Tidal Wetland Prioritization for the Smith River Watershed, Umpqua River Estuary of Oregon

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1 author:

Laura S. Brophy
Oregon State University

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Otter Slough, Smith River Watershed, Umpqua River Estuary of Oregon
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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Prepared by:
Laura Brophy
Green Point Consulting
2625 NW Mulkey Ave.
Corvallis, OR 97330
www.GreenPointConsulting.com
(541) 752-7671

and

Khemarith So
U.S. Fish and Wildlife Service
2127 SE Marine Science Drive
Newport, OR 97365
(541) 867-4558

Prepared for:
U.S. Fish and Wildlife Service
Newport Field Office
2127 SE Marine Science Drive
Newport, OR 97365
541-867-4558

December 2005

Sponsored by:

USFWS Oregon Coastal Program
Newport Field Office
2127 SE OSU Drive
Newport, OR 97365
541-867-4558

Smith River Watershed Council
PO Box 114
Reedsport OR 97467-9733

Pacific Coast Joint Venture
1880 Willamette Falls Dr. Suite 200
West Linn OR 97068
503-697-3889

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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
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 Smith River Watershed (within 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 report is one of two reports produced from a study of the Umpqua River Estuary. The 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 40 sites that are located in the Smith River Watershed (Sites 6, 7, 38-50, 52, 53, 70-76, 83-97, 104, 105), but the discussion covers the entire Umpqua River estuary. The mainstem Umpqua sites (8-37, 51, 54-69, 77-82, and 98-103) are covered in a separate report presented to the Umpqua Basin 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 (Smith River watershed) was 650 ha; the remaining 887 ha were located along the mainstem Umpqua River. 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 (40 sites in the Smith River report area, 59 sites in the mainstem Umpqua 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. Two sites on the Smith River, totalling about 40 ha, have recently undergone deliberate restoration through dike breaching and/or dike removal.

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). Within the Smith River watershed, the largest groups in terms of area were the high and low priority groups (26% and 25% of the total area prioritized respectively; 170 ha and 162 ha). The medium-low priority group was the smallest (about 8% of the area prioritized, 51 ha). The remaining two priority groups (medium and medium-high) fell between 120 and 147 ha (about 19 to 23% of the area prioritized).

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 (covers sites in the entire Umpqua estuary).

3. GIS shapefile of study sites (ArcView shapefile: u_tidalw.shp). Metadata are provided with the shapefile. The shapefile includes sites in the entire Umpqua estuary.

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 and Smith River tidal wetlands

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 (including the estuarine portion of the Smith River watershed) are rich. The Umpqua and Smith are important producers of salmon and steelhead. The mainstem Umpqua supports spawning runs of coho, fall chinook, spring chinook, winter steelhead, and summer steelhead, and the Smith River has spawning runs of coho, fall chinook and winter 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 Umpqua River 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 Smith River portion of 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. On the mainstem, 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 along the mainstem include Bolon Island Industrial Park, the Gardiner Mill, and the city of Winchester Bay (Scranton 2004). By contrast, the Smith River watershed is primarily agricultural and contains few filled areas. Some fills are located in along the Smith River Road near the mouth of Frantz Creek, but the majority of historic tidal wetlands in the Smith River are now diked pastures. In recent years, some of the diked lands have been restored through deliberate breaching or removal of dikes, and others are reverting to tidal influence through natural breakdown of dikes. However, most of the diked lands remain closed to tidal influence.

Dredging is periodically conducted in coastal rivers to deepen the navigational channel. In the past, some of the dredged material has been placed on current or former tidal wetlands. Some examples on the mainstem 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. The sites identified in this study may contain both wetlands and uplands, because our base map (from which we derived the site boundaries) was the National Wetland Inventory mapping, which is based primarily on aerial photograph interpretation. Therefore, onsite determination of wetland boundaries is recommended before making decisions about site uses.

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 Smith River Watershed Council also provided input into the process during meetings with our team, and through interviews with landowners. 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 Smith River portion of the Umpqua River estuary included dikes, ditches, culverts, tidegates, grazing, and partial fill. Logging and driftwood removal have also affected many tidal sites in the estuary. We did not specifically evaluate logging/wood removal at study sites, because most tidal forests were logged in early settlement times, so 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 40 sites that are located in the Smith River watershed (Sites 6, 7, 38-50, 52, 53, 70-76, 83-97, 104, 105). The 59 sites that are located along the mainstem Umpqua River (sites 8-37, 51, 54-69, 77-82, and 98-103) are covered in a separate report presented to the Umpqua Basin 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). 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 (Figure 1). 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.

Figure 1 shows 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). Figure 4 shows the results of the site size scoring.

Tidal channel condition

Channel morphology and tidal connectivity are important indicators of tidal wetland function and overall hydrologic condition. Site alterations such as ditching, diking, tidegates, restrictive culverts, and roads impede or prevent tidal flow and alter tidal channel structure, 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

Figure 5 shows the results of the classification of tidal channel condition.

Wetland connectivity

In landscape ecology terms, connectivity (spatial connection of habitats to one another) is the opposite of fragmentation (isolation of habitats). 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 1988). To determine connectivity, the total area of EPB- and NWI-mapped wetlands within a one-mile buffer around each site was calculated.

Figure 6 shows the results of the wetland connectivity analysis.

Salmonid habitat connectivity

The Smith River supports spawning populations of coho, winter steelhead, and fall 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 Figure 7.

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 Figure 8.

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).

Figure 9 shows 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 Figure 1. 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 on the Oregon coast, 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 and Smith River Watershed Councils, 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 Figure 2. Land ownership types (based on landowner name) are listed in Table 3 below and mapped in Figure 3.

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 Inside UGB	Entire site is outside Urban Growth Boundaries Part of all of the site is inside an Urban Growth Boundary

We recorded the results of this analysis in the site information table (Appendix E) in the field "In/On UGB?" No sites in the Smith River watershed were located on or near a UGB, so the entries in this field are "N" for all the Smith River sites.

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. However, we did ask the Smith River Watershed Council to gather input from local residents on the acceptability of restoring and conserving wetlands on each site. In response, the Council coordinator contacted landowners for a number of sites and questioned them directly about the acceptability of restoration or conservation on their site. The landowner's views were expressed on a scale of 1 to 5, where 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 scores are shown in Figure 10.

Not all sites were scored, and not all landowners were interviewed. This was not a problem, as landowner contact was not actually expected during this project. Landowner contacts are generally the first step in the next stage of action planning (site selection and preliminary site-specific design). To follow up on this prioritization, we recommend contacting landowners who have expressed interest, as well as other landowners for high priority sites who have not yet been interviewed. As described above, this prioritization is designed to provide strategic focus for tidal wetland conservation and restoration actions undertaken in partnership with willing landowners.

Results and discussion

The final site prioritization is shown in Figure 1. 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 and Smith River 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. Most of these are located along the mainstem Umpqua River (Winchester Bay marina, the northern part of the city of Reedsport, the Gardiner Mill, and the west portion of Bolon Island) but a few are along the Smith River (fills along the highway and railroad at East Gardiner, and near the mouth of 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 1156 ha, 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 Smith River watershed has a considerably larger area of diked wetlands, with 18 separate sites diked for use as pasture. (Not all of these are currently being actively grazed.) The mainstem Umpqua has most of the "completely filled" tidal wetlands, and also has more areas affected by partial fill. The largest partially filled site 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).

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 2% of the total historic tidal wetland area, 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 to keep the information current.

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/removal (sites 47 and 71).*

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

		Smith River			Umpqua mainstem		
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	23.2	3.4	n/a	295.5	25.0
	Y (diked)**	18.0	380.9	56.6	7.0	255.0	21.6
	D (intensively ditched)	7.0	61.4	9.1	14.0	140.6	11.9
Total major alterations			***465.5***	***69.1***		***691.1***	***58.5***
Minor	C (culvert/tidegate)	1.0	5.5	0.8	3.0	10.4	0.9
	F (minor/partial fill)	1.0	1.9	0.3	2.0	136.5	11.6
	G (grazing)	1.0	101.3	15.0		0.0	0.0
	R (road/RR crossing)	4.0	39.1	5.8	5.0	56.1	4.7
Total minor alterations		***7.0***	***147.9***	***22.0***	***10.0***	***203.1***	***17.2***
Unaltered	N (none)	8.0	60.1	8.9	28.0	287.9	24.4
Grand Total		***40.0***	***673.5***	***100.0***	***59.0***	***1182.0***	***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/removal (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

Figure 1 shows 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)

	Smith River			Umpqua mainstem			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	8	170.5	26.2	11	139.8	15.8	19	310.3	20.2
Medium-High	8	120.3	18.5	12	242.0	27.3	20	362.3	23.6
Medium	8	146.6	22.5	12	148.9	16.8	20	295.5	19.2
Medium-Low	8	51.4	7.9	12	279.0	31.5	20	330.4	21.5
Low	8	161.5	24.8	12	76.8	8.7	20	238.3	15.5
Grand Total	40	650.3	100.0	59	886.5	100.0	99	1536.8	100.0

In the Smith River report area, the highest-priority sites are located at Butler Creek, Frantz Creek, Stowe Marsh, and Otter Slough. Medium-high priority sites are scattered throughout the lower reaches of the river. The pastures located above Otter Slough fall into the medium to low priority groups. However, restoration of any former tidal wetland site will add considerably to the ecological functions of the estuary, so this prioritization should not be used to eliminate any site from consideration.

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. The Smith River Watershed Council's input (Figure 10) has already "jump-started" this process by interviewing landowners for 13 sites. A good place to start for site-specific planning would be high or medium priority sites (Figure 1) where landowners have expressed a high or medium level of interest (Figure 10). Another logical next step would be to contact those landowners for of high- and medium-priority sites who have not yet been interviewed. 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 some of the highest-ranked sites in the study area. This information may be important for decision-making, and should be reviewed before contacting landowners or taking other actions in the estuary. **For all of these sites, the highest priority action is conservation of the existing wetlands.** Other potential actions are described below and in **Restoration recommendations** above.

