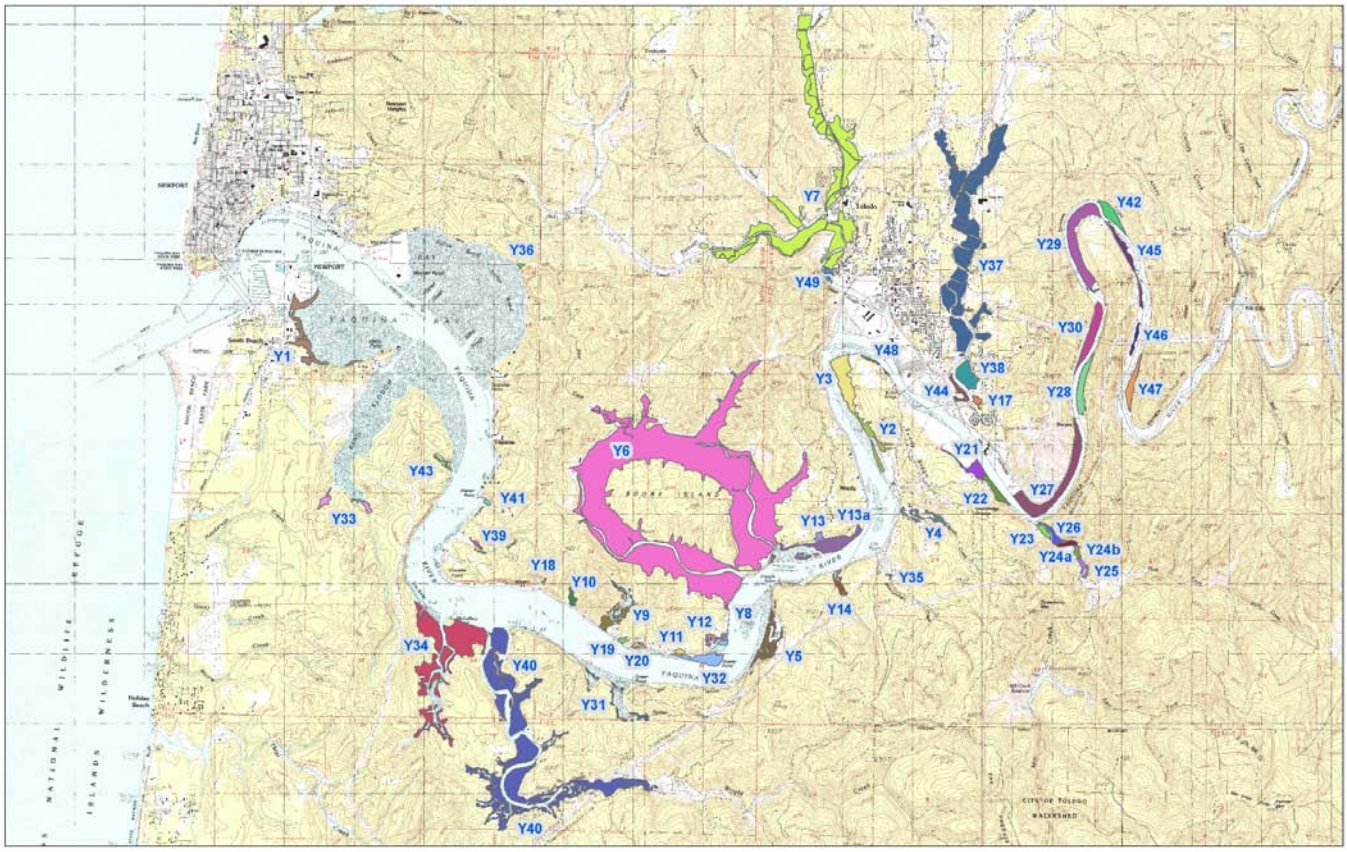
Recommended NWI Revisions and GIS Layer Development for Tidal Wetlands of the Yaquina and Alsea River Estuaries

July 2010



Map 1: Current and former tidal wetlands of the Yaquina River estuary, showing site numbers based on the 1999 Yaquina and Alsea River Basins Estuarine Wetland Site Prioritization (Brophy 1999)

