Tidal Wetland Prioritization for the Umpqua River Estuary

Tidal channel and emergent tidal marsh, Umpqua River estuary.
Photo by L. Brophy.

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Green Point Consulting
U.S. Fish and Wildlife Service
Pacific Coast Joint Venture

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Abbreviations

ACOE	U.S. Army Corps of Engineers
DLCD	Department of Land Conservation and Development
DSL	Department of State Lands
EPB	Estuary Plan Book
GIS	Geographic Information Systems
HGM	Hydrogeomorphic (as in the HGM wetland functional assessment method)
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
PDF	Adobe Portable Document Format
UBWC	Umpqua Basin Watershed Council
UGB	Urban Growth Boundary
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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 land areas in the Umpqua 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. Information was stored in a Geographic Information System (GIS) and in Excel spreadsheets. The GIS shapefiles, spreadsheets and maps can be used to organize information about tidal wetlands and estuary conservation activities. The estuary is a dynamic place, so we recommend 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. The study uses an ecosystem perspective, prioritizing wetland areas ("sites") rather than specific restoration projects. Criteria for prioritization included size of site, tidal channel condition, wetland connectivity, salmonid habitat connectivity, historic vegetation type, and diversity of current vegetation types. Information on these characteristics was obtained from publicly available data, field reconnaissance (offsite observation), and aerial photograph interpretation. Number of landowners, ownership type, proximity to development, and community perceptions can also be important factors in restoration planning. These factors are addressed in supplemental analyses.

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 jurisdictional wetlands; existing NWI maps were used for site boundaries. Because NWI maps are based on offsite data and establishment of wetland boundaries requires field work (beyond the scope of this project), this study's sites may contain both wetlands and uplands. The results of this study do not alter the regulatory status of any resources, and the study is not intended to replace existing regulatory planning processes. For example, this study cannot substitute for regulatory resource evaluations such as determinations of significance in the context of comprehensive planning programs. This prioritization is not intended to be an assessment of site functions. Assessment of tidal wetland functions is a complex and technical field (Simenstad et al. 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 a broad range of 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. 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.

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. Even sites ranked low in this study are important, because so many tidal wetlands have been lost or converted to other habitat types. All tidal wetlands offer valuable ecological services to people and wildlife.

To improve the accuracy and usefulness of this study, we 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 historic tidal wetlands in the Umpqua River Estuary up to the head of tide. "Historic tidal wetlands" means areas that are currently tidal wetlands, or were formerly tidal wetlands before human alteration. Emergent, scrub-shrub and forested tidal wetlands were included, but consistent with statewide methods (Brophy 2005a), aquatic beds (eelgrass and algae beds) and mud flats 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 (from Adamus 2005a and Jim Good, Oregon State University, personal communication). 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.

Two separate watershed councils operate in the Umpqua River estuary: the Umpqua Basin Watershed Council and the Smith River Watershed Council. To serve the needs of the two councils, we wrote two separate reports. This report focuses on the 59 sites that are located within the estuary of the mainstem Umpqua (sites 8-37, 51, 54-69, 77-82, and 98-103), but the discussion covers the entire Umpqua River estuary. The 40 sites located in the Smith River watershed (Sites 6, 7, 38-50, 52, 53, 70-76, 83-97, 104, 105) are covered in a separate report presented to the Smith River Watershed Council (Brophy and So 2005a). Site numbers were created in sequence as sites were defined, and have no relationship to site locations in the estuary. Each map (Figures 1 through 10) shows site numbers in boxes with pointers to the site.

Summary of results

We identified 1537 ha (3800A) of historic tidal wetlands within the entire Umpqua River estuary (including the Smith River). The total historic wetland area covered by this report (mainstem Umpqua) was 887 ha; the remaining 650 ha are located in the Smith River watershed. In a separate study, Scranton (2004) identified more than 320 ha (790A) of historic tidal wetlands in the Umpqua River estuary that have been completely filled and converted to developed uses. (Such completely filled areas were excluded from our study, in accordance with state methods [Brophy 2005a]). The resulting total historic tidal wetland area is 1857 ha (4589 A) – a figure 90% larger than the previous estimate of total historic tidal wetland area in the Umpqua River estuary (Good 2000). The difference is due to inclusion of major fills, as well as new data generated during this study through the use of aerial photograph analysis, local knowledge, and field reconnaissance. However, it is important to note that sites identified in this study may contain some non-wetland areas; site boundaries were taken from existing data sources, and field determination of wetland boundaries was beyond the scope of this study.

Using landscape ecology principles, we defined 99 sites within the entire Umpqua River estuary (59 sites in the mainstem Umpqua report area, 40 sites in the Smith River report area). We used aerial photographs, field reconnaissance and local input to determine the types of alterations to the sites. We then added in major fill areas from Scranton (2004). The results show that of the historic tidal wetlands within the entire Umpqua River estuary (including the Smith River), 62% (1157 ha) have been completely filled or affected by major alterations that strongly affect tidal flows (17% filled; 45% affected by major alterations). Another 19% (351 ha) have undergone minor alterations like culverted drainages, minor or partial fills (but no development), and road crossings. Nineteen percent (348 ha) are relatively undisturbed.

We prioritized sites for conservation and restoration using ecological criteria, creating five priority groups with 19 to 20 sites each in the Umpqua River estuary (including the Smith River). The largest proportion of the area fell into the medium-high priority group (23.6% of the estuary, 362 ha). The low-priority group was the smallest (15.5% of the estuary, 238 ha). The remaining three priority groups were about equal in size (about 20% of the estuary and about 300 ha each).

Products

The following products are provided with this report:

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

- **Appendix A. Restoration principles.** Principles of tidal wetland restoration.
- **Appendix B. Restoration approaches.** General recommendations for restoration in Oregon's tidal wetlands south of the Columbia.
- **Appendix C. Site ranking tables** (from Excel spreadsheet, u_tidalw.xls):
  - Table C1: Site rankings, sorted by ranking (top down)
  - Table C2: Site rankings, sorted by site number
- **Appendix D. Data details (metadata)**
  - Table D1. Data sources
  - Table D2. Key to site information table fields
  - Table D3. Key to plant species codes used in site information table
  - Data limitations
  - Notes on site information table fields
- **Appendix E. Site information table**, including ranking factor scores and other site details (also contained in Excel spreadsheet described below)
- **Appendix F. Figures (maps)**
  - Figure 1. Total score
  - Figure 2. Number of landowners
  - Figure 3. Land ownership type
  - Figure 4. Size of site
  - Figure 5. Tidal channel condition
  - Figure 6. Wetland connectivity
  - Figure 7. Salmon habitat connectivity
  - Figure 8. Historic vegetation type (% of site that was historically spruce swamp)
  - Figure 9. Diversity of vegetation classes
  - Figure 10. Watershed council input (community perceptions)

2. Excel spreadsheet of site information (u_tidalw.xls) containing all attributes in the tidal wetland shapefile.

3. GIS shapefile of study sites (ArcView shapefile: u_tidalw.shp). 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 us. Contact information is listed on page 2.

Background

The Umpqua River estuary

The Umpqua River estuary is classified by the Oregon Department of Land Conservation and Development (DLCD) as a Shallow Draft Development estuary (Cortright et al. 1987). Other estuaries in this category include Nehalem River, Tillamook Bay, Depoe Bay, Siuslaw 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).

Like many of Oregon's estuaries, the Umpqua is a "drowned river mouth" system, with broad tide flats located low in the system. The Umpqua estuary is strongly influenced by the large volume of fresh water carried by the Umpqua River. The Umpqua watershed is the largest watershed draining to the Oregon coast south of the Columbia, with an area of 4500 square miles.

The biological resources of the Umpqua River estuary are rich. The Umpqua is one of Oregon's most important producers of salmon and steelhead, supporting spawning runs of coho, fall chinook, spring chinook, winter steelhead, and summer steelhead (ODFW 2004). As described in "Tidal wetland functions" below, all of these salmonids use the estuary's tidal wetlands to forage and to acclimate to ocean salinities before ocean entry. The estuary is an important area for waterfowl and many other wetland-dependant species, including several breeding pairs of bald eagles. The lower reaches of the Umpqua and Smith Rivers support substantial populations of dabbling ducks and diving ducks, and this area is one of only two important wintering areas for tundra swans in Oregon (Oregon Wetlands Joint Venture 1994). The estuary also provides critical rearing and feeding habitat for crabs, shellfish such as mussels and oysters (including commercial oyster facilities), and many marine fishes such as lingcod, flounder and sole.

All of the major types of tidal wetlands in Oregon are found in the Umpqua River estuary, including mud flats, aquatic beds (eelgrass and algae beds, exposed only briefly during lower low tides), emergent marsh (including low and high marsh), scrub-shrub wetlands, and forested wetlands. Consistent with statewide methods (Brophy 2005a), this study does not address aquatic bed habitats, for which management issues are quite distinct. Although the salt marsh is the best-known type of tidal wetland, tidal wetlands are found throughout the full range of salinities, from the marine salinity zone to the freshwater tidal zone near head of tide. Many tidal wetlands in the upper estuary (low-brackish or freshwater tidal zone) are scrub-shrub and forested wetlands, collectively known as "tidal swamps." Few undisturbed examples of tidal swamp remain in Oregon, so these habitats are little understood. These areas were converted to agricultural use early in the estuary's history, because they are at relatively high elevations and have less frequent tidal flooding compared to tidal marshes in the lower estuary.

Bulrush marsh (dominated by softstem and hardstem bulrush, *Schoenoplectus tabernaemontani* and/or *S. acutus*) is more common in the Umpqua River estuary than in many other Oregon estuaries south of the Columbia, probably because of the strong freshwater influence here.

Human land uses have caused many changes to the Umpqua River estuary. Many former tidal wetlands have been filled and/or excavated to develop port facilities, mills, marinas, and other industrial, commercial and residential sites. The City of Reedsport north of Providence Creek is built almost entirely on former tidal wetlands (Scranton 2004). Other major areas of filled tidal wetlands include Bolon Island Industrial Park, the Gardiner Mill, and the city of Winchester Bay (Scranton 2004). Many former tidal marshes and swamps are now diked and ditched; two of the largest of these are the Dean Creek Elk Viewing Area and Leeds Island. In recent years, some of the diked lands have been restored through deliberate breaching of dikes, and others are reverting to tidal influence through natural breakdown of dikes. However, the vast majority of diked lands remain closed to tidal influence.

Dredging of the Umpqua River is periodically conducted to deepen the navigational channel. In the past, some of the dredged material has been placed on current or former tidal wetlands. Some examples include the north end of Steamboat Island, Leeds Island, and the Dean Creek Elk Viewing Area. Given the high losses of tidal wetlands in the study area, we recommend dredged material disposal be conducted on upland sites in the future. This study may assist future dredged material disposal planning, by identifying tidal wetland areas to avoid. (Even low-priority tidal wetlands should be avoided, because all tidal wetlands provide unique functions and all tidal wetlands have been heavily impacted by past human activities.)

Tidal wetland functions

Tidal wetlands serve many vital functions in the watershed. They include water quality (sediment detention and stabilization, nutrient and contaminant stabilization and processing), ecological support (food chain support, native vegetation support), and wildlife habitat (habitat for fish, birds, invertebrates, and mammals). Detailed evaluation methods for these functions are found in the HGM (hydrogeomorphic) functional assessment method for tidal wetlands of the Oregon coast (Adamus 2005a).

The value of tidal wetland functions may be enhanced by the location of these wetlands in a critical landscape position -- low in the watershed, in an economically important nursery zone for anadromous and marine organisms, and near 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 (Simenstad and Bottom 2004). Tidal wetlands are a crucial part of this continuum, providing highly productive rearing and foraging habitats, 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, which in turn allows increased ocean survival (Miller and Sadro 2003).

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 rank 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 ecosystems as ranked by Costanza et al. 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 easily accessible 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% of Oregon's tidal wetlands have been converted to other human uses (Christy 2004, Good 2000, Boule and Bierly 1987) since the 1850s. 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 alterations

Alterations to estuaries can be site-specific (located only on a particular site, such as a dike or ditch) or estuary-wide (affecting all sites). Estuary-wide alterations affect many or all tidal wetlands in an estuary, even those wetlands with no onsite changes. Examples of estuary-wide alterations include altered sediment deposition patterns; changed peak flows, water circulation patterns, and flooding regimes; water and sediment contamination; widespread development creating impermeable surfaces (such as 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 2005a), this study addresses only site-specific alterations, but estuary-wide factors should be considered when planning a site-specific restoration project.

Site-specific alterations 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.

Alterations that eliminate, 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 eliminate, reduce, or alter those unique tidal wetland functions. Wetland changes due to altered tidal flow can include a decrease in tidal channel complexity, shifts 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 matter 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 (Frenkel and Morlan 1991, Brophy 2004).

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, due to soil subsidence and impeded freshwater drainage. However, many of the original tidal wetland's functions (such as salmonid habitat and sediment detention) may no longer be performed, or may be performed at greatly reduced levels, when tidal flows are eliminated.

Even where tidal flows are still present, human alterations can strongly affect tidal wetland functions. ***Ditches*** change tidal flow patterns, inundation regimes, 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 salmon and other aquatic organisms, and can cause erosion in adjacent areas. ***Excavation, fill*** and ***dredged material disposal*** change site elevations, inundation regimes, 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 can be removed or 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).

The goal of removing human alterations is to re-establish the natural forces that create tidal wetlands. 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 A).

Restoration of tidal flow is the most important component of tidal wetland restoration design, but 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 8 in **Restoration recommendations** at the end of this report shows potential restoration actions corresponding to site alterations. Other details are provided in Appendix B, **Restoration approaches.**

Methods

This study prioritized tidal wetland sites for conservation and restoration, using existing data, aerial photograph interpretation, field reconnaissance, and local knowledge. Site characterization was conducted during 2003-2004.

Information sources

We located and described tidal wetland sites by using publicly accessible data, local knowledge, and new information from aerial photograph interpretation and field reconnaissance (generally from offsite vantage points).

We used geographic information systems (GIS) software to organize, analyze and display data for this study. GIS data came from a variety of publicly available sources (Table D1, Appendix D). The GIS database included landforms, elevation, wetland inventories, soil type, historic vegetation, habitat type, salmon distribution, hydrography, salinity, land ownership, and urban areas mapping.

This project's map of tidal wetland sites was developed from 1:24,000 scale National Wetland Inventory maps. Using the information described above, we merged and split the NWI mapped wetlands to create analysis units (sites) that met this project's needs (see **Site definition** below). We included only those NWI wetlands that appeared to be current or former tidal wetlands based on available information.

We characterized sites using aerial photographs, field reconnaissance, local knowledge, and other sources. Color infrared aerial photographs were obtained from the Army Corps of Engineers (May 2001 color infrared photos at 1:24,000 scale) and from the Bureau of Land Management (June 2002 true color photos at 1:12,000 scale). We assessed site alterations and vegetation patterns by stereoscopic analysis of the aerial photographs and by field observation (generally from offsite vantage points). Further characterization of vegetation was enabled by a helicopter overflight provided by the U.S. Coast Guard, North Bend Station, and accompanying aerial photographs taken during that mission by David Pitkin of the Oregon Coast National Wildlife Refuge Complex. Interviews with local residents and other regional experts provided a historical context and other details for individual sites and for the estuary as a whole. The Umpqua Basin Watershed Council organized a workshop for landowners and the public, in which local residents had input into the process; the results are used in this analysis.

One of the primary goals of site characterization was identification of alterations to historic tidal wetlands. Alterations identified in the Umpqua River estuary included dikes, ditches, culverts, tidegates, grazing and excavation. Logging and driftwood removal also affect many tidal sites in the Umpqua River estuary. We did not specifically evaluate logging/wood removal at study sites, because logging is difficult to detect using current aerial photographs. Impacts from logging are best addressed during site-specific restoration design; some suggestions are found in **Restoration approaches** below.

Site definition

To provide strategic guidance for tidal wetland restoration and conservation, we defined analysis units called "sites." In general, a site is a contiguous wetland area with internally connected water flow (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 follow ownership boundaries.

We conducted this analysis for the entire Umpqua River estuary, because the estuary functions as an ecological whole, not in two separate parts. Sites within the entire Umpqua River estuary (including the Smith River) are numbered from 6 through 105. There are no sites numbered 1-5 or 73.

Two separate watershed councils operate in the Umpqua River estuary: the Umpqua Basin Watershed Council and the Smith River Watershed Council. To serve the needs of the two councils, we wrote two separate reports. This report focuses on the 59 sites that are located within the estuary of the mainstem Umpqua (sites 8-37, 51, 54-69, 77-82, and 98-103). The other 40 sites (6, 7, 38-50, 52, 53, 70-76, 83-97, 104, 105) are located in the Smith River watershed; these sites are covered in a separate report presented to the Smith River Watershed Council (Brophy and So 2005a). Site numbers were created in sequence as sites were defined, and have no relationship to site locations in the estuary. Each map (Figures 1 through 10) shows site numbers in boxes with pointers to the site.

Prioritization method development and review

The prioritization method used in this study has been extensively reviewed and tested, and follows statewide methods (Brophy 2005a). The Umpqua Basin Watershed Council's technical team reviewed the method during its implementation in the Umpqua River estuary to ensure it met local needs. Development of the Estuary Assessment module of the OWEB Watershed Assessment Manual (Brophy 2005a) was based on the methods used in this prioritization, as well as our prioritizations in the Nehalem River estuary (Brophy and So 2005b) and the Siuslaw River estuary (Brophy 2005b). The OWEB method was reviewed by a team of regional experts in tidal wetland ecology and restoration and revised in response to their recommendations.

Restoration sites vs. conservation sites and joint prioritization

This study, like the statewide method (Brophy 2005a), prioritizes restoration sites and conservation sites jointly. The goal of our prioritization method is to identify areas of high current or potential ecological function, and this goal is best accomplished by considering all sites together. 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 or enhancement opportunities, such as improved culverts on the upslope side or removal of introduced (non-native) species.

Even though restoration and conservation sites have been prioritized jointly, the site information table (Appendix E) can be used to develop separate conservation and restoration action plans. For example, to develop an action plan for conservation of existing high-functioning tidal wetlands, select the highest-ranking wetlands that have no alterations listed in the site information table. To develop a restoration action plan, select the highest-ranking wetlands that have alterations shown.

Prioritization criteria

The following ecological criteria were used to prioritize sites:

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

Each site was scored for each of these criteria on a consistent scale, so that all criteria were equally weighted. The criterion scores were summed for a total site score, which represents a site's likelihood of contributing to tidal wetland functions in the estuary. After scoring, the sites were grouped into five priority categories: High, medium-high, medium, medium-low, and low (Figures 1a, 1b). 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 on conservation or restoration efforts may be the greatest.

Non-ecological criteria, such as number of landowners, landowner type, land use regulations, and community perceptions also affect restoration decision-making. These factors are addressed in the **Supplemental analyses** section.

Table 1 shows a summary of the criteria used to prioritize sites, the data sources, and the scoring levels for each criterion.

Table 1. 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 categories in text.
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 center of site.	Convert full range of values for study area to scores of 1 (smallest area) to 5 (largest area).
Salmonid habitat connectivity	Oregon Dept. of Fish and Wildlife salmon habitat mapping	See components of salmonid habitat connectivity score below (Table 2)	See Table 2.
Historic wetland type	Oregon Natural Heritage Program historic vegetation mapping	Proportion of site that was historically spruce swamp	Convert full range of values for study area 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) mapped on site.	One Cowardin class = score of 1 Two Cowardin classes = 3 Three Cowardin classes = 5
TOTAL SCORE			Add all 6 criteria scores (maximum possible score = 30; minimum possible score = 6)

Table 2. Components of salmon habitat connectivity criterion

Factor	Data source	Description	Levels
Number of salmonid stocks spawning upstream	Oregon Dept. of Fish and Wildlife salmon habitat mapping	Number of salmonid stocks spawning upstream of site in stream system feeding site (main stem or tributary). Range: 0 to 5.	Convert full range of values for study area to scale of 1 (0 stocks) to 5 (5 stocks).
Distance to spawning	Oregon Dept. of Fish and Wildlife salmon habitat mapping	Average distance from site to nearest ODFW mapped spawning and rearing habitat.	For each stock, convert full range of values for study area to scores of 1 (longest distance) to 5 (shortest distance). Take average of 5 salmonid stock scores for each site. NOTE INVERSE SCORING.
TOTAL			Add both salmon habitat connectivity scores and rescale to a range of 1 to 5.

Figures 1a and 1b show 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 other wetland prioritization methods (White et al. 1998; Schreffler and Thom 1993; Lebovitz 1992; Brophy 1999; Costa et al. 2002). The size of a wetland is closely related to the level of functions it provides. All other factors being equal, bigger is 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. Site size was rescaled to obtain a size score ranging from 1 (smallest site in study area) to 5 (largest site in study area). Figures 4a and 4b show 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, generally resulting in lower channel complexity and shorter total channel length. Highly altered channels and blocked tidal flow reduce tidal wetland functions, and make restoration more difficult and expensive.

Remnant channels were considered in the channel condition score, since their presence may indicate a lower level of alteration and potentially faster return of functions after restoration. In addition, sites with prominent remnant channels may require only relatively low-cost restoration methods (such as grazing setasides or culvert upgrades) to return to full wetland functions. More highly-altered sites, by contrast, may require more expensive and technically complex restoration techniques such as dike breaching, ditch filling, and excavation of tidal channels.

Aerial photographs and field reconnaissance were used to determine whether a site within the tidal zone had high (good), medium or low (poor) channel condition. Human alterations to tidal exchange (blockages like dikes and tidegates) were also considered in evaluating this criterion. Channel condition and tidal flow blockages were generally visible in aerial photographs, either directly (visible ditching, diking, tidegates, etc.) or indirectly as a change in the appearance of channels or vegetation compared to undisturbed areas. The categories for this factor are defined as follows:

1. Limited or no tidal exchange, heavily ditched: The site is either no longer hydrologically connected to the estuary and receives no tidal influence, or it is hydrologically altered but still allowing some amount of tidal flow to the interior of the site, either through a leaky tidegate or culvert or through small breaches in the dike. A combination of dikes, ditches, tidegates, culverts, extensive ditches, and other hydrologic barriers and flow alterations affect the site. Few or no remnant meandering channels are visible. Score = 1

2. Limited tidal exchange, not heavily ditched: The site has been hydrologically altered, but either that alteration is minimal (such as a bridge or nonrestrictive culvert), or events such as dike breaches, tidegate failure, or tidegate removal have allowed partial reestablishment of tidal flow. The site is not ditched; tidal flow is carried in meandering channels. Score = 3

3. Tidal flow intact: Air photo interpretation and field reconnaissance reveal no obvious signs of hydrologic alteration. The site is relatively undisturbed with sinuous, meandering tidal channels. Existing tidal wetland restoration sites (where dikes have been deliberately breached) are included in this category. Score = 5

Figures 5a and 5b show 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). Sites with good wetland 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 adequately serve their needs. For many species, interconnected wetlands offer important opportunities for juvenile dispersal.

Interconnected wetlands of different salinity regimes (e.g. salt, brackish and freshwater wetlands) offer juvenile salmon the opportunity for gradual adjustment 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 (Komar 1998). 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 River 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 (EPB) mapped eelgrass beds (EPB attributes 1.3.9 and 2.3.9) for this analysis. Eelgrass 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 each site was calculated.

Figures 6a and 6b show the results of the wetland connectivity analysis.

Salmonid habitat connectivity

The Umpqua River watershed supports spawning populations of coho, winter and summer steelhead, and fall and spring chinook salmon, as well as searun cutthroat trout. All of these anadromous stocks must migrate through the estuary; therefore, all tidal wetland sites within the estuary could potentially provide salmonid habitat functions. In order to discriminate between relative levels of importance in terms of fish use, we scored sites on their connectivity to salmon spawning habitat. The connectivity metric was composed of two subscores: 1) **Number of salmonid stocks spawning upstream**, and 2) **Distance to spawning** (Table 2).

