of wetland functions or detracts from the main goal of restoration: to re-establish site conditions that existed prior to disturbance.

Wetland creation means making a wetland where one did not previously exist. By definition, wetland creation sites lack the natural processes that normally create tidal wetlands, so a much higher level of engineering is required to attempt to replicate those natural processes. Wetland creation is often unsuccessful and unsustainable, particularly in the long term, because it relies on human intervention and engineering rather than pre-existing natural forces (Mitsch 2000). Tidal wetland creation (making a new tidal wetland where tidal flow never existed previously) may even cause unexpected problems for other nearby tidal wetlands by altering the natural patterns of tidal flows.

Incorporate salmon life history

Current research is rapidly expanding our knowledge of how salmon use Oregon's tidal wetlands, but our knowledge base is still very limited. To restore tidal wetlands for salmon habitat functions, a landscape approach is needed, focusing on connectivity of habitats and restoration of the full continuum of habitats needed by rearing and migrating juveniles. Some studies have suggested that the slightly brackish (oligohaline) zone of the estuary may be particularly important for osmotic transition, and may need to be strategically targeted for restoration (Simenstad and Bottom 2004). The oligohaline zone includes the tidal swamp habitat that is prioritized in this study.

Develop a comprehensive, strategic restoration plan

This study uses landscape-scale analysis and ecological principles to establish priorities for restoration – an approach that has been called "strategic planning for restoration." Strategic planning is preferable to "opportunistic restoration," which selects sites simply because they are available for restoration. Subsequent action planning should continue to address ecosystem issues such as habitat interconnections, the effects of nearby (or distant) disturbance on project sites, and the relative scarcity of different habitats within the study area.

An important example of a strategic approach is combining tidal and nontidal wetland conservation and restoration actions. Sites in this study that have adjacent nontidal wetlands offer particularly valuable opportunities for protecting or restoring vital habitat connections and linkages. Planning for tidal wetland conservation and restoration should include adjacent nontidal wetlands (and adjacent uplands) whenever possible.

Use history as a guide, but recognize irreversible change

This study identifies all historic tidal wetlands. While most of these sites can probably be restored, some sites may be difficult to restore to their historic wetland type. Subsidence (sinking of the soil surface) can mean that former high marsh and tidal swamp sites restore to mud flats or low marsh rather than their original habitat types. Subsided sites may slowly return to their original elevations through accretion of sediment, but the process may be very slow (Frenkel and Morlan 1991). Human land uses in the estuaries and their watersheds have caused long-term, estuary-wide changes. Examples include altered sediment and detritus deposition patterns; changed peak flows, water circulation patterns, and flooding regimes; and widespread fill, urbanization, and road building. These changes to the fundamental processes that historically created tidal wetlands may affect the "restorability" of some areas.

Field investigations recommended as followup to this study (see **Data limitations** above) will help determine which areas still have adequate tidal flows for restoration of tidal wetlands. Field investigation is particularly important in the upper estuary, where tidal velocities and/or ranges were low even prior to disturbance. These studies should include elevation surveys, water level (tidal range) measurements, plant community analysis, and other measurements as needed to determine the feasibility of restoring tidal influence and tidal wetland habitats at the site. Freshwater inflow to restoration sites should also be evaluated, because these flows also structure tidal wetlands and affect their functions. These analyses are highly technical, so expert assistance is recommended.

Monitor performance both independently and comprehensively

Every tidal wetland restoration site should be monitored using established monitoring protocols (Thayer *et al* 2005; Simenstad and others 1991; Zedler 2001). Monitoring must begin before restoration is designed, because baseline information is needed for critical design decisions. Monitoring should continue long after restoration to determine whether restoration was successful, and to assist in adaptive management. Post-restoration monitoring is also needed to help guide future restoration efforts, because tidal wetland restoration is still very much a developing science.

Use interdisciplinary science and peer review

Interdisciplinary technical assistance is needed for restoration design. Expertise is needed in biology (botany, fish ecology, landscape ecology), hydrology, geology, geophysics, sedimentology, chemistry, statistics, engineering, and other fields. The best approach is to assemble an interdisciplinary team as the first step in the design process. Such a team can help evaluate the biological soundness and feasibility of restoration goals, and can advise on baseline and followup monitoring.

Early consultation with the team is needed to establish baseline monitoring protocols, because baseline data are needed to develop a restoration design. Baseline monitoring will provide solid data on site characteristics critical to restoration design, such as site topography (elevations), tidal range, groundwater hydrology, current fish use, and plant communities (which are good indicators of long-term tidal and hydrologic conditions).

Appendix 2. Restoration approaches

This section provides some general considerations for conservation and restoration actions. GPC recommends consultation with appropriate technical experts for any conservation or restoration project.

Permits and regulatory coordination

Restoration activities often require extensive coordination with many different regulatory agencies. Numerous permits and approvals may be needed, so it's important to start this process early to avoid unexpected obstacles or delays. Early contact with land use planning officials at the City, Port, County, and State levels is recommended to obtain comprehensive information. The Wetlands Division of the Oregon Department of State Lands, (503)-378-3805, can provide information about the process and recommended contacts.

Archaeological sites

Before European settlement, Oregon's estuaries were widely used by Native American peoples for dwelling and gathering places and a source of livelihood. Therefore, every estuary restoration project should consider the possibility that there may be archaeological sites within or near the project area. State and federal laws prohibit destruction or disturbance of known archaeological sites. In the case of inadvertent discovery of cultural resources, state and federal laws require that the project be halted and the appropriate Tribe be contacted immediately. To understand the historic and cultural context of each site, and to avoid possible impacts to cultural resources, every restoration project should begin with consultation with the appropriate tribal groups.

Conservation and habitat linkages

The most immediate need for every site in the study area is conservation of the existing wetlands. This is particularly true for the unaltered sites. Written landowner agreements for conservation (such as conservation easements and deed restrictions) are among the many useful tools for wetland conservation. At a minimum, current stewardship should be continued; additional conservation actions such as establishment of protective buffers may also be important to maintain existing functions. Many conservation and restoration sites offer good opportunities for education. School groups and local organizations can assist in planning, implementing, and monitoring conservation and restoration activities at tidal wetland sites. Public understanding leads to public support of wetland conservation.

It's important to identify and conserve adjacent nontidal wetlands as well as upland habitats when planning conservation at tidal wetland sites. The best conservation plans protect the linkages and connections that are vital to wetland and upland habitat functions. Protecting the gradient from tidal to nontidal wetlands may also help prevent loss of tidal wetlands in the event of sea-level rise due to sudden or gradual geomorphic or large-scale hydrologic change.

Dike breaching and dike removal

The majority of Oregon's tidal wetlands were diked to block tidal flows and allow conversion to pastures. To restore tidal flow to diked sites, dikes can be breached at selected locations, preferably at locations of former natural tidal channels. Or, dikes can be removed completely, enhancing sheet flow, nutrient cycling and natural sedimentation patterns.

Dike breaching and removal can be technically challenging operations, with complex trade-offs in biological functions, hydrology, erosion and deposition patterns, and engineering constraints. Techniques for successful dike breaching and dike removal are still evolving in Oregon, so early consultation with experts (such as wetland scientists, hydrologists, and engineers) is recommended before designing restoration.

Ditch filling and meander restoration

If a site has extensive ditching that has eliminated flow through meandering channels, ditch filling and meander restoration should be considered. Deep, winding natural tidal channels with overhanging banks offer a higher quantity and quality of habitat for fish and other organisms, compared to shallow, broad, straight ditches. To redirect water through meandering remnant or restored channels, ditches may be filled or blocked. Ditch filling is generally more effective than plugging, because the relentless force of tidal ebb and flow will usually erode blockages placed in ditches (Cornu 2005, Brophy 2004). This is particularly true if the ditches are deeper than the remnant tidal channels – generally the case on grazing land where remnant channels are often filled with sediment and ditches are "scoured".

Partial excavation of meandering channels, preferably following visible or surveyed remnant channels, may speed the restoration process. However, excavation is not always recommended, and this process presents complex design questions and challenges. Excessive excavation of channels may dewater adjacent areas, much as ditching can. Input from experts (such as tidal wetland scientists, hydrologists, geomorphologists, and engineers) is required for this aspect of restoration.

If tidal action is strong at a site, excavation of remnant channels maybe unnecessary. "Self-design," in which water flows are allowed to create their own meandering path through processes of erosion and deposition, may be the best approach in many cases (Mitsch 2000). Self-design avoids the dilemma of water "not going where the engineers want it to go." Self-design also encourages diffuse flow of water across the site, which contributes to natural restoration of wetlands.

Culvert and tidegate upgrades

It can be difficult for basin-wide tidal wtland studies to assess conditions at specific tidegates and restrictive culverts. These structures can't be directly viewed on aerial photographs, and they are difficult to characterize during brief field trips because they are often underwater at mid- to high tide, and/or hidden under overhanging vegetation.

During initial site-specific planning, careful evaluation is needed for all water inlets and outlets to and from candidate restoration or conservation sites. Particular attention should be paid to culvert invert elevations (the elevation of the bottom of the culvert above the streambed), the action of tidegates (free or impeded), differences in water levels at the upstream and downstream ends of culverts, impounded water on the upslope side, velocities of flows relative to surrounding water bodies, and other characteristics that reveal flow restrictions. Where existing culverts are impounding water on the upslope side, culvert upgrades can sometimes cause drainage and loss of freshwater wetlands. If a proposed culvert upgrade might drain impounded wetlands, this loss should be balanced against the ecological functions that would be improved by the upgrade.

One restoration option is installation of "fish-friendly" tidegates, which increase fish access to streams and wetlands above the gate. Such devices may be a good choice where a landowner does not want to restore tidal flow. However, providing fish access to a site does not restore the ecological functions of tidal wetlands if tidal flow is still impeded. Tidegate removal (often accompanied by a culvert upgrade) is a better option for restoration of the full tidal wetland ecosystem, but the caveats above apply in all cases.

Water flow issues and property protection

Tidal wetland restoration usually alters surface water flows, and careful planning is necessary to ensure this does not damage property. Many tidal wetlands can be restored with no risk to adjacent properties, because the restoration sites are usually at a considerably lower elevation than nearby structures. However, it is still important to accurately assess existing conditions and proposed changes to site hydrology and flow patterns when planning restoration. Particular attention should be paid to topography, elevations of structures, tidal range, water table depths, and surface and subsurface water flow. Tidal range should be monitored during both normal and extreme events of tidal action, river or stream flow, and precipitation. The potential effects of water flow changes on nearby structures and properties should be carefully considered. Hydrologists and engineers experienced in the tidal zone can offer very useful advice.

Buffer establishment

Buffers around wetlands can greatly improve their functions by protecting habitats from sediment and nutrient-laden runoff, invasive species, fill intrusion, and other disruptive effects of human land uses. In addition, interfaces between wetlands and uplands are heavily used by many species of wildlife.

Buffer establishment around the margins of wetland sites should preferentially use native upland plantings. Native plantings require a weed control plan. Technical help from experts in native plant restoration and weed control is recommended.

Fill removal

The most expensive type of restoration is removal of large areas of fill material. Former wetlands that have been entirely filled were excluded from this study. Most of these areas have been converted to economically valuable uses like residential developments and commercial operations. Besides the expense and controversy that would surround restoration proposals in such areas, restoration is also less likely to succeed, because the original soils are gone and there are few native plant communities nearby to provide seeds and propagules for revegetation.

However, some sites have small areas of fill which could be removed to improve wetland functions. Old roadways that are no longer used, former home sites abandoned due to frequent flooding, and small areas of dredged material offer such opportunities.

Grazing reductions

Many coastal ag lands are used for pastures, and the resulting livestock production contributes to the local economy. However, livestock grazing alters plant communities and the physical structure of tidal and formerly tidal wetlands. Livestock degrade tidal channels, lowering the quality of fish habitat and altering water characteristics. Grazing compacts soils, leading to oxidation of soil organic matter and major changes in biological soil processes. Because grazing greatly reduces many wetland functions, removal or reduction of grazing is an important component of many tidal wetland restoration projects. The lowest, wettest portions of pastures may provide poor grazing and little economic return, so they are good candidates for grazing reductions and setasides. Expansion of grazing setasides beyond the boundaries of wetlands is also desirable, in order to establish upland buffers that enhance the biological functions of the wetland (see **Buffer establishment** above).

Appendix 3. Ranking tables

Table 1. Ranking factor scores and total score, sorted by rank (top to bottom)

Site ID	Size score	Tidal channel condition score*	Wetland connectivity score	Salmonid diversity score	Historic swamp score	Current vegetation diversity score	Total score*	Ranking group
53	1.8	5.0	4.0	5.0	3.3	5.0	29.0746	High
11	3.3	5.0	4.8	5.0	2.3	3.0	28.4486	High
12	3.1	5.0	4.9	5.0	1.5	3.0	27.4738	High
55	1.3	5.0	3.3	5.0	3.7	3.0	26.3171	High
59	2.0	5.0	3.7	5.0	4.5	1.0	26.2007	High
45	1.9	5.0	1.2	5.0	3.0	5.0	26.0946	High
25	1.2	3.0	5.0	5.0	2.9	5.0	25.0808	High
9	1.1	5.0	2.6	5.0	1.0	5.0	24.6817	High
29	5.0	4.0	3.2	5.0	2.1	1.0	24.2592	High
28	1.1	4.5	3.4	5.0	4.7	1.0	24.2050	High
33	1.1	5.0	3.3	3.7	1.0	5.0	24.0140	High
7	1.2	5.0	3.7	5.0	1.0	3.0	23.9037	High
10	1.0	5.0	3.5	5.0	1.0	3.0	23.5198	High
41	1.7	5.0	1.3	5.0	4.3	1.0	23.3300	High
15	1.3	5.0	4.1	3.7	1.0	3.0	23.0316	Medium-high
13	1.0	3.0	5.0	5.0	1.0	5.0	23.0294	Medium-high
1	1.2	4.5	1.6	5.0	1.0	5.0	22.8475	Medium-high
54	1.6	5.0	4.1	5.0	1.0	1.0	22.6627	Medium-high
34	1.1	5.0	2.4	3.7	2.5	3.0	22.6303	Medium-high
23	2.5	4.0	4.2	5.0	1.9	1.0	22.6137	Medium-high
3	1.3	5.0	2.2	5.0	1.0	3.0	22.5331	Medium-high
56	2.2	2.0	4.1	5.0	4.1	3.0	22.4724	Medium-high
8	1.0	5.0	4.4	5.0	1.0	1.0	22.4552	Medium-high
26	3.5	2.5	3.7	5.0	4.2	1.0	22.4384	Medium-high
44	1.3	3.5	1.1	5.0	3.0	5.0	22.3808	Medium-high
65	1.1	4.5	3.2	5.0	1.0	3.0	22.2995	Medium-high
63	1.1	3.5	3.1	5.0	5.0	1.0	22.1477	Medium-high
31	1.1	5.0	3.1	3.7	1.2	3.0	22.0639	Medium-high
51	1.0	5.0	3.9	5.0	1.0	1.0	21.9215	Medium
30	1.1	5.0	3.1	3.7	1.0	3.0	21.8675	Medium
60	2.3	1.5	3.8	5.0	4.7	3.0	21.8308	Medium
52	1.1	5.0	3.7	5.0	1.0	1.0	21.7238	Medium
6	1.1	5.0	3.6	5.0	1.0	1.0	21.6735	Medium
47	1.2	4.0	1.2	5.0	3.0	3.0	21.4009	Medium
42	1.0	5.0	1.3	5.0	1.0	3.0	21.3871	Medium
5	1.1	5.0	3.2	5.0	1.0	1.0	21.3689	Medium
38	1.1	4.5	1.8	5.0	1.3	3.0	21.2355	Medium
17	1.5	2.5	4.2	2.3	3.1	5.0	21.1755	Medium

