Lower Columbia Estuary Partnership

Historical Habitat Change in the Lower Columbia River and Estuary

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Lower Columbia Estuary Partnership

Presented to the Landscape Planning Workshop,

March 21, 2013

Skamania Lodge

Lower Columbia Estuary Partnership

- **One of 28 estuaries in EPA's National Estuary Program**
  - Network of community based programs working to protect and restore the water quality and ecological integrity of estuaries of "National Significance"

- **Bi-State – Federal Partnership:**
  - OR, WA, US EPA

- **3 Program Areas**
  - Habitat Restoration, Ecosystem Monitoring, Stewardship

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Estuary Partnership Restoration Program

- **Project development, coordination of partner projects**

- **CCMP targeted actions and goals**
  - Restore ecosystem structure and function through restoring natural habitat diversity; key to restoring diversity of salmon life history strategies

  - 19k acres restored/protected by 2014

- **Restoration Prioritization Strategy**
  - Framework for conducting landscape scale restoration using a strategic approach, rather than opportunistic

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Restoration Prioritization Strategy

- **Funded by EPA**

- **Incorporates a variety of data, including:**
  - Historical Habitat Change
  - Juvenile Chinook salmon Habitat Suitability Index
  - Priority lower Columbia tributaries (OR/WA Recovery Plans)
  - Suitable and available habitats for:
    - Tule Chinook, Columbia White Tailed Deer, migratory birds
  - Priority Contaminant Clean-up Sites

- **Draft Report Available on EP website**

  http://www.estuarypartnership.org/habitat-restoration-strategy

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Why Consider Habitat Change?

- **Assumption: Historical habitat diversity played a key role in supporting a diversity of salmon life history strategies**

- **Cited as key task for ecosystem restoration approach**
  An Ecosystem-Based Approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia R. Estuary. Johnson et al. (2003)

- **Why another analysis?**

  Availability of improved data sets (current and historical) allowing for better comparison and greater detail

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Habitat Change Overview

- **Objectives**

  Compare pre-Anglo European landscape to present landscape in the LCRE floodplain.

  Quantify changes, set targets for recovery of ‘priority’ habitats

  Use CREEC Hydro-geomorphic Reaches as basis for analysis

- **Methods**

  GIS overlay of existing historical and present data

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Habitat Change Data Requirements

- **Temporal/Spatial**

  Complete data coverage of LCRE floodplain (mouth to Bonneville) for both 'Current' and 'Historical' periods

  Historical period: pre Anglo European settlement (prior to diking/agriculture)

- **Accuracy**

  Good spatial alignment (Historical is primary concern)

  High confidence in the predicted habitat types

For most prior LCRE change analysis efforts, the above conditions have typically not ALL been met

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Previous Studies of LCRE Historical Habitats

Author & Year	Report	Spatial Extent	Historical Period (Data Source)	Current Period (Data Source)	Primary Limitation
Thomas 1983 (CREDDP)	CREST/ LCEP	RM 0 – 43	1880s (OC &GS)	1980 (Thomas)	spatial (H,C)
Graves/Christy 1995	CREST/ LCEP	RM 0 – 102	1880s (OC &GS)	1991 (aerial photo)	spatial (H,C)
Allen/USACOE 1991	OSU/ LCEP	RM 0 – 146	1948, 1961, 1973, 1983 (aerial photo)	1991 (aerial photo)	temporal (H,C)
OR GAP 1999	PSU/ LCEP	RM 0 – 146	Late 1800s (GLO)	1993 (LandSAT)	spatial (H)
NOAA-CCAP 1994	NOAA	RM 0 – 146	1989 (LandSAT)	1993 (LandSAT)	temporal (H,C)
Garano 2003	LCEP	RM 0 – 146	1992 (LandSAT)	2000 (LandSAT)	temporal (H)
Burke 2004 – 2006		RM 0 – 43	1880s (OC &GS)	2000 (LandSAT)	spatial (H)

OC&GS: Office of Coast and Geodetic Survey
GLO: General Land Office

C: current data source
H: historical data source

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Historical Landscape Reconstruction: T-sheets

- **US Coast & Geodetic Survey Topographic Sheets (T-sheets)**

Survey maps of nearshore zone, created from 1850 – 1890 for the coastal US.

Paper/cloth sheets scanned and georeferenced by NOAA

Accuracy assessment by *Daniels, R.C. and R.H. Huxford. 2001*

Columbia River Sheets:

- Mapped to RM 129 (Rooster Rock). 27 sheets total.
- Survey period predates most diking and draining of tidal wetlands (*Tidal Marshes of the United States.* Nesbit, 1885)

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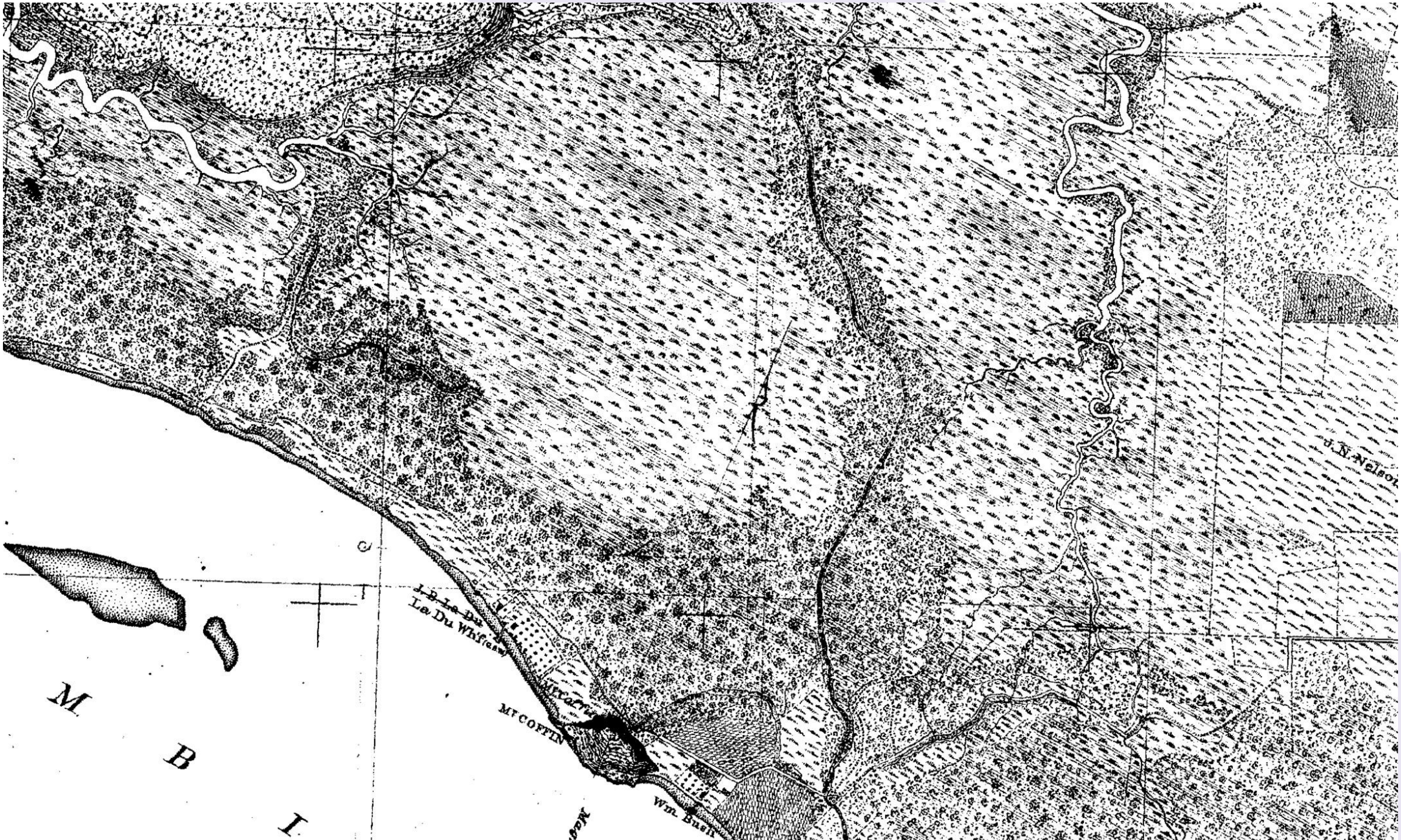
Historical Landscape Reconstruction: T-sheets

Scanned T-Sheet example:



Historical Landscape Reconstruction: T-sheets

SHORE AND SEA BOUNDARIES

WITH SPECIAL REFERENCE
TO THE INTERPRETATION AND USE
OF COAST AND GEODETIC SURVEY DATA

BY

AARON L. SHALOWITZ, LL.M.
Special Assistant to the Director

In Two Volumes

Publication 10–1

U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*
COAST AND GEODETIC SURVEY
H. Arnold Karo, *Director*

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Historical Landscape Reconstruction: T-sheets

From Shalowitz – Shore and Sea Boundaries Volume II Part 2, Chap 4 (1964)

443. High-Water Line in Tidal Marshes

4431. *Formation of Marsh*

In areas of tidal marshes, a different procedure was followed. Marsh is a product of the shallow water of lagoons and other sheltered localities. It usually results from the deposit of sediment on the bottom, which is thus built up to a point where certain kinds of vegetation can take root. The presence of this vegetation accelerates the upward building by its own decay and deposit upon the bottom and by intercepting fine sediment in the waters causing its deposit. During the early stages of the marsh, grass may even grow so rankly that it will rise above the water surface when the ground in which it grows is still below the plane of low water. When marsh building has progressed to a stage where the level is somewhere between high and low water, waves and currents attack its seaward edge, forming a small vertical cliff here. This is a characteristic feature of marsh in this stage of development. The marsh continues building, somewhat more slowly, until ultimately it is dry all the time or substantially all the time. It is then known as meadow. Unless there is some evidence on the survey, it must be assumed in the case of marsh that the high-water line has not been determined.[22]

4432. *The Surveyed Line—Outer Edge of Marsh*

Obviously, it would be an extremely difficult task to identify the actual high-water line in marsh areas. The marsh may be in various stages of growth, from its early beginnings, when it is mostly in a submerged stage, to its latest development, when it is close to or slightly above the plane of high water. Between these two extreme conditions, marsh areas may be entirely submerged at low water, may be exposed at low water and submerged at high water, or may be partially exposed at high water. From the standpoint of the Bureau's topographic surveys, this means that where there are marsh areas, the actual high-water line might start at the water's edge in one portion of the marsh and meander through the area in irregular fashion, terminating at another portion at the water's edge or at the edge of firm ground in the interior.

22. This statement on marsh formation is paraphrased from testimony given by R. S. Patton, while Chief of the Chart Division (later Director) of the Bureau, in the case of *Best Renting Co.* v. *City of New York*, 162 N.E. 497 (1928). Involved was the question whether under a deed from the Crown conveying land, including all marshes and creeks, the land of the plaintiff was included in a grant as meadows or marshes. Material on tidal marshes can be found in Annual Report of the U.S. Coast Survey 82–86 (1869); in Nesbit, Tide Marshes of the United States, Misc. Special Report No. 7, U.S. Department of Agriculture (1885); and in Johnson, The New England-Acadian Shoreline 517–561 (1925).

From a study of successive topographic and hydrographic surveys, the progressive development of a marsh area with relation to the tide can be traced. This is important in determining ownerships of a past date, especially where the land has become bare at high water either through natural processes or through artificial development.

446. The Low-Water Line

A feature on topographic surveys which frequently assumes significance for purposes other than charting is the low-water line. One reason for this is that in some of the states the tidelands (lands between high and low tide) are subject to alienation by the state.[37] Many of the grants to such lands were made years ago prior to waterfront improvements, and it frequently becomes important to know where the low-water line was located at the time of the grant or as close thereto as possible. The hydrographic and topographic surveys of the Bureau often provide the only authentic evidence available.[38] In using these surveys, it is essential that a proper understanding be had of the method of surveying such line, the accuracy with which it is determined, and any other information that would tend to throw light on its delineation on the survey sheet.

4461. *How Determined*

Both to the hydrographer and the topographer, the low-water line is one of the most uncertain and difficult features to delineate. Unlike the high-water line, it is actually visible but momentarily to the topographer. If located by the hydrographer it must generally be accomplished when the height of the tide is well above low water, making it difficult to develop readily its many irregularities. It was, therefore, recognized at a very early period in the work of the Coast Survey that the determination of the low-water line must be left for its final delineation to both parties, "everyone to work according to his best knowledge, and compare afterwards."[39] This provision was, of course, never interpreted to mean that the low-water line on both surveys must be made to agree (an examination of a number of the early surveys supports this conclusion), but

37. In *Oakland* v. *Buteau*, 29 P. 2d 177 (1934), the Supreme Court of California defined the "line of ship channel" as the line of "ordinary low tide."

38. Although riparian ownership in this country extends generally to high-water mark, in a few states it extends to low-water mark. In Massachusetts, for example, by virtue of a 1641–1647 ordinance, the title of the owner of land bounded by tidewater extends to low-water mark where the sea does not ebb beyond 100 rods (1,650 feet). *Commonwealth* v. *Alger*, 61 Mass. 53, 67–81 (1853).

