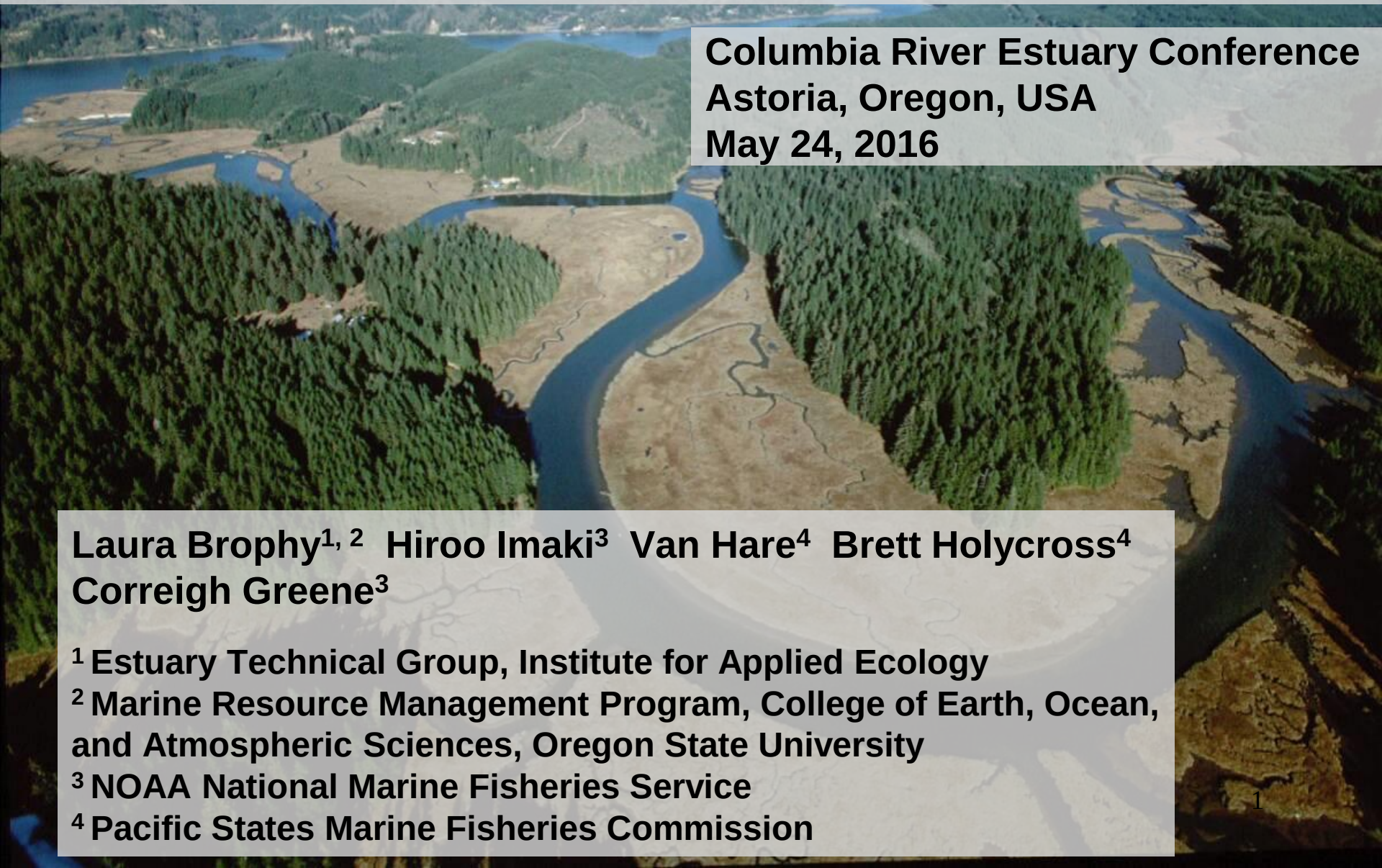
Mapping the extent of U.S. West Coast tidal wetlands using extreme water level data and LIDAR



Columbia River Estuary Conference
Astoria, Oregon, USA
May 24, 2016

Laura Brophy[1, 2] Hiroo Imaki[3] Van Hare[4] Brett Holycross[4] Correigh Greene[3]

[1] Estuary Technical Group, Institute for Applied Ecology
[2] Marine Resource Management Program, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University
[3] NOAA National Marine Fisheries Service
[4] Pacific States Marine Fisheries Commission

Who is IAE/ETG?

IAE: Small independent non-profit – Corvallis, OR

ETG is a subgroup within IAE that provides:

- Scientific decision support for estuary management
- On-the-ground wetland monitoring and research
- Tools for strategic planning – conservation and restoration

What is the context?

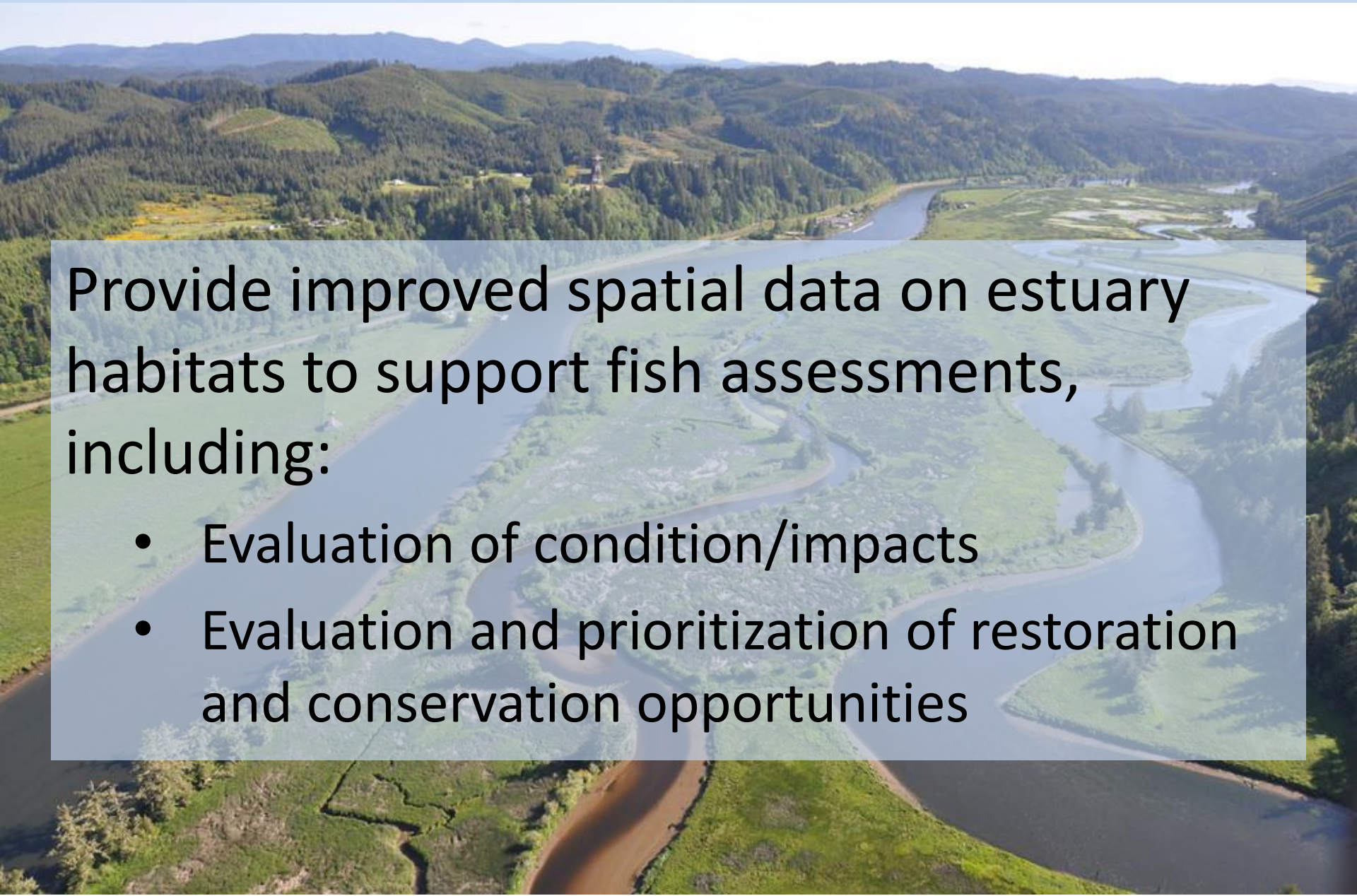
The team was convened by PMEP…

Pacific Marine & Estuarine Fish Habitat Partnership

Goal: Develop a spatial framework to support West Coast fish habitat assessments

More info: http://www.pacificfishhabitat.org/overview-of-the-west-coast-fish-habitat-assessments

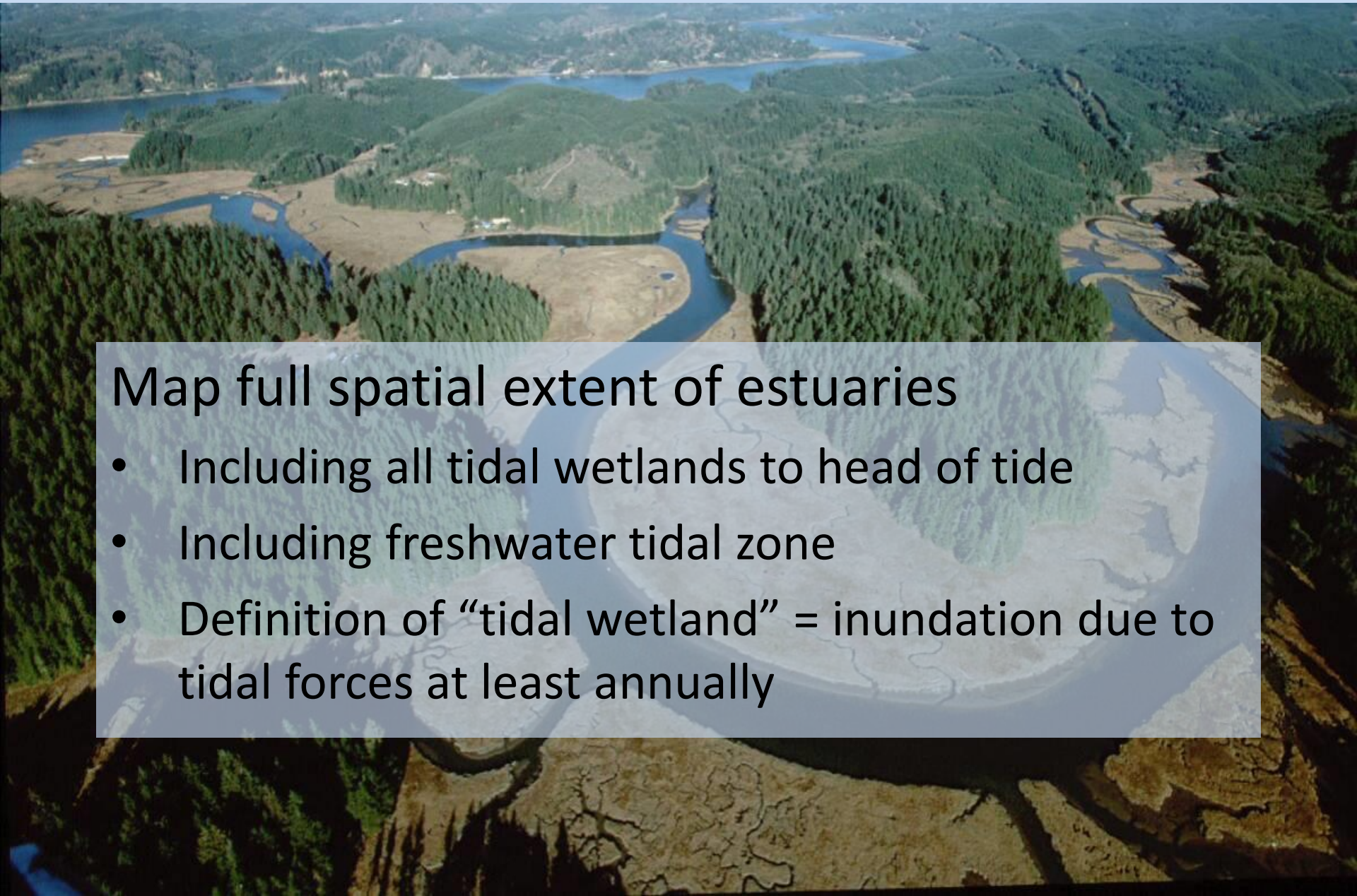
Why are we mapping W Coast estuaries?



Provide improved spatial data on estuary habitats to support fish assessments, including:

- Evaluation of condition/impacts
- Evaluation and prioritization of restoration and conservation opportunities

What's our general approach?



Map full spatial extent of estuaries

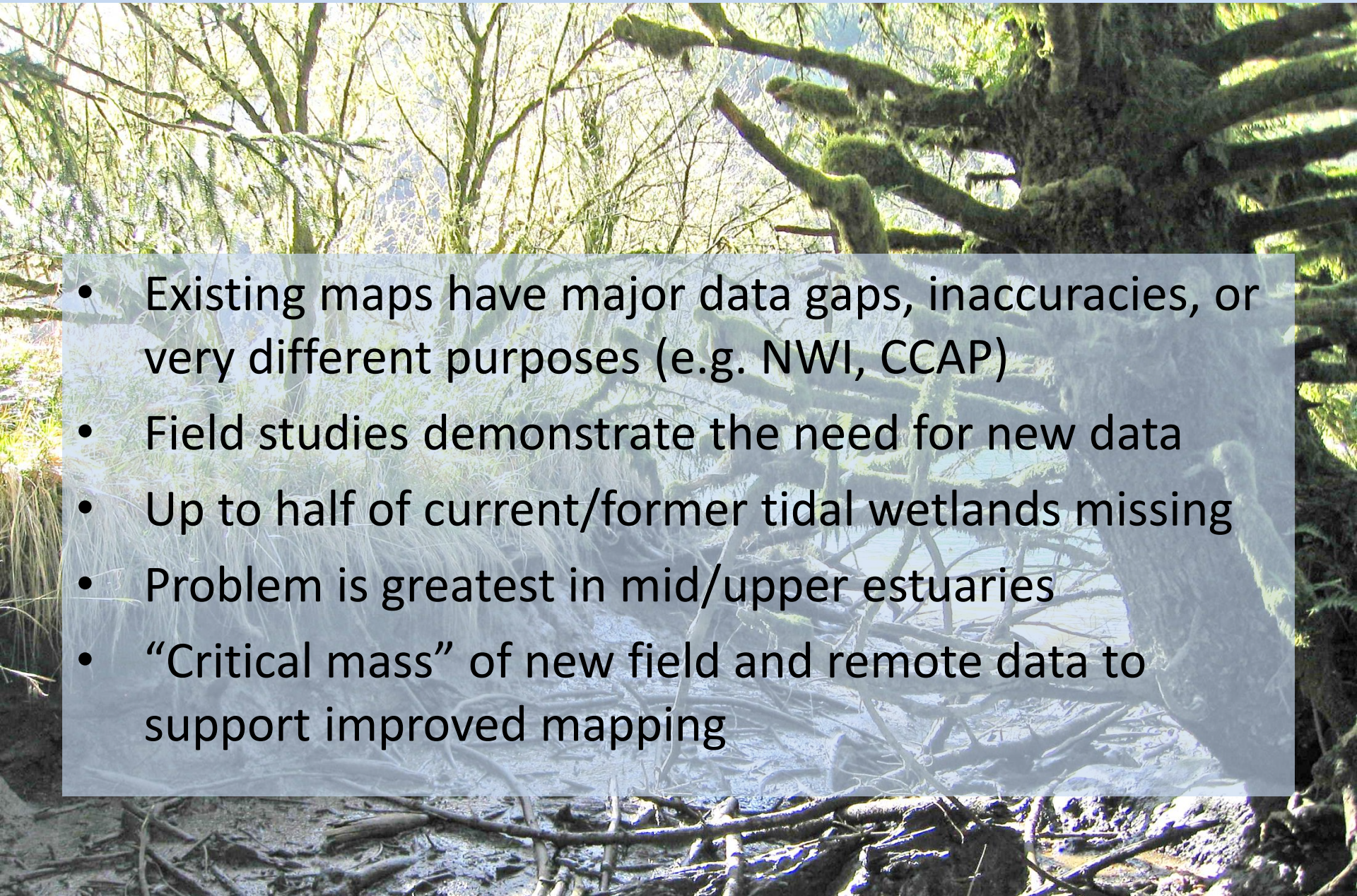
- Including all tidal wetlands to head of tide
- Including freshwater tidal zone
- Definition of "tidal wetland" = inundation due to tidal forces at least annually

What's our general approach?