Our data source for this analysis was the Oregon Department of Fish and Wildlife 1:100,000 scale salmon distribution mapping (ODFW 2004). Since equivalent ODFW data are not available for searun cutthroat, cutthroat were not considered in the analysis. The number of stocks spawning upstream of each site was determined from the ODFW data, and distance to the nearest ODFW-mapped spawning and rearing habitat was determined using GIS network analysis. (Spawning and rearing habitat is defined by ODFW as habitat where "eggs are deposited and fertilized, where gravel emergence occurs, and where at least some juvenile development occurs.") The range of distances within the study area was rescaled to a range of 1 to 5 for each stock's score, and scores for all stocks were averaged for the final distance to spawning score.

The final **salmonid habitat connectivity score** was obtained by averaging the two subscores (number of salmonid stocks, and distance to spawning).

The salmonid habitat connectivity score is not intended to evaluate actual use levels. Salmonid use of Oregon tidal wetlands is currently being actively investigated, with much new information being generated (e.g., Bottom et al. 2004). To help address the many unknowns in salmon use of tidal wetlands, we selected prioritization criteria that would have broad influence over use levels, such as site size, channel condition, and wetland connectivity.

The results of the salmon habitat connectivity scoring are shown in Figures 7a and 7b.

Historic vegetation type

We use the term "historic vegetation type" to mean the type of wetland vegetation that was present on a site prior to human alteration. 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." In other words, restoration planning should attempt to restore the "chain of habitats" from headwaters to ocean. This chain is broken when human alterations to the landscape eliminate or greatly reduce a particular habitat type.

In Oregon, one tidal wetland type that has been disproportionately affected by human activity is tidal swamp (tidal forested or scrub-shrub wetland). In the Columbia River estuary, the Youngs Bay, Baker Bay, Grays Bay, and Upper Estuary subbasins lost 80 to 100% of their tidal swamps between the 1850s and 1980s (Thomas 1983); the only subbasin that retained more than 50% of its tidal swamp in the 1980s was Cathlamet Bay. Preliminary estimates for Oregon estuaries south of the Columbia show tidal swamp losses around 90 to 95% since the 1850s, compared to about 70% for tidal marshes (Brophy, unpublished).

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 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). Nearly all of these swamp areas were cleared early in this century. We used historic vegetation mapping (Hawes et al. 2002, Christy et al. 2001) to locate areas of former tidal spruce swamp. We intersected the historic vegetation layer and the sites layer to determine the proportion of each site that was historically swamp. This proportion was then rescaled to obtain the historic vegetation score ranging from 1 (0% spruce swamp) to 5 (100% spruce swamp).

The results of the historic vegetation type analysis are shown in Figures 8a and 8b.

Diversity of current vegetation types

Many wetland functional assessment methods use diversity and interspersion of vegetation cover classes as an indicator of functional level (Adamus 2005a, Adamus and Field 2001, Roth et al. 1996). 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 herbaceous vegetation like grasses and sedges), scrub-shrub (dominated by shrubs), and forested (dominated by trees).

To obtain a vegetation diversity score, the NWI layer was intersected with the sites layer. The proportion of each Cowardin class within each site was determined; classes present on less than 10% of a site were excluded since these often represented dikes or road embankments. 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).

Figures 9a and 9b show the results of the vegetation diversity analysis.

Scoring method

For each prioritization factor, the raw values were converted to a scale of 1 to 5, where 1 represents relatively poor condition and 5 corresponds to the best condition based on this study's methods. For example, a score of 5 for the size criterion would indicate large site size; for the channel condition criterion, a score of 5 would indicate relatively unaltered channel morphology and tidal exchange. Scores of 5 for the other criteria would indicate high wetland connectivity; high salmonid habitat connectivity; high percent historic swamp, and high current vegetation diversity. Rescaling was conducted across the entire Umpqua River estuary (including the Smith River), because the estuary functions as an ecological whole.

For the total score, all six scores were added:

> Total score = Sum of scores for Size of site + Channel condition + Wetland connectivity + Salmon habitat connectivity + Historic wetland type + Diversity of vegetation classes

After scoring, the sites were separated into the "ranking groups" shown in Figures 1a and 1b. 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 group boundary may have very similar scores. Individual criterion and total scores can be found in the site ranking tables (Appendix C) and in the site information table (Appendix E).

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, we recommend reviewing the details contained in the site information table, as well as the supplemental data described in the next section of this report.

Supplemental analyses

Land ownership, proximity to urbanization, land use regulations and community perceptions can strongly affect restoration logistics, timing and opportunities. The scope of work for this project did not include investigation of land use regulations, but we did consider land ownership, proximity to urbanization, and community perceptions. Through discussion with several watershed councils and other advisors, we decided to use these three factors as supplemental analyses, keeping the prioritization focused on ecological criteria. We recommend further consideration of non-ecological factors in the next step of action planning (landowner contacts and site-specific planning).

Land use regulations

A number of land use regulations affect coastal lands in Oregon. Examples include local and county comprehensive plans, port plans, the statewide coastal zone management program, land use zoning and special designations (planning "overlays"). The scope of work for this project did not include investigation of these regulations, but they strongly affect restoration and conservation activities in all tidal wetlands. We recommend early consultation with land-use planning staff to avoid regulatory surprises and delays during implementation of restoration or conservation actions. For further information, see the "Land use regulations" section of the Estuary Assessment module in the Oregon Watershed Assessment Manual (Brophy 2005a).

Land ownership

To assist in action planning, we determined the number of major landowners and the type of ownership for each site. The number of landowners at a site can affect restoration logistics, 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 near-term potential for loss of a wetland, because it may influence the likelihood of development. Ownership type may also influence the cost of restoration and the appropriate avenues and strategies for restoration.

Some authors (Lebovitz 1992, Dean et al. 2000) have theorized that land ownership type relates directly to cost or logistical complexity of site acquisition and/or restoration. However, in our experience, there is actually a complex, multidimensional relationship between land ownership type, restoration potential, cost, logistics, 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 many 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.

Clearly, the relationships between land ownership and restoration priority and logistics are complex. We discussed this with the Umpqua Basin Watershed Council technical team, and agreed to use only ecological factors in the prioritization scoring and include land ownership as a supplemental analysis.

Land ownership was determined using a GIS layer of tax parcels obtained from the Douglas County Assessor's Office. Because of registration issues (boundaries of tax lots did not precisely line up with site boundaries), we determined landowner number and type on the computer screen by visually comparing property and site boundaries. Although tax lots for each site were determined as accurately as possible, ownership and property boundaries should be verified when developing 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.

Number of landowners for each site is shown in Figures 2a and 2b. Land ownership types (based on landowner name) are listed in Table 3 below and mapped in Figures 3a and 3b.

Table 3. Ownership categories

Factor	Data source	Levels	Description
Ownership category	Land ownership data from County assessor's office	Tribe Federal State Port County City	Specific categories of public ownership
		Private/mixed	Private ownership, or a mixture of public and private ownership

Some high-priority restoration sites have multiple landowners. If some landowners do not want to participate in restoration or conservation of the site, it may be possible to take action on some parcels (sub-areas of the site) without affecting other parcels. The feasibility of such partial restoration or conservation depends on the characteristics of the site.

Proximity to urbanization

We used proximity to the Urban Growth Boundary (UGB) as a simple index of site vulnerability to development pressure. In this context, development pressure means the likelihood of a tidal wetland site becoming converted or lost due to urban development. Sites converted to urban uses are usually filled, and are generally difficult to restore for biological, social and economic reasons. Table 4 describes the data source and levels for proximity to urbanization.

Table 4. Proximity to urbanization

Factor	Data source	Levels	Description
Proximity to urban areas	Urban Growth Boundary mapping from ODOT/DLCD	Outside UGB	Entire site is outside Urban Growth Boundaries
		Inside UGB	Part of all of the site is inside an Urban Growth Boundary

Each site's proximity to the UGB can be seen in Figures 3a and 3b; we also highlighted sites inside or on the boundary in the site information table (Appendix E) in the field "In/On UGB?"

Although we highlighted sites within the UGB, all sites in this study are subject to federal, state, county, and/or local land use regulations (see "**Land use regulations**" above).

Community perceptions

Although we prioritized tidal wetland sites according to ecological criteria, peoples' ideas, values and attitudes about the land are equally important to the process. For example, restoration and conservation can only proceed if the landowner is interested and willing; and community perceptions can strongly affect the success of a particular restoration project as well as the potential for future actions in the estuary.

The scope of work for this study did not include determination of landowner interest, but we did ask the Umpqua Basin Watershed Council to help us address community perceptions. They organized a workshop in January 2004, in which community members provided input into the prioritization process and expressed their views about specific sites. This process was deliberately subjective, allowing us to take account of important community values that cannot easily be quantified. About 20 landowners and other local residents interested in the estuary ranked each site on a scale of 1 to 5. A score of 1 represented low acceptability of restoration (at altered sites) or low acceptability of conservation (at unaltered sites). A score of 5 represented high acceptability. The rankings are shown in Figures 10a and 10b. Participants also provided comments on sites, ranging from general perceptions to specific site characteristics and history. The comments which were compiled by UBWC and used in this study's site characterization process, improving the accuracy of the analyses and final prioritization.

Results and discussion

The final site prioritization is shown in Figures 1a and 1b. The scores for the six individual prioritization criteria are shown for each site in the ranking tables (Appendix C) and illustrated in Figures 4 through 9. Appendix E contains a detailed site information table including all data used in the prioritization. Narrative descriptions of high-ranked sites are provided later in the Results section. A general discussion of results follows.

Total historic tidal wetland area

We use the term "historic tidal wetlands" to refer to areas that were tidal wetlands prior to European settlement. Historic tidal wetlands include current tidal wetlands, as well as former tidal wetlands that have been converted to nontidal or nonwetland status through human alterations to the landscape.

This study identified 1537 ha (3800A) of historic tidal wetlands within the entire Umpqua River estuary (including the Smith River). In accordance with state methods (Brophy 2005a), we excluded former tidal wetlands that have been completely filled and converted to developed uses. However, an accurate historic perspective should include such developed areas. We used a recent tidal wetlands map (Scranton 2004) to locate that author's best estimate of major fill areas, and added them to the historic tidal wetlands located during our study. The resulting total historic tidal wetland area is 1857 ha (4589 A) – a figure 90% larger than the previous estimate of total historic tidal wetland area in the Umpqua River estuary (Good 2000). The difference is due to consideration of major fills, as well as new data generated during this study through aerial photograph analysis, local knowledge, and field reconnaissance.

Alterations to Umpqua tidal wetlands

We used aerial photographs, field reconnaissance and local input to determine the types of alterations to historic tidal wetlands. The types of alterations identified in the estuary are shown in Table 8. As described in **Methods** above, we did not attempt to determine whether sites had been altered by logging, since this alteration is common but difficult to detect using aerial photographs. The specific alterations identified at each site are listed in the ranking tables (Appendix C) and site information table (Appendix E).

In accordance with statewide methods (Brophy 2005a), our study excluded historic tidal wetlands that have been completely filled and converted to developed uses. However, a complete picture of the changes that have occurred in the Umpqua River estuary should include these areas. Therefore, we consulted maps created by Scranton (2004) to locate major areas of historic tidal wetlands that have been completely filled and are now developed. These include the Winchester Bay marina, the northern part of the city of Reedsport, the Gardiner Mill, the west portion of Bolon Island, and fills at East Gardiner and the lumber mill at Frantz Creek. These areas are summarized as "completely filled" in Tables 5 and 6.

The results of our analysis (Table 5) show that within the entire Umpqua River estuary (including the Smith River), about 62% of the historic tidal wetland area has been completely filled, or has undergone major alterations that strongly affect tidal flows (such as diking and intensive ditching). About 19% (351 ha) of historic tidal wetlands have undergone minor alterations like culverted drainages and road crossings; and 19% percent (348 ha) are relatively undisturbed.

Comparing the two report areas (Table 6), the mainstem Umpqua has most of the "completely filled" tidal wetlands (Winchester Bay marina, city of Reedsport, Gardiner Mill, Bolon Island).

The mainstem also has more areas affected by partial fill; the largest is Steamboat Island, which has been used for disposal of dredged material. According to local information, the Dean Creek Elk Viewing Area has also been received dredged material disposal, to raise the pasture for improved elk grazing (we recommend checking with BLM to confirm this input). The Smith River watershed has a considerably larger area of diked wetlands, with 18 separate sites diked for use as pasture. On the mainstem, Leeds Island and the Dean Creek Elk Viewing Area are the largest diked wetlands, with smaller diked areas on Scholfield Creek, Dean Creek, and north of the Gardiner Mill.

Tidal wetland restoration is occurring in some areas in the estuary. The field "ACT_REST" in the site information table indicates whether each site has undergone active restoration of tidal flow through dike breaching, according to local information sources. The two sites that have been actively restored through deliberate dike breaching or dike removal in recent years are sites 47 and 71 on the Smith River. These sites total about 40 ha, which represents about 3% of the total area with major alterations, and about 10% of the Smith River diked wetland area. Other areas are restoring gradually due to natural dike breakdown, and other kinds of restoration are also occurring in the estuary, including riparian plantings and wetland mitigation. For example, Steamboat Island has been used as a mitigation site for local wetland fills. Detailed information on wetland regulatory activities (fill/removal permits and mitigation) can be obtained from the Douglas County land use planning department and the Oregon Department of State Lands' Wetland division (541-378-3805); also see "**Land use regulations**" above. As information on restoration and mitigation activities is gathered or updated, we recommend entering it into the tidal wetlands shapefile attribute table and site information table.

It is important to remember that all tidal wetlands -- even the "unaltered" sites -- are affected by overall estuary changes such as sediment regime changes, water contamination, and large-scale hydrologic alterations caused by human land uses. Due to the lack of detailed information on how such changes affect wetland functions, and in accordance with statewide methods (Brophy 2005a), this study did not address estuary-wide alterations. However, estuary-wide alterations should be considered in site-specific planning.

Table 5. Tidal wetland areas and alterations, entire Umpqua River estuary (including Smith River).

Abbreviations in the 2nd column are those used in the site information table (e.g., Y = diked). Sites are summarized according to the most intensive alteration present onsite, and alterations are listed in decreasing order of intensity. For example, most diked wetlands are also ditched, so the category "diked" includes wetlands that are diked and ditched. The category "ditched" includes wetlands that are ditched but not diked.

Alteration category	Most intensive alteration on site	Number of sites	Area (ha)	% of total area
Major	Completely filled *(from Scranton 2004*)*	n/a*	318.7	17.2
	Y (diked)**	25.0	635.9	34.3
	D (intensively ditched)	21.0	201.9	10.9
Total major alterations			***1156.6***	***62.3***
Minor	C (culvert/tidegate)	4.0	15.9	0.9
	F (minor/partial fill)	3.0	138.5	7.5
	G (grazing)	1.0	101.3	5.5
	R (road/railroad crossing)	9.0	95.2	5.1
Total minor alterations		***17.0***	***350.9***	***18.9***
Unaltered	N (none)	36.0	348.0	18.8
Grand Total		***99.0***	***1855.5***	***100.0***

**Historic tidal wetlands that have been completely filled and converted to developed uses were excluded from our study. However, we added these areas in from Scranton (2004) to offer a more accurate historic perspective.*
*** Of the diked areas, about 40 ha on the Smith River have been recently restored through dike breaching (sites 47 and 71).*

Table 6. Tidal wetland areas and alterations, by report area. Notes for Table 5 apply.

		Mainstem Umpqua			Smith		
Alteration category	Most intensive alteration on site	No. of sites	Area (ha)	% of total area	No. of sites	Area (ha)	% of total area
Major	Completely filled *(from Scranton 2004*)*	n/a	295.5	25.0	n/a	23.2	3.4
	Y (diked)**	7.0	255.0	21.6	18.0	380.9	56.6
	D (intensively ditched)	14.0	140.6	11.9	7.0	61.4	9.1
Total major alterations			***691.1***	***58.5***		***465.5***	***69.1***
Minor	C (culvert/tidegate)	3.0	10.4	0.9	1.0	5.5	0.8
	F (minor/partial fill)	2.0	136.5	11.6	1.0	1.9	0.3
	G (grazing)		0.0	0.0	1.0	101.3	15.0
	R (road/RR crossing)	5.0	56.1	4.7	4.0	39.1	5.8
Total minor alterations		***10.0***	***203.1***	***17.2***	***7.0***	***147.9***	***22.0***
Unaltered	N (none)	28.0	287.9	24.4	8.0	60.1	8.9
Grand Total		***59.0***	***1182.0***	***100.0***	***40.0***	***673.5***	***100.0***

**Historic tidal wetlands that have been completely filled and converted to developed uses were excluded from our study. However, we added these areas in from Scranton (2004) to offer a more accurate historic perspective.*
*** Of the diked areas, about 40 ha on the Smith River have been recently restored through dike breaching (sites 47 and 71).*

Plant communities are often good indicators of site disturbance or alteration. During field reconnaissance, we observed plant communities from offsite and used the information to help us characterize site alterations. Dominant species that we observed on the study sites are listed in the site information table (Appendix E); also see Appendix D, **Notes on site information table fields** for details. Codes for plant species are found in Table D3 of Appendix D.

Prioritized sites

Figures 1a and 1b show the study sites divided into five ranking groups: High priority, medium-high, medium, medium-low, and low priority. The ranking groups were obtained by dividing the total number of sites into five equal-sized groups, so there are nine sites within each group. Table 7 shows the land area within each priority group; Appendix C shows each site's ranking group, individual prioritization factor scores, and alterations. As described in **Methods** above, the 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 E) and in the **Site narratives** below. Other important information can be obtained through further investigations, including onsite assessments.

Table 7. Ranking group area summary (by report area)

	Mainstem Umpqua			Smith			Entire Umpqua estuary		
Ranking Group	No. of sites	Area (ha)	% of total area	No. of sites	Area (ha)	% of total area	No. of sites	Grand Total	% of total area
High	11	139.8	15.8	8	170.5	26.2	19	310.3	20.2
Medium-High	12	242.0	27.3	8	120.3	18.5	20	362.3	23.6
Medium	12	148.9	16.8	8	146.6	22.5	20	295.5	19.2
Medium-Low	12	279.0	31.5	8	51.4	7.9	20	330.4	21.5
Low	12	76.8	8.7	8	161.5	24.8	20	238.3	15.5
Grand Total	59	886.5	100.0	40	650.3	100.0	99	1536.8	100.0

In the mainstem Umpqua report area, many high-priority sites are located along Scholfield Creek. This stream has spawning populations of coho and winter steelhead, and an unusually high proportion of the original tidal marsh habitats remain along its lower reaches. The Scholfield Creek wetlands are designated as Significant Habitats in the Oregon Estuary Plan Book (Cortright et al. 1987) and are recognized as important habitat in City and County planning documents. Other high-priority sites are located between river miles 12 and 18, along Dean Creek, and near the Cutoff and Steamboat Island. Many of the upstream areas (RM 12-18) were historically forested tidal wetlands (spruce swamps). High-priority sites are individually described in the site narratives below.

The next step: Landowner outreach and site-specific planning

This prioritization is a first step in strategic planning for conservation and restoration in the estuary. A logical next step is to locate landowners who are interested in restoring or conserving tidal wetlands on their property. A good place to start would be high or medium-high priority sites (Figures 1a and 1b) that also ranked high in the community perceptions workshop (Figures 10a and 10b). Once willing and interested landowners are located, a variety of site-specific activities can begin, including preliminary site visits, verification of land ownership boundaries, baseline monitoring to determine current conditions, regulatory contacts to determine required permits, archaeological investigations, and many other steps to maximize the chances of successful action.

More detailed guidance for landowner outreach and site-specific planning can be found in Appendices A and B, Simenstad and Bottom (2004), Brophy (1999), and Brophy (2005a), as well as many technical documents related to tidal wetland restoration such as Zedler (2001), Borde et al. (2004) and Diefenderfer et al. (2003).

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 longer to recover their original functions (Frenkel and Morlan 1991). Similarly, restoration of any tidal wetland can add to the ecological functions of the estuary. 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.

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 Assessment module (Brophy 2005a) 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, **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 (see Table 8).

Tidal wetland restoration generally focuses on restoring tidal flow within meandering tidal channels. This is the highest-priority action for sites where tidal flow is restricted, and it usually involves a suite of procedures such as dike breaches, culvert upgrades or removal, ditch filling, and meander restoration. For grazed sites, an important restoration option 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 interior 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.

The choice of restoration methods depends on the alterations present at each site. Alterations observed at each site are listed in the column "ALTTYPE" in the site information table (Appendix E). Abbreviations and examples of potential restoration actions for each type of alteration are listed in Table 8 below. Decisions among these options (and others) will require careful consideration of site characteristics and restoration goals. Not all of the listed restoration actions will be appropriate at every site; only careful onsite assessment can determine the appropriate actions.

Table 8. 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 fish-friendly tidegate; installation of self-regulating tidegate for tidal exchange up to a preset maximum water level; replace restrictive culvert with bridge
Road/railroad crossing	R	Culvert upgrade; bridge installation; raise road/railroad on causeway; realign road/railroad and remove fill
Partial fill	F	Remove partial fill to restore site functions. (Note: this study excludes completely filled areas that have been converted to developed uses.)
Excavation	X	Fill excavated area to original wetland surface elevation
Grazing	G	Pasture management; riparian fencing and plantings; remove livestock; woody plantings where appropriate (on natural levees, etc.) (Note: Grazing is not separately listed as an alteration in the site information table unless no other major alterations are present)
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 that protect or restore habitat linkages and connections (see Appendix A, **Restoration Principles**). The slightly brackish to freshwater tidal zone of the estuary may offer particularly high habitat values (Simenstad and Bottom 2004), so linking sites in this zone to adjacent nontidal wetlands may offer great benefits.

Archaeological sites

Information in this section was provided by Lisa Morris, Cultural Resource Protection Coordinator for the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians. Lisa Morris can be contacted by email at lmorris@ctclusi.org or by phone at 541-888-9577.

> *"For many generations the overall health of the estuaries was directly linked to the ways of life for the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians. The Umpqua Tidal Wetlands Project will improve estuarine health by providing valuable information to various stakeholders to assist in the prioritization of future tidal wetland restoration activities. Information from this project will be a valuable resource for the Tribes for improving overall watershed conditions for future generations to come.*
>
> *The Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians have determined that there are known archaeological sites within or in the immediate vicinity of some proposed project areas. 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 avoid inadvertent damage to cultural resources and costly delays to projects, the Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians request prior consultation on all projects within this study area early in the feasibility study phase of project planning. For large projects and projects which the Tribes determine to have a reasonable likelihood of adversely affecting Tribal cultural resources, the Tribes request that funds be budgeted for conducting necessary cultural resource surveys and cultural resource mitigation as determined to be appropriate by the Confederated Tribes. The Tribes also request at least a 72-hour notice prior to any ground disturbance in order to monitor sites to ensure that no sites are inadvertently disturbed.*
>
> *Federal and state laws prohibit intentional excavation of known or suspected cultural resources without an archaeological permit and require immediate notification of the appropriate Tribe if resources are discovered, uncovered, or disturbed. 43 CFR 10 applies to tribal and federal lands, federal projects, federal agencies, as well as to federal actions and federally funded (directly or indirectly) projects. ORS 97.745 prohibits the willful removal, mutilation, defacing, injury, or destruction of any cairn, burial, human remains, funerary objects, or objects of cultural patrimony of any native Indian. ORS 358.920 prohibits excavation, injury, destruction, or alteration of an archeological site or object or removal of an archeological object from public or private lands."*
>
> -- Lisa Morris, Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians, personal communication

Natural levees and sediment deposition

Sediment deposition during high river flows can lead to the formation of "natural levees" along riverbanks. Natural levees are common features of the estuary; 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 the OWEB Estuary Assessment module (Brophy 2005a).

Natural levees are easily confused with dikes or filled areas, but it is important to distinguish between these features in order to develop appropriate restoration plans. Tidal wetland restoration often involves removal or breaching of manmade dikes, but natural levees should generally be left in place. In this study, we used field experience, aerial photograph interpretation, published information and local knowledge to identify dikes as site alterations and distinguish them from natural levees. Characteristics like slope profile, vegetation, and soil disturbance were used to identify likely dikes. Sites where the existence of a dike was possible but could not be determined in this study are noted in the site information tables (field "ALTTYP" includes the abbreviation "Y?").