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Summary

We created a GIS layer of current and likely former tidal wetlands in the Yaquina and Alsea estuaries, working from the National Wetland Inventory (NWI) mapping and applying our field knowledge of the estuaries, as well as newly available data such as LiDAR and recent aerial orthophotos. We identified all NWI polygons that corresponded to the study sites in our 1999 tidal wetland prioritization (Brophy 1999), and added several new sites. The resulting shapefiles contain 49 sites totaling 2,177 acres in the Yaquina estuary, and 39 sites totaling 1,045 acres in the Alsea estuary. We also reviewed the NWI wetland classification for these areas, and recommended revisions for 286 NWI polygons in the Yaquina estuary (1,133 acres), and 99 NWI polygons in the Alsea basin (373 acres). We identified substantial areas of likely former tidal wetlands that are classified as upland in the National Wetland Inventory (441 acres in the Yaquina estuary, and 51 acres in the Alsea estuary) but did not recommend a wetland classification to these areas, since the project's scope of work did not allow us to determine their current wetland status. The results provide considerable new data for estuarine resource management in these two estuaries.

Project Goals

The goals of this project were:

1) Generate a GIS dataset (shapefile) for tidal wetlands of the Yaquina and Alsea estuaries of Oregon (emergent, shrub and forested classes), providing a GIS map to accompany our 1999 tidal wetland prioritization in these estuaries (Brophy 1999);
2) Provide updated information on major changes at the study sites identified in the 1999 prioritization; and
3) Recommend revisions to the National Wetland Inventory's wetland classification for tidal wetlands within the study area.

This study included emergent, scrub-shrub and forested tidal wetlands but excluded other tidal wetland habitat classes such as mud flats, seagrass beds and algae beds. This was consistent with the methods used in the 1999 prioritization (Brophy 1999) and in Oregon's estuary assessment manual (Brophy 2007a).

Intended uses and limitations of mapping

This study is intended to be used for planning purposes only; it is non-regulatory in nature. In general, we did not define new wetlands, but instead characterized wetlands already mapped in the National Wetland Inventory. (In a few cases, we used data from our own recent field studies to identify wetlands that were classified as uplands in the NWI.) Our methods and suggested wetland classification revisions should be thoroughly reviewed by NWI staff prior to their inclusion in the NWI. As is always the case with NWI mapping, users should be aware that there may be upland areas within mapped wetlands, and there may be unmapped wetlands and tidal waters of the state that are subject to regulation.

Scope of Work

Specific tasks accomplished during this project are listed below.

Task 1: *Working from existing NWI polygons, create a GIS shapefile for the tidal wetland sites defined and characterized in the 1999 assessment and prioritization of tidal wetlands in the Yaquina and Alsea estuaries (Brophy 1999).* This study included tidal wetlands in the emergent, scrub-shrub and forested classes, following the methods described in Brophy (2007a). Consistent with the original prioritization (Brophy 1999) and the Oregon estuary assessment method (Brophy 2007a), algae beds, seagrass beds, and mud flats were not included. Polygon digitization followed the methods described in Brophy (2007a). Site polygons for the Yaquina River estuary were created by aggregating and splitting NWI polygons from the NWI shapefile provided by EPA at the beginning of this project (**Yaqshed_NWI_022010**). For the Alsea River estuary, we used the current National Wetland Inventory mapping, available online at http://www.fws.gov/wetlands/.

Task 2: *Interpret 2005 aerial orthoimagery (2005 EPA/DLCD and NAIP) to characterize changes in site conditions since the 1999 study. Incorporate information from other data sources as needed.*

Task 3: *Attribute each site with the following data from the 1999 assessment, modifying attributes to reflect information obtained in task 2 as described below:*