Map current and historical tidal wetlands

- Historical wetland mapping informs restoration planning
- "Historical" = pre-European settlement

Why not use existing (digital) maps?



- Existing maps have major data gaps, inaccuracies, or very different purposes (e.g. NWI, CCAP)
- Field studies demonstrate the need for new data
- Up to half of current/former tidal wetlands missing
- Problem is greatest in mid/upper estuaries
- “Critical mass” of new field and remote data to support improved mapping

Methods for improved mapping

- Goal: Map full extent of tidal wetlands - current and historic
- Downslope (seaward) boundary: bathymetry
- Upslope (landward) boundary: Challenging
- Starting point: accepted definition (inundation due to tidal forces at least 1X/yr)

Mapping the upslope boundary

- Determine water level elevation that defines upper boundary (annual inundation)
- Map the areas below this elevation on the landscape

Upslope limit of tidal wetlands?

- In our area, NOAA publishes no datums between MHHW and Highest Measured Tide
- Annual inundation falls between MHHW & HMT
- Ultimately, a modeling exercise
- Hydrodynamic models? Not for the whole West Coast…

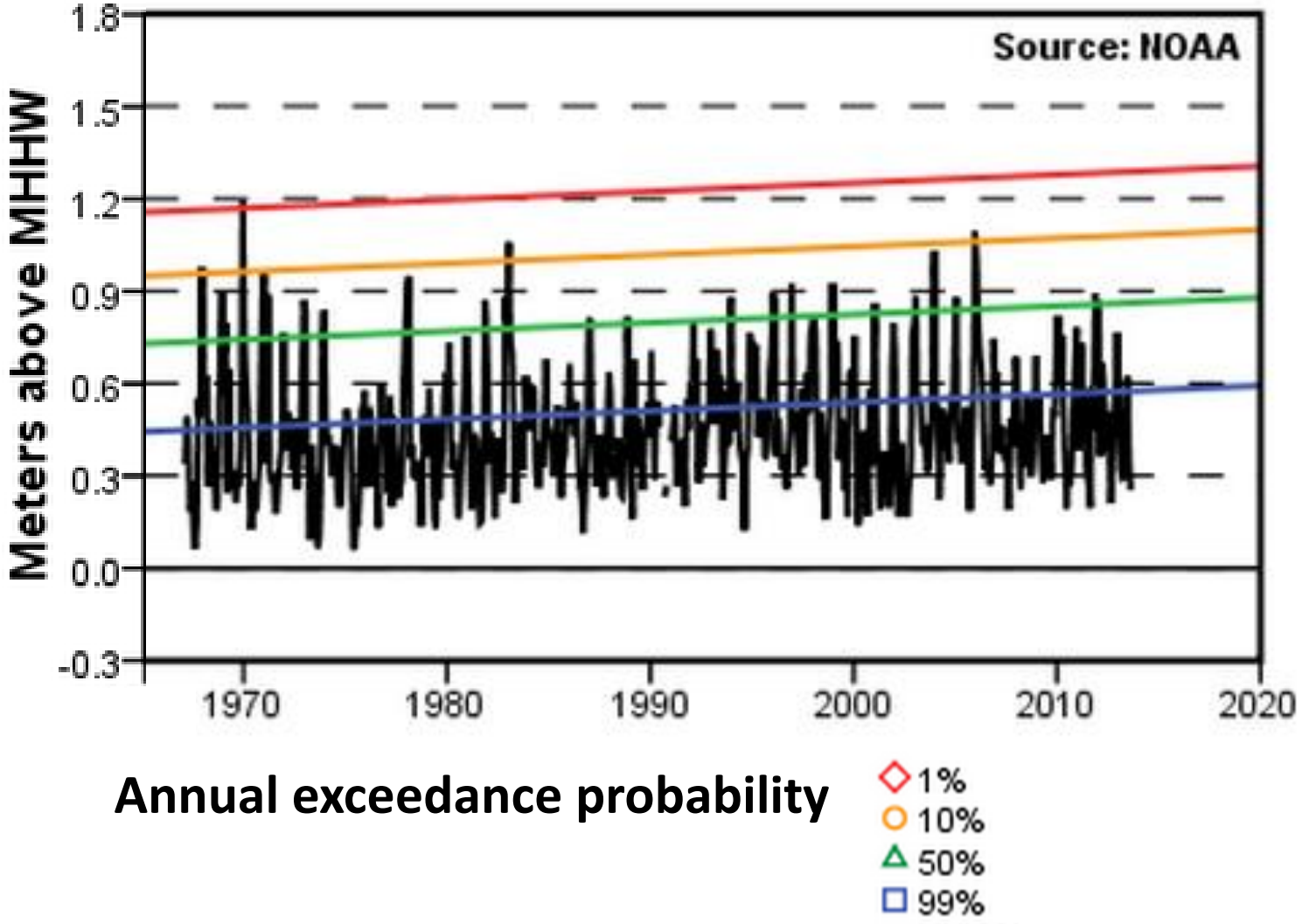
Updating Oregon's estuarine wetland habitat maps: Modernizing the foundation for coastal resource management

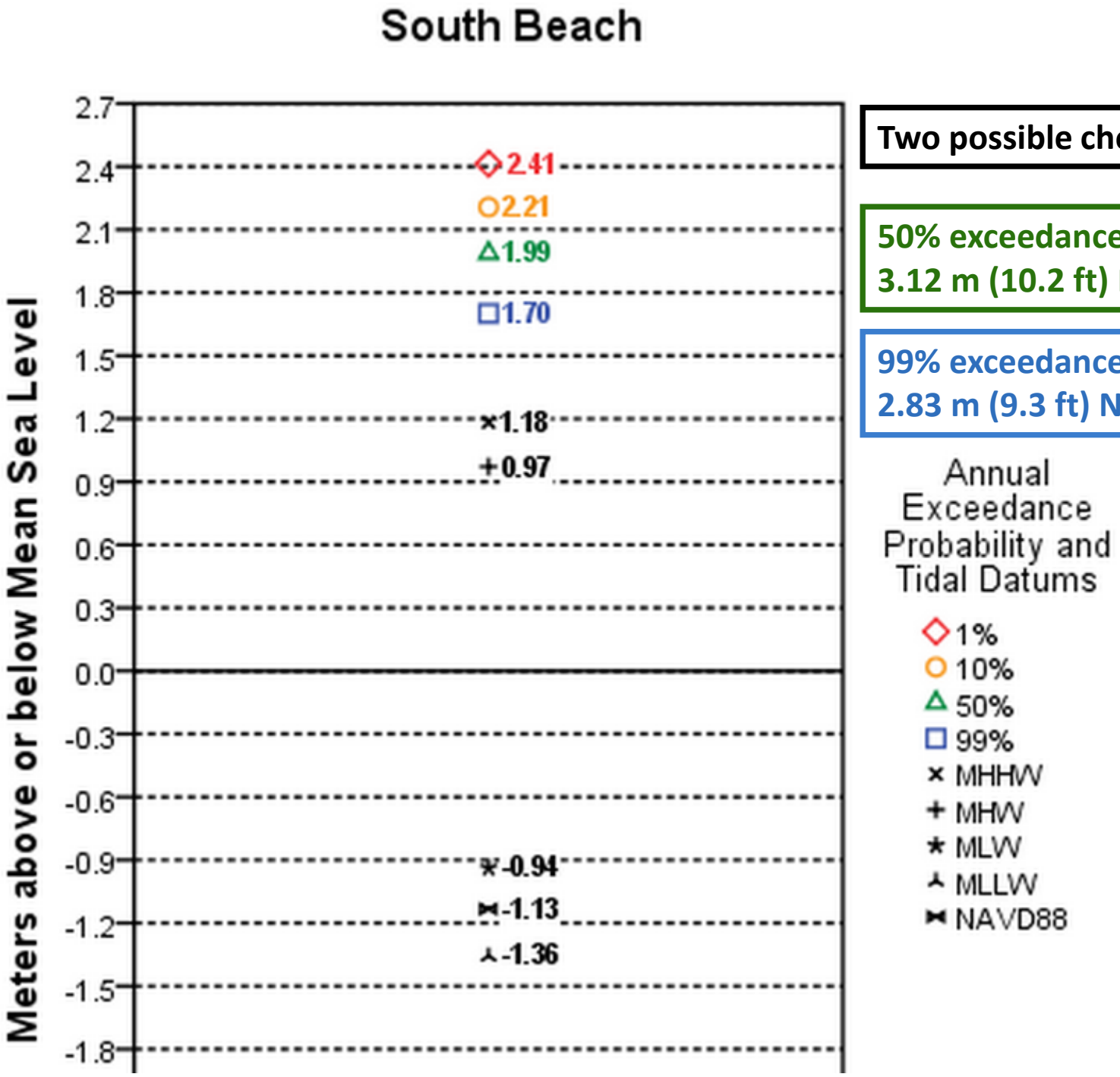
Products released Oct. 2014:
http://www.coastalatlas.net/cmecs

Andy Lanier[1], Laura Brophy[2],
Tanya Haddad[1], Laura Mattison[1]

[1]Oregon Coastal Management Program,
Department of Land Conservation and Development, Salem, OR
[2]Estuary Technical Group, Institute for Applied Ecology, Corvallis, OR

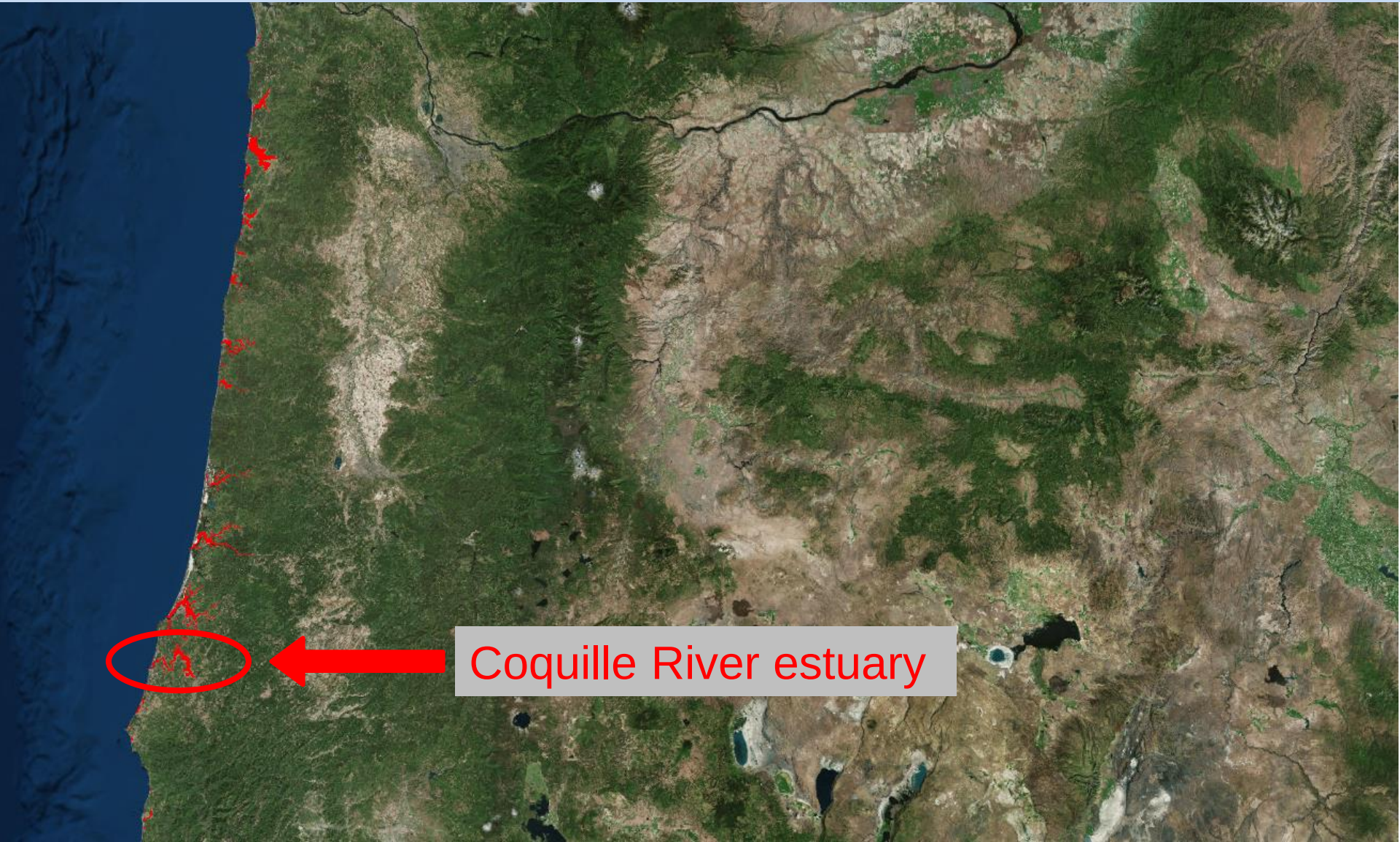
The solution:
NOAA extreme water level analysis




South Beach
Meters above or below Mean Sea Level
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
-0.3
-0.6
-0.9
-1.2
-1.5
-1.8
2.41
2.21
1.99
1.70
1.18
0.97
-0.94
-1.13
-1.36
Two possible choices:
50% exceedance =
3.12 m (10.2 ft) NAVD88
99% exceedance =
2.83 m (9.3 ft) NAVD88
Annual Exceedance Probability and Tidal Datums
1%
10%
50%
99%
MHHW
MHW
MLW
MLLW
NAVD88

Choosing a probability level to map tidal wetlands: Compare to field data across entire outer coast of Oregon

Compare to field data across entire OR coast
Example: Coquille River estuary, S OR Coast



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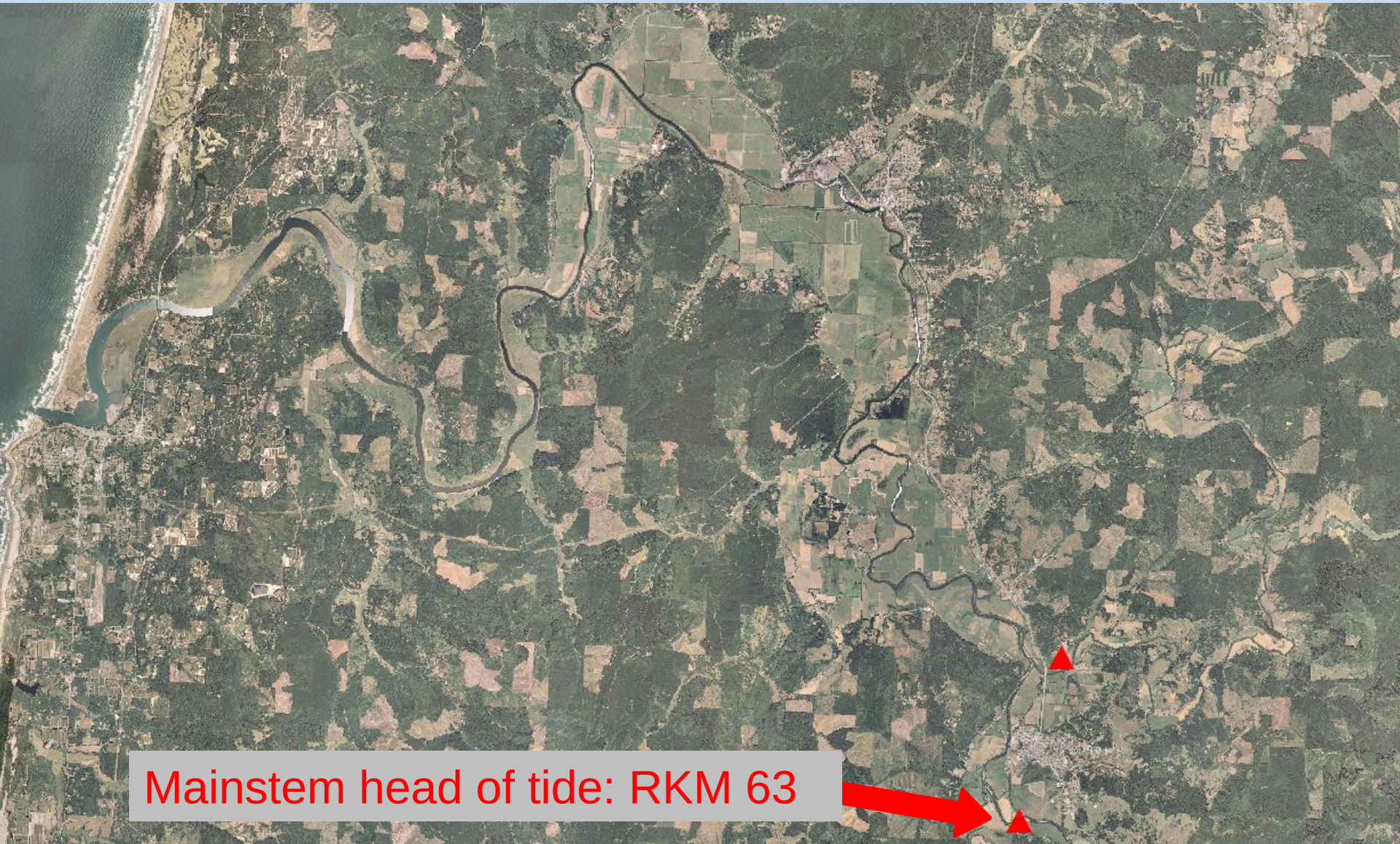