Site narratives

In this section, we provide brief narratives describing the highest-ranked sites in the study area, and some other sites 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.

High-priority sites

Site 8: The primary need at this site is conservation of the existing wetland. Based on offsite observation and aerial photograph interpretation, this site appears to include an intact remnant of tidal spruce swamp. Only a handful of intact tidal swamp sites remain on the Oregon coast (Jefferson 1974). Although airphoto analysis could not reveal precisely how far into the site tidal influence extends, the fact that the site encompasses the natural gradient from tidal into nontidal forested wetland gives it great ecological value. Based on aerial reconnaissance, the adjacent fields to the east (although not mapped as wetland in the NWI) may provide valuable opportunities for restoring even more of the original gradient of wetland types here.

Site 9: Field reconnaissance is required to determine the primary needs at this site, but conservation of existing wetlands is certain to be among them. This site is located on the north bank of the Umpqua at River Mile 18. Its historic vegetation was spruce swamp; spruce is still the dominant conifer here, and it is classified in the NWI as a tidally-influenced freshwater forested wetland. Entry points for tidal flow onto the site are not clear in aerial photos, and this site could not be observed during field reconnaissance due to lack of accessible vantage points. Field data should be collected on the site's tidal channels, freshwater channels, and plant communities. Airphotos suggest a linear alteration such as a ditch, access road, or /power line at the base of the hillslope; this should be field checked.

Site 12: The primary need at this site is conservation of the existing wetland. Located on Dean Creek, this site is valuable because it occupies the transition zone from slightly brackish/freshwater tidal wetland into nontidal freshwater wetland. Dominant vegetation is a mix of brackish-tolerant species (softstem bulrush, black twinberry) and those that generally grow in freshwater wetlands (cattail, reed canarygrass, willows). The plant communities are diverse and include herbaceous emergent wetland (below the bridge, where brackish water influence appears higher), and scrub-shrub and forested wetland above the bridge. Sitka spruce and other woody vegetation provides good channel shading and potential large wood input east of the bridge.

The site's channels are meandering and appear largely intact, with only a few sections straightened. The primary straightened channel segment is a ditched cutoff adjacent to the road just upstream of the bridge. The original meandering channel still remains and appears to carry most of the tidal flow, so channel restoration is probably unnecessary here.

A prominent historic meander starts about 1/4 mile above the bridge. This meander may have become cut off from the main channel of Dean Creek through natural stream development processes, or through human manipulation of the site. In either case, it may currently offer good rearing habitat for salmon during high water periods.

The bridge does not appear to restrict typical tidal flows. The road embankment has altered the site's hydrology by preventing diffuse flow across one section of the marsh surface, but overall the site appears to be in very good condition.

Scholfield Creek sites (Sites 59, 60, 62, 64, 66, 81, 82): These sites on Scholfield Creek are located in the slightly brackish-to-freshwater tidal zone of the tributary and are ranked "Medium-High" (Sites 59, 62, 81 and 82), and "High" (Sites 60, 64, 66). These sites all have good connectivity to other wetlands, and to steelhead and coho spawning grounds. They all have intact, meandering tidal channels with little or no ditching. All five sites have moderately diverse plant communities (emergent plus either scrub-shrub or forested classes). These wetlands (along with the others along Scholfield Creek) are recognized as Significant Habitats in the Estuary Plan Book.

All five sites are somewhat affected by the railroad which runs through the valley. The embankment affects diffuse flow (including sheet flow) where it crosses wetland surfaces. Site 62 shows some turbulence pools (scour pools) at the railroad crossing which indicate some restriction of tidal flow. However, the plant communities appear similar to those at nearby sites without the restriction, so the effect of the restriction may be minimal. The west portion of Site 60 shows possible plant community changes due to restriction of tidal exchange at the railroad crossing. These tidal flow restrictions should be field-checked to determine their status.

The channel of Scholfield Creek was apparently straightened just above the confluence with Oar Creek, so that it is now confined between the road and the railroad instead of skirting the base of the hillslope to the west. This channel cutoff has converted the old primary channel meander at the hillslope base (on the north portion of Site 64) into a tributary channel/backwater wetland, and undoubtedly has affected site ecology in many ways. However, the old channel still carries substantial tidal flow, and the site continues to support diverse native plant communities.

Site 67: This small site occupies the low ground on an island about halfway down the east side of North Spit. Local residents report that the site is a seal haulout area. The site ranks high because of its proximity to EPB-mapped eelgrass beds, historic vegetation type, accessibility to migrating salmonids, and diversity of vegetation classes. The wetland status and habitat types of the island as a whole should be investigated. The higher central area of the site is mapped as tidal shrub swamp in the Estuary Plan Book, and soils here are mapped as Bragton muck, a tidally influenced wetland soil type. However, this central area is mapped as upland, not wetland, in the National Wetland Inventory.

Field observation of this site was not possible during this project, and its status could not be determined from aerial photos. Field investigation and consultation with port and county planning staff is recommended. Although the site is not designated as a Dredged Material Disposal Site in the Estuary Plan Book, it appears possible that it has received such material. If field investigation shows vegetation dominated by species indicating disturbance – for example, Himalayan blackberry and Scotch broom – this would provide evidence of dredged material disposal here. Analysis of deep soil cores could reveal whether the site did originally support shrub swamp. If so, removal of the dredged material could re-establish the original tidal inundation regime.

Site 98: This site occupies several islands adjacent to Site 8. The islands have scrub-shrub and forested vegetation, with willow dominant on most of the islands but other woody species present. We recommend field checking vegetation, soils and hydrology to determine the status of these islands. Like Site 8, they may be examples of tidal swamp, a very rare habitat type on the Oregon coast; or, they may be drier and seldom subject to tidal inundation. Local input suggests these islands are currently expanding due to rapid sediment deposition.

Site 99: This site is known as Spruce Reach Island; it is located adjacent to the Dean Creek Elk Viewing Area, on the north side of Highway 38. Hydrology here is somewhat disrupted by the highway, but tidal flow still enters the site through a channel/ditch along the north side of the highway. The site shows the full gradient of wetland types from emergent tidal wetland (dominated by softstem bulrush and reed canarygrass), up into scrub-shrub tidal wetland (dominated by willows and Pacific crabapple) and tidal forest (dominated by Sitka spruce). Some sites in this zone of the estuary have very high natural levees, so the wetland status of the spruce forested area should be checked. We recommend field checking vegetation, soils and hydrology at this site, to determine whether the site could provide a good reference area for restoration of tidal swamp. A report to the BLM Coos Bay District prepared by Green Point Consulting (Brophy, 2002) provides recommendations for monitoring in this area.

Site 101: Like Spruce Reach Island, this site provides a potential reference area for restoration of tidal wetlands nearby (i.e., within the Dean Creek Elk Viewing Area). Although the presence of Highway 38 affects the site's hydrology, the site still shows meandering tidal channels, and demonstrates the natural gradient from low emergent tidal wetland (dominated by Lyngbye's sedge, softstem bulrush and cattail) up into higher tidal swamp (dominated by willows). Local input suggests the site's channels were once used for log storage. If so, the channels may have been dredged, and the dredged material may have been disposed of on the site itself. We saw no evidence of such dredging or disposal, but before using the site as a reference area, land use history should be determined and soils should be cored for evidence of dredged material disposal. If no dredged material disposal has occurred on the site, this site may provide a useful reference area for tidal scrub-shrub wetland (a type of tidal swamp). A report to the BLM Coos Bay District prepared by Green Point Consulting (Brophy, 2002) provides recommendations for monitoring in this area.

Site 103: Vegetation on this site is Sitka spruce forest, with alder and willows intermingled with the spruce. The site is classified as forested wetland in the National Wetland Inventory, and is shown as spruce swamp in the ONHP historic vegetation layer. No major tidal channels enter the site, so its tidal wetland status should be field-checked by documenting plant communities, soils and hydrology, and measuring site elevation *versus* tidal range in nearby channels. Of the few spruce swamp sites remaining in the estuary, this site appears to be one of the least altered. If tidal influence is present, the site could provide useful reference data for restoration of this valuable and rare habitat type.

Medium-high priority sites

Sites 55, 59: These two medium-high priority sites are inside or near various intensive land use planning zones such as the City of Reedsport's Urban Growth Boundary and the Goal 16 planning area (Estuarine Resources). Other, lower-priority sites such as sites 24, 26, 27, 28, 30, 31, 32, 54, 57, 58, 68, 78, and 79 are also within or adjacent to the Reedsport UGB, and many other sites are within intensive coastal land-use planning zones. Before considering any actions at these sites, all relevant land-use planning agencies should be consulted. We recommend consulting the "Land Use Regulations" section in the Estuary Assessment module of the Oregon Watershed Assessment Manual (Brophy 2005a) for guidance on dealing with land-use regulatory issues during site-specific action planning. (Also see "**Land use regulations**" in **Supplemental analyses** above.)

Site 55 is within the City of Reedsport; much of the site is zoned Water-Dependent Industrial (information provided by City of Reedsport) and appears to be included in an industrial development site owned by the Port of Umpqua. Some dredging appears to have occurred in the channels adjacent to Site 55, and some of the dredged material may have been disposed of on the site. Wetland status and tidal influence should be field-checked before planning any action for this site.

Site 22 (Steamboat Island): This site is one of the largest tidal wetlands in the study area. Historic vegetation on the entire island is mapped as tidal marsh. According to local information, dredged material disposal has occurred on parts of the island, and the site was grazed in the past. The dredged material disposal areas are clearly visible on aerial photos, since they are elevated and now support woody vegetation. Portions of the island have also been used as wetland mitigation areas. Further dredged material disposal on the wetland should be avoided, since it seriously damages or eliminates tidal wetland functions.

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.

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.

Borde, A.B., L.K. O'Rourke, R.M. Thom, G.W. Williams, and H.L. Diefenderfer. 2004. National Review of Innovative and Successful Coastal Habitat Restoration. Prepared for National Oceanic and Atmospheric Administration Coastal Services Center. Prepared by Battelle Marine Sciences Laboratory, Sequim, WA.

Bottom, D., I. Fleming, K. Jones, and S. Simenstad. 2004. Salmonid Use of Restored Estuarine Wetlands: Regional Application of the Salmon River Estuary Study. Oregon Sea Grant project #R/ECO-14. Project description: http://seagrant.oregonstate.edu/research/ecosystems.html. Accessed 14 February 2005.

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). 2005a. 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). 2005b. Tidal wetland prioritization for the Siuslaw River estuary. Prepared for the Siuslaw Watershed Council, Mapleton, OR.

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). 2002. Dean Creek Elk Viewing Area, West End: Plant Communities and Monitoring Recommendations. Prepared for U.S. Department of Interior Bureau of Land Management, North Bend, OR. 21 pp.

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 Smith River (Umpqua) Estuary. Prepared for USFWS Coastal Program, Newport Field Office.

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

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.

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

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.

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

Diefenderfer, H.L., R.M. Thom, and J.E. Adkins. 2003. Systematic Approach to Coastal Ecosystem Restoration. Prepared for National Oceanic and Atmospheric Administration Coastal Services Center. Prepared by Battelle Marine Sciences Laboratory, Sequim, WA and NOAA Coastal Services Center, Charleston, SC.

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.

Kagan, J.A., J.A. Christy, M.P. Murray, and J.A. Titus. 2005. Classification of Native Vegetation of Oregon. Oregon Natural Heritage Program. Available at: http://oregonstate.edu/ornhic/publications.html

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

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.

Miller, B.A., and S. Sadro. 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Trans. Am. Fish. Soc. 132: 546-559.

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.

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

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.

Oregon Wetlands Joint Venture. 1994. Joint Venture Implementation Plans: Southern Oregon Coast. Prepared for Pacific Coast Joint Venture. Accessed 5 February at: http://www.ohjv.org/pdfs/southern_oregon_coast.pdf

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., 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., 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.

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.

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.

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

Appendix A. 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 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

The National Research Council (1992) defines restoration as "Return of an ecosystem to a close approximation of its condition prior to disturbance." According to the NRC, "Restoration is ... a holistic process not achieved through the isolated manipulation of individual elements." 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 may alter 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, and deposition of sediment and detritus. 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 site manipulation 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).

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. Experts 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, adjacent upland buffers and connected upland habitats whenever possible.

Use history as a guide, but recognize irreversible change

This study identifies all historic tidal wetlands. While most of the altered 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 may 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).

Besides site-specific changes like subsidence, human activities in estuaries and 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 are recommended as followup to this study, to help determine which areas have appropriate elevations and tidal ranges 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 et al. 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 will also help guide future restoration efforts, because tidal wetland restoration is still a developing science.

Use interdisciplinary science and peer review

Interdisciplinary technical assistance is needed for restoration design. Expertise may be needed in biology (botany, fish ecology, landscape ecology), hydrology, geology, hydrology, 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 soundness and feasibility of restoration goals and design, 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 B. Restoration approaches

This section provides some general considerations for conservation and restoration actions. We recommend 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 is 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. Further information is found in the Estuary Assessment module of the OWEB Watershed Assessment Manual (Brophy 2005a), in the "Land Use regulation" section.

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.

It is 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 change, or large-scale hydrologic change.

Education

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 helps build public support for wetland conservation.

Dike breaching and dike removal

The majority of Oregon's tidal wetlands were diked to block tidal flows, and then converted to pastures. To restore tidal flow to diked sites, dikes can be breached at selected locations, preferably at locations of former natural tidal channels. Alternatively, 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 historic 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 wetland studies to assess conditions at specific tidegates and restrictive culverts. These structures cannot 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, good site-specific planning must include accurate assessment of existing conditions and proposed changes to site hydrology and flow patterns. 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 generally require a weed control plan and ongoing maintenance during establishment. 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 may be 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, broken-down dike remnants, and small areas of dredged material offer such opportunities.

Woody plantings and large wood placement

Logging and driftwood removal have radically reduced the availability of large woody debris in Oregon estuaries. 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, woody plantings and 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. Woody plantings should be carefully designed to avoid areas that are too wet or too dry for the species used. Species chosen should be appropriate for the specific tidal wetland habitats being restored. For example, three native species that are tolerant of wet conditions and slightly brackish water are Sitka spruce, black twinberry, and Pacific crabapple. In freshwater tidal swamps, a wide range of wetland shrubs and trees are appropriate, such as Sitka spruce, shore pine, Western red cedar, willows, and dogwoods.

Grazing reduction

Many coastal agricultural lands are used for pastures, and the resulting livestock production contributes to the local economy. However, grazing by livestock 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 C. Ranking tables

Table C1. Ranking factor scores and total score, sorted by rank (top to bottom)

Descriptive names of prioritization factors are in first row; second row shows the GIS field names.

Site ID	Site size score	Salmon habitat connec-tivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioriti-zation score	Ranking group
GPC_ID	SIZE_ SCOR	CONS_ SCOR	CONW1M_ SCO	HVT_ SCOR	DIVR_ SCOR	CHAN_ SCOR	ALTTYPE	WC_ INPUT	ECOL_SUM	RANK_GRP
8	1.4	4.8	2.2	4.9	5	5	None	3.5	23.3	High
103	1.1	4.2	5.0	3.7	3	5	None	4.5	21.9	High
99	1.5	4.4	3.9	1.6	5	5	None	4.4	21.4	High
101	1.3	4.0	4.0	1.0	3	5	None	4.3	18.4	High
98	1.2	4.7	3.3	1.0	3	5	None	3.9	18.2	High
9	1.1	4.7	1.4	4.8	1	5	None	3.4	18.1	High
12	1.5	3.3	2.2	1.0	5	5	None	3.5	18.0	High
67	1.1	3.4	3.9	1.0	3	5	None	4.8	17.5	High
66	1.2	2.9	4.2	1.0	3	5	R	3.5	17.3	High
64	1.3	2.9	4.0	1.0	3	5	R	3.5	17.3	High
60	1.1	2.7	4.5	1.0	3	5	R	4.7	17.3	High
62	1.2	2.8	4.3	1.0	3	5	R	5.0	17.2	Med-High
55	1.1	4.1	3.0	1.0	5	3	F	2.4	17.2	Med-High
81	1.5	3.0	3.6	1.0	3	5	None	3.9	17.1	Med-High
102	1.2	4.4	4.5	4.8	1	1	D	2.6	16.9	Med-High
29	1.0	3.5	3.3	1.0	3	5	None	3.7	16.8	Med-High
25	1.1	3.3	3.3	1.0	3	5	None	5.0	16.7	Med-High
22	3.8	4.1	1.7	1.0	1	5	F	5.0	16.6	Med-High
65	1.4	3.0	2.9	1.0	5	3	D, C	1.8	16.3	Med-High
20	1.5	3.9	3.8	1.0	1	5	None	4.4	16.2	Med-High
82	1.5	2.8	2.7	1.0	5	3	D, C, R	1.8	16.0	Med-High
59	1.2	2.7	5.0	1.0	1	5	D	4.1	15.9	Med-High
51	1.0	4.1	3.7	1.0	1	5	None	5.0	15.8	Med-High
54	1.2	4.0	3.5	1.0	1	5	F	4.9	15.8	Medium
61	1.4	2.8	4.5	1.0	1	5	None	3.5	15.7	Medium
23	1.1	3.4	4.3	1.0	1	5	None	4.8	15.7	Medium
35	1.4	2.8	2.3	1.0	3	5	D, C	4.4	15.5	Medium
77	1.5	2.8	2.1	1.0	3	5	None	3.6	15.4	Medium
57	1.2	2.6	4.0	1.0	1	5	None	4.2	14.8	Medium
19	1.7	3.7	2.4	1.0	1	5	None	4.6	14.8	Medium
37	1.3	2.7	1.7	1.0	3	5	None	4.6	14.7	Medium
10	1.1	4.8	1.7	1.0	1	5	None	3.8	14.6	Medium
13	1.2	4.9	1.4	1.0	5	1	D, X	3.9	14.6	Medium
15	1.0	4.8	1.4	1.0	1	5	None	3.4	14.3	Medium
11	1.1	4.7	1.5	1.0	1	5	None	2.9	14.2	Medium
14	1.1	4.8	1.3	1.0	1	5	None	3.1	14.2	Med-Low
100	5.0	4.5	1.5	1.0	1	1	Y,D,C,R,F	3.6	14.1	Med-Low

Site ID	Site size score	Salmon habitat connec-tivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioriti-zation score	Ranking group
21	1.0	3.4	2.6	1.0	1	5	None	4.6	14.0	Med-Low
16	1.0	5.0	1.0	1.0	1	5	None	2.2	14.0	Med-Low
17	1.0	4.9	1.0	1.0	1	5	None	2.2	14.0	Med-Low
56	1.1	4.0	4.6	2.1	1	1	D	3.5	13.9	Med-Low
33	1.0	3.6	2.1	1.0	1	5	None	4.7	13.8	Med-Low
36	1.3	2.8	2.6	1.0	3	3	D, C	2.1	13.7	Med-Low
80	1.3	2.5	2.6	1.0	1	5	R	4.4	13.4	Med-Low
63	1.2	3.3	3.4	1.0	3	1	Y, D, C, X	2.2	12.9	Med-Low
24	2.0	4.1	3.6	1.0	1	1	Y, D, C, R	1.9	12.7	Med-Low
34	1.2	1.6	2.7	1.0	1	5	None	4.1	12.4	Med-Low
30	1.1	2.5	2.9	1.0	1	3	C, R	2.2	11.5	Low
58	1.2	2.3	1.9	1.0	1	3	Y, C, R	4.1	10.4	Low
26	1.0	2.5	3.8	1.0	1	1	D, C	1.9	10.4	Low
69	1.1	4.8	1.3	1.0	1	1	D, C	3.8	10.3	Low
18	1.0	3.6	2.2	1.0	1	1	Y, D, R, X	1.3	9.8	Low
27	1.3	2.5	2.9	1.0	1	1	D, C	1.9	9.7	Low
79	1.0	2.5	2.9	1.0	1	1	Y, D, C	1.7	9.4	Low
32	1.1	1.0	2.2	1.0	1	3	C	2.0	9.3	Low
28	1.0	1.5	3.7	1.0	1	1	D, C	1.5	9.3	Low
68	1.0	1.9	3.2	1.0	1	1	D, C	2.0	9.2	Low
31	1.1	1.9	2.9	1.0	1	1	D, C	2.0	9.0	Low
78	1.4	2.3	2.2	1.0	1	1	Y, D, C	2.9	9.0	Low

Table C2. Ranking factor scores and total score, sorted by site number

Descriptive names of prioritization factors are in first row; second row shows the GIS field names.

Site ID	Site size score	Salmon habitat connec-tivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioriti-zation score	Ranking group
GPC_ID	SIZE_SCOR	CONS_SCOR	CONW1M_SCO	HVT_SCOR	DIVR_SCOR	CHAN_SCOR	ALTTYPE	WC_INPUT	ECOL_SUM	RANK_GRP
8	1.4	4.8	2.2	4.9	5	5	None	3.5	23.3	High
9	1.1	4.7	1.4	4.8	1	5	None	3.4	18.1	High
10	1.1	4.8	1.7	1.0	1	5	None	3.8	14.6	Medium
11	1.1	4.7	1.5	1.0	1	5	None	2.9	14.2	Medium
12	1.5	3.3	2.2	1.0	5	5	None	3.5	18.0	High
13	1.2	4.9	1.4	1.0	5	1	D, X	3.9	14.6	Medium
14	1.1	4.8	1.3	1.0	1	5	None	3.1	14.2	Med-low
15	1.0	4.8	1.4	1.0	1	5	None	3.4	14.3	Medium
16	1.0	5.0	1.0	1.0	1	5	None	2.2	14.0	Med-low
17	1.0	4.9	1.0	1.0	1	5	None	2.2	14.0	Med-low
18	1.0	3.6	2.2	1.0	1	1	Y, D, R, X	1.3	9.8	Low
19	1.7	3.7	2.4	1.0	1	5	None	4.6	14.8	Medium
20	1.5	3.9	3.8	1.0	1	5	None	4.4	16.2	Med-high
21	1.0	3.4	2.6	1.0	1	5	None	4.6	14.0	Med-low
22	3.8	4.1	1.7	1.0	1	5	F	5.0	16.6	Med-high
23	1.1	3.4	4.3	1.0	1	5	None	4.8	15.7	Medium
24	2.0	4.1	3.6	1.0	1	1	Y, D, C, R	1.9	12.7	Med-low
25	1.1	3.3	3.3	1.0	3	5	None	5.0	16.7	Med-high
26	1.0	2.5	3.8	1.0	1	1	D, C	1.9	10.4	Low
27	1.3	2.5	2.9	1.0	1	1	D, C	1.9	9.7	Low
28	1.0	1.5	3.7	1.0	1	1	D, C	1.5	9.3	Low
29	1.0	3.5	3.3	1.0	3	5	None	3.7	16.8	Med-high
30	1.1	2.5	2.9	1.0	1	3	C, R	2.2	11.5	Low
31	1.1	1.9	2.9	1.0	1	1	D, C	2.0	9.0	Low
32	1.1	1.0	2.2	1.0	1	3	C	2.0	9.3	Low
33	1.0	3.6	2.1	1.0	1	5	None	4.7	13.8	Med-low
34	1.2	1.6	2.7	1.0	1	5	None	4.1	12.4	Med-low
35	1.4	2.8	2.3	1.0	3	5	D, C	4.4	15.5	Medium
36	1.3	2.8	2.6	1.0	3	3	D, C	2.1	13.7	Med-low
37	1.3	2.7	1.7	1.0	3	5	None	4.6	14.7	Medium
51	1.0	4.1	3.7	1.0	1	5	None	5.0	15.8	Med-high
54	1.2	4.0	3.5	1.0	1	5	F	4.9	15.8	Medium
55	1.1	4.1	3.0	1.0	5	3	F	2.4	17.2	Med-high
56	1.1	4.0	4.6	2.1	1	1	D	3.5	13.9	Med-low
57	1.2	2.6	4.0	1.0	1	5	None	4.2	14.8	Medium
58	1.2	2.3	1.9	1.0	1	3	Y, C, R	4.1	10.4	Low
59	1.2	2.7	5.0	1.0	1	5	D	4.1	15.9	Med-high

Site ID	Site size score	Salmon habitat connec-tivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioriti-zation score	Ranking group
60	1.1	2.7	4.5	1.0	3	5	R	4.7	17.3	High
61	1.4	2.8	4.5	1.0	1	5	None	3.5	15.7	Medium
62	1.2	2.8	4.3	1.0	3	5	R	5.0	17.2	Med-high
63	1.2	3.3	3.4	1.0	3	1	Y,D,C,X	2.2	12.9	Med-low
64	1.3	2.9	4.0	1.0	3	5	R	3.5	17.3	High
65	1.4	3.0	2.9	1.0	5	3	D, C	1.8	16.3	Med-high
66	1.2	2.9	4.2	1.0	3	5	R	3.5	17.3	High
67	1.1	3.4	3.9	1.0	3	5	None	4.8	17.5	High
68	1.0	1.9	3.2	1.0	1	1	D, C	2.0	9.2	Low
69	1.1	4.8	1.3	1.0	1	1	D, C	3.8	10.3	Low
77	1.5	2.8	2.1	1.0	3	5	None	3.6	15.4	Medium
78	1.4	2.3	2.2	1.0	1	1	Y, D, C	2.9	9.0	Low
79	1.0	2.5	2.9	1.0	1	1	Y, D, C	1.7	9.4	Low
80	1.3	2.5	2.6	1.0	1	5	R	4.4	13.4	Med-low
81	1.5	3.0	3.6	1.0	3	5	None	3.9	17.1	Med-high
82	1.5	2.8	2.7	1.0	5	3	D, C, R	1.8	16.0	Med-high
98	1.2	4.7	3.3	1.0	3	5	None	3.9	18.2	High
99	1.5	4.4	3.9	1.6	5	5	None	4.4	21.4	High
100	5.0	4.5	1.5	1.0	1	1	Y,D,C,R,F	3.6	14.1	Med-low
101	1.3	4.0	4.0	1.0	3	5	None	4.3	18.4	High
102	1.2	4.4	4.5	4.8	1	1	D	2.6	16.9	Med-high
103	1.1	4.2	5.0	3.7	3	5	None	4.5	21.9	High

Appendix D. Data details (metadata)

Table D1. Table of data sources

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 2002 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
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
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
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
Douglas County Tax lots and Ownership	Douglas Co. Assessor's Office	Shapefile	unknown	No	No

Table D2. Key to site information table fields

This table lists all fields found in the tidal wetlands shapefile attribute table and the Excel spreadsheet of site data. The printed site information table (Appendix E) includes a subset of these fields, which are marked with an asterisk below; for those fields, the brief description is the Excel spreadsheet column header.