1. Site name (if any)
2. Site size (sq m)
3. TRS location (Township, Range, Section)
4. General site description (1999 data, unless major changes are visible in 2005 aerials)
5. Approximate number of landowners (1999 data)
6. Habitat type, for example, "tidal marsh," "diked freshwater wetland" (1999 data, unless major changes are visible in 2005 aerials)
7. Dominant plant species (1999 data; only available for a subset of sites where access was obtained in 1999)
8. Alteration type and approximate date, e.g. "diked prior to 1939" (1999 data, unless major changes are visible in 2005 aerials)
9. Possible restoration actions (1999 data, unless major changes are visible in 2005 aerials)
10. Current land use (1999 data, unless major changes are visible in 2005 aerials)
11. Adjacent land use (1999 data, unless major changes are visible in 2005 aerials)
12. Connections to streams
13. Comments from experts (1999 data)
14. Recommended next step (1999 data, unless major changes are visible in 2005 aerials)
15. Other reports (1999 data)
16. Recommended revisions to NWI wetland classification (if any) for the underlying NWI polygons within each site. ***Note: recommended revisions to the NWI classification were provided in a separate shapefile, because each site contained many separate NWI polygons. See Products below for details.***
17. Further notes and recommendations

After this initial scope of work was established, LiDAR data became available, so we added a fourth major task:

Task 4. *Use 2009 LiDAR data (bare earth model) to help identify current and former tidal wetlands within the study area.*

Products and GIS projection

The following products were created in the course of this study:

1. GIS datasets (shapefile format) of tidal wetland sites corresponding to the study sites in our 1999 prioritization of tidal wetlands in the Yaquina and Alsea estuaries (Brophy 1999): **Yaq_tidalw_GPC_8aug10** for the Yaquina estuary, and **Als_tidalw_GPC_8aug10** for the Alsea estuary. Attribute tables contain all data in the original site information tables (except land ownership, which is likely to have changed), as well as updates from this project. Metadata are included with the shapefiles.
2. GIS datasets (shapefile format) of NWI polygons in the Yaquina and Alsea estuaries, containing recommended revisions to the NWI classification (**Yaqshed_NWI_GPC_073110** and **Alsea_NWI_GPC_073110** respectively). Datasets include metadata, based on the metadata provided by EPA for the original Yaquina NWI layer.

The projection for all GIS products was Oregon Lambert HARN (international feet), to match the projection of the large LiDAR datasets used in the analysis.

Study area

The project study area included the entire Yaquina River estuary and the entire Alsea River estuary, from ocean to head of tide on the mainstem and all tributaries.

Methods

We used our knowledge of the Yaquina and Alsea estuaries, along with LiDAR data, aerial photos, and other existing data to help locate current and former tidal wetlands within the study area.

LiDAR analysis

LiDAR data were analyzed to determine the percentage of area within each NWI polygon that fell within three elevation zones (elevations in ft NAVD88):

Alsea estuary	Yaquina estuary
<8ft	<9ft
8-11ft	9-11ft
11-13ft	11-13ft

These elevation zones were deliberately broad because tidal datums vary in different parts of the estuary, and tidal datums alone do not determine inundation regime. Tidal inundation regimes are the product of both tidal forces and river flows (the "fluvial component"). River flows combine with high tides to create much more frequent inundation at higher elevations compared to what would be predicted using tidal datums alone (Brophy 2009, Brophy *et al.* 2007-2010). This is particularly true in winter, but also observable in spring and fall, and it is an especially important phenomenon in the middle and upper estuary where river valleys are more confined.

The lowest zone represented areas that are clearly tidal wetlands, based on information from our own studies (Brophy *et al.* 2007-2010, Brophy 2009), tidal datums from NOAA, and data provided by EPA. For example, Christoper Janousek of EPA (personal communication) conducted analyses of NOAA tide height records and determined that typical monthly high tides in the lower Yaquina estuary are around 9ft. The next elevation range (8-11ft for the Alsea, 9-11ft for the Yaquina) was selected to include areas likely to experience tidal inundation during winter, or in spring and fall during high river flows. The top elevation range (11-13ft) was investigated because it covers the range of NOAA values for Highest Measured Tide and therefore includes potential Tidal Waters of the State as described in Oregon regulatory statutes. However, we did not use this higher range in our final analysis, since most tidal wetlands in our study area occurred below this elevation range.

We examined each NWI polygon which had more than 25% of its area within any of these elevation zones. As described in the next section, we then used our knowledge of the estuaries, along with aerial photo interpretation and other data sources, to determine which of these polygons were likely to be current or former tidal wetlands.