39. "Addition to the Instructions lately given for the planetable surveys of the Coast Survey," dated Sept. 7, 1840, and filed in volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846."

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Historical Landscape Reconstruction: T-sheets

From Shalowitz – Shore and Sea Boundaries Volume II Part 2, Chap 4 (1964)

444. Inner Edge of Marsh

On many of the early topographic surveys, the inner or landward limits of the marsh (the line separating the marsh from the fast land) are shown variously by "a continuous line, a dotted line, or by a continuous line with short hachures at right angles to it, by lone hachures or ends of the parallel lines significant of marsh areas." [29] The Bureau has always interpreted such line as indicating merely the dividing line between the marsh land and the fast or upland, and not as representing any particular tidal elevation other than that inshore of this line the land is bare at all stages of the tide. Generally, it may be considered as the limit of penetration of the highest tides, but, as has been noted previously, in certain stages of marsh development it may coincide with the high-water line (*see* 4432).

The detail with which the line was surveyed depended largely upon its accessibility. Not being a feature readily seen by the mariner the tendency was towards generalization.[30] Where the dividing line between the two characters of land was inaccessible, as where the upland was heavily wooded or overgrown, or where marsh faded imperceptibly into meadow, the dividing line was altogether omitted and the transition shown by the appropriate conventional symbol.

Notwithstanding its use on some of the early surveys, the representation of the inner edge of the marsh by a definite line was never a requirement until the publication of the Topographic Manual of 1928 when it was made permissive by the instruction that "The inner edge of the marsh (the limit of submergence at high water) when clearly defined may be drawn by a line distinctly lighter than the high-water line." [31] The parenthetical phrase used here should be considered as a very general definition of the "inner edge of the marsh" and not as referring to an exact tidal plane (*see* 4432).

29. From letter of F. C. Donn, a field and office man, to the chairman of the topographical conference convened in 1892 by the Superintendent of the Coast Survey (*see* 465). Annual Report, U.S. Coast and Geodetic Survey (Part II) 610 (1891).

30. In all references to the inner edge of marsh or fast land in the early manuals, the discussion deals with the inking of the topographic sheet (by appropriate conventional symbols) and not with the surveying aspect. But it may be concluded that there was no intention that the dividing line be located with great accuracy and detail the value of which would be vitiated by a generalization in the final inking. Annual Report, U.S. Coast Survey 218 (1860), and Wainwright (1922), *op. cit. supra* note 13, at 66. Occasionally, however, as a result of the judgment of the individual topographer, the inner edge of the marsh was very carefully delineated. For example, on Register No. T–1369 (1874), the dividing line between the inner edge of the salt marsh and the outer edge of the fresh marsh is shown by a continuous fine black line. A note in the early correspondence (Jan. 2, 1875) states that "Care was taken to delineate exactly the division line between salt and fresh water marsh, a point that may be of future value in land dispute."

31. Swainson (1928), *op. cit. supra* note 3, at 9. But at page 93 it is stated that "Neither the inner border of a marsh nor a shoal covered at high tide has a distinct continuous line to mark its limits, each being represented in its proper form and within its area by its conventional symbol only."

This practice of using a definite line for the inner edge of the marsh was reversed in 1938 by *Field Memorandum No. 1, supra* note 23, at 242, which provides in part that "The edge of high ground at the back of the marsh, mangrove and cypress areas shall be indicated by symbols only . . . and *not* by a fine line."

The practice in 1949 was to show the inshore limits of marsh by a broken blue line on planimetric and topographic manuscripts, but by conventional symbols on shoreline manuscripts.[32]

445. Marsh Areas Mostly Flooded at High Water

A feature frequently encountered on topographic surveys is a marsh representation (with solid or broken horizontal rulings), without a solid bounding line. This is interpreted to indicate that there existed no well-defined edge at high water which the topographer could consider the dividing line between land and water. What he saw was a marshy area mostly flooded at high water. Such formations are characteristic of marsh in the early stages of development and may be found contiguous to a well-defined marsh or outside the high-water line. The elevation of the ground in such cases is below high water and usually below low water, although scattered tufts of grass may in places protrude above high water.

The earliest reference to such formations was contained in the treatise on the planetable published in the Annual Report of 1865. They were referred to as "grassy shoals" and "grass upon flats, or shoals covered at high tide," and were described as "always found in water scarcely agitated by waves or currents." They were to be shown on the finished topographic sheet without a "distinct continuous line to mark their limits, each being represented in its proper form and within its area by its conventional sign only, but the shape should be well and correctly defined." [33] This practice is still continued on planetable surveys [34] and on photogrammetric surveys.[35]

The same collateral sources mentioned in 4433 should be examined for additional information regarding the condition of such marsh areas with respect to the tidal plane.[36]

32. Swanson (1949), *op. cit. supra* note 25, at 340, 343.

33. Annual Report, U.S. Coast Survey 220, 230 (1865). Appended to this report, as Sketch No. 32, is a composite drawing of the eastern end of Deer Island and shows the method of representing such marsh areas. (*See* fig. 49.)

34. *Field Memorandum No. 1 (1938), supra* note 23, at 241.

35. Swanson (1949), *op. cit. supra* note 25, at 343.

36. *See,* for example, Descriptive Report for Register No. T–5976 (1949). There have been instances where such marsh formations have been enclosed by a dotted or pecked line (*see* Register No. T–1115 (1869)). This is interpreted to be a cartographic expedient rather than a distinction from those areas shown without such enclosing line (*see* contemporary hydrographic survey Register No. H–1064 (1869), and representation on recent topographic survey of same area, Register No. T–5976 (1949)).

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Historical Landscape Reconstruction: T-sheets

From Shalowitz – Shore and Sea Boundaries Volume II Part 2, Chap 4 (1964)

Analysis and Interpretation of Topographic Surveys 163

FIGURE 41.—Mapping an Alaska shoreline with the planetable. The planetabler constructs his map as he surveys. The rodman on the point of rocks is holding a telemeter rod and the observer is measuring its distance and direction from the planetable.

4113. *Mapping the Shoreline*

In mapping the shoreline, the topographer set up his instrument at some commanding point where he could see the beach for 400 or 500 yards. The rodman walked along the beach setting up his rod at short intervals and particularly wherever there was a change in direction. The topographer deter-

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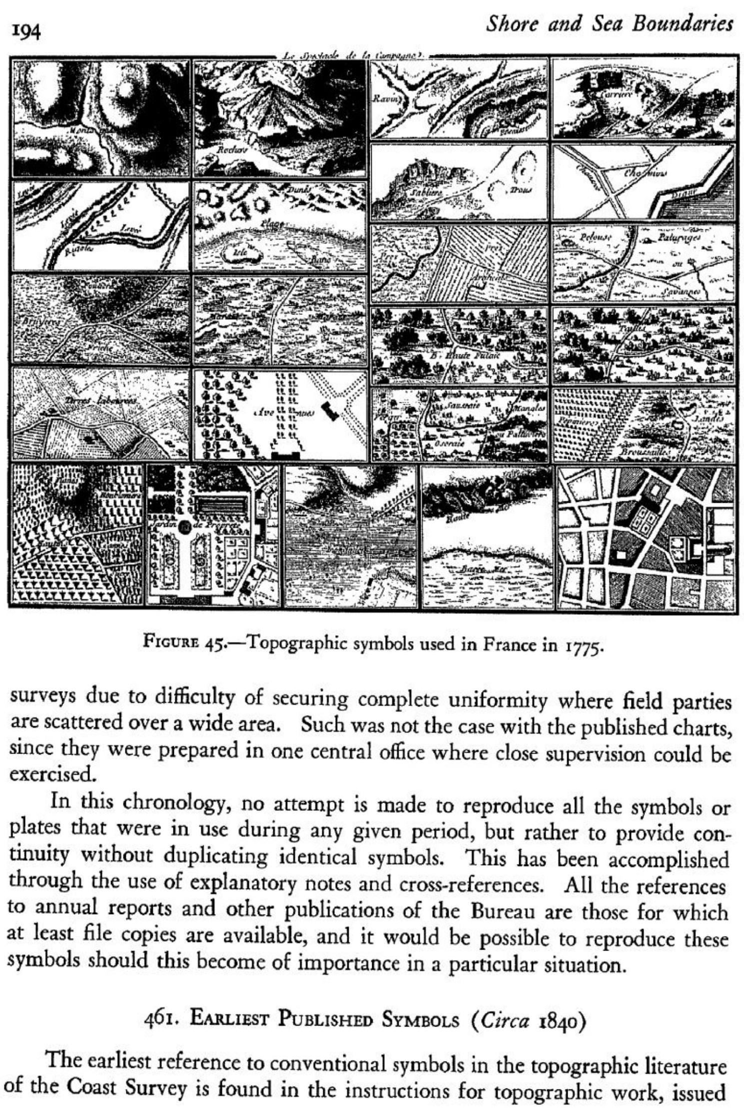
Historical Landscape Reconstruction: T-sheets

Chronology of T-Sheet Symbols (From Shalowitz, 1964)



194 Shore and Sea Boundaries

FIGURE 45.—Topographic symbols used in France in 1775.

surveys due to difficulty of securing complete uniformity where field parties are scattered over a wide area. Such was not the case with the published charts, since they were prepared in one central office where close supervision could be exercised.

In this chronology, no attempt is made to reproduce all the symbols or plates that were in use during any given period, but rather to provide continuity without duplicating identical symbols. This has been accomplished through the use of explanatory notes and cross-references. All the references to annual reports and other publications of the Bureau are those for which at least file copies are available, and it would be possible to reproduce these symbols should this become of importance in a particular situation.

461. EARLIEST PUBLISHED SYMBOLS (*Circa* 1840)

The earliest reference to conventional symbols in the topographic literature of the Coast Survey is found in the instructions for topographic work, issued

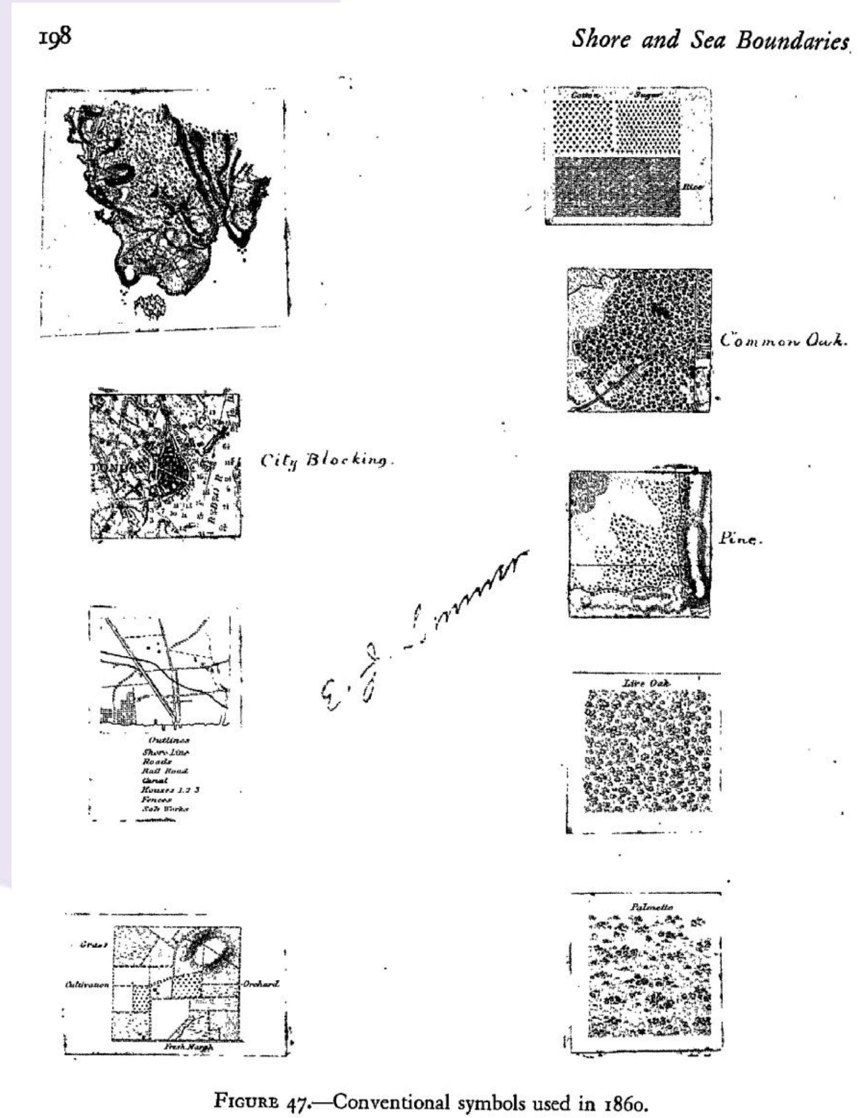


FIGURE 47.—Conventional symbols used in 1860.