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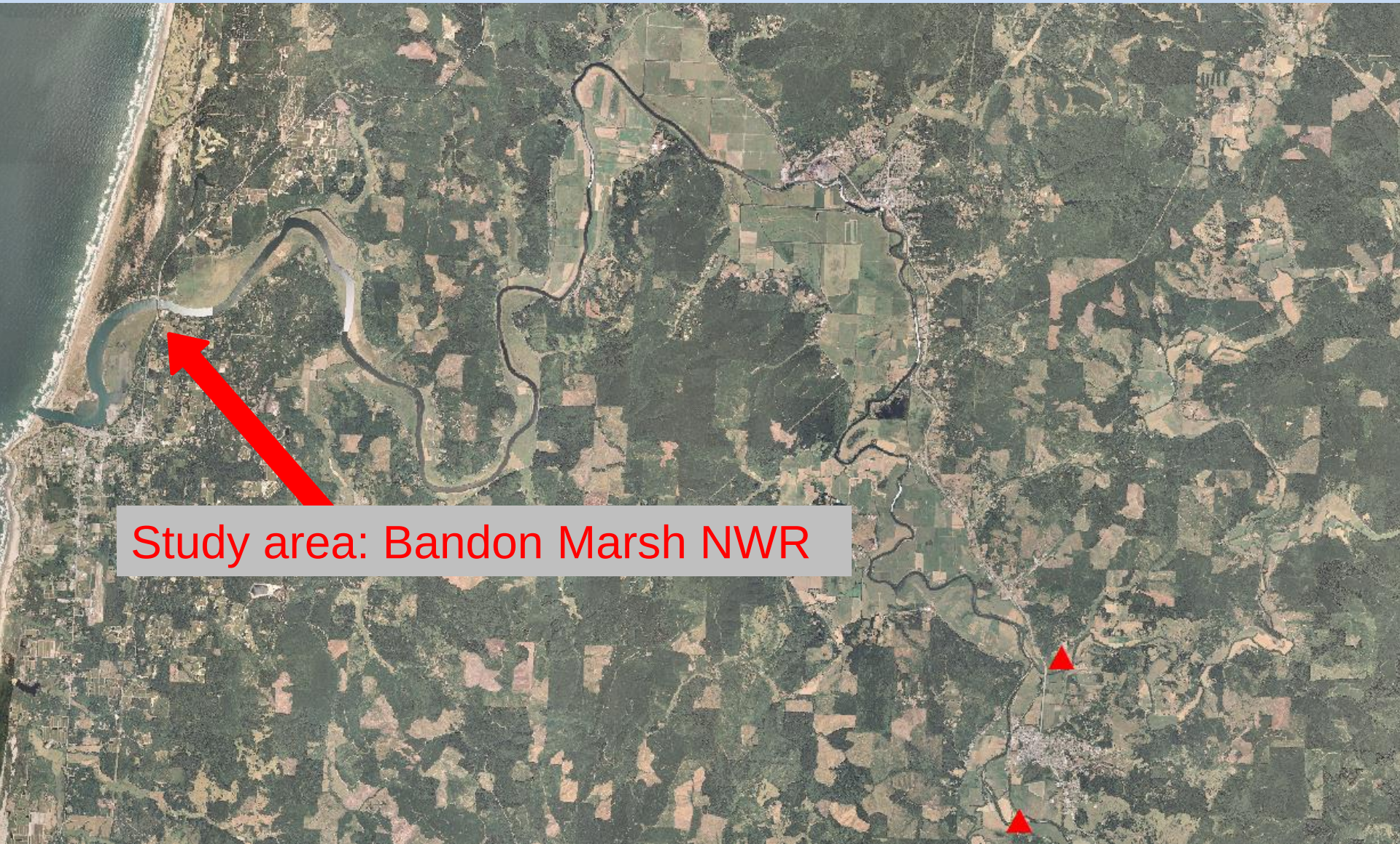

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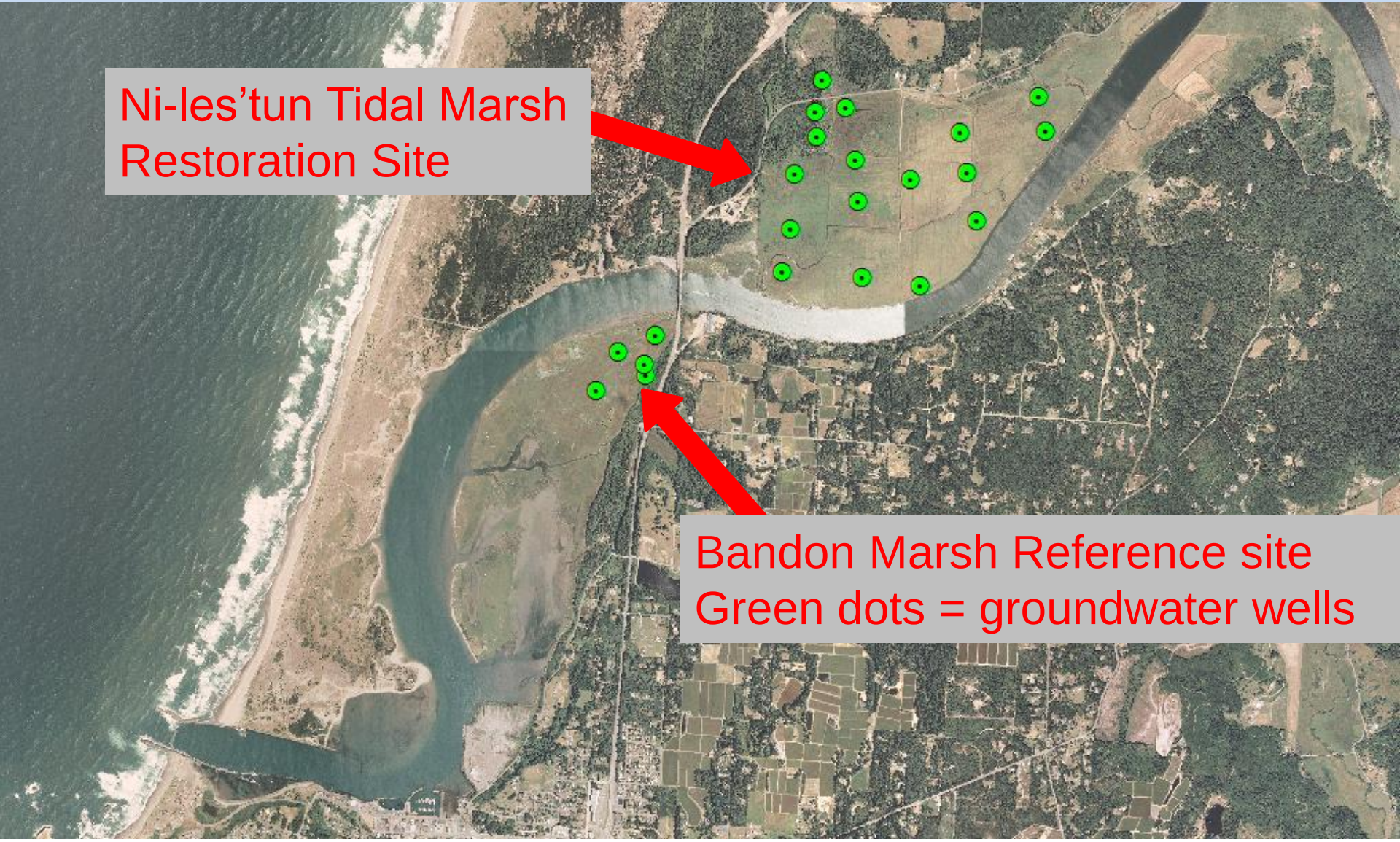

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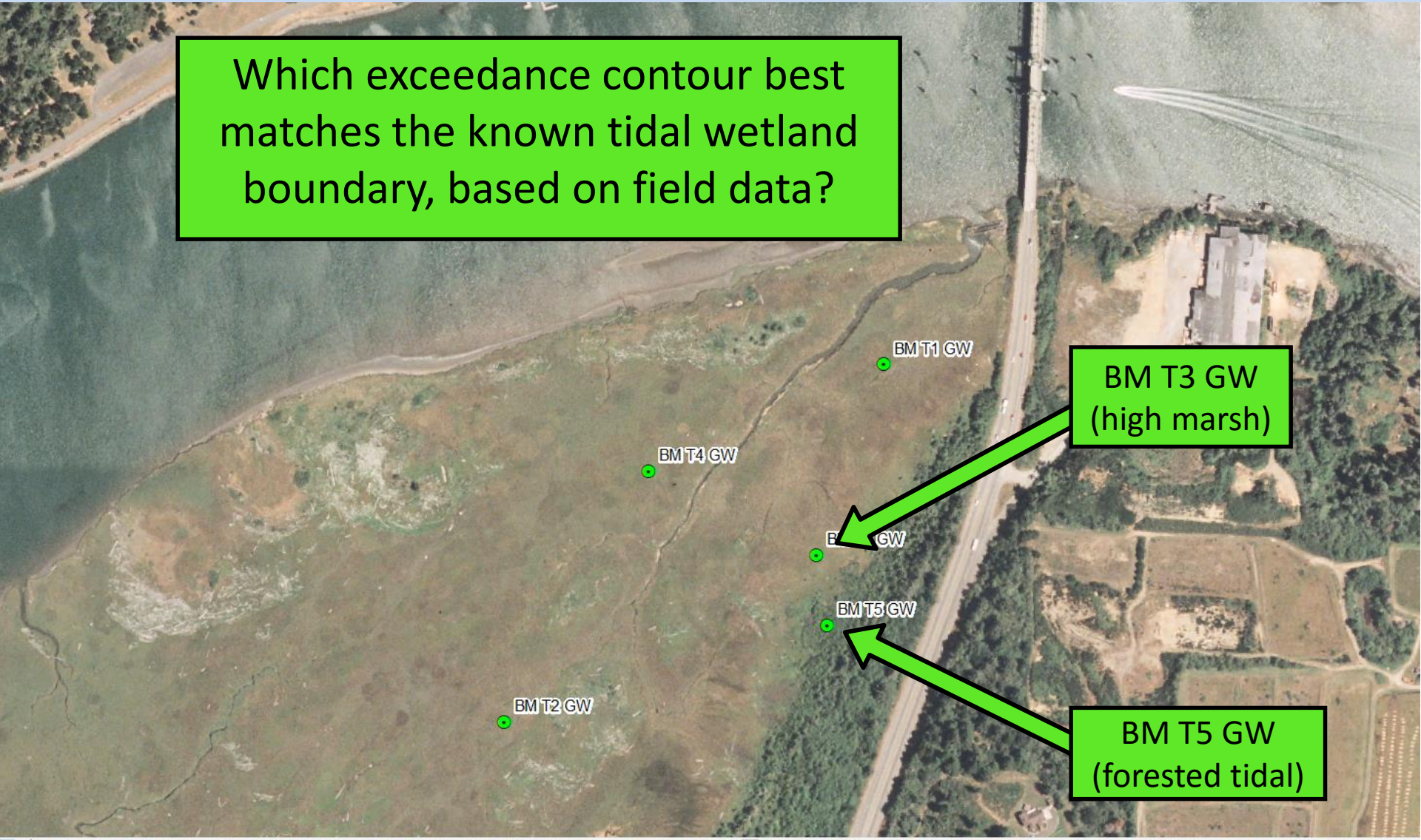
Example: Coquille River estuary, S OR Coast



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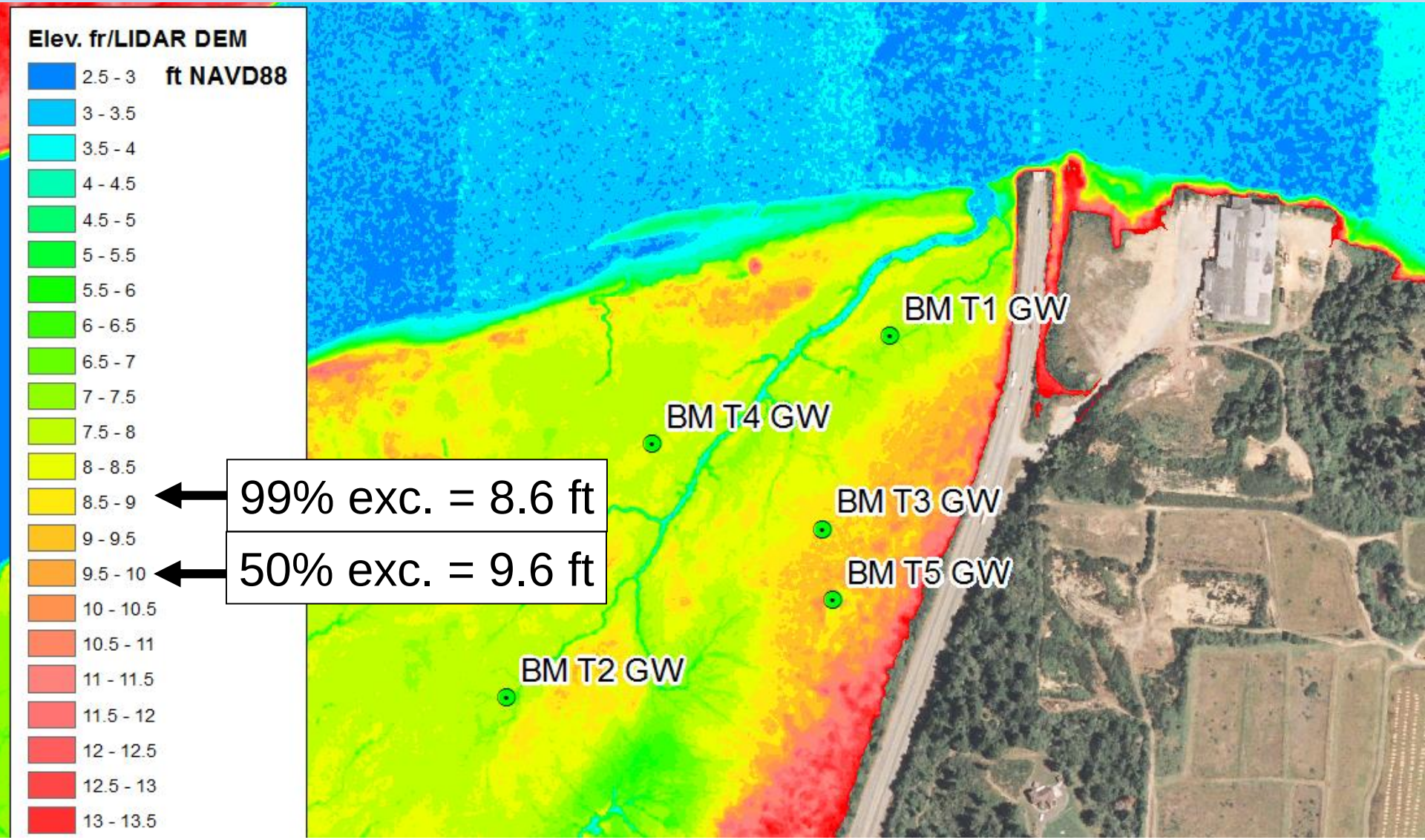