For extensive tide gated areas like Boone Slough, Nute Slough, Depot Slough, and Olalla Slough, few visual indicators remain of former tidal status. For these areas, we used the LiDAR analysis to locate areas with >25% of their land area below 11ft, and identified these as likely former tidal wetland areas (attribute "GPC_NWI" = "FTW" in NWI shapefiles).

As in the original study (Brophy 1999), we excluded areas that have been filled and converted to developed uses from this study, even if they were within tidal range. An example was the former log storage yard at the Siletz Tribes mill site just downstream of Mill Creek, on the north bank of the Yaquina River.

We included all NWI polygons in the study regardless of size, but we did not assign new site numbers to areas totaling less than 1 acre in size.

Wetland classification

We combined the LiDAR analysis with field knowledge, field data, aerial photograph interpretation, and other information to determine the appropriate wetland classification for each NWI polygon in our study area. For consistency with the NWI, we used the Cowardin wetland classification system (Cowardin *et al*. 1979). In many cases the existing NWI classification appeared to be correct. However, we recommended a revised NWI classification for many polygons: 286 polygons in the Yaquina estuary totaling 1,133 acres, and 99 NWI polygons in the Alsea basin totaling 373 acres.

The most useful aerial photographs were high-resolution 2004, 2005 and 2006 color infrared photographs provided by DLCD and EPA. We used airphoto interpretation to identify tidal channels, brackish *versus* freshwater vegetation, topographic transitions, areas developed for human use, dikes, restrictive culverts and tide gates, and other features that helped distinguish between tidal wetlands and nontidal wetlands or uplands. We also drew heavily on our own field data from tidal wetlands in the Yaquina, Alsea and other Oregon estuaries (Brophy 2003, 2004, 2007b, 2007c, 2009; Brophy and Christy 2008, 2009; Brophy *et al.* 2007-2010), and salinity data provided by EPA staff (Cheryl Brown and Christopher Janousek, personal communication).

Estuarine vs. Palustrine system (salinity regime)

Wetlands with low flow (summer/early fall) salinity equal to or greater than 0.5ppt (originating from marine salinity) are classified in the Cowardin system as estuarine wetlands (Cowardin *et al*. 1979). Tidal wetlands with salinities below 0.5ppt ("freshwater tidal wetlands") are classified as palustrine wetlands, and are assigned a "water regime modifier" to indicate tidal influence. We therefore sought salinity data to assist our classification of tidal wetlands.

Cheryl Brown of U.S. EPA provided a shapefile containing salinity data for the Yaquina estuary originating from many sources (>8000 data points). Almost all the measurements were on the mainstem river. Interestingly, despite the NWI's classification of tidal wetlands as Palustrine above River Mile 14, late summer and early fall salinities were in the range of 5-10ppt as far upstream as River Mile 19.5 – near the upstream limit of tidal wetlands in the Yaquina system. Therefore, we classified only very limited areas as palustrine, tidally-influenced wetlands. Additional salinity data from Poole Slough on the Yaquina were provided by Christopher Janousek of EPA; these helped inform our classification in that area.

For the Alsea estuary, we used data from our own field studies (Brophy 2003, 2006; Brophy and Christy 2008, 2009), to determine which areas should be classified in the estuarine system *versus* the palustrine system. Field observations of vegetation were the primary means for this classification; dominance of brackish-tolerant species indicated wetlands that should be placed in the estuarine system.

Naturally, salinity in a tidal wetland may differ from the salinity in the adjacent tidal water body. For example, a forested tidal wetland near the hillslope base may have much lower salinity than the nearby tidal river, due to freshwater drainage from the nearby uplands. For areas where we lacked specific field data, we used aerial photos to help determine estuarine vs. palustrine classification. Reed canarygrass (*Phalaris arundinacea*) red alder (*Alnus rubra*) are two species that do not tolerate much salinity, and which are identifiable in aerial photographs. Using aerial photos, we identified tidal wetlands that were dominated by these species and classified those wetlands as tidally-influenced palustrine wetlands, even if nearby river reaches had summertime salinity above 0.5ppt according to available data.

Cowardin classification modifiers

Water regime (hydrologic) modifiers and special modifiers were included in our recommended Cowardin classifications. These modifiers provide very important information and should therefore be retained in the classification. Modifiers were used according to the definitions provided in Cowardin *et al.* (1979).