Site ID	Size score	Tidal channel condition score*	Wetland connectivity score	Salmonid diversity score	Historic swamp score	Current vegetation diversity score	Total score*	Ranking group
4	1.0	5.0	2.9	5.0	1.0	1.0	20.9494	Medium
14	1.0	5.0	4.5	1.0	1.0	3.0	20.5484	Medium
62	1.2	1.5	3.3	5.0	4.9	3.0	20.4538	Medium
57	1.7	3.0	3.5	1.0	4.8	3.0	19.9618	Medium
2	1.2	5.0	1.7	5.0	1.0	1.0	19.9108	Medium-low
40	1.0	5.0	1.7	5.0	1.0	1.0	19.7156	Medium-low
70	1.2	5.0	1.4	5.0	1.0	1.0	19.5366	Medium-low
64	2.0	2.0	2.9	5.0	2.5	3.0	19.3789	Medium-low
46	1.2	3.0	1.1	5.0	3.0	3.0	19.3409	Medium-low
49	1.2	3.0	1.1	5.0	3.0	3.0	19.2517	Medium-low
61	1.2	2.5	4.0	1.0	3.0	5.0	19.1028	Medium-low
16	1.3	4.5	4.1	2.3	1.3	1.0	18.9762	Medium-low
35	1.2	3.0	2.3	3.7	4.6	1.0	18.8026	Medium-low
32	2.1	1.5	3.1	3.7	1.9	5.0	18.7482	Medium-low
19	1.1	4.5	2.2	2.3	1.0	3.0	18.5438	Medium-low
36	1.5	4.5	2.0	3.7	1.0	1.0	18.1318	Medium-low
22	1.0	5.0	3.9	1.0	1.0	1.0	17.9317	Medium-low
18	1.0	4.5	3.3	2.3	1.0	1.0	17.6049	Medium-low
24	1.1	5.0	3.2	1.0	1.0	1.0	17.3065	Low
68	2.5	1.5	2.8	5.0	1.0	3.0	17.2888	Low
58	1.3	3.0	3.9	1.0	1.7	3.0	16.8700	Low
66	1.2	1.0	2.4	2.3	4.9	3.0	15.8751	Low
50	1.5	2.0	1.0	5.0	3.0	1.0	15.4864	Low
37	1.1	2.5	1.9	5.0	1.0	1.0	14.9720	Low
43	1.3	2.5	1.3	5.0	1.2	1.0	14.8021	Low
48	1.5	1.5	1.2	5.0	3.0	1.0	14.7191	Low
20	1.7	2.5	1.2	2.3	1.3	3.0	14.5972	Low
67	1.1	2.5	2.7	1.0	1.1	3.0	13.8513	Low
39	1.1	1.5	1.8	5.0	1.0	1.0	12.8922	Low
69	1.2	1.5	2.3	2.3	1.0	3.0	12.7506	Low
21	1.1	2.0	1.0	1.0	1.0	3.0	11.1621	Low
27	1.0	2.0	3.0	1.0	1.0	1.0	10.9842	Low

*Tidal channel condition score is double-weighted in calculating the total score.

Table 2. Ranking factor scores and total score, sorted by site

Site ID	Size score	Tidal channel condition score*	Wetland connectivity score	Salmonid diversity score	Historic swamp score	Cowardin class diversity score	Total score*	Ranking group
1	1.2	4.5	1.6	5.0	1.0	5.0	22.8475	Medium-high
2	1.2	5.0	1.7	5.0	1.0	1.0	19.9108	Medium-low
3	1.3	5.0	2.2	5.0	1.0	3.0	22.5331	Medium-high
4	1.0	5.0	2.9	5.0	1.0	1.0	20.9494	Medium
5	1.1	5.0	3.2	5.0	1.0	1.0	21.3689	Medium
6	1.1	5.0	3.6	5.0	1.0	1.0	21.6735	Medium
7	1.2	5.0	3.7	5.0	1.0	3.0	23.9037	High
8	1.0	5.0	4.4	5.0	1.0	1.0	22.4552	Medium-high
9	1.1	5.0	2.6	5.0	1.0	5.0	24.6817	High
10	1.0	5.0	3.5	5.0	1.0	3.0	23.5198	High
11	3.3	5.0	4.8	5.0	2.3	3.0	28.4486	High
12	3.1	5.0	4.9	5.0	1.5	3.0	27.4738	High
13	1.0	3.0	5.0	5.0	1.0	5.0	23.0294	Medium-high
14	1.0	5.0	4.5	1.0	1.0	3.0	20.5484	Medium
15	1.3	5.0	4.1	3.7	1.0	3.0	23.0316	Medium-high
16	1.3	4.5	4.1	2.3	1.3	1.0	18.9762	Medium-low
17	1.5	2.5	4.2	2.3	3.1	5.0	21.1755	Medium
18	1.0	4.5	3.3	2.3	1.0	1.0	17.6049	Medium-low
19	1.1	4.5	2.2	2.3	1.0	3.0	18.5438	Medium-low
20	1.7	2.5	1.2	2.3	1.3	3.0	14.5972	Low
21	1.1	2.0	1.0	1.0	1.0	3.0	11.1621	Low
22	1.0	5.0	3.9	1.0	1.0	1.0	17.9317	Medium-low
23	2.5	4.0	4.2	5.0	1.9	1.0	22.6137	Medium-high
24	1.1	5.0	3.2	1.0	1.0	1.0	17.3065	Low
25	1.2	3.0	5.0	5.0	2.9	5.0	25.0808	High
26	3.5	2.5	3.7	5.0	4.2	1.0	22.4384	Medium-high
27	1.0	2.0	3.0	1.0	1.0	1.0	10.9842	Low
28	1.1	4.5	3.4	5.0	4.7	1.0	24.2050	High
29	5.0	4.0	3.2	5.0	2.1	1.0	24.2592	High
30	1.1	5.0	3.1	3.7	1.0	3.0	21.8675	Medium
31	1.1	5.0	3.1	3.7	1.2	3.0	22.0639	Medium-high
32	2.1	1.5	3.1	3.7	1.9	5.0	18.7482	Medium-low
33	1.1	5.0	3.3	3.7	1.0	5.0	24.0140	High
34	1.1	5.0	2.4	3.7	2.5	3.0	22.6303	Medium-high
35	1.2	3.0	2.3	3.7	4.6	1.0	18.8026	Medium-low
36	1.5	4.5	2.0	3.7	1.0	1.0	18.1318	Medium-low
37	1.1	2.5	1.9	5.0	1.0	1.0	14.9720	Low
38	1.1	4.5	1.8	5.0	1.3	3.0	21.2355	Medium
39	1.1	1.5	1.8	5.0	1.0	1.0	12.8922	Low
40	1.0	5.0	1.7	5.0	1.0	1.0	19.7156	Medium-low
41	1.7	5.0	1.3	5.0	4.3	1.0	23.3300	High

Site ID	Size score	Tidal channel condition score*	Wetland connectivity score	Salmonid diversity score	Historic swamp score	Cowardin class diversity score	Total score*	Ranking group
42	1.0	5.0	1.3	5.0	1.0	3.0	21.3871	Medium
43	1.3	2.5	1.3	5.0	1.2	1.0	14.8021	Low
44	1.3	3.5	1.1	5.0	3.0	5.0	22.3808	Medium-high
45	1.9	5.0	1.2	5.0	3.0	5.0	26.0946	High
46	1.2	3.0	1.1	5.0	3.0	3.0	19.3409	Medium-low
47	1.2	4.0	1.2	5.0	3.0	3.0	21.4009	Medium
48	1.5	1.5	1.2	5.0	3.0	1.0	14.7191	Low
49	1.2	3.0	1.1	5.0	3.0	3.0	19.2517	Medium-low
50	1.5	2.0	1.0	5.0	3.0	1.0	15.4864	Low
51	1.0	5.0	3.9	5.0	1.0	1.0	21.9215	Medium
52	1.1	5.0	3.7	5.0	1.0	1.0	21.7238	Medium
53	1.8	5.0	4.0	5.0	3.3	5.0	29.0746	High
54	1.6	5.0	4.1	5.0	1.0	1.0	22.6627	Medium-high
55	1.3	5.0	3.3	5.0	3.7	3.0	26.3171	High
56	2.2	2.0	4.1	5.0	4.1	3.0	22.4724	Medium-high
57	1.7	3.0	3.5	1.0	4.8	3.0	19.9618	Medium
58	1.3	3.0	3.9	1.0	1.7	3.0	16.8700	Low
59	2.0	5.0	3.7	5.0	4.5	1.0	26.2007	High
60	2.3	1.5	3.8	5.0	4.7	3.0	21.8308	Medium
61	1.2	2.5	4.0	1.0	3.0	5.0	19.1028	Medium-low
62	1.2	1.5	3.3	5.0	4.9	3.0	20.4538	Medium
63	1.1	3.5	3.1	5.0	5.0	1.0	22.1477	Medium-high
64	2.0	2.0	2.9	5.0	2.5	3.0	19.3789	Medium-low
65	1.1	4.5	3.2	5.0	1.0	3.0	22.2995	Medium-high
66	1.2	1.0	2.4	2.3	4.9	3.0	15.8751	Low
67	1.1	2.5	2.7	1.0	1.1	3.0	13.8513	Low
68	2.5	1.5	2.8	5.0	1.0	3.0	17.2888	Low
69	1.2	1.5	2.3	2.3	1.0	3.0	12.7506	Low
70	1.2	5.0	1.4	5.0	1.0	1.0	19.5366	Medium-low

*Tidal channel condition score is double-weighted in calculating the total score.

Appendix 4. Site information table

Table 1. Key to site information table fields (and site shapefile attributes)

Shapefile field name	Field description
SITE_ID	Site number. Sites are numbered upwards from ocean to head of tide. Sites on the mainstem are sites 1-50 and site 70; sites 51-69 are on the North Fork.
SOURCE	Source of GIS data (site polygon)
SHAPE_AREA	Area of site (sq m)
OWN_TYP	Ownership category (Federal, state, county, port, private industrial, private non-industrial, or mixed)
MAJ_ZONE	Primary generalized land use zoning, excluding water (from DLCD)
CRMP_DMD	Is site shown in the Coastal Resource Management Plan (part of the Lane Count Rural Comprehensive Plan) as a designated dredged material disposal (DMD) site?
ALT_TYP	Types of alterations on site. C=restrictive culvert or tidegate; D=ditching; F=fill; G=grazed (only listed if no other major alterations); R=road/RR crosses site; X=excavation; Y=dike
SITE_SZ	Size of site in hectares
SIZE_SCO	Size score (scale of 1 to 5, 5 is largest)
TID_X	Tidal exchange score (1=none, 3=restricted, 5=full)
TG_LOC	Tidegate location score (1=offsite, 3=onsite, 5=no tidegate)
DITCH	Ditching score (1=heavily ditched, 3=somewhat ditched, 5=unditched)
RMCH	Remnant channel score (1=no remnant channels, 3=some, 5=many)
TCC_SUM	Tidal channel condition sum (TID_X + TG_LOC + DITCH + RMCH)
TCC_SCO	Tidal channel condition score (TCC_SUM/4)
WLCN_SQM	Area of other wetlands within 1 mile buffer (sq m)
WLCN_HA	Area of other wetlands within 1 mile buffer (ha)
WLCN_SCO	Wetland connectivity score (scale of 1 to 5)
NSTOCKS	Number of salmonid stocks spawning above site in mainstem or tributary
NTYP_SCO	Score for number of salmonid stocks (scale of 1 to 5)
SWMP_SZ	Area of site that was historically swamp (forested wetland) (sq m)
SWMP_PCT	Percent of site that was historically swamp (forested or scrub-shrub wetland)
SWMP_SCO	Score for percent of site that was historically swamp (scale of 1 to 5)
EM_TOTAL	Total area of NWI-mapped emergent wetlands on site
EM_PCT	Percent of site that is mapped as emergent wetland in NWI
SS_TOTAL	Total area of NWI-mapped scrub-shrub wetlands on site
SS_PCT	Percent of site that is mapped as scrub-shrub wetland in NWI
FO_TOTAL	Total area of NWI-mapped forested wetlands on site
FO_PCT	Percent of site that is mapped as forested wetland in NWI
ESF_TOT	Total area of NWI-mapped emergent, scrub-shrub and forested wetlands on site
ESF_PCT	Percent of site that is mapped as emergent, scrub-shrub and forested wetlands in NWI
N_CWDN	Number of NWI-mapped Cowardin classes (EM, SS, FO) on site
CWDN_SCO	Score for number of NWI Cowardin classes on site (1 class=score of 1, 2 classes=score of 3, 3 classes=score of 5)
TOT_SCO	Sum of all 6 component scores, with tidal channel condition double-weighted. TOT_SCO = SZ_SCO + 2(TCC_SCO) + WLCN_SCO + NTYP_SCO + SWMP_SCO + CWDN_SCO.

Shapefile field name	Field description
REST_CON	Category of site (restoration site or conservation/protection site)
Lot1	Map lot number occupying highest % of site area (>5%)
Lot2	Map lot number occupying 2nd highest % of site area (>5%)
Lot3	Map lot number occupying 3rd highest % of site area (>5%)
Lot4	Map lot number occupying 4th highest % of site area (>5%)
Lot5	Map lot number occupying 5th highest % of site area (>5%)
Lot6	Map lot number occupying 6th highest % of site area (>5%)
Zone_top	Generalized land use zoning category occupying highest % of site area (>20%)
Zone_2nd	Generalized land use zoning category occupying 2nd highest % of site area (>20%)
Bufzn1	Generalized land use zoning category occupying highest % of 500m buffer around site
Bfzn1pct	% of 500m buffer occupied by bufzn1 land use category
Bufzn2	Generalized land use zoning category occupying 2nd highest % of 500m buffer around site
Bfzn2pct	% of 500m buffer occupied by bufzn2 land use category
Bufzn3	Generalized land use zoning category occupying 3rd highest % of 500m buffer around site
Bfzn3pct	% of 500m buffer occupied by bufzn3 land use category
GPC_NOTES	Notes about site characteristics
INFO_NEEDS	Information needs for site characterization
NXT_STEP	Recommended next step for site
VEG_TYP	Notes on tidal wetland habitat type and vegetation at site
PLANT_SPP	Plant species observed on site
REST_OPT	Restoration options, in order from most intensive to least intensive (not all possibilities are listed)
LIMITS	Potential limits, obstacles or challenges to restoration or conservation
EXIST_REST	Existing deliberate actions taken onsite to restore tidal flows
RANK_GRP	Ranking group

Table 2. Key to plant species codes in site information table

Species	Abbreviation	Common name
Achillea millefolium	ACHMILL	yarrow
Agrostis spp.	Agrostis	bentgrass
Agrostis stolonifera (A. alba)	AGRSTO	creeping bentgrass
Alnus rubra	ALNRUB	red alder
Alopecurus pratensis	ALOPRA	meadow foxtail
Argentina egedii	ARGEGE	Pacific silverweed
Carex lyngbyei	CARLYN	Lyngbye's sedge
Carex obnupta	CAROBN	slough sedge
Deschampsia caespitosa	DESCES	Tufted hairgrass
Distichlis spicata	DISSPI	Seashore saltgrass
Eleocharis palustris	ELEPAL	Creeping spikerush
Erechtites minima	EREMIN	Coast burnweed
Festuca arundinacea	FESARU	tall fescue
Festuca rubra	FESRUB	Red fescue
Grindelia stricta	GRISTR	Gumweed
Holcus lanatus	HOLLAN	common velvetgrass
Juncus balticus	JUNBAL	Baltic rush
Juncus effusus	JUNEFF	soft rush
Juncus lesueurii	JUNLES	salt rush
Lilaeopsis occidentalis	LILOCC	Lilaeopsis
Lolium perenne	LOLPER	perennial ryegrass
Lonicera involucrata	LONINV	black twinberry
Lotus corniculatus	LOTCOR	birdsfoot trefoil
Lysichiton americanus	LYSAME	skunk cabbage
Lythrum salicaria	LYTSAL	purple loosestrife
Malus fusca	MALFUS	Pacific crabapple
Oenanthe sarmentosa	OENSAR	water parsley
Phalaris arundinacea	PHAARU	reed canarygrass
Phragmites australis (=P. communis)	PHRAUS	common reed
Picea sitchensis	PICSIT	Sitka spruce
Pinus contorta	PINCON	shore pine
Ranunculus repens	RANREP	creeping buttercup
Rhamnus purshiana	RHAPUR	cascara
Rumex spp.	Rumex	dock
Salicornia virginica	SALVIR	pickleweed
Salix spp.	Salix	willows
Salix hookeriana	SALHOO	dune willow
Schoenoplectus (Scirpus) maritimus	SCHMAR	seacoast bulrush
Schoenoplectus (Scirpus) microcarpus	SCHMIC	small-fruited bulrush
Schoenoplectus (Scirpus) tabernaemontani	SCHTAB	softstem bulrush
Schoenoplectus (Scirpus) acutus	SCHACU	hardstem bulrush
Spiraea douglasii	SPIDOU	rose spiraea
Trifolium repens	TRIREP	white clover
Typha latifolia	TYPLAT	broadleaf cattail