Historical Landscape Reconstruction: T-sheets

Chronology of T-Sheet Symbols (From Shalowitz, 1964)

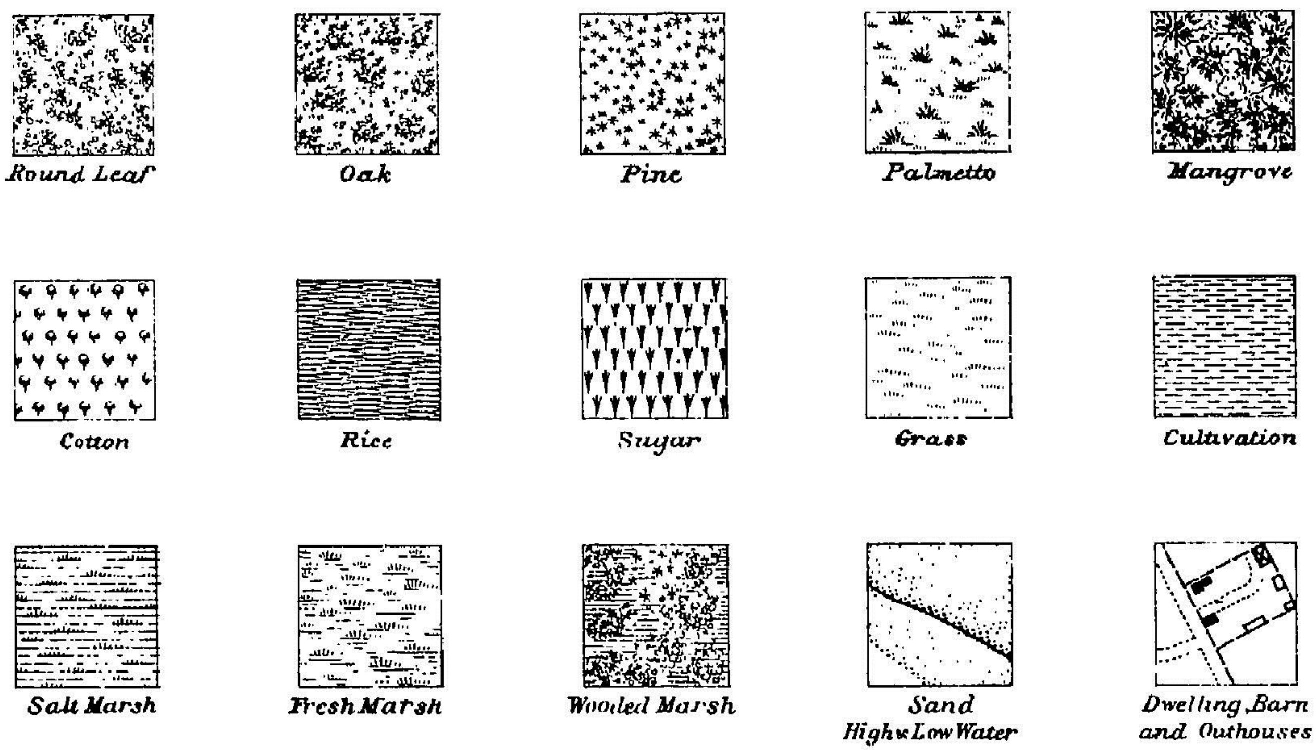


FIGURE 50.—Conventional symbols used in 1865.

final drawing was done by one familiar with the character of the ground. On

Historical Landscape Reconstruction: T-sheets

Chronology of T-Sheet Symbols (From Shalowitz, 1964)

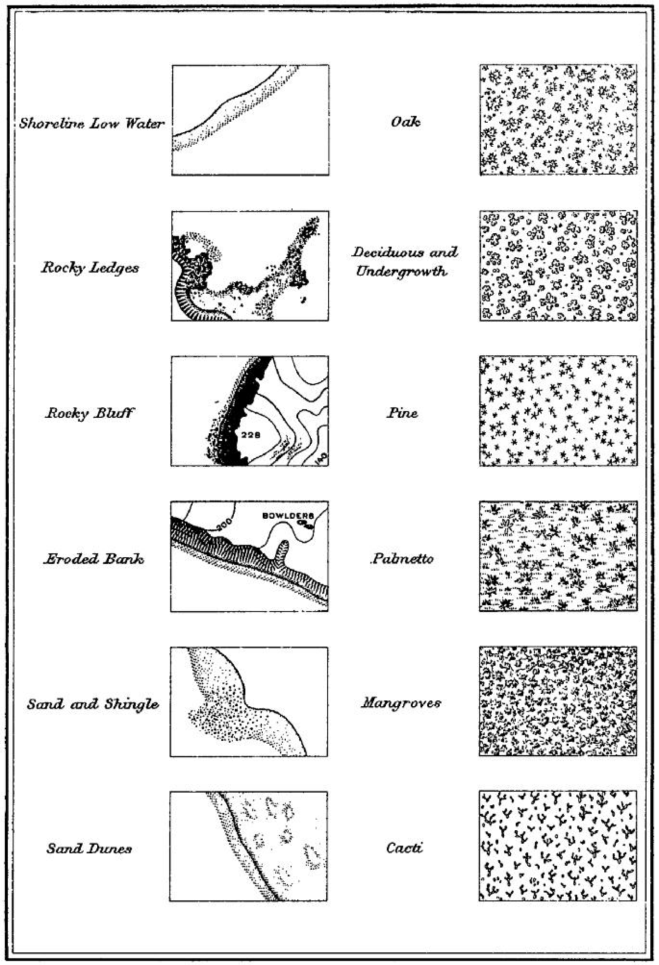


FIGURE 51.—Conventional symbols used in 1892.

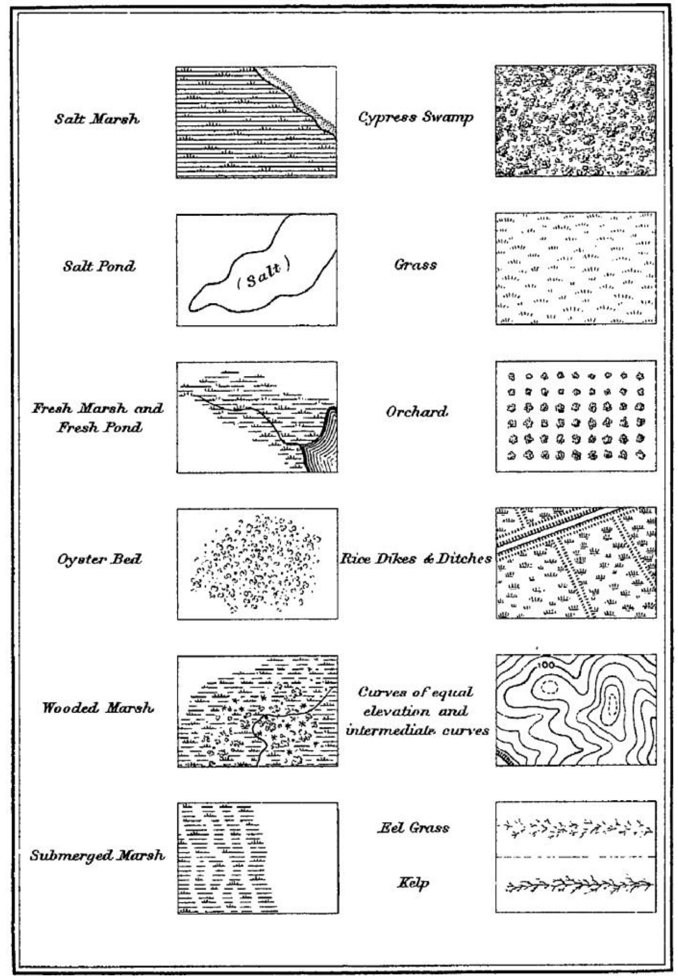


FIGURE 52.—Conventional symbols used in 1892.

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Historical Landscape Reconstruction: T-sheets

- **T-Sheet Digitization: Jennifer Burke, Univ. of WA. 2006-2010**

Extended work of Thomas (1983) and Graves/Christy (1995)

- Increased spatial extent (RM 42/105 to RM 129)
- Modified classification (increased detail)

Difficulties

- Multiple surveyors using slightly different mapping conventions
- Quality of scanned images

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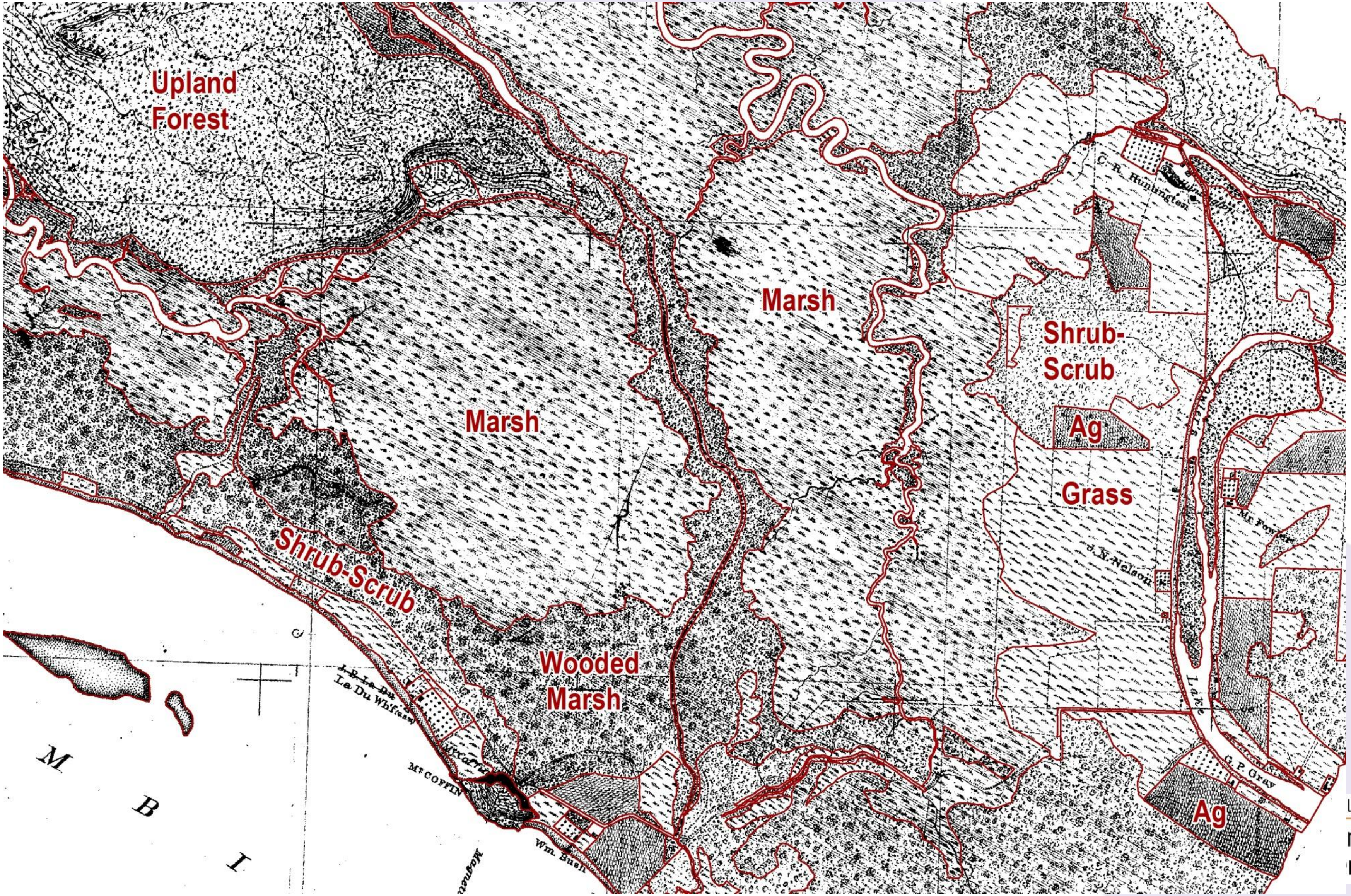
Historical Landscape Reconstruction: T-sheets

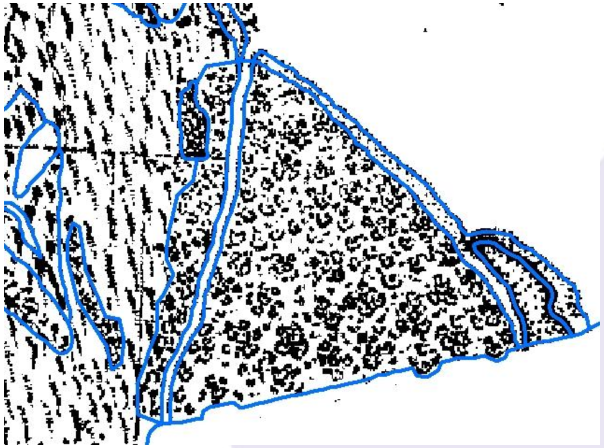
GIS Reconstruction of T-Sheet Data



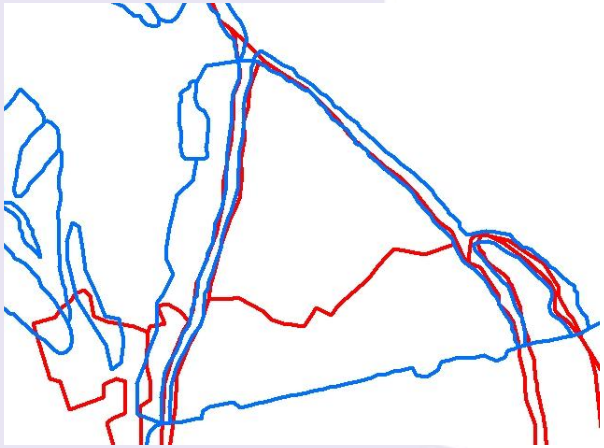
Historical Landscape Reconstruction: T-sheets

