



# CORE CMECS GIS PROCESSING METHODS OREGON ESTUARY PROJECT OF SPECIAL MERIT



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**8/11/2014**

The Oregon Estuary Project of Special Merit was a 24 month project to produce estuary and shorelands habitat information, using the federally adopted Coastal and Marine Ecological Classification Standard (CMECS) version 4.0. While no new geospatial information was collected as part of this project, many recently collected or published data sets were utilized to derive CMECS habitat products. This document describes the methods used by the project team in the generation of Oregon estuary CMECS habitat products.

# Table of Contents

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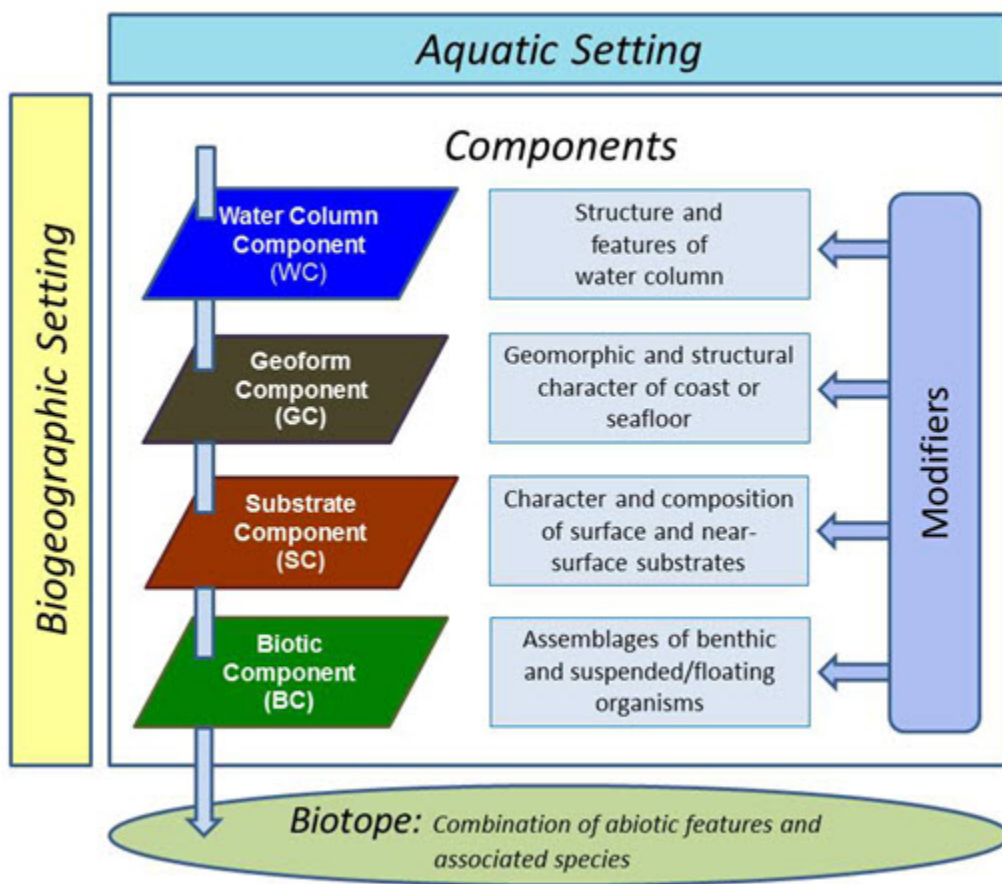
|   |    |
|---|----|
| Background .....                                      | 2  |
| Guiding Principles and Methods .....                  | 3  |
| Aquatic Setting (AS): .....                           | 7  |
| The Estuarine System .....                            | 7  |
| Biogeographic Setting (BS): .....                     | 8  |
| Biogeographic Realm: .....                            | 8  |
| Biogeographic Province: .....                         | 9  |
| Water Column Component (WC): .....                    | 9  |
| Geoform Component (GC) .....                          | 9  |
| Tectonic Setting: .....                               | 9  |
| Physiographic Setting: .....                          | 9  |
| Level 1 and 2 Geoform: .....                          | 10 |
| Geologic Geoforms .....                               | 11 |
| Biogenic Geoforms: .....                              | 13 |
| Anthropogenic Geoforms .....                          | 13 |
| Biotic Component (BC): .....                          | 16 |
| 2. Benthic and Attached Biota: .....                  | 16 |
| Substrate Component (SC): .....                       | 20 |
| Combining multiple substrate input data sources ..... | 22 |
| 1.0- Geologic substrate- .....                        | 22 |
| 2.0 - Biogenic Substrate .....                        | 25 |
| 3.0 - Anthropogenic Substrate .....                   | 25 |
| Modifiers .....                                       | 27 |
| Anthropogenic Impact Modifiers .....                  | 28 |
| Data Appendix: .....                                  | 30 |

## Background

The Oregon Estuary Project of Special Merit was an 18 month project to produce estuary and shorelands habitat map information, using the federally adopted Coastal and Marine Ecological Classification Standard (CMECS) version 4.0. While no new geospatial information was collected as part of this project, many recently collected or published data sets were utilized to derive CMECS habitat products. This document describes the methods used by the project team in the generation of Oregon estuary CMECS products. This work was done within a computerized mapping system, also known as a Geographic Information System (GIS).

CMECS characterizes marine and coastal environments in terms of two settings and four components (See Figure Below). Settings offer alternate but complementary approaches for partitioning the marine and coastal world. Components provide specific tools for describing observation (sampling) sites. Settings are applicable to all components.

Figure 1 CMECS System Diagram



Our project team attempted to produce information products for all settings and components, to the highest levels of classification within each setting or component that could be determined based upon the availability of information in the input data sources. The only major thematic area of CMECS for which we were not able to produce information products was the Water Column Component. This

document describes the analytical process used to produce CMECS products from the available resource information and is intended to share the methods we used with future practitioners interested in applying CMECS in other estuary settings.

An important component of our project was identification of diked areas. These are areas that were once part of the estuary, but have been disconnected from tidal flows by man-made structures (dikes or other barriers). The inclusion of diked areas in our products is intended to advance the understanding of human impacts to Oregon estuaries, and to help coastal land managers' plan for restoration activities. We identified diked areas using the methods described in **Anthropogenic Modifiers** below.

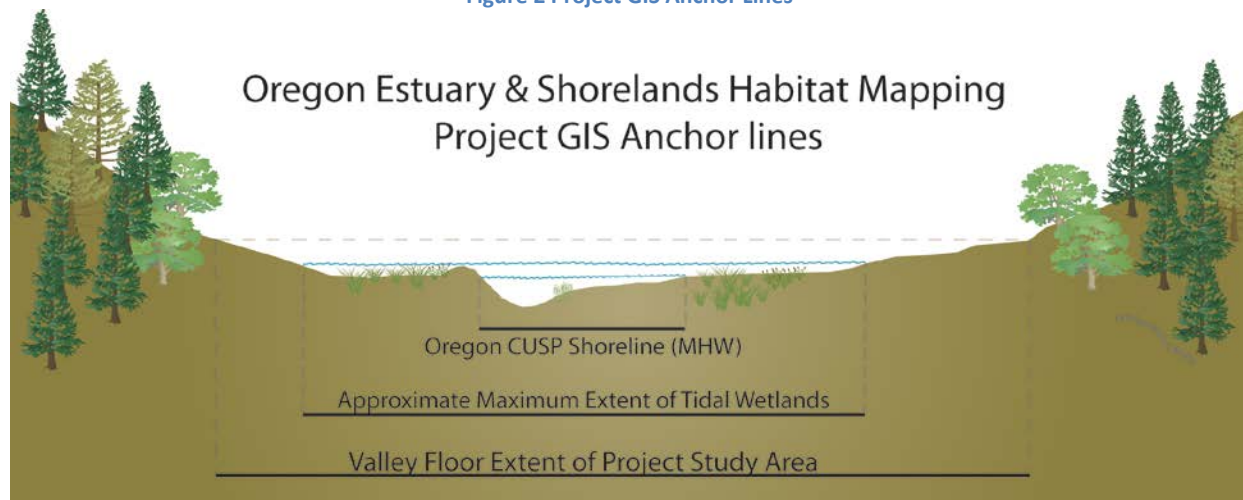
## Guiding Principles and Methods

The project team used a set of guiding principles to limit the scope of the project, with the goal of creating a statewide estuary CMECS framework that could be built upon in future project work. Those principles were used in the determination of operation procedures which the team followed when working in the GIS, and are listed and explained below. Following the explanation of the project's guiding principles, the methods used to generate GIS products for each component and setting are described. The goal of this document is to adequately capture the methods used in the generation of our products, so that future work can build on the foundation our CMECS products provide.

**Operational Procedure #1** - A vector-based data file type approach was used. While we used raster GIS information in the development of our information products, all products generated from our work are in the vector data format.

**Operational Procedure #2 - Project Anchor Layers:** Project Anchor Layers are GIS layers which form the boundaries of the project analysis layers and are carried through all subsequent GIS processing steps. They enforce key geometry features within the layers (components) for the estuary project. These lines are often used in multiple instances in the CMECS hierarchy. The figure below shows a schematic profile of how the Anchor Layers relate to one another in the estuarine landscape.

Figure 2 Project GIS Anchor Lines



The three Project Anchor Layers consist of a Project Study Area (based on the valley floor extent), an Approximate Maximum Extent of Tidal Wetlands, and a shoreline that represents the mean high water level. All three layers were derived from geospatial analysis of high resolution LIDAR elevation data collected by the [Oregon LIDAR Consortium](#) (collected in 2008 for the south coast and 2009 for the north coast). The vertical datum of that information was NAVD 88.

#### **Methods for delineating the Valley Floor Extent of Project Study Area:**

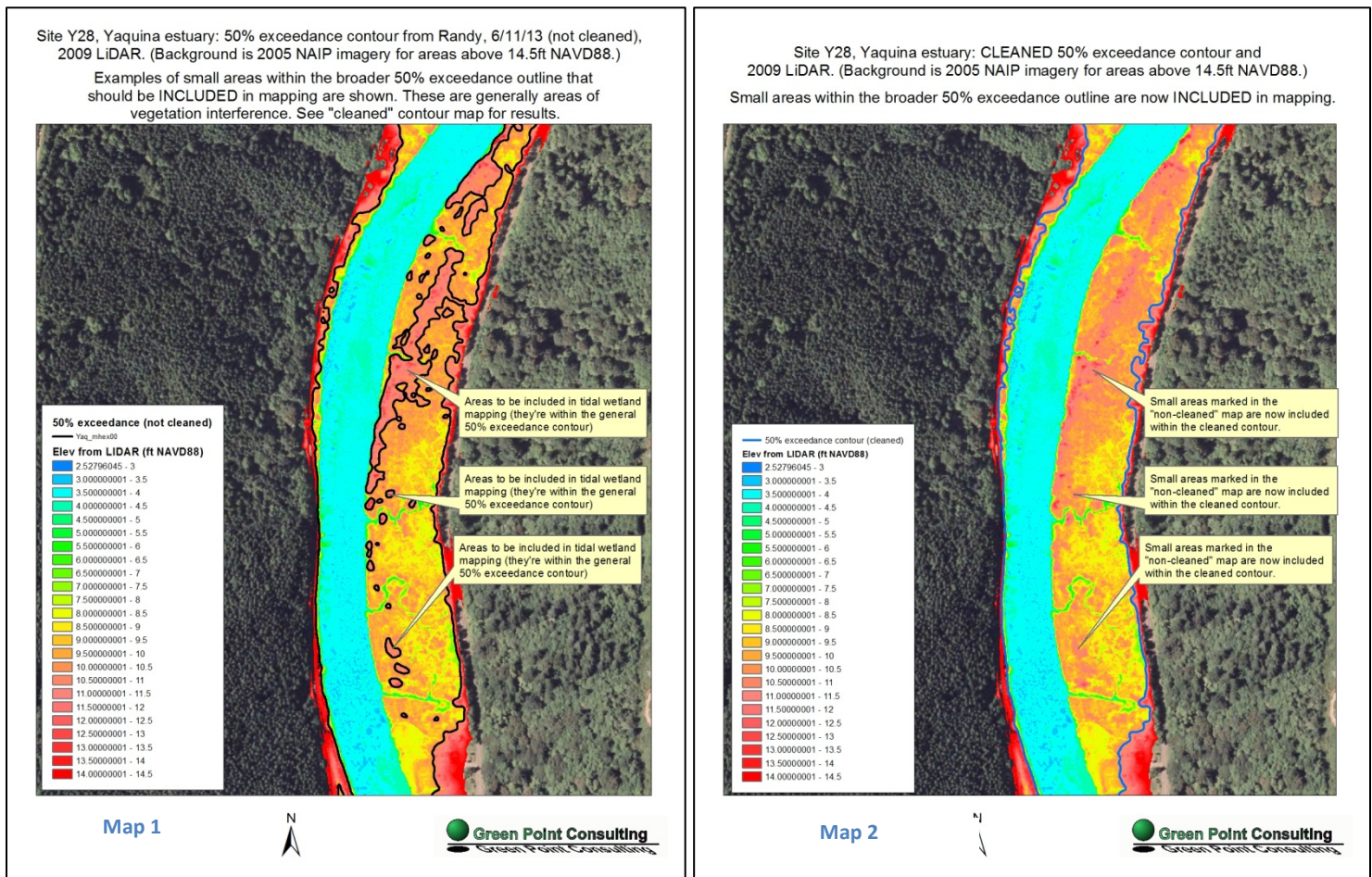
- a) A rectangular extent polygon was created around each estuary that contained the full extent of the system. That rectangle was transformed into a shapefile (called “clipper”).
- b) The Bare Earth Digital Elevation Model (DEM) was clipped to the clipper (“Extract by Rectangle” tool in Spatial Analyst Tools/Extraction toolbox).
- c) If using more than one DEM quad, then those quads were merged together (“Mosaic to New Raster” tool in Data Management Tools/Raster/Raster Dataset toolbox).
- d) Contour lines were generated from the DEM using a one meter contour interval (“Contour” tool in Spatial Analyst Tools/Surface toolbox).
- e) A range of contours best capturing the edge of the valley floor were selected, extracted, and used to generate a new feature layer.
- f) From those extracted contours, the best one was chosen from one side of the mouth of the estuary and then all the way around the estuary back to the mouth
- g) Because the elevation of the valley floor increases as one moves up the landscape, different contour line segments (representing the best fit of the edge of the valley floor) had to be merged together into a single data layer.
  - a. To connect these contours into one line, each line had to be split and then connected to the next line. When switching contour lines, the first contour line was split where it needed to be switched, the last point of that line was moved so it intersected with the next best contour line, that contour line was split where it intersected with the last line, and the section of the new contour line that was not used was deleted.
  - b. Once all of the best fit lines had been spliced together, a single shapefile representing the valley floor was generated.
- h) To facilitate use of that data layer, the line layer was converted into a polygon (“Feature to Polygon” tool in Data Management Tools/Features toolbox) any slivers that were generated in the conversion were eliminated using the “Dissolve” tool (under Data Management Tools/Generalization toolbox).