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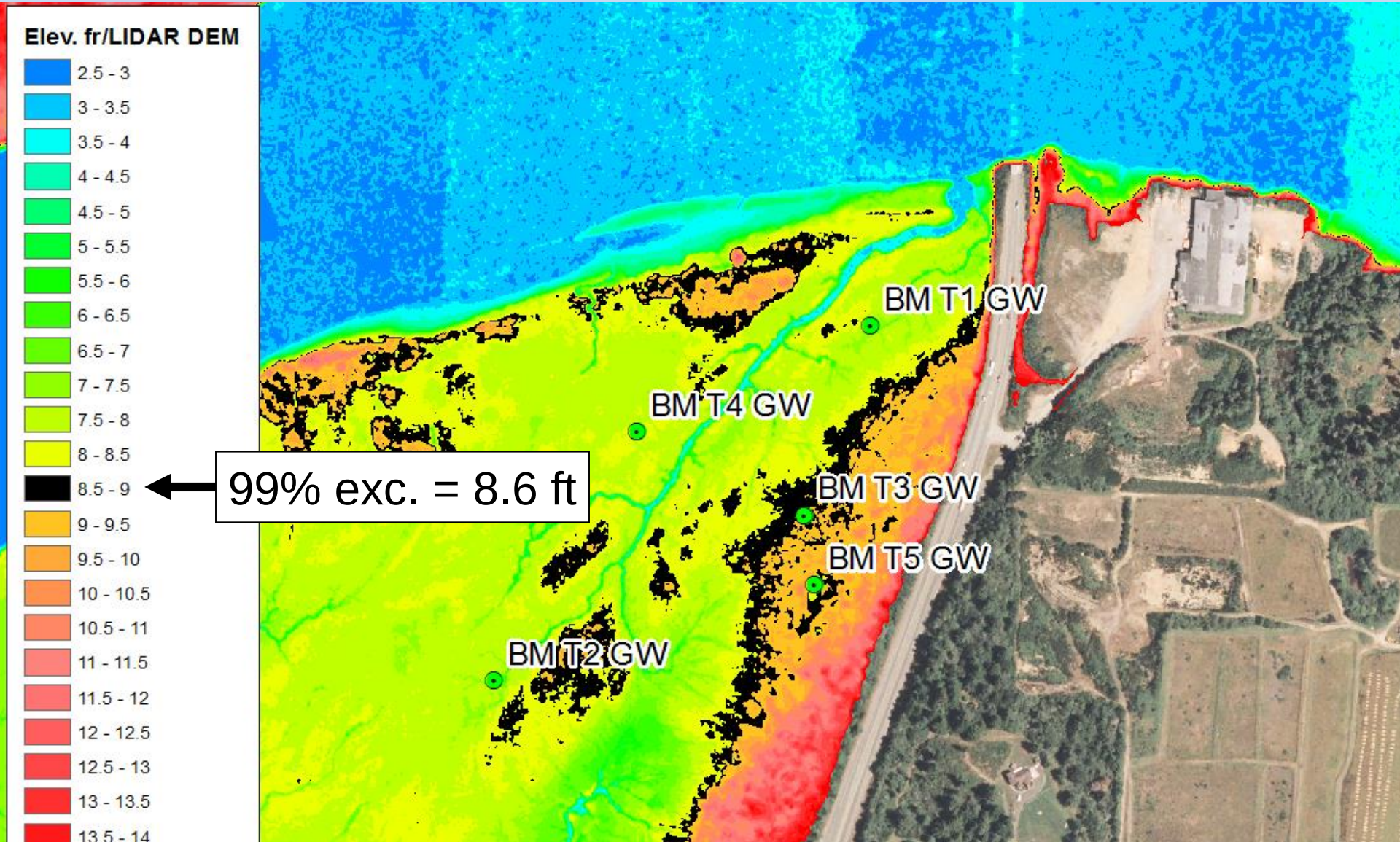
Example: Coquille River estuary, S OR Coast



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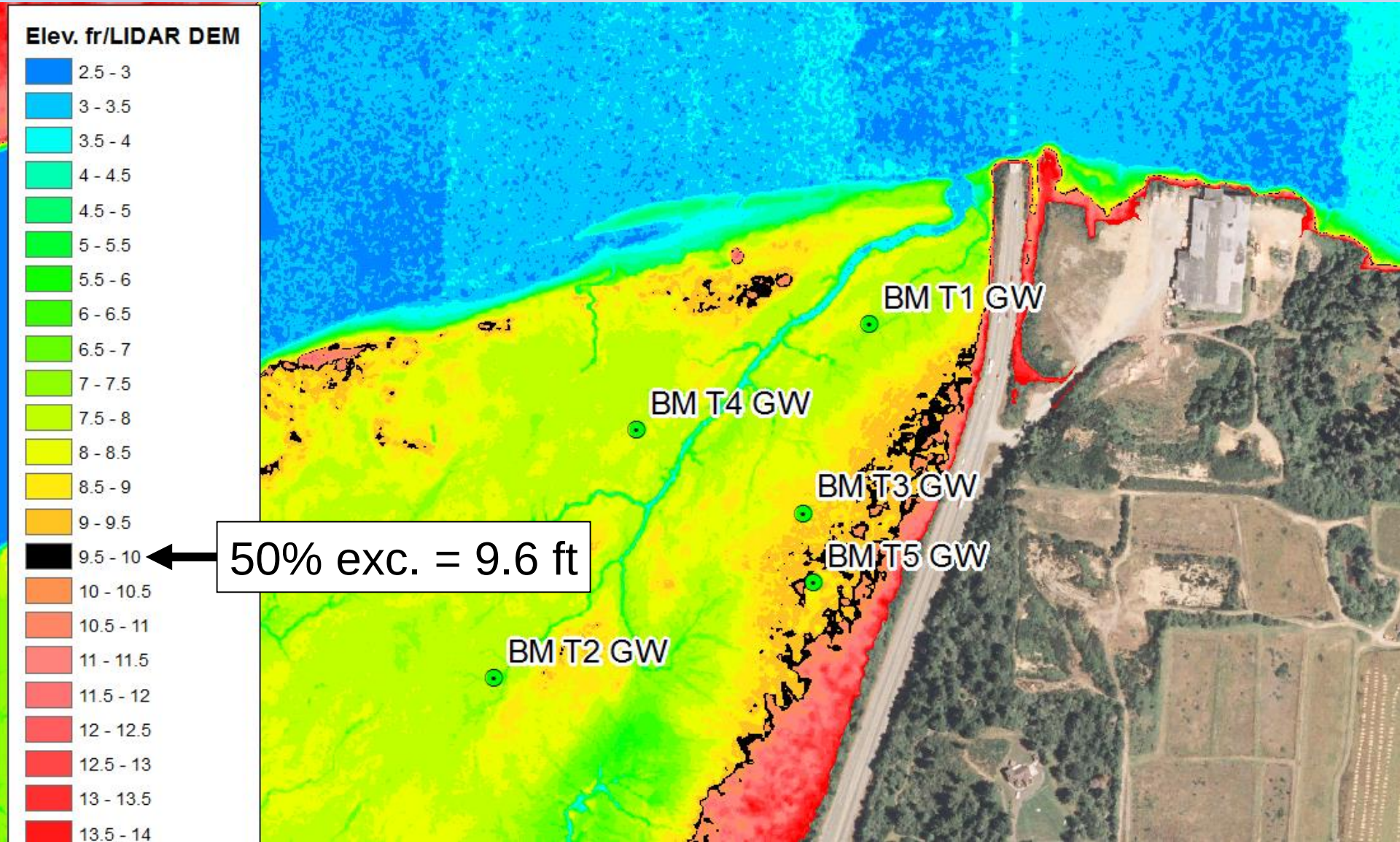
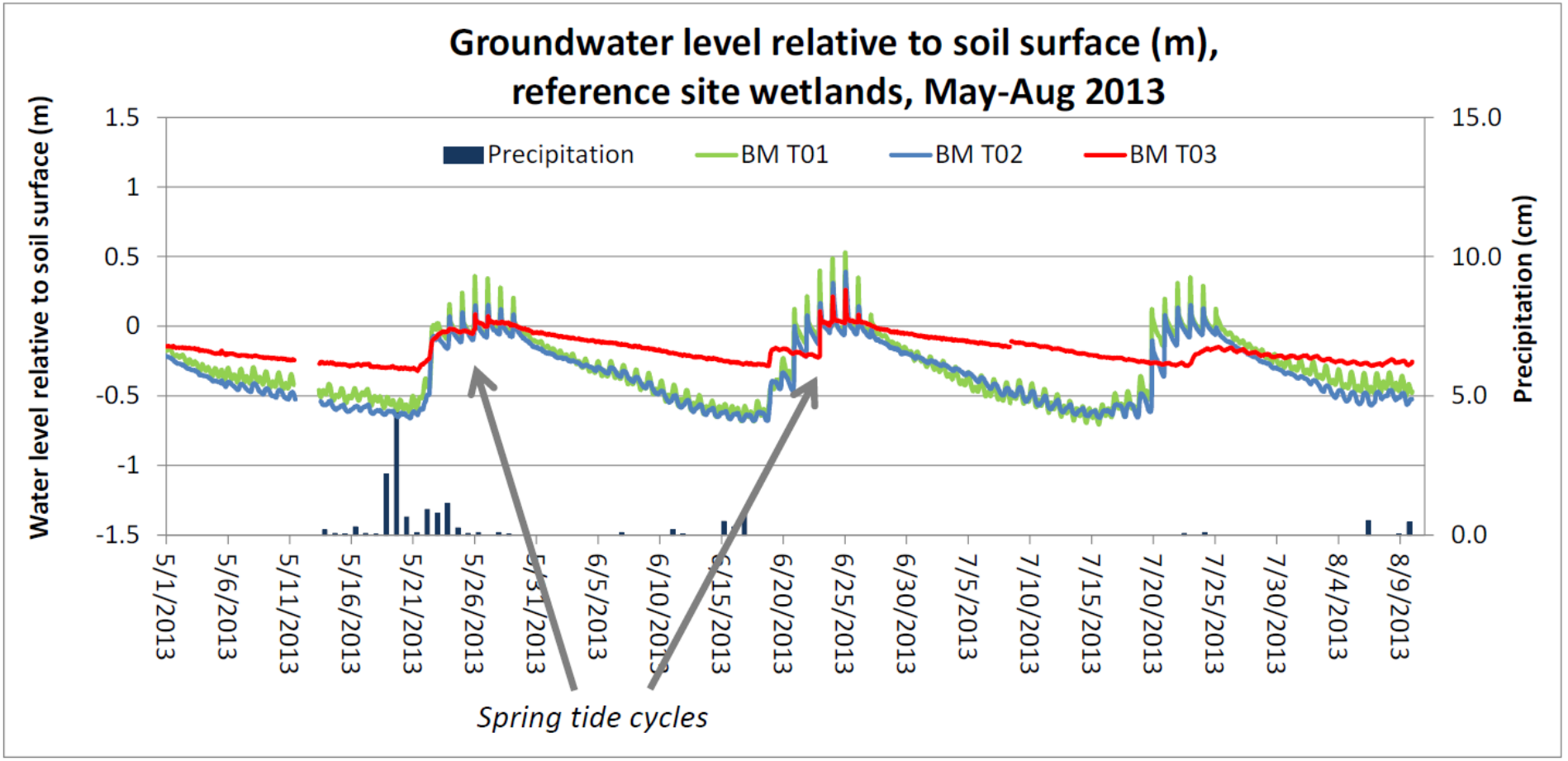
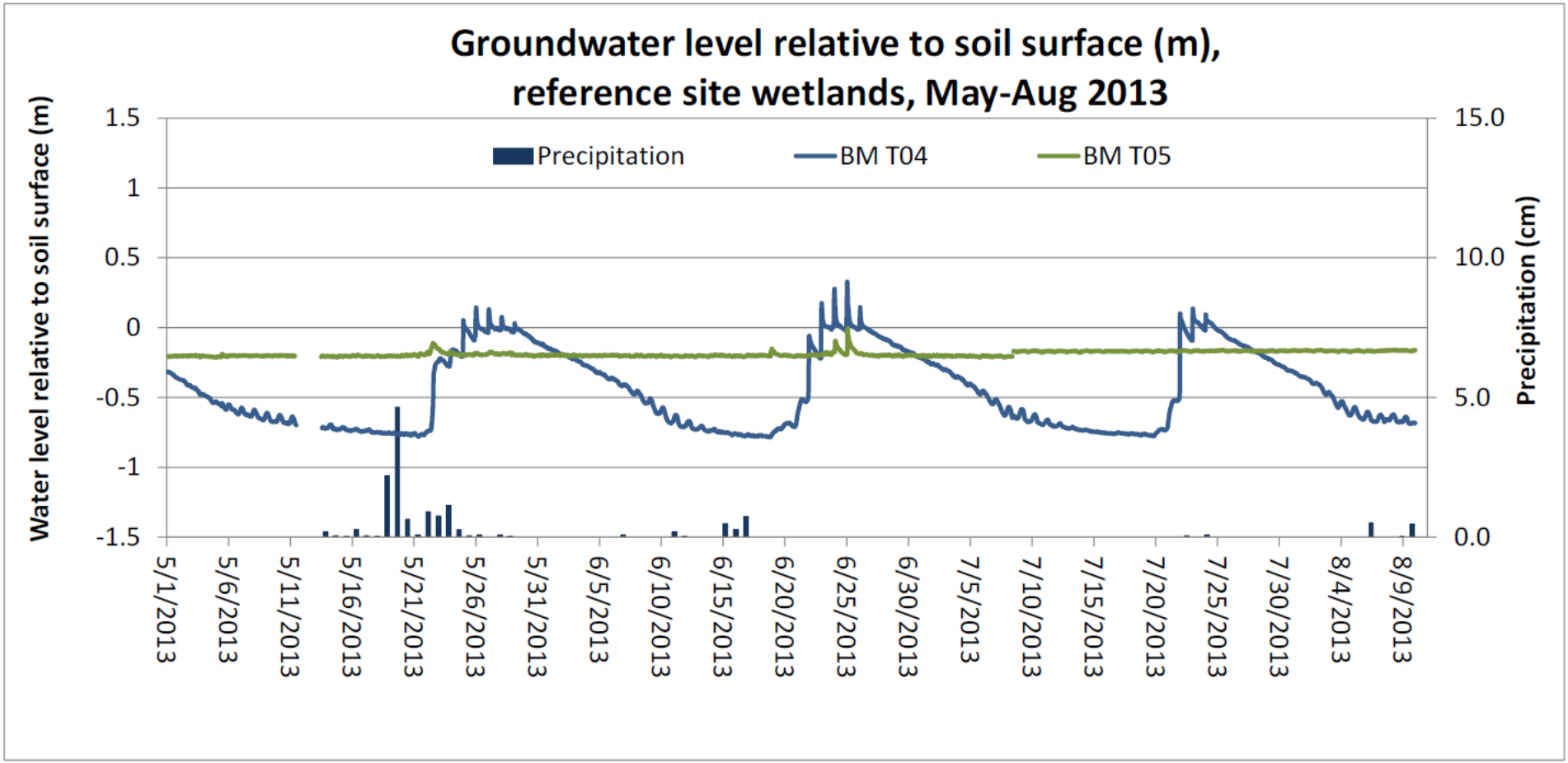



Groundwater level relative to soil surface (m), reference site wetlands, May-Aug 2013
Water level relative to soil surface (m)
Precipitation (cm)
Precipitation
BM T01
BM T02
BM T03
1.5
1
0.5
0
-0.5
-1
-1.5
15.0
10.0
5.0
0.0
5/1/2013
5/6/2013
5/11/2013
5/16/2013
5/21/2013
5/26/2013
5/31/2013
6/5/2013
6/10/2013
6/15/2013
6/20/2013
6/25/2013
6/30/2013
7/5/2013
7/10/2013
7/15/2013
7/20/2013
7/25/2013
7/30/2013
8/4/2013
8/9/2013
Spring tide cycles