Water regime modifiers

When the Cowardin classification is applied to Oregon's estuaries, low salt marsh is generally assigned the "N" modifier, which is defined as "regularly flooded" ("tidal water alternately floods and exposes the land surface at least once daily"), and high salt marsh and brackish marsh are generally assigned the "P" modifier, which is defined as "irregularly flooded" ("tidal water floods the land surface less often than daily") (Cowardin *et al.* 1979). For wetlands that were already classified in the estuarine system in the NWI, we did not generally attempt to correct these modifiers, since that would require modeling of tide heights versus ground surface elevations. When we found NWI polygons that were classified as palustrine but appeared to be estuarine, we assigned the "N" and "P" modifiers as appropriate based on elevation and our knowledge of the specific site. Estuarine scrub-shrub and estuarine forested wetlands (E2SS and E2FO) were assigned the "P" modifier, since in our study area these wetland types generally do not flood daily.

For tidally-influenced palustrine wetlands, the Cowardin classification offers the same hydrologic regime modifiers used in nontidal systems, but with the word "tidal" added: R=seasonally flooded (tidal), S=temporarily flooded (tidal), T=semipermanently flooded (tidal), and V=permanently flooded (tidal). These modifiers are not well-suited to the observed flooding regimes in freshwater tidal wetlands of Oregon. We have documented regular flooding of tidally-influenced palustrine wetlands during spring tide cycles throughout the year, with more frequent flooding during high winter flow periods (Brophy 2009, 2007b; Brophy *et al*. 2007-2010). Given the limited choices, we selected the best-suited hydrologic modifier from the Cowardin system ("seasonally flooded (tidal)") and we used this modifier for all tidally-influenced palustrine wetlands in our study area.

Special modifiers

Special modifiers generally describe site alterations. We applied these modifiers based on local knowledge and aerial photo interpretation. These modifiers are very important to the understanding of these systems and should not be viewed as optional in NWI map usage.

Former tidal wetlands behind dikes, tide gates and restrictive culverts should be classified in the NWI as diked wetlands (modifier "h"). However, such areas often lack the "h" modifier in existing NWI mapping. In some cases, this may be due to the NWI's reliance on remote data; we have found that field work and site-specific analysis are often needed to identify hydrologic alterations, especially restrictive culverts and tide gates. It is also possible that NWI protocols limit the use of the "diked" modifier to those polygons directly adjacent to the dike or hydrologic restriction.

We added the "diked" modifier to all wetland polygons which we considered likely to be former tidal wetlands with hydrology affected by dikes, tide gates or restrictive culverts. Such areas were at low elevations (usually below 8 or 9 ft), and were located behind dikes, tide gates, and restrictive culverts. In major tributary and slough systems like Boone Slough, Nute Slough, Depot Slough, and Olalla Slough, some of these polygons were at a considerable distance from the dike or tidal restriction. Nevertheless, , we felt the use of the "diked" modifier was appropriate because elevations were generally low, and tidal forcing in these systems was likely to have been quite strong, given the size of the slough systems.

New sites added to 1999 study

As described in Scope of Work above, this project was intended to create a GIS layer for the sites identified in the 1999 prioritization of tidal wetlands of the Yaquina and Alsea estuaries (Brophy 1999). However, in a few cases, the LiDAR data allowed us to identify new tidal wetland or former tidal wetland sites. In most cases, these areas were already classified as wetlands in the NWI, but they were not previously classified as tidal wetlands, nor did they have special modifiers suggesting hydrologic change that could have eliminated tidal flows.

The new sites in each estuary are listed below, with approximate acreages and site numbers corresponding to the numbering system in the 1999 study. ***Site visits by a knowledgeable wetland scientist are recommended to determine the status of these areas.***

Yaquina estuary:

- Site Y44 (7 acres): Partially filled forested tidal wetland at the mouth of Olalla Slough, about 7 acres
- Site Y45 (13 acres): Diked pasture in the upper estuary, probably former tidal swamp
- Site Y46 (4 acres): Diked pasture in the upper estuary, probably former tidal swamp
- Site Y47 (12 acres): Undiked tidal swamp (forested and shrub tidal wetland) in the upper estuary, about 12 acres
- Site Y48 (2 acres): Fringing marsh on south bank of Yaquina R., just upstream of Site Y3
- Site Y49 (3 acres): Undiked tidal marsh just outside the tide gates on Depot Slough