(This page intentionally left blank)

SITE_ID	SOURCE	SHAPE _AREA	OWN_ TYPE	CRMP_ DMD	ALT_TYP	SITE_SZ	SIZE_SCO	TID_X	TG_LOC	DITCH	RMCH	TCC_SUM	TCC_SCO	WLCN_SQM
1	HGM	79248	State	N	Y,C	7.92	1.20	3	5	5	5	18	4.50	727525.66
2	NWI	87297	Federal	N	None	8.73	1.22	5	5	5	5	20	5.00	760921.42
3	HGM	114872	Mixed	N	None	11.49	1.30	5	5	5	5	20	5.00	1212024.80
4	HGM	10359	Mixed	N	None	1.04	1.00	5	5	5	5	20	5.00	1806460.31
5	HGM	57998	Port	N	None	5.80	1.14	5	5	5	5	20	5.00	2041401.80
6	HGM	41050	Port	N	None	4.11	1.09	5	5	5	5	20	5.00	2334607.10
7	HGM	71908	State	N	None	7.19	1.18	5	5	5	5	20	5.00	2452298.20
8	HGM	25096	Private non-industrial	N	None	2.51	1.04	5	5	5	5	20	5.00	3021691.21
9	HGM	50963	Private non-industrial	N	None	5.10	1.12	5	5	5	5	20	5.00	1487480.67
10	HGM	10687	Mixed	N	None	1.07	1.00	5	5	5	5	20	5.00	2279244.09
11	HGM	798241	Private non-industrial	N	None	79.82	3.26	5	5	5	5	20	5.00	3377199.24
12	HGM	730685	Mixed	N	None	73.07	3.07	5	5	5	5	20	5.00	3417800.50
13	HGM	20367	Private non-industrial	N	Y,C,R	2.04	1.03	1	3	3	5	12	3.00	3509750.84
14	HGM	22681	Mixed	N	None	2.27	1.04	5	5	5	5	20	5.00	3104863.28
15	HGM	115718	Mixed	N	None	11.57	1.30	5	5	5	5	20	5.00	2731010.95
16	HGM	106173	Mixed	N	R	10.62	1.28	3	5	5	5	18	4.50	2726382.55
17	HGM	198660	Private industrial	N	Y,D,C,R	19.87	1.54	1	3	1	5	10	2.50	2826093.04
18	HGM	10109	Private non-industrial	N	Y,C,R	1.01	1.00	3	5	5	5	18	4.50	2074545.75
19	HGM	30016	Private industrial	N	Y,C,R	3.00	1.06	3	5	5	5	18	4.50	1146123.00
20	HGM	264705	Mixed	N	Y,D,C,R	26.47	1.73	1	3	1	5	10	2.50	368840.36
21	HGM	51473	Private non-industrial	N	Y,C offsite; C,D onsite	5.15	1.12	1	1	3	3	8	2.00	224506.35
22	HGM	21086	Private industrial	N	R	2.11	1.03	5	5	5	5	20	5.00	2596535.48
23	HGM	550151	Mixed	Y	Y,D,C	55.02	2.55	3	5	3	5	16	4.00	2808624.20
24	HGM	37867	Mixed	Y	None	3.79	1.08	5	5	5	5	20	5.00	2037497.43
25	HGM	92394	Mixed	N	Y,C	9.24	1.24	3	5	1	3	12	3.00	3488655.04

SITE_ID	WLCN_HA	WLCN_SCO	NSTOCKS	NTYP_SCO	SWMP_SZ	SWMP_PCT	SWMP_SCO	EM_TOTAL	EM_PCT	SS_TOTAL	SS_PCT	FO_TOTAL	FO_PCT	ESF_TOT	ESF_PCT
1	72.75	1.65	3	5	0.00	0.00	1.00	32138.74	40.55	7497.93	9.46	8367.85	10.56	48004.52	60.57
2	76.09	1.69	3	5	0.00	0.00	1.00	62256.10	71.32	0.00	0.00	0.00	0.00	62256.10	71.32
3	121.20	2.23	3	5	0.00	0.00	1.00	97624.50	84.99	0.00	0.00	7619.86	6.63	105244.36	91.62
4	180.65	2.95	3	5	0.00	0.00	1.00	5189.34	50.10	0.00	0.00	0.00	0.00	5189.34	50.10
5	204.14	3.23	3	5	0.00	0.00	1.00	53707.79	92.60	0.00	0.00	0.00	0.00	53707.79	92.60
6	233.46	3.58	3	5	0.00	0.00	1.00	37812.73	92.11	0.00	0.00	0.00	0.00	37812.73	92.11
7	245.23	3.73	3	5	0.00	0.00	1.00	64422.67	89.59	0.00	0.00	325.32	0.45	64747.99	90.04
8	302.17	4.41	3	5	0.00	0.00	1.00	16276.66	64.86	0.00	0.00	0.00	0.00	16276.66	64.86
9	148.75	2.56	3	5	0.00	0.00	1.00	19989.84	39.22	20773.33	40.76	1301.77	2.55	42064.93	82.54
10	227.92	3.52	3	5	0.00	0.00	1.00	7190.85	67.28	0.00	0.00	604.77	5.66	7795.62	72.94
11	337.72	4.84	3	5	269206.08	33.72	2.35	747148.37	93.60	0.00	0.00	14152.93	1.77	761301.30	95.37
12	341.78	4.89	3	5	94802.73	12.97	1.52	684071.26	93.62	0.00	0.00	20299.31	2.78	704370.56	96.40
13	350.98	5.00	3	5	0.00	0.00	1.00	13573.36	66.65	1062.87	5.22	17.63	0.09	14653.86	71.95
14	310.49	4.51	0	1	0.00	0.00	1.00	16884.48	74.44	0.00	0.00	692.05	3.05	17576.53	77.49
15	273.10	4.06	2	4	0.00	0.00	1.00	73150.56	63.21	0.00	0.00	1500.53	1.30	74651.09	64.51
16	272.64	4.06	1	2	8252.87	7.77	1.31	93820.20	88.37	0.00	0.00	0.00	0.00	93820.20	88.37
17	282.61	4.18	1	2	105534.87	53.12	3.13	81741.07	41.15	305.90	0.15	1157.95	0.58	83204.92	41.88
18	207.45	3.27	1	2	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	114.61	2.15	1	2	0.00	0.00	1.00	23714.77	79.01	0.00	0.00	2737.94	9.12	26452.72	88.13
20	36.88	1.22	1	2	20955.14	7.92	1.32	158637.16	59.93	0.00	0.00	876.81	0.33	159513.96	60.26
21	22.45	1.04	0	1	0.00	0.00	1.00	13260.13	25.76	0.00	0.00	299.11	0.58	13559.23	26.34
22	259.65	3.90	0	1	0.00	0.00	1.00	15429.82	73.18	0.00	0.00	0.00	0.00	15429.82	73.18
23	280.86	4.16	3	5	125164.13	22.75	1.91	516662.75	93.91	0.00	0.00	0.00	0.00	516662.75	93.91
24	203.75	3.23	0	1	0.00	0.00	1.00	32069.59	84.69	0.00	0.00	0.00	0.00	32069.59	84.69
25	348.87	4.97	3	5	43199.63	46.76	2.87	40659.19	44.01	1601.39	1.73	15261.67	16.52	57522.26	62.26

SITE_ID	N_CWDN	CWDN_SCO	TOT_SCO	REST_CON	LOT1	LOT2	LOT3	LOT4	LOT5	LOT6	ZONE_TOP	ZONE_2ND	bufzn1
1	3	5	22.8475	REST	1812090000500	0	0	0	0	0	LAU11		LAU11
2	1	1	19.9108	CON	1812160000300	1812000000200	0	0	0	0	LAN1		LAN1
3	2	3	22.5331	CON	1812263300900	1812260000700	1812352203500	0	0	0	LAU11		LAU11
4	1	1	20.9494	CON	1812264201800	1812263106200	1812263102400	1812264202100	0	0	LAU11		LAU11
5	1	1	21.3689	CON	1812260000800	0	0	0	0	0	LAU11		LAU11
6	1	1	21.6735	CON	1812260000800	1812250000066	0	0	0	0	LAN1		LAN1
7	2	3	23.9037	CON	1812260000300	1812250000066	0	0	0	0	LAN1		LAU11
8	1	1	22.4552	CON	1812250002100	0	0	0	0	0	LAI1	LAF2	LAN1
9	3	5	24.6817	CON	1812350000400	1812350000300	0	0	0	0	LAF2		LAF2
10	2	3	23.5198	CON	1812360000600	1812360001100	1812350000100	1812360001000	1812360000700	1812360001200	LAN1	LAF2	LAF2
11	2	3	28.4486	CON	1811300000400	1812250002500	0	0	0	0	LAN1		LAN1
12	2	3	27.4738	CON	1811300000300	1811300000100	1811300000800	1811300000500	0	0	LAN1		LAN1
13	3	5	23.0294	REST	1811302004300	1811302004200	1811302002600	1811302002800	1811302004800	0	LAI1	LAR1	LAF2
14	2	3	20.5484	CON	1811300000700	1811300000600	0	0	0	0	LAN1		LAN1
15	2	3	23.0316	CON	1811310000900	1811310000802	1811310001001	1811310000800	0	0	LAN1	LAF1	LAF1
16	1	1	18.9762	REST	1811310001200	1811310000100	1811310000700	1811310000400	0	0	LAF2	LAN1	LAF2
17	3	5	21.1755	REST	1811300000700	1811000002400	0	0	0	0	LAF2	LAF1	LAF1
18	1	1	17.6049	REST	1811310000700	0	0	0	0	0	LAF2		LAF1
19	2	3	18.5438	REST	1811310001000	0	0	0	0	0	LAF1		LAF1
20	2	3	14.5972	REST	1911060000509	1911060000508	1911070000400	1911070000305	1911070001100	0	LAF2		LAF1
21	2	3	11.1621	REST	1912120001101	1911070001400	0	0	0	0	LAF2		LAF2
22	1	1	17.9317	REST	1811290000201	0	0	0	0	0	LAF1		LAF1
23	1	1	22.6137	REST	1811290000100	1811290000201	1811200001000	0	0	0	LAA1	LAF1	LAF1
24	1	1	17.3065	CON	1811290000201	1811290000100	0	0	0	0	LAF1	LAA1	LAF1
25	3	5	25.0808	REST	1811210000300	1811200000100	1811210001100	1811160002001	0	0	LAA1	LAF2	LAA1

SITE_ID	bfzn1pct	bufzn2	bfzn2pct	bufzn3	bfzn3pct	GPC_NOTES	INFO_NEEDS
1	98.57		0.00		0.00	7-8ft culvert looks recent. Dead wax-myrtle shows poss. hydrologic chg. [end]	Has large, recent culvert drained formerly impounded wetland? [end]
2	68.86		0.00		0.00	Good gradient from tidal marsh into nontidal interdunal swale. [end]	[blank]
3	93.01		0.00		0.00	Restrictive culverts@Hwy 126. DMD area; partial DMD removal for restor [end]	Spartina alterniflora here? DMD removal for restoration? [end]
4	71.23		0.00		0.00	Narrow strip, strongly affected by adjacent Hwy 126 [end]	[blank]
5	43.31		0.00		0.00	Islands created from dredged material, according to Lane Co. Comp. Plan. [end]	Were islands completely created from DMD? [end]
6	30.92		0.00		0.00	[blank]	[blank]
7	25.22	LAN1	23.80	LAF2	22.28	[blank]	[blank]
8	47.08	LAF2	33.06		0.00	[blank]	[blank]
9	61.11		0.00		0.00	Restrictive culvert at road crossing, upper end of site. [end]	Determine whether culvert at top of site has tidal influence. [end]
10	40.48	LAN1	23.49		0.00	[blank]	[blank]
11	51.57		0.00		0.00	Cox Island Nature Conservancy preserve [end]	Determine status of Spartina patens eradication effort. [end]
12	39.35	LAF2	23.12		0.00	E boundary is railroad. [end]	[blank]
13	40.73	LAN1	31.01		0.00	Hwy 126=dike; tidegate recently replaced, had been malfunctioning. [end]	[blank]
14	59.37	LAF2	29.01		0.00	[blank]	[blank]
15	55.53	LAN1	27.32		0.00	[blank]	[blank]
16	45.28	LAN1	34.20	LAF1	20.53	RR crossing and bridge at W end are only obvious alterations. [end]	[blank]
17	65.37	LAF2	24.71		0.00	Tidegated. Can't det. wetland boundary, but N end was historically swamp. [end]	[blank]
18	37.53	LAN1	33.29	LAF2	29.18	RR=dike. Poss. buried culvert. Outflow to N; beaver dams here create pond. [end]	What is condition of tidal connection? [end]
19	71.56		0.00		0.00	RR&rd=dikes.Restrictv culvrt=hi velocity flow.Upper prt: diffuse drainage.[end]	[blank]
20	54.19	LAF2	40.61		0.00	Main tidegate at N recently replaced with top-opening type. [end]	[blank]
21	84.53		0.00		0.00	Tidegate offsite on 3a. Small, culvert-impounded willow swamp @E. [end]	[blank]
22	38.96	LAN1	30.80		0.00	Unaltered except for RR across W end. [end]	[blank]
23	47.51	LAA1	25.49		0.00	W portion has dike breach (deliberate?; E portion, dike still intact. [end]	Was dike breach on W end a restoration project, or a natural breach? [end]
24	60.45	LAA1	34.91		0.00	[blank]	[blank]
25	44.88	LAF1	24.01	LAF2	22.65	Hwy 126 acts as dike; road crossing impounds upper end. [end]	[blank]

SITE_ID	NXT_STEP	VEG_TYP	PLANT_SPP
1	Determine degree of tidal influence, site history. [end]	Muted tidal forested wetland grading up to nontidal interdunal wetland [end]	SALHOO, PHAARU, ARGEGE, EPICIL, JUNEFF, LOTCOR [end]
2	[blank]	Fully tidal high marsh grading up into nontidal interdunal swale [end]	DESCES, GRISTR, ARGEGE, CARLYN, AGRSTO, JUNLES, FESRUB, SALHOO, PINCON [end]
3	Continue Spartina control. Det. if culverts under 126 restrict tidal flow. [end]	Fully tidal high marsh; along Munsel Cr. N of 126, muted tidal freshwater [end]	DESCES-AGRSTO-CARLYN-SCHTAB. Spartina reported in 2005 [end]
4	[blank]	Fully tidal low to high marsh with willow fringe [end]	CARLYN,DESCES,SCHTAB,Salix fringe on upper edge. [end]
5	Verify site history. [end]	Fully tidal; airphoto interp indicates high marsh [end]	[blank]
6	[blank]	Fully tidal; airphoto interp indicates high marsh [end]	[blank]
7	[blank]	Fully tidal low to high marsh [end]	DESCES-dominated high marsh, some SCHTAB [end]
8	[blank]	Fully tidal low to high marsh with willow fringe [end]	From riverbank up: CARLYN>DESCES>SCHTAB>Salix [end]
9	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
10	[blank]	Fully tidal low to high marsh [end]	[blank]
11	Assist with Spartina patens eradication. [end]	Fully tidal low to high marsh [end]	Spartina patens is found here; eradication underway. [end]
12	[blank]	Fully tidal low to high marsh [end]	[blank]
13	[blank]	Tidegated marsh, currently nontidal [end]	CARLYN,AGRSTO,TYPLAT [end]
14	[blank]	Fully tidal low to high marsh [end]	[blank]
15	[blank]	Fully tidal high marsh [end]	CARLYN, DESCES, AGRSTO, patches of SCHTAB [end]
16	[blank]	Fully tidal low to high marsh [end]	[blank]
17	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	[blank]
18	Determine condition of tidal connection. [end]	Muted tidal wetland, currently primarily freshwater beaver pond [end]	[blank]
19	[blank]	Muted tidal low to high marsh [end]	[blank]
20	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Wet areas:PHAARU,CAROBN,JUNEFF. Drier: HOLLAN,Agrostis,LOTCOR,TRIREP,LOLPER[en d]
21	[blank]	Pasture w/offsite tidegate, now nontidal; some emergent,scrub-shrub wetland[end]	Wet areas:SCIMIC,LYSAME(Salix in ungrazed); drier:LOTCOR,Agrostis,HOLLAN [end]
22	[blank]	Fully tidal low to high marsh [end]	[blank]
23	[blank]	Diked pasture, mixed muted & nontidal, low/high marsh & freshwater wetland [end]	[blank]
24	[blank]	Fully tidal low to high marsh [end]	[blank]
25	Determine historic channel connection points under Hwy. 126. [end]	Muted tidal high marsh to tidal shrub swamp [end]	W to E:CARLYN-DESCES>DESCES-AGRSTO>SCHTAB-PHAARU>SPIDOU/PHAARU-TYPLAT>Salix[end]