Groundwater level relative to soil surface (m), reference site wetlands, May-Aug 2013
Water level relative to soil surface (m)
Precipitation (cm)
Precipitation
BM T04
BM T05
1.5
1
0.5
0
-0.5
-1
-1.5
15.0
10.0
5.0
0.0
5/1/2013
5/6/2013
5/11/2013
5/16/2013
5/21/2013
5/26/2013
5/31/2013
6/5/2013
6/10/2013
6/15/2013
6/20/2013
6/25/2013
6/30/2013
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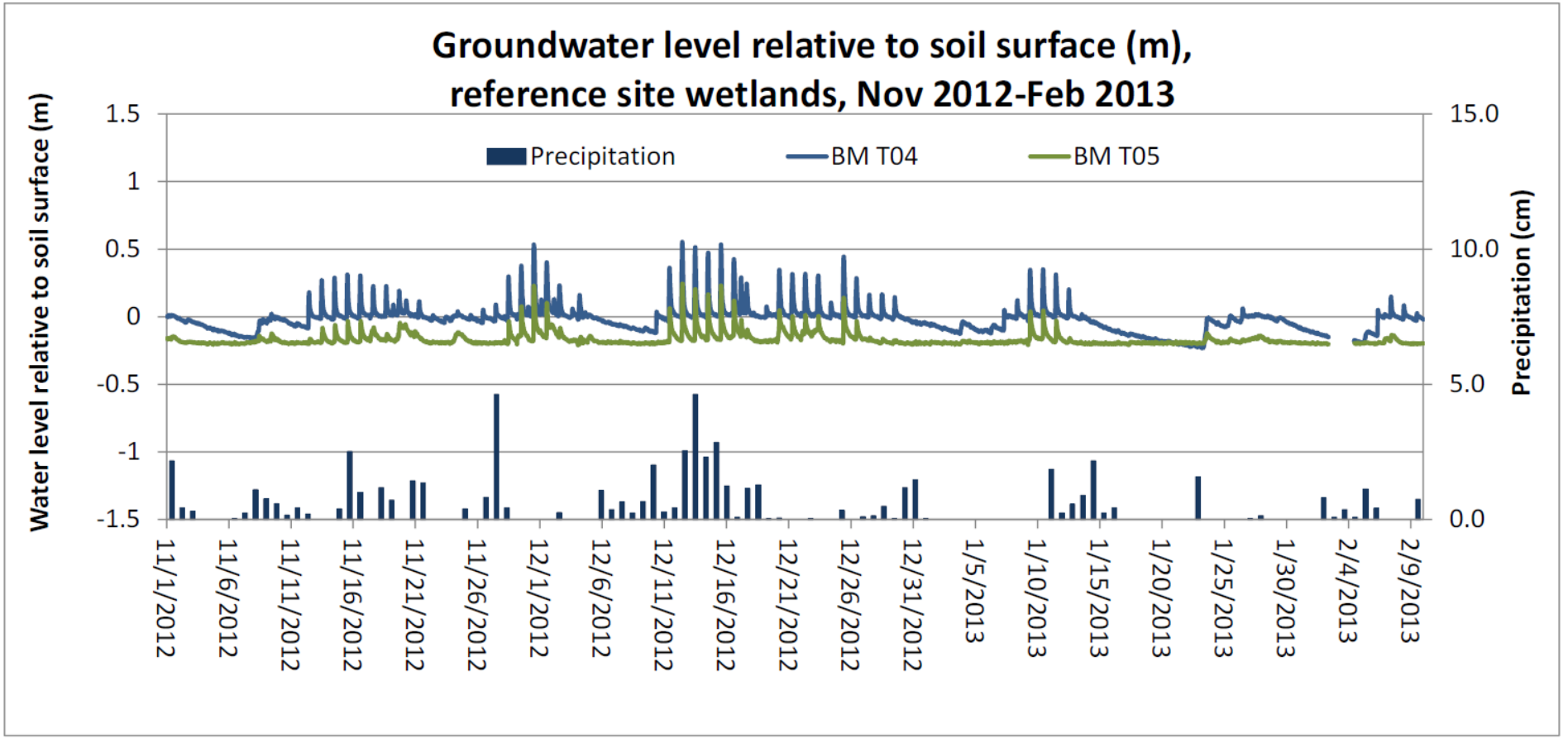
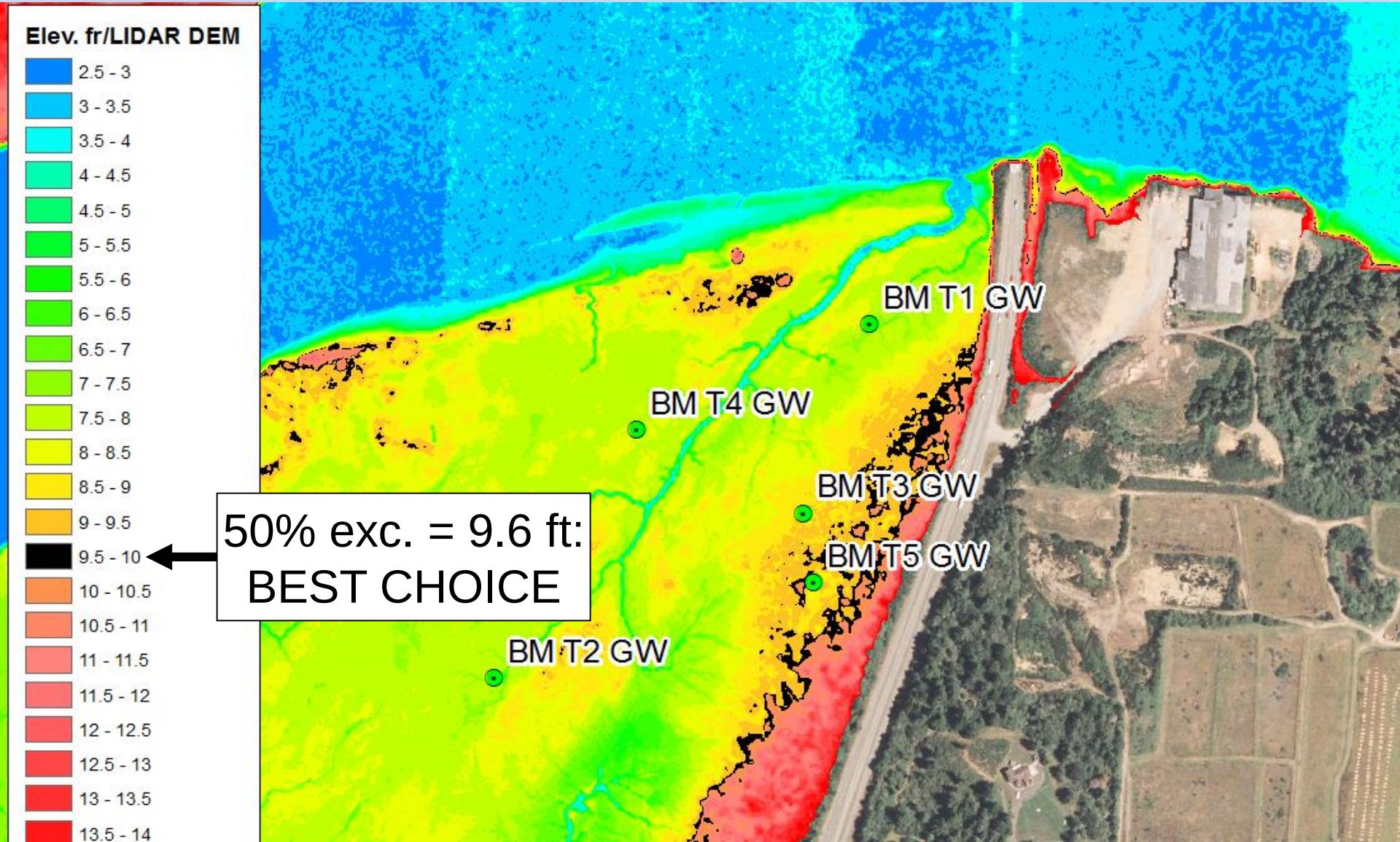
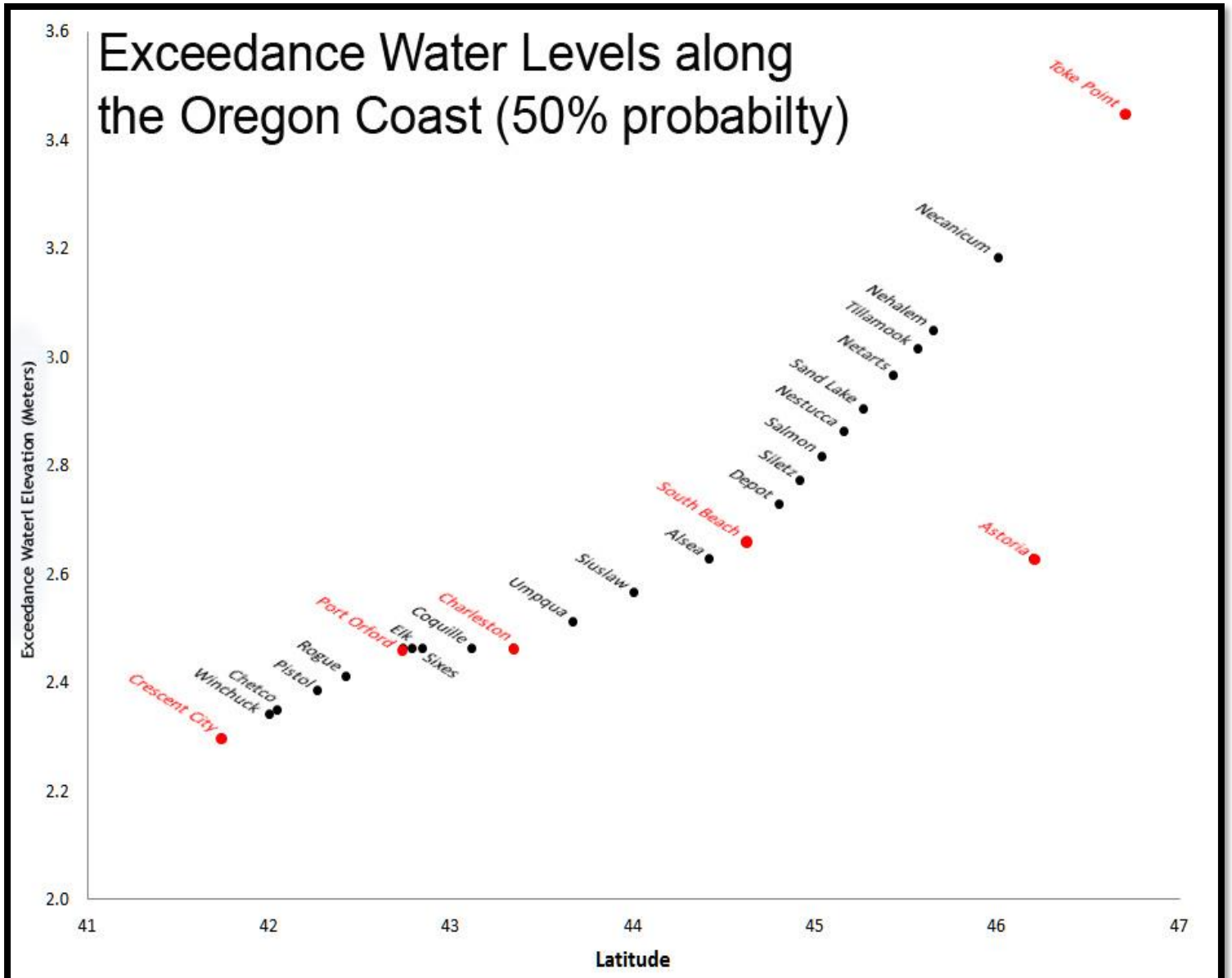
7/25/2013
7/30/2013
8/4/2013
8/9/2013


Groundwater level relative to soil surface (m), reference site wetlands, Nov 2012-Feb 2013
Water level relative to soil surface (m)
Precipitation (cm)
Precipitation
BM T04
BM T05
1.5
1
0.5
0
-0.5
-1
-1.5
15.0
10.0
5.0
0.0
11/1/2012
11/6/2012
11/11/2012
11/16/2012
11/21/2012
11/26/2012
12/1/2012
12/6/2012
12/11/2012
12/16/2012
12/21/2012
12/26/2012
12/31/2012
1/5/2013
1/10/2013
1/15/2013
1/20/2013
1/25/2013
1/30/2013
2/4/2013
2/9/2013

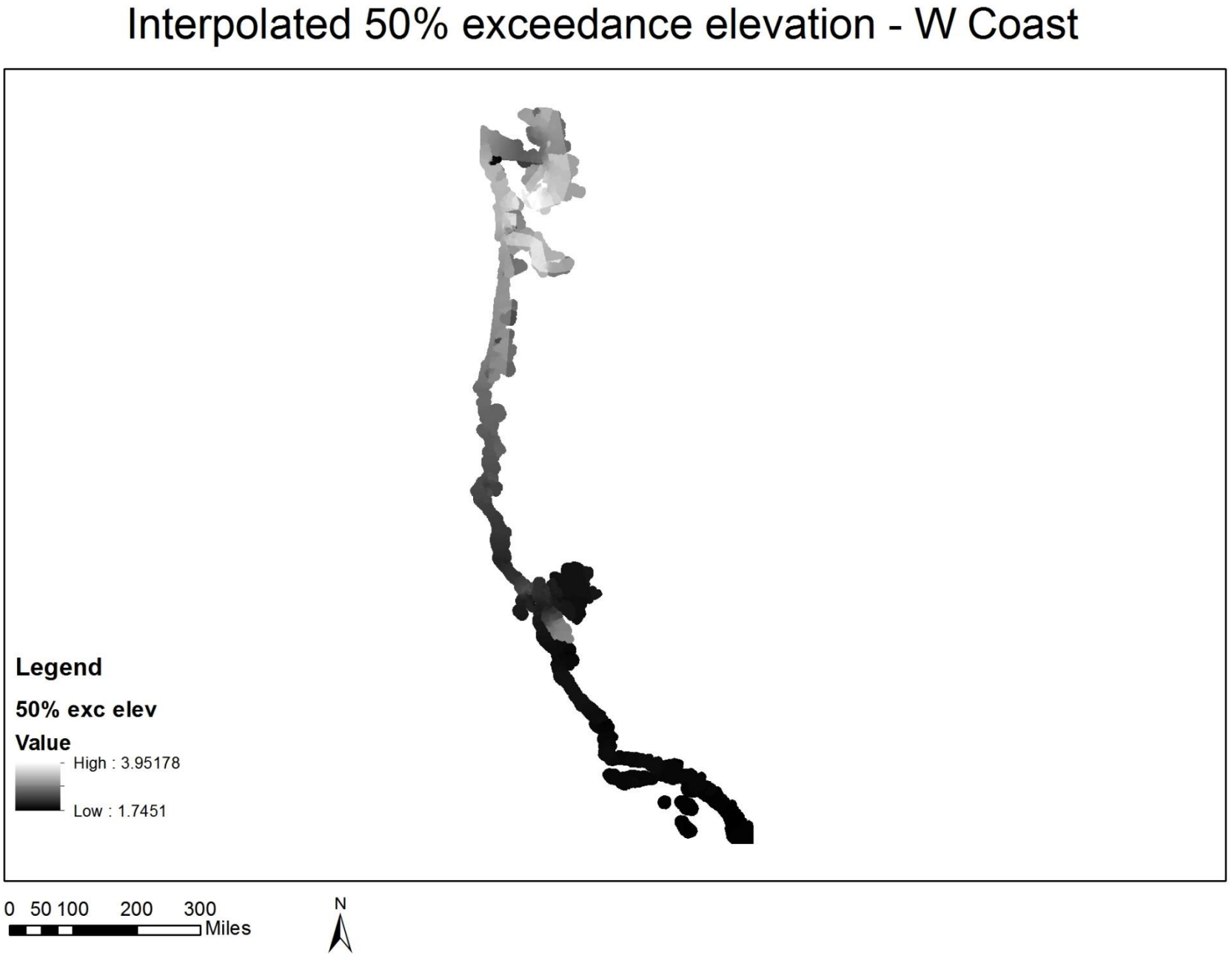
Compare to field data across entire OR coast
Example: Coquille River estuary, S OR Coast



50% exceedance elevations were interpolated between 4 NOAA tide stations on the OR coast