Alsea estuary:

- Site A38 (8 acres): Tidal marsh and tidal swamp (forested tidal wetland), River Mile 2 of Drift Creek, north bank
- Site A39 (6 acres): Freshwater tidal marsh, River Mile 3 of Drift Creek; probably former tidal swamp
- Site A40 (9 acres): Forested tidal wetland or former tidal wetland, immediately east of Drift Creek tidal marsh restoration area. Site visit needed to determine hydrologic status.
- Site A41 (2 acres): Small possible tidal swamp opposite mouth of Risley Creek and Bain Slough.

Likely former tidal wetlands classified as upland in the NWI

In the major diked tributaries of the Yaquina estuary – Boone Slough, Nute Slough, Depot Slough, and Olalla Slough – we found extensive areas of low ground (generally <9ft elevation) which were classified as upland in the NWI. It seems very likely that these areas were once tidal wetlands. However, their hydrology is currently highly altered due to systemwide tide gates and extensive ditching and diking, so their current wetland status cannot be determined without onsite investigation.

We included these areas in the shapefiles that we produced, digitizing their boundaries by cutting the upland polygon at the 11ft elevation contour based on the LiDAR data. We used a consistent onscreen

scale of 1:2000 for this digitization work. The result was 64 new polygons of “likely former tidal wetlands/tidal waters of the state” in the Yaquina estuary, totaling 441 acres. Nearly all of these areas were in the large tide gated wetland complexes (Boone Slough/Nute Slough area, Depot Slough, and Olalla Slough). In the Alsea estuary, only 41 acres were characterized in this way, mostly in the middle to upper estuary.

Because the wetland status of these areas could not be determined, we could not recommend a Cowardin classification for these polygons. Instead, we assigned the code “FTW” for “Former tidal wetland,” and added the note “likely former tidal wetland/tidal waters of the state.”

In many other areas outside these digitized “likely former tidal wetlands,” the floodplain adjacent to existing NWI polygons was classified as upland in the NWI, but had elevations within our defined 9-11 or 11-13ft elevation zones. In most cases this was only a narrow fringing band. These areas are also likely tidal wetlands, former tidal wetlands, and/or tidal waters of the state, but these areas could not be added to the NWI shapefile without extensive digitization, which would have been well beyond the scope of this project. We recommend that such areas be identified using LiDAR, and included in planning for coastal resource conservation and restoration.

Notes on using the LiDAR data

In some parts of the estuary, particularly the freshwater tidal zone, it is apparent that the LiDAR signal does not successfully penetrate heavy emergent vegetation, particularly reed canarygrass. Failure of the LiDAR signal to penetrate reed canarygrass and other dense vegetation has been observed in other areas (Rob Piehl, USFS, personal communication; Randy Van Hoy, Ducks Unlimited, personal communication). The resulting bare earth model can show elevations as much as a foot or two above the actual soil surface elevation. Because of this potential inaccuracy, we recommend ground-truthing of the LiDAR bare earth model, particularly for site-specific planning and restoration design.

Recommendations

Aerial photographs were used heavily in this analysis, but the most recent high-resolution aerial photographs were those acquired in 2005 by DLCD and EPA. Field observations in 2010 indicate that changes have occurred at some sites since the 2005 photographs. NAIP (National Agricultural Imagery Program) orthophotos were flown in 2009, but were not yet available as of the writing of this report, and these may not be as high-resolution as the 2005 images. (The 2005 images were much higher-resolution, and therefore much more useful, than the 2005 NAIP orthoimages). As always, we recommend regular review of conditions to update the information provided in this report. Site visits by knowledgeable field scientists (after obtaining landowner permission for access) are particularly useful.

LiDAR data provide a very powerful new tool for studies like this one, but the scope and budget of this project greatly limited the ways in which we could use the LiDAR data. For example, the LiDAR data could be used to digitize new boundaries for NWI polygons, provided the results are reviewed and interpreted by knowledgeable wetland scientists. We recommend additional effort be expended to fully

utilize the LiDAR data for identifying wetlands; the effort would provide very useful data for strategic planning of coastal wetland conservation and restoration.