#### **Methods for delineating the Approximate Maximum Extent of Tidal Wetlands (OCMP, 2014):**

One of the most important tasks in this project was the establishment of the approximate maximum extent of the estuarine influence on habitats in Oregon. The goal of this project was to update existing resource inventory information produced in the late 1970’s and early 1980’s by the Oregon Department of Fish and Wildlife (Bottom et al, 1979). One of the areas that needed improvement over the original mapping was the identification of tidally influenced wetlands. The original ODFW habitat maps did not consistently describe the upper extent of estuarine habitats, and in many cases the ODFW habitat maps stopped well short of areas we now understand to be influenced by saline waters and/or periodic flooding associated with the

tides. The project team sought a way to more accurately and objectively identify areas on the landscape that would be identified as estuarine. The method we developed is based on NOAA's observation of extreme water levels, and the probability that water will reach a certain elevation during specific time periods. Those modeled water levels were analyzed for their extent on the landscape, and their coincidence with estuarine habitats in Oregon's well studied systems (for more information, see Appendix A).

- a) Using NOAA's Extreme Water Level Analysis modeling, the 50% exceedance water level was plotted on the landscape using the Oregon LIDAR consortium derived 3ft digital elevation model.



- b) A polygon layer was created from that modeled surface, so that it could be intersected with other layers, allowing mapping and classification of habitats. A polygon layer also allowed inclusion or exclusion of areas on the basis of size.
- c) The Approximate Maximum Extent of Tidal Wetlands polygon **includes** (merged) areas that are surrounded by low ground, even if they are slightly above the elevation of the modeled surface - **see maps 1 and 2**. These are generally dikes, areas of vegetation interference with the LIDAR signal, etc.
- d) The approximate maximum extent of tidal wetlands polygon **excludes** areas that are less than 1 acre in size.

## **Methods for producing the Oregon Continually Updated Shoreline Product (CUSP), 2014**

The last anchor layer our project team generated was a new shoreline, which was produced to complement the outer coast mean high water (MHW) shoreline generated and maintained by NOAA's National Geodetic Survey. The NOAA Continually Updated Shoreline Product, which was accessed through the [NOAA Shoreline Data Explorer](#), provides a high resolution shoreline for the outer coast of Oregon, based upon the delineation of the Mean High Water elevation from a LIDAR based Digital Elevation Model. The project team generated a shoreline for Oregon's estuaries using the same methods as those used to produce the shoreline on the outer coast (See Appendix B for more information).

**Operational Procedure #3** – Only data layer sources that cover all areas within the project study boundary were used. This decision was made in order to ensure that the many estuaries in our project area were all classified using the same objective methods, and that the resulting classes would not have inconsistent data effort associated with them. There are many site specific studies of estuarine ecosystems that have been conducted in Oregon; however, unequal treatment of estuaries based upon the presence or lack of data would have resulted in a product of unequal quality, thereby increasing the uncertainty associated with the use of the data products.

**Operational Procedure #4** – The original source geometry was used for component layer transformations (from the source data into CMECS). Source geometries were only altered when polygons with identical attributes were merged.

# CMECS Settings and Components

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## Aquatic Setting (AS):

The Aquatic Setting (AS) is comprised of three hierarchical levels (System, Subsystem and Tidal Zone) and provides the context for all CMECS components. It distinguishes oceans, estuaries and lakes, deep and shallow waters and submerged and intertidal environments within which more refined classification of geological, physicochemical, and biological information can be organized.

## The Estuarine System

The Estuarine System is defined by salinity and geomorphology. This System includes tidally influenced waters that (a) have an open-surface connection to the sea, (b) are regularly diluted by freshwater runoff from land, and (c) exhibit some degree of land enclosure. In CMECS the Estuarine System has four subsystems: Coastal, Open Water, Tidal Riverine Coastal, and Tidal Riverine Open Water.

**2.1 Estuarine Coastal** – The Estuarine Coastal Subsystem extends from the supratidal zone at the land margin up to the 4 meter depth contour in waters that have salinity greater than .5 (during the average annual low flow). CMECS calls for mean higher high water (MHHW) to differentiate tidal/non-tidal zones within this zone; however, the Approximate Maximum Extent of Tidal Wetlands boundary (described above) was used to represent this boundary in this project, as the MHHW elevation datum does not capture the full extent of habitats influenced by the tides (see Appendix A). The upper bounds of “Coastal” was differentiated from non-coastal, or terrestrial, as it is captured in areas above the approximate maximum extent of tidal wetland boundary but still within the project boundary. Everything below the approximate maximum extent of tidal wetland boundary but above the 4m depth line is classified as “Estuarine Coastal.”

**2.1.A107 Estuarine Coastal (Diked)** – Same as 2.1, but those areas that fell within one of Duck’s Unlimited Diked Land polygons (or were identified as diked by the project’s Technical Advisory Committee and Estuary Habitat Specialist) were given a “Diked” modifier. In CMECS, this modifier is called “Impounded/Diverted”, but in Oregon, the term “diked” is more commonly used.

**2.2 Estuarine Open Water** - The -4m depth line separates the Coastal aquatic from the Open Water aquatic and is dependent on the quality of the bathymetry in each system. This line does not exist in many smaller estuaries, as their maximum depth may be less than 4m. Areas deeper than -4m are considered “Open Water,” calculated using -4m below the mean lower low water (MLLW) tidal datum.

The data digital elevation model tiles (<http://www.ngdc.noaa.gov/mgg/inundation/>) were merged into a single coastwide data set and converted to the appropriate MLLW elevation datum. The -4m contour was then extracted and converted to a polygon file type.

**2.2.1 - Estuarine Open Water Subtidal** – Same as 2.2 and only assigned to polygons that connect to the ocean.

**2.3 Estuarine Tidal Riverine Coastal** - Same method as “Estuarine Coastal” except with the addition of salinity considerations (salinity has to be less than 0.5 practical salinity units (PSU) to be considered Tidal Riverine). In our case we gathered salinity observation values from the Oregon Department of Environmental Quality (DEQ) Laboratory Analytical Storage and Retrieval LASAR data set for points within our project boundary. The point observations were analyzed to determine the maximum PSU for the salinity during observations in the month of September. To assign salinity values to the aquatic polygons, a point half-way between the values indicating a change from below to above 0.5 was used to divide the polygon (applied to the full width of the polygon at that point) into areas of high and low salinity.

**2.3.AI07 - Estuarine Tidal Riverine Coastal (Diked)** – Same as 2.3, but those areas that fell within one of Duck’s Unlimited Diked Land polygons (or were identified as diked by the project’s Technical Advisory Committee and Estuary Habitat Specialist) were given a “Diked” modifier. In CMECS, this modifier is called “Impounded/Diverted”, but in Oregon, the term “diked” is most commonly used.

**2.4 Estuarine Tidal Riverine Open Water** - Same method as 2.2 except with the addition of salinity considerations (salinity has to be less than 0.5 psu to be considered Tidal Riverine).

**Data Sets Used:**

- DEQ, Laboratory Analytical Storage and Retrieval (*LASAR*) database, 2013
- Approximate Maximum Extent of Tidal Wetlands, OCMP, 2014
- Oregon Continually Updated Shoreline Product, OCMP, 2014
- Ducks Unlimited, 2011
- NOAA Tsunami Inundation modeling DEMs including:
  - Astoria, OR/WA 1/3 arc-second MHW DEM, NGDC, 2008
  - Garibaldi, OR 1/3 arc-second MHW DEM, NGDC, 2007
  - Central Oregon Coast, OR 1/3 arc-second MHW DEM, NGDC, 2008
  - Port Orford, OR 1/3 arc-second MHW DEM, NGDC, 2008

## **Biogeographic Setting (BS):**

The Biogeographic Setting was determined using the Marine Ecosystems of the World (MEOW) classification technique, which provides global coverage and creates a nested, three-tiered system of realms, provinces, and ecoregions (moving from larger-scale to smaller-scale units). Using the MEOW system allows the identification of valuable regional and local characterizations that are functions of climate, geological setting, and evolutionary history.

## **Biogeographic Realm:**

Very large regions of coastal, benthic, or pelagic ocean across which biota are internally coherent at higher taxonomic levels, as a result of a shared and unique evolutionary history. Oregon is within the Temperate Northern Pacific Realm.

**Biogeographic Province:**

Large areas defined by the presence of distinct biota that have at least some cohesion over evolutionary time frames. Although historical isolation will play a role, many of these distinctive biota have arisen as a result of distinctive abiotic features that circumscribe their boundaries. These may include geomorphological features, hydrographic features, or geochemical influences.

Oregon is in the Cold Temperate Northeast Pacific Province.

**Biogeographic Ecoregion:** Areas of relatively homogeneous species composition, clearly distinct from adjacent systems. Oregon is part of the Oregon, Washington, Vancouver Coast and Shelf Ecoregion.

**Water Column Component (WC):**

The WC represents a new approach to the ecological classification of open water settings. The component describes the water column in terms of vertical layering, water temperature and salinity conditions, hydroforms, and biogeochemical features. Modifiers allow users to further subdivide water column units. Representative units include “cold, oligohaline estuarine open water surface layer” and “warm marine offshore western boundary current oceanic epipelagic upper layer.”

For this project, the Water Column Component was not mapped because no comprehensive data were available.

**Geoform Component (GC)**

The GC describes the major geomorphic and structural characteristics of the coast and seafloor. This component is divided into four subcomponents that describe tectonic and physiographic settings and two levels of geoform elements (based upon the scale of the features) that include geological, biogenic, and anthropogenic geoform features. Representative units include lagoon, ledge, tidal channel/creek, and moraine.

**Tectonic Setting:**

At the largest scales, the GC is divided in eight planetary features that reflect global tectonic processes. Generally, these features are thousands of square kilometers or larger in size. Oregon is located within a Convergent Active Continental Margin, which is defined by intense areas of active magmatism, where the oceanic lithosphere is subducted beneath the continental lithosphere.

**Physiographic Setting:**

Spatially nested within the tectonic settings, physiographic settings describe landscape-level geomorphological features from the coast to mid-ocean spreading centers. The three classes of physiographic settings we applied to the Oregon estuarine environments included: an Embayment/Bay; a Lagoonal Estuary; and a Riverine Estuary. Previous studies in Oregon have sought to classify estuaries by type (Good, Lee & Brown) and those studies were used to inform the CMECS classifications. In general, Oregon’s smaller estuarine systems did not fit well into the CMECS classification system, and

therefore we have chosen to provide the Lee & Brown classification along with the CMECS class in the attribute table. The physiographic setting classes are shown below in Table 1.