Column heading	**Brief description**	**Full description**
GPC_ID*	Site ID	Site number. Reflects order of site definition, not location in estuary. Some numbers are omitted.
SUB_ESTUAR	Subestuary	Sub-estuary (Umpqua mainstem vs. Smith River)
LOCATION*	Location	Location of site in estuary
AREA	Site area (m2)	Site area in sq m
PERIMETER	Site perimeter (m)	Site perimeter in m
ACRES*	Site size (A)	Site size in acres
HECTARES*	Site size (ha)	Site size in hectares
SIZE_SCOR*	Site size score	Site size score (scale of 1 to 5)
NUM_OWN*	Number of owners	Number of landowners (field verification recommended)
OWN_TYPE*	Ownership Type	Ownership type
UGB*	In/On UGB?	Is site within (or on) the Urban Growth Boundary?
COHO_V12	Coho?	Do coho spawn upstream of the site (in the tributary on which the site is located)?
CH_F_V12	Fall chinook?	Do fall chinook spawn upstream of the site (in the tributary on which the site is located)?
CH_S_V12	Spring chinook?	Do spring steelhead spawn upstream of the site (in the tributary on which the site is located)?
ST_W_V12	Winter steelhead?	Do winter steelhead spawn upstream of the site (in the tributary on which the site is located)?
ST_S_V12	Summer steelhead?	Do summer steelhead spawn upstream of the site (in the tributary on which the site is located)?
NSTOCKS*	# of salmon biotypes	Number of salmon stocks spawning upstream (in the tributary on which the site is located)
SNPUCOHO	Distance to spawning score - coho	Score for distance to spawning - coho
SNPUCHF	Distance to spawning score - fall chinook	Score for distance to spawning - fall chinook
SNPUCHS	Distance to spawning score - spring chinook	Score for distance to spawning - spring chinook
SNPUSTW	Distance to spawning score - winter steelhead	Score for distance to spawning - winter steelhead
SNPUSTS	Distance to spawning score - summer steelhead	Score for distance to spawning - summer steelhead
AVG_SNP*	Avg. distance to spawning	Average score for distance to spawning of all biotypes
SUM_CONS	Salmonid habitat connectivity score sum	Sum of two subscores for salmonid habitat connectivity

Column heading	Brief description	Full description
CONS_SCOR*	Salmon connectivity score	Salmon connectivity score (sum of subscores, rescaled to scale of 1 to 5)
DIF_AREA1M	Wetland area w/in 1 mile (sq m)	Wetlands (other than site itself) within 1 mile circle around center of site (in square meters)
CONW1M_A*	Wetland area w/in 1 mile (A)	Wetlands (other than site itself) within 1 mile circle around center of site (in acres)
CONW1M_SCO*	Wetland connectivity score	Wetland connectivity score (scale of 1 to 5)
P_HISTVEG	% of each historic vegetation type	Percent of site occupied by each historic vegetation type (from ONHP mapping)
PCT_FSL*	% historic spruce swamp	Percent of site that was historically spruce swamp
HVT_SCOR*	Historic vegetation score	Historic vegetation score (from % historic spruce swamp) (scale of 1 to 5)
NWICLASS*	% of each NWI class	Percent of site occupied by each NWI wetland type
DIVRSTY10*	Number of Cowardin classes	Number of Cowardin classes, excluding types <10% of site
DIVR_SCOR*	Vegetation diversity score	Vegetation diversity score (from # of Cowardin classes) (scale of 1 to 5)
HYDCOND*	Channel condition	Channel condition (1=low, 2=medium, 3=high)
CHAN_SCOR*	Channel condition score	Channel condition score (scale of 1 to 5)
ALTTYPE*	Alteration types	Types of alterations present on site (field verification recommended). Alteration type (Y=dike, C=culvert/tidegate, D=ditch, R=road/RR, F=fill, X=excavation) (reflects the highest-intensity alteration present on the site)
AltTyp2*	Most intensive alteration	Abbreviation for the highest-intensity alteration type present on the site
Alt_Group*	Alteration group	Alteration group: major or minor (reflects the highest-intensity alteration present on the site)
ACT_REST*	Active restoration?	Is tidal flow being deliberately restored to the site? (e.g., through dike breaching)
NOTES*	Notes	Notes on site conditions
VEG_NOTES*	Vegetation notes	Notes on site vegetation as observed from offsite (field verification recommended)
WC_INPUT*	Watershed council input	Results of community workshop ranking acceptability of conservation/restoration at each site
ECOL_SUM*	Final ecological prioritization score	Final score used in prioritization (sum of all sub-scores; potential range 6 to 30)
Rank_Grp*	Ranking group	Ranking group as determined in ArcView using quantile method (equal numbers of sites in each group)

* Field contained in printed site information table (Appendix E).

Table D3. Key to plant species codes in site information table

Scientific names follow those in the USDA plants guide (www.plants.usda.gov). This is not a complete species list for the study area; it lists only those plants recorded in field notes during site reconnaissance.

Abbreviation	Species	Common name
ALNRUB	*Alnus rubra*	red alder
ARGEGE	*Argentina egedii*	Pacific silverweed
CARLYN	*Carex lyngbyei*	Lyngbye's sedge
CAROBN	*Carex obnupta*	slough sedge
DESCES	*Deschampsia caespitosa*	tufted hairgrass
DISSPI	*Distichlis spicata*	seashore saltgrass
JUNBAL	*Juncus balticus*	Baltic rush
JUNEFF	*Juncus effusus*	soft rush
LONINV	*Lonicera involucrata*	black twinberry
LYSAME	*Lysichiton americanus*	skunk cabbage
LYTSAL	*Lythrum salicaria*	purple loosestrife
MALFUS	*Malus fusca*	Pacific crabapple
PHAARU	*Phalaris arundinacea*	reed canarygrass
PICSIT	*Picea sitchensis*	Sitka spruce
POPTRI	*Populus balsamifera* ssp. *trichocarpa*	Black cottonwood
RUBSPE	*Rubus spectabilis*	salmonberry
SALVIR	*Salicornia virginica*	pickleweed
Salix	*Salix spp.*	willows
SALHOO	*Salix hookeriana*	dune willow
SALSIT	*Salix sitchensis*	Sitka willow
SCHTAB*	*Schoenoplectus tabernaemontani*	Softstem bulrush*
SPIDOU	*Spiraea douglasii*	rose spiraea
THUPLI	*Thuja plicata*	Western redcedar
TRIMAR	*Triglochin maritimum*	seaside arrowgrass
TYPLAT	*Typha latifolia*	common cattail

*On the Oregon coast, softstem bulrush can be difficult to distinguish from hardstem bulrush (*Schoenoplectus acutus*); the two species may also hybridize (Richard Halse, Oregon State University, personal communication). Therefore, where the site information table shows softstem bulrush, either species may be present.

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 results. Positional and registration errors were apparent in some GIS analyses. 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 et al. 1991) and is not within the scope of this study.

Our study area included the full historic extent of tidal wetlands in the estuary. However, we were not able to evaluate some site characteristics that affect restoration potential. For example, it may not be possible to restore the full historic range of tidal influence at every sit due to 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 change. 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. See Appendix A, **Restoration Principles: "Use history as a guide, but recognize irreversible change" for** more information on this topic.

Notes on site information table fields

A key to fields in the site information table is provided in Appendix D (Table D2). Additional notes about specific fields are found below.

ALTTYPE (alteration types)

The field "ALTTYPE" shows the types of alterations present on each site, based on aerial photograph interpretation, field reconnaissance (generally offsite observation), local knowledge, and other data sources. Abbreviations used for the alteration types are shown in Table 8. Grazing is not listed as an alteration unless the site is free of structural alterations like dikes, ditches, tidegates and restrictive culverts.

Logging and driftwood removal were widespread in the accessible tidal forests and marshes of the estuary. However, aerial photograph analysis cannot easily determine where these activities have occurred; 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.

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. However, as explained in **Study area** above, filled and developed areas were not included in this study, so fill is not listed as an alteration type.

NOTES

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

VEGNOTES (vegetation notes)

Plant species that appear to be dominant on the site are listed here. This information was based on offsite observation, except in a few cases where sites were visited with landowner permission. In many cases, only part of the site could be seen, so this should not be considered a final or complete description of plant communities. Onsite evaluation of plant communities is recommended for every site before any site-specific planning is begun.

Appendix E. Site Information table

Tidal Wetland Prioritization for the Umpqua River Estuary of Oregon, December 2005

Contacts: Laura Brophy, Green Point Consulting, 541-752-7671; Fred Seavey, USFWS Oregon Coastal Program, 541-867-4558

See Appendix D, Table D2 for field descriptions; see full report for details

Note: This table excludes sites within the Smith River Watershed of the Umpqua Estuary.

Sites in the Smith River Watershed are described in the report, "Tidal Wetland Prioritization for the Smith River Watershed, Umpqua Estuary of Oregon."

Site ID	Sub-estuary	Location	Site size (A)	Site size (ha)	Site size score	Number of owners	Ownership Type	In/On UGB?	# of salmon stocks	Avg. distance to spawning	Salmon habitat connectivity score	Wetland area w/in 1 mile (sq m)	Wetland area w/in 1 mile (A)	Wetland connectivity score	% historic spruce swamp	Historic vegetation score	% of each NWI class	Number of Cowardin classes
8	Umpqua	Umpqua R. mile 17	49.41	19.99	1.44	2	Federal/ Private	n	5	4.56	4.78	538837	133.15	2.20	97.75	4.91	0.08774 E2EMN, 0.08118 PEMC, 0.10211 PEMR, 0.43339 PFOC, 0.15174 PFOR, 0.14384 PSSC	3
9	Umpqua	Umpqua R. mile 18	14.76	5.97	1.11	2	Private	n	5	4.49	4.74	210711	52.07	1.41	95.77	4.83	1.0000 PFOS	1
10	Umpqua	Island, Umpqua R. mile 17	12.10	4.90	1.09	1	Private	n	5	4.65	4.82	312487	77.22	1.66	0.00	1.00	1.0000 PFOS	1
11	Umpqua	Umpqua R. mile 19	9.00	3.64	1.06	2	Private	n	5	4.42	4.70	239485	59.18	1.48	0.00	1.00	0.86925 PFOR, .13075 other	1
12	Umpqua	Dean Cr.	53.10	21.49	1.47	3	Private	n	2	4.57	3.25	556168	137.43	2.24	0.00	1.00	0.12562 PEMC, 0.11565 PEMCh, 0.39447 PEMT, 0.02148 PFOA, 0.13998 PFOR, 0.20282 PSSC	3
13	Umpqua	Umpqua R. mile 19	19.78	8.01	1.16	4	State/ Private	n	5	4.90	4.95	224423	55.46	1.44	0.00	1.00	0.48572 PEMB, 0.35690 PFOR, 0.05358 PSSB, 0.10380 PSSR	3
14	Umpqua	Brandy Bar	10.96	4.43	1.08	1	Private	n	5	4.54	4.76	168721	41.69	1.31	0.00	1.00	1.0000 PFOS	1
15	Umpqua	Umpqua R. mile 20	6.31	2.55	1.03	2	State	n	5	4.59	4.79	219141	54.15	1.43	0.00	1.00	1.0000 PFOR	1
16	Umpqua	Charlotte Cr.	4.61	1.87	1.02	2	Private	n	5	5.00	5.00	39821	9.84	1.00	0.00	1.00	1.0000 PFOR	1
17	Umpqua	Charlotte Cr.	4.44	1.80	1.02	3	Private	n	5	4.90	4.95	40504	10.01	1.00	0.00	1.00	1.0000 PFOR	1
18	Umpqua	Gardiner mill	3.78	1.53	1.01	2	Private	n	5	2.28	3.61	539841	133.39	2.21	0.00	1.00	1.0000 PSSR	1
19	Umpqua	The Point	72.90	29.50	1.66	1	Port	n	5	2.47	3.71	621916	153.68	2.40	0.00	1.00	1.0000 E2EMN	1
20	Umpqua	The Cutoff	50.93	20.61	1.45	3	Port/ Private	n	5	2.89	3.93	1190938	294.28	3.77	0.00	1.00	0.96250 E2EMN, 0.03750 PFOR	1
21	Umpqua	North Spit	6.31	2.55	1.03	4	Federal/ Private	n	5	1.89	3.42	699798	172.92	2.59	0.00	1.00	0.92470 E2EMN, .07530 2.3.9	1
22	Umpqua	Steamboat Is.	298.64	120.85	3.78	1	Port	n	5	3.15	4.06	337973	83.51	1.72	0.00	1.00	0.41351 E2EMN, 0.34072 E2EMPS, 0.00066 PEMC, 0.00113 PSSC, .24398 other	1
23	Umpqua	North Spit	13.05	5.28	1.10	1	Federal	n	5	1.76	3.35	1398050	345.46	4.27	0.00	1.00	1.0000 E2EMN	1
24	Umpqua	Leeds Is.	104.68	42.36	1.96	2	Private	y	5	3.18	4.07	1133120	279.99	3.64	0.00	1.00	0.09093 PEMC, 0.79343 PEMCH, 0.03060 PEMR, 0.02588 PEMT, 0.02506 PFOA, 0.02039 PSSC, 0.01371 PSSR	1
25	Umpqua	Henderson Cove	8.18	3.31	1.05	1	Private	n	5	1.74	3.34	979515	242.04	3.27	0.00	1.00	0.14792 E2EMN, 0.82225 PFOC, .02983 2.3.9	2
26	Umpqua	Providence Cr.	6.11	2.47	1.03	2	Private	y	2	3.14	2.53	1216633	300.63	3.84	0.00	1.00	1.0000 PEMR	1
27	Umpqua	Providence Cr.	32.74	13.25	1.28	2	Private	y	2	3.08	2.50	829986	205.09	2.90	0.00	1.00	0.14773 PEMT, 0.85227 PEMCH	1
28	Umpqua	Providence Cr.	5.67	2.29	1.03	2	Private	y	0	3.12	1.50	1175068	290.36	3.74	0.00	1.00	1.0000 PEMC	1
29	Umpqua	Hunt Cove	2.80	1.13	1.00	1	Private	n	5	2.06	3.50	1005042	248.35	3.33	0.00	1.00	0.51839 PSSR, 0.48161 PFOA	2
30	Umpqua	Providence Cr.	14.04	5.68	1.11	3	Private	y	2	3.03	2.47	827948	204.59	2.90	0.00	1.00	1.0000 PEMCH	1
31	Umpqua	Providence Cr.	18.69	7.57	1.15	1	Private	y	1	2.89	1.89	839961	207.55	2.93	0.00	1.00	1.0000 PEMC	1

Site ID	Sub-estuary	Vegetation diversity score	Channel condition	Channel condition score	Alteration types	Most intensive alteration	Alteration group	Existing Restor?	General notes	Vegetation notes	Watershed Council input score	Final ecological prioritization score	Ranking Group
8	Umpqua	5	3	5	None	None	None	N	Spruce tidal swamp.	PICSIT canopy (+ALNRUB to E)/ SCHTAB-CARLYN-CAROBN	3.50	23.33	High
9	Umpqua	1	3	5	None	None	None	N	Ck base of hillslope for road/power line/ditch	Canopy: PICSIT, ALNRUB	3.38	18.09	High
10	Umpqua	1	3	5	None	None	None	N	Island at RM 17	Field check needed	3.78	14.57	Medium
11	Umpqua	1	3	5	None	None	None	N	Tidal influence probably low due to natural levee	PICSIT/LONINV/LYSAME. Upland trees on riverbank levee.	2.92	14.24	Medium
12	Umpqua	5	3	5	None	None	None	N	Channel straightened E of bridge, otherwise unaltered	LONINV/SCHTAB-TYPLAT-PHAARU; E of bridge, add Salix	3.55	17.97	High
13	Umpqua	5	1	1	D, X	D	Major	N	Channel excavated; sidecast forms berms, homesites	Field check needed	3.92	14.55	Medium
14	Umpqua	1	3	5	None	None	None	N	Brandy Bar.	THUPLI-PICSIT-POPTRI-ALNRUB canopy	3.13	14.15	Medium-Low
15	Umpqua	1	3	5	None	None	None	N	Peripheral development to W	Field check needed	3.38	14.26	Medium
16	Umpqua	1	3	5	None	None	None	N	Homesite adjacent to S. Tidal influence probably low.	Field check needed	2.18	14.02	Medium-Low
17	Umpqua	1	3	5	None	None	None	N	Homesites adjacent. Tidal influence probably low.	ALNRUB/POPTRI/Salix-LONINV-MALFUS/PHAARU	2.17	13.96	Medium-Low
18	Umpqua	1	1	1	Y, D, R, X	Y	Major	N	Site is outfall pond for effluent from aeration pond to SE.	Field check needed	1.33	9.83	Low
19	Umpqua	1	3	5	None	None	None	N	The Point	Field check needed	4.60	14.78	Medium
20	Umpqua	1	3	5	None	None	None	N	One minor ditch on S portion of site, otherwise intact	Field check needed	4.40	16.15	Medium-High
21	Umpqua	1	3	5	None	None	None	N	On North Spit	Field check needed	4.60	14.04	Medium-Low
22	Umpqua	1	3	5	F	F	Minor	N	N end: dredge material disposal. Remainder unaltered.	CARLYN-DESCES on wetland; DMD area has weedy upland spp	5.00	16.56	Medium-High
23	Umpqua	1	3	5	None	None	None	N	On North Spit	Field check needed	4.80	15.72	Medium
24	Umpqua	1	1	1	Y, D, C, R	Y	Major	N	Dredge material disposal area.	Primarily pasture grasses. S edge: TYPLAT-SCHTAB	1.92	12.67	Medium-Low
25	Umpqua	3	3	5	None	None	None	N	Henderson Cove	Field check needed	5.00	16.66	Medium-High
26	Umpqua	1	1	1	D, C	D	Major	N	Minor ditching. Tidegate is on site 24.	Field check needed	1.88	10.39	Low
27	Umpqua	1	1	1	D, C	D	Major	N	Tidegate is offsite (on site 24).	Primarily introduced pasture grasses.	1.88	9.68	Low
28	Umpqua	1	1	1	D, C	D	Major	N	Tidegate is offsite (on site 24).	Primarily introduced pasture grasses.	1.50	9.26	Low
29	Umpqua	3	3	5	None	None	None	N	Hart Cove	Field check needed	3.67	16.83	Medium-High
30	Umpqua	1	2	3	C, R	C	Minor	N	Tidegate offsite; road @bottom of site. Meandering channel.	Low spots: JUNEFF. Road crossing impounds main channel	2.17	11.48	Low
31	Umpqua	1	1	1	D, C	D	Major	N	Tidegate is offsite (on site 24).	Field check needed	2.00	8.97	Low