- **Edge Matching Adjoining Digitized T-Sheets (LCEP)**

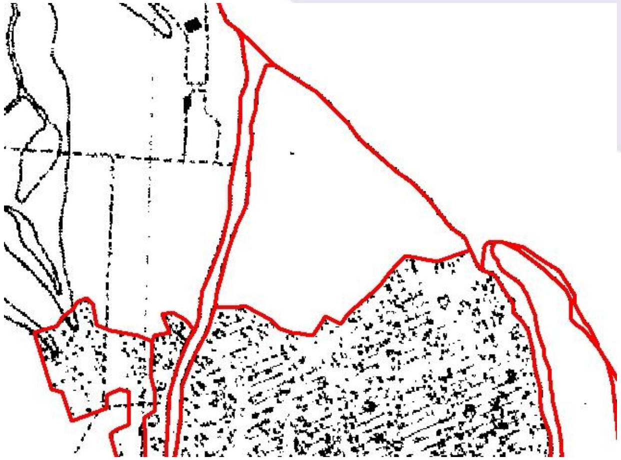
Sheet 1455 + digitized features



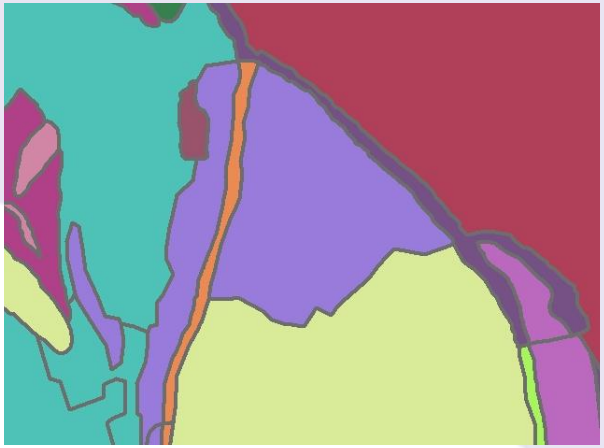
Digitized features overlay



Sheet 1495 + digitized features



Edge-matched features based on reference data



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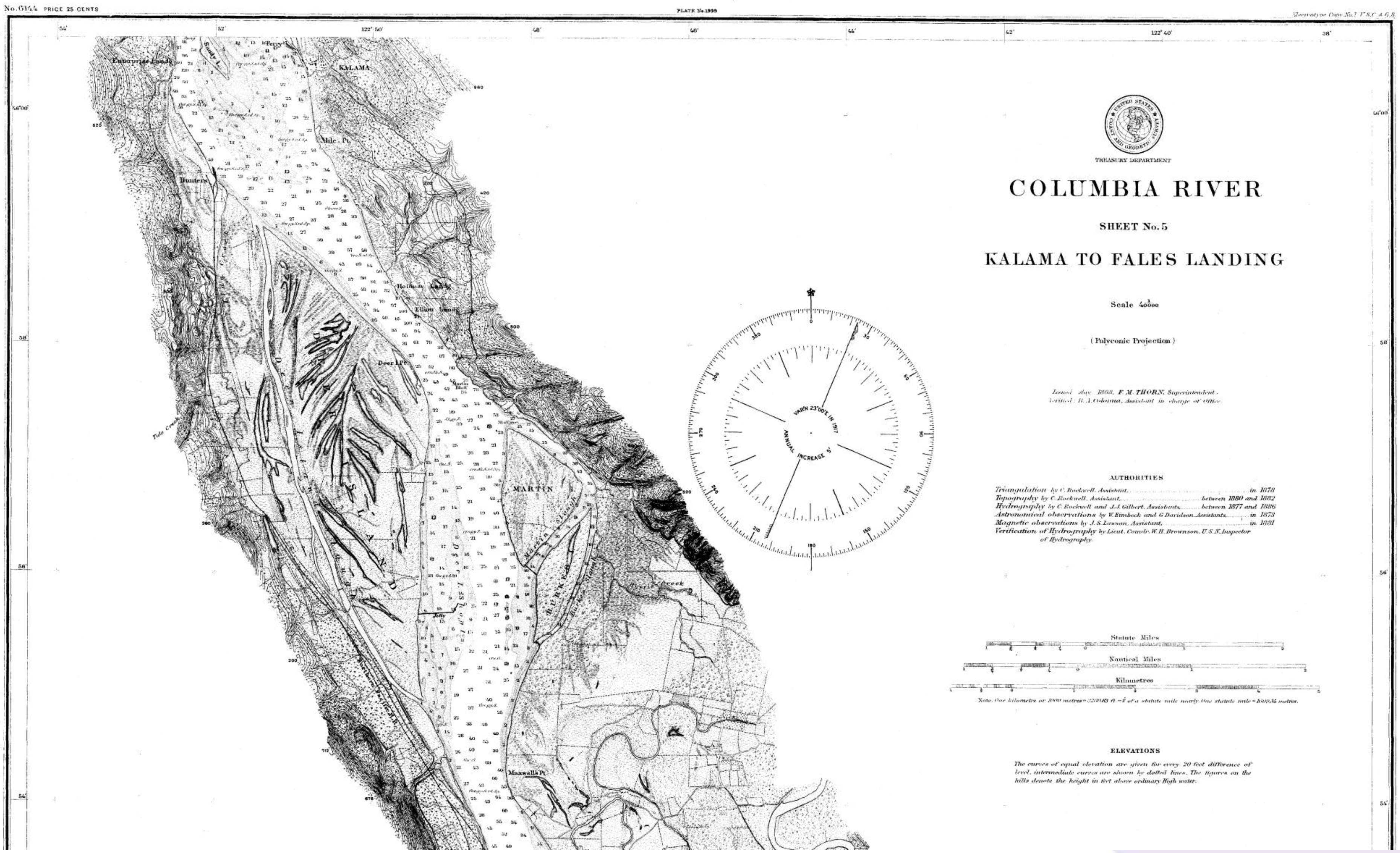
Historical Landscape Reconstruction: T-sheets

- **Edge Match Reference Data**



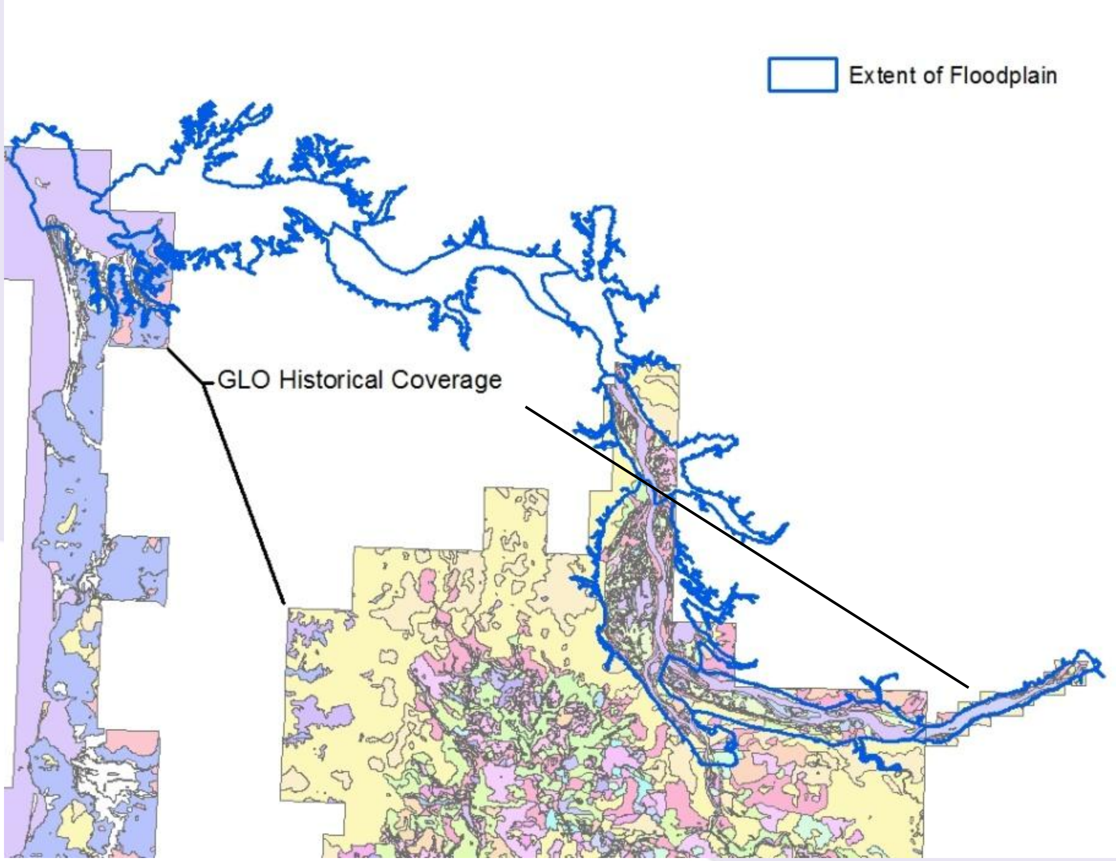
Historical Landscape Reconstruction: GLO maps

- **Maps and Field Notes from General Land Office Cadastral Survey**

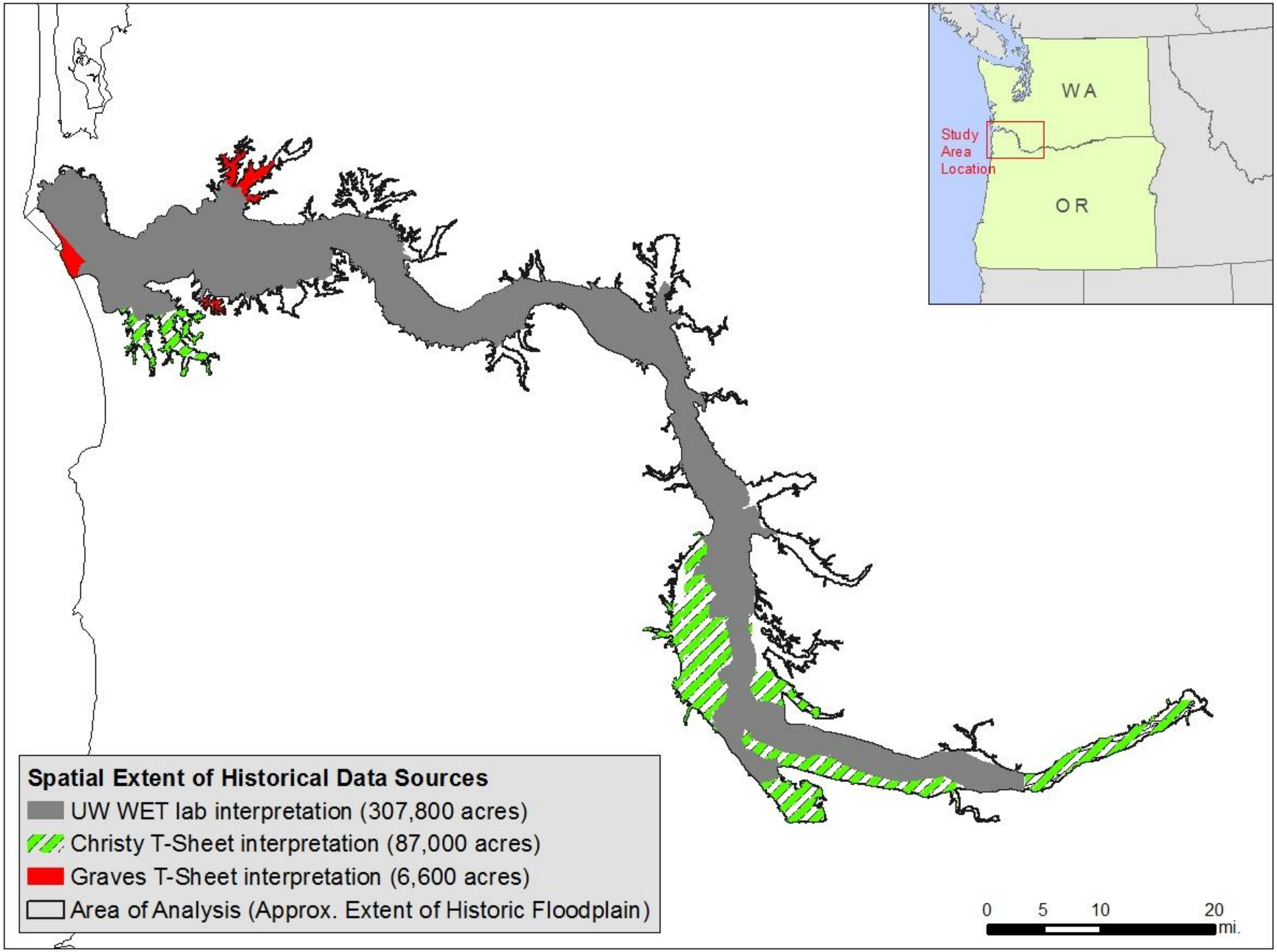
  Same survey period as T-sheets (late 1800s)