Table 1. Physiographic Setting Classification

| Estuary        | CMECS Class      | Lee & Brown  |
|----------------|------------------|--|
| Columbia       | Riverine Estuary | Highly River Dominated                                     |
| Necanicum      | Riverine Estuary | Moderately River Dominated drowned river mouth (bar built) |
| Ecola Creek    | Riverine Estuary | Tidally restricted coastal creek                           |
| Nehalem        | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Tillamook Bay  | Riverine Estuary | Tide-dominated drowned river mouth                         |
| Netarts Bay    | Bay              | Bar Built  |
| Sand Lake      | Lagoonal         | Bar Built  |
| Nestucca       | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Neskowin Creek | Riverine Estuary | Tidally restricted coastal creek                           |
| Salmon         | Riverine Estuary | Moderately River Dominated drowned river mouth (bar built) |
| Siletz         | Riverine Estuary | Moderately River Dominated drowned river mouth (bar built) |
| Depoe Bay      | Riverine Estuary | Marine Harbor/Cove (Drowned river mouth)                   |
| Yaquina        | Riverine Estuary | Tide-dominated drowned river mouth                         |
| Beaver Creek   | Riverine Estuary | Tidally restricted coastal creek                           |
| Alsea          | Riverine Estuary | Moderately River Dominated drowned river mouth             |
| Yachats River  | Riverine Estuary | Tidally restricted coastal creek                           |
| Siuslaw        | Riverine Estuary | Moderately River Dominated drowned river mouth             |
| Siltcoos       | Riverine Estuary | Tidally restricted coastal creek                           |
| Umpqua         | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Coos           | Riverine Estuary | Tide-dominated drowned river mouth                         |
| Coquille       | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Sixes          | Lagoonal Estuary | Blind-Drowned river mouth                                  |
| Elk            | Lagoonal Estuary | Blind-Drowned river mouth                                  |
| Rogue          | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Hunter Creek   | Riverine Estuary | Tidally restricted coastal creek                           |
| Pistol         | Lagoonal Estuary | Blind-Drowned river mouth                                  |
| Chetco         | Riverine Estuary | Highly River Dominated drowned river mouth                 |
| Winchuck       | Lagoonal Estuary | Blind-Drowned river mouth                                  |

The CMECS classes were applied to the project boundary polygons, as those encompassed the whole of the estuarine systems.

### Level 1 and 2 Geoform:

Geoforms are physical, coastal, and seafloor structures that are generally no larger than hundreds of square kilometers in size. The size determination may be an areal extent or a linear distance. Larger geoforms (Level 1) are generally larger than one square kilometer, and correspond to Megahabitats in

the Greene et al. classification system (2007). Smaller geoforms (Level 2) are generally less than one square kilometer in size, and correspond to meso and macro scale habitats in the Greene et al. classification scheme. Level 1 and Level 2 geoforms are arranged as two separate subcomponents so that they can be used in tandem to describe complex spatial patterns of geoform structures. Geoforms of both Level 1 and Level 2 are broken out into Geologic, Biogenic, and Anthropogenic.

## **Geologic Geoforms**

Geologic Geoforms are formed by the abiotic processes of uplift, erosion, volcanism, deposition, fluid seepage, and material movement. Waves, currents, wind, chemical dissolution, seismic motion, and chemical precipitation all contribute to these geoforms and give them their distinctive qualities.

### **G109 – Channel**

-Tidal wetlands data (Scranton 2002) were used to identify sections of the estuarine water bodies that meet the definition of a channel (a general term for a linear or sinuous depression on an otherwise more flat area). Those areas were then generated by selectively copying areas from the Oregon CUSP shoreline into a new feature class of Channels.

### **G10903 – Slough**

-“Slough” is a geoform type under “channel” defined as: (a) a sluggish body of water in a tidal flat, bottomland, or coastal marshland, or (b) a sluggish channel of water in which water flows slowly through either low, swampy ground or a section of an abandoned river channel. Sloughs were found by selecting points with the attribute “slough” in the Oregon Geographic Names Information System (GNIS) data layer. Then, using the Oregon CUSP MHW shoreline, a polygon for each slough was copied into a new feature class of Sloughs.

### **G121- Fan**

-Fans are deltaic geoforms that take the shape of a fan where there is a source of water running into another body of water; they are formed by sediment transport. National Wetland Inventory (NWI) data was used to select those polygons that contain AB (Aquatic Bed) and US (Unconsolidated Substrate) in all systems (Estuarine, Palustrine, and Marine) except Lacustrine (Marine habitats in the NWI data were included because some M polygons came into the mouth of the Project Boundary). Those polygons that met the definition of a fan were classified based on the polygon’s shape (determined using aerial photographic imagery).

### **G10203 – Shoreline Fan**

-Shoreline fans are deltaic geoforms that take the shape of a fan and are built out into the sea. NWI data was used to select those polygons that contain AB (Aquatic Bed) and US (Unconsolidated Substrate) in all NWI systems (Estuarine, Palustrine, and Marine) except Lacustrine (Marine was included because some M polygons came into the mouth of the Project Boundary). Polygons were classified as “Shoreline Fan” based on the polygon’s shape (determined using aerial photographic imagery).

## **G122 Flat**

-Flats are various shapes that represent a nearly level surface often composed of unconsolidated sediments and most commonly found in the intertidal or shallow subtidal zones. NWI data was used to select those polygons that contain AB (Aquatic Bed) and US (Unconsolidated Substrate) in all systems (Estuarine, Palustrine, and Marine) except Lacustrine (Marine was included because some M polygons came into the mouth of the Project Boundary). Polygons were classified as “Flat” based on the polygon’s shape (determined using aerial photographic imagery).

## **G129 – Island**

-Islands are defined as an area of land completely surrounded by water – or an elevated area of land surrounded by swamp or marsh, which is isolated at high water or during floods. The Oregon CUSP MHW shoreline was used to delineate island areas greater than 1 acre in size.

## **G136 – Marsh Platform**

-Marsh platforms are described as the flat, often thick, accumulation of peat that supports emergent marsh vegetation. Marsh Platforms are commonly dissected by tidal creeks. NWI data was used to select those polygons that contain EM (Emergent Marsh) in all systems (Estuarine, Palustrine, and Marine) except Lacustrine (Marine was included because some M polygons came into the mouth of the Project Boundary). Polygons were classified as “marsh platform” based on the polygon’s shape (determined using aerial photographic imagery).

## **G141 – Natural Levees**

-Natural Levees are defined as an embankment of sediment, bordering on one or both sides of a river (or other feature). The Levees Inventory (Mattison, 2011) was used for the CMECS “Natural Levees” classification. Lines classified as “Natural levee/high river bank” in the inventory were turned into polygons by buffering the line features (based on an average width of observed random samples) by 20ft.

### **G141.A106 – Natural Levees Fill**

-Natural Levees are defined as an embankment of sediment, bordering on or both sides of a river (or other feature). The Levees Inventory (Mattison, 2011) was used for the CMECS “Natural Levees” classification. Lines classified as “Natural Levee with Man-Made Enhancements” in the inventory were turned into polygons by buffering the line features (based on an average width of observed random samples) by 20ft. The resulting polygons were given the anthropogenic modifier “Fill”.

## **G161 – Shore**

-A shore is defined as the intersection of a specified plane of water with a beach that migrates with changes of the tide or of the water level. NWI was used to pull out those polygons that contain AB (Aquatic Bed) and US (Unconsolidated Substrate) in all NWI systems (Estuarine, Palustrine, and Marine) except Lacustrine (Marine was included because some M polygons came into the mouth of the Project Boundary). Polygons were classified as “Shore”, based on the polygon’s shape (determined using aerial photographic imagery).

#### **Other Water –**

-Water features in the main body of the estuary did not fall within one of the established geoform Level 1 or Level 2 classes (the closest would be a depression). To keep the coverage of water features in our estuary habitat classification complete, we (the project team) generated an “other water” category to capture the lower, open water, landform of the estuary system.

#### **Biogenic Geoforms:**

Biogenic Geoforms are physical features and landforms that were created by the action of living organisms. These primarily consist of different types of reefs. As with all geoforms the characteristic of concern in this component is the physical shape of these reef features, not the living biology that may have participated in their genesis.

For this project, no Biogenic Geoforms were mapped, because no comprehensive data were available.

#### **Anthropogenic Geoforms**

##### **G312 - Dam**

-A dam is defined as an obstruction across a flow that produces a lake, pond, or other widening. The ODFW Fish Passage Barrier Inventory was used to identify the location of dams. The LiDAR DEM’s were used to Heads-Up-Digitize the dam features (often confirmed using aerial photographic imagery).

##### **G30201 – Artificial Levee**

-Artificial Levees are defined as either: (a) dike along the side of a river channel erected to prevent overflow during floods, usually running along the channel direction and near the natural levee crests of streams; or (b) an artificial embankment constructed along the bank of a watercourse or an arm of the sea to protect land from inundation. The Levees Inventory (Mattison, 2011) was used to generate the CMECS “Artificial Dikes” classification. Those dikes classified as man-made dikes and/or roads in the Levees Inventory were Heads-Up-Digitized into polygon features using LiDAR DEM surface.

### **g30202 - Breached Dike (new code)**

- The Levees Inventory (Mattison, 2011) was used to classify “Breached Dikes” as a new CMECS code “Breached Dike”. The lines classified as “Breached Dike” in the Levees Inventory were turned into polygons by the creation of a buffer based on an average width of a random sample.

### **g313 - Dock/Pier**

-A dock or pier is defined as a landing place for vessels normally oriented perpendicular to the shore with a flat surface for off-loading materials. The DLCD Public Access Inventory was used to identify piers. LiDAR was then used to Heads-Up-Digitize these areas into polygon features and classify them as CMECS categories “Dock/Pier”.

### **g315 - Dredge Deposit**

-Dredge Deposit is defined as an accumulation on the land surface (or seafloor) where spoil materials from a dredging operation are placed. They often exhibit some topographic expression and can support biological communities that are different than the surrounding area. The Levees Inventory (Mattison, 2011) was used to classify “Sidecast of Significance” as Dredge Deposits. The lines features classified as “Sidecast of Significance” in the Levees Inventory were converted into polygons by the creation of a buffer based on the average width of a random sample of the observed features. Other sources were evaluated (Dredge Material deposit sites from the Oregon Estuary Plan Book), but were not used because of the uncertain status of each site (some of which still remain wetlands).

### **g318 - Fill Area**

-A Fill Area is defined as a topographically low area into which unconsolidated material has been placed in order to raise the ground level as part of development or expansion of coastal infrastructure. Our project team used several input data sources to identify fill areas; they are listed below by source.

- The Tidal Wetlands data set (Scranton, 2004) was used to identify areas as “Fill area”. In some instances fill areas (formerly dikes) were removed since Scranton published his data, and in those known locations (based upon expert knowledge provided by our Technical Advisory Committee and Estuary Habitat Specialist) they were also removed in our data products.
- LiDAR was used to determine if the road alters the underlying landscape and thereby constitutes a distinct geoform—if so, it was classified as “Fill Area”. Roads, highways, and streets (BLM, 2014) were used to identify the road centerlines. Line features were turned into polygon features by the creation of a buffer based on an average width of a random sample (based upon a classification of each road type provided by Geofabrik, 2013).

- A railroad line layer (ODOT 2008) was used to identify fill area associated with the presence of railroad tracks. The LiDAR DEM was used to Heads-Up-Digitize the associated “Fill Areas”.
- The Federal Aviation Administration (FAA) Airports data layer was used to identify areas of fill associated with airports. The LiDAR DEM was used to Heads-Up-Digitize those “Fill Areas”.
- An estuary subset of Department of State Lands (DSL)’s Wetland Impacted Area layer (from the Land Administration System (LAS) Database) was used to identify those areas that have been issued a permit for filling wetlands. The LiDAR DEM was used to confirm if those areas have been filled and to Heads-Up-Digitize the “Fill Areas”.

### **g320 – Harbor**

-A Harbor is defined as a small bay or a sheltered part of a body of water, usually well protected against high waves and strong currents, that serves as a safe anchorage for ships and where port facilities are present. DLCD’s Public Access Inventory was used to identify harbors. LiDAR was used to Heads-Up-Digitize these areas into polygon features and classify them as “Harbor”.

-An estuary subset of DSL’s Wetland Impacted Area layer (from the LAS database) was used to identify those areas that have been issued a permit for filling wetlands (often associated with the maintenance of a harbor). NAIP aerial photographs were used to confirm if those areas have been filled and to Heads-Up-Digitize those areas and classify them as “Harbor”.

### **g323 - Marina/Boat Ramp**

-The Marina/Boat ramp class is defined as a series of docks, walkways, slips, and support infrastructure for in-water storage of yachts and boats. DLCD’s Public Access Inventory was used to identify boat ramps. The LiDAR DEM was used to Heads-Up-Digitize these areas into polygon features and classify them. Additionally, an estuary subset of DSL’s Wetland Impacted Area layer (from the LAS dataset) was used to identify those areas that have been issued a permit for filling wetlands. The LiDAR DEM was used to confirm filled areas and to Heads-Up-Digitize them to the “Boat Ramp/Marina” class.

### **g329 - Rip Rap Deposit**

-The Rip Rap Deposit class is defined as an accumulation of rock or boulders placed along a waterway or shoreline to reduce erosion. The Levees Inventory (Mattison, 2011) was used to identify “Rip Rap Deposits”. Those line features classified as rip rap in the Levees Inventory were Heads-Up-Digitized into polygon features using LiDAR.

#### **Data Sets:**

- DSL LAS dataset, 2011
- FAA, 2010
- Geofabrik, 2013
- Lee and Brown, 2009

- Oregon LiDAR Consortium: North Coast, DOGAMI, 2009 (LiDAR, 2009)
- Oregon LiDAR Consortium: South Coast, DOGAMI, 2008 (LiDAR, 2008)
- Mattison, 2011
- NWI, 2013
- Oregon Fish Passage Barriers, ODFW, 2011 (ODFW, 2011)
- Railroads, ODOT, 2008 (ODOT, 2008)
- Oregon CUSP Shoreline, 2014
- Scranton, R. 2004

## **Biotic Component (BC):**

The BC is a hierarchical classification that identifies (a) the composition of floating and suspended biota and (b) the biological composition of coastal and marine benthic and attached biota.