Site ID	Sub-estuary	Location	Site size (A)	Site size (ha)	Site size score	Number of owners	Ownership Type	In/On UGB?	# of salmon stocks	Avg. distance to spawning	Salmon habitat connectivity score	Wetland area w/in 1 mile (sq m)	Wetland area w/in 1 mile (A)	Wetland connectivity score	% historic spruce swamp	Historic vegetation score	% of each NWI class	Number of Cowardin classes
32	Umpqua	Providence Cr.	11.71	4.74	1.08	2	Private	y	0	2.14	1.00	530393	131.06	2.18	0.00	1.00	1.0000 PSSF	1
33	Umpqua	Macey Cove	4.30	1.74	1.01	2	Federal/ Private	n	5	2.32	3.64	513998	127.01	2.14	0.00	1.00	1.0000 E2EMN	1
34	Umpqua	Winchester Cr.	20.21	8.18	1.16	1	Private	n	0	3.30	1.59	735086	181.64	2.68	0.00	1.00	1.0000 PSSC	1
35	Umpqua	Winchester Cr.	47.72	19.31	1.42	2	Private	n	2	3.67	2.79	569768	140.79	2.28	0.00	1.00	0.15793 PFOC, 0.84207 PSSC	2
36	Umpqua	Winchester Cr.	30.81	12.47	1.26	3	Private	n	2	3.70	2.81	720708	178.09	2.64	0.00	1.00	0.25709 PSSC, 0.74291 PEMC	2
37	Umpqua	Winchester Cr.	29.91	12.10	1.25	2	Private	n	2	3.56	2.74	323023	79.82	1.68	0.00	1.00	0.08740 PEMC, 0.09575 PEMFB, 0.02491 PFOA, 0.06576 PFOC, 0.72617 PSSC	2
51	Umpqua	Bolon Is.	6.30	2.55	1.03	1	State	n	5	3.22	4.09	1169370	288.95	3.72	0.00	1.00	1.0000 E2EMNS	1
54	Umpqua	Scholfield Cr. mouth	24.97	10.11	1.21	1	Private	y	5	3.10	4.03	1084746	268.04	3.52	0.00	1.00	1.0000 E2EMP	1
55	Umpqua	Scholfield Cr. mouth	13.75	5.57	1.10	2	Port/ Private	y	5	3.22	4.09	877445	216.82	3.02	0.00	1.00	0.49007 E2EMN, 0.29371 PFOR, 0.21622 PSSR	3
56	Umpqua	Umpqua R. mile 13	15.91	6.44	1.12	2	State/ Private	n	5	3.07	4.02	1545224	381.82	4.63	27.82	2.11	1.0000 PEMA	1
57	Umpqua	Scholfield Cr.	26.05	10.54	1.22	3	State/ City/Private	y	2	3.31	2.61	1291672	319.17	4.02	0.00	1.00	0.28306 PEMT, 0.66610 PEMR, 0.05083 PFOR	1
58	Umpqua	Scholfield Cr.	21.16	8.56	1.17	3	Private	y	2	2.78	2.34	413625	102.21	1.90	0.00	1.00	0.54698 PEMT, 0.36857 PEMR, 0.08445 PSSC	1
59	Umpqua	Scholfield Cr.	20.70	8.38	1.17	1	City	n	2	3.54	2.73	1699311	419.90	5.00	0.00	1.00	0.42819 PEMT, 0.57181 PEMR	1
60	Umpqua	Scholfield Cr.	15.61	6.32	1.12	1	Private	n	2	3.43	2.67	1475814	364.67	4.46	0.00	1.00	0.53117 PEMR, 0.32489 PEMT, 0.10530 PFOR, 0.03863 PSSC	2
61	Umpqua	Scholfield Cr.	48.64	19.68	1.43	1	City	n	2	3.76	2.84	1471987	363.73	4.45	0.00	1.00	0.31750 PEMT, 0.68250 PEMR	1
62	Umpqua	Scholfield Cr.	19.55	7.91	1.16	1	County	n	2	3.63	2.77	1409147	348.20	4.30	0.00	1.00	0.48335 PEMT, 0.41105 PEMR, 0.10560 PSSC	2
63	Umpqua	Dean Cr.	20.74	8.39	1.17	1	Private	n	2	4.68	3.31	1049962	259.45	3.43	0.00	1.00	0.81428 PEMCH, 0.16205 PFOR, 0.02367 PEMT	2
64	Umpqua	Scholfield Cr.	38.94	15.76	1.34	2	Private	n	2	3.93	2.93	1277798	315.74	3.98	0.00	1.00	0.10827 PEMC, 0.63054 PEMT, 0.02311 PSSC, 0.23808 PSSR	2
65	Umpqua	Oar Cr.	43.52	17.61	1.38	9	Private	n	2	4.04	2.98	831531	205.47	2.91	0.00	1.00	0.00975 PEMA, 0.29069 PEMC, 0.29455 PEMR, 0.05171 PEMT, 0.23027 PFOC, 0.12303 PSSC	3
66	Umpqua	Scholfield Cr.	26.46	10.71	1.22	3	Private	n	2	3.85	2.89	1360090	336.08	4.18	0.00	1.00	0.08831 PEMR, 0.70392 PEMT, 0.20777 PSSR	2
67	Umpqua	North Spit	15.18	6.14	1.12	1	State	n	5	1.87	3.41	1257844	310.81	3.94	0.00	1.00	0.87322 E2EMN, 0.12678 2.3.9(2)	2
68	Umpqua	Providence Cr.	6.74	2.73	1.04	1	Private	y	1	2.96	1.93	958043	236.73	3.21	0.00	1.00	1.0000 PEMC	1
69	Umpqua	Umpqua R. mile 19	17.63	7.13	1.14	4	State/ Private	n	5	4.65	4.82	177380	43.83	1.33	0.00	1.00	0.00304 PFOR, 0.99696 other	1
77	Umpqua	Winchester Cr.	57.49	23.27	1.51	13	Private	n	2	3.63	2.78	514032	127.02	2.14	0.00	1.00	0.08312 PFOA, 0.05437 PFOC, 0.26943 PSSA, 0.59308 PSSC	2
78	Umpqua	Scholfield Cr.	45.50	18.41	1.40	2	Private	y	2	2.73	2.32	555059	137.15	2.24	0.00	1.00	0.08971 PEMC, 0.88440 PEMCH, 0.02589 PFOR	1
79	Umpqua	Scholfield Cr.	5.96	2.41	1.03	123	State/Privat e	y	2	3.12	2.52	814479	201.26	2.87	0.00	1.00	1.0000 PEMCH	1
80	Umpqua	Scholfield Cr.	38.13	15.43	1.33	7	State/ Private	n	2	3.12	2.52	697791	172.42	2.59	0.00	1.00	0.02180 PEMC, 0.90685 PEMR, 0.07135 PFOR	1

Site ID	Sub-estuary	Vegetation diversity score	Channel condition	Channel condition score	Alteration types	Most intensive alteration	Alteration group	Existing Restor?	General notes	Vegetation notes	Watershed Council input score	Final ecological prioritization score	Ranking Group
32	Umpqua	1	2	3	C	C	Minor	N	Ditching is minor. Tidegate is offsite (on site 24).	Sm. area of pasture at N end; otherwise unaltered	2.00	9.27	Low
33	Umpqua	1	3	5	None	None	None	N	Macey Cove	Field check needed	4.67	13.79	Medium-Low
34	Umpqua	1	3	5	None	None	None	N	Hwy. 101 flanks W side of wetland, otherwise intact.	Salix/SPIDOU-CAROBN-LYSAME	4.11	12.43	Medium-Low
35	Umpqua	3	3	5	D, C	D	Major	N	Former pasture, now regrown to shrub swamp. Minor ditching.	Salix, PICSIT swamp	4.38	15.49	Medium
36	Umpqua	3	2	3	D, C	D	Major	N	N edge is ungrazed shrub swamp	N edge: Salix swamp	2.09	13.71	Medium-Low
37	Umpqua	3	3	5	None	None	None	N	Tidal influence mainly at N end near Winchester Cr.	PICSIT/DESCES to N; Salix/CAROBN-LYSAME to S	4.60	14.68	Medium
51	Umpqua	1	3	5	None	None	None	N	Small island W of Bolon Island	Field check needed	5.00	15.85	Medium-High
54	Umpqua	1	3	5	F	F	Minor	N	Dredge material disposal on N end, otherwise unaltered.	Field check needed	4.86	15.76	Medium
55	Umpqua	5	2	3	F	F	Minor	N	Channel to S excavated,sidecast on site. Most is still tidal	Mixed:CARLYN-DESCES-SCHTAB @S, PICSIT-ALNRUB/Salix in center	2.36	17.21	Medium-High
56	Umpqua	1	1	1	D	D	Major	N	Partly mowed, partly grazed.	Pasture grasses; wettest at W side	3.50	13.88	Medium-Low
57	Umpqua	1	3	5	None	None	None	N	Undisturbed tidal marsh; sm. area of spruce tidal swamp	Field check needed	4.18	14.85	Medium
58	Umpqua	1	2	3	Y, C, R	Y	Major	N	Tidal exchange good; culvert not very restrictive. Road=dike	LONINV/SCHTAB-CARLYN-TYPLAT-PHAARU; PICSIT/Salix to S	4.14	10.42	Low
59	Umpqua	1	3	5	D	D	Major	N	Minor ditching, otherwise unaltered	Field check needed	4.13	15.90	Medium-High
60	Umpqua	3	3	5	R	R	Minor	N	RR crosses site; otherwise unaltered	Field check needed	4.67	17.25	High
61	Umpqua	1	3	5	None	None	None	N	Disposal site to E; otherwise unaltered	Field check needed	3.55	15.73	Medium
62	Umpqua	3	3	5	R	R	Minor	N	RR bridge somewhat restrictive, but otherwise unaltered	Field check needed	5.00	17.23	Medium-High
63	Umpqua	3	1	1	Y, D, C, X	Y	Major	N	Dean Creek diked pasture	Field check needed	2.17	12.92	Medium-Low
64	Umpqua	3	3	5	R	R	Minor	N	RR crosses site; otherwise unaltered. Historic channel loc.?	PICSIT swamp mixed w/LONINV-SCHTAB-PHAARU marsh	3.55	17.25	High
65	Umpqua	5	2	3	D, C	D	Major	N	Main channel ditched. Some veg removal at E end.	W end: SCHTAB-DESCES-PHAARU. E end: PICSIT/CAROBN-PHAARU	1.77	16.27	Medium-High
66	Umpqua	3	3	5	R	R	Minor	N	RR crosses site, but doesn't disrupt major channels	SCHTAB-PHAARU	3.50	17.29	High
67	Umpqua	3	3	5	None	None	None	N	Island midway down North Spit	Field check needed	4.75	17.46	High
68	Umpqua	1	1	1	D, C	D	Major	N	Tidegate is offsite (on site 24).	Upper (E) side: CAROBN	2.00	9.18	Low
69	Umpqua	1	1	1	D, C	D	Major	N	Mowed; any ag use?	PHAARU in mowed area; POPTRI-ALNRUB/Salix where unmowed	3.77	10.29	Low
77	Umpqua	3	3	5	None	None	None	N	Fills along Hwy101, minor ditching@E end, otherwise intact	DESCES-AGRSTO-ARGEGE; PICSIT; Salix-LONINV/DESCES to E	3.56	15.43	Medium
78	Umpqua	1	1	1	Y, D, C	Y	Major	N	Diked pasture	JUNEFF scattered among introduced pasture grasses.	2.86	8.96	Low
79	Umpqua	1	1	1	Y, D, C	Y	Major	N	Mowed but does not appear agricultural.	Field check needed	1.70	9.41	Low
80	Umpqua	1	3	5	R	R	Minor	N	RR crosses site; otherwise unaltered	Field check needed	4.40	13.43	Medium-Low

Site ID	Sub-estuary	Location	Site size (A)	Site size (ha)	Site size score	Number of owners	Ownership Type	In/On UGB?	# of salmon stocks	Avg. distance to spawning	Salmon habitat connectivity score	Wetland area w/in 1 mile (sq m)	Wetland area w/in 1 mile (A)	Wetland connectivity score	% historic spruce swamp	Historic vegetation score	% of each NWI class	Number of Cowardin classes
81	Umpqua	Scholfield Cr.	52.37	21.19	1.47	1	Private	n	2	4.09	3.01	1111577	274.67	3.58	0.00	1.00	0.11374 PEMR, 0.73868 PEMT, 0.11787 PFOR, 0.02971 PFOS	2
82	Umpqua	Scholfield Cr.	54.03	21.87	1.48	5	Private	n	2	3.75	2.83	743814	183.80	2.70	0.00	1.00	0.77128 PEMC, 0.12763 PSSC, 0.10109 PFOC	3
98	Umpqua	Islands, Umpqua R. mile 16	29.12	11.79	1.25	1	Private	n	5	4.43	4.71	991000	244.88	3.29	0.00	1.00	0.38717 E2EMN, 0.24751 E2EMP, 0.21639 PEMR, 0.14893 PFOS	2
99	Umpqua	Spruce Reach Island	54.14	21.91	1.48	1	Federal	n	5	3.92	4.45	1262557	311.98	3.95	14.24	1.57	0.16267 PEMR, 0.55914 PFOS, 0.27818 PSSR	3
100	Umpqua	Dean Cr. Elk Viewing Area	428.32	173.33	5.00	1	Federal	n	5	4.11	4.55	263406	65.09	1.54	0.00	1.00	0.00754 PEMA, 0.16360 PEMAH, 0.69849 PEMCH, 0.02347 PEMFH, 0.01968 PFOA, 0.05689 PFOCH, 0.02885 PSSCH, 0.00147 other	1
101	Umpqua	Adjacent to Dean Cr. EVA	37.23	15.07	1.32	2	State	n	5	3.05	4.01	1297857	320.70	4.03	0.00	1.00	0.40282 PEMR, 0.26661 PEMT, 0.29761 PFOR, 0.03296 PFOS	2
102	Umpqua	Umpqua R. mile 13	27.33	11.06	1.23	1	Private	n	5	3.82	4.40	1485699	367.12	4.49	94.70	4.79	1.0000 PEMA	1
103	Umpqua	Umpqua R. mile 13	11.54	4.67	1.08	1	State/ Private	n	5	3.46	4.22	1687679	417.03	4.97	66.57	3.66	0.10431 E2EMN, 0.89569 PFOA	2

Site ID	Sub-estuary	Vegetation diversity score	Channel condition	Channel condition score	Alteration types	Most intensive alteration	Alteration group	Existing Restor?	General notes	Vegetation notes	Watershed Council input score	Final ecological prioritization score	Ranking Group
81	Umpqua	3	3	5	None	None	None	N	RR borders site at S (upland) edge	LONINV/SCHTAB-TYPLAT-DESCES; some PICSIT swamp areas	3.91	17.06	Medium-High
82	Umpqua	5	2	3	D, C, R	D	Major	N	Ditched pasture	CAROBN-PHAARU, pasture grasses	1.82	16.01	Medium-High
98	Umpqua	3	3	5	None	None	None	N	Islands reportedly growing due to rapid sediment accumulation	From river upslope: CARLYN,LYTSAL,SCHTAB-TYPLAT,ALNRUB/Salix	3.89	18.25	High
99	Umpqua	5	3	5	None	None	None	N	Hwy. 42 on S edge affects hydrology, but otherwise intact	PICSIT forest. Nr road: Salix-MALFUS/SCHTAB-PHAARU	4.40	21.45	High
100	Umpqua	1	1	1	Y, D, C, R, F	Y	Major	N	Dean Creek Elk Viewing Area. Some dredge material disposal.	Field check needed	3.59	14.09	Medium-Low
101	Umpqua	3	3	5	None	None	None	N	Island N of Hwy 136 and outside Dean Creek Elk Viewing Area	TYPLAT-SCHTAB; CARLYN; LYTSAL; Salix-ALNRUB on riverbank	4.30	18.36	High
102	Umpqua	1	1	1	D	D	Major	N	Mowed/grazed	Field check needed	2.63	16.90	Medium-High
103	Umpqua	3	3	5	None	None	None	N	Mowed/grazed	PICSIT-ALNRUB canopy, CAROBN openings	4.50	21.94	High

Appendix F. Figures (maps)

Note: For the mainstem Umpqua report, each figure is divided into two sections (e.g., Figure 1a shows the lower estuary, and Figure 1b shows the upper estuary).

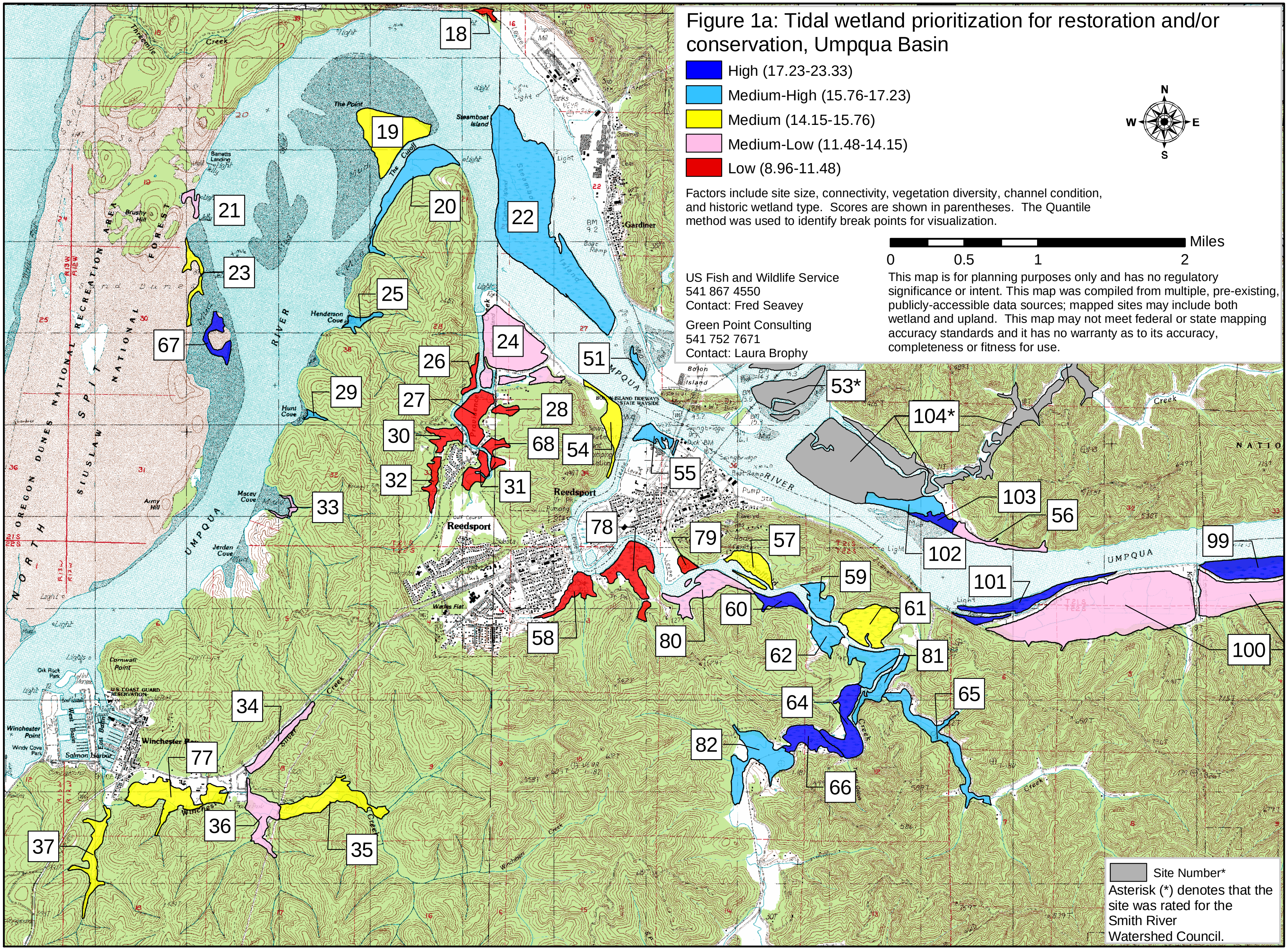

Figure 1a: Tidal wetland prioritization for restoration and/or conservation, Umpqua Basin

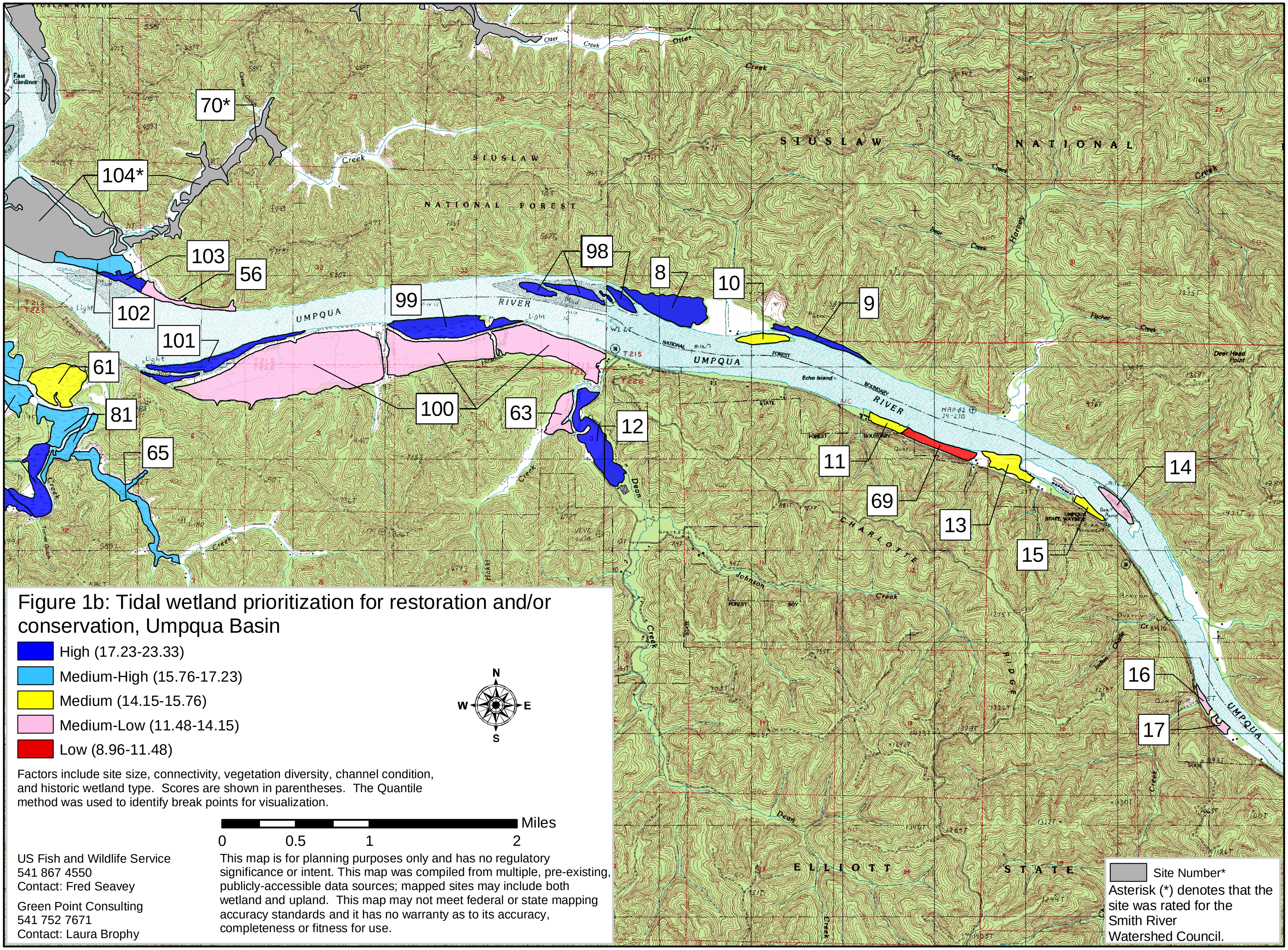

Figure 1b: Tidal wetland prioritization for restoration and/or conservation, Umpqua Basin

Factors include site size, connectivity, vegetation diversity, channel condition, and historic wetland type. Scores are shown in parentheses. The Quantile method was used to identify break points for visualization.

Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.

US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey

Green Point Consulting
541 752 7671
Contact: Laura Brophy

This map is for planning purposes only and has no regulatory significance or intent. This map was compiled from multiple, pre-existing, publicly-accessible data sources; mapped sites may include both wetland and upland. This map may not meet federal or state mapping accuracy standards and it has no warranty as to its accuracy, completeness or fitness for use.