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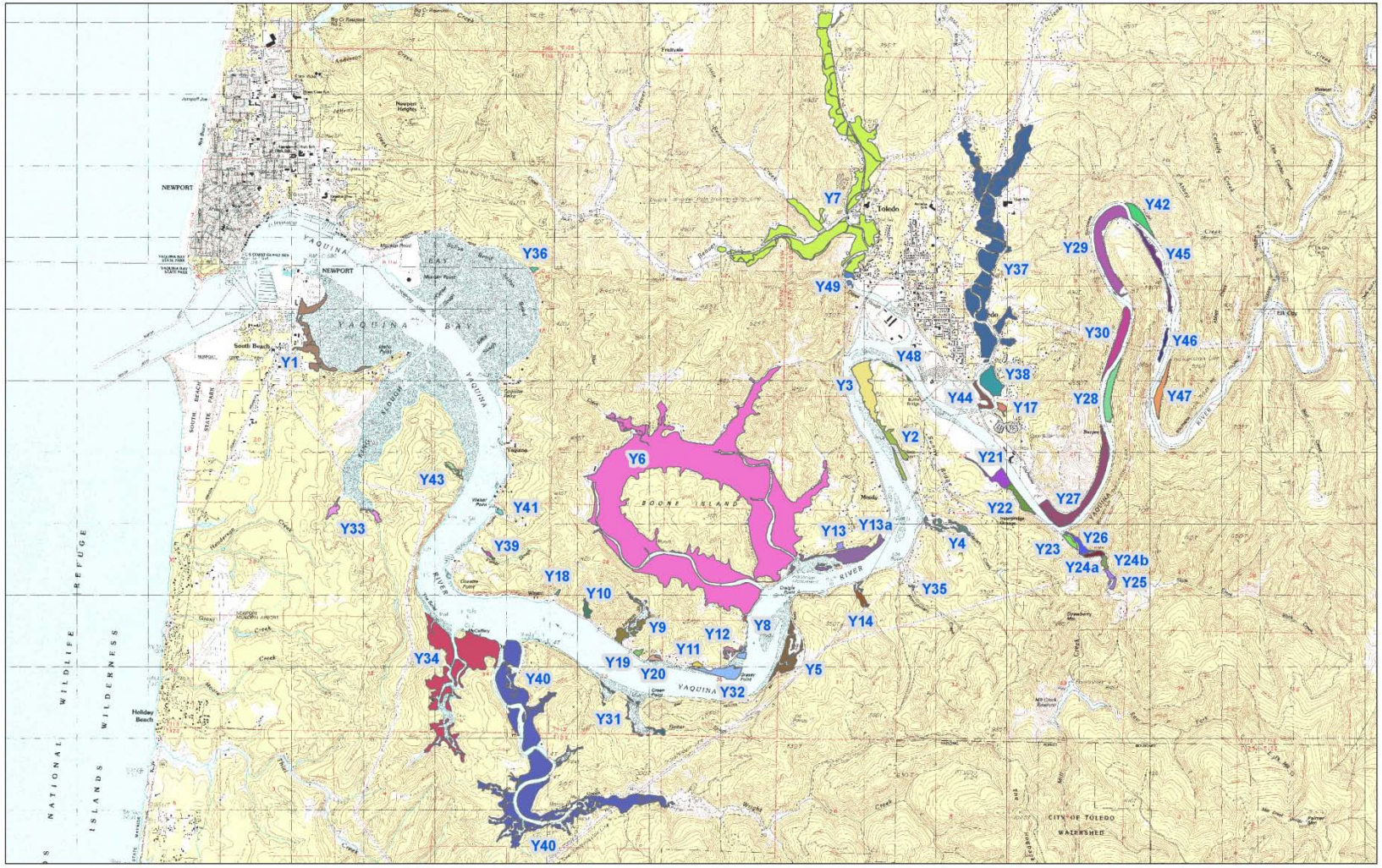
Appendix 1.

Maps of tidal wetland sites from 1999 prioritization, and new sites identified in this 2010 update

Tidal wetlands and likely former tidal wetlands of the Yaquina River Estuary, Oregon, USA

Polygons from National Wetland Inventory; labels indicate sites defined in Brophy (1999).