SITE_ID	REST_OPT	LIMITS	EXIST_REST	RANK_GRP
1	Tidal restoration unlikely (would require removal of portions of N jetty) [end]	N jetty causes muted tidal influence, but jetty is unlikely to be altered. [end]	[blank]	MEDIUM-HIGH
2	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-LOW
3	Additional DMD removal; culvert upgrade under 126. [end]	In UGB, surrounded by urban development. [end]	DMD removal for mitigation on or adjacent to this site. [end]	MEDIUM-HIGH
4	Protect existing wetlands. [end]	Adjacent highway limits restoration potential. [end]	[blank]	MEDIUM
5	Protect existing wetlands. [end]	LCCP shows site as mitigation area, to be excavated to tideflat. See report [end	[blank]	MEDIUM
6	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM
7	Protect existing wetlands. [end]	Future construction of new N Fork Bridge may affect site. [end]	[blank]	HIGH
8	Protect existing wetlands. [end]	Future construction of new N Fork Bridge may affect site. [end]	[blank]	MEDIUM-HIGH
9	Protect existing wetlands, upgrade culvert at upper end of site. [end]	[blank]	[blank]	HIGH
10	Protect existing wetlands. [end]	[blank]	[blank]	HIGH
11	Assist with Spartina patens eradication; remove Scots broom, other exotics.[end]	[blank]	[blank]	HIGH
12	Protect existing wetlands. [end]	[blank]	[blank]	HIGH
13	Remove tidegate, build dikes to protect homes. [end]	Restoration unlikely due to residences in tidal zone, recent new tidegate. [end]	[blank]	MEDIUM-HIGH
14	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM
15	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-HIGH
16	Could broaden railroad bridge; but probably not necessary. [end]	[blank]	[blank]	MEDIUM-LOW
17	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	Tidegate recently replaced. [end]	[blank]	MEDIUM
18	Restore tidal connection under railroad/to N (but don't disturb beaver). [end]	[blank]	[blank]	MEDIUM-LOW
19	Improve tidal connection under RR. [end]	[blank]	[blank]	MEDIUM-LOW
20	Remove/upgrade tidegates/culverts (but upgraded recently), fill ditches [end]	Large tidegate recently replaced. [end]	[blank]	LOW
21	Remove/upgrade tidegates/culverts (but upgraded recently), fill ditches [end]	Offsite tidegate [end]	[blank]	LOW
22	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-LOW
23	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	W portion has dike breach (deliberate?) [end]	MEDIUM-HIGH
24	Protect existing wetlands. [end]	[blank]	[blank]	LOW
25	Reconnect tidal flow under Nwy 126; upgrade restrictive culvert mid-site[end]	[blank]	[blank]	HIGH

SITE_ID	SOURCE	SHAPE _AREA	OWN_ TYPE	CRMP_ DMD	ALT_TYP	SITE_SZ	SIZE_SCO	TID_X	TG_LOC	DITCH	RMCH	TCC_SUM	TCC_SCO	WLCN_SQM
26	HGM	880807	Private non-industrial	Y	Y,D,C	88.08	3.50	1	3	1	5	10	2.50	2457276.21
27	HGM	14044	Private industrial	N	Y,C offsite; C onsite	1.40	1.01	1	5	1	1	8	2.00	1826579.22
28	HGM	34821	Private industrial	N	None	3.48	1.07	5	5	3	5	18	4.50	2171984.72
29	HGM	1405526	Private non-industrial	N	Y,D,C	140.55	5.00	3	5	3	5	16	4.00	2012196.29
30	HGM	48537	Private non-industrial	N	None	4.85	1.11	5	5	5	5	20	5.00	1924306.29
31	HGM	40236	Private industrial	N	None	4.02	1.09	5	5	5	5	20	5.00	1923819.77
32	HGM	394869	Private industrial	N	Y,D,C,R	39.49	2.10	1	3	1	1	6	1.50	1943929.68
33	HGM	35223	Private industrial	N	None	3.52	1.07	5	5	5	5	20	5.00	2077664.76
34	HGM	37527	County	N	None	3.75	1.08	5	5	5	5	20	5.00	1344988.16
35	HGM	77173	Mixed	N	Y,D,C	7.72	1.19	1	3	3	5	12	3.00	1280212.89
36	HGM	170800	Mixed	N	Y (breached),D	17.08	1.46	3	5	5	5	18	4.50	1014721.15
37	HGM	35494	Private non-industrial	N	C,D	3.55	1.07	3	5	1	1	10	2.50	934982.22
38	HGM	62183	Mixed	N	D	6.22	1.15	5	5	3	5	18	4.50	855537.01
39	HGM	43388	Mixed	Y	Y,D	4.34	1.10	1	3	1	1	6	1.50	849913.72
40	HGM	24173	Mixed	Y	R	2.42	1.04	5	5	5	5	20	5.00	749079.34
41	HGM	237926	Mixed	Y	None	23.79	1.65	5	5	5	5	20	5.00	477773.73
42	HGM	24648	Mixed	N	None	2.46	1.04	5	5	5	5	20	5.00	475130.18
43	HGM	124800	Private non-industrial	Y	C,D,R	12.48	1.33	3	5	1	1	10	2.50	440499.55
44	HGM	116795	Private non-industrial	Y	Y,D,C	11.68	1.31	3	3	3	5	14	3.50	250620.20
45	HGM	336471	Mixed	N	G	33.65	1.94	5	5	5	5	20	5.00	320427.47
46	HGM	97078	Mixed	Y	Y,D,C	9.71	1.25	1	5	3	3	12	3.00	264411.38
47	HGM	93650	Private non-industrial	Y	Y,D,C	9.37	1.24	3	5	3	5	16	4.00	322358.66

SITE_ID	WLCN_HA	WLCN_SCO	NSTOCKS	NTYP_SCO	SWMP_SZ	SWMP_PCT	SWMP_SCO	EM_TOTAL	EM_PCT	SS_TOTAL	SS_PCT	FO_TOTAL	FO_PCT	ESF_TOT	ESF_PCT
26	245.73	3.73	3	5	706828.46	80.25	4.21	757056.76	85.95	0.00	0.00	0.00	0.00	757056.76	85.95
27	182.66	2.97	0	1	0.00	0.00	1.00	2245.44	15.99	0.00	0.00	0.00	0.00	2245.44	15.99
28	217.20	3.39	3	5	32602.21	93.63	4.75	32963.74	94.67	0.00	0.00	0.00	0.00	32963.74	94.67
29	201.22	3.20	3	5	373402.30	26.57	2.06	579064.76	79.26	0.00	0.00	0.00	0.00	579064.76	79.26
30	192.43	3.09	2	4	0.00	0.00	1.00	41396.23	85.29	0.00	0.00	4316.75	8.89	45712.98	94.18
31	192.38	3.09	2	4	2220.93	5.52	1.22	29125.18	72.39	0.00	0.00	606.16	1.51	29731.34	73.89
32	194.39	3.11	2	4	85323.39	21.61	1.86	188167.73	47.65	11975.39	3.03	2100.11	0.53	202243.23	51.22
33	207.77	3.28	2	4	0.00	0.00	1.00	31647.90	89.85	233.55	0.66	1011.02	2.87	32892.47	93.38
34	134.50	2.39	2	4	13997.68	37.30	2.49	30123.84	80.27	2627.92	7.00	0.00	0.00	32751.76	87.28
35	128.02	2.31	2	4	70006.95	90.71	4.63	66947.59	86.75	0.00	0.00	0.00	0.00	66947.59	86.75
36	101.47	2.00	2	4	395.97	0.23	1.01	106621.28	62.42	0.00	0.00	0.00	0.00	106621.28	62.42
37	93.50	1.90	3	5	0.00	0.00	1.00	3360.49	9.47	0.00	0.00	0.00	0.00	3360.49	9.47
38	85.55	1.80	3	5	4395.12	7.07	1.28	25314.46	40.71	19724.96	31.72	0.00	0.00	45039.42	72.43
39	84.99	1.80	3	5	0.00	0.00	1.00	18381.89	42.37	0.00	0.00	0.00	0.00	18381.89	42.37
40	74.91	1.68	3	5	0.00	0.00	1.00	15264.13	63.15	0.00	0.00	0.00	0.00	15264.13	63.15
41	47.78	1.35	3	5	197967.71	83.21	4.33	195308.30	82.09	0.00	0.00	0.00	0.00	195308.30	82.09
42	47.51	1.35	3	5	0.00	0.00	1.00	12853.48	52.15	3480.39	14.12	0.00	0.00	16333.87	66.27
43	44.05	1.30	3	5	5294.25	4.24	1.17	56373.07	45.17	0.00	0.00	0.00	0.00	56373.07	45.17
44	25.06	1.08	3	5	0.00	0.00	3.00	80018.58	68.51	1038.55	0.89	23352.98	19.99	104410.11	89.40
45	32.04	1.16	3	5	0.00	0.00	3.00	52676.87	15.66	46048.73	13.69	1730.56	0.51	100456.16	29.86
46	26.44	1.09	3	5	0.00	0.00	3.00	75099.61	77.36	1316.07	1.36	0.00	0.00	76415.68	78.72
47	32.24	1.16	3	5	0.00	0.00	3.00	38040.50	40.62	7872.19	8.41	0.00	0.00	45912.69	49.03

SITE_ID	N_CWDN	CWDN_SCO	TOT_SCO	REST_CON	LOT1	LOT2	LOT3	LOT4	LOT5	LOT6	ZONE_TOP	ZONE_2ND	bufzn1
26	1	1	22.4384	REST	1811200000601	0	0	0	0	0	LAA1		LAF1
27	1	1	10.9842	REST	1811200000100	0	0	0	0	0	LAF1	LAA1	LAF1
28	1	1	24.2050	CON	1811210000900	0	0	0	0	0	LAN1	LAF1	LAF1
29	1	1	24.2592	REST	1811150001000	1811210000100	1811210000200	0	0	0	LAA1	LAN1	LAA1
30	2	3	21.8675	CON	1811210000100	0	0	0	0	0	LAN1		LAF1
31	2	3	22.0639	CON	1811210000900	1811210001000	1811280000100	0	0	0	LAF1	LAN1	LAF1
32	3	5	18.7482	REST	1811280000100	1811270000400	1811210001000	0	0	0	LAF1	LAN1	LAF1
33	3	5	24.0140	CON	1811210000500	0	0	0	0	0	LAF1	LAN1	LAF1
34	2	3	22.6303	CON	1811150001300	0	0	0	0	0	LAA1		LAA1
35	1	1	18.8026	REST	1811150001400	0	0	0	0	0	LAA1		LAA1
36	1	1	18.1318	REST	1811150001401	1811220000500	1811150001400	1811150001403	0	0	LAA1	LAF1	LAA1
37	1	1	14.9720	REST	1811100000402	1811100000600	0	0	0	0	LAR1		LAA1
38	2	3	21.2355	REST	1811150000400	1811150001300	1811113001200	1811150000500	1811113001500	0	LAA1	LAR1	LAA1
39	1	1	12.8922	REST	1811140000200	1811150001300	1811140000300	0	0	0	LAA1		LAA1
40	1	1	19.7156	REST	1811110001600	1811110001700	1811113003700	1811140000200	0	0	LAR1	LAF1	LAF1
41	1	1	23.3300	CON	1811110001400	1811110001600	0	0	0	0	LAN1		LAF1
42	2	3	21.3871	CON	1811110001500	1811110001600	1811120001500	0	0	0	LAN1		LAF1
43	1	1	14.8021	REST	1810070000600	1811120001400	1810070000700	1811120000901	1811120001300	0	LAR1		LAF1
44	3	5	22.3808	REST	1810180000100	1810070001600	1810083001000	0	0	0	LAF2	LAA1	LAF1
45	3	5	26.0946	REST	1810160000200	1810084400100	0	0	0	0	LAA1	LAF2	LAF1
46	2	3	19.3409	REST	1810084400100	1810090000700	0	0	0	0	LAF2	LAI1	LAF2
47	2	3	21.4009	REST	1810090000200	1810090000202	1810090000201	0	0	0	LAF2		LAF2

SITE_ID	bfzn1pct	bufzn2	bfzn2pct	bufzn3	bfzn3pct	GPC_NOTES	INFO_NEEDS
26	40.11	LAA1	29.58		0.00	Lowest portion of site is nr 126 & W end; Gradual slope up to E & river. [end]	[blank]
27	52.75	LAA1	42.33		0.00	Impounded behind RR embankment & restrictive culvert. [end]	How is impounded pond used? [end]
28	46.45	LAN1	35.32		0.00	Channels look somewhat altered; possible log storage site? [end]	Was site modified for log storage or other activity (dredged channels)? [end]
29	38.66	LAF1	31.70		0.00	High ground is actively pastured. Low ground restoring, some muted tidal. [end]	[blank]
30	40.24	LAN1	34.71	LAA1	24.59	[blank]	[blank]
31	70.31	LAN1	29.22		0.00	Very minor ditching. Partial dike on middle lobe is breached. [end]	[blank]
32	90.41		0.00		0.00	Tidal influence was historically strongest in lower portion of site. [end]	Tidegated? [end]
33	42.39	LAA1	33.63	LAN1	23.98	[blank]	[blank]
34	81.61		0.00		0.00	[blank]	[blank]
35	76.08	LAF1	22.93		0.00	[blank]	Tidegated? [end]
36	59.33	LAF1	40.67		0.00	Karnowsky Cr. restor. site. Incl'd HGM "water" that is actually mud flat. [end]	Is tidal exchange still muted? Any remaining tidegates/culverts? [end]
37	43.53	LAF1	30.20	LAR1	22.23	[blank]	Tidegated, or just restrictive culvert? [end]
38	36.81	LAF1	31.84	LAR1	27.15	Dike & borrow ditch form W site boundary. [end]	[blank]
39	45.92	LAF1	30.21	LAR1	23.87	Typical side-ditched valley, diked pasture betw. ditches. Lg. culverts [end]	[blank]
40	36.84	LAR1	23.50	LAA1	20.38	Ditch (borrow?) E of bridge abutment. [end]	Was bridge material borrowed from ditch to E? [end]
41	56.03		0.00		0.00	Phragmites tentatively identified here. [end]	[blank]
42	51.22	LAN1	35.28		0.00	Tidal spruce swamp incl's areas betw. separate polygons & beyond them to E [end]	[blank]
43	49.06	LAF2	28.47		0.00	Airphoto suggests very restrictive culvert, or tidegate [end]	Any tidal exchange? tidegate or restrictive culvert? Rescore if chgs. [end]
44	53.33	LAF2	23.77		0.00	Tidegated and probably diked. [end]	Restricted tidal flow, or none? [end]
45	58.55		0.00		0.00	Tidal influence strongest in lower portion; partial dike (breached)@NW end.[end]	[blank]
46	44.20	LAF1	41.25		0.00	Site has perimeter dike (built-up natural levee) and cross-dike (farm rd). [end]	Does site have any tidal flow? tidegate? if so, tid_x=3, tg_loc=3. [end]
47	49.97	LAF1	26.26		0.00	Hwy. 126 acts as dike. [end]	Assume some tidal exchange thru restrictive culvert. If not, tid_x=1 [end]