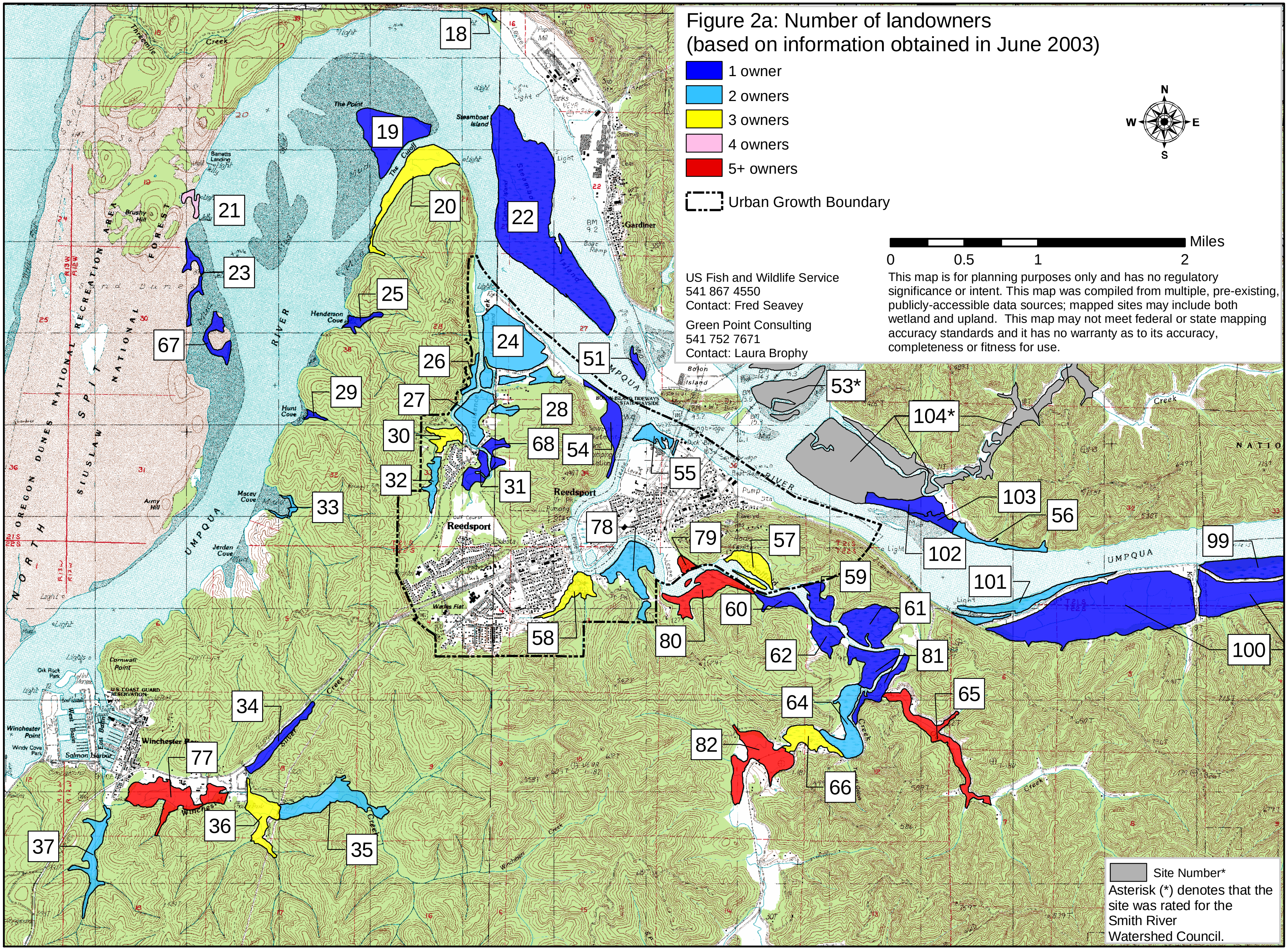

Figure 2a: Number of landowners
(based on information obtained in June 2003)

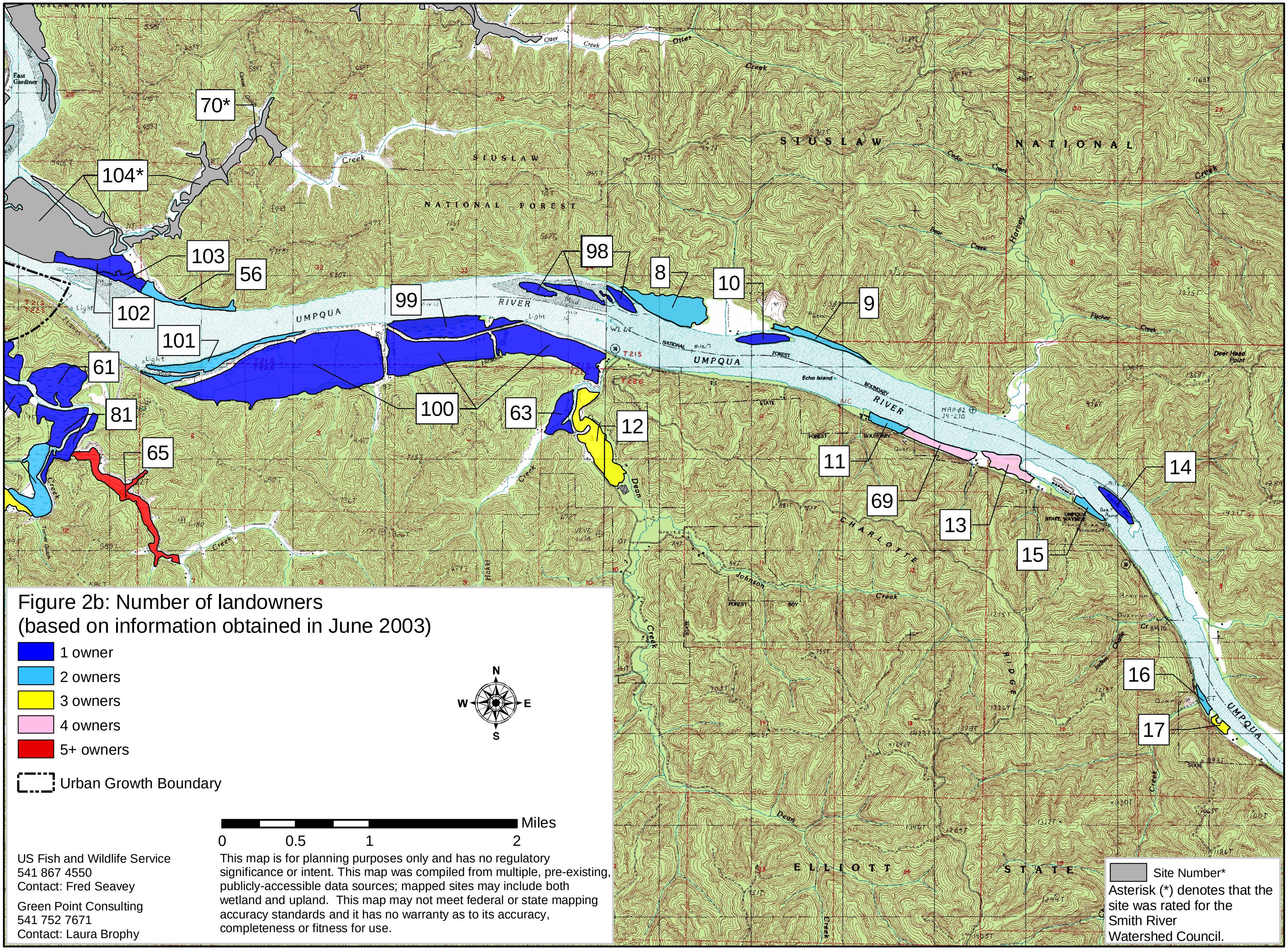

Figure 2b: Number of landowners (based on information obtained in June 2003)

US Fish and Wildlife Service
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Green Point Consulting
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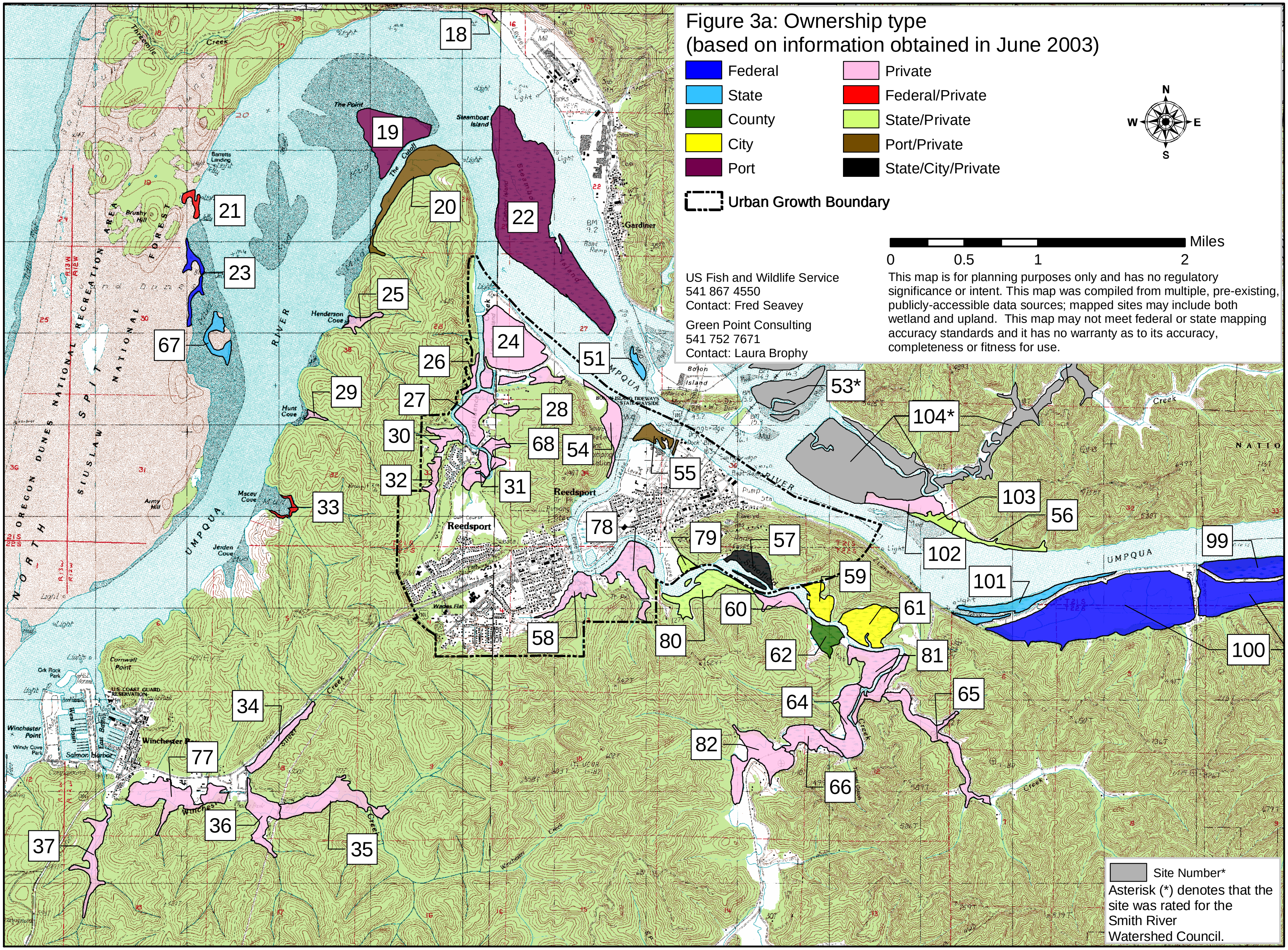
Figure 3a: Ownership type
(based on information obtained in June 2003)
Federal
State
County
City
Port
Private
Federal/Private
State/Private
Port/Private
State/City/Private
Urban Growth Boundary
Miles
0 0.5 1 2
US Fish and Wildlife Service
541 867 4550
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Green Point Consulting
541 752 7671
Contact: Laura Brophy
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Site Number*
Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.
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81
82
99
100
101
102
103
104*
Reedsport
Gardiner
UMPQUA RIVER

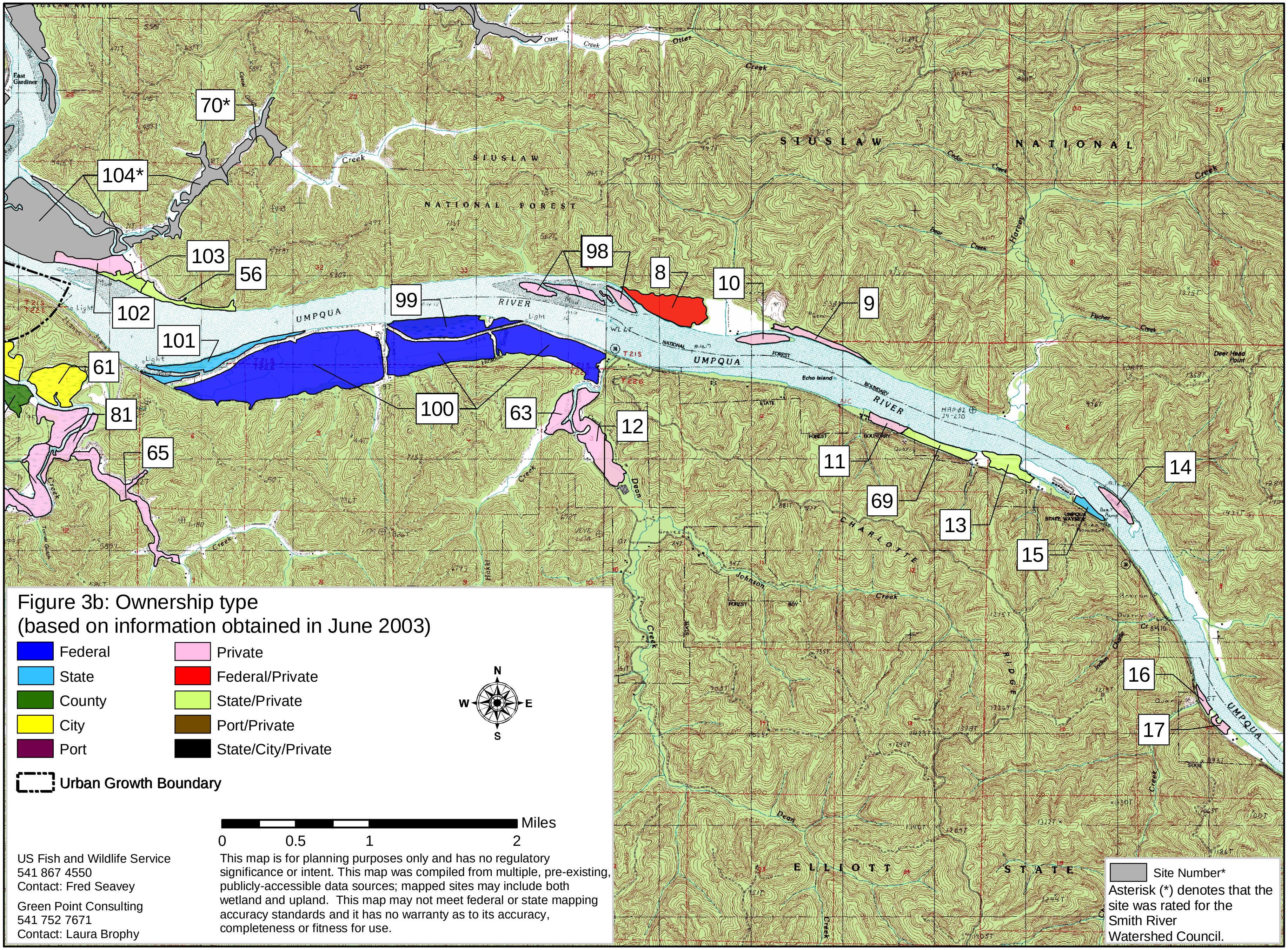

Figure 3b: Ownership type
(based on information obtained in June 2003)

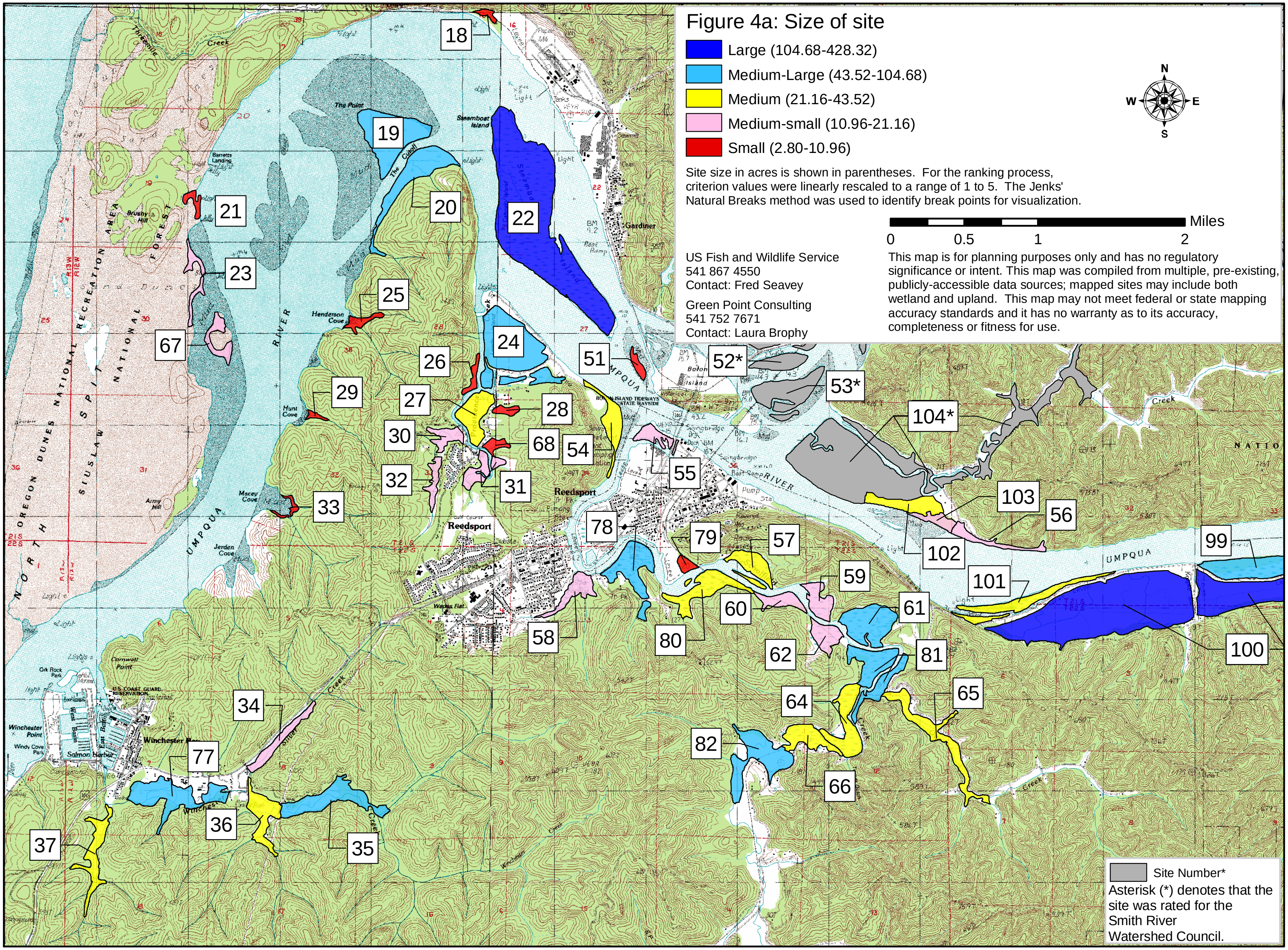
Figure 4a: Size of site
Large (104.68-428.32)
Medium-Large (43.52-104.68)
Medium (21.16-43.52)
Medium-small (10.96-21.16)
Small (2.80-10.96)
Site size in acres is shown in parentheses. For the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.
0 0.5 1 2 Miles
N S E W
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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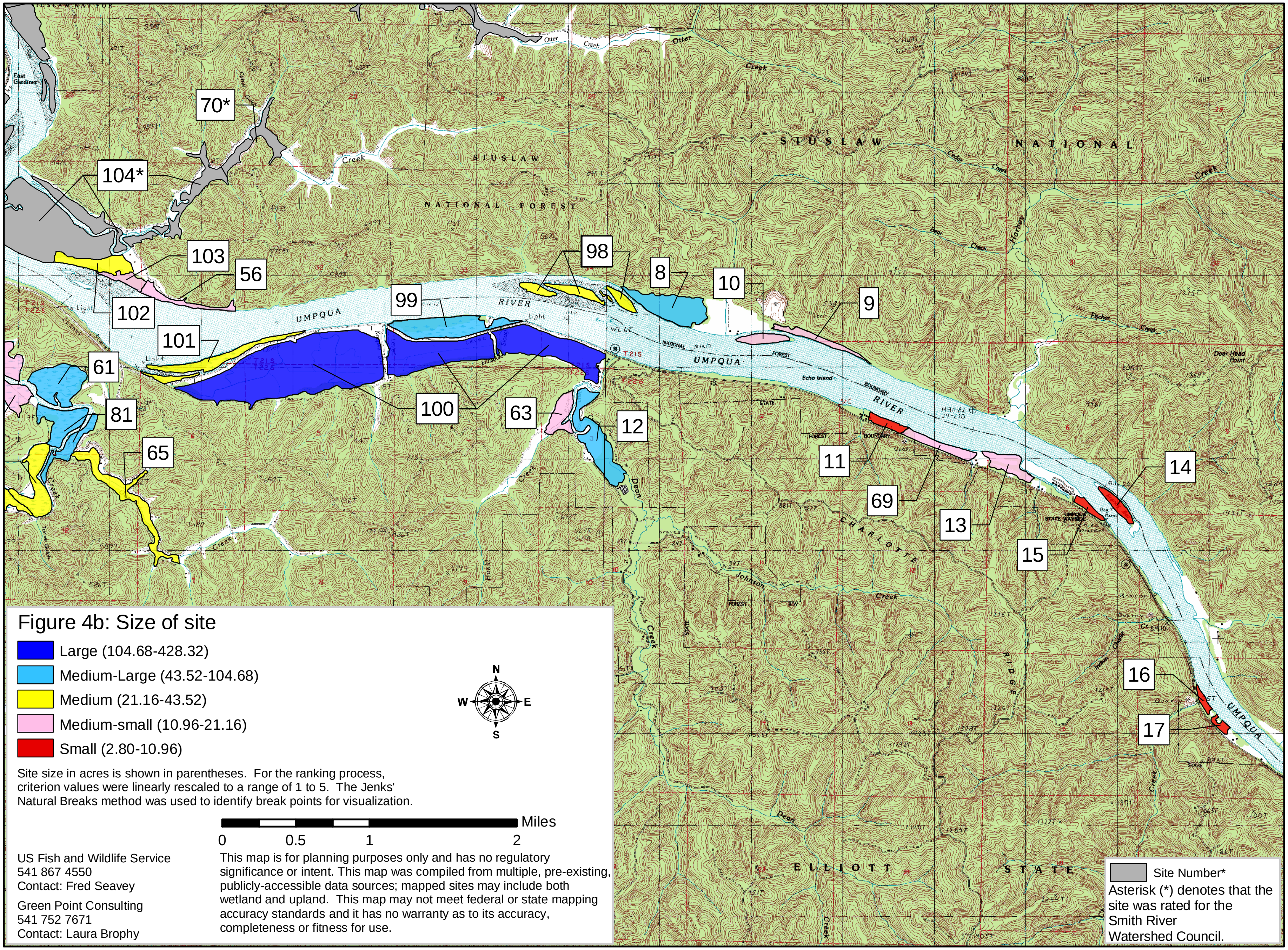
Site Number*
Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 51 52* 53* 54 55 56 57 58 59 60 61 62 64 65 66 67 68 77 78 79 80 81 82 99 100 101 102 103 104*
UMPQUA RIVER
Reedsport
Gardiner
Winchester Bay


70*
104*
103
56
102
101
61
81
65
99
100
98
8
10
9
63
12
11
69
13
15
14
16
17
UMPQUA
RIVER
SIUSLAW
NATIONAL FOREST
SIUSLAW NATIONAL
Echo Island
CHARLOTTE
RIDGE
ELLIOTT STATE
Figure 4b: Size of site
Large (104.68-428.32)
Medium-Large (43.52-104.68)
Medium (21.16-43.52)
Medium-small (10.96-21.16)
Small (2.80-10.96)
Site size in acres is shown in parentheses. For the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.
N
W
E
S
Miles
0
0.5
1
2
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
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Site Number*
Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.

