COLLABORATIVE SCIENCE FOR ESTUARIES

WEBINAR SERIES

David Sutherland
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South Slough NERR

Improved Understanding of Sediment Dynamics for the Coos Estuary

National Estuarine
Research Reserve System
Science Collaborative

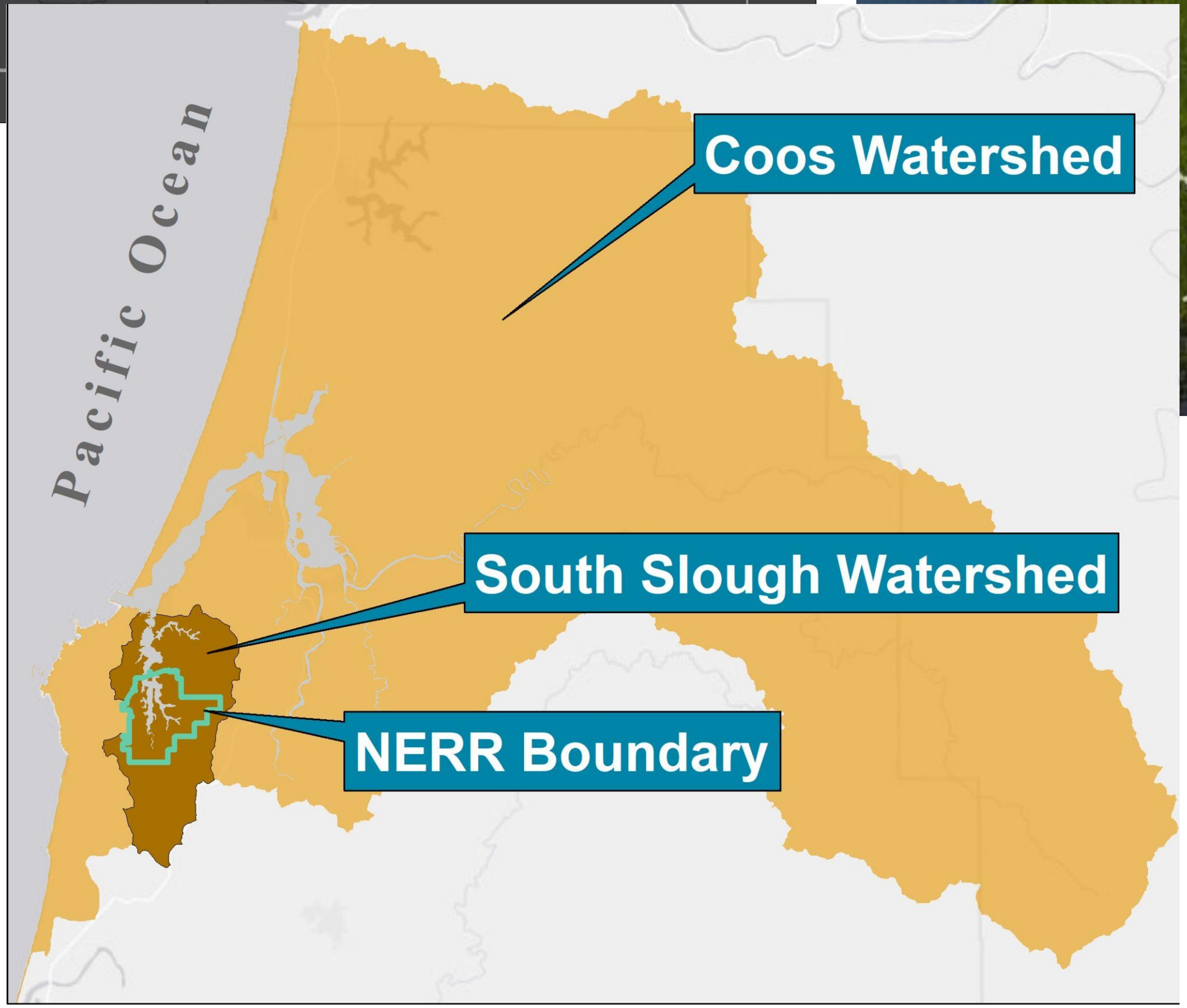
Date: Wednesday, September 29, 2021
Time: 4:00-5:00 PM ET

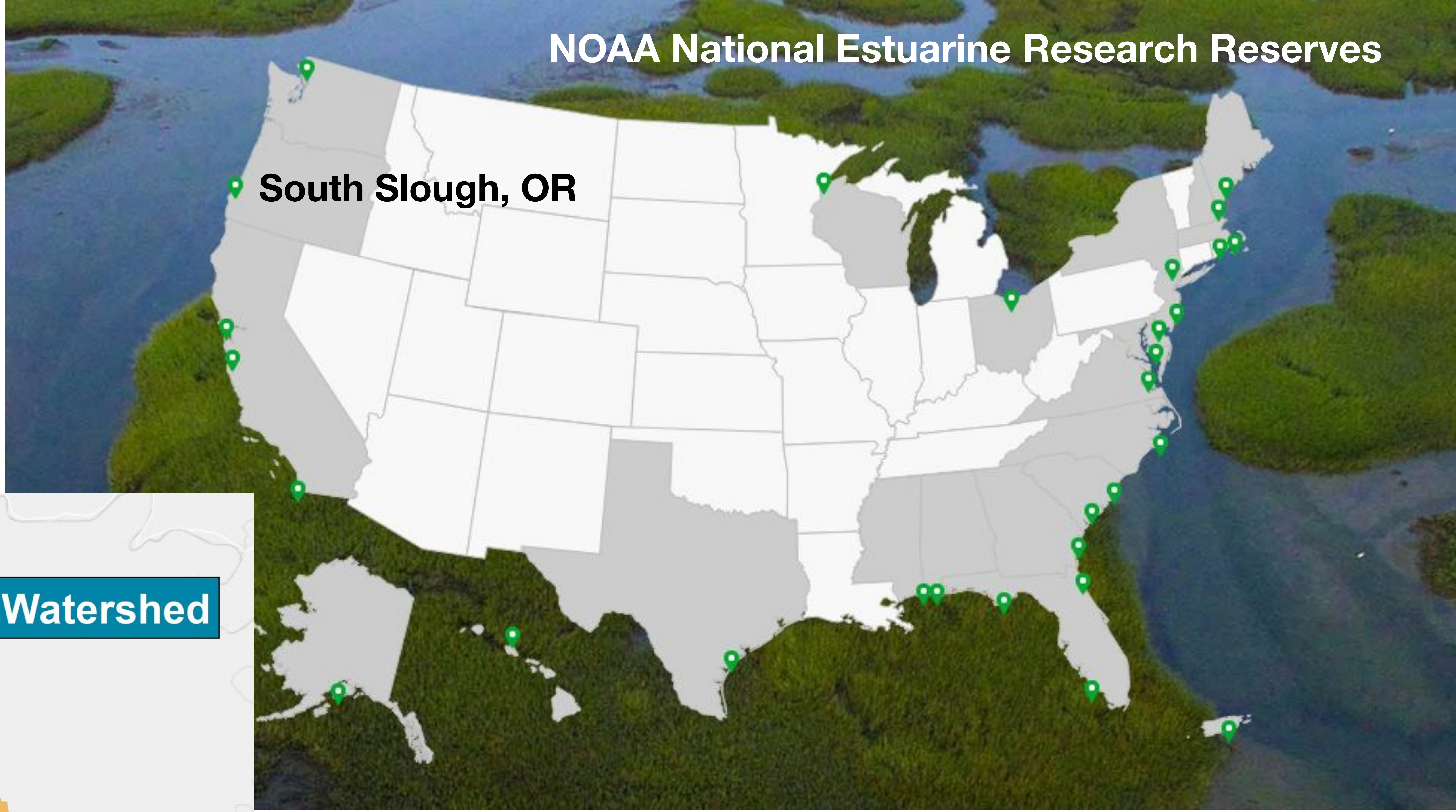
Improved Understanding of Sediment Dynamics for the Coos Estuary

Dave Sutherland, Jenni Schmitt, & Emily Eidam

Ali Helms, SSNERR
Dave Ralston, WHOI
Peter Ruggiero, OSU
Freelin Reasor, Coos Watershed Association
Molly Keogh, Bass Dye, Ted Conroy, U Oregon
...and more!


Kennewick
Lewiston Orchards
Portland
Salem
Oregon
Eugene
Pacific Ocean
Coos Watershed