SITE_ID	NXT_STEP	VEG_TYP	PLANT_SPP
26	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Wet areas:ARGEGE,PHAARU,CAROBN,ELEPAL. Drier:HOLLAN,LOTCOR,TRIREP,Agrostis [end]
27	[blank]	Diked & impounded freshwater wetland, currently nontidal [end]	[blank]
28	Determine site history. [end]	Fully tidal low to high marsh [end]	[blank]
29	Open further breaches to more fully restore tidal exchange. [end]	Restoring tidal marsh, some areas muted tidal due to remaining dikes. [end]	CARLYN,SCHTAB,TYPLAT,PHAARU. Natural levee: FESARU,HOLLAN,Agrostis,LOLPER [end]
30	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
31	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
32	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	[blank]
33	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
34	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
35	Determine tidal status, conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	[blank]
36	Check for invasive Phragmites australis. [end]	Restoring tidal marsh [end]	CARLYN,SCHTAB,TYPLAT,PHAARU [end]
37	Determine tidal status, conditions at tidal entry point [end]	Muted tidal wetland, emergent, scrub-shrub and possibly forested [end]	PHAARU to W, Salix,ALNRUB to E [end]
38	[blank]	Fully tidal low to high marsh and tidal swamp [end]	[blank]
39	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	HOLLAN, ALOPRA, LOLPER, LOTCOR, TRIREP [end]
40	Determine site history. [end]	Fully tidal low to high marsh [end]	[blank]
41	Confirm ID of common reed (Phragmites). [end]	Fully tidal low to high marsh [end]	CARLYN,SCHTAB,PHAARU,PHRAUS (invasive Phragmites) [end]
42	Confirm ID of common reed (Phragmites). [end]	Fully tidal spruce swamp [end]	PICSIT,ALNRUB,SAMRAC,CAROBN,LYSAME,PHAARU,VICGIG,ATHFIL [end]
43	Determine tidal status, conditions at tidal entry point [end]	Muted tidal pasture, some emergent freshwater wetland [end]	Wet (to N): CAROBN,JUNEFF,PHAARU,Salix. Drier (to S):HOLLAN,Agrostis,HYPRAD[end]
44	Determine tidal status, whether purple loosestrife is present [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	PHAARU,CAROBN,SCHTAB,TYPLAT,poss. loosestrife; PICSIT,ALNRUB,LYSAME @S edge[end]
45	[blank]	Fully tidal pasture, emergent and scrub-shrub [end]	Wet areas: PHAARU,SCHTAB,SALHOO,ALNRUB. Drier:HOLLAN,LOTCOR,FESARU,RUBDIS [end]
46	Determine tidal status, conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	PHAARU,JUNEFF,TYPLAT,ELEPAL [end]
47	Determine tidal status, conditions at tidal entry point [end]	Muted or nontidal wetland, emergent and scrub-shrub [end]	PHAARU,TYPLAT,CAROBN,SPIDOU,Salix [end]

SITE_ID	REST_OPT	LIMITS	EXIST_REST	RANK_GRP
26	Breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	Dike is also access to homes on natural levee (need to get elevations) [end]	[blank]	MEDIUM-HIGH
27	Remove/upgrade tidegate/culvert [end]	[blank]	[blank]	LOW
28	Protect existing wetlands. [end]	[blank]	[blank]	HIGH
29	Remove dike or open additional breaches to improve tidal flow [end]	[blank]	Earthen dam breach on W end, dike breaches on E end [end]	HIGH
30	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM
31	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-HIGH
32	Remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	MEDIUM-LOW
33	Protect existing wetlands. [end]	[blank]	[blank]	HIGH
34	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-HIGH
35	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	MEDIUM-LOW
36	Remove remaining dike and any remaining culverts/tidegates [end]	[blank]	Dike breach [end]	MEDIUM-LOW
37	Remove/upgrade tidegate/culvert, fill ditches [end]	Homes nearby; carefully determine their elevation and tidal range [end]	[blank]	LOW
38	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM
39	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	LOW
40	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-LOW
41	Confirm ID of common reed (Phragmites); control if confirmed. [end]	[blank]	[blank]	HIGH
42	Confirm ID of common reed (Phragmites); control if confirmed. [end]	[blank]	[blank]	MEDIUM
43	Remove/upgrade tidegate/culvert, fill ditches [end]	Homes on natural levee; carefully determine their elevation and tidal range [end	[blank]	LOW
44	Chk for purple loosestrife; remove/upgrade tidegates/culverts, fill ditches[end]	Homes nearby; carefully determine their elevation and tidal range [end]	[blank]	MEDIUM-HIGH
45	Continue grazing reductions (grazing already removed fr/lower portions) [end]	[blank]	[blank]	HIGH
46	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	Homes on natural levee; carefully determine their elevation and tidal range [end	[blank]	MEDIUM-LOW
47	Remove/upgrade tidegates/culverts [end]	[blank]	[blank]	MEDIUM

SITE_ID	SOURCE	SHAPE _AREA	OWN_ TYPE	CRMP_ DMD	ALT_TYP	SITE_SZ	SIZE_SCO	TID_X	TG_LOC	DITCH	RMCH	TCC_SUM	TCC_SCO	WLCN_SQM
48	HGM	184623	Private non-industrial	Y	Y,D,C	18.46	1.50	1	3	1	1	6	1.50	370065.15
49	HGM	63266	State	N	C,D	6.33	1.15	3	5	1	3	12	3.00	270785.75
50	HGM	179775	Mixed	Y	Y,D,C,R	17.98	1.49	1	5	1	1	8	2.00	188328.16
51	HGM	21274	Private non-industrial	N	None	2.13	1.03	5	5	5	5	20	5.00	2587665.90
52	HGM	30692	Private non-industrial	N	None	3.07	1.06	5	5	5	5	20	5.00	2401035.96
53	HGM	286206	Private non-industrial	N	None	28.62	1.79	5	5	5	5	20	5.00	2689002.33
54	HGM	218466	State	N	None	21.85	1.60	5	5	5	5	20	5.00	2723983.35
55	HGM	121237	Private non-industrial	N	None	12.12	1.32	5	5	5	5	20	5.00	2117844.55
56	HGM	431853	Private non-industrial	N	Y,D,C	43.19	2.21	1	3	1	3	8	2.00	2787120.47
57	HGM	237698	Private non-industrial	N	Y,C offsite; D onsite	23.77	1.65	1	3	3	5	12	3.00	2257608.07
58	HGM	100839	Private non-industrial	N	Y,C offsite; none onsite	10.08	1.26	1	3	3	5	12	3.00	2578319.33
59	HGM	343318	Private non-industrial	N	Y (breached)	34.33	1.96	5	5	5	5	20	5.00	2457562.08
60	HGM	470634	Private non-industrial	N	Y,D,C	47.06	2.32	1	3	1	1	6	1.50	2522836.89
61	HGM	68632	Private non-industrial	N	Y,C offsite; none onsite	6.86	1.17	1	1	3	5	10	2.50	2659251.80
62	HGM	89936	Private non-industrial	N	Y,D,C	8.99	1.23	1	3	1	1	6	1.50	2122785.26
63	HGM	29877	Private non-industrial	N	Y,C offsite	2.99	1.06	3	1	5	5	14	3.50	1924643.45
64	HGM	356487	Private non-industrial	N	Y,D,C	35.65	1.99	1	3	1	3	8	2.00	1774562.20
65	HGM	49001	Private non-industrial	N	Y,D,C	4.90	1.11	3	5	5	5	18	4.50	2005140.92
66	HGM	90545	Private non-industrial	N	Y,C offsite; D,C onsite	9.05	1.23	1	1	1	1	4	1.00	1384021.23
67	HGM	33569	Private non-industrial	N	Y,C offsite; D,C onsite	3.36	1.07	1	1	3	5	10	2.50	1577171.75
68	HGM	535833	Private non-industrial	N	Y,D,C	53.58	2.51	1	3	1	1	6	1.50	1667841.84
69	HGM	67742	Private non-industrial	N	Y,C offsite; D,C onsite	6.77	1.17	1	1	3	1	6	1.50	1228010.33
70	HGM	68845	Mixed	N	R	6.88	1.17	5	5	5	5	20	5.00	494098.55

SITE_ID	WLCN_HA	WLCN_SCO	NSTOCKS	NTYP_SCO	SWMP_SZ	SWMP_PCT	SWMP_SCO	EM_TOTAL	EM_PCT	SS_TOTAL	SS_PCT	FO_TOTAL	FO_PCT	ESF_TOT	ESF_PCT
48	37.01	1.22	3	5	0.00	0.00	3.00	88555.71	47.97	0.00	0.00	0.00	0.00	88555.71	47.97
49	27.08	1.10	3	5	0.00	0.00	3.00	5769.29	9.12	0.00	0.00	24439.96	38.63	30209.26	47.75
50	18.83	1.00	3	5	0.00	0.00	3.00	98083.74	54.56	0.00	0.00	0.00	0.00	98083.74	54.56
51	258.77	3.89	3	5	0.00	0.00	1.00	15461.26	72.68	0.00	0.00	0.00	0.00	15461.26	72.68
52	240.10	3.66	3	5	0.00	0.00	1.00	28941.34	94.30	0.00	0.00	0.00	0.00	28941.34	94.30
53	268.90	4.01	3	5	162526.88	56.79	3.27	256200.48	89.52	11734.05	4.10	2447.41	0.86	270381.94	94.47
54	272.40	4.05	3	5	638.77	0.29	1.01	216017.26	98.88	0.00	0.00	0.00	0.00	216017.26	98.88
55	211.78	3.32	3	5	81067.84	66.87	3.67	115800.33	95.52	0.00	0.00	172.52	0.14	115972.85	95.66
56	278.71	4.13	3	5	338320.24	78.34	4.13	362762.90	84.00	0.00	0.00	726.97	0.17	363489.86	84.17
57	225.76	3.49	0	1	226838.96	95.43	4.82	218726.33	92.02	0.00	0.00	9306.09	3.92	228032.41	95.93
58	257.83	3.88	0	1	18444.96	18.29	1.73	10132.91	10.05	0.00	0.00	59610.64	59.11	69743.55	69.16
59	245.76	3.73	3	5	301483.87	87.81	4.51	105213.42	46.66	0.00	0.00	0.00	0.00	105213.42	46.66
60	252.28	3.81	3	5	435232.82	92.48	4.70	453828.23	96.43	3429.28	0.73	0.00	0.00	457257.52	97.16
61	265.93	3.98	0	1	33616.21	48.98	2.96	6879.76	10.02	45805.28	66.74	427.80	0.62	53112.84	77.39
62	212.28	3.33	3	5	87579.32	97.38	4.90	83569.36	92.92	662.90	0.74	0.00	0.00	84232.26	93.66
63	192.46	3.09	3	5	29875.99	100.00	5.00	0.00	0.00	26704.45	89.38	0.00	0.00	26704.45	89.38
64	177.46	2.91	3	5	131511.57	36.89	2.48	326900.51	91.70	0.00	0.00	850.73	0.24	327751.24	91.94
65	200.51	3.19	3	5	0.00	0.00	1.00	0.00	0.00	39397.24	80.40	5957.33	12.16	45354.57	92.56
66	138.40	2.44	1	2	87628.10	96.78	4.87	77678.83	85.79	82.46	0.09	0.00	0.00	77761.29	85.88
67	157.72	2.67	0	1	935.43	2.79	1.11	4737.66	14.11	0.00	0.00	15808.49	47.09	20546.14	61.21
68	166.78	2.78	3	5	0.00	0.00	1.00	306488.83	57.20	0.00	0.00	178.00	0.03	306666.83	57.23
69	122.80	2.25	1	2	0.00	0.00	1.00	58435.55	86.26	2747.32	4.06	0.00	0.00	61182.87	90.32
70	49.41	1.37	3	5	0.00	0.00	1.00	5859.68	8.51	0.00	0.00	0.00	0.00	5859.68	8.51

SITE_ID	N_CWDN	CWDN_SCO	TOT_SCO	REST_CON	LOT1	LOT2	LOT3	LOT4	LOT5	LOT6	ZONE_TOP	ZONE_2ND	bufzn1
48	1	1	14.7191	REST	1810100001012	1810100001407	1810090001501	1810100001007	0	0	LAR1	LAA1	LAF2
49	2	3	19.2517	REST	1810100001600	0	0	0	0	0	LAF2		LAF2
50	1	1	15.4864	REST	1810100001700	1810110002200	1810110002305	1810110002303	0	0	LAF2	LAR1	LAF1
51	1	1	21.9215	CON	1812250000700	1812250000600	0	0	0	0	LAN1		LAF2
52	1	1	21.7238	CON	1812250000600	1812240000033	0	0	0	0	LAN1		LAN1
53	3	5	29.0746	CON	1812240000900	1812240000902	1812240001100	0	0	0	LAN1		LAF2
54	1	1	22.6627	CON	1811190000600	0	0	0	0	0	LAN1		LAF2
55	2	3	26.3171	CON	1812240000801	0	0	0	0	0	LAN1		LAN1
56	2	3	22.4724	REST	1811190000300	1811180000300	1812240000100	1811190000201	1811190000200	0	LAN1	LAA1	LAF2
57	2	3	19.9618	REST	1811180000300	1811180000301	0	0	0	0	LAA1	LAF2	LAF2
58	2	3	16.8700	REST	1811180000300	1811180000301	1811190000200	1811180000302	0	0	LAA1	LAF2	LAF2
59	1	1	26.2007	REST	1812130001607	1811190000400	0	0	0	0	LAA1	LAN1	LAF2
60	2	3	21.8308	REST	1812130001500	1811180000301	1811070001400	0	0	0	LAA1	LAF2	LAF2
61	3	5	19.1028	REST	1811180000301	1811070001400	1811180000300	1811180000302	0	0	LAF2	LAA1	LAA1
62	2	3	20.4538	REST	1812130001400	0	0	0	0	0	LAA1		LAF2
63	1	1	22.1477	REST	1812130001400	0	0	0	0	0	LAA1	LAF2	LAF2
64	2	3	19.3789	REST	1811070000601	1811070000500	1811070001000	0	0	0	LAA1		LAF2
65	2	3	22.2995	REST	1811070001201	0	0	0	0	0	LAF2	LAA1	LAF2
66	2	3	15.8751	REST	1811070000300	1811070000500	0	0	0	0	LAF2		LAF2
67	2	3	13.8513	REST	1811070000601	1811070000701	0	0	0	0	LAA1		LAA1
68	2	3	17.2888	REST	1811070001300	1811080000900	1811070000800	1811070000701	0	0	LAA1	LAF1	LAF2
69	2	3	12.7506	REST	1811070000904	1811070000400	1811080000300	0	0	0	LAA1	LAF2	LAA1
70	1	1	19.5366	REST	1811120001800	1810180000400	1810180000300	0	0	0	LAF1		LAF1