Site 46: Located at the mouth of Frantz Creek, this site is undiked and unditched, and supports a range of native tidal wetland plant communities. Its tidal circulation is somewhat affected by the presence of the Smith River Road along its north edge. The road embankment was built directly across former wetland, so of course the wetland that was formerly present under the road was lost during construction. Road effects on the remaining wetland include blockage of diffuse flow from the formerly connected wetland to the north, and changes to tidal channels. However, tidal exchange with the adjacent river is still intact. The site's tidal wetland habitat types range from softstem bulrush on the lowest areas, tufted hairgrass marsh on slightly higher ground, and tidal swamp on the highest areas with woody cover of Sitka spruce, black twinberry, and other shrubs. The gradient of habitat types makes this a valuable site, even though its size is small.

Site 47 (Stowe Marsh): This site was originally diked, but the dike had breached during high water events. In 2000, in conjunction with restoration at Site 71, two sections of the dike were removed to enhance floodplain function (http://www.epa.gov/nps/Section319III/OR.htm). The wetland now shows diverse native vegetation, including softstem bulrush marsh in low areas, tufted hairgrass on higher marsh, and tidal spruce swamp on the far west end of the site. Despite the diking, channels on the site are not heavily ditched and show moderately sinuous, meandering morphology.

Some of the dike remains. Removal of remaining dike offers some potential for additional future restoration work, though the benefits of such work should be weighed against the high costs of dike removal. If all of the site's tidal channels are now fully reconnected, the remaining dike section probably has little effect on site functions.

Site 86: This small site consists of undisturbed wetlands along Hudson Slough. The site's good connectivity to the surrounding wetlands, intact tidal channels (undiked, unditched), and historic vegetation type (spruce swamp) lead to its prioritization over nearby sites. A successful conservation/restoration strategy for Hudson Slough would ideally include as many of the sites clustered along its tidal section as possible (see Appendix B, **Restoration Principles**, and Appendix C, **Restoration Approaches**). The undiked tidal wetlands in Hudson Slough are identified as Significant Habitats in the Oregon Estuary Plan Book (Cortright et al 1987).

Site 91: This wetland is located along the lower 1.2 km of Frantz Creek. The wetland area once included the log storage area on lower Frantz Creek as well, but that portion of the former wetland is not included in this study (our study excluded areas that are completely filled and converted to developed uses). The remaining wetland is relatively undisturbed (undiked and unditched). The wetland may be affected by restriction of tidal flows; possible restrictions include the narrowing and rerouting of the tidal channel at the log facility, and the two road crossings at the site's lower end. In addition, runoff or other side effects of the current industrial operation may affect the wetland.

This site spans the transition zone from tidal to nontidal wetlands, and is well-connected to additional nontidal wetlands upstream. If possible, conservation actions here should include both the tidal and nontidal wetlands. Protection of this gradient helps retain important linkages between habitat zones. This connectivity of habitats is vital to full wetland function (Simenstad and Bottom, undated).

Site 95: This site is located along Otter Slough. It is undiked and supports diverse native vegetation ranging from typical brackish tidal marsh including Lyngbye's sedge and tufted hairgrass, to freshwater tidal marsh (softstem bulrush, cattail), and some tidal shrub swamp (willows). Some alterations are present on the site, but do not appear to have greatly affected its characteristics. For example, some excavation of channels may have occurred, but tidal flow is still unrestricted and largely follows typical meandering channels.

Conservation of the existing wetlands is the primary action needed for this site. The site is mapped as having historically been spruce swamp, so plantings of Sitka spruce along natural levees and on higher ground might help recreate the historic conditions. The reasons for the change in habitat type from spruce swamp to emergent marsh are unknown and may relate to general watershed characteristics, site manipulation that is not currently obvious, or changes to other nearby sites.

As for all sites, we recommend considering conservation actions that include adjacent sites to rebuild the habitat linkages that characterized the original landscape. For example, restoring tidal flow to Site 94, immediately adjacent to Site 95, would build on any conservation actions taken at Site 95, enhancing functions of both sites.

Site 104 (Butler Creek): At 101 ha (250 A), this site is the largest remaining undiked and unfilled tidal wetland in the Umpqua estuary. The only major human disturbance to the site has been livestock grazing. The site is undiked, has not been ditched or filled, and has no road or railroad crossings. According to the land manager, the site has been grazed since 1881, with the heaviest grazing during the 1960's to 1980's. The lower portion of the site is grazed only during the summer. Some small areas (under 5 ha) on the far west end of the site appear to have possibly received dredged material disposal, but the remainder of the site appears unaffected.

Airphoto interpretation indicates that grazing has caused some changes to channel morphology and plant communities. However, the site has intact meandering tidal channels, and shows the natural gradient of plant communities from low tidal marsh up into tidal spruce swamp on the east end of the site. The tidal wetland habitats on this site appear to be intact and very high-functioning. The landowners have been active with the Umpqua Soil and Water Conservation District, and have placed some large woody debris in streams on their land. This site offers outstanding conservation and restoration opportunities. Strategic grazing setasides could be used to improve habitat functions in specific areas on the site. According to the land manager, reed canarygrass is dominant in some parts of the site (for example, up Butler Creek valley), and grazing is currently suppressing the reed canarygrass. Plans for grazing setasides on the site should first determine whether reed canarygrass is a potential problem, and if so, the plans should include a reed canarygrass control program.

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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 livestock production contributes to the local economy, history and culture. 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 can reduce wetland functions, 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. Fencing of cattle away from streams and tidal creeks can improve wetland functions. 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 connectivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioritization score	Ranking group
GPC_ ID	SIZE_ SCOR	CONS_ SCOR	CONW1M _SCO	HVT_ SCOR	DIVR_ SCOR	CHAN_ SCOR	ALTTYPE	WC_ INPUT	ECOL_SUM	Rank_Grp
47	1.5	3.5	4.2	5.0	3	5	Y	5.0	22.2	High
46	1.1	3.6	3.4	4.0	3	5	None	0.0	20.1	High
104	3.3	4.4	2.4	1.5	3	5	G	4.0	19.6	High
86	1.0	3.1	4.6	4.8	1	5	None	0.0	19.4	High
93	1.1	3.0	4.2	4.4	1	5	None	1.0	18.7	High
88	1.0	3.1	3.5	5.0	3	3	F	0.0	18.6	High
91	1.2	3.1	2.6	3.1	3	5	R	0.0	17.9	High
95	1.5	3.0	2.6	4.5	1	5	None	0.0	17.5	High
53	1.4	4.5	3.9	1.0	1	5	R	0.0	16.8	Med-high
89	1.1	3.6	4.4	1.7	1	5	None	0.0	16.7	Med-high
50	1.0	4.4	4.2	1.0	1	5	None	0.0	16.6	Med-high
52	1.2	4.5	4.0	1.0	1	5	R	0.0	16.6	Med-high
71	1.4	3.4	2.8	1.0	3	5	Y, D	5.0	16.6	Med-high
94	1.1	3.0	3.3	5.0	3	1	Y, D, C, R	0.0	16.4	Med-high
40	1.1	2.0	4.2	1.0	3	5	C	0.0	16.3	Med-high
72	2.2	3.4	3.6	4.8	1	1	Y, D, C	1.0	16.0	Med-high
90	1.6	3.5	3.9	5.0	1	1	Y, D, C	0.0	16.0	Medium
41	1.0	3.5	4.3	1.0	1	5	None	0.0	15.8	Medium
85	1.0	3.1	4.7	1.0	1	5	R	0.0	15.7	Medium
45	1.1	3.6	4.1	4.8	1	1	Y, D, C	0.0	15.7	Medium
38	1.2	3.5	3.8	1.0	3	3	D, C [Y?]	0.0	15.5	Medium
75	2.4	3.6	2.2	1.0	5	1	Y, D, C	3.0	15.2	Medium
44	1.7	3.3	3.8	4.2	1	1	Y, D, C	0.0	15.0	Medium
105	1.2	3.0	2.0	4.7	1	3	D	0.0	14.9	Medium
92	1.2	3.0	3.7	4.5	1	1	Y, D, C	0.0	14.4	Med-low
87	1.3	3.0	3.1	1.0	1	5	None	0.0	14.4	Med-low
49	1.1	4.4	3.4	1.0	3	1	Y, D, C, R	0.0	14.0	Med-low
83	1.1	3.1	4.7	1.0	1	3	Y	0.0	13.8	Med-low
7	1.2	3.6	3.9	1.0	3	1	Y, D	1.0	13.6	Med-low
84	1.0	3.1	4.5	1.0	1	3	Y, D	0.0	13.5	Med-low
48	1.0	2.0	3.8	4.0	1	1	D, C	0.0	12.8	Med-low
43	1.1	3.5	4.4	1.0	1	1	Y, D, C	0.0	12.0	Med-low
96	2.1	3.5	3.2	1.0	1	1	Y, D, C	3.0	11.8	Low
6	1.1	3.4	3.8	1.0	1	1	D, C	0.0	11.3	Low
74	1.2	3.5	3.4	1.0	1	1	Y, D, C	1.0	11.1	Low
97	1.9	3.5	2.3	1.0	1	1	Y, D, C	1.0	10.7	Low
76	1.4	3.4	2.6	1.0	1	1	Y, D, C	1.0	10.4	Low
42	1.5	2.3	3.2	1.0	1	1	D, C	3.0	10.1	Low
39	1.0	1.9	4.0	1.0	1	1	D, C	1.0	10.0	Low
70	1.2	3.0	1.7	1.0	1	1	D	0.0	8.9	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 connectivity score	Wetland connec-tivity score	Historic vegeta-tion score	Vegeta-tion diversity score	Channel condition score	Alteration types	Water-shed council input	Final ecological prioritization score	Ranking group
GPC_ID	SIZE_SCOR	CONS_SCOR	CONW1M_SCO	HVT_SCOR	DIVR_SCOR	CHAN_SCOR	ALTTYPE	WC_INPUT	ECOL_SUM	Rank_Grp
6	1.1	3.4	3.8	1.0	1	1	D, C	0.0	11.3	Low
7	1.2	3.6	3.9	1.0	3	1	Y, D	1.0	13.6	Med-low
38	1.2	3.5	3.8	1.0	3	3	D, C [Y?]	0.0	15.5	Medium
39	1.0	1.9	4.0	1.0	1	1	D, C	1.0	10.0	Low
40	1.1	2.0	4.2	1.0	3	5	C	0.0	16.3	Med-high
41	1.0	3.5	4.3	1.0	1	5	None	0.0	15.8	Medium
42	1.5	2.3	3.2	1.0	1	1	D, C	3.0	10.1	Low
43	1.1	3.5	4.4	1.0	1	1	Y, D, C	0.0	12.0	Med-low
44	1.7	3.3	3.8	4.2	1	1	Y, D, C	0.0	15.0	Medium
45	1.1	3.6	4.1	4.8	1	1	Y, D, C	0.0	15.7	Medium
46	1.1	3.6	3.4	4.0	3	5	None	0.0	20.1	High
47	1.5	3.5	4.2	5.0	3	5	Y	5.0	22.2	High
48	1.0	2.0	3.8	4.0	1	1	D, C	0.0	12.8	Med-low
49	1.1	4.4	3.4	1.0	3	1	Y, D, C, R	0.0	14.0	Med-low
50	1.0	4.4	4.2	1.0	1	5	None	0.0	16.6	Med-high
52	1.2	4.5	4.0	1.0	1	5	R	0.0	16.6	Med-high
53	1.4	4.5	3.9	1.0	1	5	R	0.0	16.8	Med-high
70	1.2	3.0	1.7	1.0	1	1	D	0.0	8.9	Low
71	1.4	3.4	2.8	1.0	3	5	Y, D	5.0	16.6	Med-high
72	2.2	3.4	3.6	4.8	1	1	Y, D, C	1.0	16.0	Med-high
74	1.2	3.5	3.4	1.0	1	1	Y, D, C	1.0	11.1	Low
75	2.4	3.6	2.2	1.0	5	1	Y, D, C	3.0	15.2	Medium
76	1.4	3.4	2.6	1.0	1	1	Y, D, C	1.0	10.4	Low
83	1.1	3.1	4.7	1.0	1	3	Y	0.0	13.8	Med-low
84	1.0	3.1	4.5	1.0	1	3	Y, D	0.0	13.5	Med-low
85	1.0	3.1	4.7	1.0	1	5	R	0.0	15.7	Medium
86	1.0	3.1	4.6	4.8	1	5	None	0.0	19.4	High
87	1.3	3.0	3.1	1.0	1	5	None	0.0	14.4	Med-low
88	1.0	3.1	3.5	5.0	3	3	F	0.0	18.6	High
89	1.1	3.6	4.4	1.7	1	5	None	0.0	16.7	Med-high
90	1.6	3.5	3.9	5.0	1	1	Y, D, C	0.0	16.0	Medium
91	1.2	3.1	2.6	3.1	3	5	R	0.0	17.9	High
92	1.2	3.0	3.7	4.5	1	1	Y, D, C	0.0	14.4	Med-low
93	1.1	3.0	4.2	4.4	1	5	None	1.0	18.7	High
94	1.1	3.0	3.3	5.0	3	1	Y, D, C, R	0.0	16.4	Med-high
95	1.5	3.0	2.6	4.5	1	5	None	0.0	17.5	High
96	2.1	3.5	3.2	1.0	1	1	Y, D, C	3.0	11.8	Low
97	1.9	3.5	2.3	1.0	1	1	Y, D, C	1.0	10.7	Low
104	3.3	4.4	2.4	1.5	3	5	G	4.0	19.6	High
105	1.2	3.0	2.0	4.7	1	3	D	0.0	14.9	Medium