Pacific Ocean
Coos Watershed
South Slough Watershed
NERR Boundary


NOAA National Estuarine Research Reserves
South Slough, OR

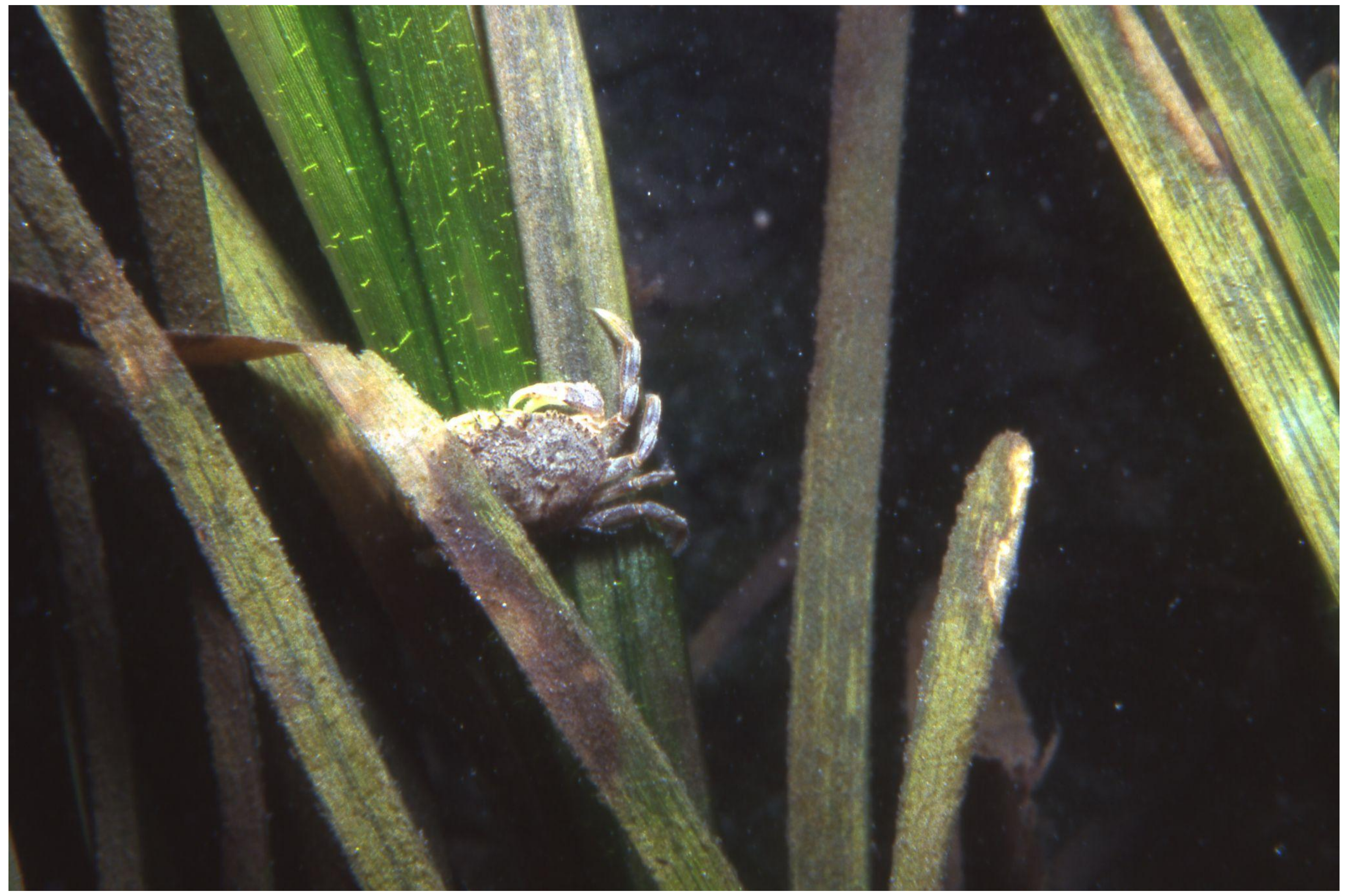
Estuary Importance:

- Industry - Timber, agriculture, fishing, aquaculture

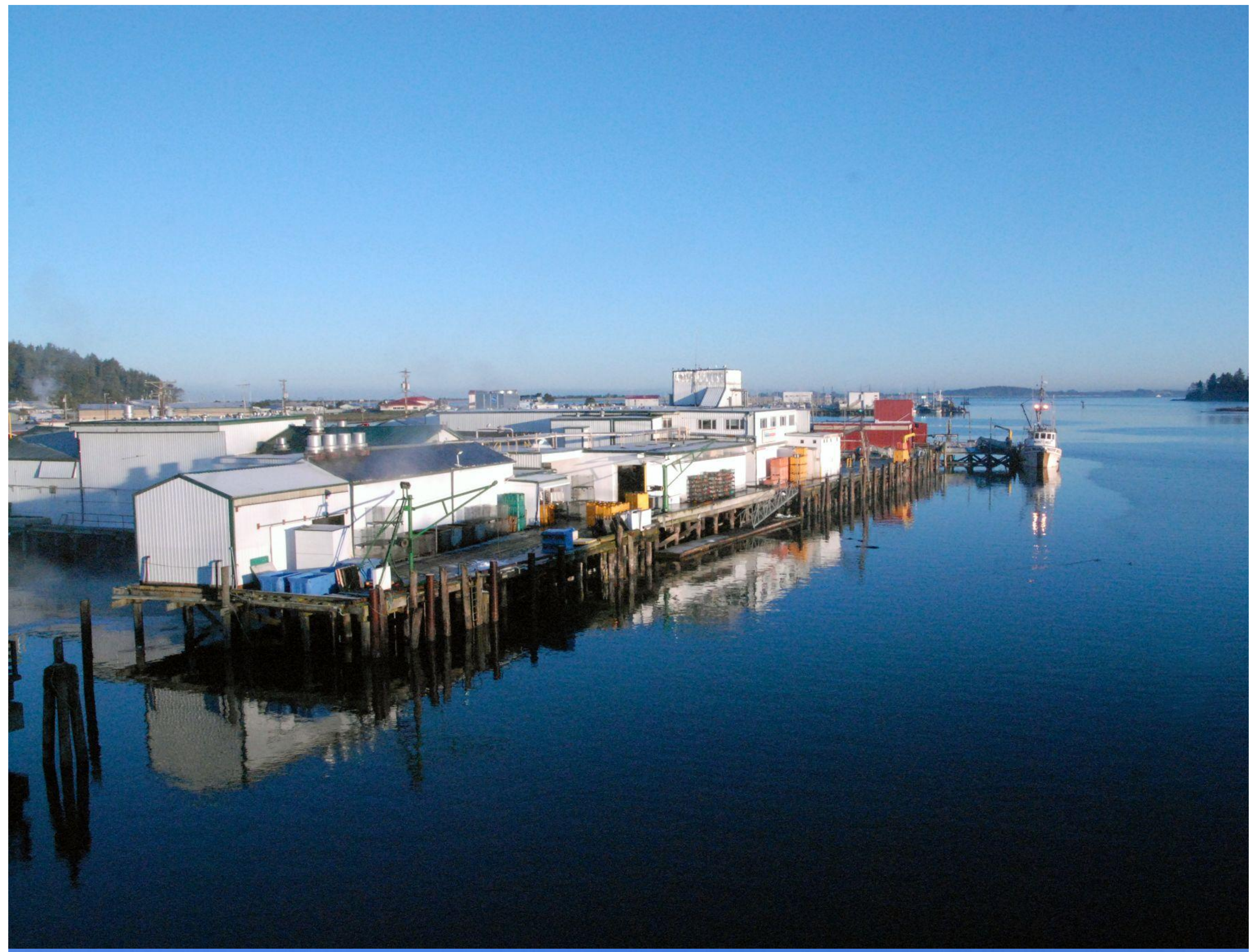
- Recreation - fishing, shellfishing, kayaking, crabbing

- Ecology - wetland habitats, tide flats, nursery grounds

- Cultural - three federally recognized tribes have roots in the Coos estuary



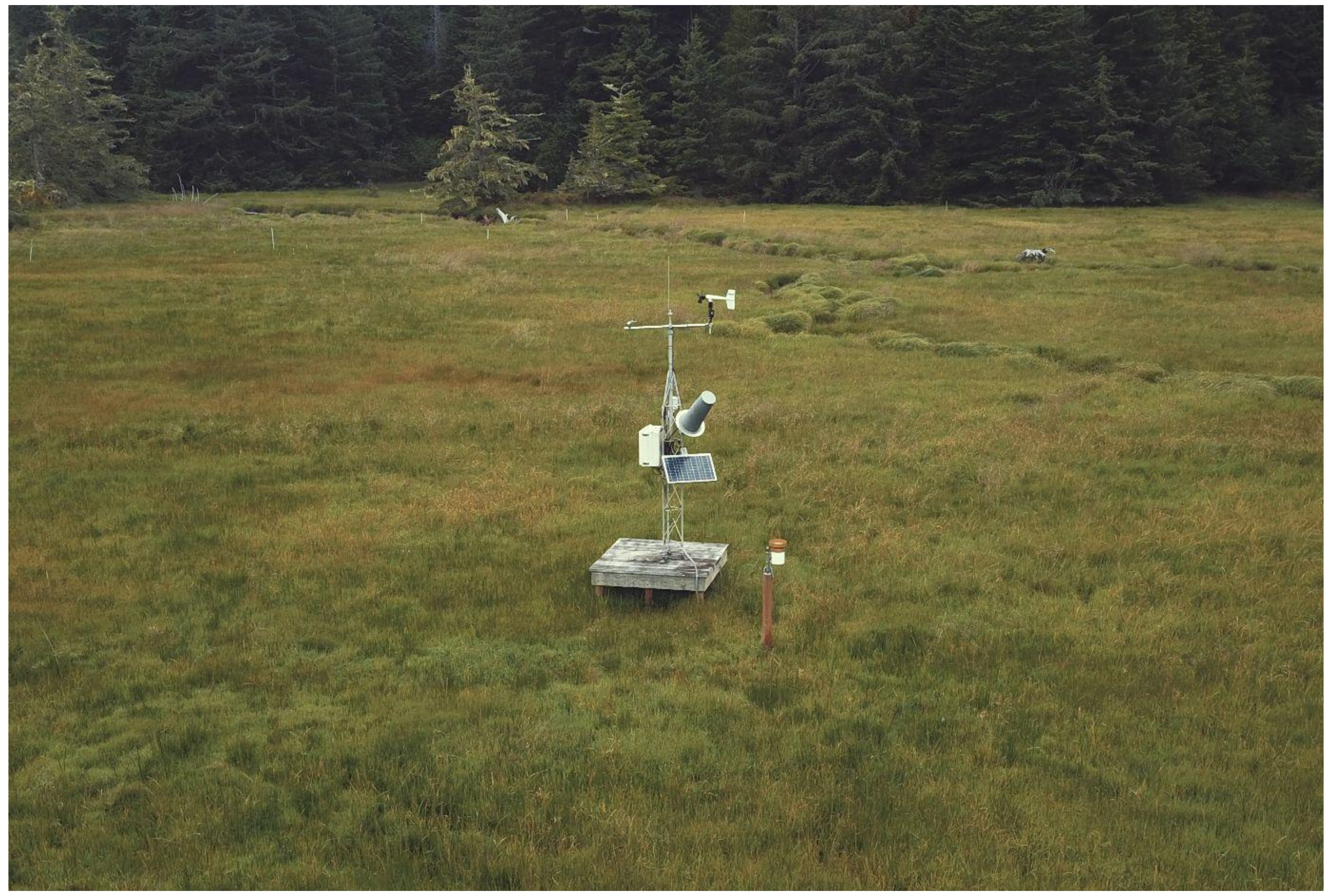
Project goal



Characterize **present day sediment distributions** & fluxes and **develop validated hydrodynamic and sediment transport model** to address end-user management objectives