  Digitized by John Christy (Oregon Natural Heritage Program, 1999)

  Fill gaps in T-sheet data



Historical Landscape Reconstruction: Final Coverage



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Present Day Landscape: LCEP 2010 Data Set

- **LCEP 2010 High Resolution Land Cover Data Set**

  Funded by Bonneville Power Administration

  Part of Columbia R. Estuary Ecosystem Classification

  Classification scheme adopted from 2000 LCEP LandSAT TM classification (Garano)

  High resolution (0.25 acre) *segmented* approach based on:

  2009 NAIP, 2010 LiDAR, 2007-2008 LandSAT

  Improved estimates for tidal/fluvial and diking extents based on recent LiDAR and WSE data

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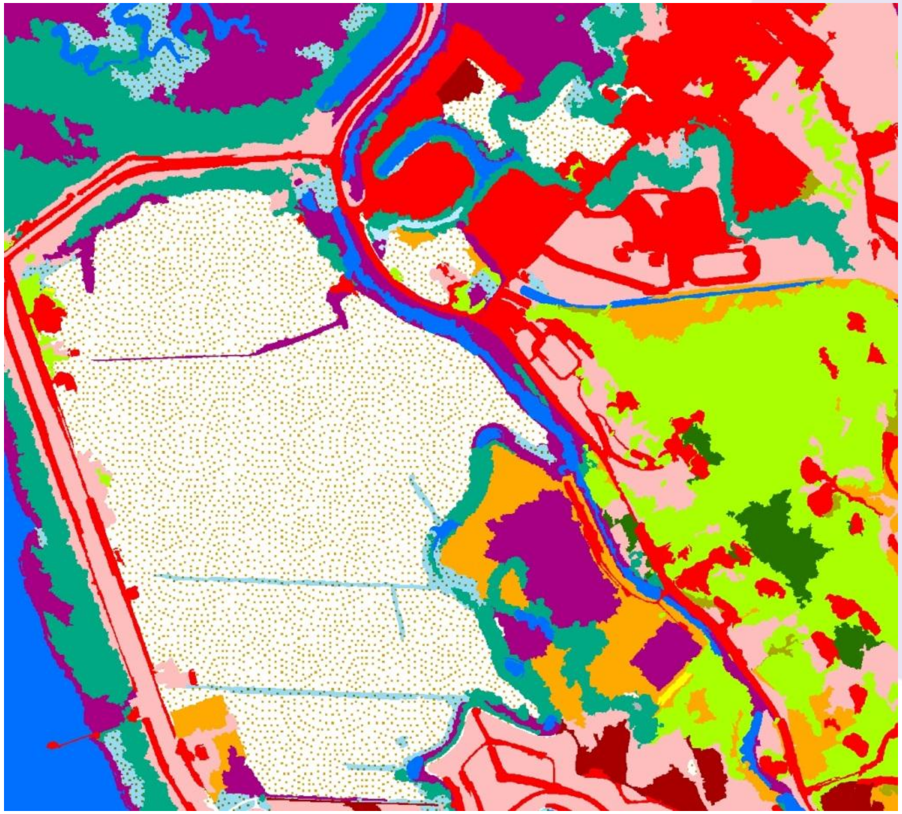
Present Day Landscape: LCEP 2010 Data Set

- **Segmented vs. Raster Land Cover Data Comparison**

2010 LCEP High Resolution (NAIP)



2000 LCEP 30m (LandSAT)

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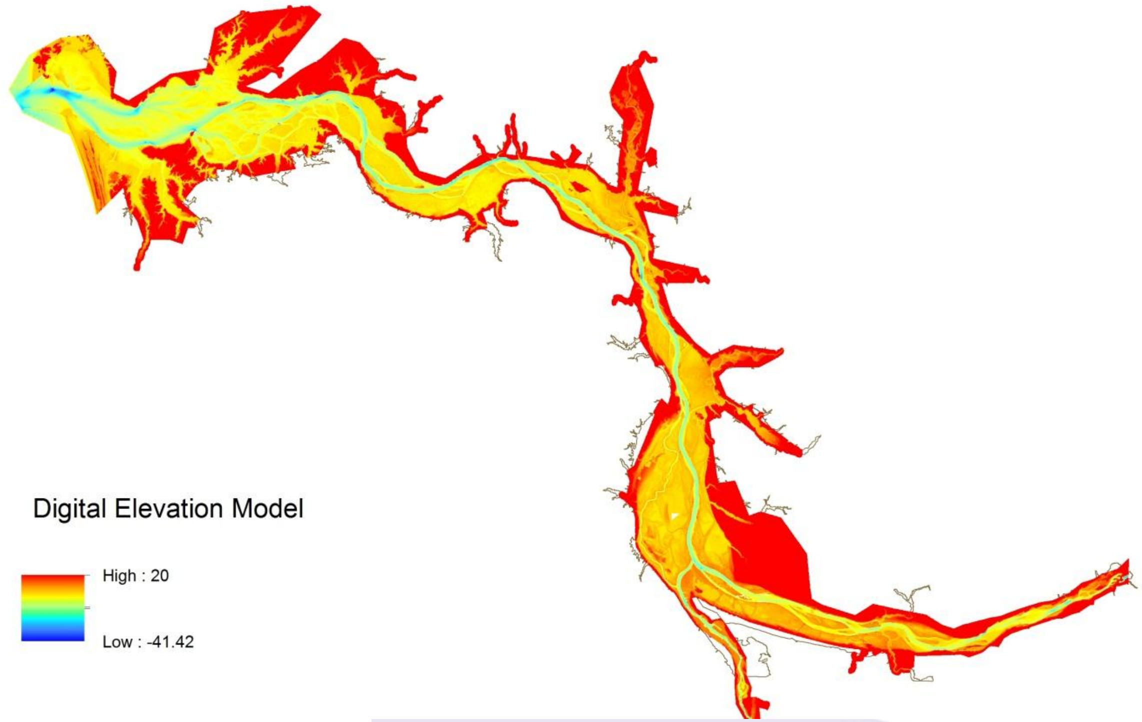
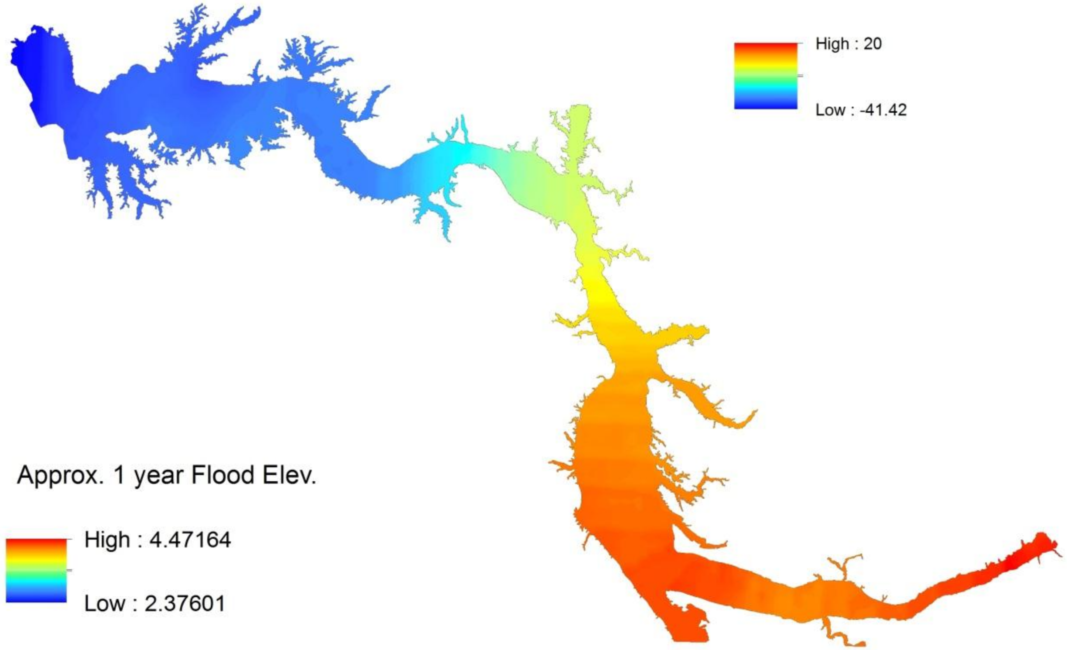
Present Day Landscape: LCEP 2010 Data Set

Derivation of Tidal/Non-Tidal/ Diked Designation for Wetlands Habitats:

1) Compare Approximate 1 Year Water Surface Elevation Data to LiDAR Derived DEM (tidal vs. non-tidal)





2) Add levee and point barrier information (tidal vs. diked)

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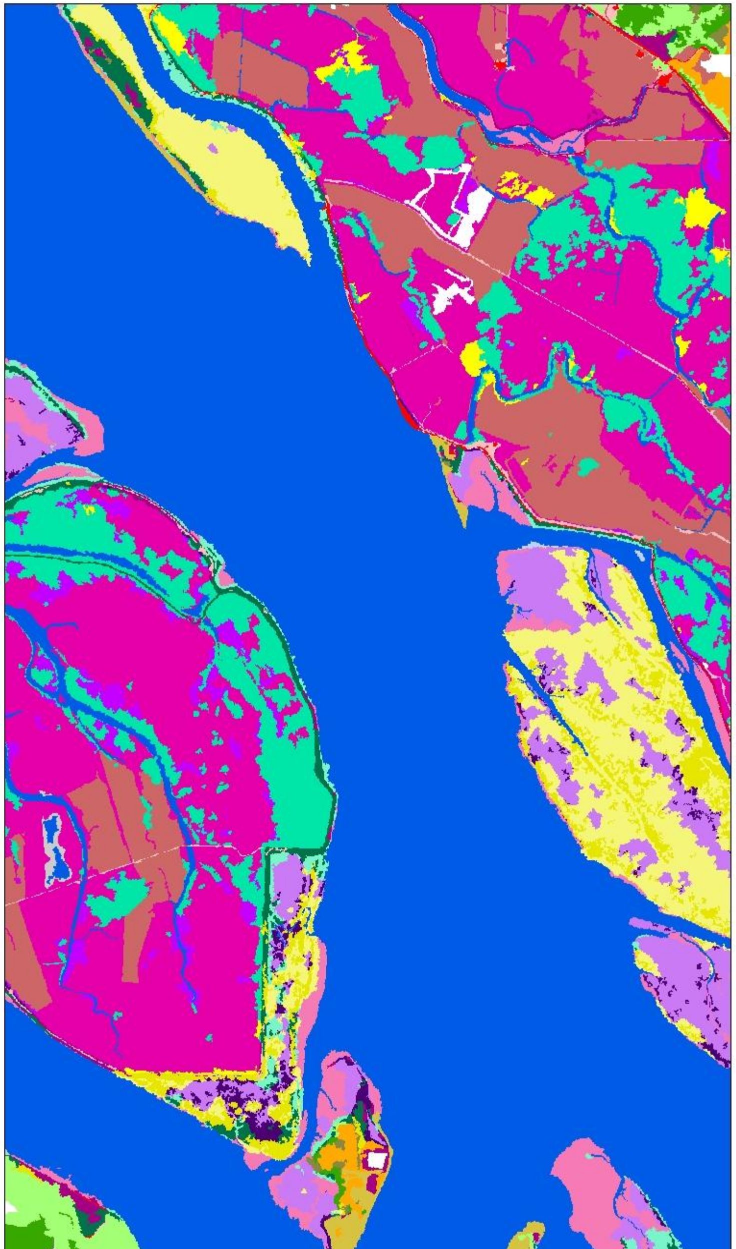
Present Day Landscape: LCEP 2010 Data Set



Cover Classes

- Coniferous Upland Forest
- Deciduous Upland Forest
- Coniferous Wetland Forest - Non Tidal
- Coniferous Wetland Forest - Tidal
- Coniferous Wetland Forest - Diked
- Deciduous Wetland Forest - Non Tidal
- Deciduous Wetland Forest - Tidal
- Deciduous Wetland Forest - Diked
- Shrub-Scrub Upland
- Shrub-Scrub Wetland - Non Tidal
- Shrub-Scrub Wetland - Tidal
- Shrub-Scrub Wetland - Diked
- Herbaceous Upland
- Herbaceous Wetland - Non Tidal
- Herbaceous Wetland - Tidal
- Herbaceous Wetland - Diked
- Aquatic Beds
- Agriculture
- Tree Farms
- Bare
- Mud
- Sand
- Rock
- Urban - Impervious
- Open Space Developed
- Water