### **1. Planktonic Biota:** – Not mapped (no comprehensive data available)

### **2. Benthic and Attached Biota:**

**2.1 Reef Biota** – Not mapped (No comprehensive data available)

**2.2 Faunal Bed** – Not mapped (No comprehensive data available)

**2.3 Microbial communities** – Not mapped (No comprehensive data available)

**2.4 Moss and Lichen Communities** – Not mapped (No comprehensive data available)

**2.5 Aquatic Vegetation Bed** – This class includes subtidal or intertidal bottoms and any other areas characterized by a dominant cover of rooted vascular plants, attached macroalgae, or mosses, which are usually submersed in the water column or floating on the surface. They may be exposed during low tides.

**2.5.2.1 Aquatic Vascular Vegetation** – This subclass includes aquatic vascular vegetation beds dominated by submerged, rooted, vascular species (such as seagrasses). National Wetland Inventory Intertidal Aquatic Bed mapping (E2AB) was used to map algal beds (E2AB1) and additional vascular (seagrass) beds (E2AB3) and cross-walk them into CMECS. Additionally, NOAA Coastal Change Analysis Program (C-CAP) aquatic bed data (2010) was merged with NWI derived features to produce a final mapped extent of this class. Prior to using the C-CAP data, several years of information were analyzed for the extent of the aquatic bed class. It was found that the aquatic bed class in C-CAP had a remarkably consistent spatial extent during the years of data available (List specific years evaluated here), thereby allowing the use of a single year of data to represent the extent. The inclusion of all detected beds through the inclusion of NWI and C-CAP data provides an approximation of the maximum extent of this CMECS class. As seagrass beds are spatially

and temporally dynamic, this layer that shows areas suitable for development of aquatic bed habitats – even if they are not currently occupied.

**2.6 Emergent Wetland-** This class is defined as areas that are characterized by erect, rooted, herbaceous hydrophytes – excluding emergent mosses and lichens. This vegetation is usually present for most of the growing season in most years, and is usually dominated by perennial plants.

All non-developed land surfaces below the Approximate Maximum Extent of Tidal Wetlands boundary are tidal wetlands or former tidal wetlands, by definition. Mapping methods for the lowest tidal wetlands are described above (in Aquatic Setting for Open Water and in Biotic/Benthic/Attached Biota/Aquatic Vegetation Bed for seagrass and algal flats). The remainder of the area below the Approximate Maximum Extent of Tidal Wetlands boundary is classified as emergent, scrub-shrub or forested wetland. The NWI data was used to classify the majority of these areas, but areas below the Approximate Maximum Extent of Tidal Wetlands boundary that are not mapped in NWI are still Emergent Wetlands. These last areas are classified into emergent wetlands, scrub-shrub wetlands, and forested wetlands using C-CAP. Finally, any areas classified as tidal wetlands in the NWI, but which lie above the Approximate Maximum Extent of Tidal Wetlands boundary, were mapped as the CMECS vegetation class that matches the NWI classification (direct crosswalk).

**2.6.1 Emergent Tidal Marsh** –The Emergent Tidal Marsh subclass is defined as a community dominated by emergent, halophytic, herbaceous vegetation (with occasional woody forbs or shrubs) along low-wave energy, intertidal areas of estuaries and rivers. The vegetation is usually arranged in distinct zones of parallel patterns, which occur in response to gradients of tidal flooding frequency and duration, water chemistry (especially salinity), or other disturbances.

Data from NWI and C-CAP were used in the classification of areas as Emergent Tidal Marsh habitat. The following steps were used in the derivation of this CMECS subclass:

- 1) NWI data was used to locate all emergent tidal marsh habitats (all variants of E2EM codes, all variants of Riverine Emergent codes, such as: R1EM) within the Approximate Maximum Extent of Tidal Wetlands boundary. Regardless of whether NWI classifies these as tidal or non-tidal marsh habitats, they were included in the CMECS mapping as “Emergent Tidal Marsh.”
- 2) NWI was used to locate all emergent **tidal** marsh habitats **outside of** the Approximate Maximum Extent of Tidal Wetlands boundary (these include NWI Estuarine System emergent wetlands such as E2EMP, and NWI Palustrine System emergent wetlands with tidal hydrology modifiers S, R, T or V, such as PEMR). Based on the experience of our Technical Advisory Committee and Estuary Habitat Specialist, it was assumed that NWI’s tidal classification is conservative, i.e. there is little risk of NWI classifying non-tidal wetlands as tidal. Also, spatial data analysis during this project showed that there are very few NWI tidal wetlands outside the Approximate Maximum Extent of Tidal Wetlands boundary.

**2.6.1.1 Brackish Emergent Tidal Marsh** – These areas are dominated by species with a wide range of salinity tolerance; salinity may range from 0.5 to 30 (PSS). NWI data were used to identify habitats within the Estuarine System, which is defined by brackish salinity (Cowardin et al. 1979), such as E2EMP and E2EMN. These were classified within the Brackish Emergent Tidal Marsh biotic group.

3) For areas not mapped in NWI but within the Approximate Maximum Extent of Tidal Wetlands boundary, emergent tidal marsh habitat classes were generated from C-CAP using the following steps:

- 1) Convert C-CAP raster to polygons
- 2) Intersect C-CAP polygons with the Approximate Maximum Extent of Tidal Wetlands boundary polygon
- 3) Select all C-CAP polygons within the Approximate Maximum Extent of Tidal Wetlands boundary polygon
- 4) Group the following C-CAP-derived polygon class values into the CMECS classification for Emergent Tidal Marsh: Cultivated; Pasture/Hay; Grassland; Palustrine Emergent Wetland; and Estuarine Emergent Wetland.

**2.7 Scrub-Shrub Wetland**- This class is defined as wetland areas dominated by woody vegetation that is generally less than 6 meters tall.

**2.7.1 Tidal Scrub-Shrub Wetland** – This subclass is defined as estuarine or tidal riverine wetland dominated by shrub vegetation that have less than 10% tree cover.

Data from NWI and C-CAP were used to classify areas as Tidal Shrub-Scrub Wetland habitat. The following steps were used in the derivation of this CMECS subclass:

- 1) The NWI data was used to locate all scrub-shrub wetlands within the Approximate Maximum Extent of Tidal Wetlands boundary polygon – regardless of whether NWI classifies these as tidal or nontidal wetlands.
- 2) NWI was used to locate all scrub-shrub **tidal** wetlands **outside** of the Approximate Maximum Extent of Tidal Wetlands boundary polygon (these include NWI Estuarine System scrub-shrub wetlands such as E2SSP, and NWI Palustrine System scrub-shrub wetlands with tidal hydrology modifiers S, R, T or V, such as PSSR). Based on experience of our Technical Advisory Committee and Estuary Habitat Specialist, it can be safely assumed that NWI's tidal classification is conservative, i.e. there is little risk of NWI classifying nontidal wetlands as tidal. Also, spatial data analysis during this project showed that there are very few NWI tidal wetlands outside the Approximate Maximum Extent of Tidal Wetlands boundary.

**2.7.1.1 Brackish Tidal Scrub-Shrub Wetland** – Defined as tidal areas dominated by shrub or immature tree species that are less than 6 meters tall and have a range of salt tolerance; salinity may range from 0.5 to 30 (PSU). Scrub-shrub Tidal Wetlands were

classified as Brackish if the NWI codes indicated that the habitats were within the Estuarine System (for example, E2SSP).

3) For areas not mapped in NWI, but within the Approximate Maximum Extent of Tidal Wetlands boundary, Tidal Scrub-Shrub Wetlands were generated from C-CAP using the following steps:

- 1) Convert C-CAP raster to polygons
- 2) Intersect C-CAP polygons with the Approximate Maximum Extent of Tidal Wetlands boundary polygon
- 3) Select all C-CAP polygons within the Approximate Maximum Extent of Tidal Wetlands boundary polygon
- 4) Group the following C-CAP-derived polygon class values into the CMECS classification for Scrub-Shrub Tidal Wetland: Scrub-Shrub; Palustrine Scrub-Shrub Wetland; and Estuarine Scrub-Shrub Wetland.

**Note:** Those NWI Scrub-Shrub polygons that have a number after SS (such as E2SS1N) were analyzed to determine if that data could be used to classify to the “Biotic Community” level in CMECS. It was found that there is not enough specificity in the NWI data to get to the Biotic Community level in CMECS.

**2.8 Forested Wetland** – Areas in this class are characterized by woody vegetation that is generally 6 meters or taller.

**2.8.1 Tidal Forest/Woodland**– This subclass is defined as areas of estuarine or tidal riverine wetland with greater than 10% tree cover.

Data from NWI and C-Cap were used in the classification of areas as Forested Tidal Wetland habitat. The following steps were used in the derivation of this CMECS subclass:

- 1) NWI was used to locate all forested wetlands within the Approximate Maximum Extent of Tidal Wetlands boundary – regardless of whether NWI classifies these as tidal or nontidal wetlands. These were included in the CMECS mapping as “Forested Tidal Wetland.”
- 2) NWI was used to locate all forested **tidal** wetlands **outside** the Approximate Maximum Extent of Tidal Wetlands boundary.
- 3) For areas not mapped in NWI, but within the Approximate Maximum Extent of Tidal Wetlands boundary, Forested Tidal Wetlands were generated from C-CAP using the following steps:
  - 1) Convert C-CAP raster to polygons
  - 2) Intersect C-CAP polygons with the Approximate Maximum Extent of Tidal Wetlands boundary polygon
  - 3) Select all C-CAP polygons within the Approximate Maximum Extent of Tidal Wetlands boundary polygon

4) Group the following C-CAP-derived polygon class values into the CMECS classification for Forested Tidal Wetland: Deciduous Forest; Evergreen Forest; Mixed Forest; Palustrine Forested Wetland; Estuarine Forested Wetland.

4) Those NWI Forested polygons that have a number after FO (such as PFO1C) were analyzed to determine if that data could be used to classify to the “Biotic Community” level in CMECS. It was found that there is not enough specificity in the NWI data to get to the Biotic Community level in CMECS.

**Diked areas:** After completing the classification above, diked areas (based on Duck’s Unlimited Diked Land polygons and other areas identified as diked by the project’s Technical Advisory Committee and Estuary Habitat Specialist) were demoted to the “class” level in the CMECS Biotic Component hierarchy. Vegetation class was determined from NWI or C-CAP as described above. Diked areas with emergent vegetation were classified as “Emergent wetland” (CMECS class 2.6); diked areas with scrub-shrub vegetation were classified as “Scrub-shrub wetland” (CMECS class 2.7), and diked areas with forested vegetation were classified as “Forested wetland” (CMECS class 2.8).

**Data Sets Used:**

- NWI, 2013
- C-CAP, 2010

## **Substrate Component (SC):**

Substrate is defined in CMECS as “the non-living materials that form an aquatic bottom or seafloor, or that provide a surface (e.g., floating objects, buoys) for growth of attached biota. Substrate may be composed of any substance, natural or manmade”.

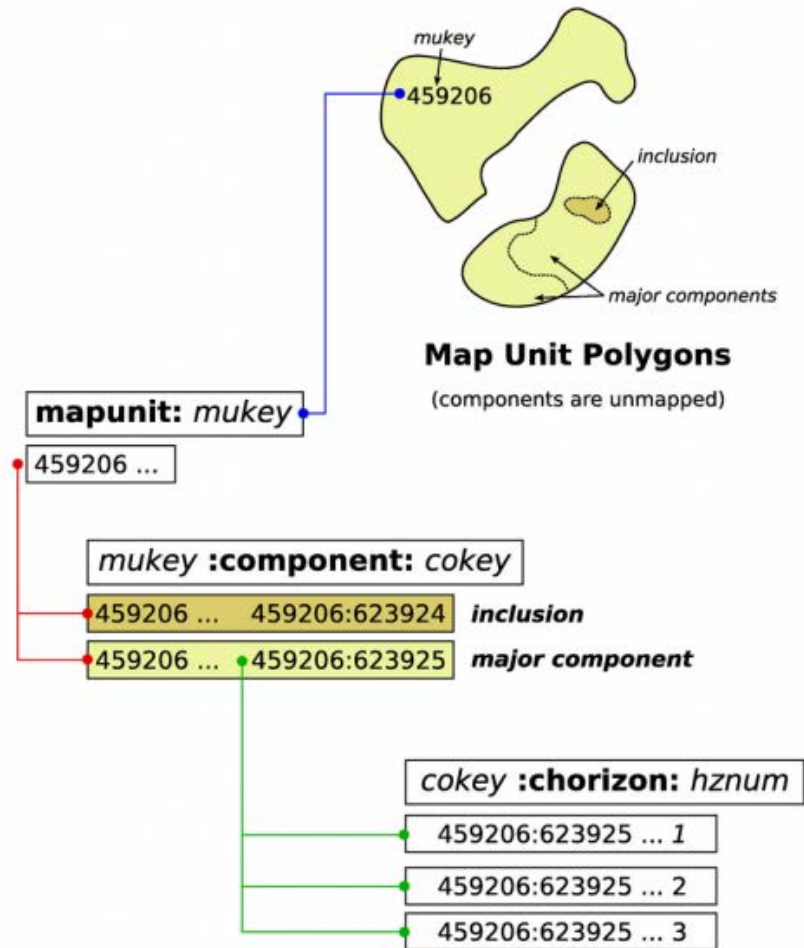
There are three primary CMECS substrate types: Biogenic, Geologic, and Anthropogenic

We used many primary coast-wide inputs in our CMECS substrate component classification:

- US Department of Agriculture Natural, Resources Conservation Service Soil Survey Geographic Database (NRCS SSURGO) soils contributed Geologic and Biogenic substrate information.
- US Fish and Wildlife Service National Wetland Inventory contributed Geologic substrate information where NRCS was unavailable (sub-aqueous areas).
- Anthropogenic substrate was derived from an assortment of sources: roads, railroads, dikes, boat ramps and various other sources of “fill” information.
- NRCS SSURGO soils data consists of map unit geometry, with many related tables containing information about soil properties. A single map unit polygon may be composed of many soil components (horizontal), each of which will have many soil horizons (vertical). Figure 3 below shows the inherent complexity of the Soils data product (excerpted from (Dylan Beaudette, NRCS)).