Project highlights

- Developed and validated a **hydrodynamic and sediment model** for Coos Bay
- Used this model to explore how estuary has **changed over past 150 years** in terms of tidal range, salt intrusion length, sedimentation, etc.
- Furthered collaborations with **end-users and stakeholders** to enable future science and policy goals
- Inspired **new collaborative projects** that build upon lessons learned



Summary of project data, links, papers, products, movies, etc., here:

http://www.nerrssciencecollaborative.org/project/Sutherland16

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Bathymetry

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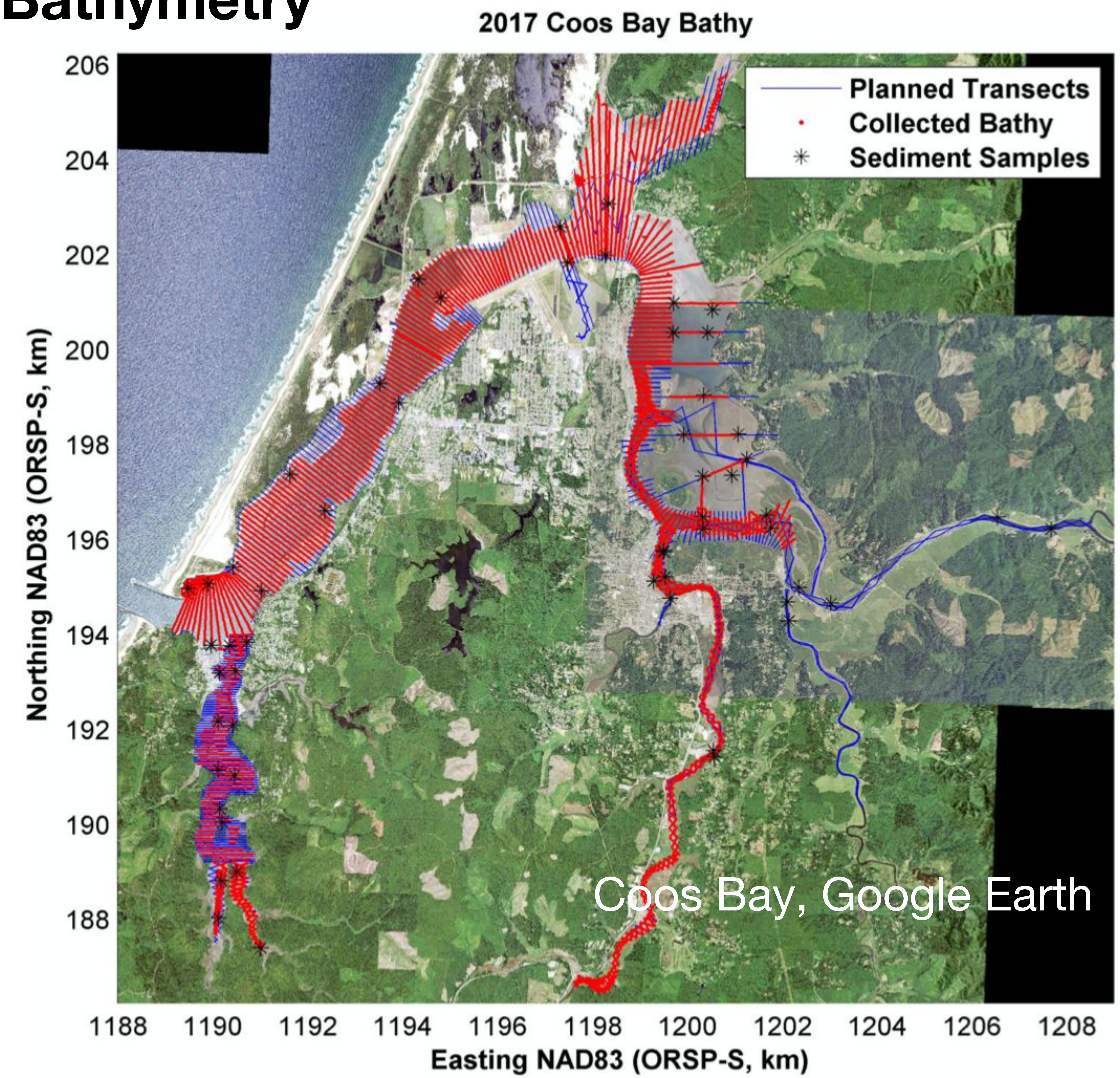

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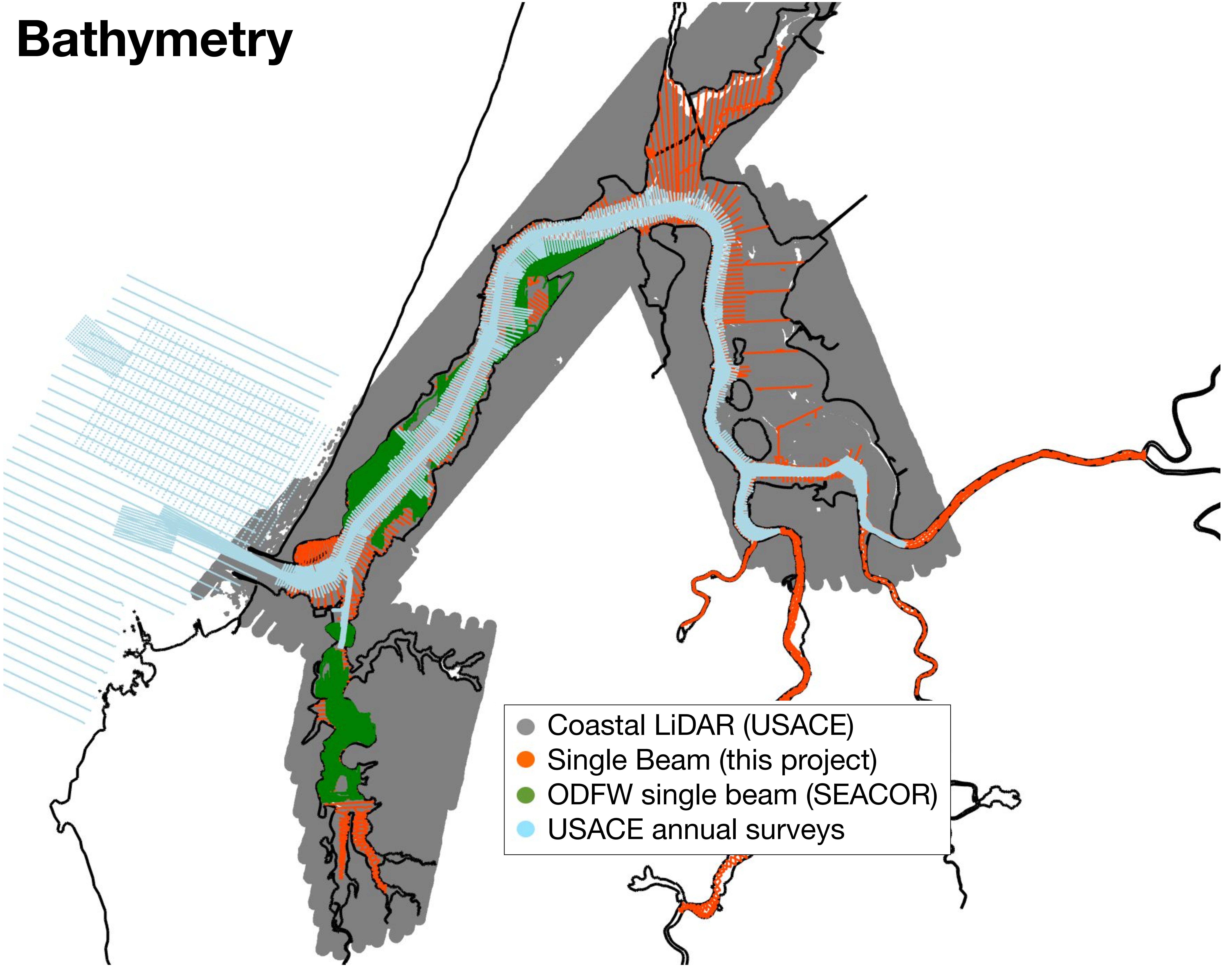