Cover Class Crosswalk

Normalized Class	Code	T-Sheet Classes (Burke)	T-Sheet Classes (Graves/Thomas)	GLO Classes (Christy)	2010 Classes (LCEP)
Herbaceous Tidal WL	HWT	- Marsh: tidal - Submerged Marsh: Tidal	- Marsh: tidal	- Tidal marsh: salinity undifferentiated - Marsh: unknown - Wapato Marsh	- Herbaceous Tidal WL
Herbaceous Non-tidal WL	HWNT	- Marsh: floodplain, upland - Submerged Marsh: floodplain		- Seasonally or perennially wet prairie - Marsh/Wet Meadow, unknown	- Herbaceous Non-tidal WL - Herbaceous Diked WL
Shrub-Scrub Tidal WL	SWT	- Shrub-Scrub Marsh: Tidal	- Willow Swamp: Tidal	- Willow Swamp - Swamp: unknown	- Shrub/Scrub Tidal WL
Shrub Scrub Non-tidal WL	SWNT	- Shrub Scrub Marsh: floodplain		- Wetland: unknown	- Shrub/Scrub Non-tidal WL - Shrub/Scrub Diked WL
Forested Tidal WL	FWT	- Wooded Marsh: Tidal	- Spruce Swamp: Tidal - Cottonwood Swamp: Tidal	- Sitka Spruce Swamp - Ash Swamp	- Coniferous Tidal WL Forest - Deciduous Tidal WL Forest:
Forested Non-tidal WL	FWNT	- Wooded Marsh: Floodplain, Upland		- Black Cottonwood Riparian - Red Alder – Mixed Conifer Riparian - Red Alder swamp - Mixed Riparian - Riparian Sitka Spruce Forest - Mixed Riparian - Black Cottonwood Riparian	- Coniferous Non-tidal WL Forest - Coniferous Diked WL Forest - Deciduous Non-tidal WL Forest - Deciduous Diked WL Forest

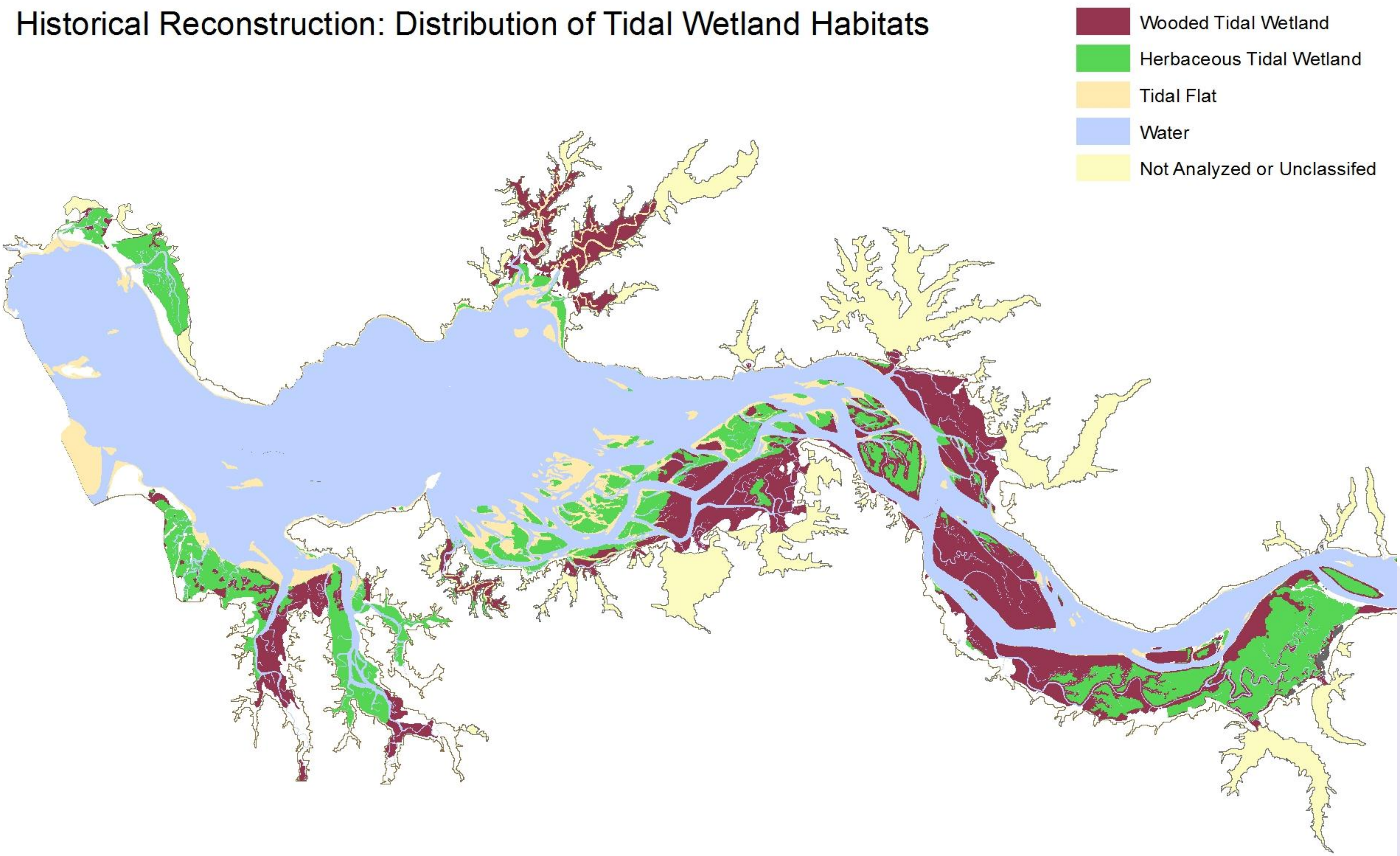
Cover Class Crosswalk

Normalized Class	Code	T-Sheet Classes (Burke)	T-Sheet Classes (Graves/Thomas)	GLO Classes (Christy)	2010 Classes (LCEP)
Herbaceous non-wetland	H	- Grass: upland, floodplain		- Prairie, wet and dry undifferentiated - Upland and xeric prairie	- Herbaceous non-wetland
Shrub-Scrub non-wetland	S	- Shrubs: upland, floodplain		- Doug Fir (Savannah) - Rose or briar thickets - Brush fields or thickets on slopes and ridges - Brush, composition unknown - Brush fields or thickets on bottoms or wet terraces	- Shrub/Scrub non-wetland
Forested non-wetland	F	- Mixed Forest: upland, floodplain - Pine: upland, floodplain - Woodland: upland, floodplain		- Doug Fir - Doug Fir/White Oak - White Oak - Sitka Spruce - Doug Fir/White Oak (Woodland) - Doug Fir (Woodland)	- Coniferous Forest - Deciduous Forest
Tidal Sand/Mud Flats	TF	- Sand flat, tidal	- Tidal Flats, - Shallows		- Sand - Mud
Agriculture	AG	- Orchard: upland, floodplain - Cultivated: upland, floodplain			- Agriculture - Tree Farms

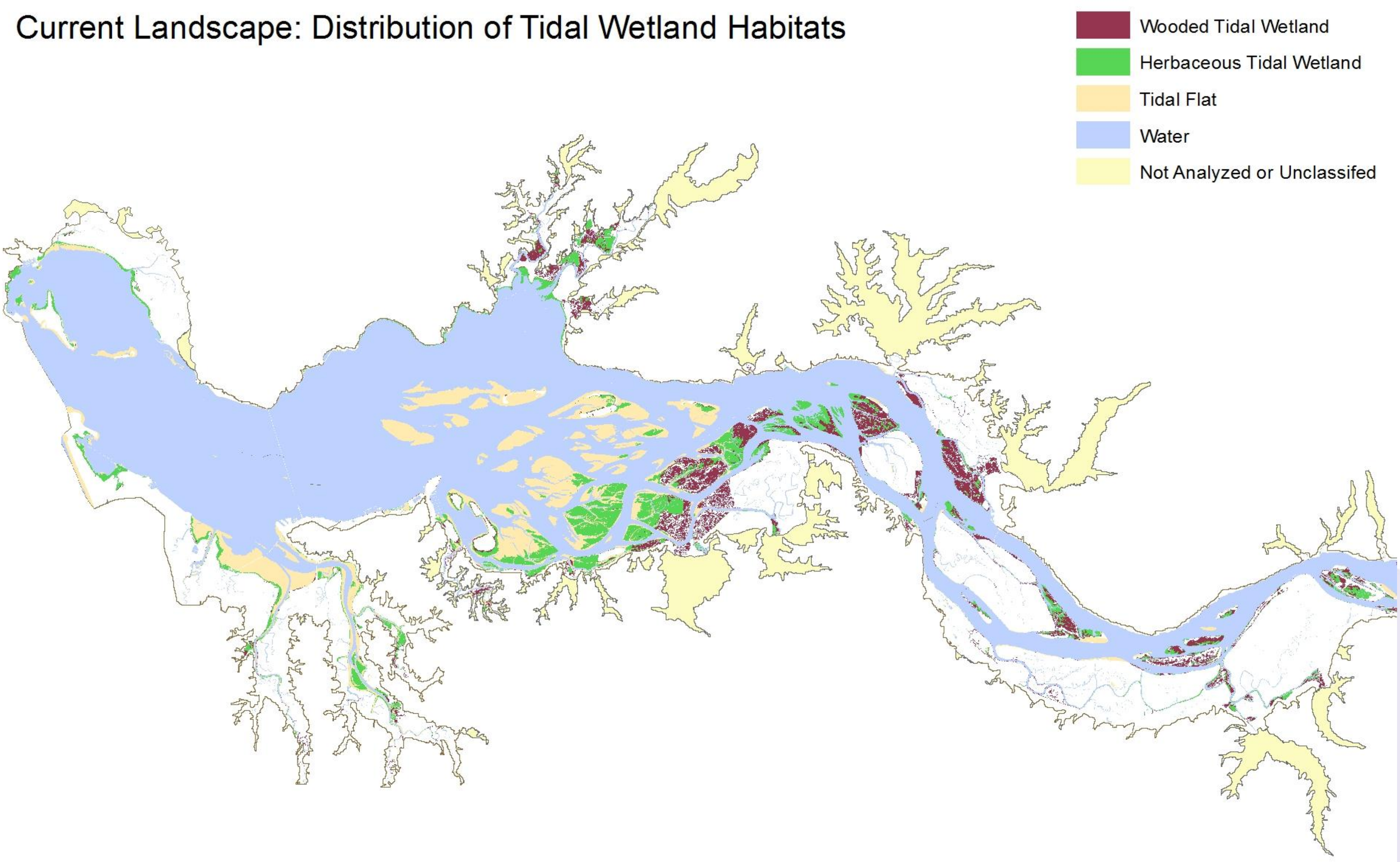
Cover Class Crosswalk

Normalized Class	Code	T-Sheet Classes (Burke)	T-Sheet Classes (Graves/Thomas)	GLO Classes (Christy)	2010 Classes (LCEP)
Developed	D	- Dwellings: upland, floodplain - Road: upland, floodplain - Levee: upland, floodplain - Overwater Structure: floodplain			- Urban: Impervious - Urban: Open Space Developed
Water	W	- Riverine/Estuarine: tidal - Open Water: upland, floodplain - Stream/river: upland, floodplain	- Deep Water - Medium/Shallow Water	- Water Bodies - Seasonally Flooded Lake	- Aquatic Beds - Water
Other	O	- Barren: upland, floodplain - Sand: floodplain - Sand Flat: floodplain - Rocky bluff: upland - Eroded Bank: upland		- Rock Outcrops, talus, exposed bedrock, scree etc. - Gravel bar	- Barren -Rock
Unclassified	UNC	- Unclassified			