Figure 3 NRCS Soils Data Diagram

## SSURGO Table Diagram



The NRCS diagram above shows how map units in the database are structured so that they are related to soil horizons through the Mapunit Key. For the purposes of this project, the CMECS classification of any NRCS SSURGO substrate map unit was determined using the physical characteristics of that surface soil horizon's dominant component. For map units where there was not a dominant soil component, the top two subdominant components were used together. In the vast majority of cases, the final CMECS substrate classification of a map unit was not impacted by the use of two subdominant soil components as inputs (i.e. the subcomponent crosswalk results did not disagree). In the rare situation where CMECS classification of each soil subdominant component would have led to conflicting CMECS crosswalk results, the CMECS class was "rolled-up" to the point of agreement in a more generalized CMECS class.

The method of cross-walking data from the NRCS SSURGO Data into CMECS was determined by analyzing the different sediment size classes of each system, and correlating them through a set of rules to equate one class to another in the different classification systems. The NRCS soils database contains information about the engineering properties (grain size) of the soil types. CMECS also classifies geologic substrates by grain size (see Table 2 below).

In NRCS soils data, grain size information is available at four different sediment sieve levels. From a CMECS perspective, the relevant sieve sizes are sieve 10 and sieve 200 (as they correspond with CMECS grain size breaks).

**Table 2 CMECS Geological Sediment Class Grain Sizes**

| <b>Descriptor</b>         | <b>Grain Size (millimeters)</b> |
|---------------------------|---------------------------------|
| <b>Clay</b>               | < 0.004                         |
| <b>Silt</b>               | 0.004 to < 0.0625               |
| <b>Mud</b>                | < 0.0625                        |
| <b>Sand</b>               | 0.0625 to < 2                   |
| <b>(Very Fine Sand)</b>   | 0.0625 to < 0.125               |
| <b>(Fine Sand)</b>        | 0.125 to < 0.25                 |
| <b>(Medium Sand)</b>      | 0.25 to < 0.5                   |
| <b>(Coarse Sand)</b>      | 0.5 to < 1                      |
| <b>(Very Coarse Sand)</b> | 1 to < 2                        |
| <b>Gravel</b>             | 2 to < 4,096                    |
| <b>Granule</b>            | 2 to < 4                        |
| <b>Pebble</b>             | 4 to < 64                       |
| <b>Cobble</b>             | 64 to < 256                     |
| <b>Boulder</b>            | 256 to < 4,096                  |

Of these, sieve 10 (2mm), and the percentage of material that it retains, is the sieve size that determines the Coarse vs. Fine sediment size ratio.

Similarly, materials trapped between sieve 10 and sieve 200 constitutes the percent of sand in a sample, and can be used to further differentiate sediment classes. The CMECS diagram of sediment composition ratios (Figure 4 below) identifies the percentage breaks in sediment composition corresponding with coarse and fine unconsolidated sediment classes.

Finally, sieve 200 (.0625mm), and the percentage of material that passes through it, is the sieve size that determines the percent of mud in a soil sample. Unfortunately, sieve 200 is not a perfect match for the break between the finest sand and mud in CMECS, but material passing this sieve would be considered fine-textured, and thus would constitute “mud” in CMECS.

## **Combining multiple substrate input data sources**

Where present, biogenic substrate classes replaced any geologic substrates, and any anthropogenic substrate replaced any underlying geologic or biogenic soils.

### **1.0- Geologic substrate-**

Geologic Substrate had two primary inputs for the CMECS classification: NRCS soils and NWI. NRCS soils data was interpreted for the entire tidal area and provides virtually seamless coverage. However, NRCS does not contain data for sub-aqueous areas. These areas were filled using NWI substrate information.

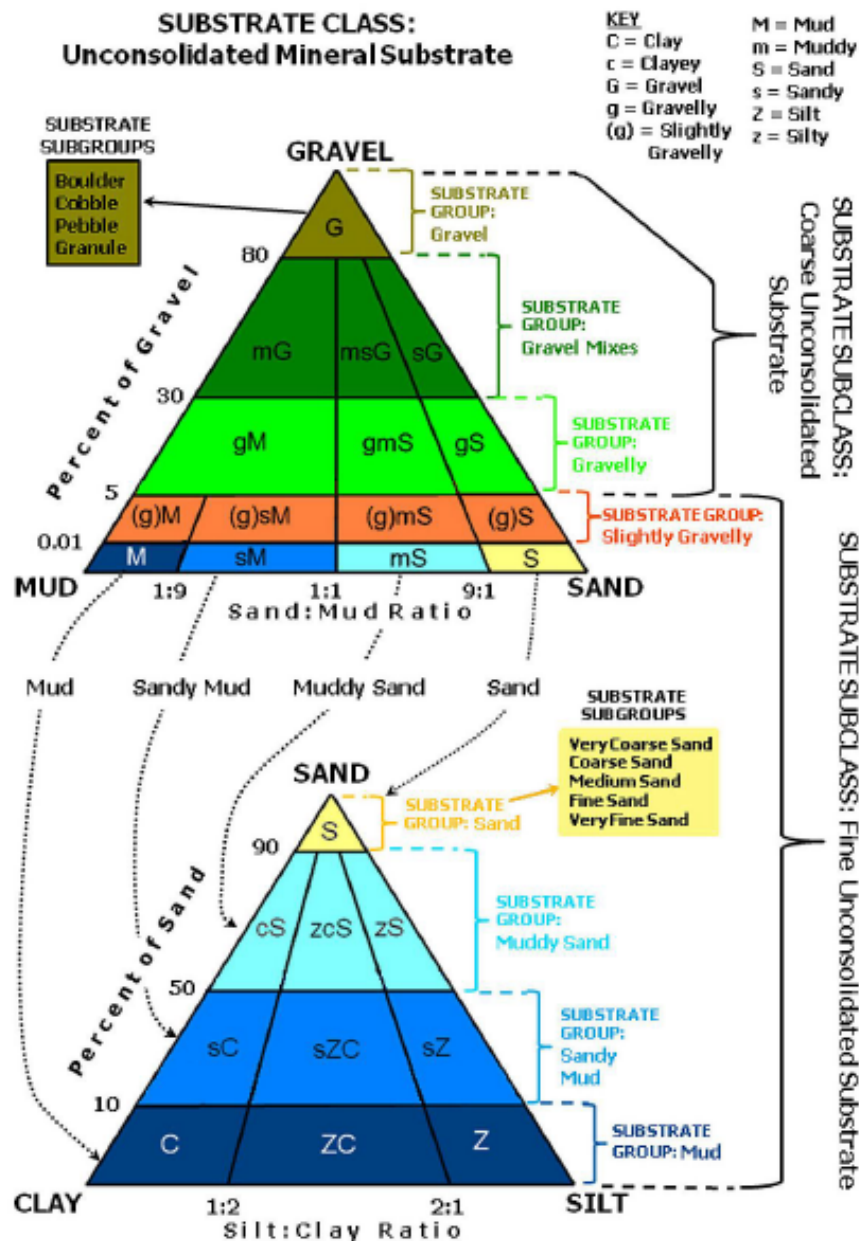
**1.1 - Rock Substrate** – This class is defined as igneous, metamorphic, or sedimentary rock with particle sizes greater than or equal to 4.0 meters (4,096 millimeters) in any dimension that cover 50% or greater of the Geologic Substrate surface.

## 1.2 – Unconsolidated Mineral Substrate -

Geologic Substrates with less than 50% cover of Rock Substrate. This CMECS class uses Folk (1954) terminology to describe any mix of loose mineral substrate that occurs at any range of sizes—from Boulders to Clay. In the sections below, we describe how the NRCS sieve size information was translated into the CMECS substrate classifications.

Many use the percentage ratios shown in figure 4 to differentiate between subclasses of course of fine sediments.

Figure 4 CMECS Substrate Composition Diagram



**1.2.1 - Coarse Unconsolidated Substrate** - If more than 95% of the sample is held by sieve 10 (2mm), the sample is Coarse Unconsolidated Substrate. These substrates correspond to the top three levels of the Folk Gravel-Sand-Mud pyramid diagram.

**1.2.1.2.1 - Sandy Gravel** - If 70-20% of the sample passes sieve 10, and less than 10% of the sample passes sieve 200 (.0625mm), then the sample is Sandy Gravel.

**1.2.1.2.2 - Muddy Sandy Gravel** - If 70-20% of the sample passes sieve 10, and less than 10% of the sample passes sieve 200, then the sample is Muddy Sandy Gravel.

**1.2.1.2.3 - Muddy Gravel** - If 70-20% of the sample passes sieve 10, and 50-100% of the sample passes sieve 200, then the sample is Muddy Gravel.

**1.2.1.3.2 - Gravelly Muddy Sand** - If 95-75% of the sample passes sieve 10, and 10-50% of the sample passes sieve 200, then the sample is Gravelly Muddy Sand.

**1.2.1.3.3 - Gravelly Mud** - If 95-75% of the sample passes by sieve 10, and 50-100% of the sample passes sieve 200, then the sample is Gravelly Mud.

**1.2.2 - Fine Unconsolidated Substrate** - Geologic Substrate surface layer contains less than 5% gravel (particles 2 millimeters to < 4,096 millimeters in diameter). These sediments are classified using the bottom two rows of the Folk (1954) Gravel-Sand-Mud diagram, (figure 4 above), and the entire Folk (1954) Sand-Silt-Clay pyramid diagram. In using the NRCS soils data, if less than 95% of the sample is held by sieve 10, the sample is Fine Unconsolidated Substrate.

**1.2.2.1.1 - Slightly Gravelly Sand** - If more than 95% of the sample passes sieve 10, and less than 10% of the sample passes sieve 200, then the sample is Slightly Gravelly Sand.

**1.2.2.1.2 - Slightly Gravelly Muddy Sand** - If more than 95% of the sample passes sieve 10, and 10-50% of the sample passes sieve 200, then the sample is Slightly Gravelly Muddy Sand.

**1.2.2.1.3 - Slightly Gravelly Sandy Mud** - If more than 95% of the sample passes sieve 10, and 50-90% of the sample passes sieve 200, then the sample is Slightly Gravelly Sandy Mud.

**1.2.2.1.4 - Slightly Gravelly Mud** - If more than 95% of the sample passes sieve 10, and 90-100% of the sample passes sieve 200, then the sample is Slightly Gravelly Mud.

**1.2.2.3 - Muddy Sand** - If 100% of the sample passes sieve 10, and 10-50% of the sample passes sieve 200, then the sample is Muddy Sand.

**1.2.2.4 - Sandy Mud** - If 100% of the sample passes sieve 10, and 50-90% of the sample passes sieve 200, then the sample is Sandy Mud.

**1.2.2.5 – Mud** - If 100% of the sample passes sieve 10, and 90-100% of the sample passes sieve 200, then the sample is Mud.

## 2.0 - Biogenic Substrate

Biogenic Substrates are classified as areas where the percent cover of non-living Biogenic Substrate exceeds percent cover of both Geologic Substrate and Anthropogenic Substrates, when all are considered separately. Biogenic substrates are classified at the higher levels by taxonomy and at the lower levels by median particle size.

Our project team classified organic soils (histosols and mixes of histosols) as Biogenic Substrates. Soils with minor components of histosols were not mapped. The following NRCS soil mapping units (Shown in Table 3) were mapped as Biogenic Substrates, based on expert guidance (Thor Thorson of NRCS). Only those soils whose major components are predominantly organic are included (or mosaics of organic and non-organic major components, such as Fluvaquents-Histosols). Soil mapping units that had only minor components of organic soils were not included.

**Table 3 Soil Units Mapped as Biogenic Substrates**

| County   | Clatsop              | Tillamook                  | Lincoln        | Lane                 | Douglas     | Coos                     | Curry |
|--|----------------------|----------------------------|----------------|----------------------|-------------|--------------------------|-------|
| Soil Units with dominant organic soil component in the map unit name | 5A-Bergsvick         | 2A-Fluvaquents-Histosols-  | 8A-Brallier    | 17-Brallier          | 28A-Bragton | 7-Brallier               |       |
|  | 6A-Brallier          | 55A-Histosols-Water        | Cs-Clatsop     | 18-Brallier Variant- |             | 11-Clatsop               |       |
|  | 11A-Coquille-Clatsop | 102A-Fluvaquents-Histosols | Tm-Tidal marsh |                      |             | 23-Fluvaquents-Histosols |       |
|  | 12A-Coquille-Clatsop |                            |                |                      |             |                          |       |

## 3.0 - Anthropogenic Substrate

Substrates where percent cover of Anthropogenic Substrate exceeds percent cover of both Geologic Substrate and Biogenic Substrates, considered separately. Anthropogenic Substrates are classified at the higher levels by composition and at the lower levels by median particle size.