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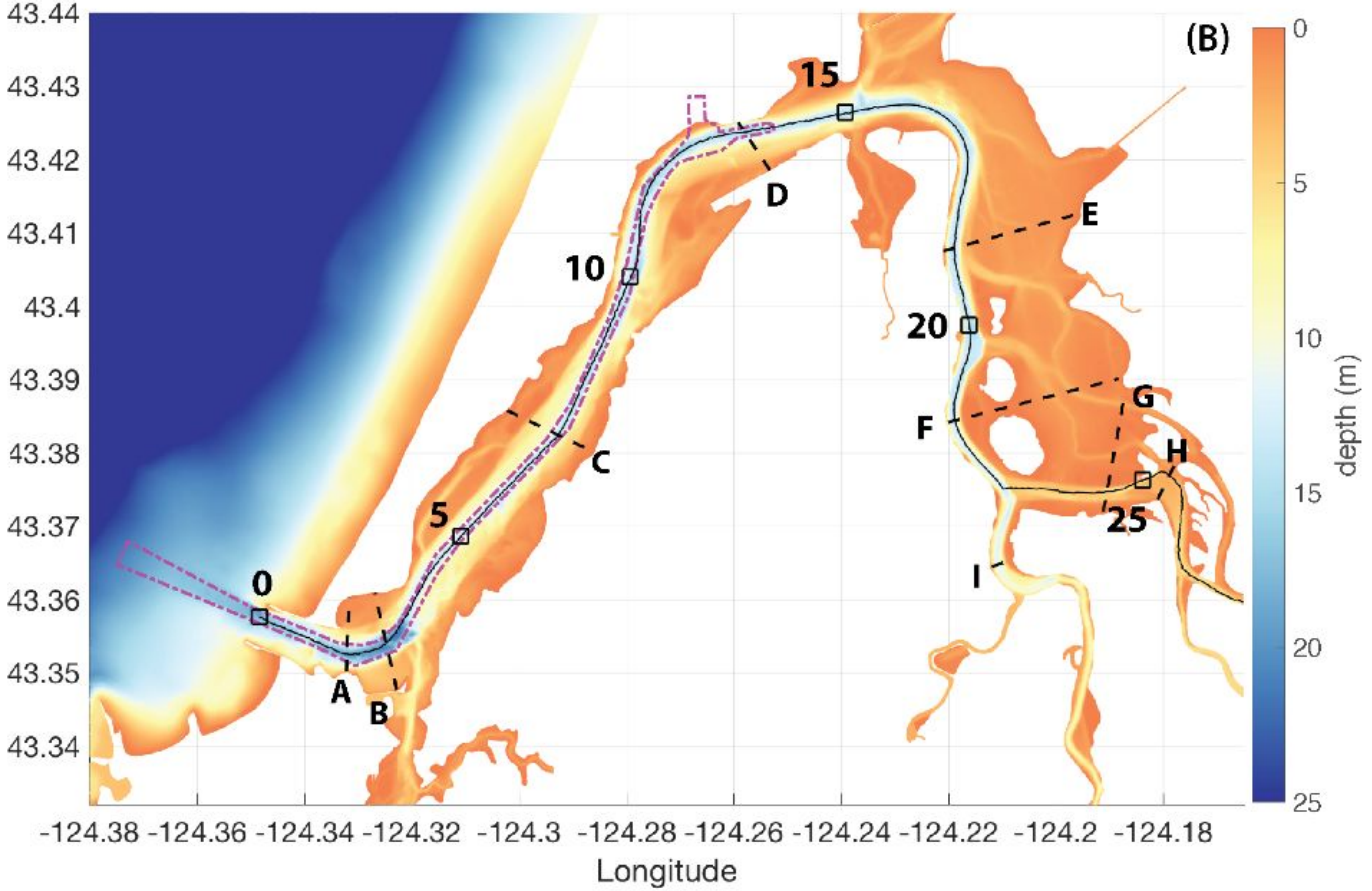
Bathymetry

- During and post-project, bathymetry product has become the most widely shared deliverable

Final product at 2-meter horizontal resolution



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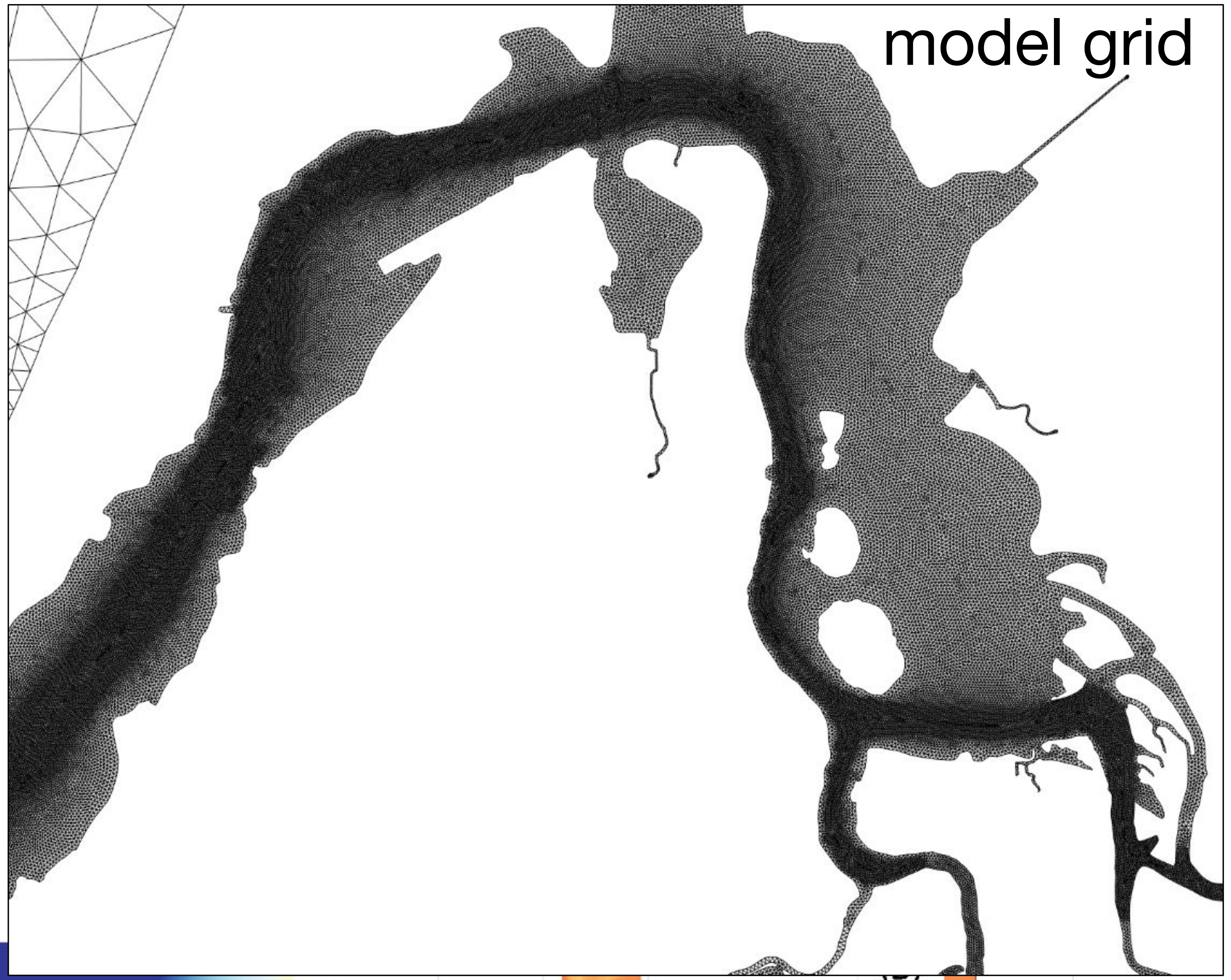
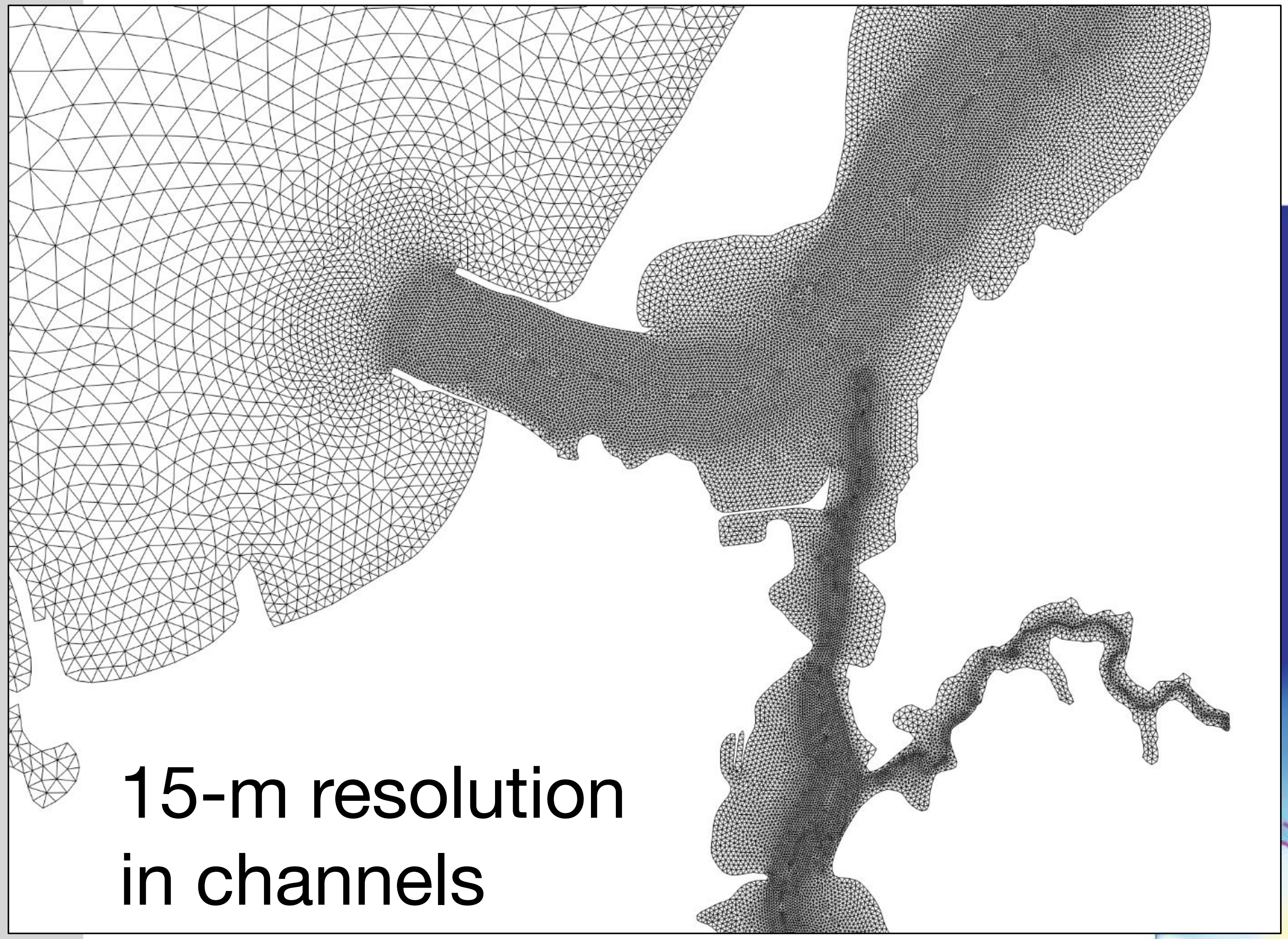
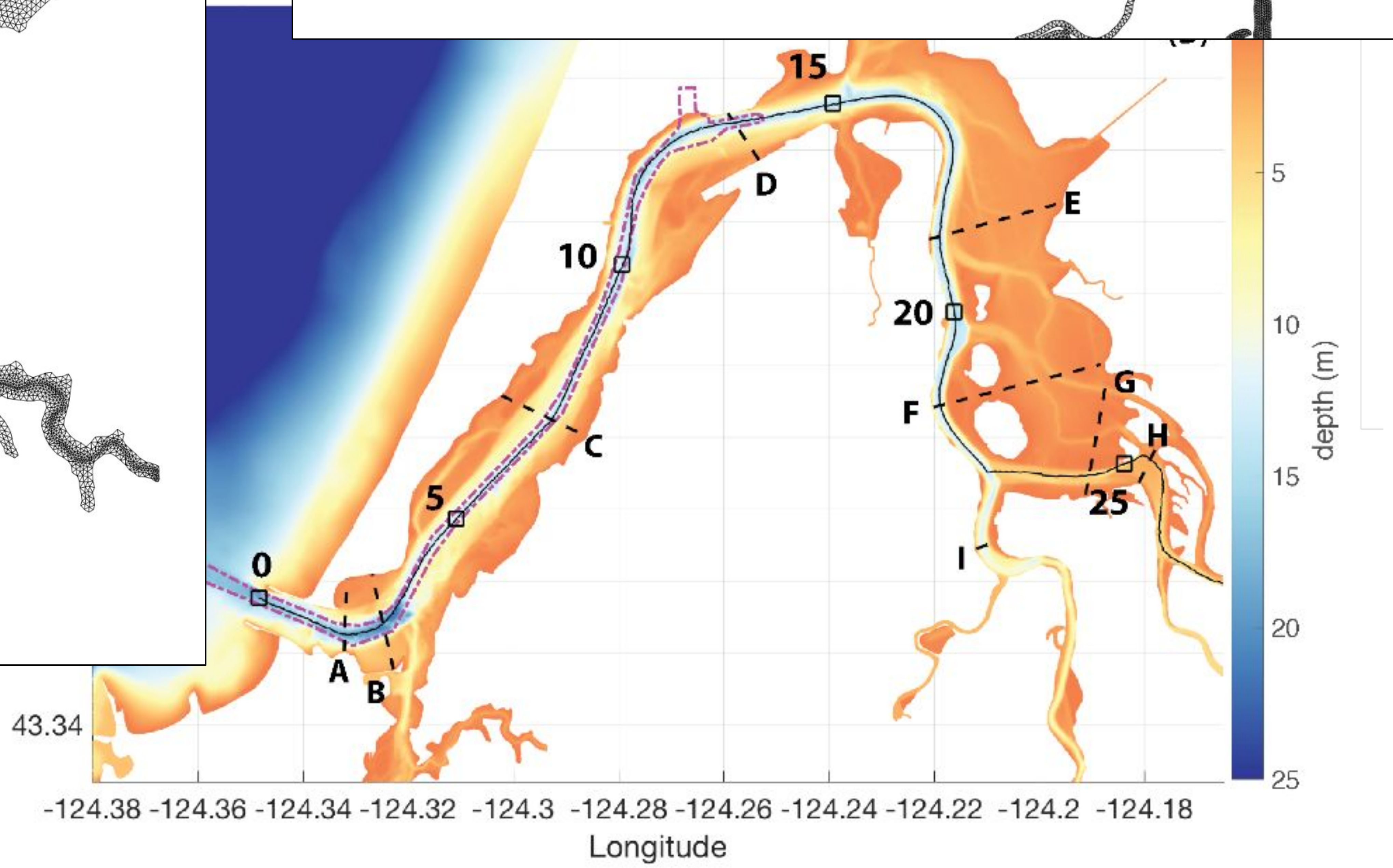
Bathymetry