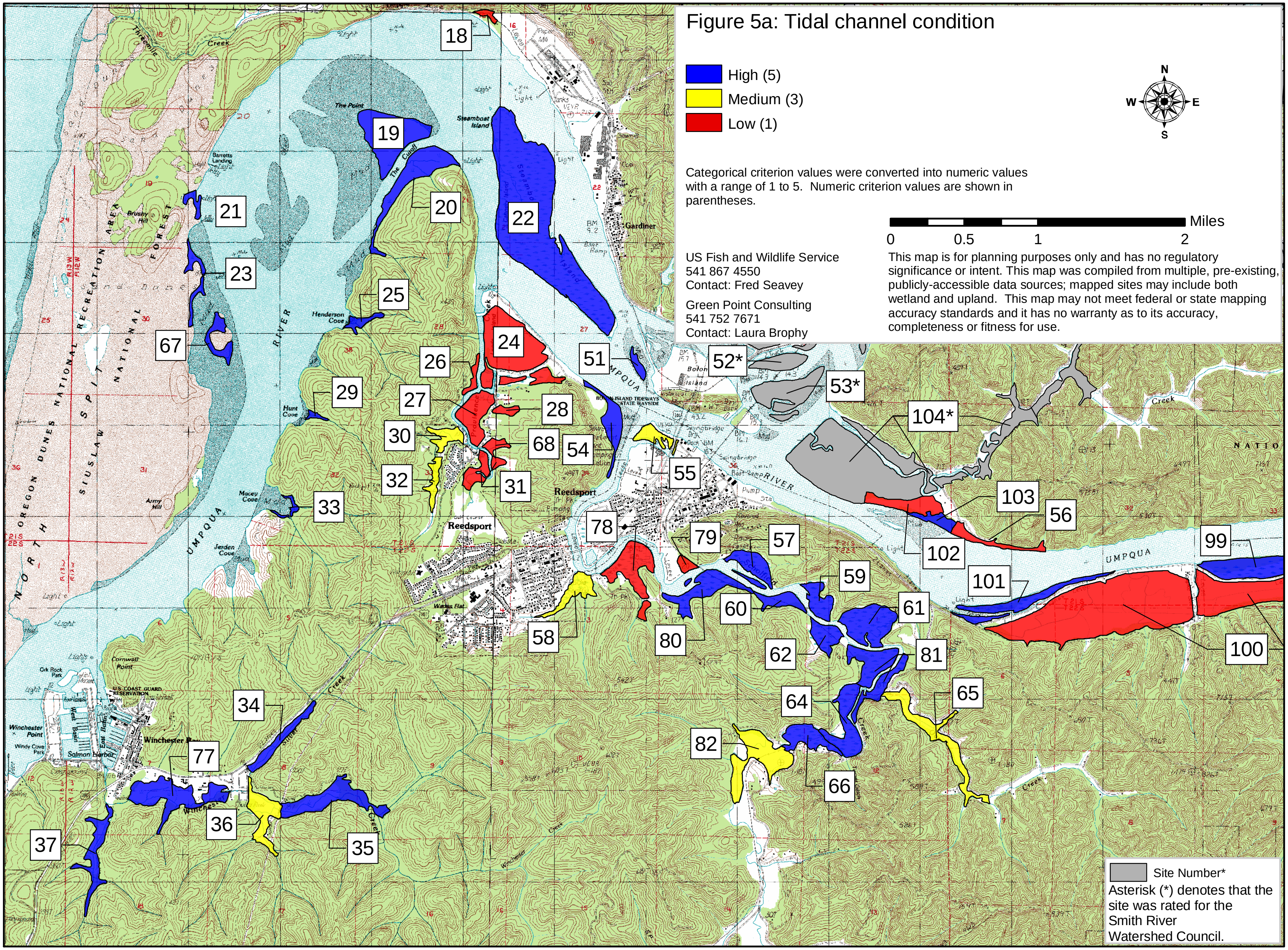

Figure 5a: Tidal channel condition

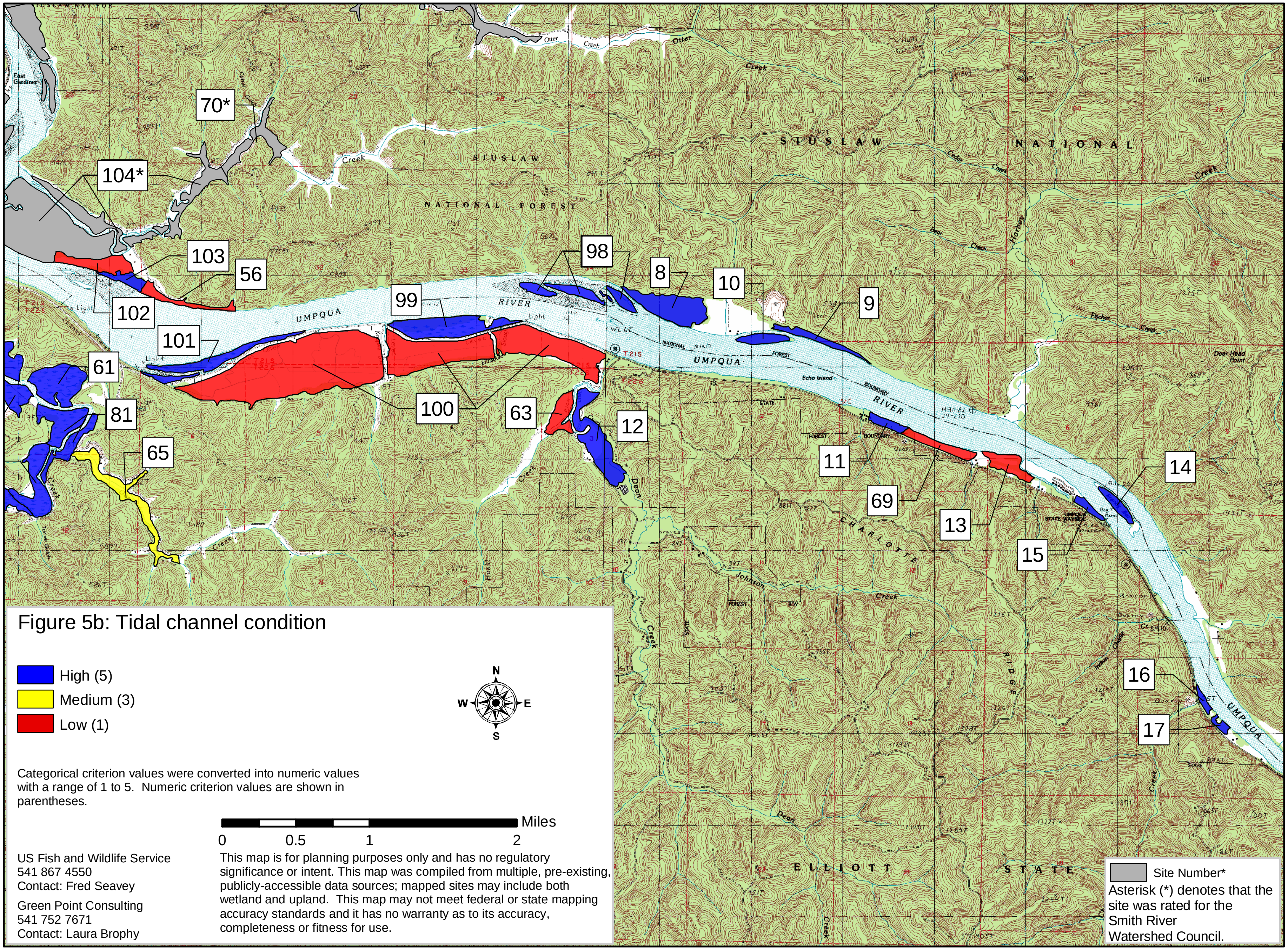

Figure 5b: Tidal channel condition

Categorical criterion values were converted into numeric values with a range of 1 to 5. Numeric criterion values are shown in parentheses.

US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey

Green Point Consulting
541 752 7671
Contact: Laura Brophy

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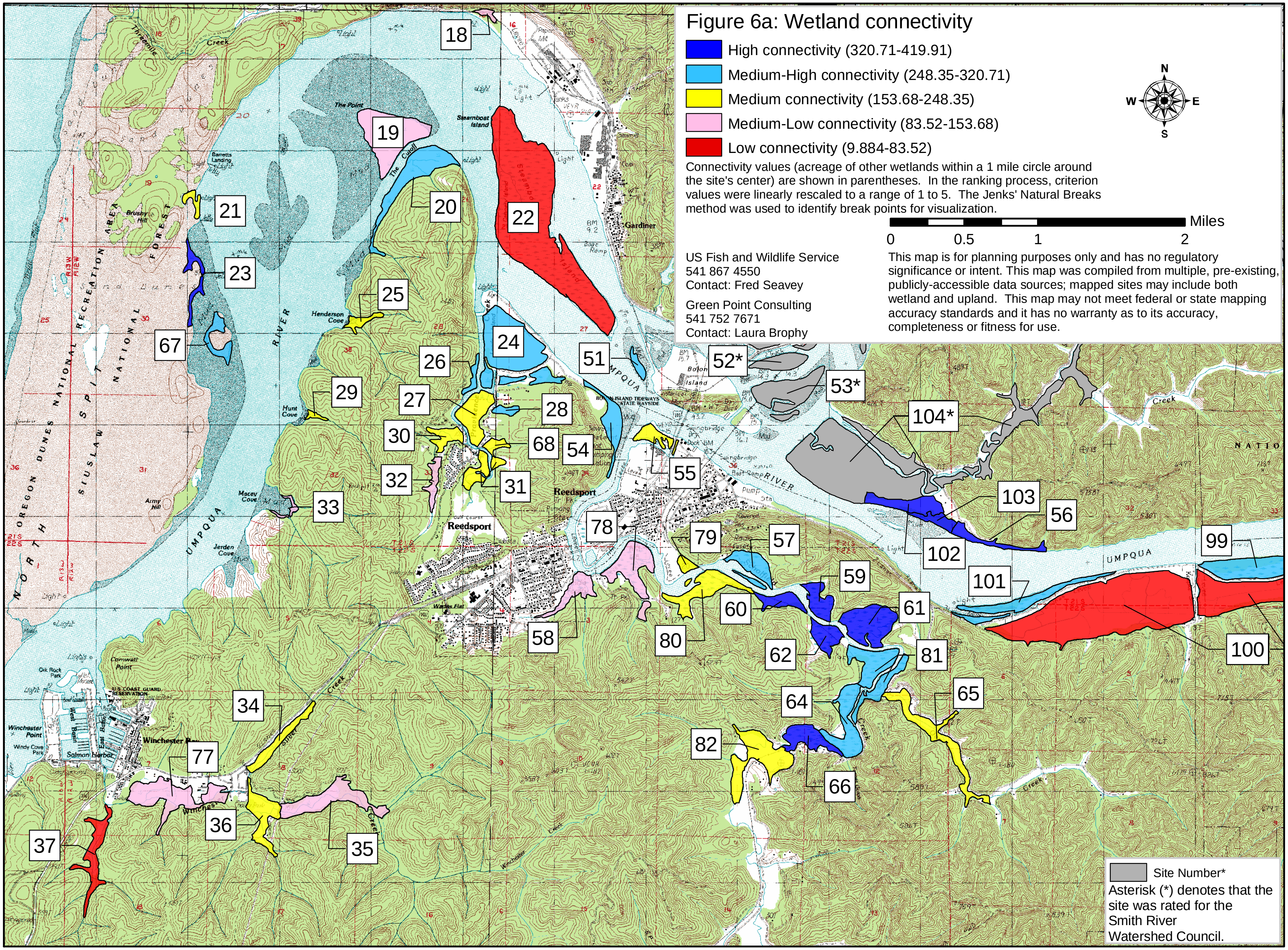
Figure 6a: Wetland connectivity
High connectivity (320.71-419.91)
Medium-High connectivity (248.35-320.71)
Medium connectivity (153.68-248.35)
Medium-Low connectivity (83.52-153.68)
Low connectivity (9.884-83.52)
Connectivity values (acreage of other wetlands within a 1 mile circle around the site's center) are shown in parentheses. In the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.
N
W
E
S
0
0.5
1
2
Miles
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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Site Number*
Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.
18
19
20
21
22
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25
26
27
28
29
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31
32
33
34
35
36
37
51
52*
53*
54
55
56
57
58
59
60
61
62
64
65
66
67
68
77
78
79
80
81
82
99
100
101
102
103
104*
Reedsport
Gardiner
UMPQUA RIVER
NORTH SPIT
OREGON DUNES NATIONAL RECREATION AREA
SIUSLAW NATIONAL FOREST
Winchester Point
Salmon Harbor

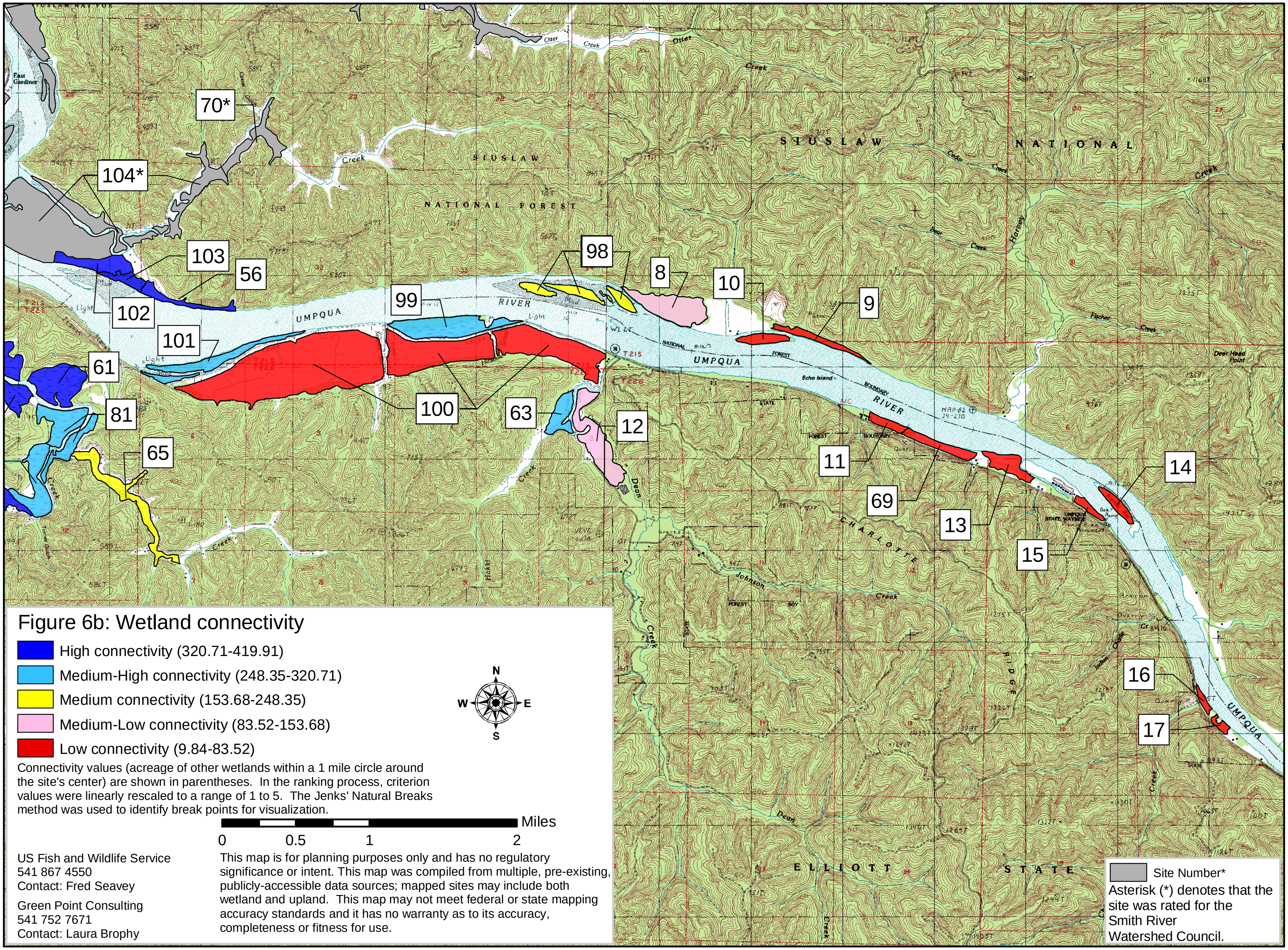
Figure 6b: Wetland connectivity
High connectivity (320.71-419.91)
Medium-High connectivity (248.35-320.71)
Medium connectivity (153.68-248.35)
Medium-Low connectivity (83.52-153.68)
Low connectivity (9.84-83.52)
Connectivity values (acreage of other wetlands within a 1 mile circle around the site's center) are shown in parentheses. In the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.
Miles
0 0.5 1 2
N
W
E
S
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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Site Number*
Asterisk (*) denotes that the site was rated for the Smith River Watershed Council.
70*
104*
103
56
102
101
61
81
65
99
98
8
10
9
100
63
12
11
69
13
15
14
16
17
UMPQUA
RIVER
SIUSLAW
NATIONAL
FOREST
CHARLOTTE
RIDGE
ELLIOTT
STATE

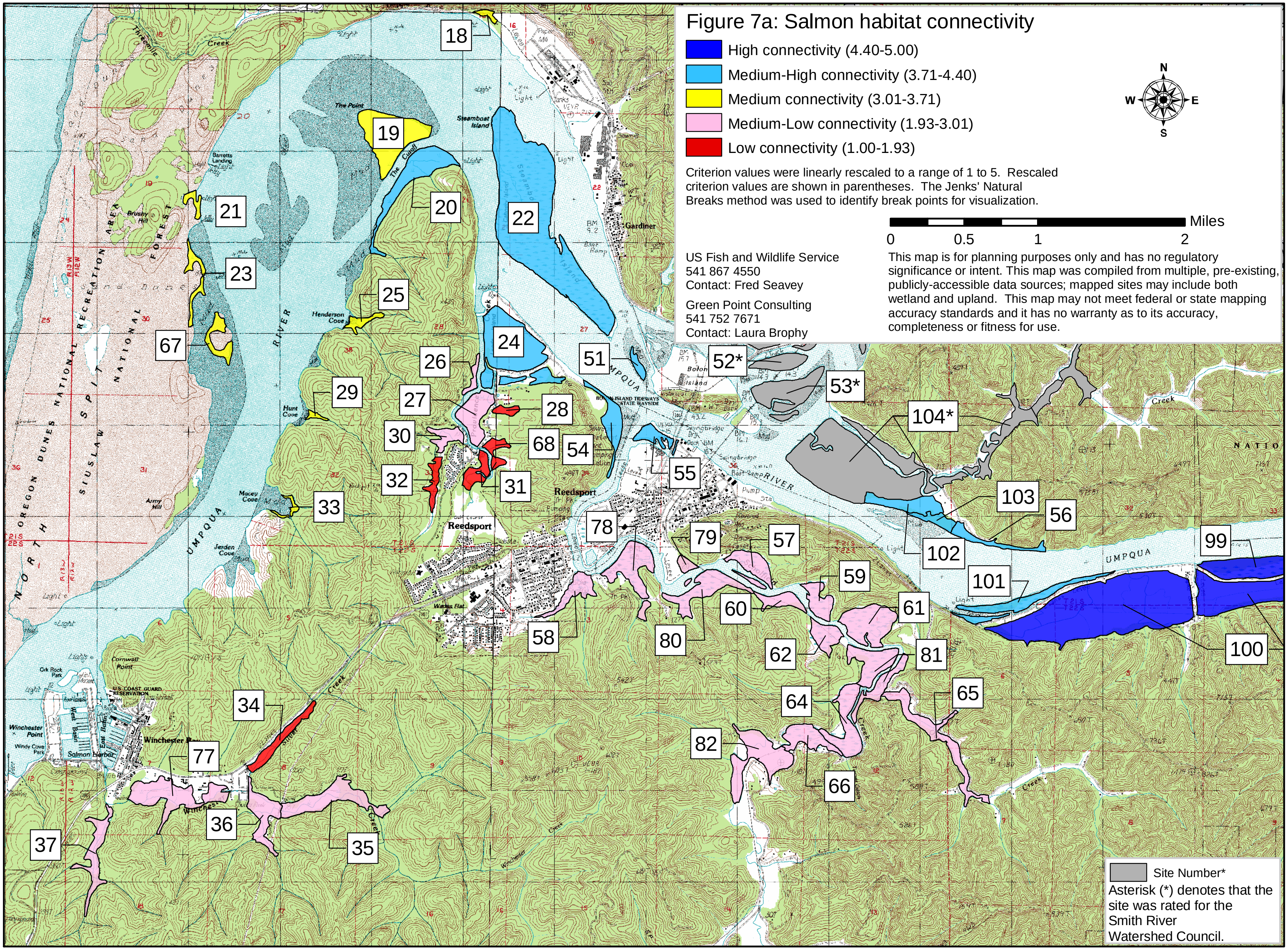
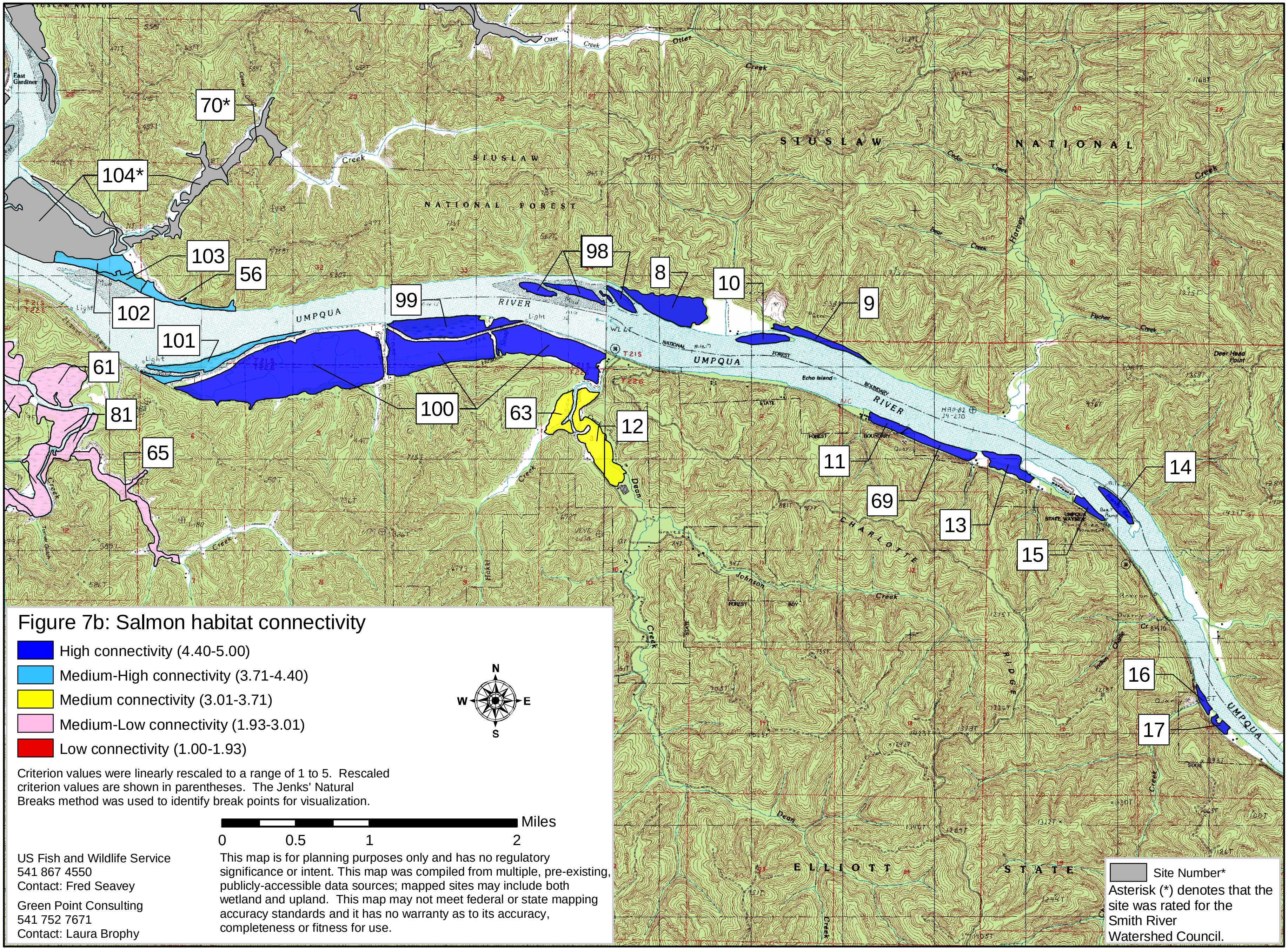