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 Smith River Watershed, 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 column descriptions; see full report for details

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
6	Smith	Smith R. mile 9	15.80	6.39	1.12	1	Private	n	3	3.79	3.37	1186618	293.21	3.76	0.00	1.00	1.0000 PEMC	1
7	Smith	Cassidy Cr.	20.31	8.22	1.16	1	Private	n	3	4.20	3.58	1228009	303.44	3.86	0.00	1.00	0.65001 PEMA, 0.21257 PEMC, 0.13718 PSSA	2
38	Smith	Smith R. mile 6	22.19	8.98	1.18	1	Private	n	3	4.05	3.50	1197850	295.99	3.79	0.00	1.00	0.26054 PEMR, 0.65287 PSSR, 0.08659 PFOR	2
39	Smith	Smith R. mile 6	2.82	1.14	1.00	2	Private	n	0	3.97	1.93	1300723	321.41	4.04	0.00	1.00	1.0000 PEMC	1
40	Smith	Camp Seven Gulch	13.66	5.53	1.10	1	Private	n	0	4.06	1.98	1366710	337.71	4.20	0.00	1.00	0.85670 PFOC, 0.14331 PEMC	2
41	Smith	Smith R. mile 6	4.56	1.85	1.02	2	Private	n	3	3.98	3.46	1403558	346.82	4.29	0.00	1.00	1.0000 PFOR	1
42	Smith	Brainard Cr.	57.53	23.28	1.51	5	Private	n	1	3.77	2.34	963135	237.99	3.23	0.00	1.00	0.96696 PEMC, 0.03304 PSSC	1
43	Smith	Brainard Cr.	14.88	6.02	1.11	1	Private	n	3	3.97	3.46	1470192	363.28	4.45	0.00	1.00	1.0000 PEMC	1
44	Smith	Otter Sl.	79.27	32.08	1.72	2	Private	n	3	3.73	3.34	1197739	295.96	3.79	79.64	4.19	1.0000 PEMCH	1
45	Smith	Franz Cr.	17.58	7.11	1.14	4	Private	n	3	4.26	3.60	1321518	326.55	4.09	96.07	4.84	1.0000 PEMCH	1
46	Smith	Franz Cr.	13.21	5.35	1.10	3	Private	n	3	4.25	3.60	1053322	260.28	3.44	74.16	3.97	0.59037 E2EMN, 0.40963 PFOR	2
47	Smith	Smith R. mile 3	53.28	21.56	1.47	3	State/ Private	n	3	4.08	3.52	1381661	341.41	4.23	99.47	4.98	0.83932 E2EMN, 0.16068 PFOR	2
48	Smith	Smith R. mile 3	5.37	2.17	1.02	2	Private	n	0	4.04	1.96	1215766	300.42	3.83	75.35	4.01	1.0000 PEMC	1
49	Smith	E. Gardiner	15.79	6.39	1.12	1	Private	n	5	3.88	4.43	1043911	257.95	3.42	0.00	1.00	0.17214 PEMC, 0.68200 PEMCH, 0.14586 PSSAH	2
50	Smith	E. Gardiner	4.91	1.99	1.02	2	Private	n	5	3.90	4.44	1352031	334.09	4.16	0.00	1.00	1.0000 E2EMN	1
52	Smith	Blacks Is.	19.76	8.00	1.16	1	County	n	5	3.96	4.47	1268503	313.45	3.96	0.00	1.00	1.0000 E2EMN	1
53	Smith	Blacks Is.	50.36	20.38	1.45	1	County	n	5	3.96	4.47	1231762	304.37	3.87	0.00	1.00	0.57059 E2EMN, 0.41581 E2EMP, .01359 other	1
70	Smith	Butler Cr.	27.79	11.25	1.23	2	Private	n	2	4.00	2.97	310692	76.77	1.65	0.00	1.00	1.0000 PEMC	1
71	Smith	Smith R. mile 2	46.85	18.96	1.41	2	State/ Private	n	3	3.82	3.38	780257	192.80	2.78	0.00	1.00	0.27630 E2EMN, 0.03612 E2EMP, 0.42275 PEMCH, 0.07439 PEMR, 0.14554 PFOR, 0.04491 PSSR	2
72	Smith	Smith R. mile 4	135.58	54.87	2.25	1	Private	n	3	3.84	3.39	1108657	273.95	3.58	94.63	4.79	0.72945 PEMCH, 0.27055 PEMAH	1
74	Smith	Joyce Cr.	24.20	9.79	1.20	1	Private	n	3	4.11	3.53	1026399	253.62	3.38	0.00	1.00	1.0000 PEMC	1
75	Smith	Noel Cr.	151.32	61.24	2.40	8	Private	n	3	4.21	3.58	547408	135.26	2.22	0.00	1.00	0.19974 PEMA, 0.03131 PEMC, 0.42426 PEMCH, 0.00128 PEMR, 0.06362 PFOA, 0.13324 PFOC, 0.14653 PSSC	3
76	Smith	Smith R. mile 2	48.42	19.59	1.43	4	Federal/ Private	n	3	3.89	3.42	704237	174.02	2.60	0.00	1.00	0.87605 PEMCH, 0.08470 PFOC, 0.03925 PSSR	1
83	Smith	Hudson Sl.	9.40	3.80	1.06	5	Private	n	2	4.19	3.06	1562618	386.12	4.67	0.00	1.00	0.91525 PEMCH, 0.08475 PSSCH	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
6	Smith	1	1	1	D, C	D	Major	N	Grazed in part	Wettest near rd (PHAARU-LYSAME); drier to N & nr river	0	11.25	Low
7	Smith	3	1	1	Y, D	Y	Major	N	Cassidy Creek	Field check needed	1	13.61	Medium-Low
38	Smith	3	2	3	D, C [Y?]	D	Major	N	Road along river is elevated; natural levee/dike (check)	PICSIT-ALNRUB/Salix-LONINV/PHAARU-VICGIG	0	15.47	Medium
39	Smith	1	1	1	D, C	D	Major	N	Lower portion of site appears wetter, not currently grazed	Field check needed	1	9.97	Low
40	Smith	3	3	5	C	C	Minor	N	Tidegate is offsite (site 72). Culvert under Smith River Rd.	Field check needed	0	16.28	Medium-High
41	Smith	1	3	5	None	None	None	N	Minor ditching at W end doesn't strongly affect hydrology	PICSIT/Salix-LONINV-MALFUS/PHAARU-TYPLAT	0	15.77	Medium
42	Smith	1	1	1	D, C	D	Major	N	Ditched pasture, culvert/tidegate below on Site 43	Field ck needed. Middle finger of site: CAROBN-PHAARU	3	10.08	Low
43	Smith	1	1	1	Y, D, C	Y	Major	N	Ditched pasture w/culvert/tidegate.	Field check needed	0	12.02	Medium-Low
44	Smith	1	1	1	Y, D, C	Y	Major	N	N end has dredged material disposal?	Pasture grasses + wetland species; field check needed	0	15.03	Medium
45	Smith	1	1	1	Y, D, C	Y	Major	N	W side filled. Rest diked. Communications tower.	JUNEFF-LOTCOR-MENPUL. Pasture grasses @Eend	0	15.68	Medium
46	Smith	3	3	5	None	None	None	N	Road fill @N edge has altered flow, but good cond.	SCHTAB-AGRSTO-DESCES; PICSIT/LONINV on higher ground	0	20.11	High
47	Smith	3	3	5	Y	Y	Major	Y	Dike partly removed (restoration project)	Mostly SCHTAB, some PHAARU. PICSIT swamp @W end	5	22.20	High
48	Smith	1	1	1	D, C	D	Major	N	Separated fr/pasture to N by road & culvert	PHAARU; RUBDIS on higher ground	0	12.84	Medium-Low
49	Smith	3	1	1	Y, D, C, R	Y	Major	N	Restrictive culvert, deep roadside ditch	CARLYN-TYPLAT-CAROBN, patches of Salix, LONINV	0	13.97	Medium-Low
50	Smith	1	3	5	None	None	None	N	Berm at N edge of site, otherwisegood cond.	CARLYN-SCHTAB-DESCES	0	16.62	Medium-High
52	Smith	1	3	5	R	R	Minor	N	RR crosses site, but otherwise unaltered & good cond.	CARLYN-SCIMAR-SCHTAB-DESCES	0	16.59	Medium-High