- First-order input into the hydrodynamic and sediment simulations (‘models’)
- Essential to getting ‘realistic’ simulations, i.e., validation against observations







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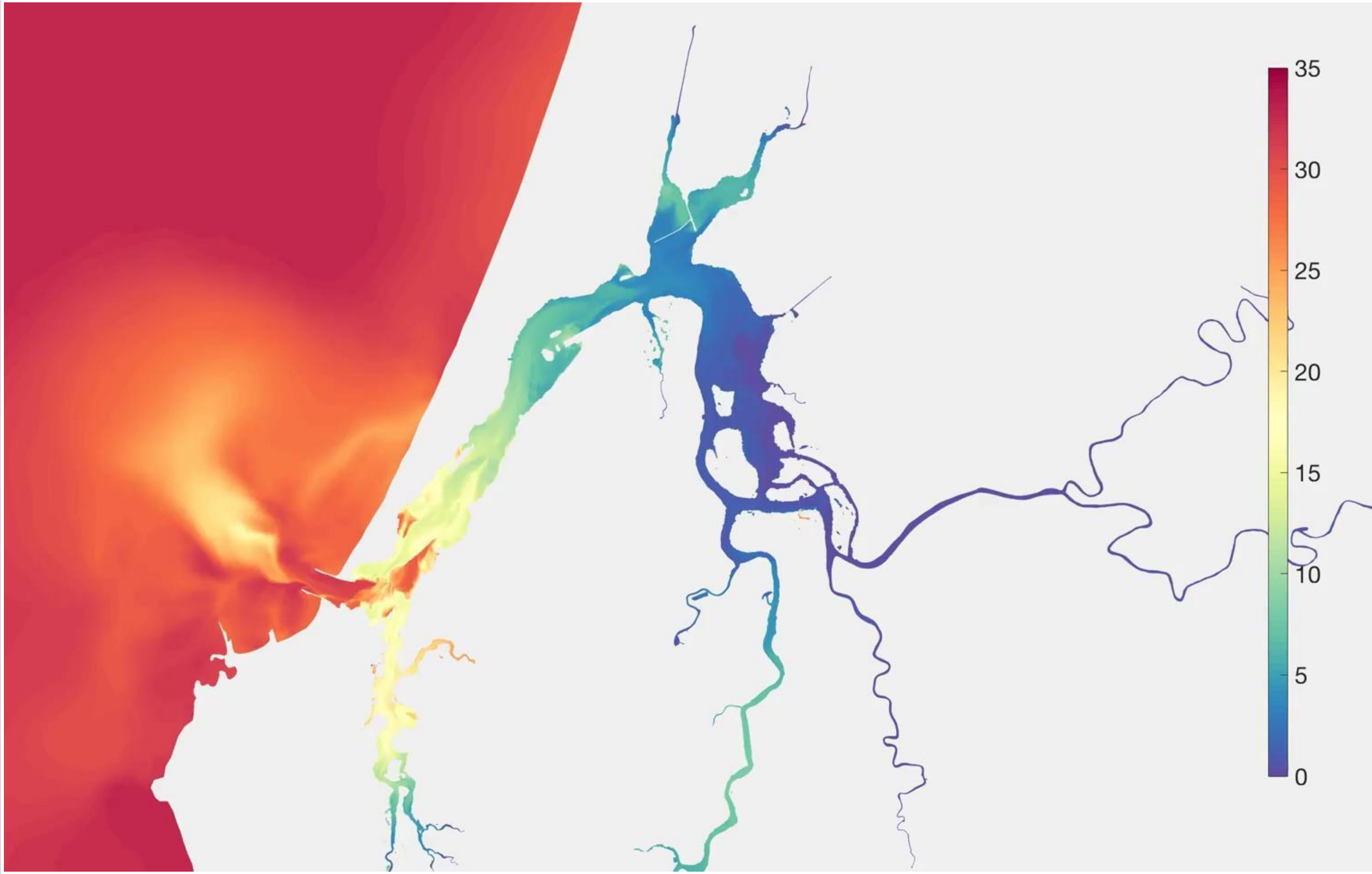
Hydrodynamic model (currents and salinity)