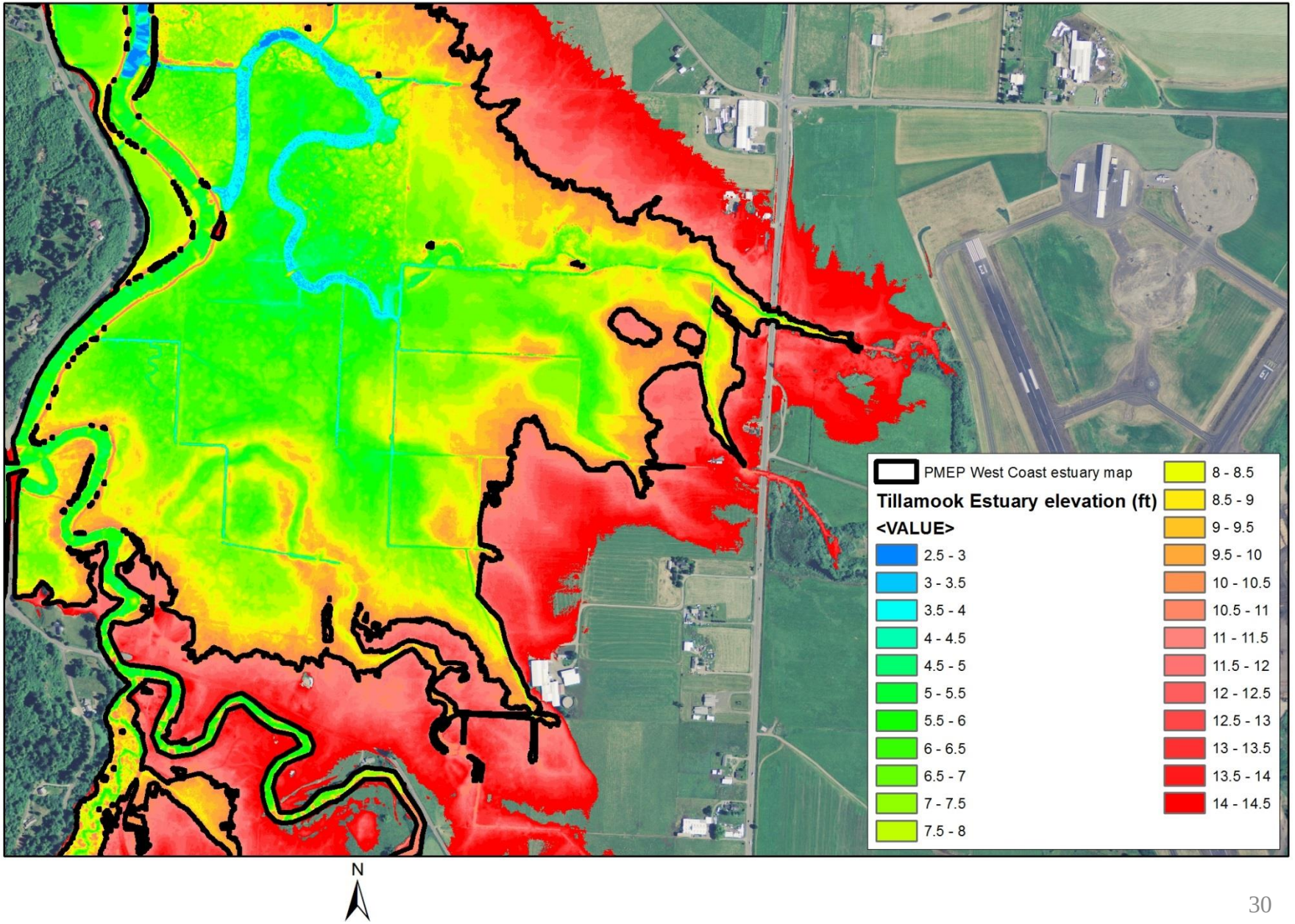
… then for the whole West Coast (21 NOAA stations)



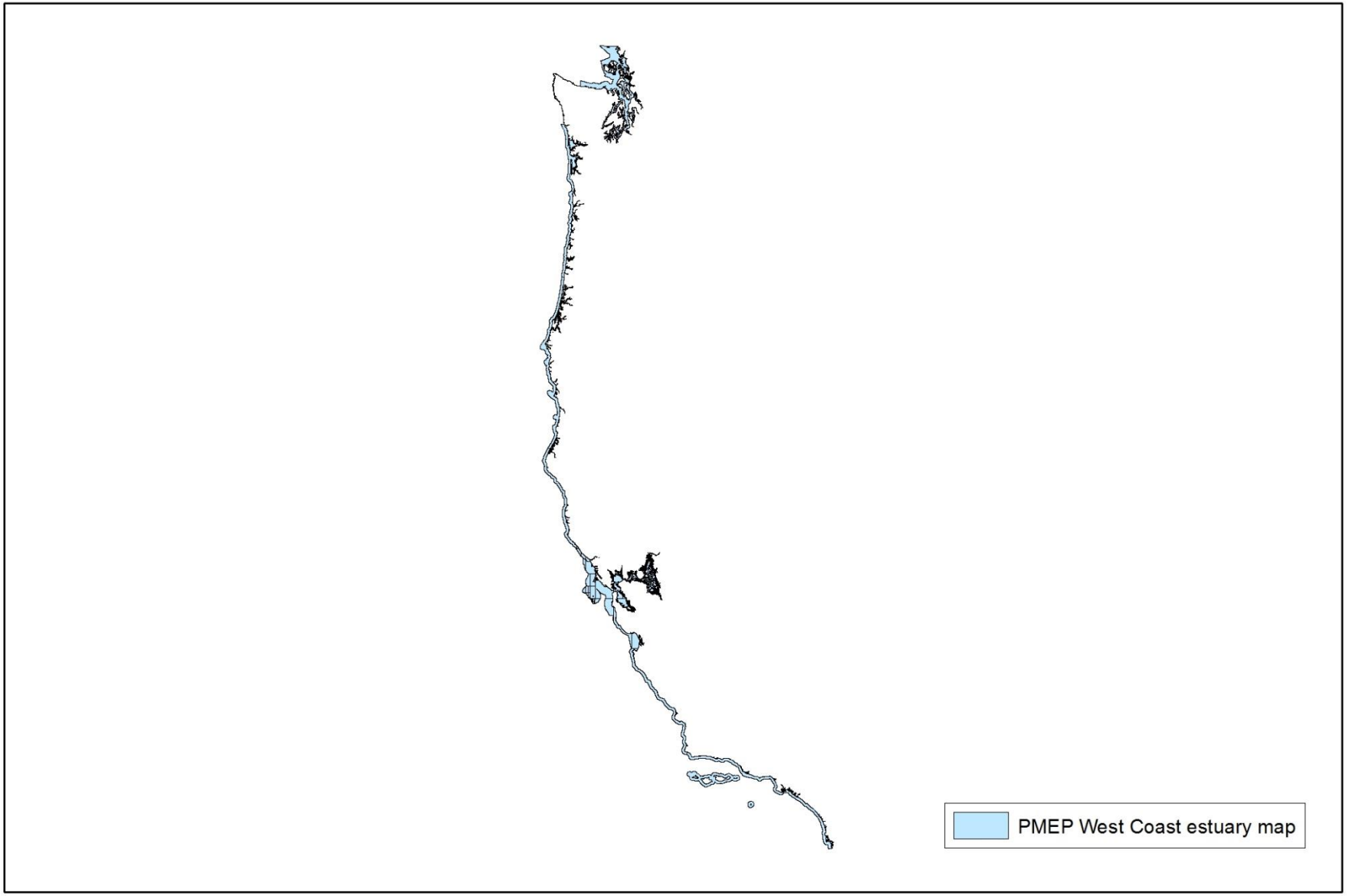
Mapping the upslope boundary

- Now we have a water level elevation that defines the upslope estuary boundary…
- Need to find the location of the estuary boundary in the landscape to generate maps.
- How? Using VDatum, *intersect the 50% exceedance surface with LIDAR Digital Elevation Model*

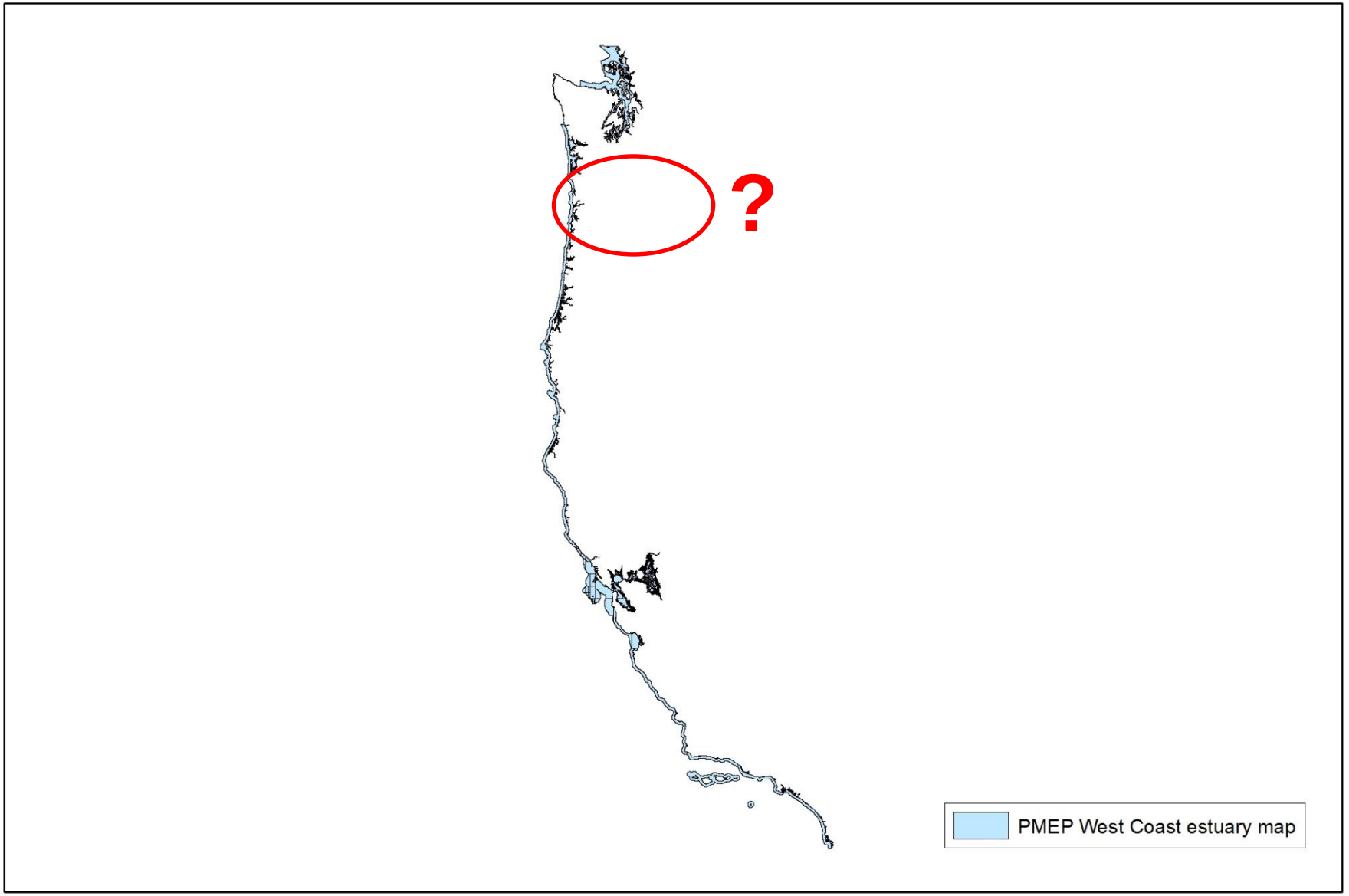
LIDAR DEM and new West Coast estuary map



New West Coast estuary map, Phase 1



New West Coast estuary map



Columbia River Estuary:

- Outer coast NOAA station data is not applicable upriver
- In parallel with our outer coast process, ERTG was developing guidelines for determining “wetted area” for hydrologic reconnection projects

ERTG 2012-01, Rev 1

ERTG Analysis of Water Levels for Site Delineation in Tidal-Dominated Regions

Prepared by the Expert Regional Technical Group of the Columbia Estuary Ecosystem Restoration Program

Prepared for the Bonneville Power Administration, U.S. Army Corps of Engineers, and NOAA Fisheries

October 2013

"Project proponents have the option of choosing either the 2-year riverine flood elevation* or [annual] Extreme High Water for delineating the area of sites."

** 2-year riverine flood elevation = 50% exceedance elevation*

Table 1. Columbia River: Two-Year Riverine Flood Elevation (feet, NAVD), Equivalent to the 50% Probability of Exceedance, by River Mile. From Corps hydrologic analysis, CENWP EC-HY, 31 May 2012, file=EC-HY_536_SBU_Rev3_05-11-12.docx.

RM 1[2]	Water-Surface Elevation (ft)	5-Percent CL	95-Percent CL
145.87	28.7	30.1	27.4
142.04	25.6	26.9	24.4
140.15	25.4	26.6	24.2
136.05	24.9	26.2	23.7
132.13	24.3	25.6	23.2
128.19	23.7	24.9	22.5
123.99	23.0	24.2	21.9
120.07	21.7	22.9	20.6
115.93	21.0	22.2	19.9
112.10	20.3	21.5	19.2
107.86	19.7	20.8	18.6
104.06	19.4	20.6	18.4
100.00	19.1	20.2	18.0
96.06	18.5	19.6	17.5
92.06	18.0	19.0	17.0
88.04	17.4	18.3	16.4
83.92	16.8	17.7	15.9
80.65	16.3	17.2	15.5
75.98	15.7	16.5	14.9
72.12	15.3	16.1	14.6
68.15	14.8	15.4	14.1
63.99	14.0	14.6	13.5
60.41	13.5	14.0	13.0
55.84	13.0	13.4	12.6
51.85	12.7	13.0	12.4
47.70	12.5	12.7	12.2
44.06	12.4	12.6	12.2
40.24	12.2	12.4	12.1
36.35	12.1	12.3	11.9
31.89	11.9	12.1	11.8
28.07	11.8	12.0	11.7
23.76	11.7	11.8	11.6
20.24	11.6	11.8	11.5
16.35	11.5	11.7	11.4
12.18	11.4	11.6	11.3
8.47	11.4	11.5	11.2
4.65	11.4	11.6	11.3
1.70	11.5	11.7	11.4
0.15	11.6	11.7	11.5

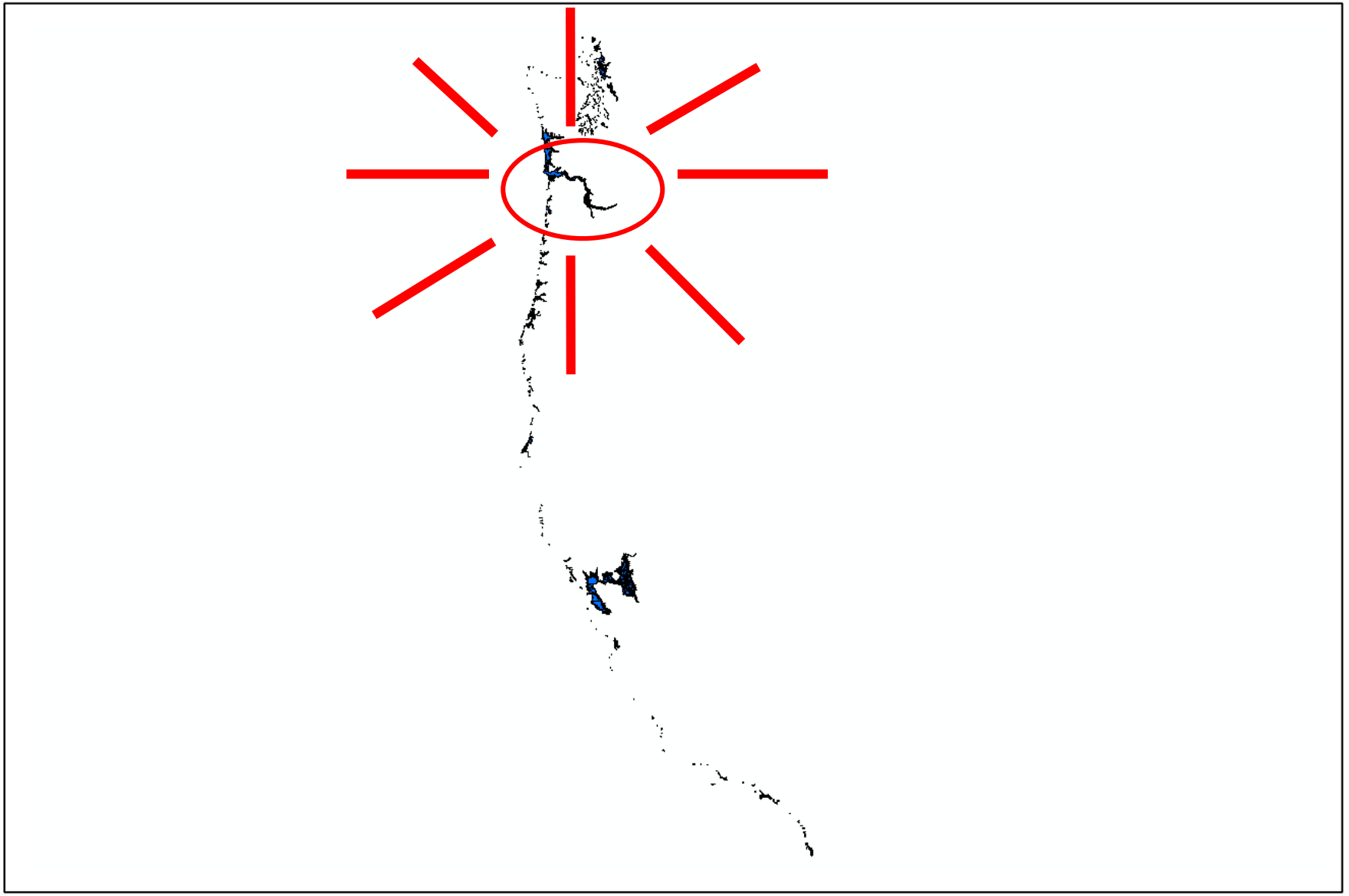
50% exceedance

RM 1[2]	Water-Surface Elevation (ft)
44.06	12.4
40.24	12.2
36.35	12.1
31.89	11.9
28.07	11.8
23.76	11.7
20.24	11.6
16.35	11.5
12.18	11.4
8.47	11.4
4.65	11.4
1.70	11.5
0.15	11.6