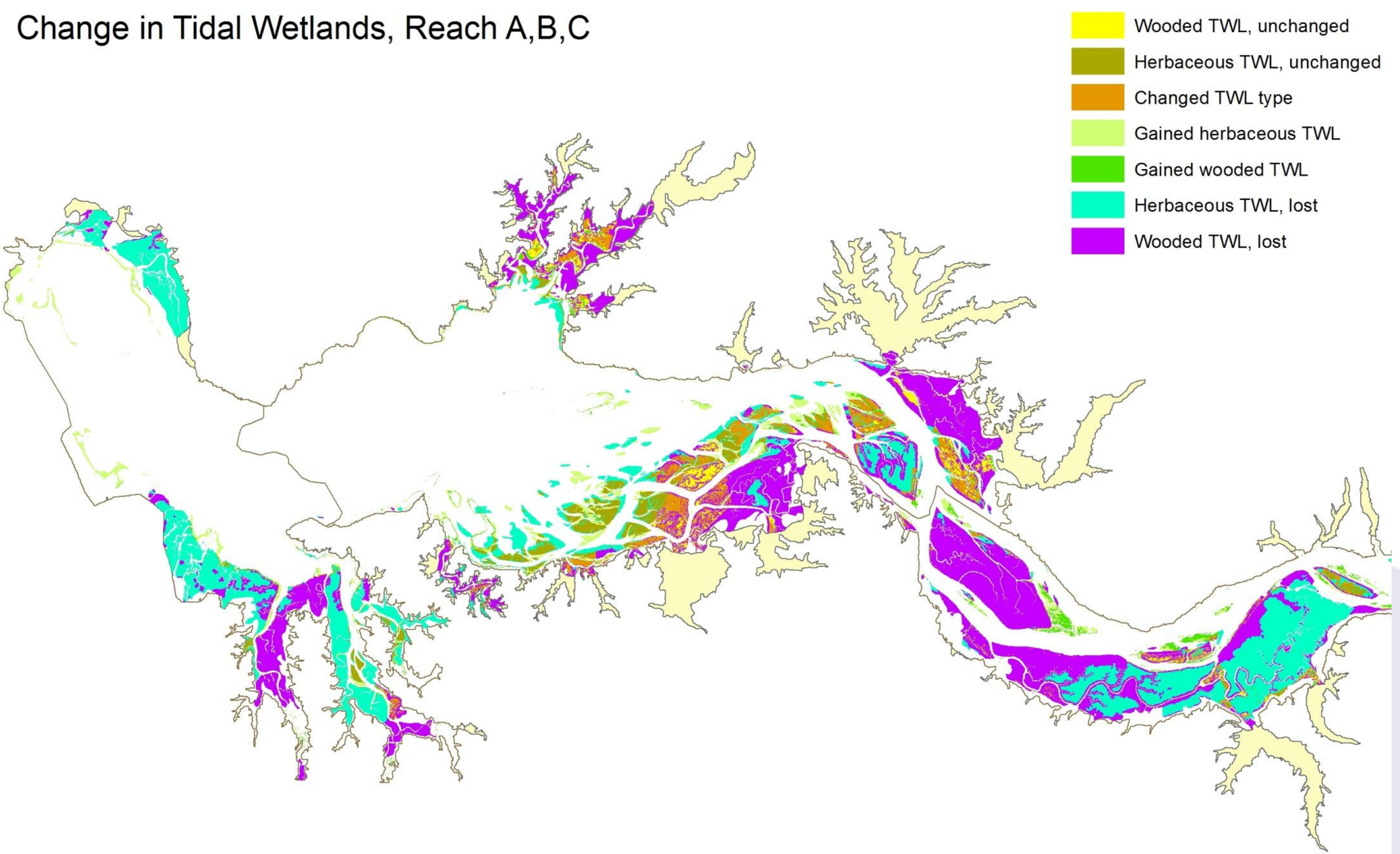
Change Analysis Results



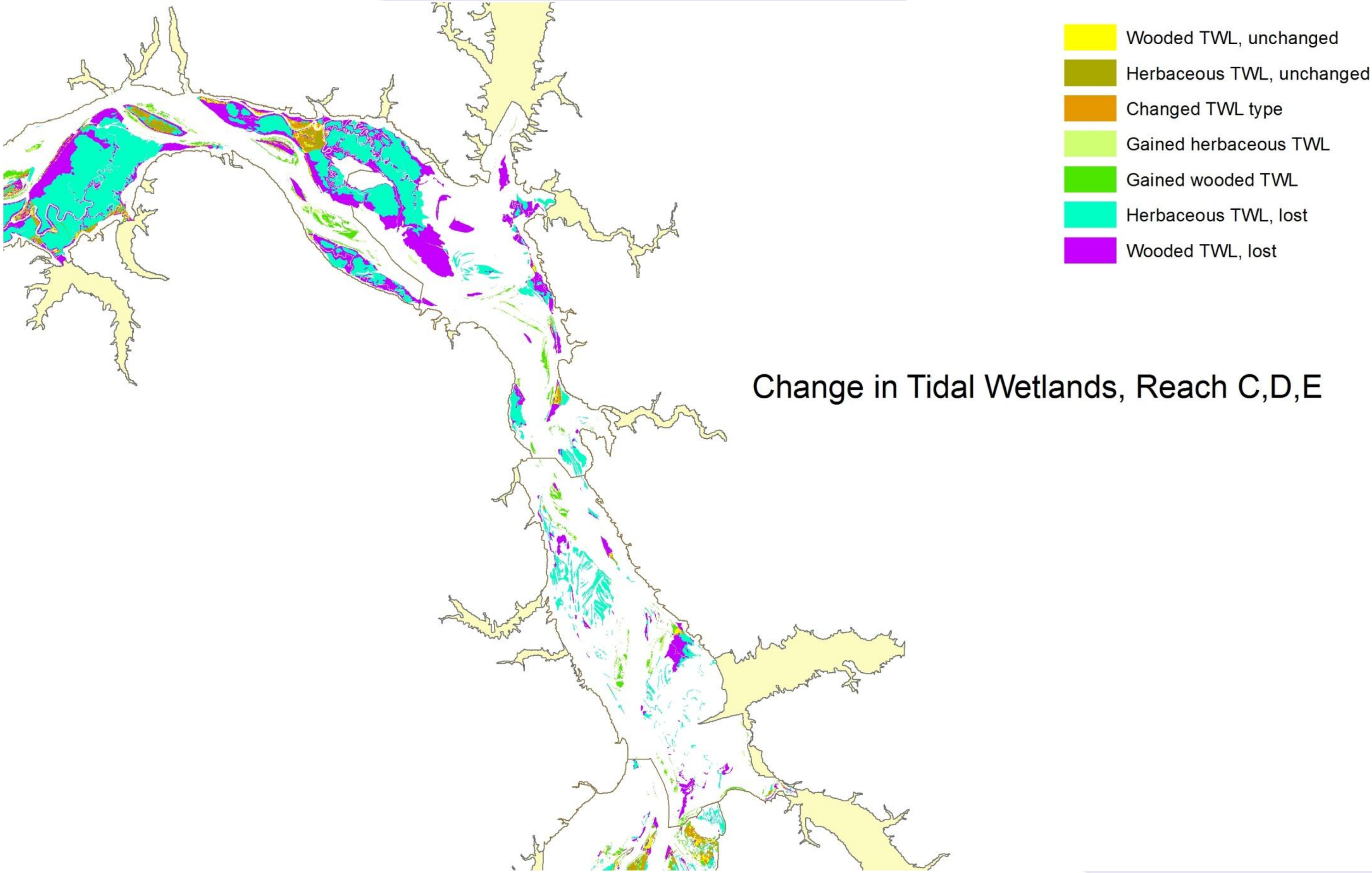
Change Analysis Results, cont'd



Change Analysis Results, cont'd

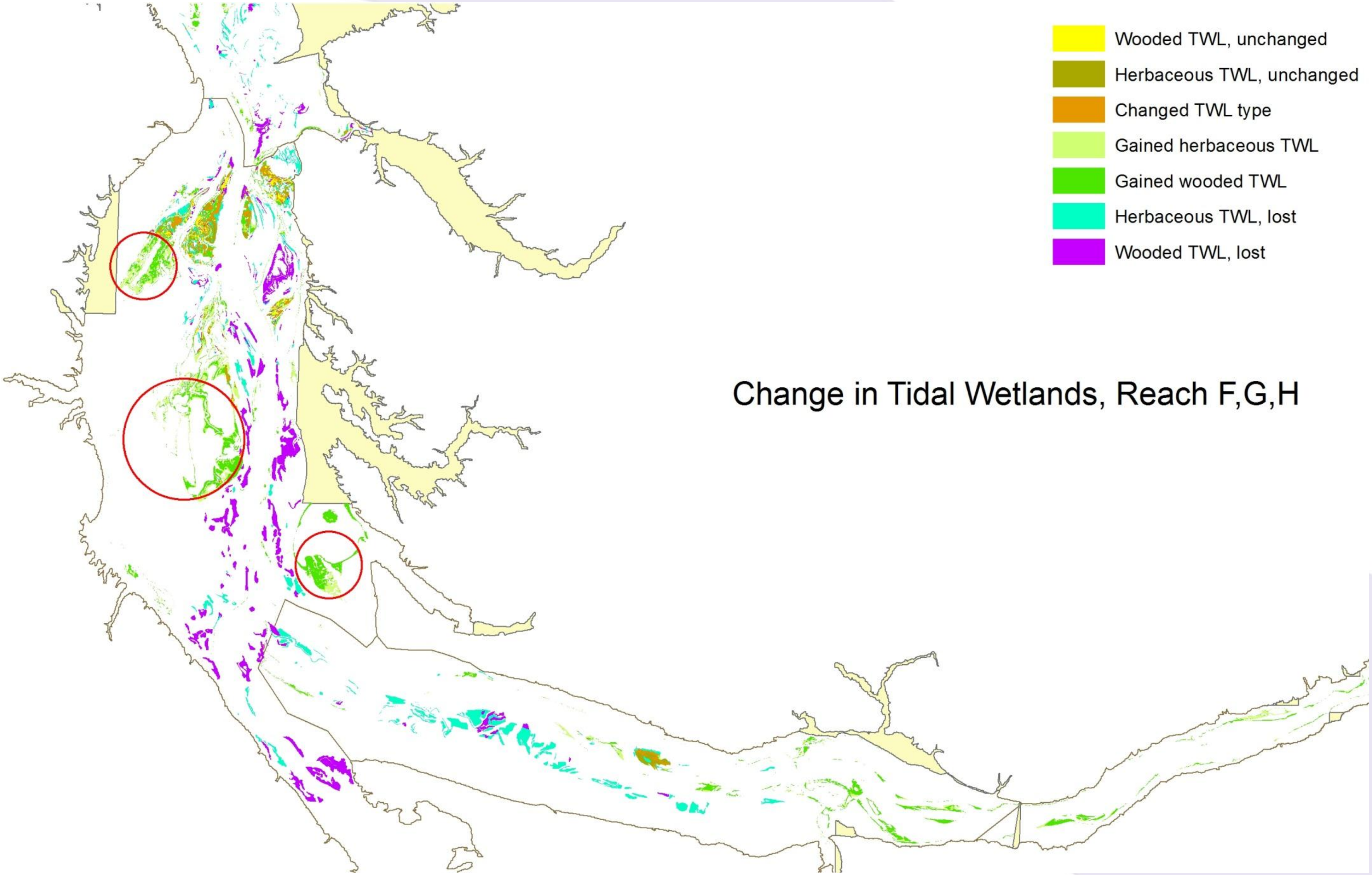


Change Analysis Results, cont'd



Change in Tidal Wetlands, Reach C,D,E

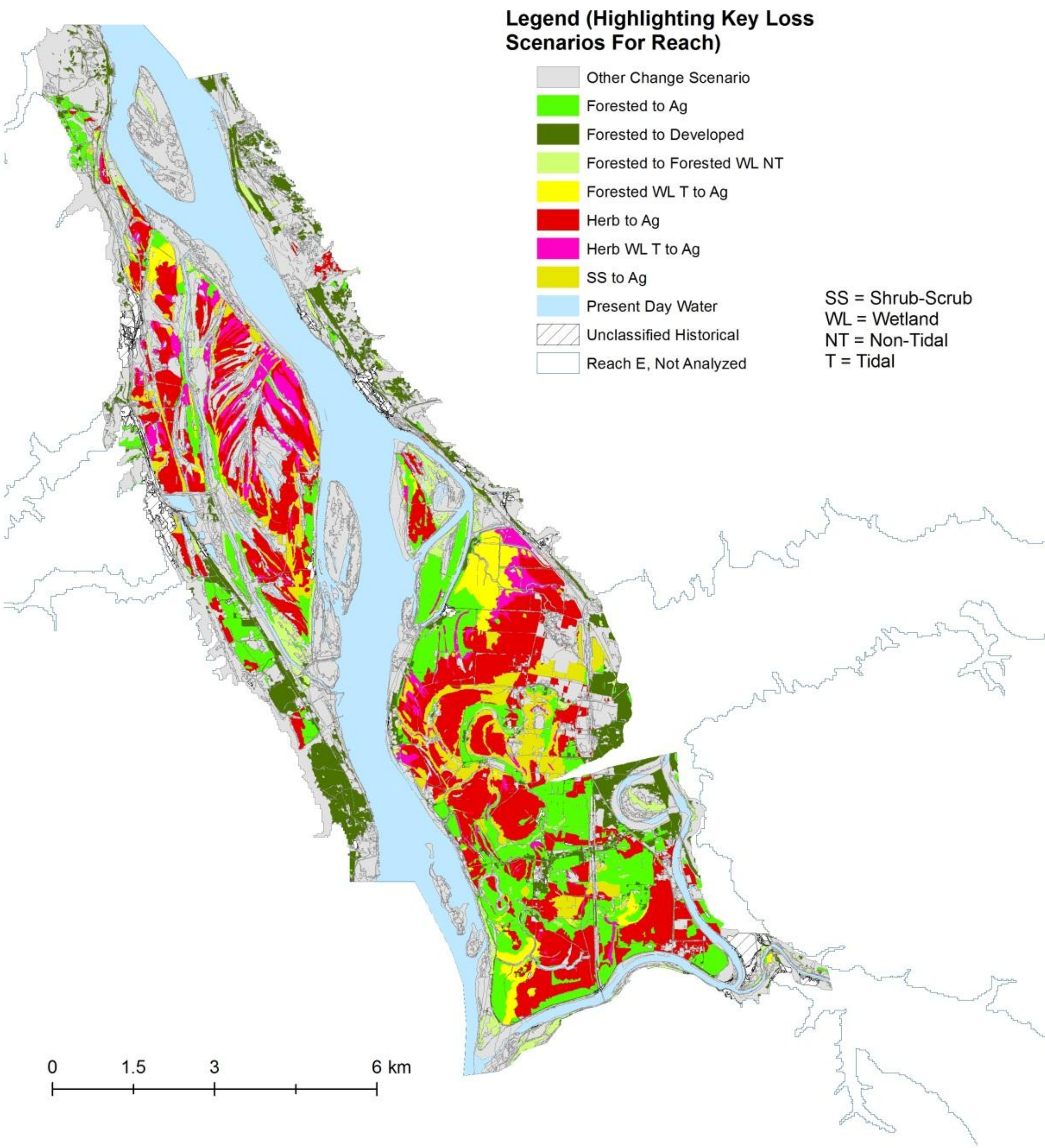
Change Analysis Results, cont'd

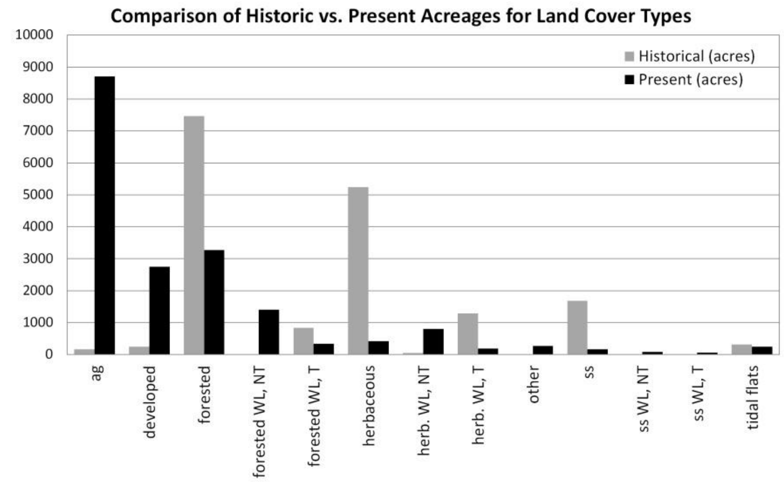


Change Analysis Results, cont'd

Present: / Historic:	Ag	D	F	H	HWNT	HWT	O	S	TF	UNC	W	WWNT	WWT	historical acres	percent loss
Agriculture (Ag)	323	1,411	265	28	42	3	47	25	7	(0)	44	67	7	2,267	
Developed (D)	216	1,023	237	38	33	7	27	16	6	(0)	55	60	5	1,724	
Forested (F)	11,559	31,482	25,355	2,449	1,552	319	983	1,430	289	(0)	2,441	4,381	730	82,969	**55**
Herbaceous (H)	9,229	9,706	2,432	1,046	1,207	337	323	245	59	(0)	635	1,197	324	8,162	**73**
Herb. wetland, non-tidal (HWNT)	6,393	1,670	450	240	749	313	37	49	8	(0)	342	681	301	11,236	
Herb. wetland, tidal (HWT)	12,521	4,859	826	646	3,472	3,877	128	126	902	(0)	2,959	3,181	1,969	35,466	**68**
Other (O)	20	298	304	12	39	76	5	31	50	(0)	589	179	30	1,632	
Shrub-scrub (S)	1,296	2,367	870	108	117	12	34	21	22	(0)	166	229	20	5,262	**52**
tidal sand/mud flats (TF)	155	722	581	129	389	1,326	81	67	2,588	(0)	5,231	746	432	12,448	
Unclassified (Unc)	(361)	(497)	(360)	(46)	(45)	(17)	(6)	(28)	(13)	(0)	(70)	(110)	(30)	(1,583)	
Water (W)	4,883	4,881	2,608	1,316	3,111	3,386	359	317	10,910	(0)	130,921	3,883	3,539	170,114	**14**
Wooded/ss wetland, non-tidal (WWNT)	1,794	2,033	1,540	671	712	419	78	99	204	(0)	795	1,556	748	10,522	
Wooded/ss wetland, tidal (WWT)	13,462	5,300	1,521	538	4,198	1,306	251	123	270	(0)	2,419	5,867	4,184	39,439	**69**
Present Acres	61,849	65,571	36,989	7,221	15,623	11,381	2,354	2,549	15,187	(0)	146,598	22,027	12,289	399,817	
% overall cover historical (excluding Water):	1.0	< 1	36	12	5	15	< 1	2.3	5			5	17		
% overall cover present (excluding Water):	24	26	15	3	6	5	1	1	6			9	5		

Change Analysis Results, cont'd





Land Cover Change Matrix

TO CLASS (Acres): / FROM CLASS (Acres):	ag	dev	forest	forest WL, NT	forest WL, T	herb.	herb. WL, NT	herb. WL, T	other	shrub-scrub	ss WL, NT	ss WL, T	tidal flats	unc.	water	wooded / ss WL, NT	wooded/ ss WL, T	Hist-orical Acres
ag	61	55	18	0	0	3	5	0	5	2	0	0	0	(0)	11	1	0	161
developed	59	110	53	4	0	7	4	0	2	5	0	0	0	(0)	8	4	0	252
forested	2419	1446	2132	451	61	193	139	38	112	117	22	5	31	(0)	307	472	67	7473
forested WL, NT	2	2	1	2	0	1	8	0	0	0	0	0	0	(0)	0	2	0	16
forested WL, T	514	62	38	74	37	5	40	7	3	1	0	3	6	(0)	44	74	40	833
herbaceous	3709	660	298	150	9	55	160	4	54	18	18	0	10	(0)	99	168	9	5243
herb. WL, NT	2	17	13	4	0	1	3	0	0	0	5	0	0	(0)	0	9	0	44
herb. WL, T	674	51	99	170	18	18	168	6	8	3	8	4	4	(0)	59	179	22	1290
other	7	2	3	1	0	0	0	0	0	0	0	0	0	(0)	1	1	0	14
ss	974	229	188	128	2	30	36	1	13	6	3	0	6	(0)	64	131	2	1680
ss WL, NT	0	0	0	0	0	0	0	0	0	0	0	0	0	(0)	0	0	0	0
ss WL, T	6	0	0	0	0	0	0	0	0	0	0	0	0	(0)	0	0	0	6
tidal flats	10	28	40	48	17	8	11	14	26	0	1	7	12	(0)	96	49	24	318
unclassified	(110)	(91)	(232)	(29)	(2)	(26)	(9)	(2)	(1)	(15)	(2)	(1)	(2)	(0)	(16)	(0)	(0)	(538)