Surface salinity
Winter 2014

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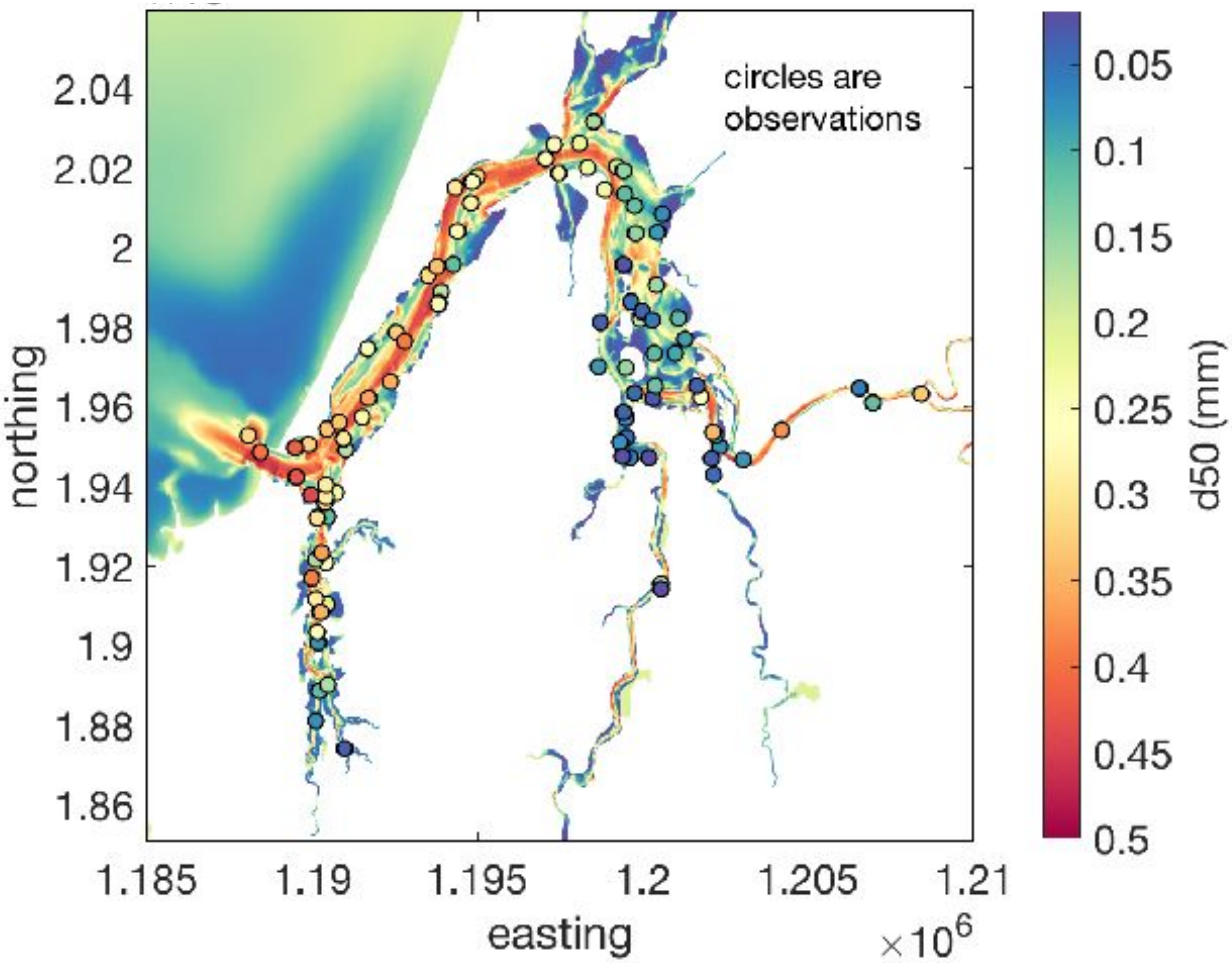
Incorporation of sediment into the model



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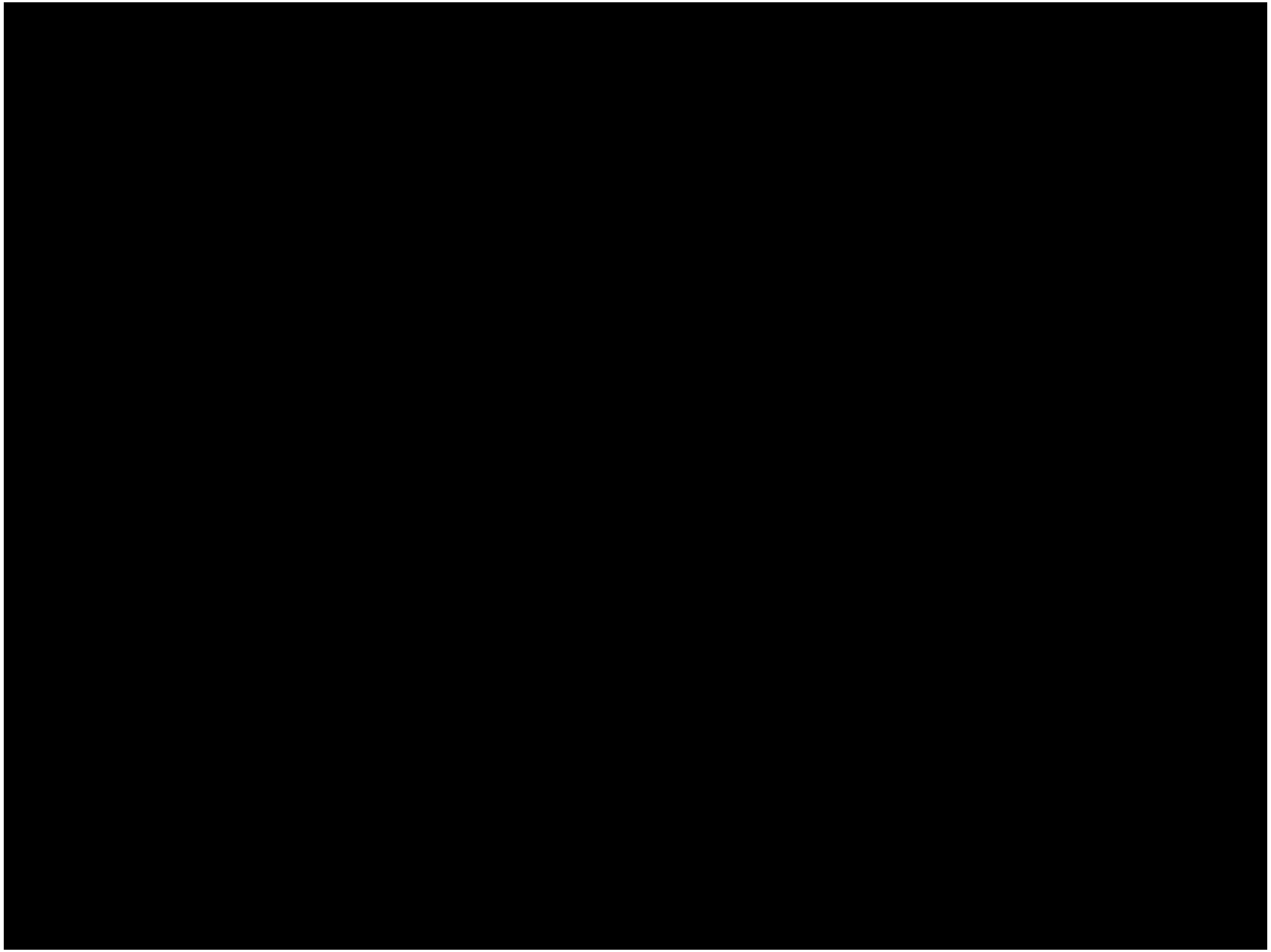