Columbia River Estuary:

- Extent of land surfaces below 50% exceedance mapped by PC Trask
- Mapping was provided to our PMEP team by PC Trask to complete our West Coast map

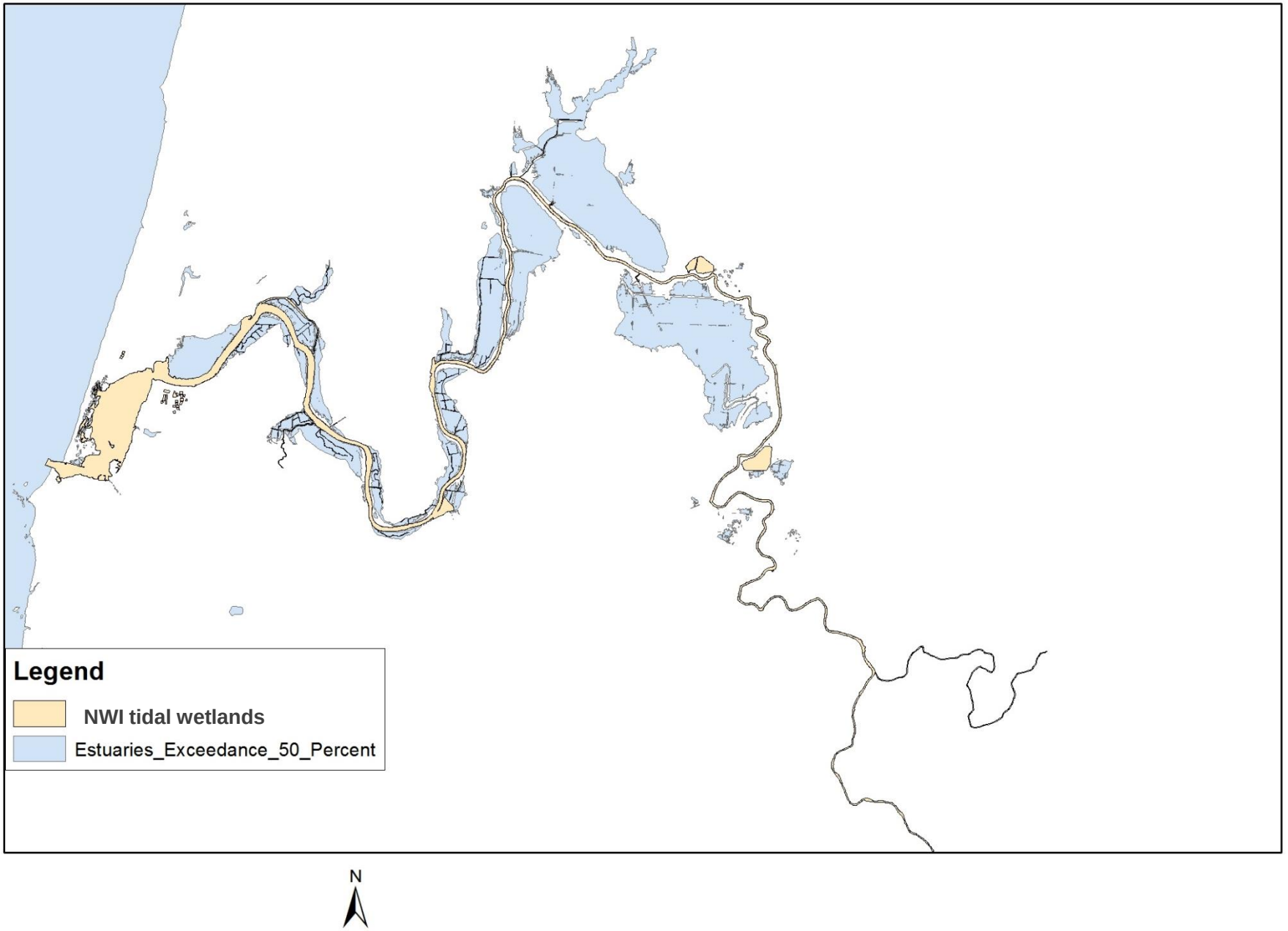
New West Coast estuary map

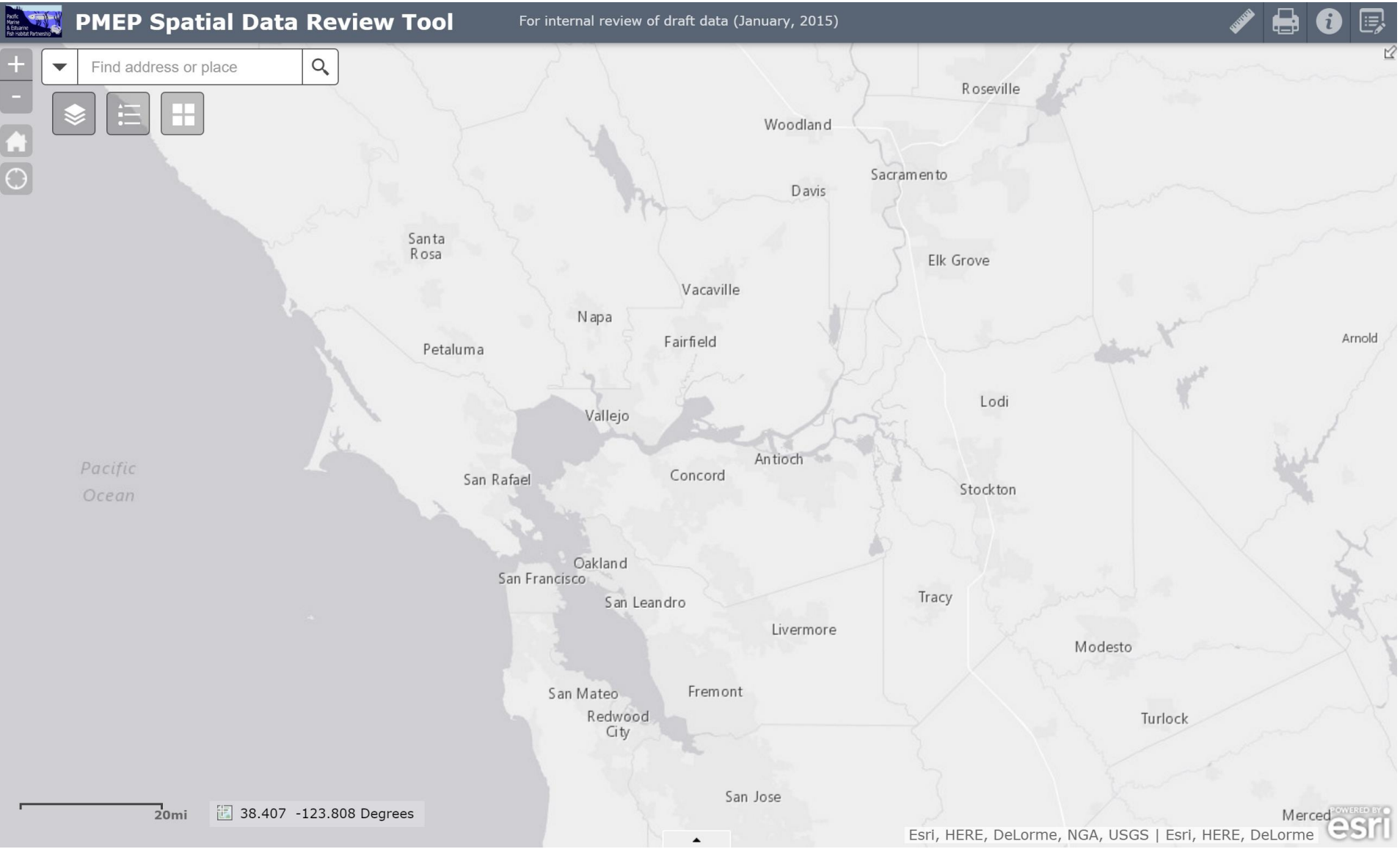


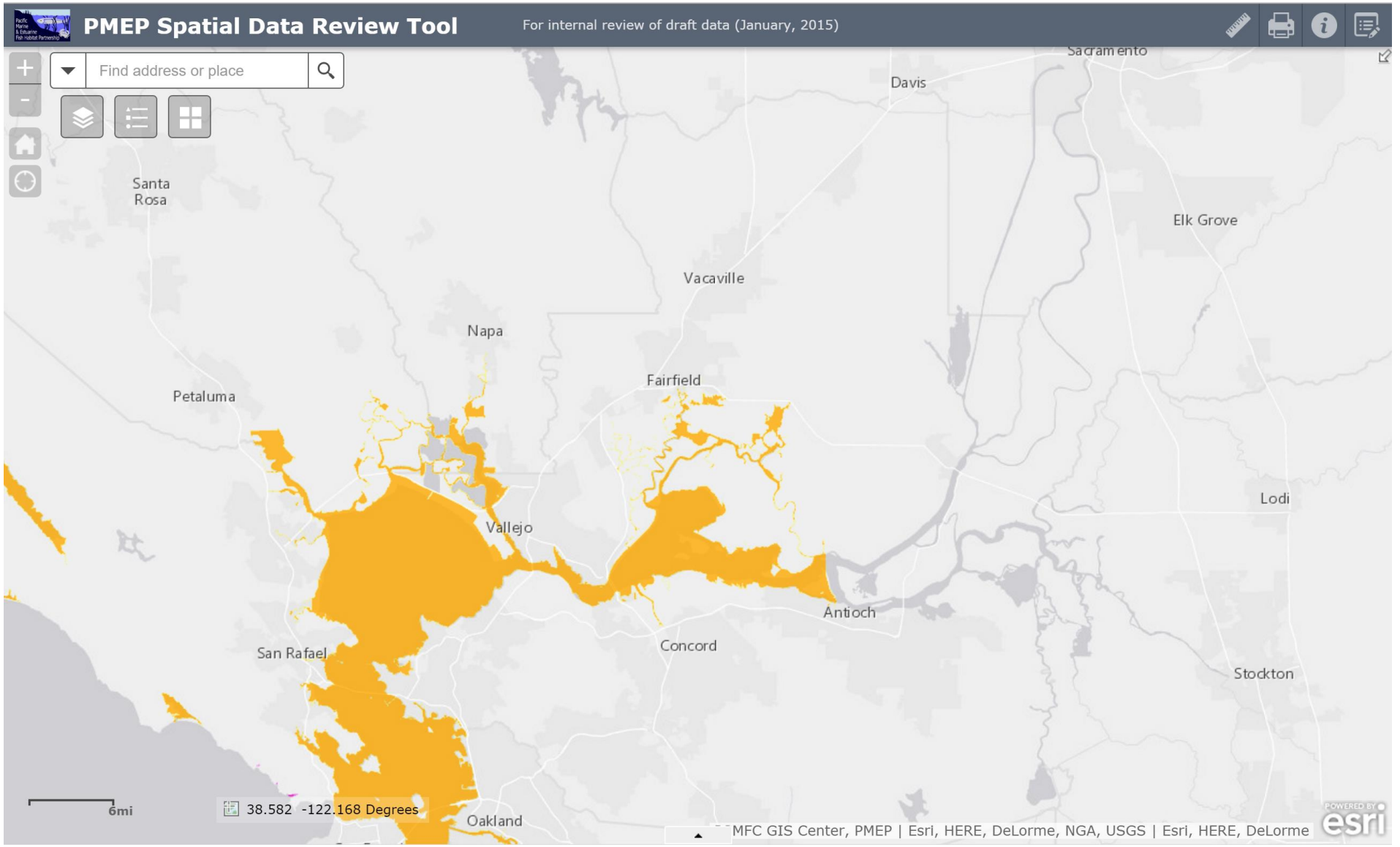
NWI estuarine wetlands – Coquille R. estuary, OR

The new maps greatly enhance our vision of West Coast tidal wetlands, past and current…

NWI vs. new West Coast estuary map – Coquille




PMEP Spatial Data Review Tool
For internal review of draft data (January, 2015)
Find address or place
Roseville
Woodland
Sacramento
Davis
Santa Rosa
Elk Grove
Vacaville
Napa
Fairfield
Petaluma
Arnold
Lodi
Vallejo
Antioch
Pacific Ocean
San Rafael
Concord
Stockton
Oakland
San Francisco
San Leandro
Tracy
Livermore
Modesto
San Mateo
Fremont
Redwood City
Turlock
San Jose
Merced
20mi
38.407 -123.808 Degrees
Esri, HERE, DeLorme, NGA, USGS | Esri, HERE, DeLorme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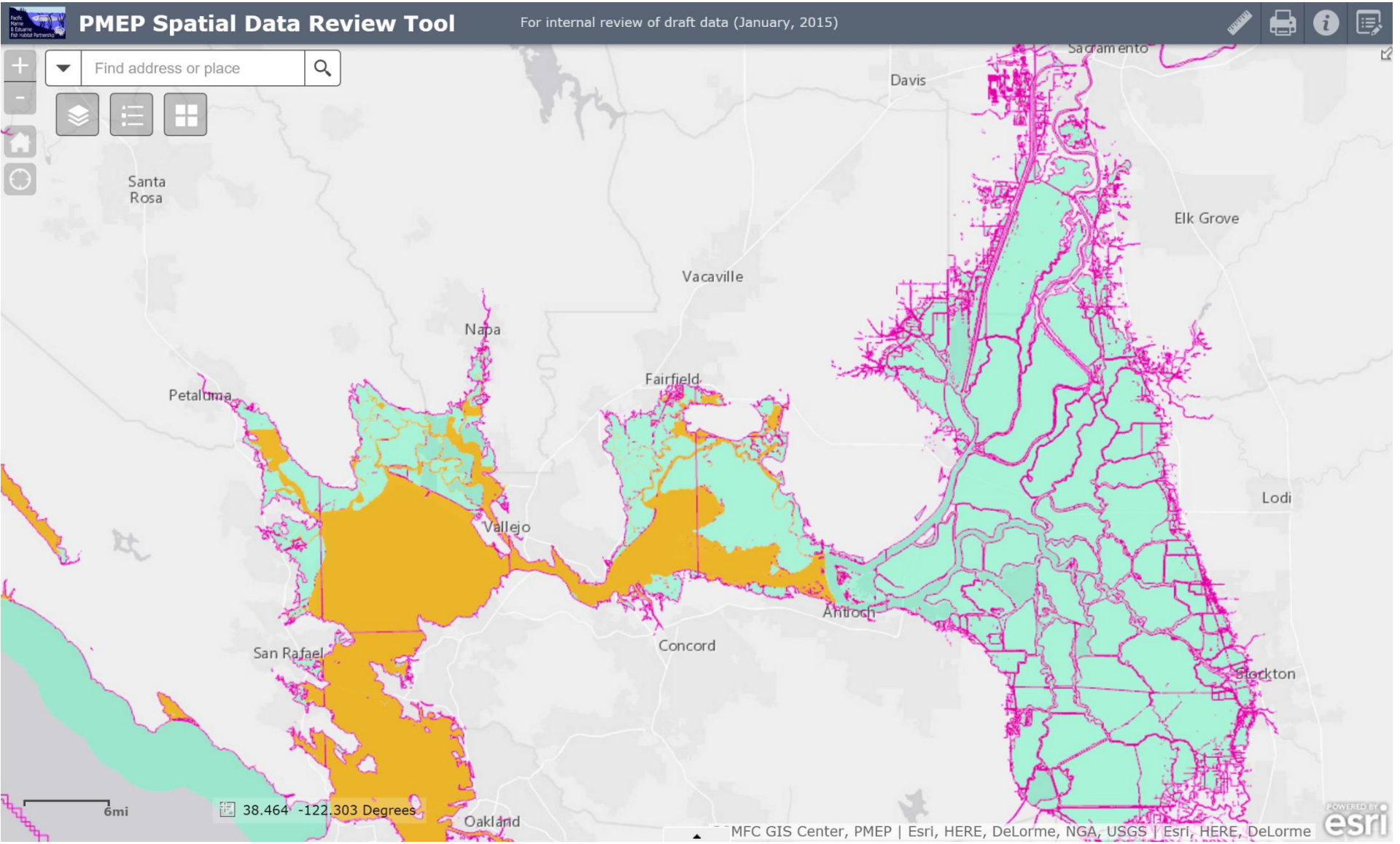
Petaluma
Lodi
Vallejo
Antioch
Concord
San Rafael
Stockton
Oakland
6mi
38.582 -122.168 Degrees
MFC GIS Center, PMEP | Esri, HERE, DeLorme, NGA, USGS | Esri, HERE, DeLorme
esri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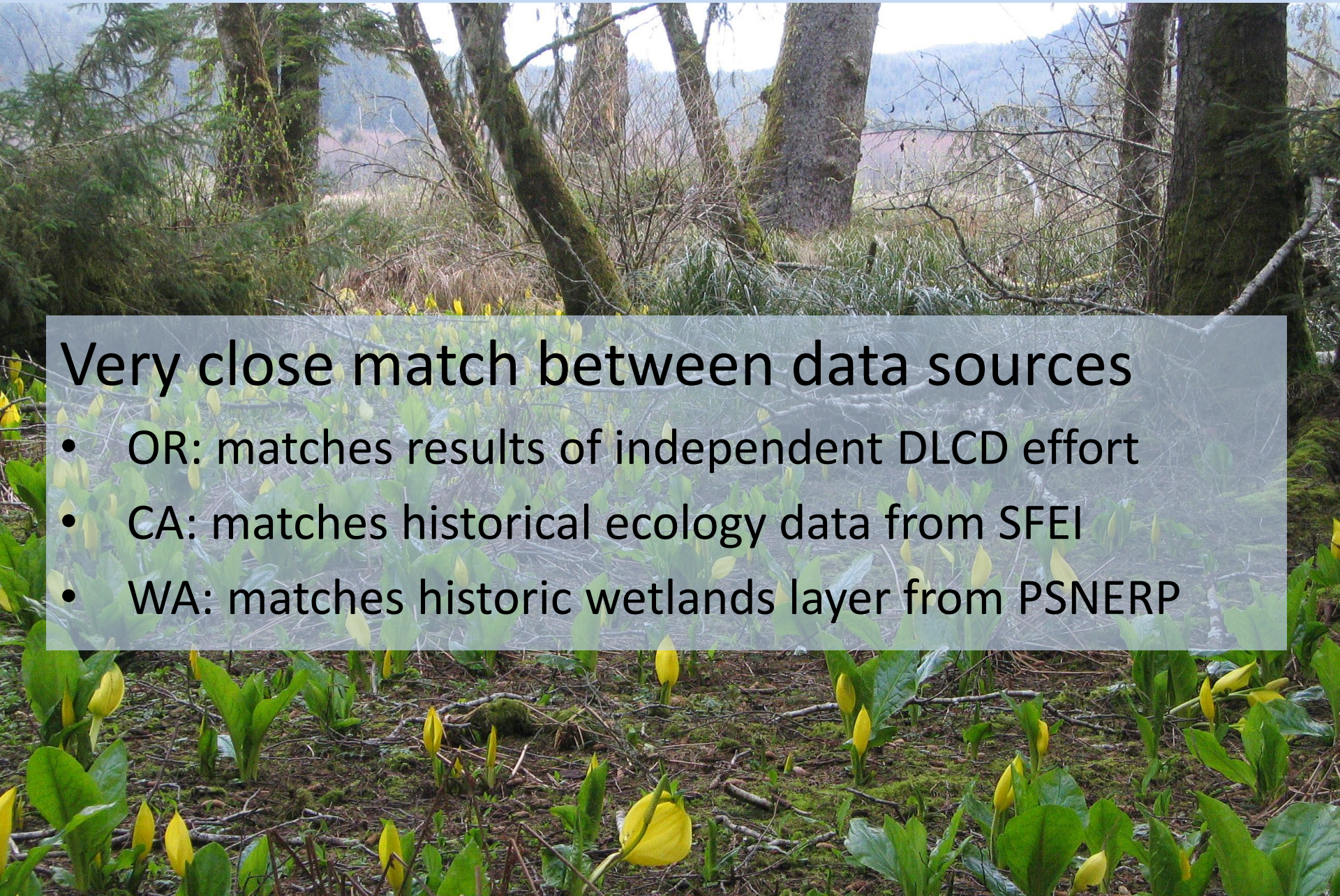
Find address or place
Sacramento
Davis
Santa Rosa
Elk Grove
Vacaville
Napa
Fairfield
Petaluma
Lodi
Vallejo
Antioch
Concord
San Rafael
Stockton
Oakland
6mi
38.464 -122.303 Degrees
MFC GIS Center, PMEP | Esri, HERE, DeLorme, NGA, USGS | Esri, HERE, DeLorme
esri