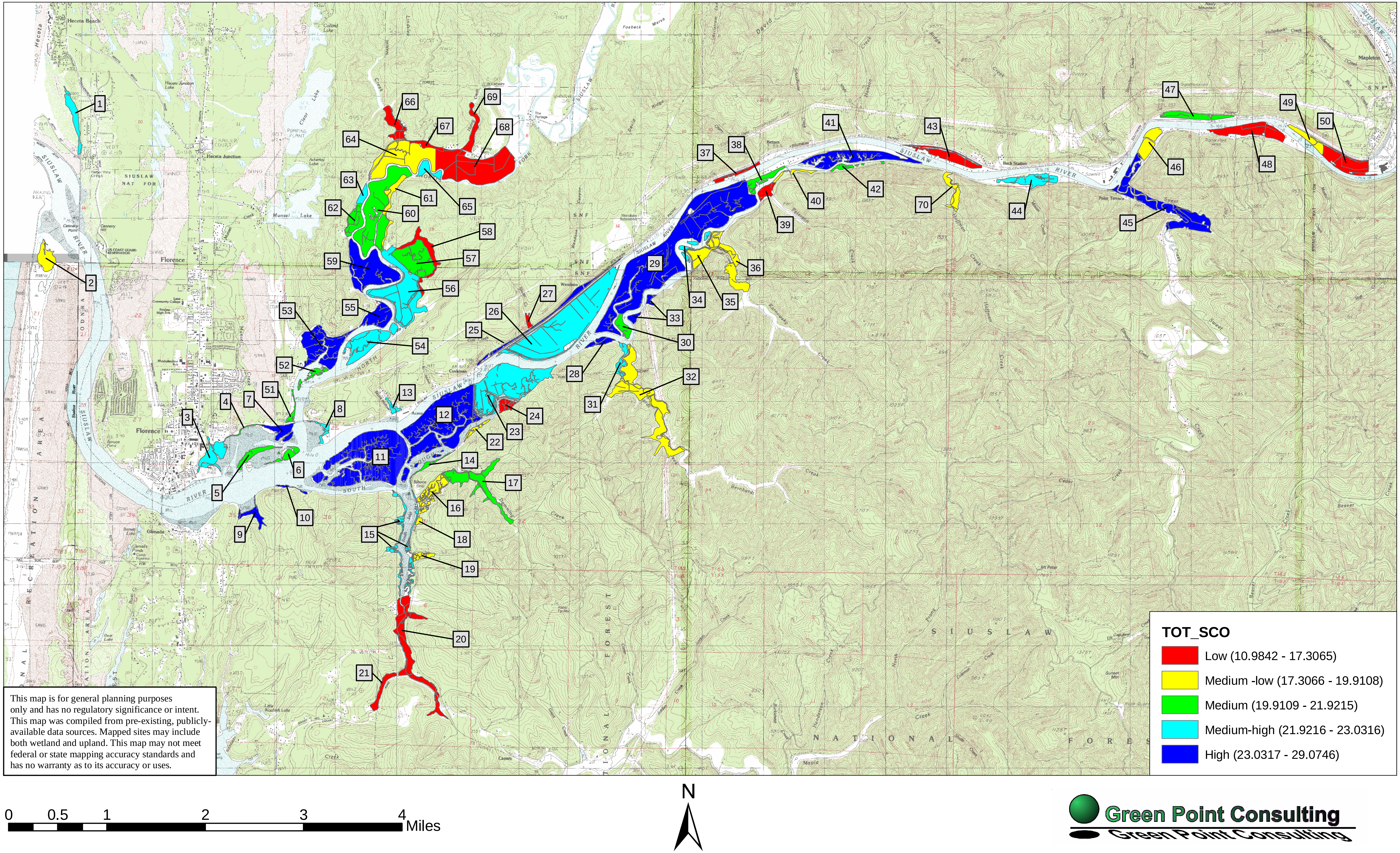
SITE_ID	bfzn1pct	bufzn2	bfzn2pct	bufzn3	bfzn3pct	GPC_NOTES	INFO_NEEDS
48	42.89	LAF1	37.93		0.00	Site appears to have built-up natural levee. Houses on levee. [end]	Tidegated w/no tidal xchg? If wrong, adjust scoring. [end]
49	46.52	LAF1	35.92		0.00	Restrictive culvert/tidegate under dike/natural levee. [end]	Restrictive culvert and some tidal exchg? If not, adjust scoring. [end]
50	38.40	LAF2	33.96		0.00	High natural levee has been built up at W end. [end]	[blank]
51	40.08	LAN1	31.99		0.00	Shrub area may be hydrologically altered by old bridge fill at N end [end]	[blank]
52	50.63	LAF2	39.18		0.00	Publicly owned islands. [end]	[blank]
53	48.54	LAN1	35.86		0.00	Minor ditching; restrictive culverts at W side under N Fork Rd. [end]	[blank]
54	54.08	LAN1	44.65		0.00	ODFW owns NE end of largest island. [end]	[blank]
55	50.68	LAF2	36.65		0.00	[blank]	[blank]
56	47.65	LAA1	32.70		0.00	Striations are from tillage. [end]	[blank]
57	46.37	LAA1	27.92		0.00	[blank]	[blank]
58	49.40	LAA1	24.77		0.00	Ditch forms W boundary of site. [end]	[blank]
59	48.99	LAA1	34.98		0.00	Existing dike breach restoration site. Lots of LWD at N end of site. [end]	[blank]
60	59.30	LAA1	38.90		0.00	[blank]	[blank]
61	55.00	LAF2	43.07		0.00	[blank]	[blank]
62	57.74	LAA1	42.26		0.00	[blank]	Tidegated, or restrictive culvert? Any tidal xchg? [end]
63	59.05	LAA1	40.95		0.00	Tidal swamp, but original channel blocked by dike to S. [end]	[blank]
64	63.13	LAA1	23.90		0.00	Two 3-4ft culverts with tidegates; top-hinged. [end]	[blank]
65	51.37	LAA1	41.88		0.00	W lobe has low (18") dike w/restrictive culvert (tidegate fell off). [end]	[blank]
66	61.37	LAA1	21.94		0.00	3-4ft culvert@N Fork Rd; poss. sidecast berms @ditches.Tidegate offsite. [end]	[blank]
67	42.97	LAF2	33.55		0.00	Tidegate offsite [end]	[blank]
68	40.27	LAF1	27.64	LAA1	25.76	High natural levee, built-up as dike. Tidegate@diagonal channel near W end [end]	[blank]
69	73.42		0.00		0.00	Culvert at W end. Tidegate offsite. [end]	[blank]
70	70.73		0.00		0.00	Minor ditching. Possible low dike on E bank just upstream of bridge. [end]	Any diking along creek? If so, chg tidx score to 3. [end]

SITE_ID	NXT_STEP	VEG_TYP	PLANT_SPP
48	Determine tidal status, conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Wet areas: PHAARU,some LYSAME. Drier areas: HOLLAN,FESARU. [end]
49	Determine tidal status, conditions at tidal entry point [end]	Muted tidal wetland, aquatic bed, emergent, scrub-shrub and forested [end]	Near Hwy 126:PHAARU,SPIDOU;SAMRAC w/unknown herbaceous layer to S [end]
50	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Wet areas: ELEPAL,AGRSTO,PHAARU. Drier areas:Agrostis, HOLLAN, LOTCOR. [end]
51	[blank]	Fully tidal high marsh; some potentially tidal shrub swamp at NW end [end]	DESCES-AGRSTO-GRISTR; some SCHTAB; Salix,CAROBN,LYSAME at N end [end]
52	[blank]	Fully tidal low to high marsh [end]	[blank]
53	[blank]	Fully tidal high marsh and tidal swamp [end]	High marsh:DESCES,JUNBAL,CARLYN,SCHTAB. Tidal swamp:PICSIT,LONINV,MALFUS[end]
54	[blank]	Fully tidal low to high marsh [end]	[blank]
55	[blank]	Fully tidal high marsh; connects to muted tidal swamp above N Fork Rd [end]	EREMIN,ACHMIL,SCHTAB,DESCES,ARGEGE,JUNBAL [end]
56	Determine conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Drier areas: ARGEGE,TRIREP,HOLLAN,Agrostis. Wet areas:JUNEFF,CAROBN,SCHTAB [end]
57	Determine conditions at tidal entry point on site 56 [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	TYPLAT, PHAARU [end]
58	Determine conditions at tidal entry point on site 56 [end]	Forested freshwater wetland, nontidal due to offsite dikes & tidegates [end]	PICSIT, ALNRUB, Salix [end]
59	[blank]	Restoring tidal marsh [end]	Mudflat being colonized by LILOCC, ELEPAL, CARLYN, DESCES. TYPLAT at N end [end]
60	Determine conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Wet areas: SCIMIC,CAROBN,ARGEGE,AGRSTO. Dry areas: ARGEGE,Agrostis,HOLLAN [end]
61	Determine conditions at tidal entry point on site 60 [end]	Forested freshwater wetland, nontidal due to offsite dikes & tidegates [end]	Airphoto indicates few PICSIT, likely Salix,ALNRUB [end]
62	Determine tidal status, conditions at tidal entry point [end]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	PHAARU,JUNEFF,CAROBN [end]
63	Determine tidal status, conditions at tidal entry point on site 62 [end]	Muted tidal, forested wetland [end]	Airphoto indicates PICSIT, likely LONINV,MALFUS [end]
64	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	Dry areas: Agrostis,LOLPER,HOLLAN,TRIREP. Wet areas: ARGEGE,PHAARU,JUNEFF [end]
65	[blank]	Diked former pasture, currently nontidal, emergent freshwater wetland [end]	PHAARU,CAROBN,VICGIG,ARGEGE; ALNRUB,Salix towards hillslope [end]
66	[blank]	Pasture w/offsite tidegate, now nontidal, some emergent freshwater wetland [end]	Wet areas: SCIMIC,PHAARU,LYSAME; drier areas: HOLLAN, LOLPER, LOTCOR [end]
67	[blank]	Forested freshwater wetland, nontidal due to offsite dikes & tidegates [end]	ALNRUB,Salix [end]
68	[blank]	Diked pasture, currently nontidal, some emergent freshwater wetland [end]	HOLLAN,LOTCOR,Agrostis,LOLPER,JUNEFF,PHAARU [end]
69	[blank]	Pasture w/offsite tidegate, now nontidal, some emergent freshwater wetland [end]	LYSAME,HOLLAN,LOTCOR [end]
70	Check for dike. [end]	Muted or fully tidal pasture, some emergent freshwater wetland [end]	Near crk:PHAARU-SCIMIC-ARGEGE; low area to S:CAROBN-LOTCOR-JUNEFF. [end]

SITE_ID	REST_OPT	LIMITS	EXIST_REST	RANK_GRP
48	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	Homes on natural levee; carefully determine their elevation and tidal range [end	[blank]	LOW
49	Remove/upgrade tidegate/culvert, fill ditches [end]	Homes on natural levee; carefully determine their elevation and tidal range [end	[blank]	MEDIUM-LOW
50	Remove/upgrade tidegates/culverts, fill ditches [end]	Homes on natural levee; carefully determine their elevation and tidal range [end	[blank]	LOW
51	Protect existing wetlands. [end]	Future construction of new N Fork Bridge may affect site. [end]	[blank]	MEDIUM
52	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM
53	Upgrade culverts under N Fork Rd to reconnect tidal swamps above road [end]	[blank]	[blank]	HIGH
54	Protect existing wetlands. [end]	[blank]	[blank]	MEDIUM-HIGH
55	Protect existing wetlands. [end]	[blank]	[blank]	HIGH
56	Breach dike @ S end, remove/upgrade tidegates/culverts,fill ditches[end]	Dike is also access road for several homes, but breach wld probably be @S end[en	[blank]	MEDIUM-HIGH
57	See Site 56 restoration options. [end]	Offsite tidegate, but same landowner. [end]	[blank]	MEDIUM
58	See Site 56 restoration options. [end]	Offsite tidegate, but mostly same landowner. [end]	[blank]	LOW
59	Dike already breached; dike removal would improve sheet flow [end]	Existing restoration (breaching) limits access for further dike removal. [end]	Two dike breaches [end]	HIGH
60	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	MEDIUM
61	See Site 60 restoration options. [end]	Offsite tidegate [end]	[blank]	MEDIUM-LOW
62	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	MEDIUM
63	See Site 62 restoration options, except for ditch filling [end]	Offsite tidegate; original tidal channel entry on adjacent property to S [end]	[blank]	MEDIUM-HIGH
64	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	MEDIUM-LOW
65	Remove/breach dike, remove/upgrade tidegates/culverts if present [end]	[blank]	[blank]	MEDIUM-HIGH
66	See Site 64 restoration options; also, riparian plantings. [end]	Offsite tidegate [end]	[blank]	LOW
67	See Site 64 restoration options. [end]	Offsite tidegate [end]	[blank]	LOW
68	Remove/breach dike, remove/upgrade tidegates/culverts, fill ditches [end]	[blank]	[blank]	LOW
69	See Site 68 restoration options. [end]	Offsite tidegate [end]	[blank]	LOW
70	If low dike exists, it could be removed. [end]	[blank]	[blank]	MEDIUM-LOW

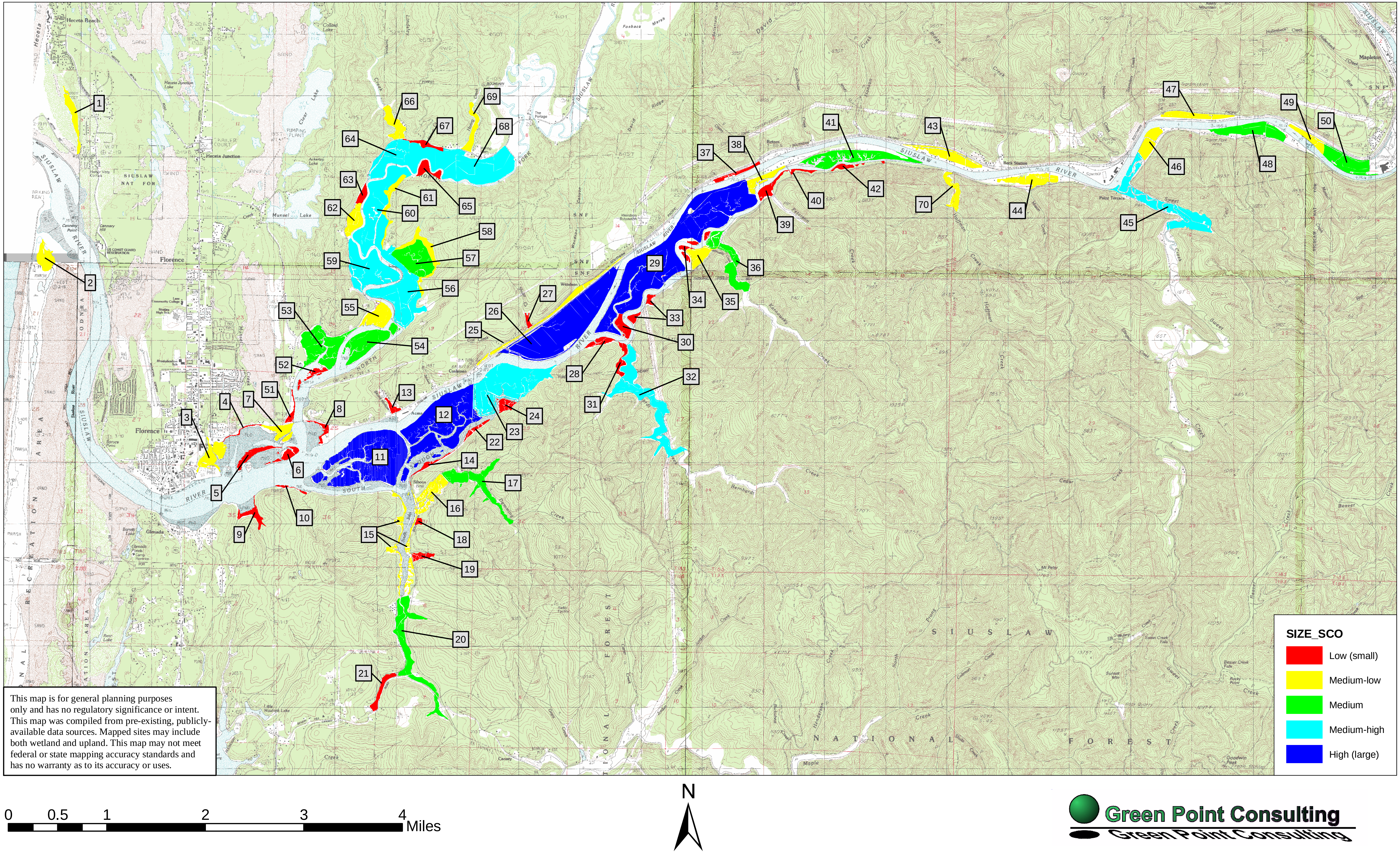
Appendix 5. Maps

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 1: Prioritization (total score)