53	Smith	1	3	5	R	R	Minor	N	Possible channel diversion for RR xing, but good cond.	CARLYN-SCIMAR-SCHTAB-DESCES	0	16.79	Medium-High
70	Smith	1	1	1	D	D	Major	N	Ditched pasture along middle Butler Creek	Field check needed	0	8.85	Low
71	Smith	3	3	5	Y, D	Y	Major	Y	Dike breached recently (restoration project)	CARLYN-SCIMAR-SCHTAB; CAROBN farther from river	5	16.58	Medium-High
72	Smith	1	1	1	Y, D, C	Y	Major	N	Extensively ditched & diked. Heavily grazed.	Low spots: JUNEFF, MENPIP. RUBDIS on ditchbanks.	1	16.00	Medium-High
74	Smith	1	1	1	Y, D, C	Y	Major	N	Berm along ditched stream reduces tidal influence	lower: CAROBN-JUNEFF; slightly higher: JUNEFF-PHAARU	1	11.11	Low
75	Smith	5	1	1	Y, D, C	Y	Major	N	Diverse veg. Possible DMD? Hummocky ground.	JUNEFF-CAROBN-PHAARU-TYPLAT-LYSAME; Salix	3	15.20	Medium
76	Smith	1	1	1	Y, D, C	Y	Major	N	NE arm of site is non-ag, flow controlled by tidegate below	pasture grasses; NE arm has Salix, PICSIT, ALNRUB	1	10.45	Low
83	Smith	1	2	3	Y	Y	Major	N	Dike has naturally breached.	SCHTAB dominant	0	13.79	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
84	Smith	Hudson Sl.	5.95	2.41	1.03	2	Private	n	2	4.17	3.05	1474469	364.34	4.46	0.00	1.00	1.0000 PEMR	1
85	Smith	Hudson Sl.	3.27	1.32	1.00	2	Private	n	2	4.19	3.06	1565410	386.81	4.68	0.00	1.00	1.0000 PEMR	1
86	Smith	Hudson Sl.	4.08	1.65	1.01	1	Private	n	2	4.17	3.05	1533410	378.91	4.60	94.17	4.77	1.0000 PEMR	1
87	Smith	Hudson Sl.	35.04	14.18	1.30	4	Private	n	2	4.13	3.03	891826	220.37	3.05	0.00	1.00	0.68911 PEMC, 0.31089 PEMR	1
88	Smith	Franz Cr.	4.79	1.94	1.02	2	Private	n	2	4.23	3.08	1056557	261.08	3.45	100.00	5.00	0.71906 PEMR, 0.28094 PSSC	2
89	Smith	Hudson Sl.	14.46	5.85	1.11	2	Private	n	3	4.21	3.58	1448854	358.01	4.40	16.39	1.66	0.20942 E2EMN, 0.72600 PEMCH, 0.06457 PEMAH	1
90	Smith	Smith R. mile 3	63.87	25.85	1.57	2	Private	n	3	4.08	3.51	1239225	306.21	3.89	100.00	5.00	0.08972 PEMAH, 0.87566 PEMCH, 0.03462 PSSC	1
91	Smith	Franz Cr.	23.16	9.37	1.19	1	Private	n	2	4.20	3.07	688120	170.03	2.56	51.69	3.07	0.51809 PEMC, 0.33565 PEMR, 0.14626 PFOC	2
92	Smith	Otter Sl.	20.32	8.22	1.16	1	Private	n	2	4.09	3.01	1160737	286.82	3.70	88.16	4.53	0.43225 PEMCH, .56775 other	1
93	Smith	Otter Sl.	18.61	7.53	1.15	3	Federal/ Private	n	2	3.99	2.96	1361441	336.41	4.19	85.01	4.40	0.57427 E2EMN, 0.02672 PEMC, .39901 other	1
94	Smith	Otter Sl.	11.70	4.73	1.08	1	Private	n	2	4.09	3.01	1000428	247.21	3.32	100.00	5.00	0.06246 PEMA, 0.35032 PSSC, 0.58722 PEMC	2
95	Smith	Otter Sl.	53.72	21.74	1.48	4	Private	n	2	4.09	3.01	693747	171.42	2.58	87.13	4.49	0.19802 E2EMP, 0.06798 PEMA, 0.38328 PEMC, 0.32065 PEMR, 0.03007 PSSR	1
96	Smith	Black Cr.	122.26	49.48	2.12	6	Private	n	3	4.14	3.54	937244	231.59	3.16	0.00	1.00	0.9559 PEMCH, 0.00890 PEMF, 0.00898 PEMR, 0.01114 PFOR, 0.01463 PSSC	1
97	Smith	Smith R. mile 9	100.36	40.61	1.92	1	Private	n	3	4.02	3.48	572771	141.53	2.28	0.00	1.00	0.18693 PEMC, 0.04691 PSSC, 0.01861 PFOC, .74755 other	1
104	Smith	Butler Cr.	250.37	101.32	3.33	1	Private	n	5	3.87	4.42	603390	149.10	2.36	12.13	1.49	0.06260 E2EMN, 0.46067 E2EMP, 0.06693 PEMA, 0.12653 PEMC, 0.13685 PEMR, 0.03674 PEMT, 0.00225 PFOA, 0.10743 PFOR	2
105	Smith	Otter Sl.	20.14	8.15	1.16	3	Private	n	2	4.04	2.98	460031	113.67	2.01	93.34	4.73	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
84	Smith	1	2	3	Y, D	Y	Major	N	Dike has naturally breached.	SCHTAB dominant	0	13.54	Medium-Low
85	Smith	1	3	5	R	R	Minor	N	Road crosses site, but otherwise unaltered	SCHTAB-DESCES	0	15.74	Medium
86	Smith	1	3	5	None	None	None	N	Undisturbed except for logging on slopes above.	Field check needed.	0	19.43	High
87	Smith	1	3	5	None	None	None	N	Driveway on berm at far S end, otherwise intact.	Field check needed.	0	14.39	Medium-Low
88	Smith	3	2	3	F	F	Minor	N	Affected by fill for lumberyard. Tidal inflow restricted.	Field check needed.	0	18.55	High
89	Smith	1	3	5	None	None	None	N	House on N edge near road, remainder undisturbed.	SCHTAB-DESCES-PHAARU; some PICSIT/Salix	0	16.74	Medium-High
90	Smith	1	1	1	Y, D, C	Y	Major	N	Strong meandering channel. S end is ditched.	PHAARU; SCHTAB nr S ditch, AGRSTO/CAROBN near river	0	15.98	Medium
91	Smith	3	3	5	R	R	Minor	N	Road crosses site, otherwise unaltered.	Upper area: Salix/CAROBN-LYSAME (likely freshwater tidal)	0	17.89	High
92	Smith	1	1	1	Y, D, C	Y	Major	N	Fully diked.	Behind dike, PHAARU-CAROBN-SCHTAB	0	14.40	Medium-Low
93	Smith	1	3	5	None	None	None	N	Road at E end = site boundary; site in good cond.	Field check needed.	1	18.69	High
94	Smith	3	1	1	Y, D, C, R	Y	Major	N	Tidegated. Potential spruce swamp restoration site.	PHAARU; PICSIT/Salix-LONINV in wooded areas	0	16.41	Medium-High
95	Smith	1	3	5	None	None	None	N	Mostly unaltered.	CARLYN-SCHTAB-TYPLAT-PHAARU; some Salix	0	17.55	High
96	Smith	1	1	1	Y, D, C	Y	Major	N	Diked; also some natural levee near river.	PHAARU-JUNEFF, pasture grasses; field check needed	3	11.83	Low
97	Smith	1	1	1	Y, D, C	Y	Major	N	Landowner says diked only at S end	PHAARU, HOLLAN-FESARU; RUBDIS; ALNRUB/Salix	1	10.68	Low
104	Smith	3	3	5	G	G	Minor	N	Grazed, but otherwise unaltered.	SCHTAB-CARLYN-DESCES at W end, PICSIT/CAROBN swamp in center	4	19.60	High
105	Smith	1	2	3	D	D	Major	N	Appears currently ungrazed.	Field check needed.	0	14.89	Medium