In our project, Anthropogenic Substrates were inferred from several sources:

- Roads (GTRN & Geofabrik)
- Railroads (ODOT)
- Dikes (Mattison)
- Boat Ramps (OCMP)
- Tidal Wetlands Fill Area (Scranton)

In general, sources that could supply better spatial resolution or higher specificity of substrate material type were given preference over sources of lower spatial resolution or substrate material type. Where multiple sources contributed potential conflicting classifications, the final CMECS class was determined by “rolling up” to the level where the more specific classes no longer disagreed.

**3.1 - Anthropogenic Rock** - Anthropogenic Substrate that is primarily composed of natural mineral materials that were purposefully or accidentally deposited by humans. This includes breakwaters made of natural stone, dredge material, artificial reefs made of natural stone, as well as beach nourishment and beach fill. Shape for this substrate class is covered in the GC (e.g., Groin, Breakwater, and Dredge Deposit). If the origin of a feature cannot be determined, it is assumed to be of natural origin and classified in the Geologic or Biogenic Substrate Origin.

Our project team used several sources to classify anthropogenic rock substrates, listed below:

- Oregon Tidal Wetlands mapping data (Scranton, 2004) was used by pulling out “Fill” polygons and classifying them as “Anthropogenic Rock.” However, those fill areas where dikes have been removed since 2004 were also removed from the CMECS “Anthropogenic Rock” classification.
- The Levees Inventory (Mattison, 2011) was used to classify “Man-Made Levees” made of earth or fill as “Anthropogenic Rock” in CMECS. Those dikes classified as man-made dikes and/or roads in the Levees Inventory were Heads-Up-Digitized into polygon features using LiDAR.
- The FAA Airport layer was used to identify airport fill, and LiDAR was used to Heads-Up-Digitize those areas and classify them as “Anthropogenic Rock” in CMECS.
- An estuary subset of DSL’s Wetland Impacted Area layer (from the LAS dataset) was used to identify those areas that have been issued a permit for filling wetlands. LiDAR was used to confirm areas that actually have been filled and Heads-Up-Digitize those areas. They were then classified as “Anthropogenic Rock” in CMECS (unless they are paved roads, which were classified as “Anthropogenic Rock Hash”).

**3.1.2 - Anthropogenic Rock Rubble** - Substrate that is dominated by Anthropogenic Rock with a median particle size of 64 millimeters to < 4,096 millimeters (Cobbles and Boulders).

- The Levees Inventory (Mattison, 2011) “Rip Rap” class ( jetties were classified as “Rip Rap” in the Levees Inventory) was used to identify “Anthropogenic Rock Rubble” in CMECS. Those “Rip Rap” features were identified in the Levees Inventory and were Heads-Up-Digitized using the LiDAR DEM to map the observed features.

**3.1.3 - Anthropogenic Rock Hash** - Substrate that is dominated by Anthropogenic Rock with a median particle size of 2 millimeters to < 64 millimeters (Granules and Pebbles).

- The Levees Inventory (Mattison, 2011) was used to classify road beds or railroad bed levees as “Anthropogenic Rock Hash” in CMECS. Those features classified as roads or railroads in the Levees Inventory were Heads-Up-Digitized using the LiDAR DEM to map the observed features.
- LiDAR was used to determine if the road alters the underlying landscape and thereby constituted a distinct geoform—if so, it was classified as “Fill Area” and given a substrate class of Anthropogenic Rock Hash. Roads, highways, and streets (BLM, 2014) were used to identify the

road centerlines. Line features were turned into polygon features by the creation of a buffer based on an average width of a random sample (based upon a classification of each road type provided by Geofabrik, 2013).

- An estuary subset of DSL's Wetland Impacted Area layer (from the LAS dataset) was used to identify those areas that have been issued a permit for filling wetlands. LiDAR was used to confirm areas that actually have been filled and to Heads-Up-Digitize those areas. They were then classified as "Anthropogenic Rock Hash" in CMECS if they are paved roads.

- The railroads line layer (ODOT, 2008) and LiDAR were used to Heads-Up-Digitize and classify railroads track beds as "Anthropogenic Rock Hash" in CMECS.

**3.3 - Construction Materials** - Anthropogenic Substrate that is composed of any single construction material or combination of construction materials (concrete, brick, rebar, pipe, porcelain, fiberglass, rubber, plastic, < 50% wood, < 50% metal, etc.) that were manufactured by humans.

- The Levees Inventory (Mattison, 2011) was used to classify dams as "Construction Materials" in CMECS. Those features classified as dams in the Levees Inventory were Heads-Up-Digitized into polygon features using the LiDAR DEM to map the observed features.

- The ODFW Fish Passage Barrier Inventory was used to classify dams as "Construction Materials" in CMECS. They were Heads-Up-Digitized into polygon features using the LiDAR DEM to map the observed features.

- An Airports data layer (FAA, 2010) was used to classify airport fill as "Anthropogenic Rock". They were Heads-Up-Digitized into polygon features using LiDAR.

#### **Data Sets:**

- SSURGO Soil Surveys, NRCS, 2013 (Soils, 2013)
- Dylan Beaudette, NRCS
- Estuarine Levees Inventory, OCMP, 2011 (Mattison, 2011).
- Scranton, R. 2004.
- Open Street Map Data Extract, Geofabrik, 2013 (Geofabrik, 2013)
- Oregon Fish Passage Barriers, ODFW, 2011 (ODFW, 2011)
- Railroads, ODOT, 2008 (ODOT, 2008)
- Oregon LiDAR Consortium: North Coast, DOGAMI, 2009 (LiDAR, 2009)
- Oregon LiDAR Consortium: South Coast, DOGAMI, 2008 (LiDAR, 2008)
- FAA, 2010
- DSL LAS dataset (2011)

## **Modifiers**

Modifiers are physicochemical, spatial, geological, biological, anthropogenic, and temporal variables with defined categorical values and ranges that are used to describe CMECS units. Modifiers can be applied when additional information is needed to further characterize an identified unit for individual applications. Modifiers provide additional environmental, structural, or biological information about the

ecosystem; modifiers are useful for description and application—but they are not required for classification according to the CMECS schema. Modifiers are a dynamic component of the CMECS in the sense that users are free to apply additional local modifiers for their project needs as long as these are reported and do not conflict with the established definition of modifiers in the CMECS document.

## **Anthropogenic Impact Modifiers**

**-Impounded/diverted (diked areas):** Areas where artificial construction impedes, redirects, or retains hydrological flow by building or placing barriers (e.g., dams, levees, dikes, berms, seawalls, or piers); these structures are designed to either retain water or to prevent inundation. To identify areas affected by dikes and other artificial barriers, we used a GIS layer of diked areas provided by Ducks Unlimited (DU).

The DU diked areas layer was generated in two steps (Kevin Petrik, personal communication, April 2014). In the first step, vector lines of dikes from the Levees Inventory (Mattison, 2011) were combined with the LIDAR DEM. Using Python code, the LiDAR elevation was sampled at intervals along the dike lines and a mean elevation was calculated for each levee. This elevation was transferred to the land on the upslope side by a GIS technician to designate the land protected by the levee. The resulting base data was combined with NWI data and used as input into SLAMM (Sea Level Affecting Marshes Model). The model initial conditions were examined for new areas of flooding. If new areas were expected to flood, further analysis was performed of aerial imagery to confirm new levee protected areas, which were added to the mapping.

In our project, we intersected the DU diked areas layer with maps for the CMECS Aquatic Setting. Wetlands classified as diked by DU were assigned the Anthropogenic Impact modifier “Impounded/diverted” (which includes diked areas). The results were reviewed by our Estuary Habitat Specialist and Technical Advisory Committee, and revisions to diked status were made based on their input.

- **Dredged:** Landscape that is mechanically altered by the removal of sediments or other materials (e.g., shell) in order to deepen or widen channels (e.g., for navigation or alteration to hydrology). Dredged channels were found by locating “Sidecast of Significance” in the Levees Inventory (Mattison, 2011). Scranton’s adjacent “Water” polygons that appeared to be sources for the sidecast material were then selected to create a separate layer. As the existence of sidecast material suggests, these polygons represent those channels that have been dredged. They were then classified as “Channels” in the Geologic Geoform Component with a modifier of “dredged”.

- **Restored:** Areas where restoration activities have been conducted; may include planted areas. The Levees Inventory (Mattison, 2011) was used to classify “Historical Dikes” as CMECS modifier “Restored”. The lines classified as “Historical Levees” in the Levees Inventory were turned into polygons by the creation of a buffer based on an average width of a random sample (20ft).

- **Filled:** Areas where materials (such as sand or shell) have been placed on (or in) an area of coast or a water body. The Levees Inventory (Mattison, 2011) was used for the CMECS “Natural Levees” classification and given the anthropogenic modifier “Fill”. Lines classified as “Natural Levee with Man-

Made Enhancements” in the inventory were turned into polygons by the creation of a buffer based on an average width of a random sample (20ft).

**Data Sets:**

- Mattison, 2011
- Ducks Unlimited, 2011.

## Data Appendix:

Approximate Maximum extent of Tidal Wetlands, OCMP, 2014 (OCMP Tidal, 2014)

Habitat Classification and inventory methods for the management of Oregon estuaries. Bottom, Dan et al. (1979). Final Report of the Oregon Estuary Inventory Project

Coastal Change Analysis Program (C-CAP) Regional Land Cover Atlas, (NOAA 2010)

NOAA Coastal Change Analysis Program (C-CAP) Regional Land Cover Database. Data collected 1995-present. Charleston, SC: National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management. Data accessed at <http://www.coast.noaa.gov/digitalcoast/data/ccapregional>.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service, Biological Services Program, Document FWS/OBS-79/31.

Ducks Unlimited, 2011. All\_protected\_dikes\_reproj.shp, provided by Kevin Petrik @kpetrik@ducks.org

Dylan Beaudette, NRCS Accessed online at: <http://casoilresource.lawr.ucdavis.edu/drupal/node/334>

Estuarine Levees Inventory, OCMP, 2011 (Mattison, 2011)

Federal Aviation Administration Airports Data Layer, 2010 (FAA, 2010)

Geographic Names Information System (GNIS), USGS, 2011 (GNIS, 2011)

DEQ, Laboratory Analytical Storage and Retrieval (LASAR) database, data delivered 10/16/2013 (CEQ, 2013)

Lands Administrative System (LAS) Removal/Fill Permit Locations, Department of State Lands, 2011. <http://chetco-new.dsl.state.or.us/mapsandapps/> (DSL LAS, 2011)

Lee II, H. and Brown, C.A. (eds.) 2009. Classification of Regional Patterns of Environmental Drivers And Benthic Habitats in Pacific Northwest Estuaries. U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Western Ecology Division. EPA/600/R-09/140. Accessed online at: <http://nepis.epa.gov/Adobe/PDF/P1006Q2H.PDF>

Marine Ecoregions of the World, Spalding, 2007 (MEOW, 2007)

National Wetlands Inventory, USFW, 2013 (NWI, 2013)

NOAA NOAA Mean High Water Continually Updated Shoreline Product, NOAA, 2013 (CUSP, 2013)

NOAA Tsunami Inundation modeling DEMs, accessed online at: <http://www.ngdc.noaa.gov/mgg/inundation/> including:

- Astoria, OR/WA 1/3 arc-second MHW DEM, NGDC, 2008
- Garibaldi, OR 1/3 arc-second MHW DEM, NGDC, 2007

- Central Oregon Coast, OR 1/3 arc-second MHW DEM, NGDC, 2008
- Port Orford, OR 1/3 arc-second MHW DEM, NGDC, 2008

Open Street Map Data Extract, Geofabrik, 2013 (Geofabrik, 2013)

Orthophoto Imagery State of Oregon Half Meter, NAIP, 2011 (NAIP, 2011)

Oregon Regional Land Cover, C-CAP, 2010

Oregon Continually Updated Shoreline Product, OCMP, 2014

Oregon LiDAR Consortium: North Coast, DOGAMI, 2009 (LiDAR, 2009)

Oregon LiDAR Consortium: South Coast, DOGAMI, 2008 (LiDAR, 2008)

Oregon Coast, OR 1/3 arc-second MHW DEM, NOAA, 2007-8 (NOAA, 2008)

Oregon Fish Passage Barriers, ODFW, 2011 (ODFW, 2011)

Protected Public Access Sites of the Oregon Coast, OCMP, 2010 (OCMP Access, 2010)

Railroads, ODOT, 2008 (ODOT, 2008)

Scranton, R. 2004. The application of Geographic Information Systems for delineation and classification of tidal wetlands for resource management of Oregon's coastal watersheds. Thesis, Marine Resource Management Program, Oregon State Univ., Corvallis, OR. GIS data accessed 9/21/2014 at [http://www.coastalatlantlas.net/downloads/shapes/tidal\\_marsh.zip](http://www.coastalatlantlas.net/downloads/shapes/tidal_marsh.zip) ; report accessed 9/21/2014 at <http://ir.library.oregonstate.edu/xmlui/handle/1957/3175>.