Green Point Consulting

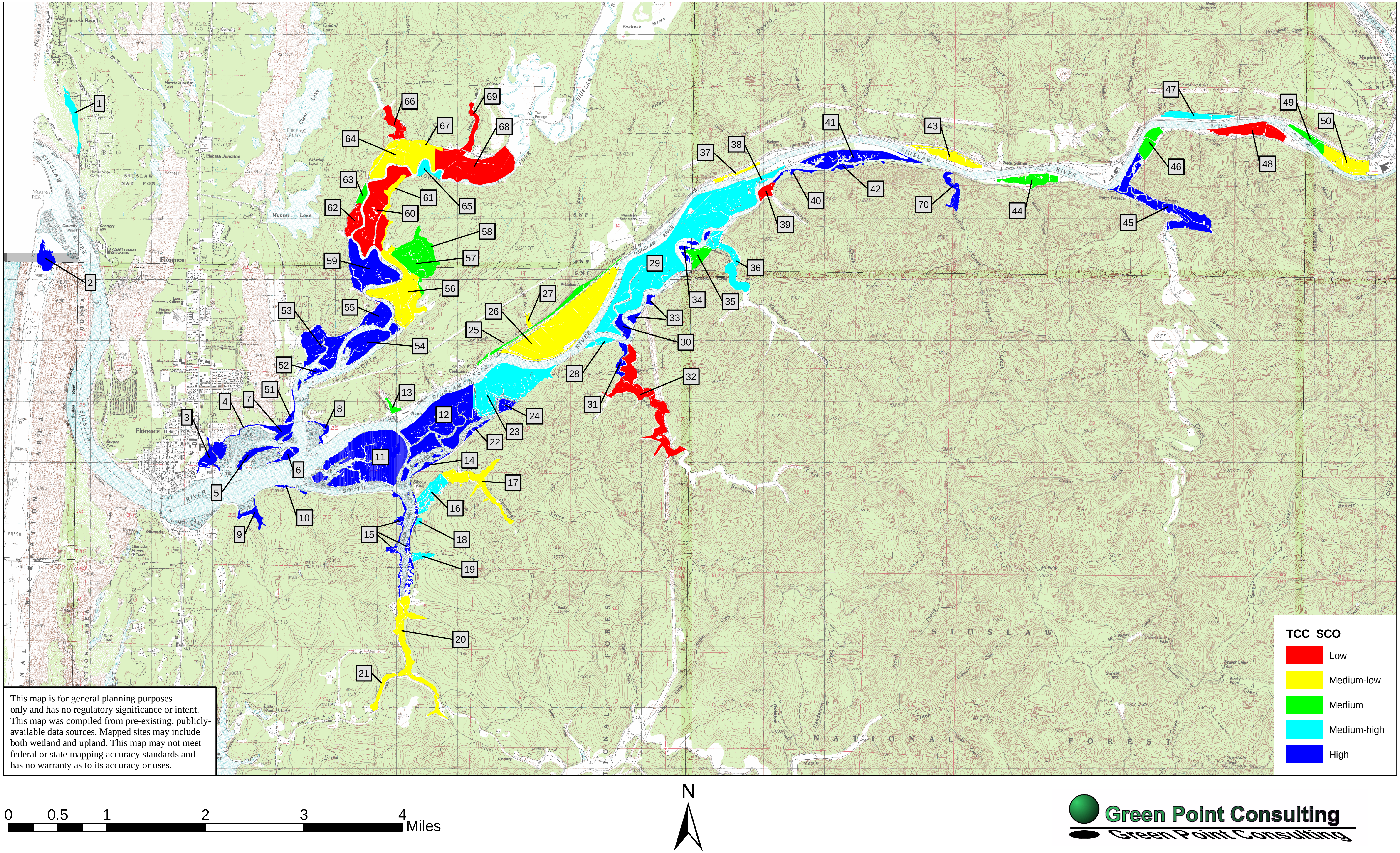
Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 2: Site size



This map is for general planning purposes only and has no regulatory significance or intent. This map was compiled from pre-existing, publicly-available data sources. Mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and has no warranty as to its accuracy or uses.

Green Point Consulting

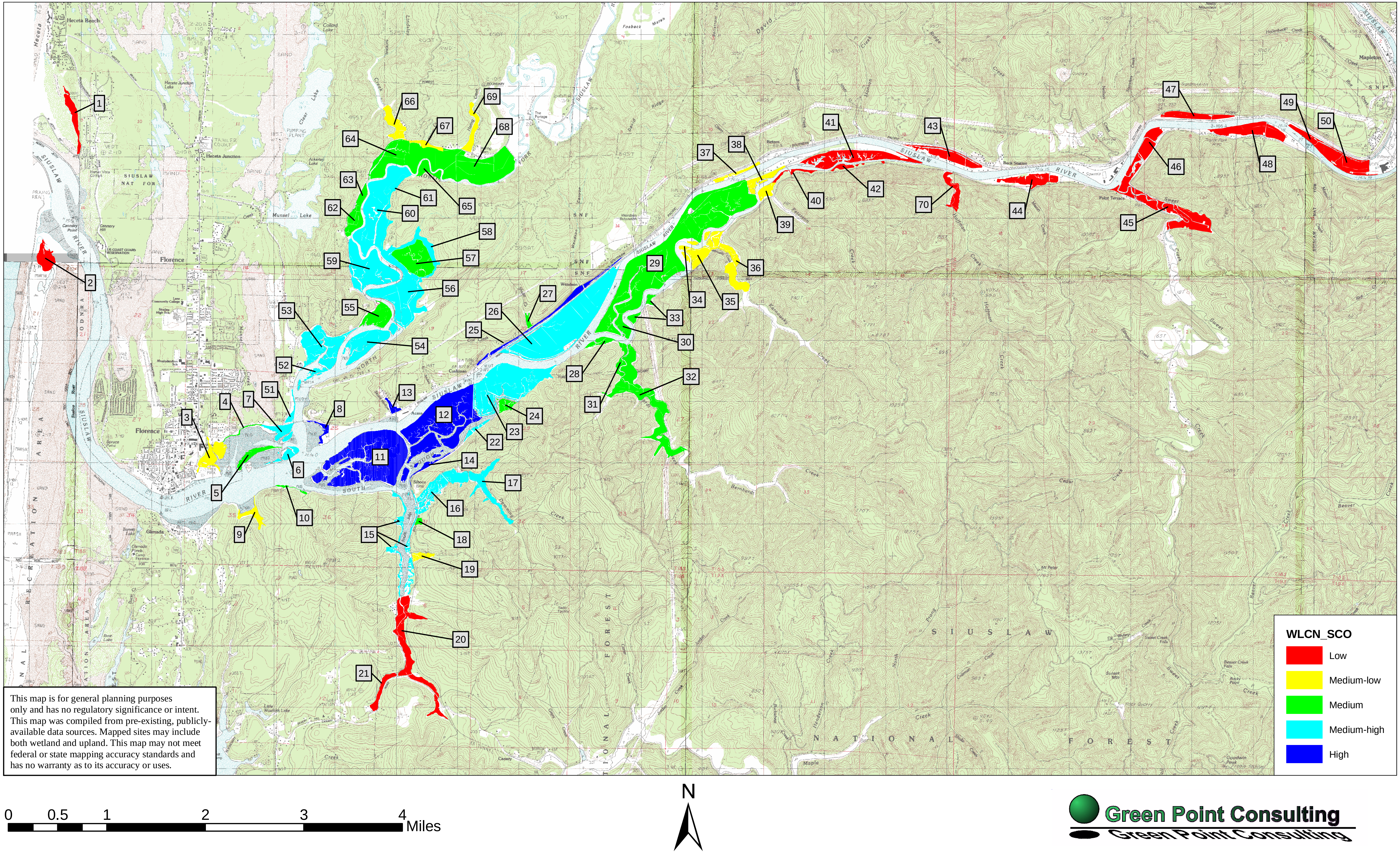
Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 3: Tidal channel condition



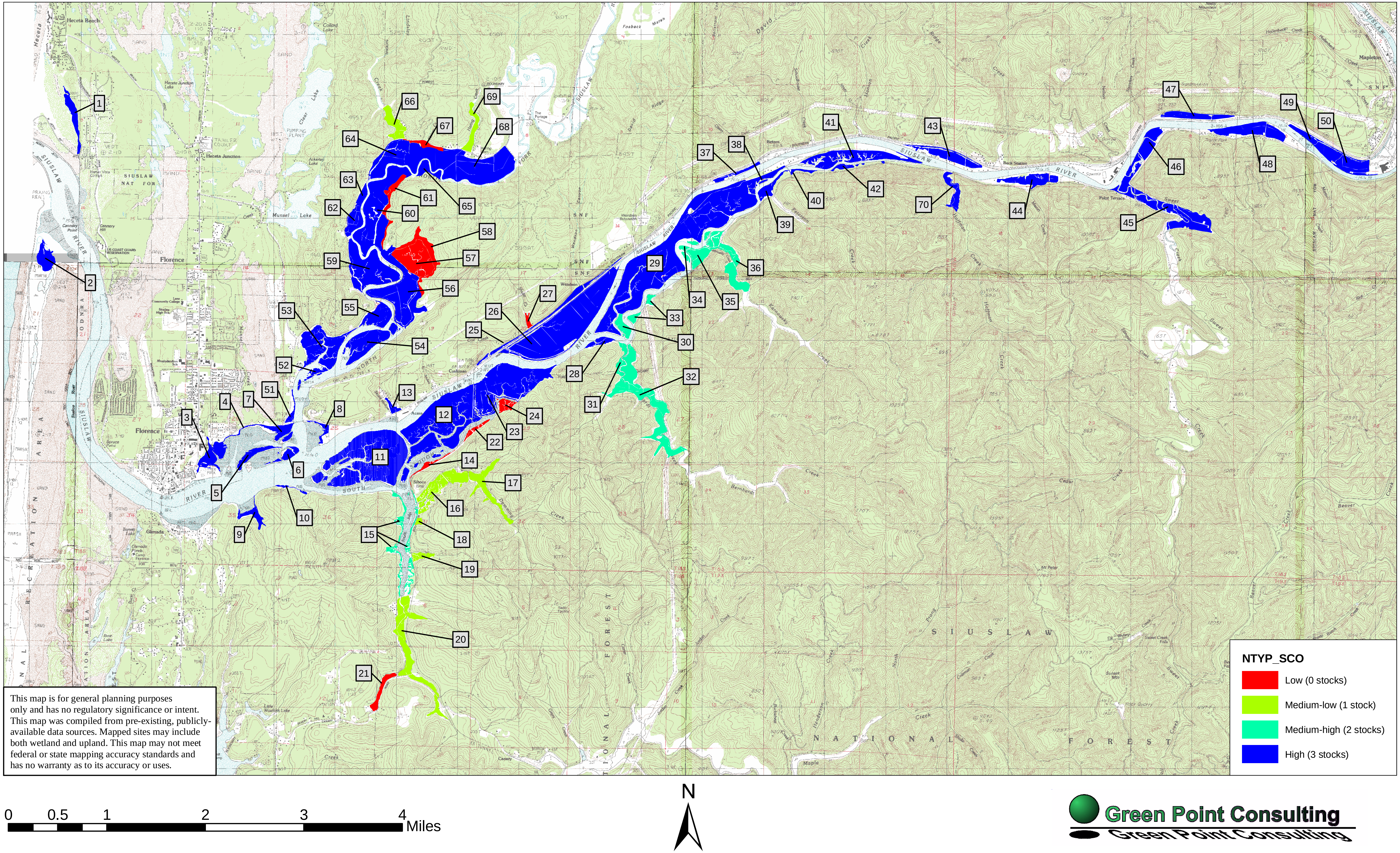
This map is for general planning purposes only and has no regulatory significance or intent. This map was compiled from pre-existing, publicly-available data sources. Mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and has no warranty as to its accuracy or uses.

Green Point Consulting

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 4: Wetland connectivity

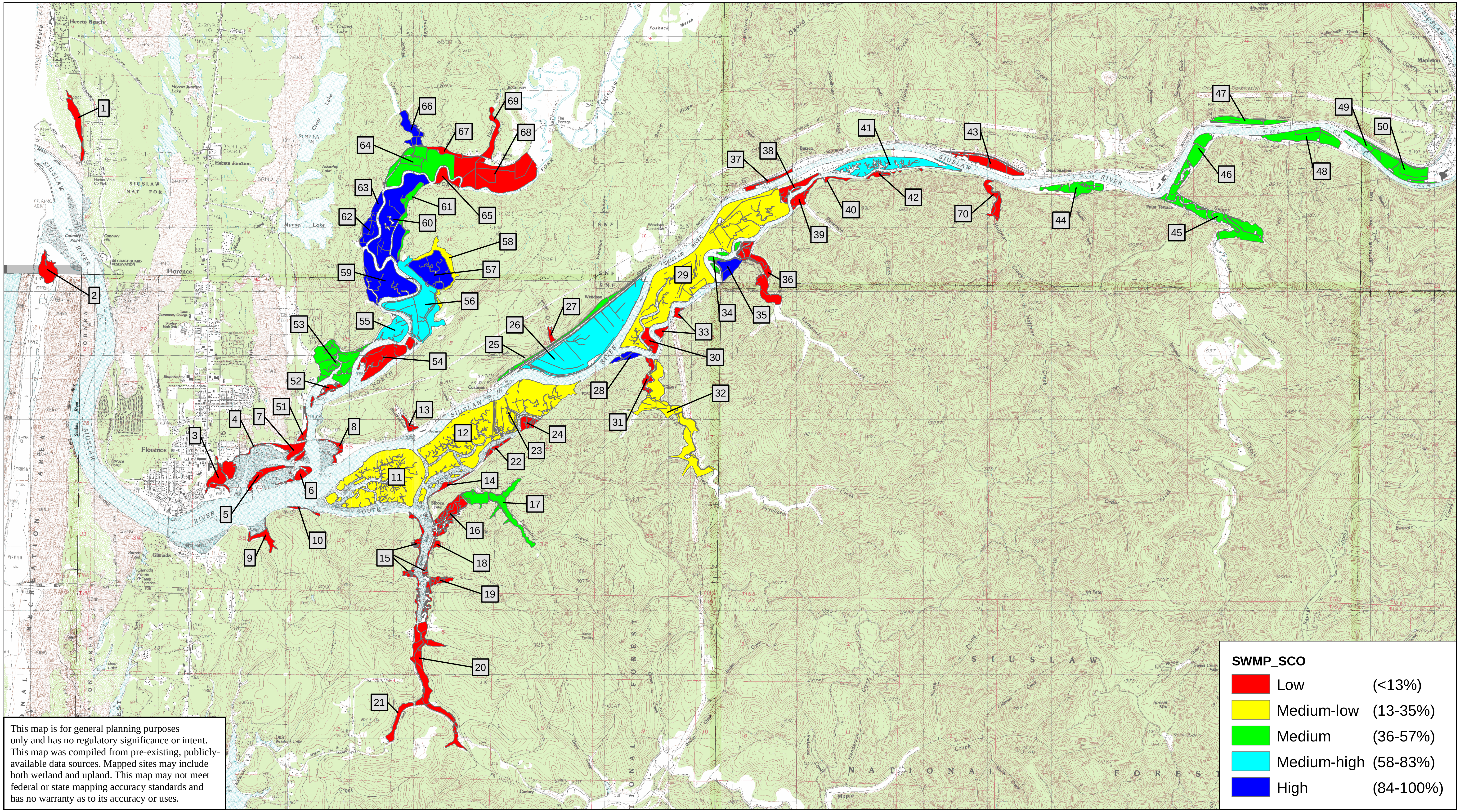


Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 5: Salmonid diversity (# of stocks spawning upstream of site)



Green Point Consulting

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005.
Map 6: Historic wetland type: Percent of site that was historically tidal shrub or forested wetland ("tidal swamp")