Appendix F. Figures (maps)

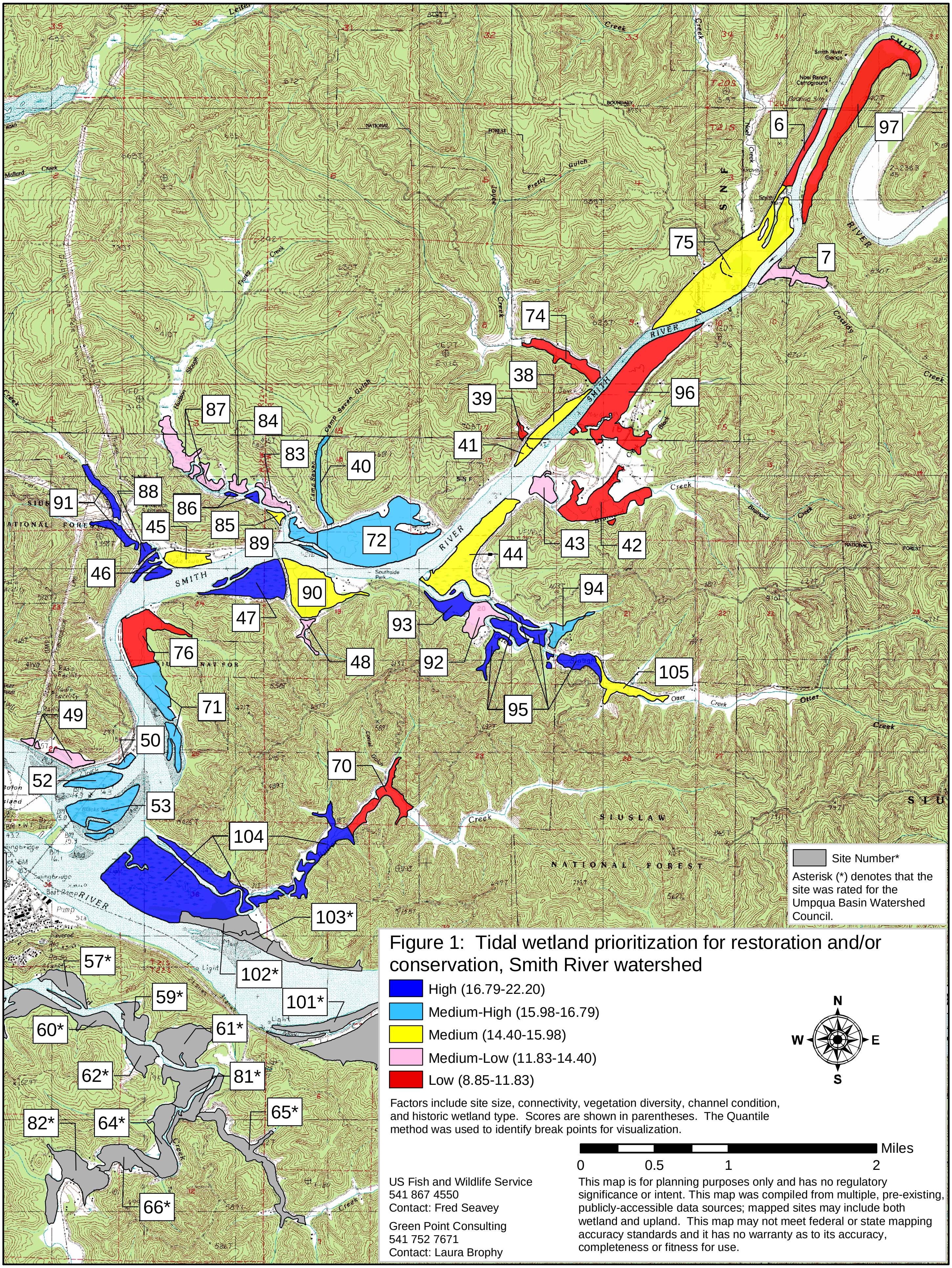

Figure 1: Tidal wetland prioritization for restoration and/or conservation, Smith River watershed

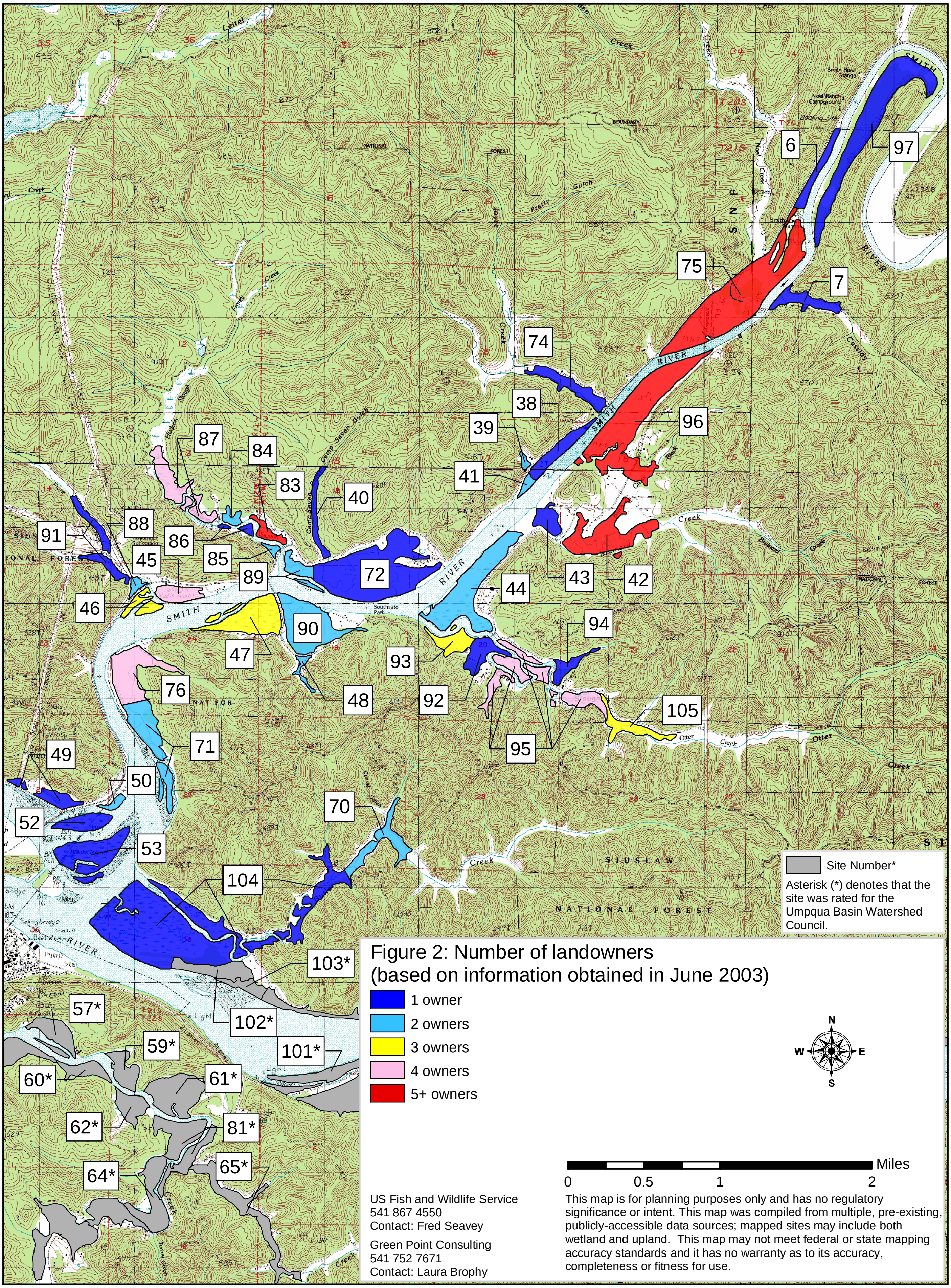

Figure 2: Number of landowners (based on information obtained in June 2003)