SSURGO Soil Surveys, NRCS, 2013 (Soils, 2013)

# Appendix A. Generating the Approximate Maximum Extent of Oregon Tidal Wetlands using Exceedance Water Level Probability Contours

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**Authored by: Andy Lanier, Randy Dana, Tanya Haddad, and Laura Mattison (Oregon Coastal Management Program) and Laura Brophy (Green Point Consulting).**

One of the most important tasks in this project was the establishment of the approximate maximum extent of the estuarine influence on habitats in Oregon. The goal of this project was to update existing Oregon Estuary Plan Book resource inventory information produced in the late 1970's and early 1980's by the Oregon Department of Fish and Wildlife (Bottom et al., 1979). One of the areas that needed improvement over the original mapping was the upslope identification of tidally influenced wetlands. The original ODFW habitat maps did not consistently describe the upper extent of estuarine habitats, and in many cases ODFW habitat maps stopped well short of areas we now understand to be influenced by saline waters and/or by periodic flooding associated with the tides.

The Coastal and Marine Ecological Classification Standard describes estuarine habitats using two different organizational constructs of the classification system: the Aquatic Setting and the Biotic Component. In CMECS' Aquatic Setting, the upper bounds of the Estuarine Coastal Subsystem and the Estuarine Tidal Riverine Coastal Subsystem correspond with the upslope boundary of Oregon's intertidal environments (or estuarine wetlands). The Aquatic Setting classification also includes the "tidal zone." CMECS' tidal zone classification differs slightly between the Estuarine Coastal Subsystem and the Estuarine Tidal Riverine Coastal Subsystem. In the Estuarine Coastal subsystem (salinities greater than 0.5 PSU), MHHW is used as the boundary between habitats referred to as "intertidal" and the higher areas referred to as "supratidal." In the Estuarine Tidal Riverine Coastal Subsystem (salinities less than 0.5 PSU), "extreme high water of spring tides" is defined as the upper boundary of the intertidal. No published data on the elevation of "extreme high water of spring tides" are available for Oregon, and our project team determined that that using the MHHW elevation as a boundary for Oregon's intertidal habitats was not appropriate, since many of Oregon's tidally influenced wetlands typically occur above the MHHW elevation. The elevations at which intertidal habitats occur in Oregon were determined by observations of the plant communities associated with emergent, scrub-shrub and forested wetlands (described in the CMECS Biotic Component) and through water level logger observations and wetland surface elevation surveys conducted within with those wetland communities. To better map Oregon's intertidal wetlands, the project team sought a more appropriate method for determining the upper boundary of Oregon's intertidal wetlands and ended up using a method derived from the NOAA Extreme Water Level Analysis 50% exceedance level.

NOAA's Extreme Water Levels analysis (<http://tidesandcurrents.noaa.gov/est/>) provides several exceedance level water elevations (1%, 10%, 50%, and 99%). These represent annual probabilities of water levels exceeding the given elevation – probabilities of 1%, 5%, 50%, and 99% respectively. This analysis is based upon the observed water levels during a period of at least 30 years, which includes the water level elevations associated with storms and floods. For example, the 50% exceedance elevation is 2.62 ft (~0.8 m) above Mean Higher High Water (MHHW) at South Beach, Oregon. This means it is probable a tide will exceed 2.62 ft above MHHW in half of all years, or on average, once every two year period. These exceedance elevations can be mapped on the landscape as contours ("exceedance contours").

During the initial stages of this project, we evaluated the fit of the 50% and 99% exceedance contours to the landscape using sites where we had high quality field data, including surveyed wetland surface elevations and year-round local water level data from electronic dataloggers. We determined that the 50% exceedance contour was a good fit for the approximate maximum extent of tidal wetlands habitats, while the 99% exceedance contour was too low (that is, tidal wetlands extend higher in the landscape). Therefore, we selected and mapped the 50% exceedance line as the upper boundary for tidal wetlands in Oregon. Our ground-truthing suggests that most areas within the 50% exceedance contour actually experience tidal inundation much more often than every two years. We attribute this observation to a combination of factors, including upwards bias of the LIDAR DEM (due to vegetation interference) and additive water heights due to river flows during fall, winter and spring.

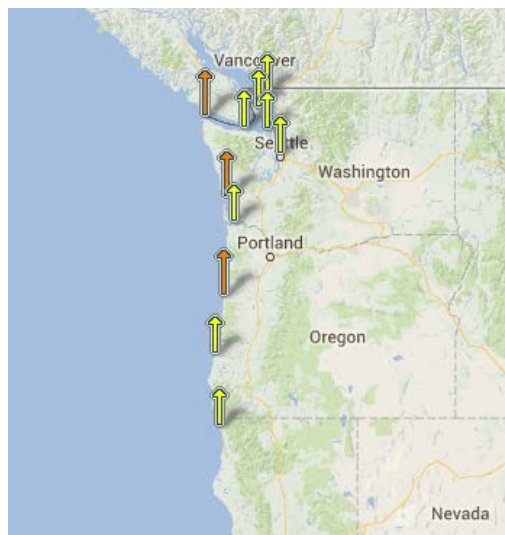


Figure 1. NOAA Extreme Water Level Observation Stations

The 50% exceedance value was calculated using NOAA's existing network of observed locations; values were interpolated for the estuaries where no base stations were available. There are four tide stations in Oregon, here referred to as base stations, for which calculates [extreme water levels](#) and the exceedance probability values: Port Orford, Charleston, South Beach, and Astoria (Figure 1). For estuaries between the base stations, the exceedance value was calculated from the relative distance of the intermediate point to the nearest bounding stations with exceedance values. Distance was determined simply as the difference in latitude. Thus, if the latitude of the mouth of an estuary of interest fell north of a base station by one quarter of the distance between the base stations, it would be assigned an exceedance value equal to the difference between the base station exceedance values multiplied by one quarter and added to the exceedance value of the southern station. Crescent City, CA and Toke Point, WA were added as base stations to provide full coverage of the Oregon coast. It was decided to not use Astoria for the outer coast calculations as it is far inland and using it skewed the general trend of exceedance values from south to north. In the

end, the result of this process was that we mapped intertidal wetlands up to the 50% exceedance elevation, and we defined the biotic classes using other types of data (that is, non-water-level data) (see Biotic Component in the main Core Methods document).

Figure 2 shows the 50% exceedance values calculated for Oregon estuaries. The values for the red locations were calculated by NOAA from long-term tidal data. The values for the black locations were calculated as simple ratios from the nearest bounding red locations. A 50% exceedance value means it is expected that a given tidal datum, e.g., MHHW, will be exceeded by the given number of feet by at least one tide in a two year period.