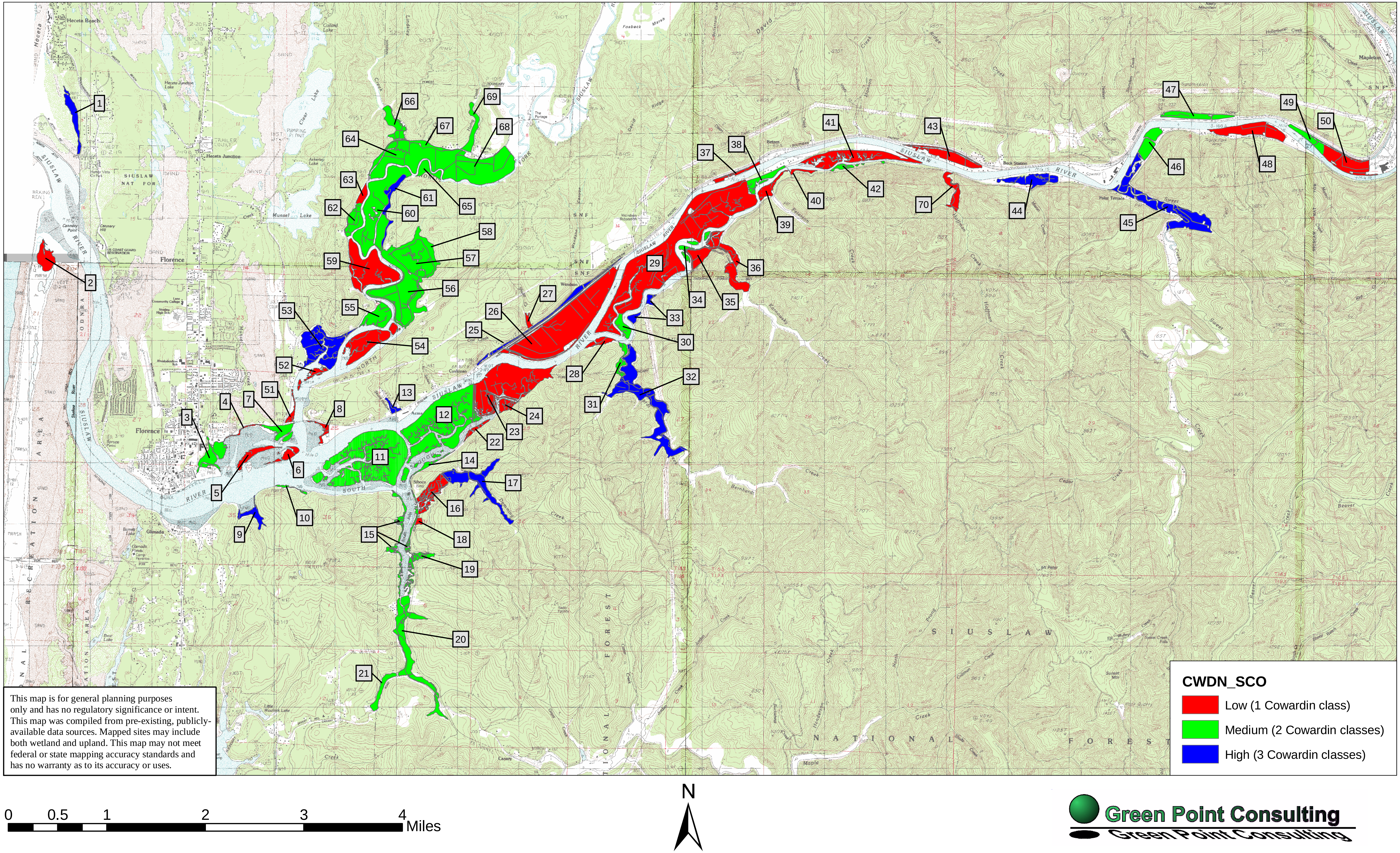


0 0.5 1 2 3 4 Miles

N

Green Point Consulting

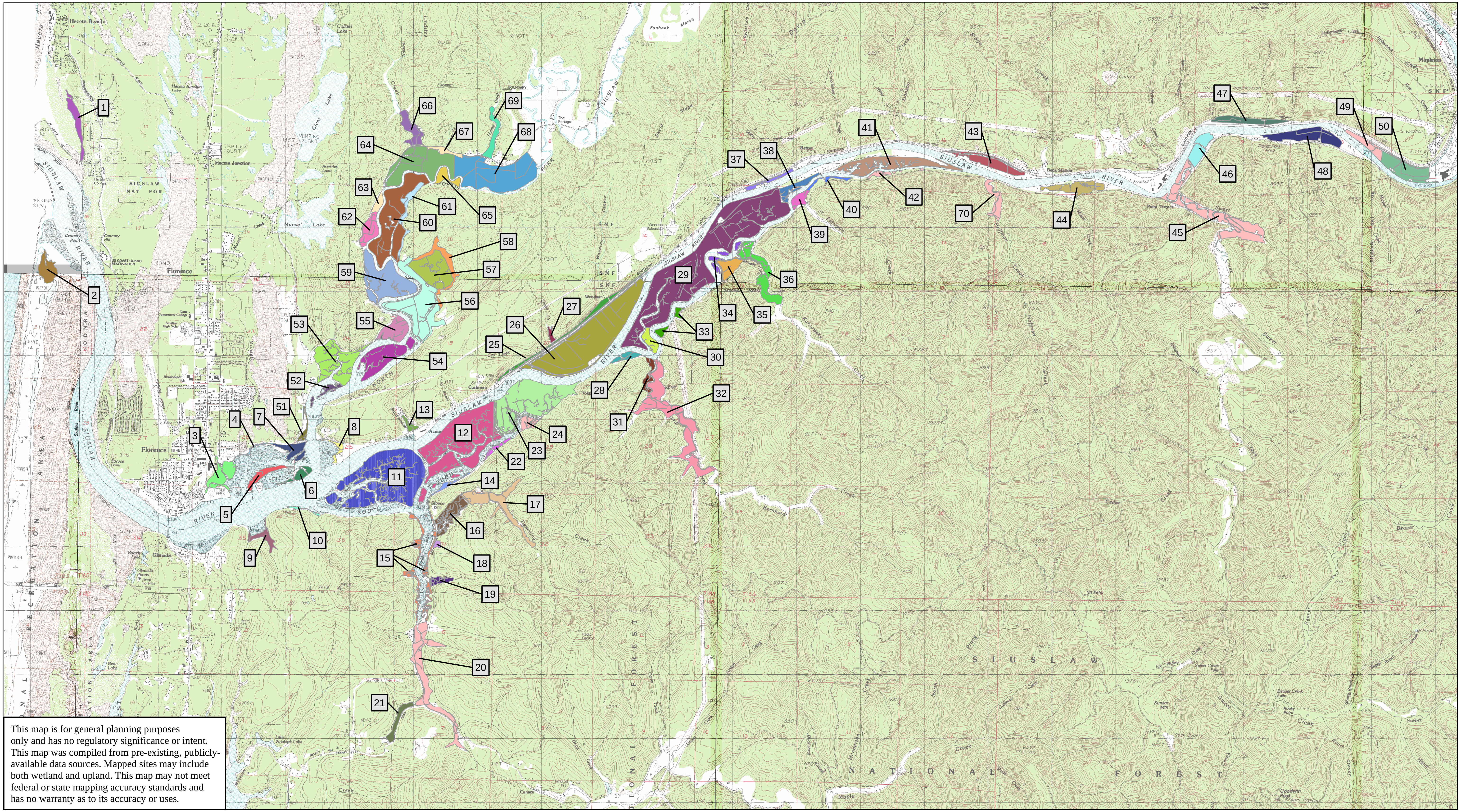
Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 7: Current vegetation type diversity



This map is for general planning purposes only and has no regulatory significance or intent. This map was compiled from pre-existing, publicly-available data sources. Mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and has no warranty as to its accuracy or uses.

Green Point Consulting

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 8: General map of sites
(Each site is colored separately; colors do not indicate priorities)



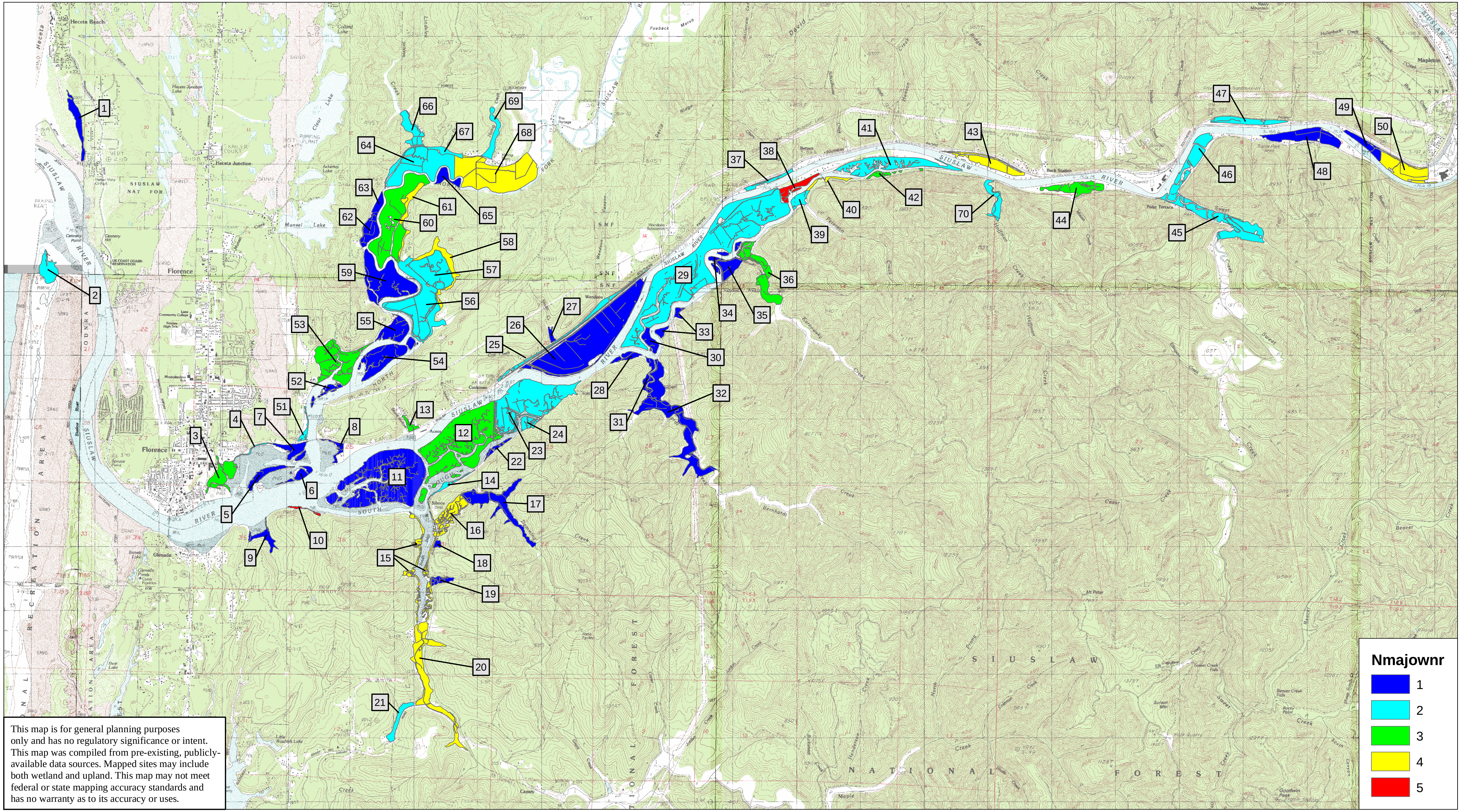
This map is for general planning purposes only and has no regulatory significance or intent. This map was compiled from pre-existing, publicly-available data sources. Mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and has no warranty as to its accuracy or uses.

0 0.5 1 2 3 4 Miles

N

Green Point Consulting

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 9: Number of major landowners

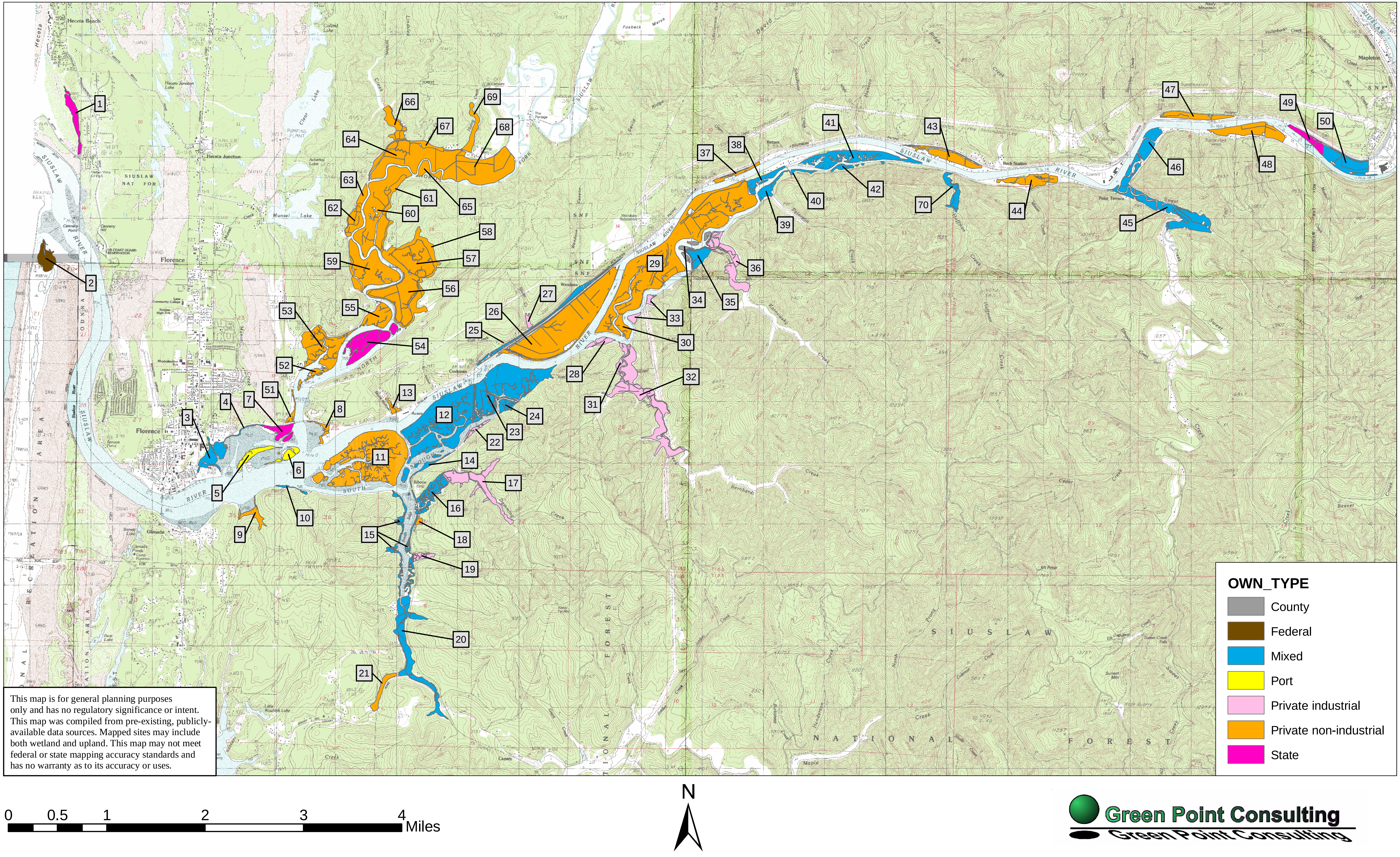


0 0.5 1 2 3 4 Miles

N

Green Point Consulting

Tidal Wetland Prioritization for the Siuslaw River Estuary, 2005. Map 10: Land ownership type



This map is for general planning purposes only and has no regulatory significance or intent. This map was compiled from pre-existing, publicly-available data sources. Mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and has no warranty as to its accuracy or uses.

Green Point Consulting