Each site is colored separately; colors do not indicate priorities.



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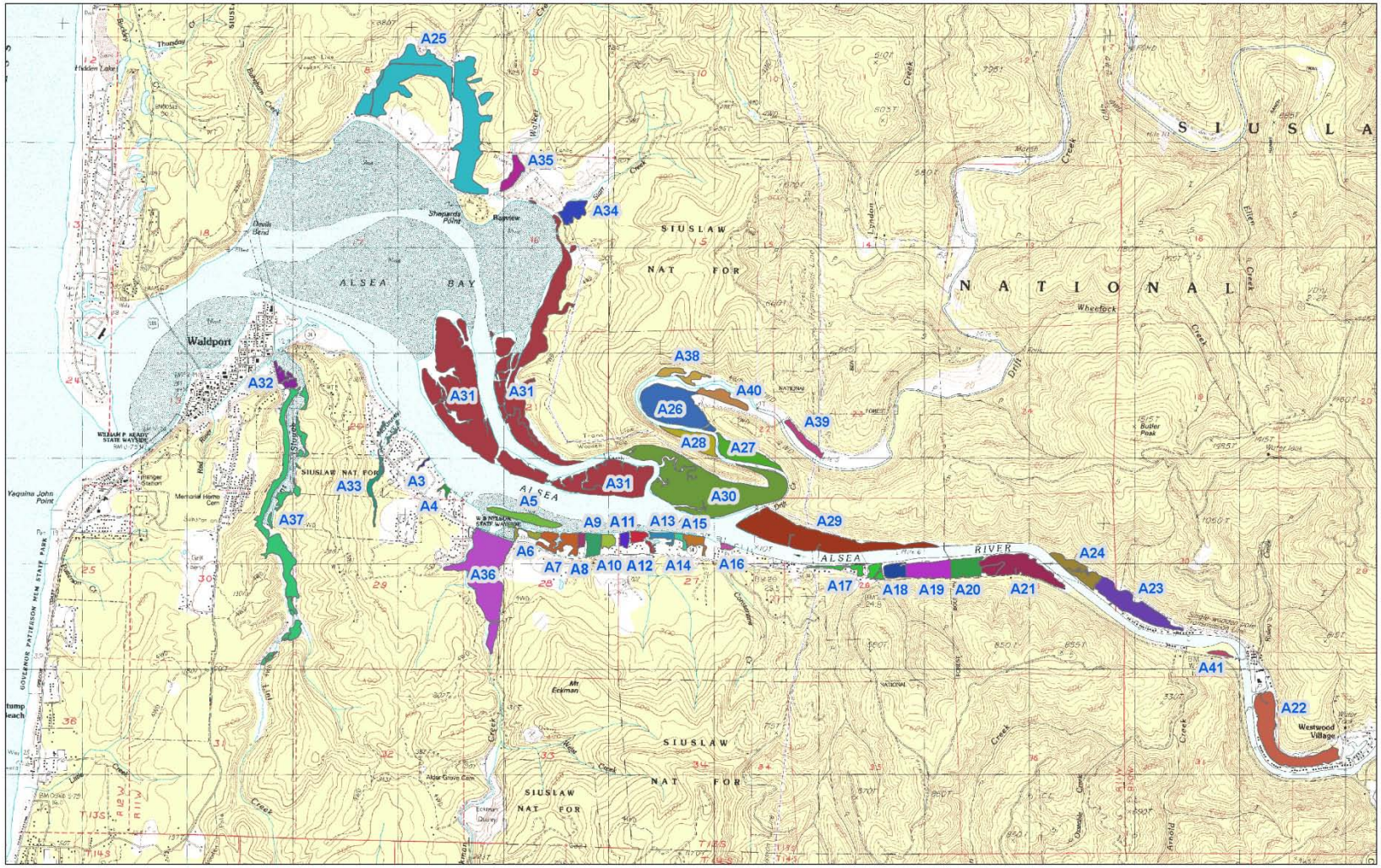
Tidal wetlands and likely former tidal wetlands of the Alsea River Estuary

Polygons from National Wetland Inventory; labels indicate sites defined in Brophy (1999).

Each site is colored separately; colors do not indicate priorities.



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