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

Green Point Consulting
541 752 7671
Contact: Laura Brophy

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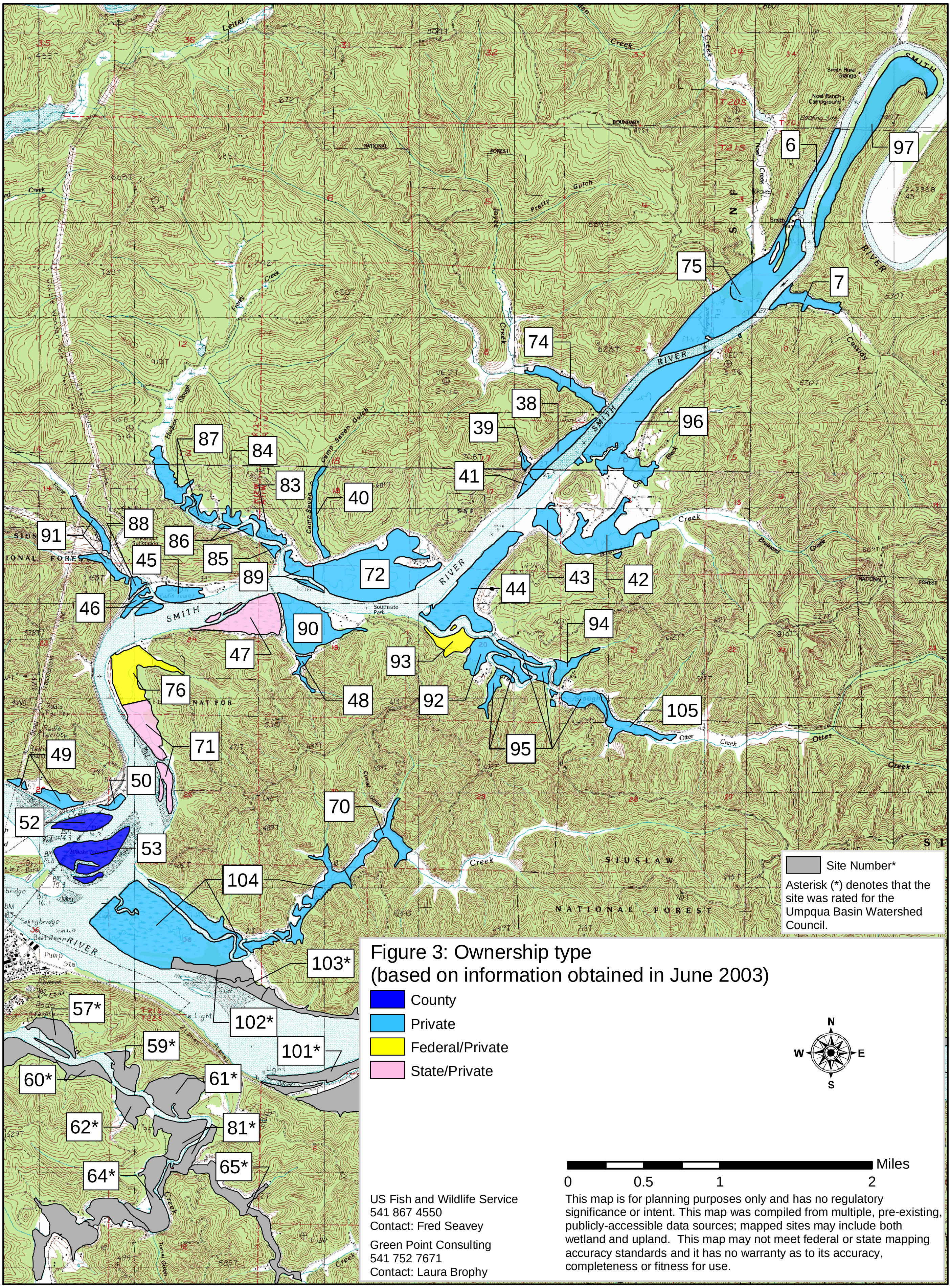
6
97
75
7
74
38
96
39
87
84
41
83
40
91
88
86
45
85
89
72
43
42
44
46
94
90
47
93
76
48
92
105
71
95
49
50
70
52
53
104
103*
57*
102*
59*
101*
60*
61*
62*
81*
65*
64*
Site Number*
Asterisk (*) denotes that the site was rated for the Umpqua Basin Watershed Council.
Figure 3: Ownership type
(based on information obtained in June 2003)
County
Private
Federal/Private
State/Private
N
W
E
S
Miles
0
0.5
1
2
US Fish and Wildlife Service
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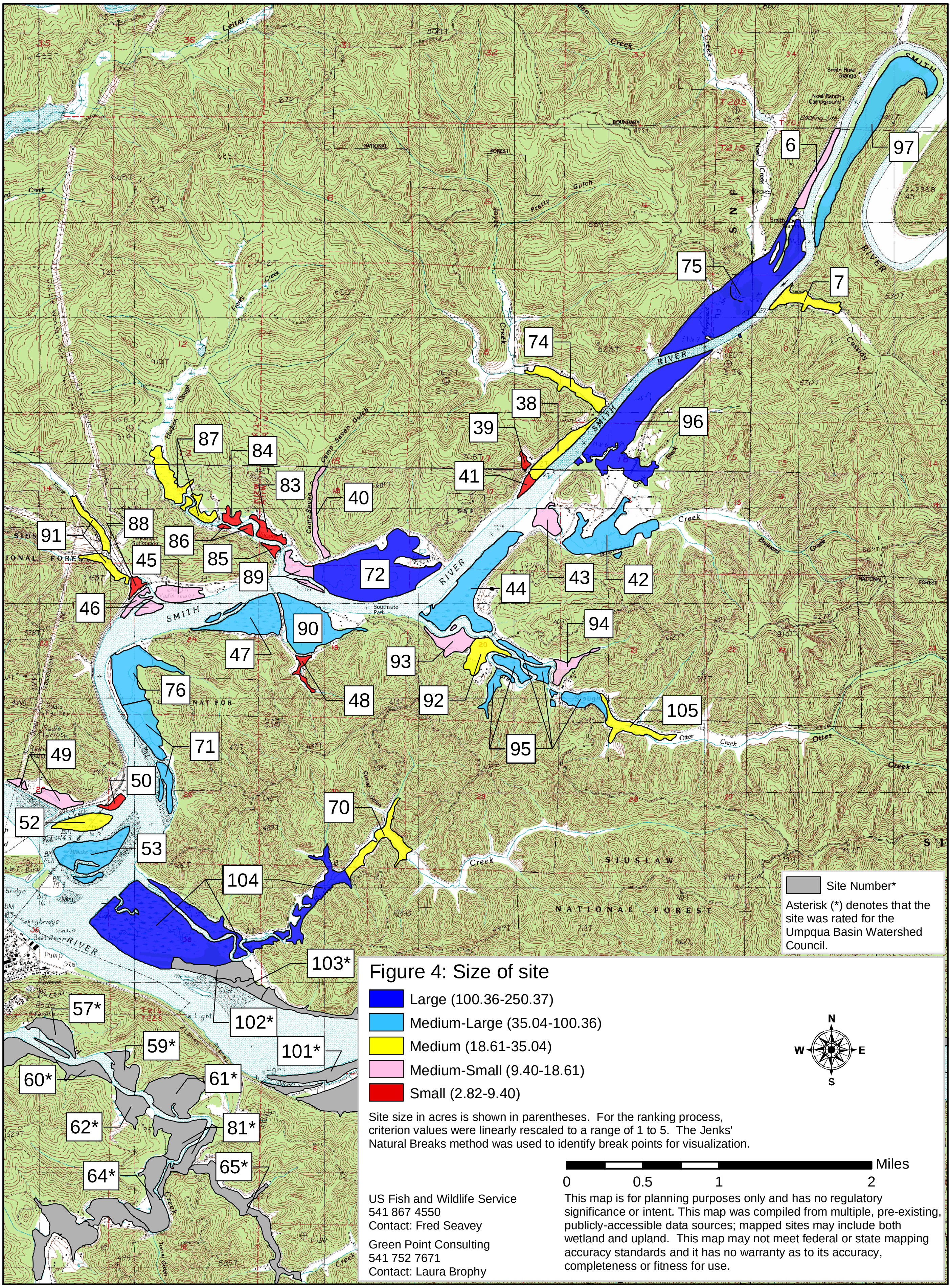