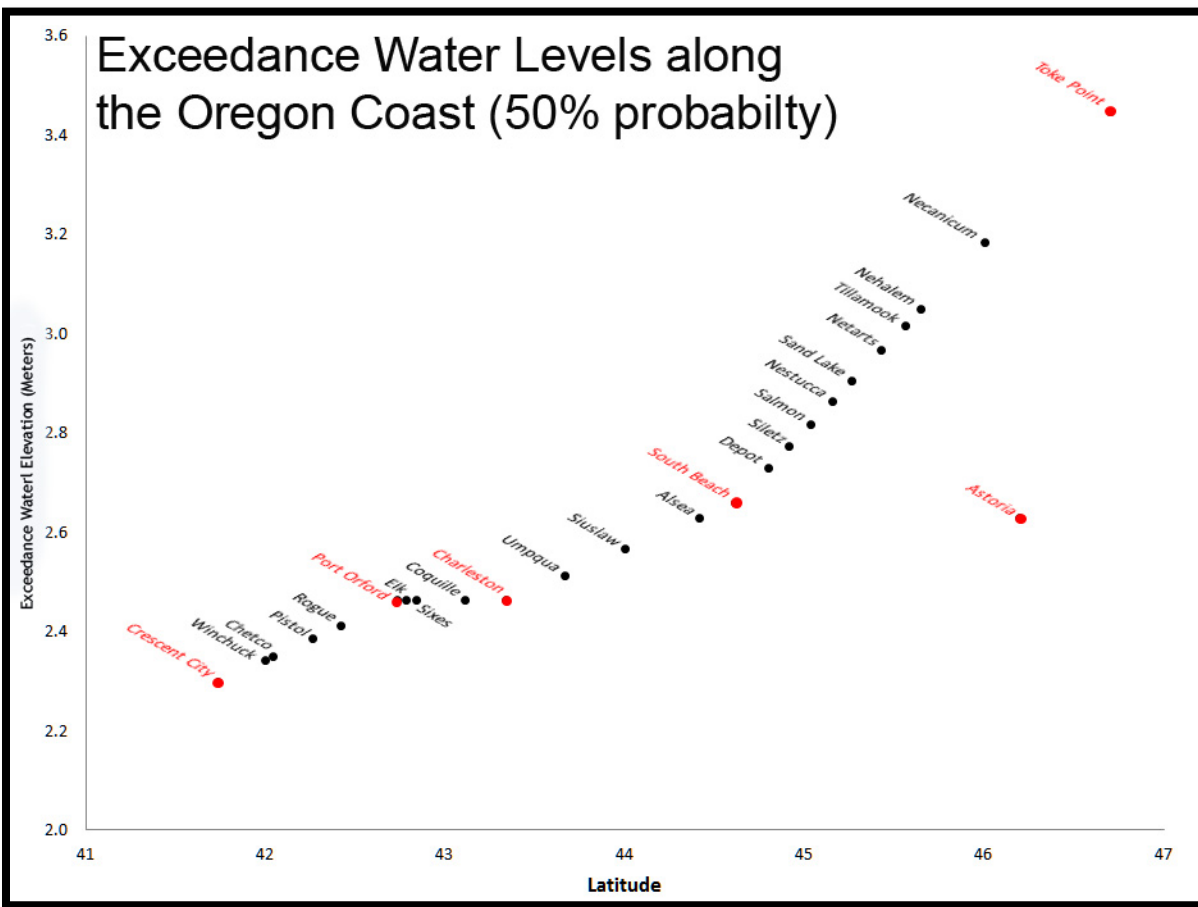


Figure 2. Oregon Coast Exceedance Water Levels

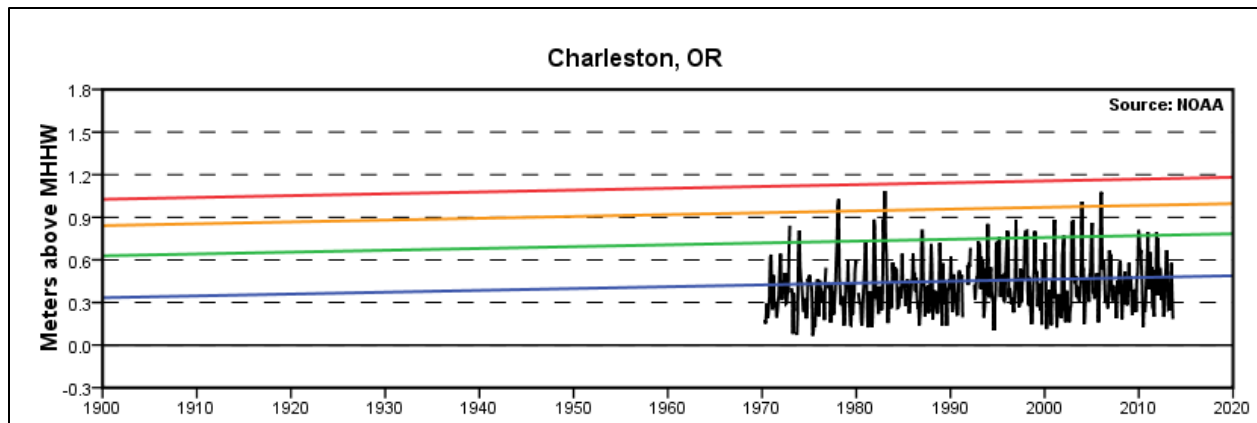


Figure 3. Extreme Water Level Plot

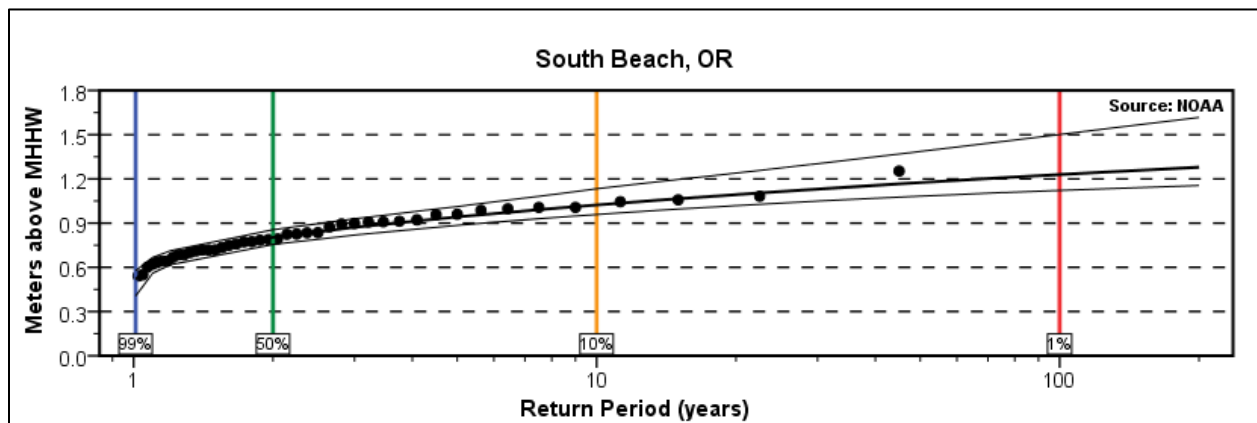
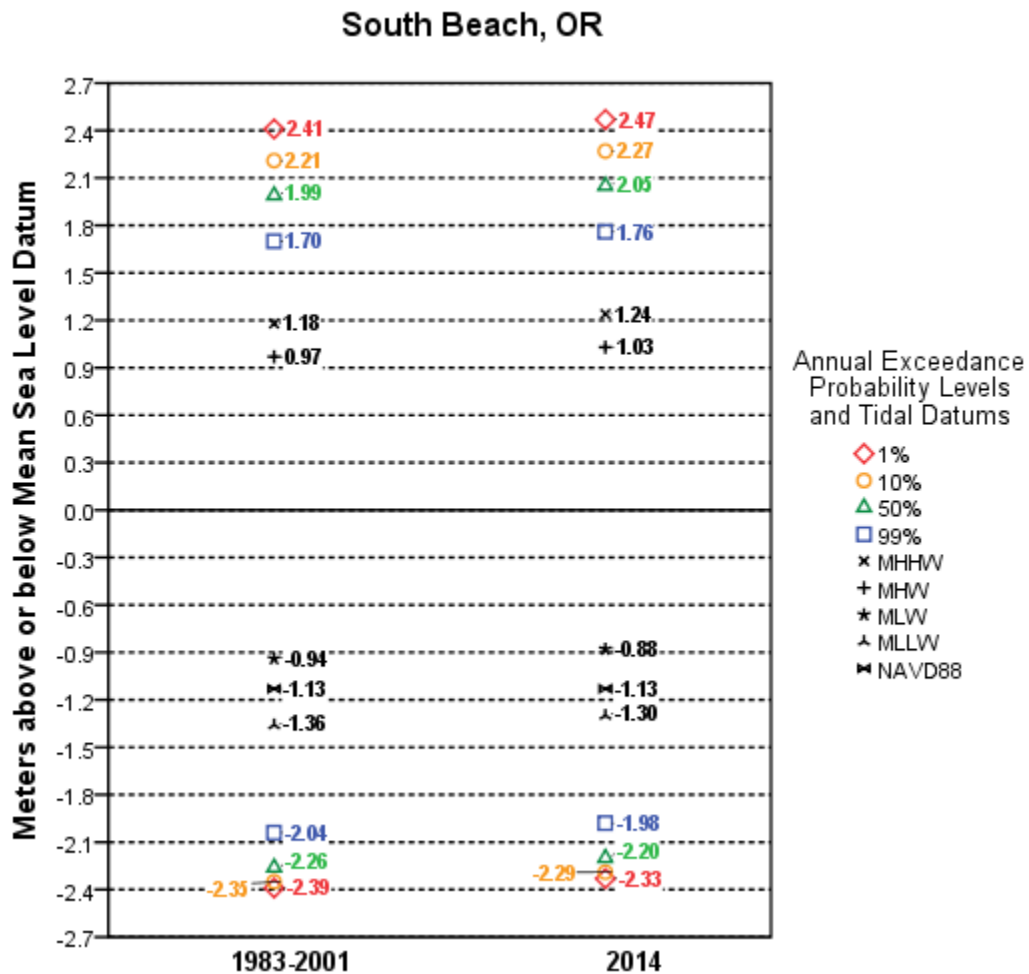


Figure 4. Annual Exceedance Probability Curve for Newport (South Beach), OR

Figures 3 and 4 show the relationship between the observed water levels and the calculated exceedance levels. Figure 5 below shows elevation values (relative to a specific tidal datum) of different exceedance level probabilities, indicating that the relationship between probability and elevation is inversely related. For example, the 1% annual exceedance water level probability is the highest elevation on the table, and the event that is least likely to occur.



### GIS specifics:

The LIDAR data used were from the [Oregon LIDAR Consortium](#), collected in 2008 for the south coast and 2009 for the north; vertical datum is NAVD 88. The elevation surface of the exceedance line derived from VDatum also has NAVD 88 as its vertical datum.

The 50% exceedance line is the intersection of an exceedance DEM (based on VDatum and exceedance values) and the bare-earth DEM (based on LIDAR sampling). The intersection of the two surfaces occurs where the bare-earth DEM rises from below the modeled water surface and represents the modeled upper boundary of tidal wetlands. This is what we are calling the exceedance line. If the two surfaces don't intersect, there is no line.

### Methods:

- Using NOAA's Extreme Water Level Analysis modeling, the 50% exceedance water level was plotted on the landscape using the Oregon LIDAR consortium derived 3ft digital elevation model.

- A polygon layer was created from that modeled surface, so that it could be intersected with other layers, allowing mapping and classification of habitats. A polygon layer also allowed inclusion/exclusion areas on the basis of size.
- The approximate maximum extent of tidal wetlands polygon includes (merged) areas that are surrounded by low ground, even if they are slightly above the elevation of the modeled surface. These are generally areas of vegetation interference with the LIDAR signal, dikes, hummocks etc.
- The approximate maximum extent of tidal wetlands polygon excludes areas that are less than 1 acre in size.

### **Inundation frequency and elevations of Oregon tidal wetlands:**

Tidal wetlands between MHHW and the exceedance line flood regularly, but with decreasing frequency as you move upslope. The frequency of flooding in this space is on a gradient.

By definition, on average, areas at MHHW flood every day on the higher high tide (that's why it's called "mean higher high water"). Areas slightly above MHHW flood less often than once a day -- but still flood many days per month. As you move up above MHHW towards the exceedance line, wetlands flood only during new moon and full moon cycles (spring tides). Areas close to the exceedance line may flood only on the higher of the two spring tide cycles each month, or may flood only during months of high river flows (depending on landscape setting) -- but they still flood with tidal periodicity and are thus tidal wetlands.

Several studies have established that Oregon's tidal wetlands occur at elevations extending well above MHHW, including the following:

- Brophy, L.S., S. van de Wetering, M.J. Ewald, L.A. Brown, and C.N. Janousek. 2014. Ni-les'tun Tidal Wetland Restoration Effectiveness Monitoring: Year 2 Post-restoration (2013). Corvallis, Oregon: Institute for Applied Ecology. Accessed 9/10/14 at [https://www.dropbox.com/s/lvukn7tzhypfkzz/Nilestun\\_Year2\\_EM\\_report\\_FINAL\\_20140730-1.pdf?dl=0](https://www.dropbox.com/s/lvukn7tzhypfkzz/Nilestun_Year2_EM_report_FINAL_20140730-1.pdf?dl=0).
- Brophy, L.S., C.E. Cornu, P.R. Adamus, J.A. Christy, A. Gray, M.A. MacClellan, J.A. Doumbia, and R.L. Tully. 2011. New tools for tidal wetland restoration: Development of a reference conditions database and a temperature sensor method for detecting tidal inundation in least-disturbed tidal wetlands of Oregon, USA. Report to the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), Durham, NH. 199 pp. Accessed March 11, 2014 at [http://oregonexplorer.info/data\\_files/OE\\_topic/wetlands/documents/01\\_Brophy\\_Cornu\\_CICEET\\_FINAL\\_complete\\_30-Aug-2011.pdf](http://oregonexplorer.info/data_files/OE_topic/wetlands/documents/01_Brophy_Cornu_CICEET_FINAL_complete_30-Aug-2011.pdf).
- Brophy, L.S. 2009. Effectiveness Monitoring at Tidal Wetland Restoration and Reference Sites in the Siuslaw River Estuary: A Tidal Swamp Focus. Prepared for Ecotrust, Portland,

OR. Green Point Consulting, Corvallis, OR. 125pp. Accessed March 11, 2014 at <http://hdl.handle.net/1957/35621>.

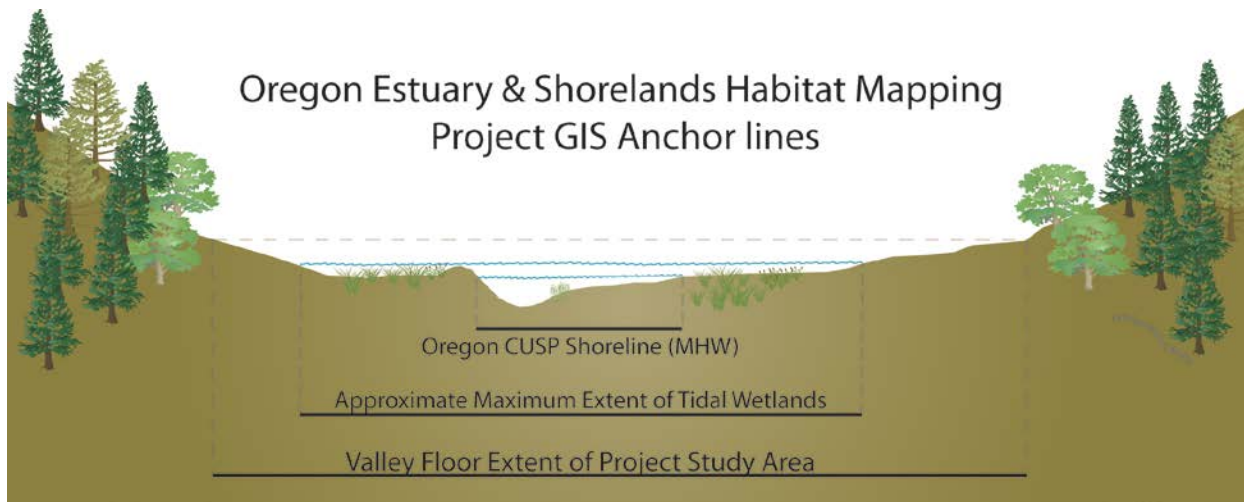
- Eilers, H. Peter. 1975. Plants, plant communities, net production, and tide levels: the ecological biogeography of the Nehalem salt marshes, Tillamook County, Oregon. Doctoral dissertation. Oregon State University, Corvallis, OR 368 pp.
- Jefferson, C.A. 1975. Plant communities and succession in Oregon coastal salt marshes. Ph.D. thesis, Department of Botany and Plant Pathology, Oregon State University. 192 pp.

### **Tidal connectivity of low areas (below the 50% exceedance elevation):**

Areas below the 50% exceedance elevation that are hydrologically isolated from tidal influence due to natural topographic barriers, if present within the study area, could create errors during application of the methods described above. Such low areas might be identified as tidal wetlands when in fact they would be non-tidal. However, it was determined during this project (and during our team's past studies) that within our study area, land below the 50% exceedance elevation is clearly connected to tidal influence -- unless artificially disconnected by man-made barriers. This connectivity is probably due to gradual uplift of the land margin, due to the outer coast's geomorphic and tectonic setting. Our Estuary Habitat Specialist carefully reviewed the areas within the Approximate Maximum Extent of Tidal Wetlands within the GIS (using aerial photographs and the LIDAR DEM), and found that the only possible exceptions to tidal connectivity of low ground in the study area were low areas between sand dunes ("interdunal swales") near river mouths. Viewed in the GIS, some of these areas lacked clearly visible channel connections to the nearby tidal water bodies. However, sandy dunal soils are hydraulically conductive, allowing water to flow through the soil easily. Therefore, even in cases where surface channel connections were not easily visible in aerial photographs or LIDAR, it was possible that these interdunal swales were hydrologically connected to tidal influence. The scope of this project did not allow field investigation of hydrology in these dunal areas, so given the uncertainties, we decided to retain the interdunal swales in the mapped products until further information becomes available.

# Appendix B: Methods for Generating the Oregon Continually Updated Shoreline Product

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As shown in the above figure, a shoreline was needed during the CMECS project to bound habitats near the water's edge, including but not limited to channels, sloughs, and islands. The OCMP generated by a MHW shoreline by intersecting two surfaces, a modeled land surface and a modeled water surface, the intersection of two surfaces being a line. The modeled land surface is a digital elevation model (DEM) derived from lidar. The modeled water surface was created using information from NOAA's VDatum tool. VDatum was used to report the height of mean high water (MHW) for the center of each cell in the lidar DEM for the area of interest. Where valid results were produced, the points were converted into a raster data set, an initial DEM for the water surface. As the VDatum model extends only a short way into estuaries, much of the area of interest is initially represented as No Data. The model was extended using the ArcGIS Euclidean Allocation tool, which replaces No Data values with the nearest data values. This method is recommended by NOAA's Coastal Services Center for this purpose. The high water surface DEM and land surface DEM were intersected and processed using ArcGIS Spatial Analyst tools to generate a smoothed line. Whenever MHW was not able to be generated (usually due to tide stage), gaps were filled by incorporating lines from Scranton's tidal wetland work, and or head's up digitizing from NAIP 2011 imagery.

The Oregon CUSP Shoreline is being considered for adoption as a state standard within Oregon's Geospatial Framework Community. A draft of the line is available for download and review from: [http://www.coastalmarinedata.net/meetings/shorelines/DRAFT\\_MHW\\_Shoreline\\_OCMP\\_2014.zip](http://www.coastalmarinedata.net/meetings/shorelines/DRAFT_MHW_Shoreline_OCMP_2014.zip)