Figure 7a: Salmon habitat connectivity



70*
104*
103
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102
101
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81
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100
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63
12
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14
16
17
UMPQUA
RIVER
SIUSLAW
NATIONAL
FOREST
CHARLOTTE
RIDGE
ELLIOTT
STATE
Figure 7b: Salmon habitat connectivity
High connectivity (4.40-5.00)
Medium-High connectivity (3.71-4.40)
Medium connectivity (3.01-3.71)
Medium-Low connectivity (1.93-3.01)
Low connectivity (1.00-1.93)
Criterion values were linearly rescaled to a range of 1 to 5. Rescaled criterion values are shown in parentheses. The Jenks' Natural Breaks method was used to identify break points for visualization.
N
W
E
S
0
0.5
1
2
Miles
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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Site Number*
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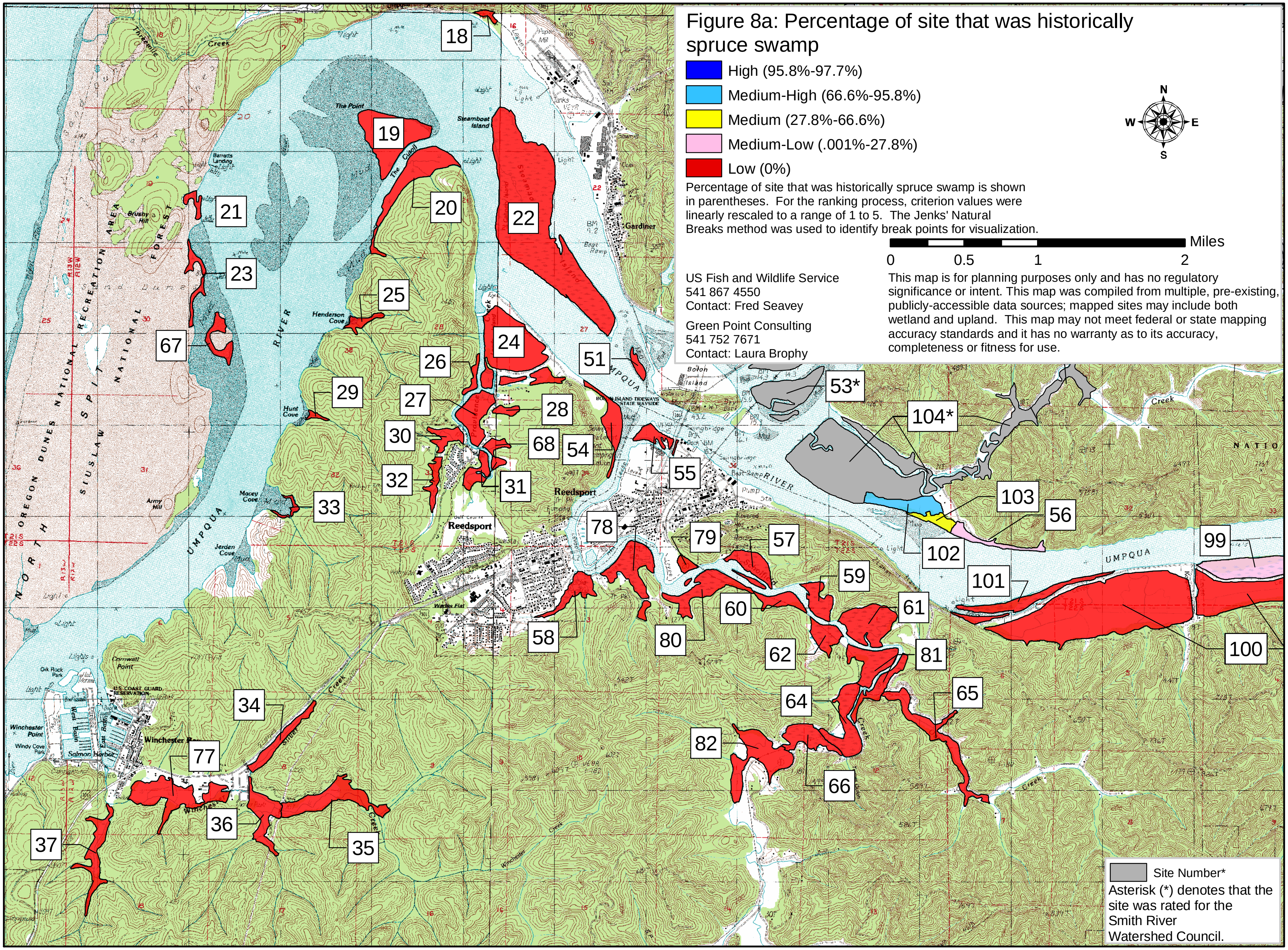
Figure 8a: Percentage of site that was historically spruce swamp
High (95.8%-97.7%)
Medium-High (66.6%-95.8%)
Medium (27.8%-66.6%)
Medium-Low (.001%-27.8%)
Low (0%)
Percentage of site that was historically spruce swamp is shown in parentheses. For the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.
Miles
0
0.5
1
2
N
S
E
W
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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Site Number*
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103
104*
Reedsport
UMPQUA
RIVER

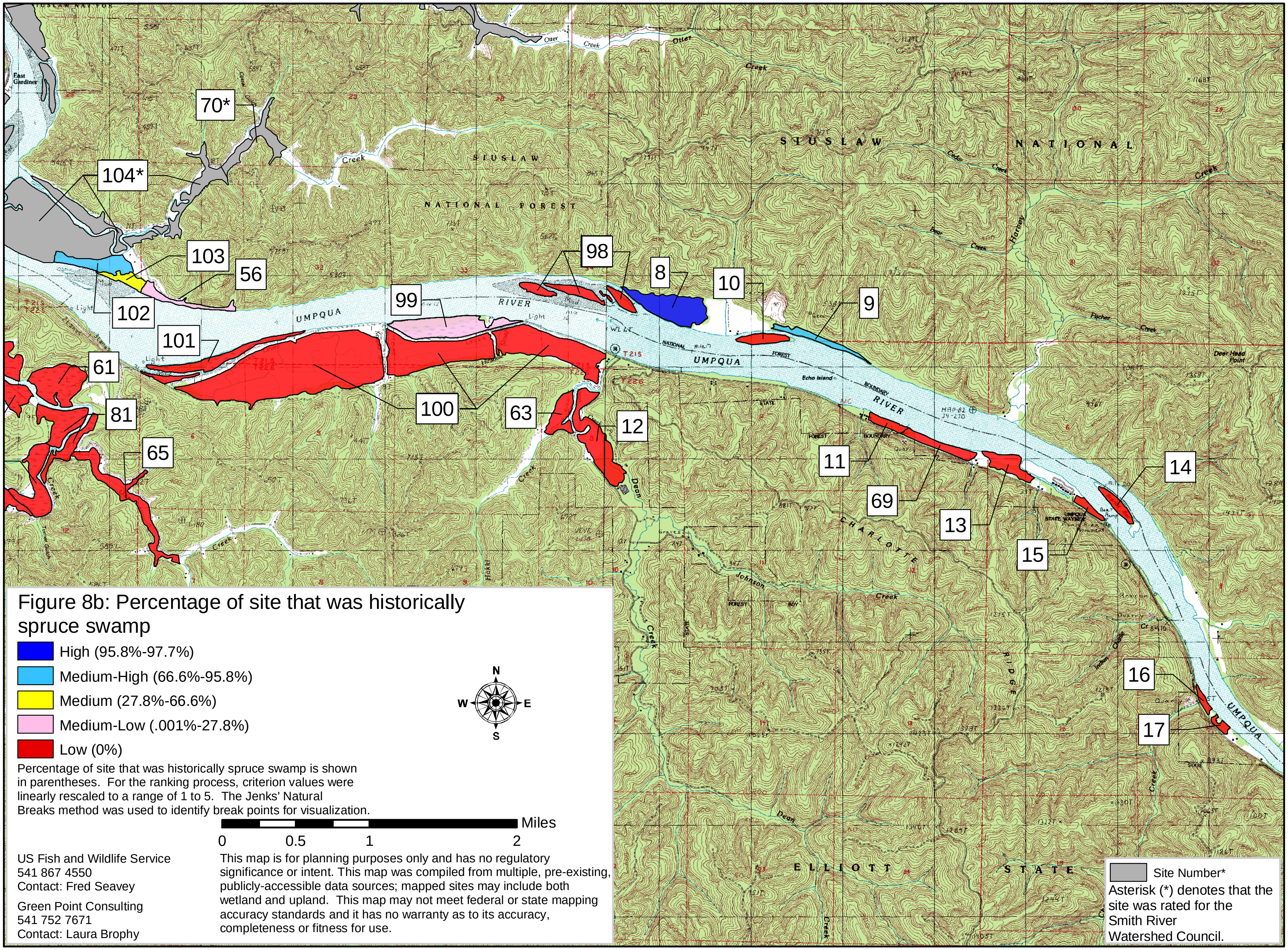

Figure 8b: Percentage of site that was historically spruce swamp

Percentage of site that was historically spruce swamp is shown in parentheses. For the ranking process, criterion values were linearly rescaled to a range of 1 to 5. The Jenks' Natural Breaks method was used to identify break points for visualization.

US Fish and Wildlife Service
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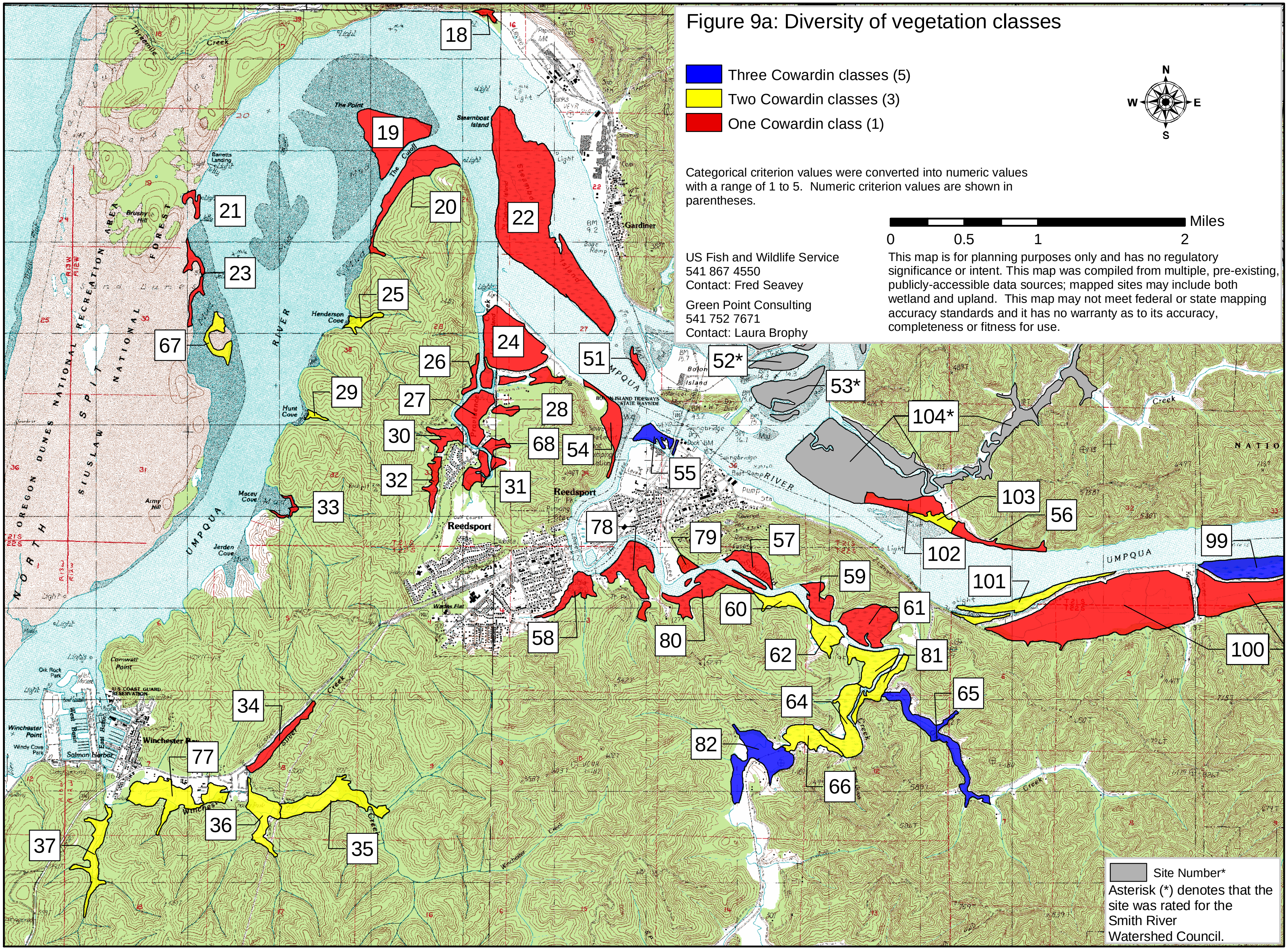
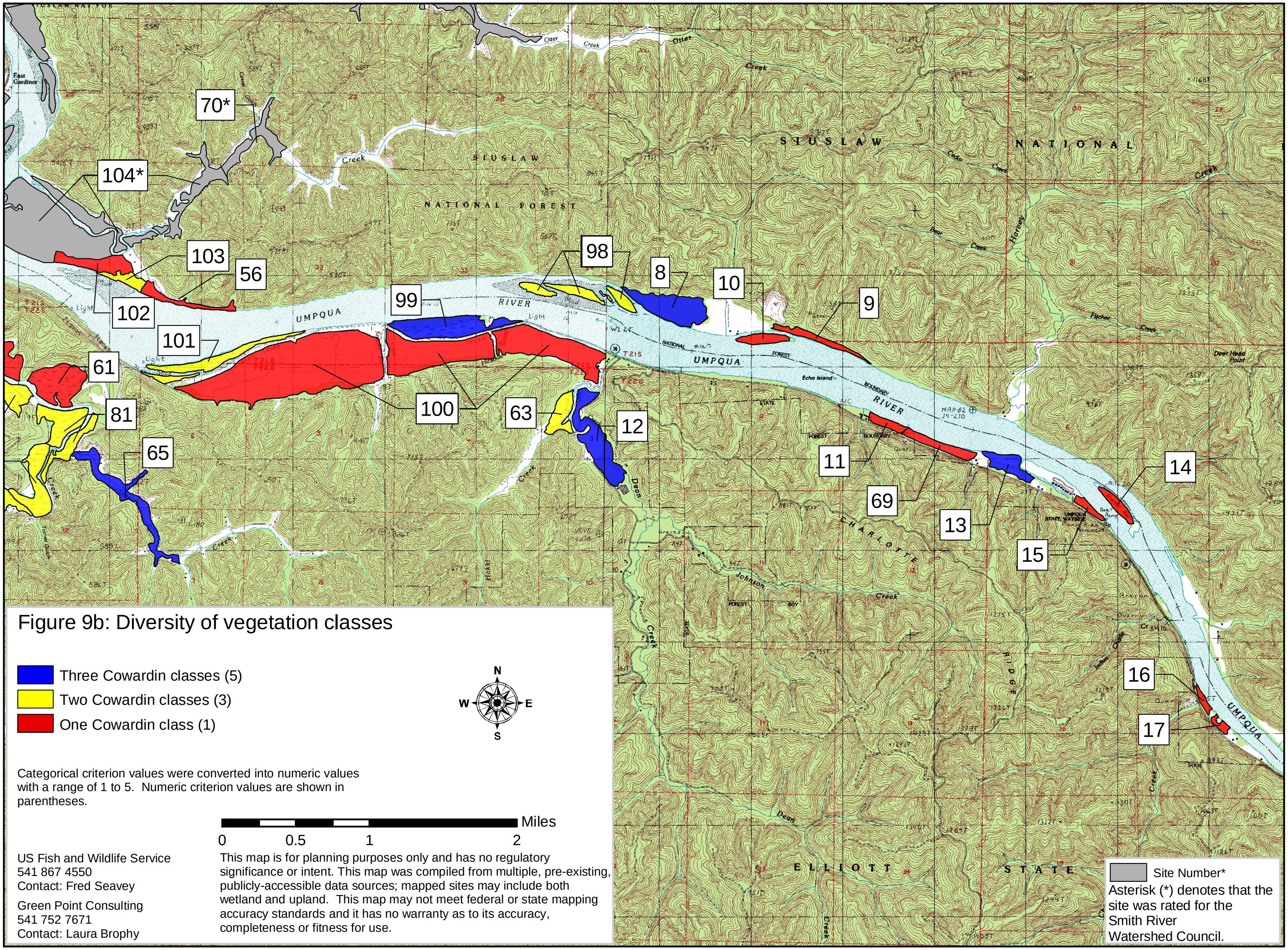


Figure 9a: Diversity of vegetation classes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69
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14
16
17
UMPQUA
RIVER
SIUSLAW
NATIONAL
FOREST
CHARLOTTE
ELLIOTT
STATE
Figure 9b: Diversity of vegetation classes
Three Cowardin classes (5)
Two Cowardin classes (3)
One Cowardin class (1)
N
W
E
S
Categorical criterion values were converted into numeric values with a range of 1 to 5. Numeric criterion values are shown in parentheses.
0
0.5
1
2
Miles
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
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Site Number*
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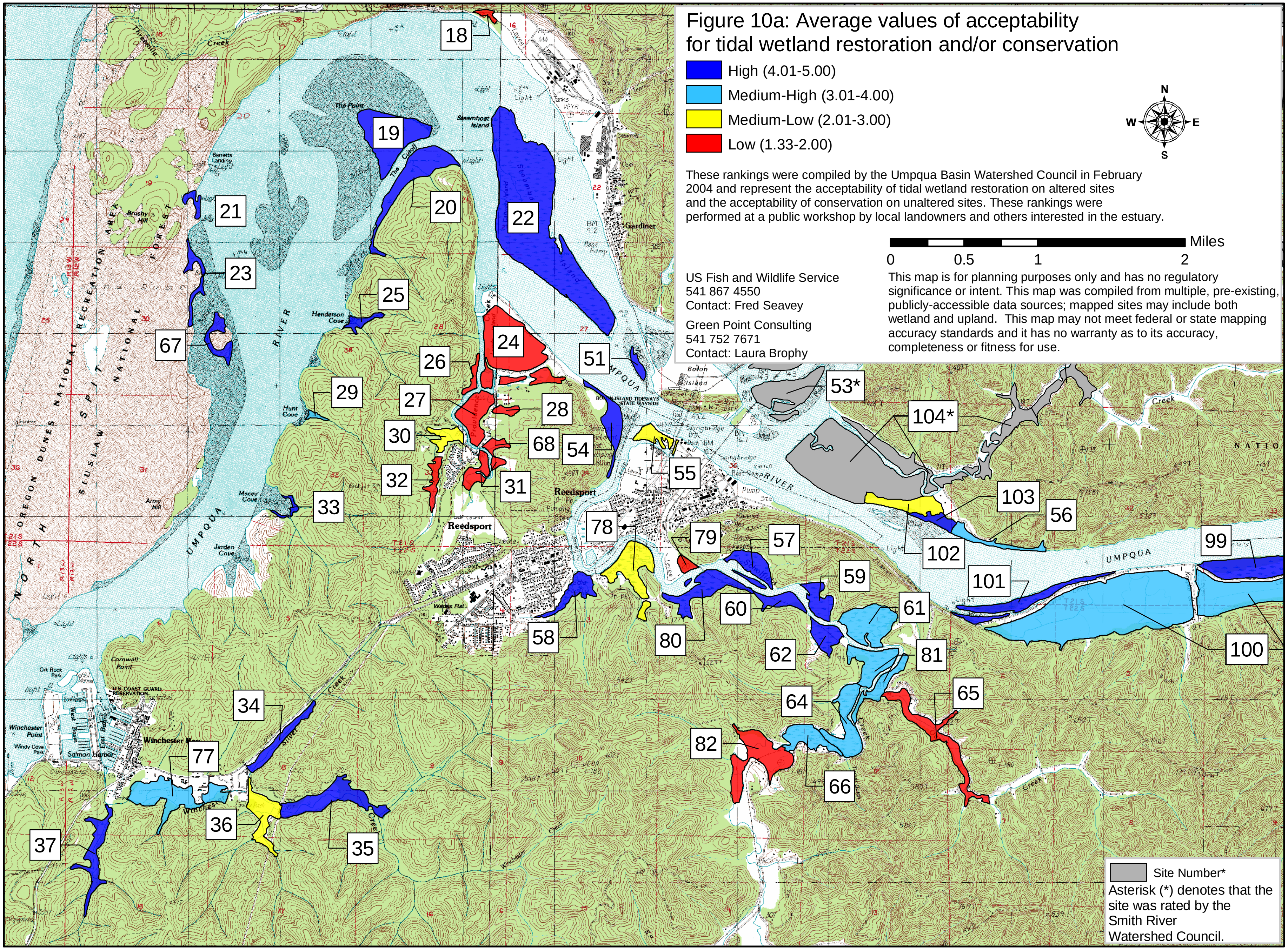
Figure 10a: Average values of acceptability
for tidal wetland restoration and/or conservation
High (4.01-5.00)
Medium-High (3.01-4.00)
Medium-Low (2.01-3.00)
Low (1.33-2.00)
N
S
E
W
These rankings were compiled by the Umpqua Basin Watershed Council in February 2004 and represent the acceptability of tidal wetland restoration on altered sites and the acceptability of conservation on unaltered sites. These rankings were performed at a public workshop by local landowners and others interested in the estuary.
Miles
0 0.5 1 2
US Fish and Wildlife Service
541 867 4550
Contact: Fred Seavey
Green Point Consulting
541 752 7671
Contact: Laura Brophy
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99
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104*
Reedsport
Gardiner
UMPQUA RIVER

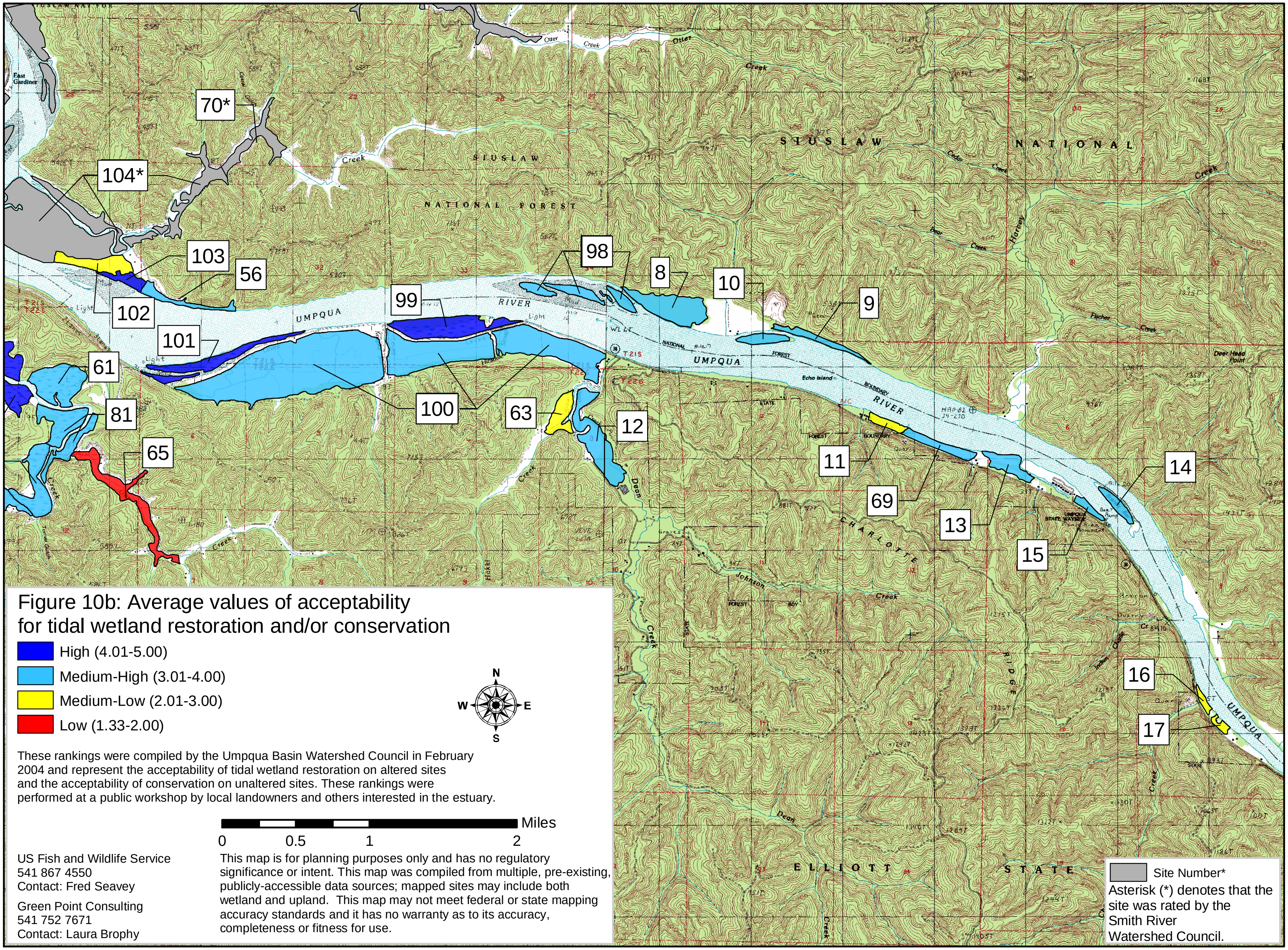

Figure 10b: Average values of acceptability for tidal wetland restoration and/or conservation