water	277	90	346	377	192	94	237	122	49	13	25	45	175	(0)	5171	402	237	7213
wooded/ss WL, NT	2	2	1	2	0	1	8	0	0	0	0	0	0	(0)	0	2	0	16
wooded/ss WL, T	520	62	38	74	37	5	40	7	3	1	0	3	6	(0)	44	74	40	839
Present Acres	8712	2752	3230	1407	337	416	809	192	272	166	83	65	244	(0)	5860	1490	401	24544
% overall cover (excluding Water) historical:	0.9%	1.5%	43.1%	0.1%	4.8%	30.3%	0.3%	7.4%	0.1%	9.7%	0.0%	0.0%	1.8%			0.1%	4.8%	
% overall cover (excluding Water) present:	46.6%	14.7%	17.3%	7.5%	1.8%	2.2%	4.3%	1.0%	1.5%	0.9%	0.4%	0.3%	1.3%			8.0%	2.1%	

Total Acres in Reach (Water + Floodplain): 38,015
Total Acres Covered by Analysis: 25,121 (66% of Total)

Historical Land Cover Change, 1880s to 2010:
Lower Columbia River,
Reach E

Lower Columbia River Estuary Partnership

Application

- **Priority Habitats By Hydrogeomorphic Reach (as identified by LCEP Science Work Group)**

  Rules:

  - Identify habitats which historically comprised >10% of total cover for the Reach
    - Include habitats which suffered >25% loss
      - Prioritize by severity of loss

  - Include 'rare' habitats (those which historically comprised <10% cover within the Reach)

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Application

Reach	Priority Habitats 1	2	3	4
A	herbaceous tidal WL	wooded tidal WL		
B	wooded tidal WL	herbaceous tidal WL		
C	wooded tidal WL	herbaceous tidal WL		
D	herbaceous tidal WL	wooded tidal WL	forested	herbaceous
E	herbaceous	forested	shrub-scrub	herbaceous tidal WL
F	forested	herbaceous	herbaceous WL	shrub-scrub
G	forested	herbaceous	herbaceous WL	
H	wooded WL			

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Application

- **Next Steps**

Determine Target acreages for recovery/protection by Reach

- Identify 'recoverable' habitat types

Consider: habitat type, effects of climate change, etc.

- Distribution based on public/private ownership

Role of Habitat Change Within Landscape Planning Framework

- Include as additional statistic for site analysis
- Other ideas??

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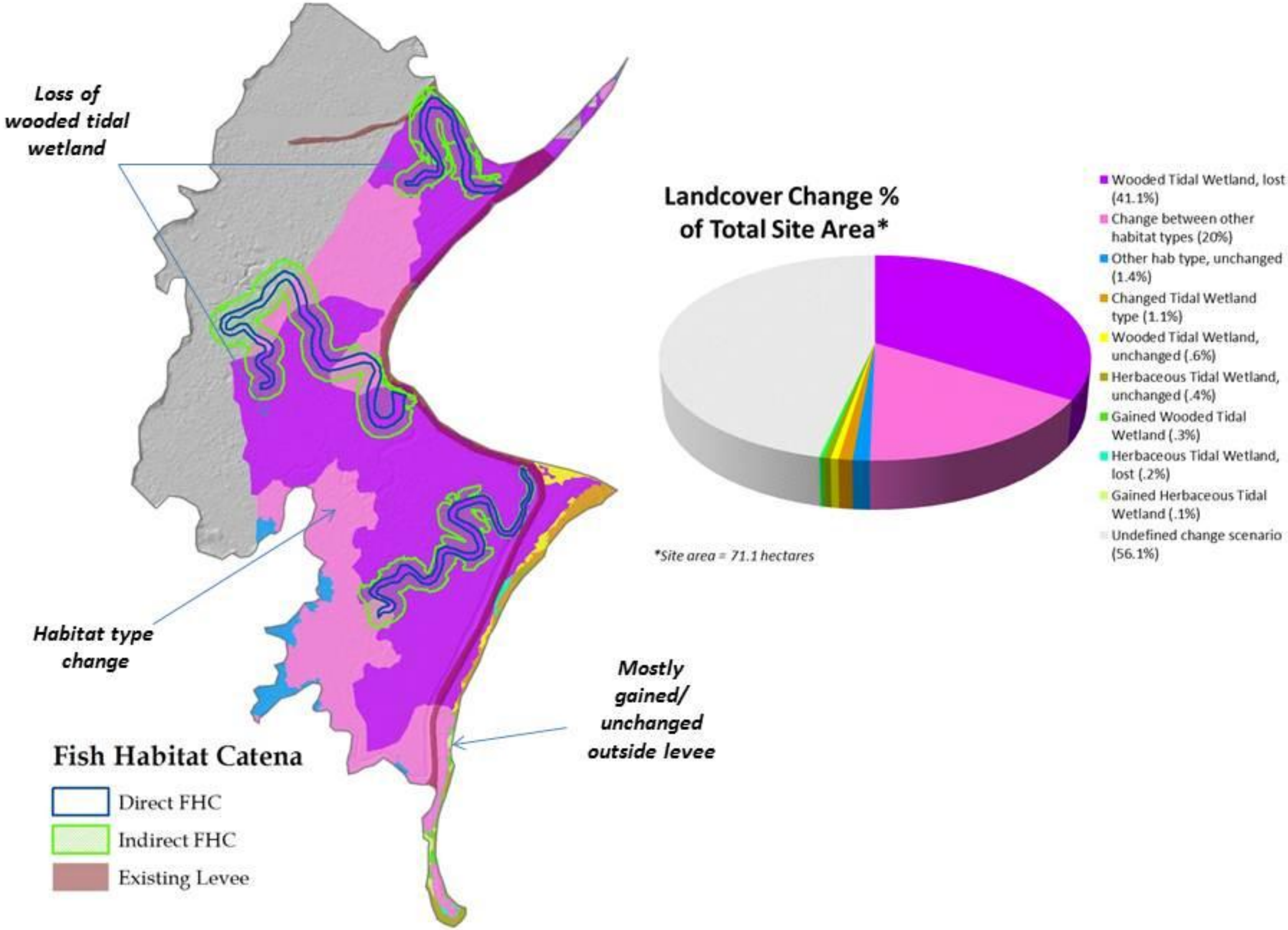
Loss of wooded tidal wetland
Habitat type change
Mostly gained/ unchanged outside levee
Fish Habitat Catena
Direct FHC
Indirect FHC
Existing Levee
Landcover Change % of Total Site Area*
Wooded Tidal Wetland, lost (41.1%)
Change between other habitat types (20%)
Other hab type, unchanged (1.4%)
Changed Tidal Wetland type (1.1%)
Wooded Tidal Wetland, unchanged (.6%)
Herbaceous Tidal Wetland, unchanged (.4%)
Gained Wooded Tidal Wetland (.3%)
Herbaceous Tidal Wetland, lost (.2%)
Gained Herbaceous Tidal Wetland (.1%)
Undefined change scenario (56.1%)
*Site area = 71.1 hectares

Acknowledgements

- **Acknowledgments**

Jennifer Burke – Digitization and explanation of historical T-Sheet Data

John Christy – Digitization of historical GLO data

Amy Borde, Heida Diefenderfer, Nikki Sather (PNNL) : cover class crosswalk

LCEP Science Work Group (Bernadette Graham Hudson, Jim Brick, Cindy Studebaker, Dan Roix, Tom Murtagh, Cathy Roberts) : Process Review

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