Data validation and review

- Ground-truthing relative to OR CMECS data
- Two expert review webinars and follow-up (input to web mapping application)
- Comparison to spatially explicit historical wetland layers (PSNERP, SFEI)

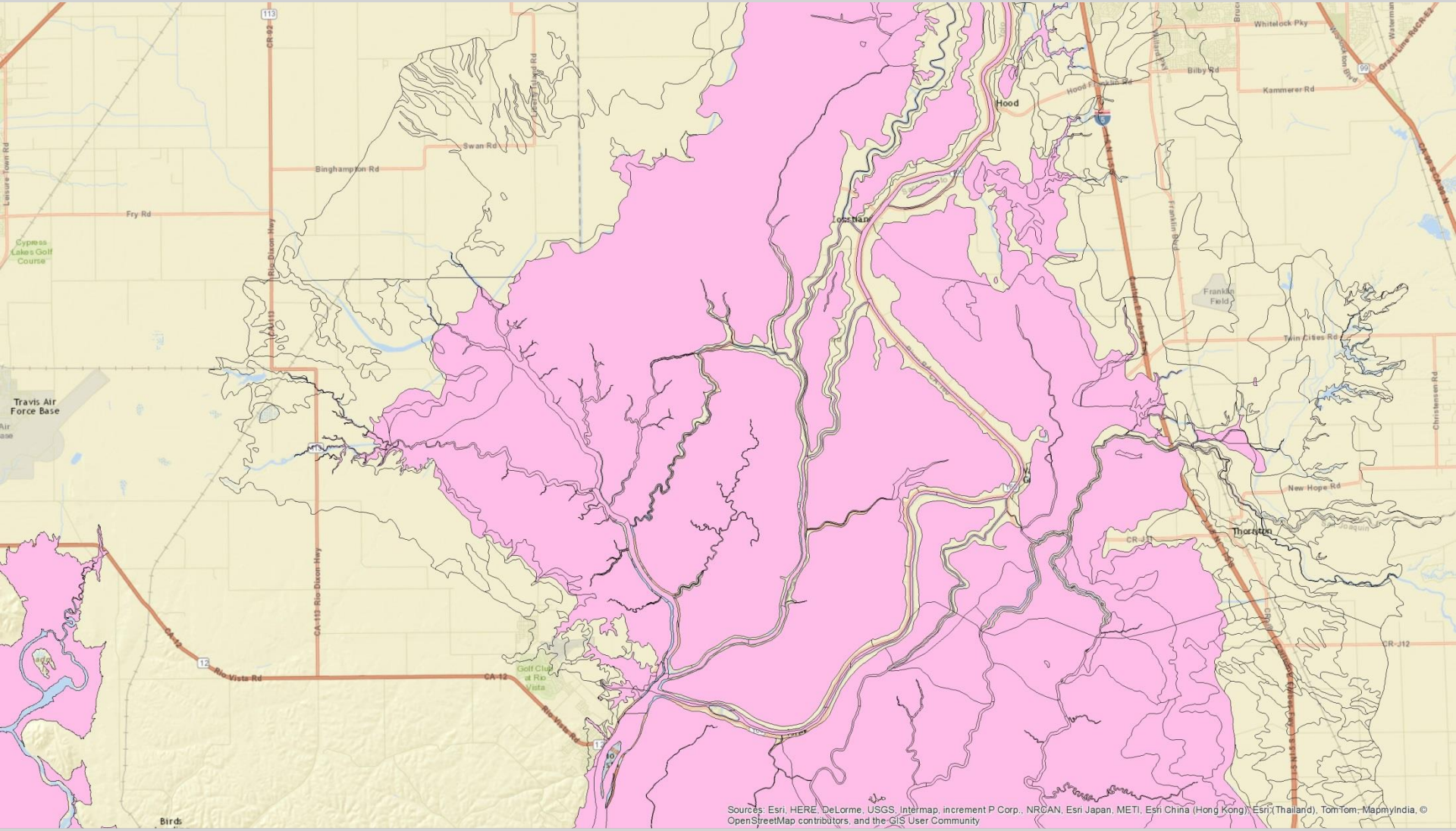
Results of review



Very close match between data sources

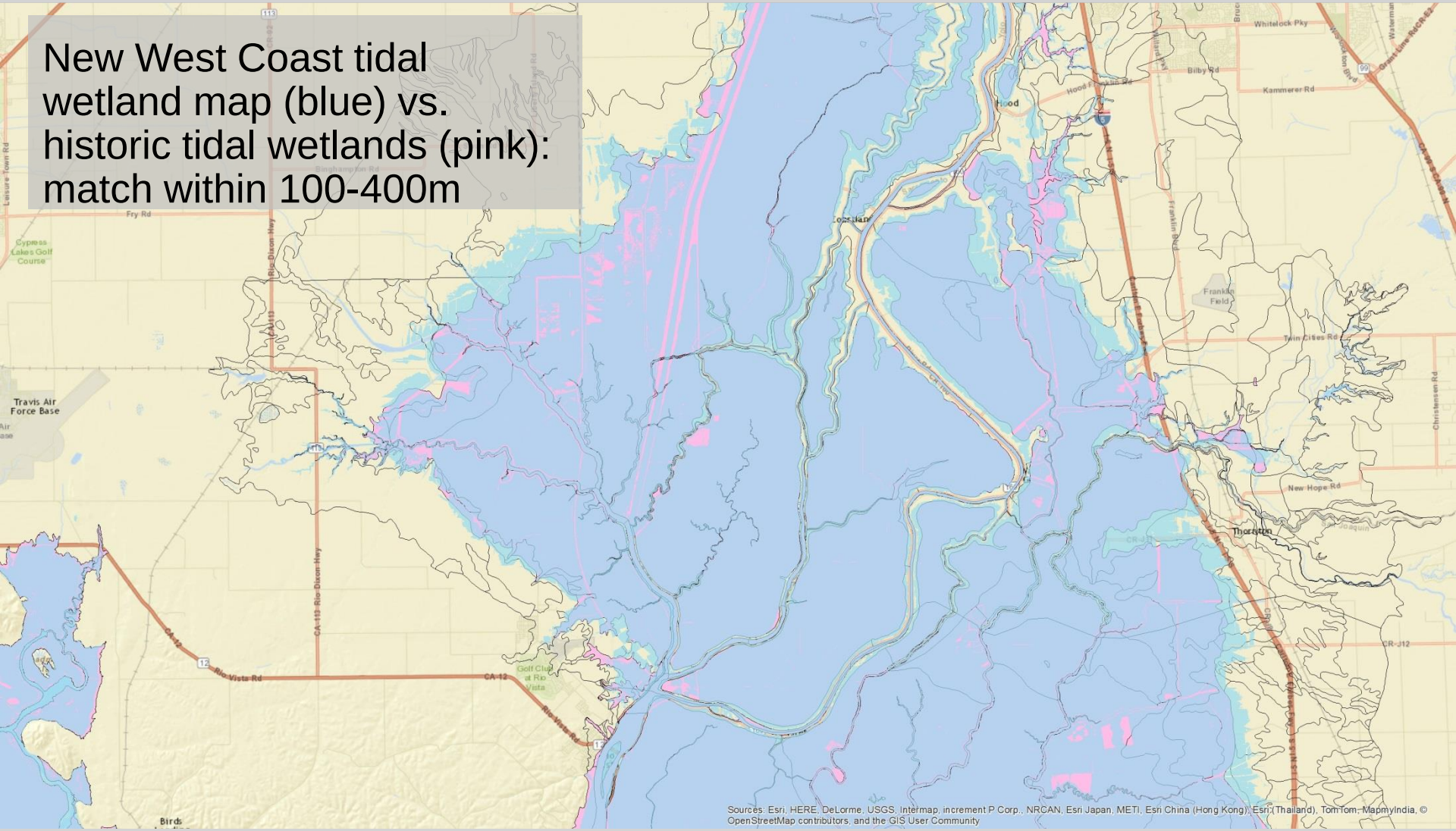
- OR: matches results of independent DLCD effort
- CA: matches historical ecology data from SFEI
- WA: matches historic wetlands layer from PSNERP

Cache Slough, Sacramento-San Joaquin Delta, CA



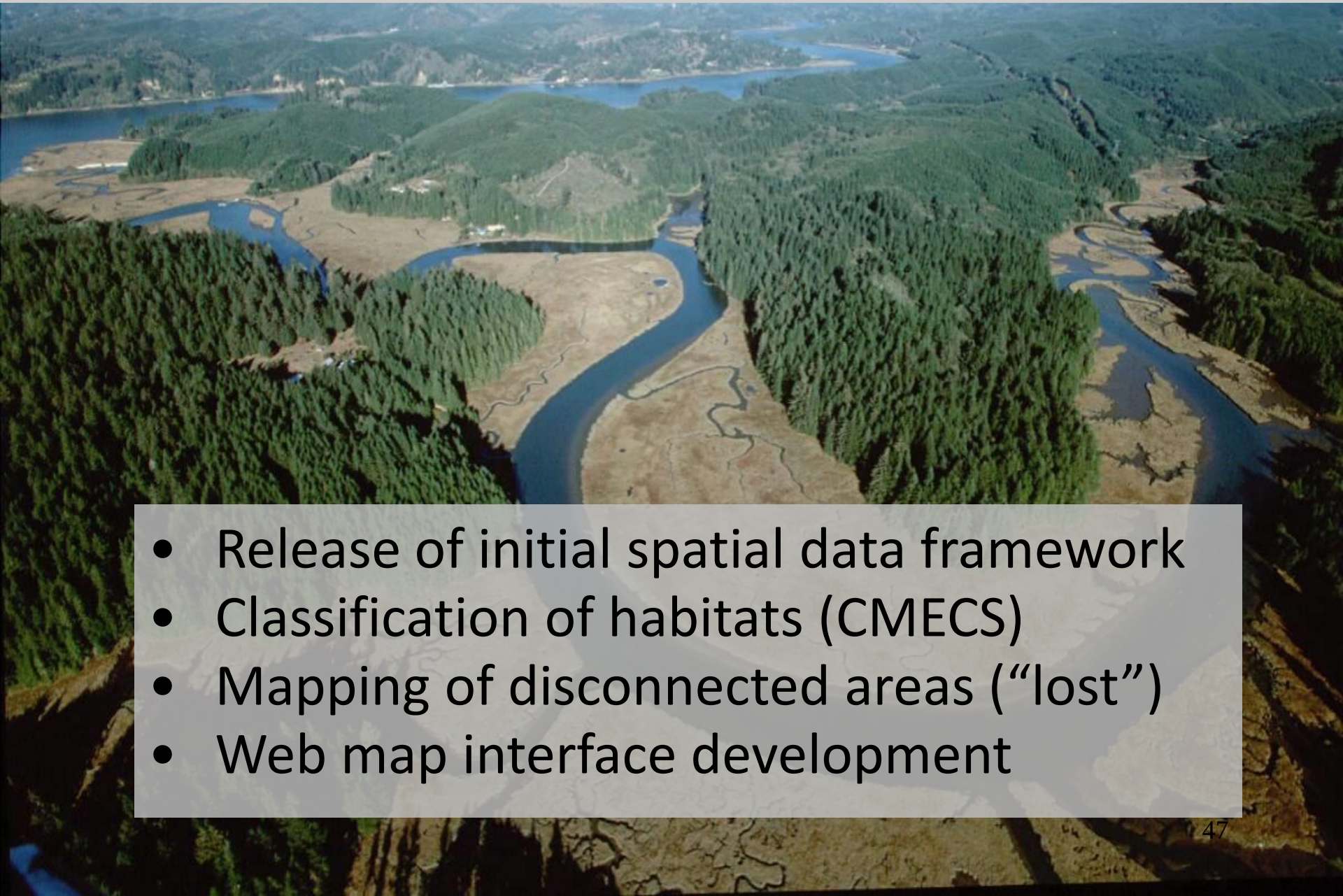
Historic tidal wetlands from Sacramento-San Joaquin Delta Historical Ecology Study (SFEI 2014)

Cache Slough, Sacramento-San Joaquin Delta, CA



Puget Sound: Similarly tight match to PSNERP historic wetlands layer

Next steps



- Release of initial spatial data framework
- Classification of habitats (CMECS)
- Mapping of disconnected areas (“lost”)
- Web map interface development

Conclusions

The new West Coast tidal wetland maps:

- Greatly improve and expand our understanding of West Coast estuaries and the habitat they provide
- Provide consistent, comprehensive coverage
- Have been positively reviewed by experts
- Closely match historical wetland maps
- Provide a solid base layer for West-coast-scale analysis of wetland losses, restoration and conservation opportunities

Thank you for listening!
Questions?

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