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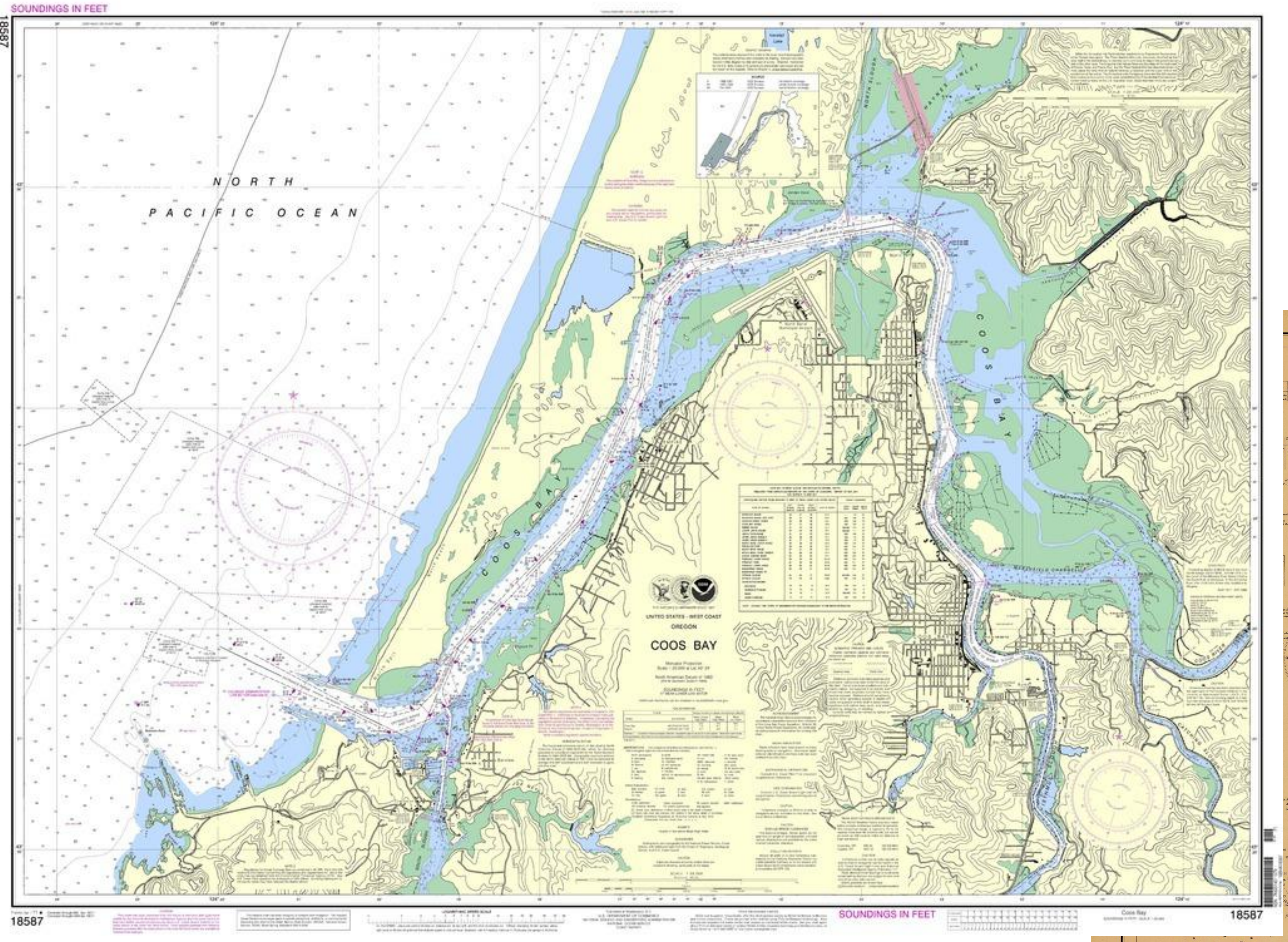
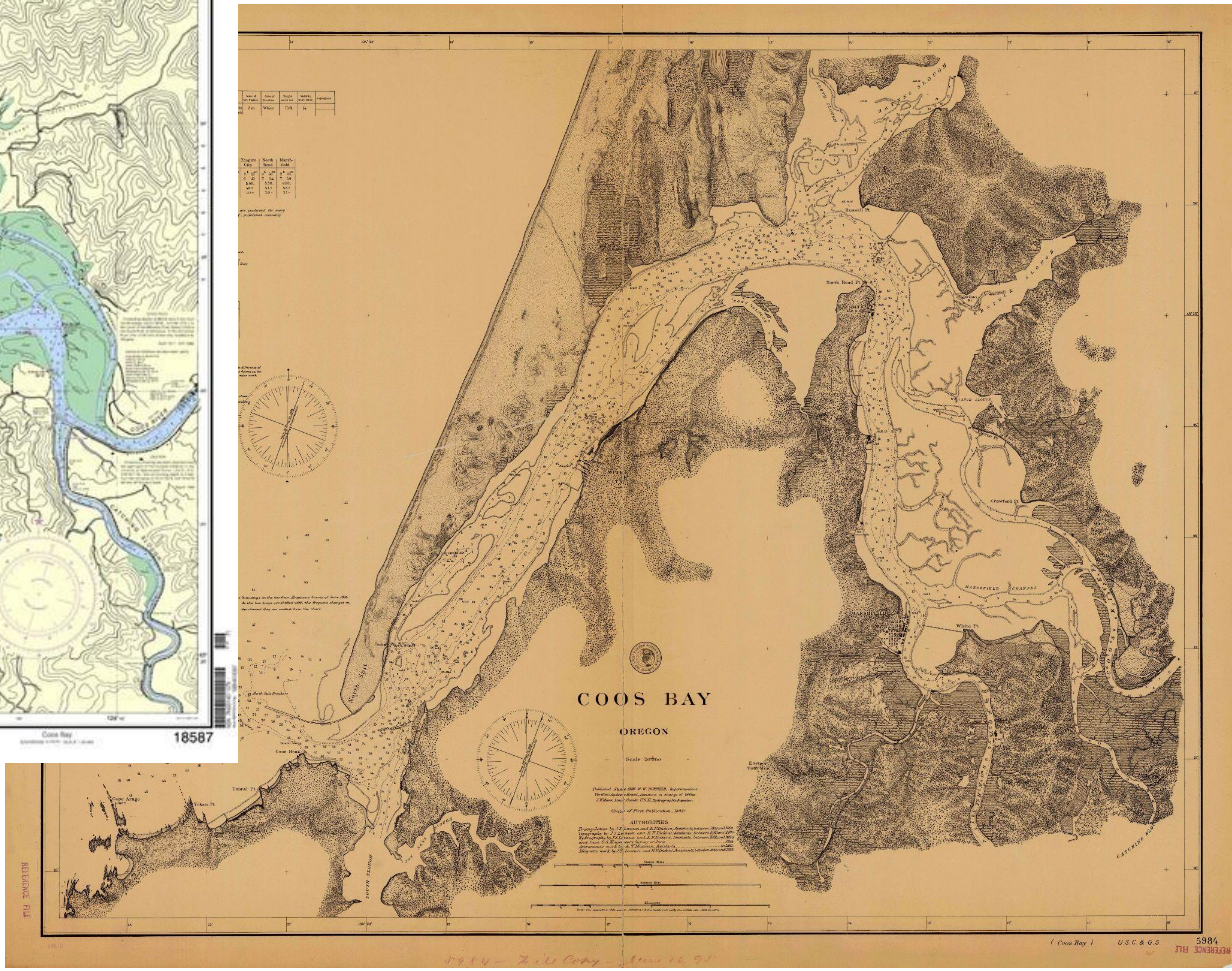
1895 NOAA Map



A series of at least 10 maps illustrating changes in shorelines is available between 1895 and 2011



2011 NOAA Map

1895 NOAA Map

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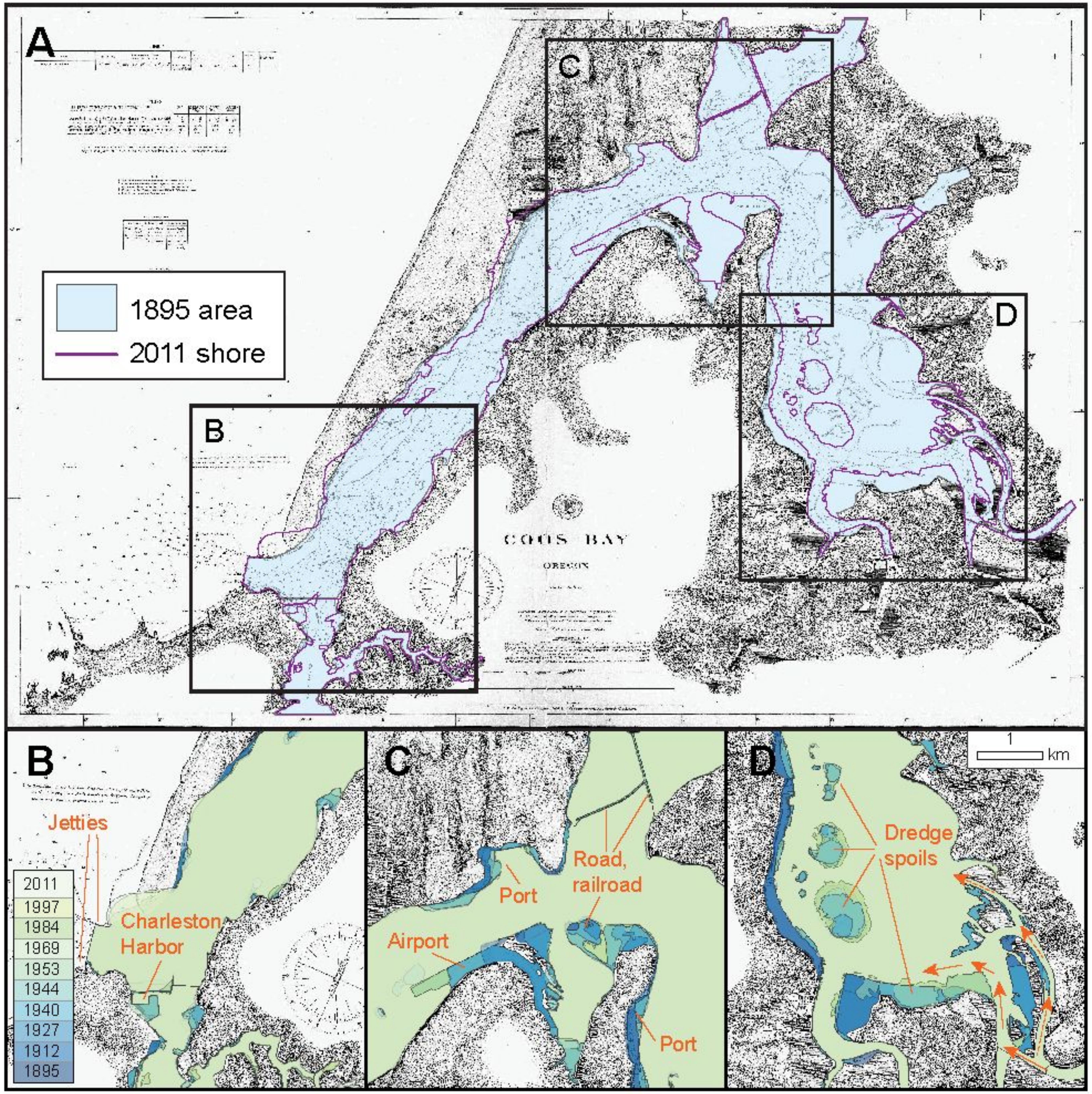

Historic chart from Coast Survey; digitization by Kira Bartlett, UO Honors Thesis