Figure 4: Size of site

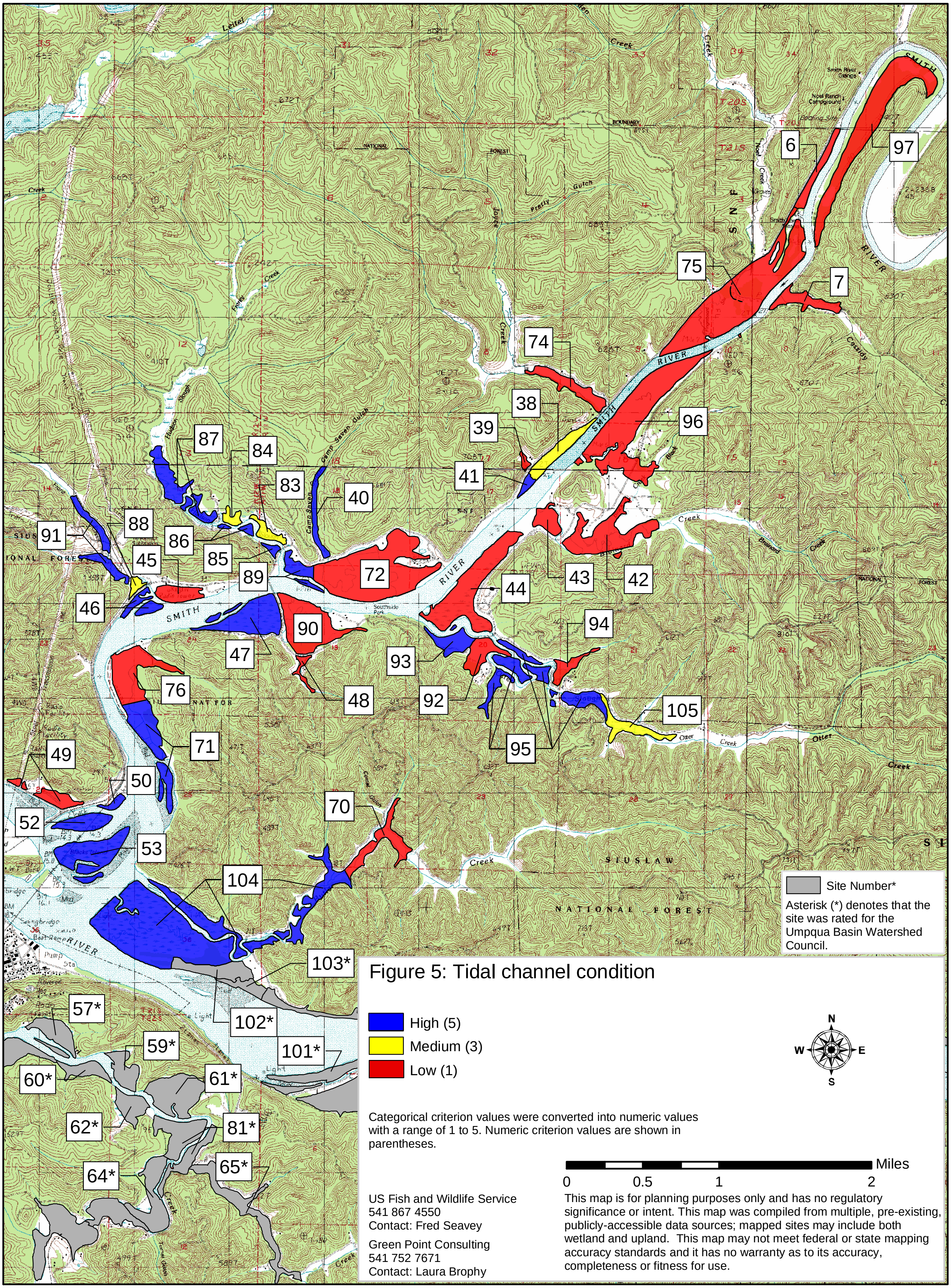

Figure 5: Tidal channel condition

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

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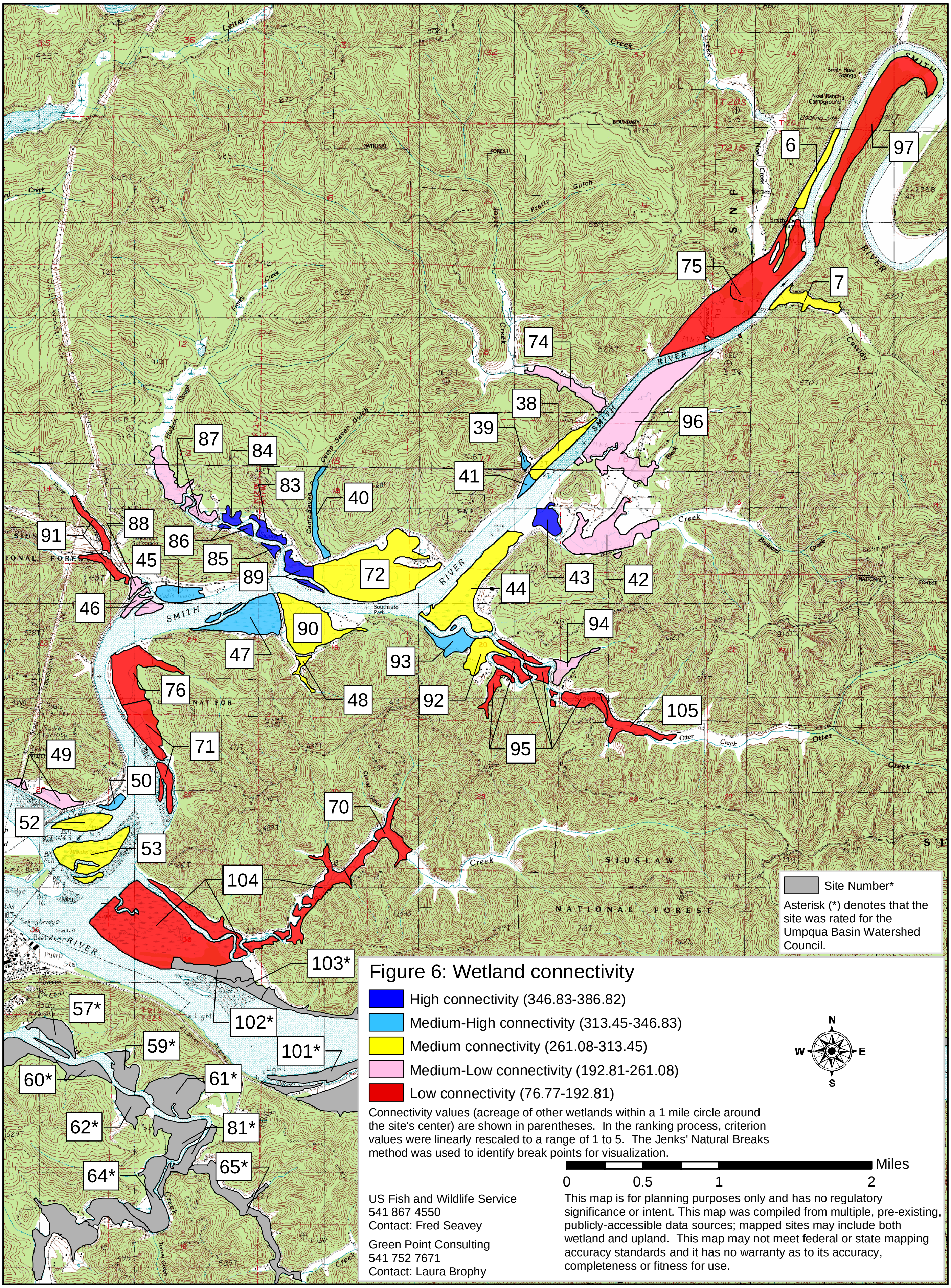

Figure 6: Wetland connectivity

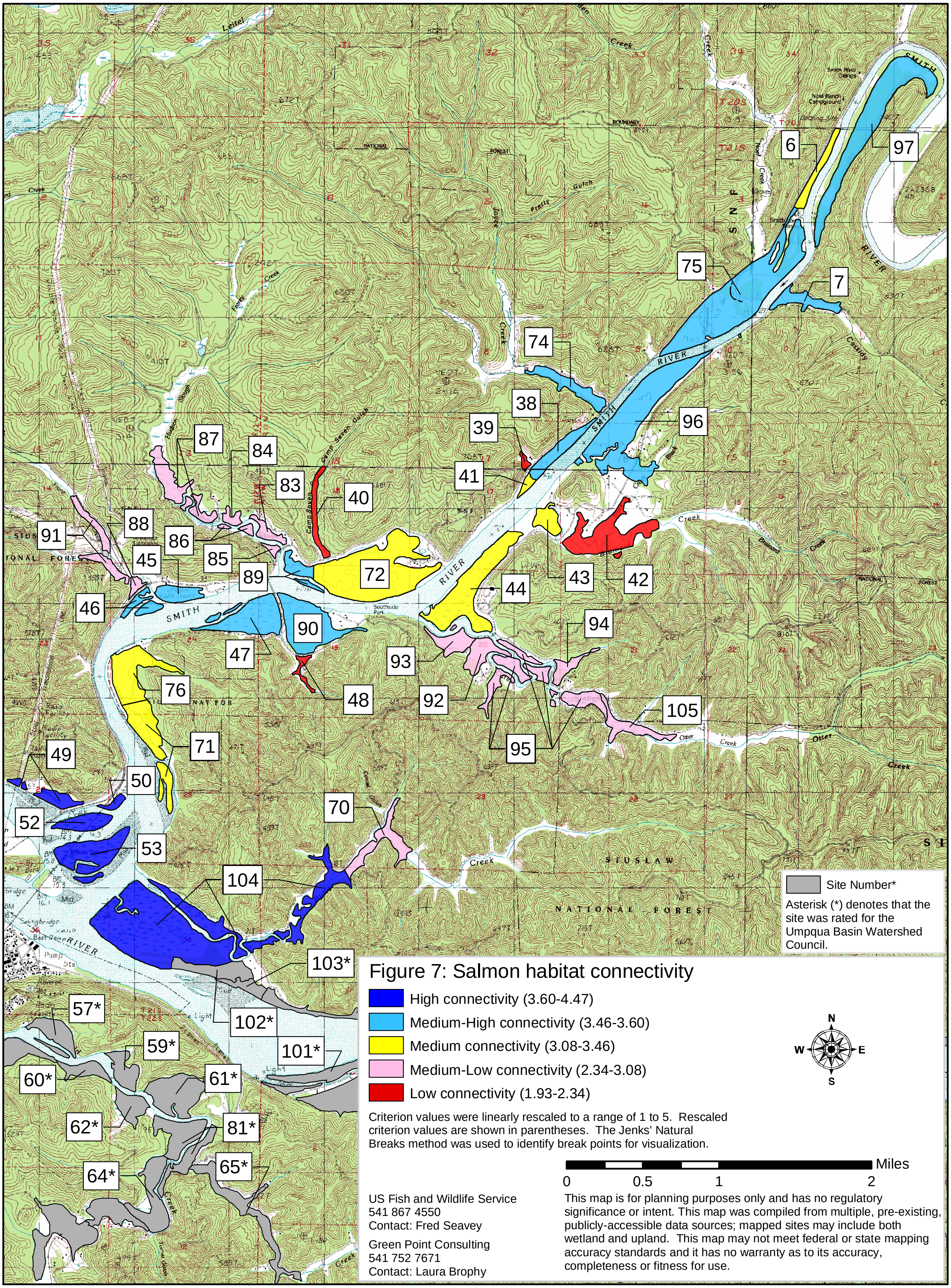

Figure 7: Salmon habitat connectivity

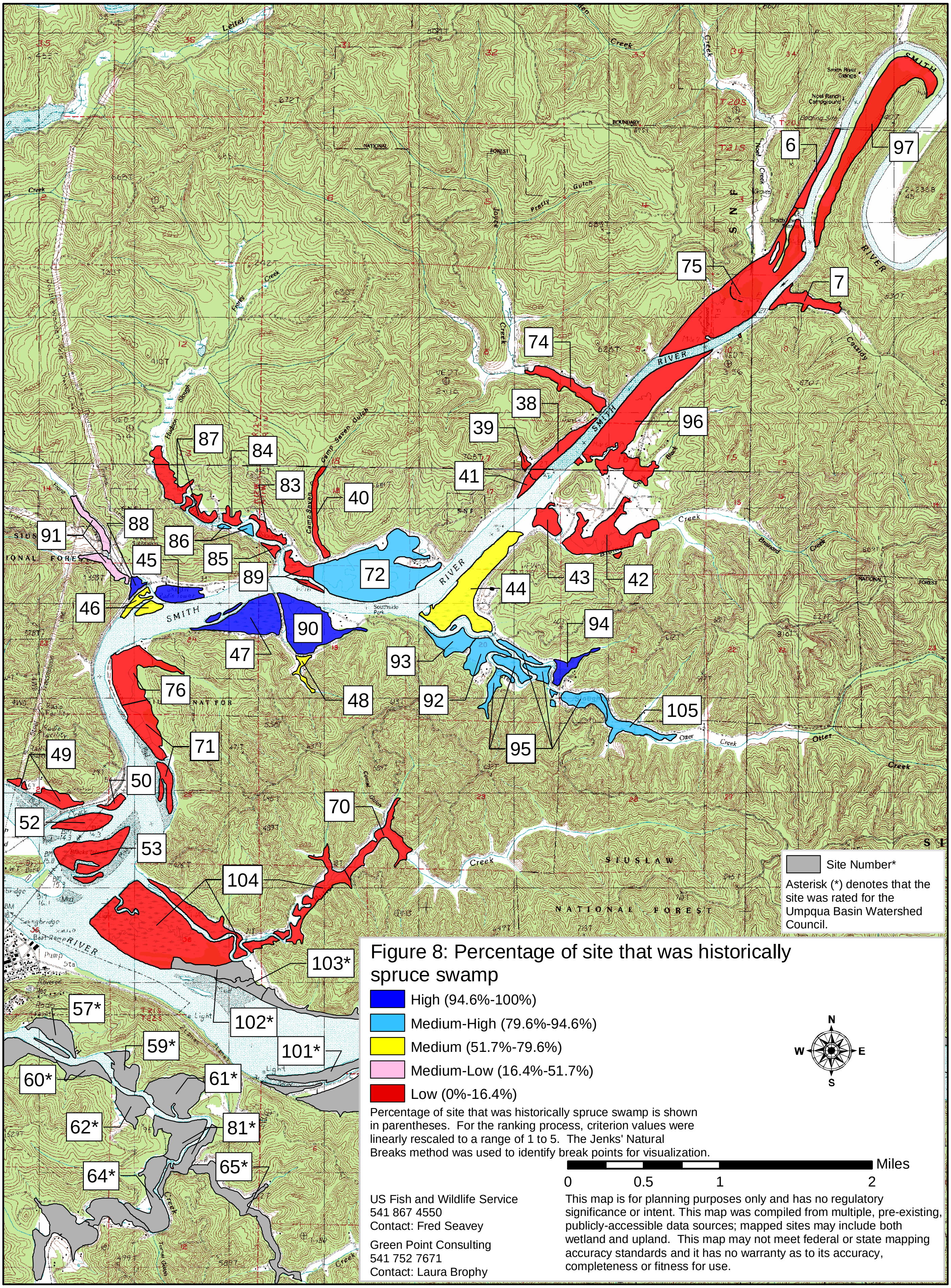

Figure 8: Percentage of site that was historically spruce swamp

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.

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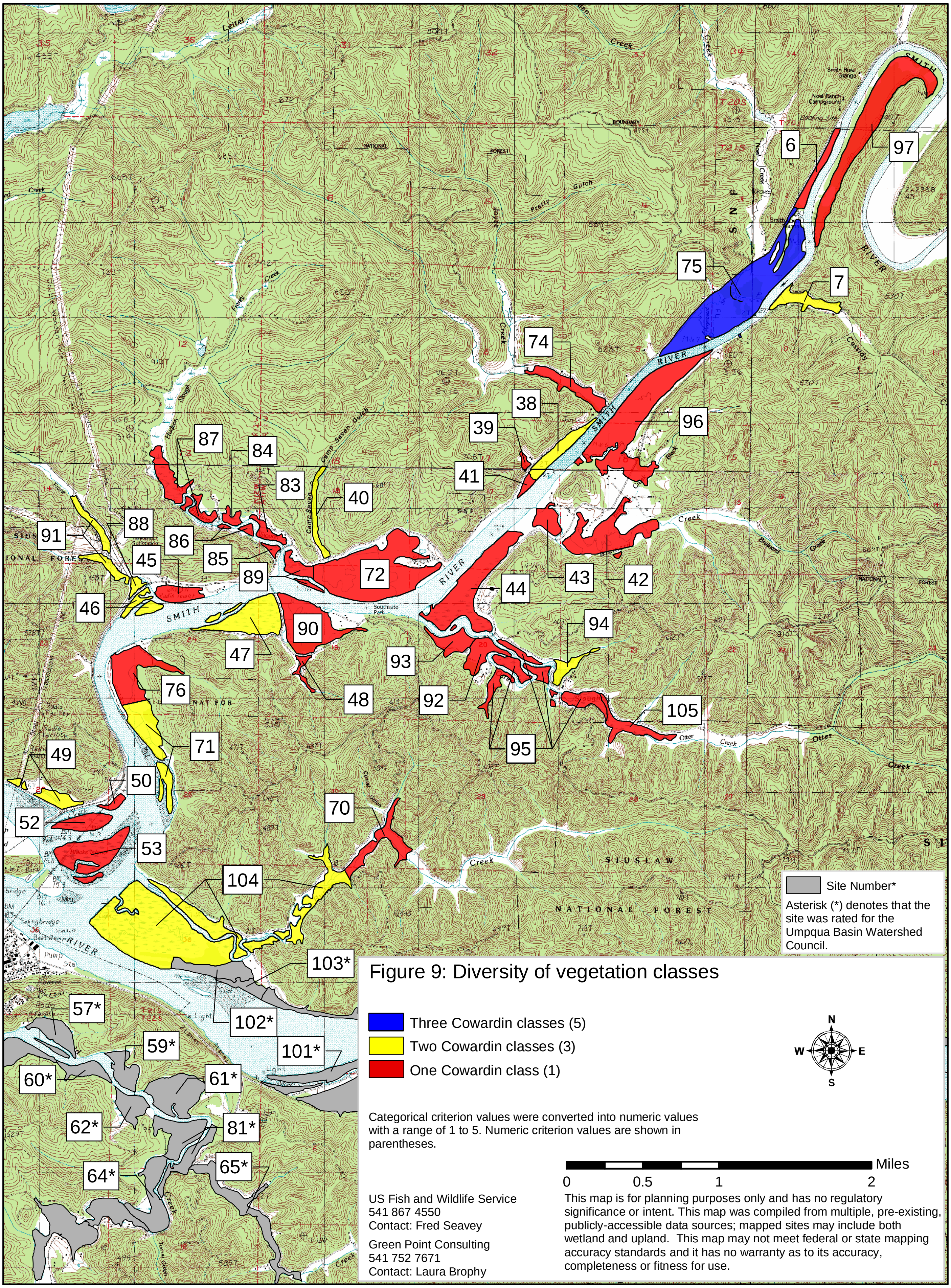

Figure 9: Diversity of vegetation classes

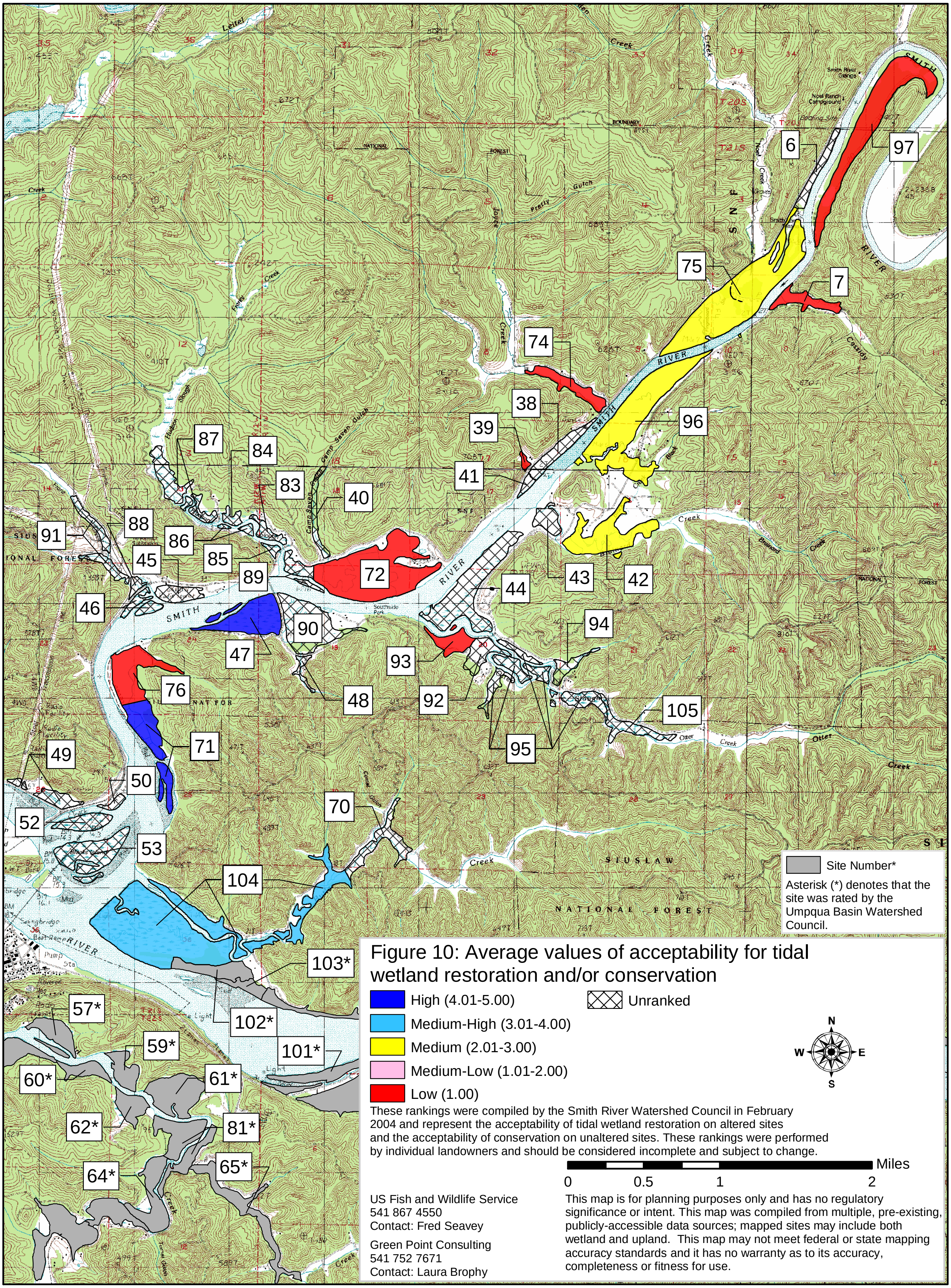

Figure 10: Average values of acceptability for tidal wetland restoration and/or conservation

These rankings were compiled by the Smith River 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 by individual landowners and should be considered incomplete and subject to change.

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