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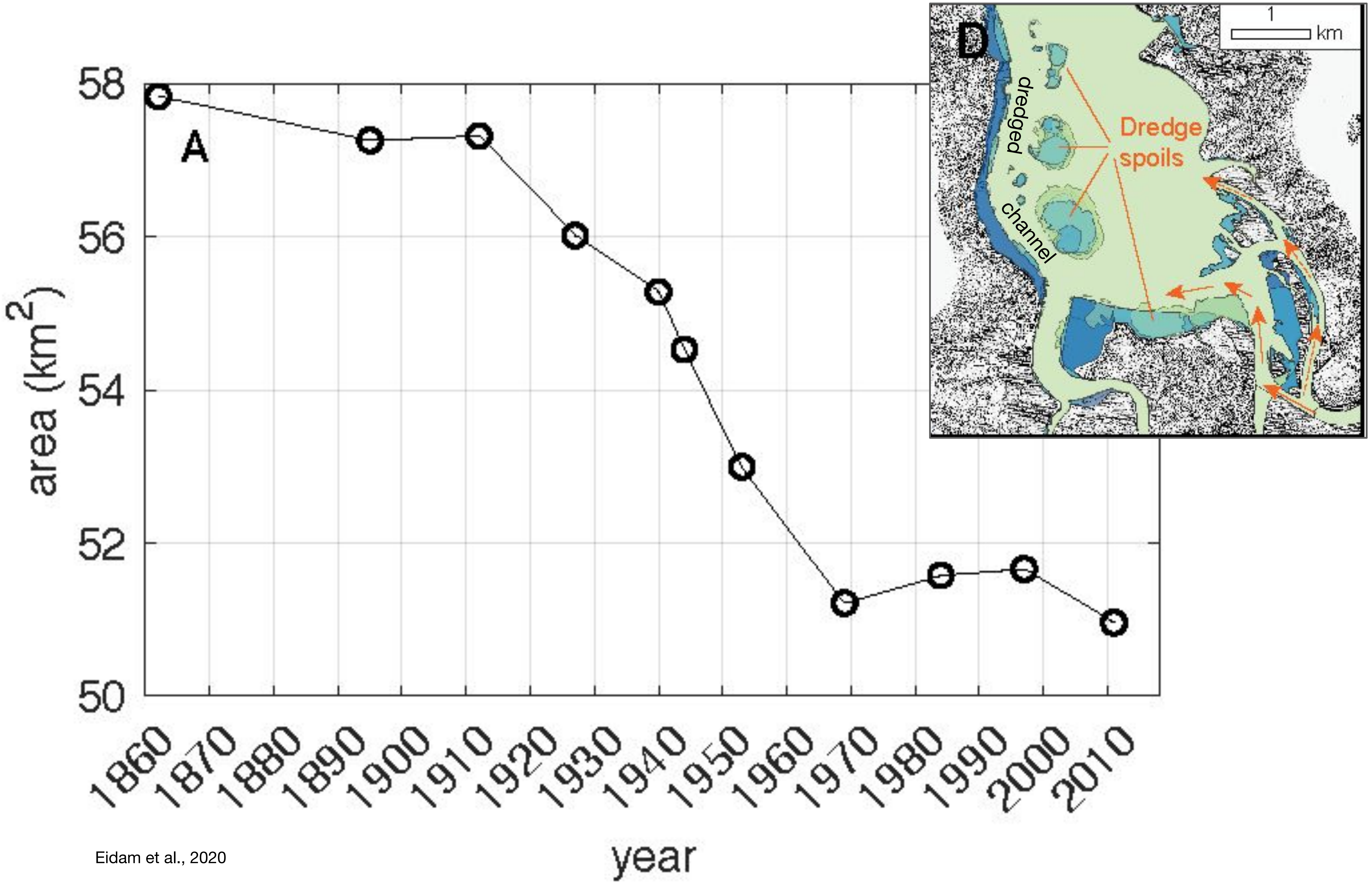
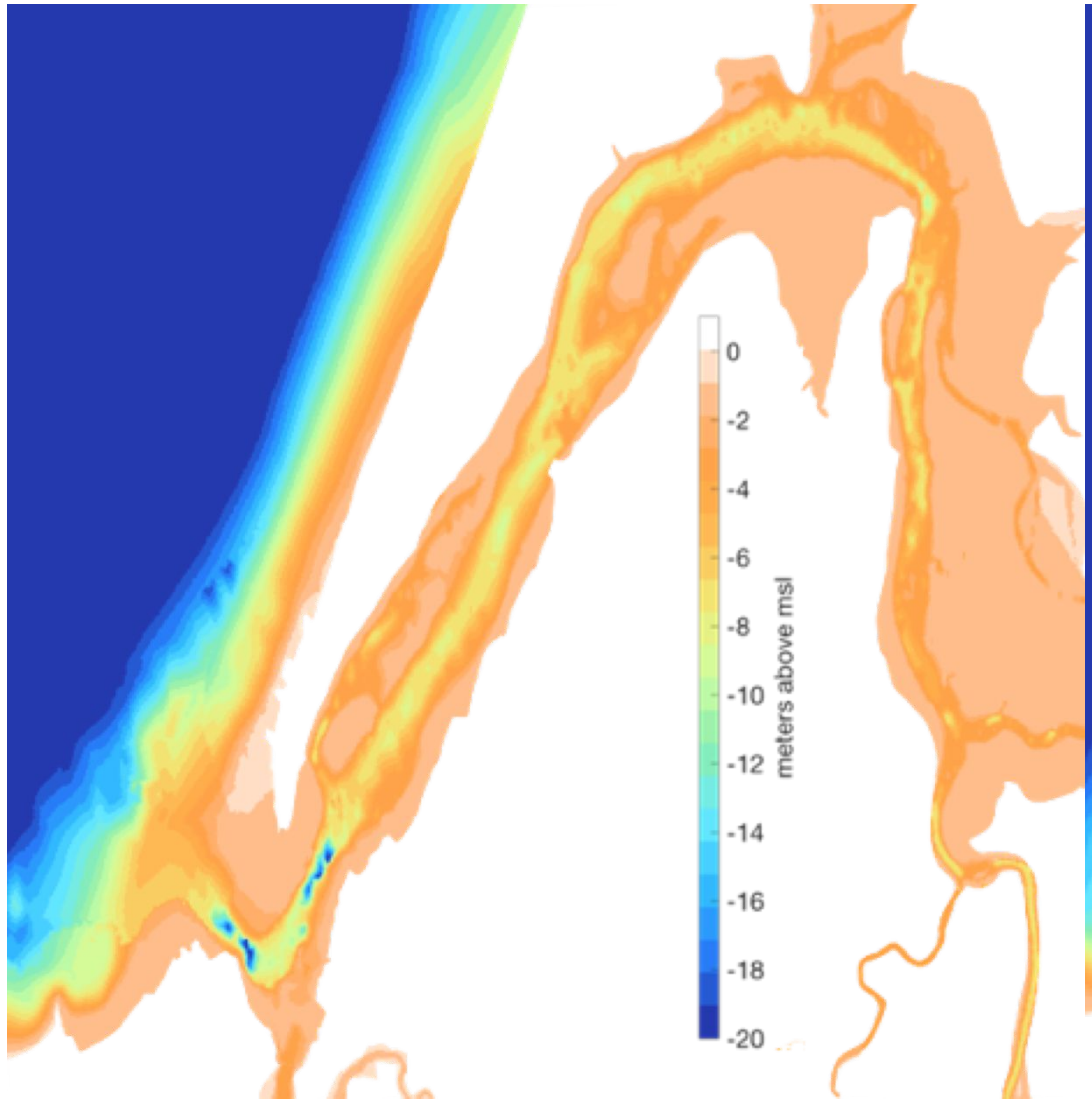
The estuarine area has decreased since the mid-1800s, but mean depths have also increased. What are the implications for sedimentation?



Eidam et al., 2020

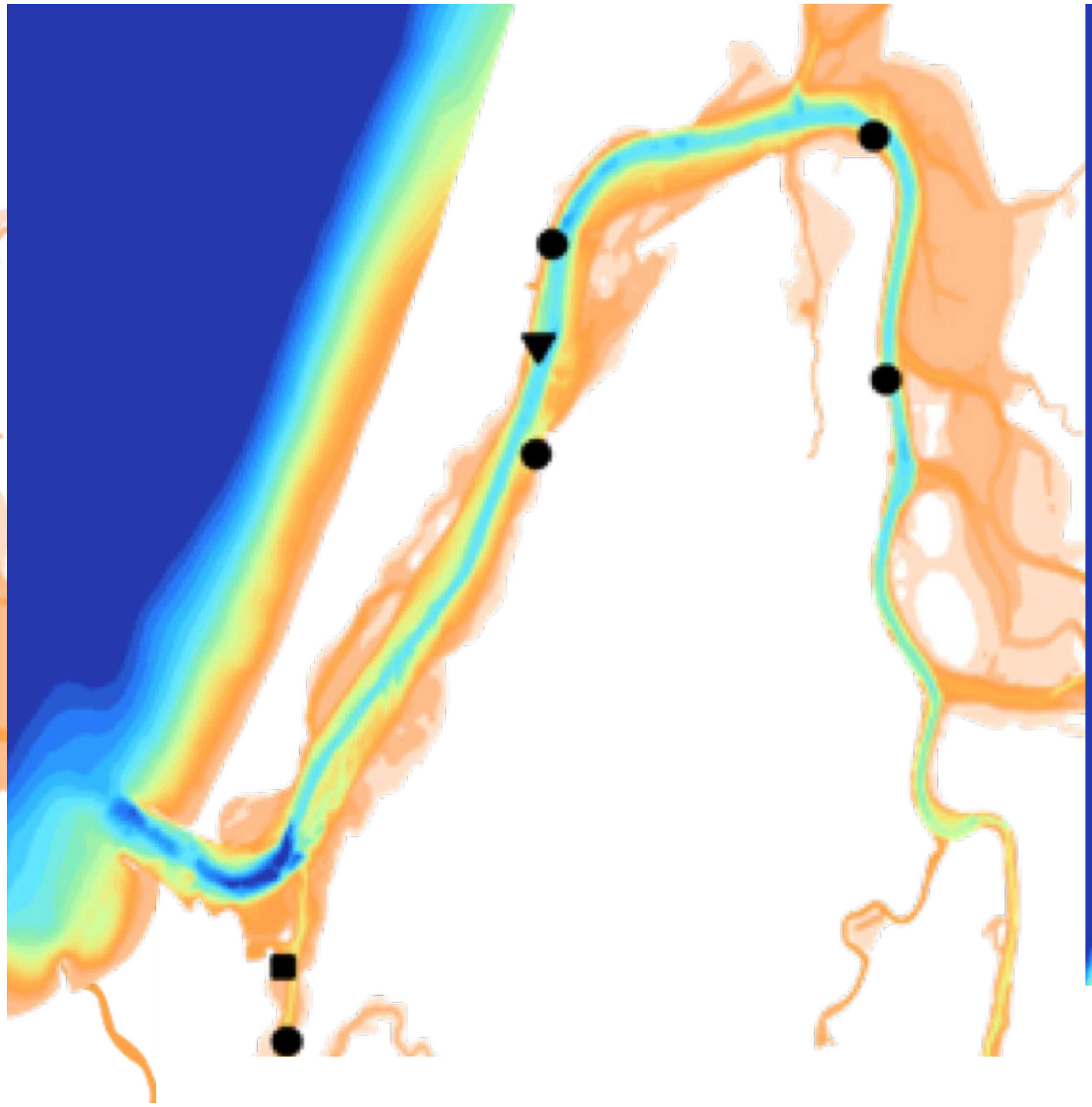
Three different bathymetry maps used to run the water + sediment model

Historic (1861/1895)



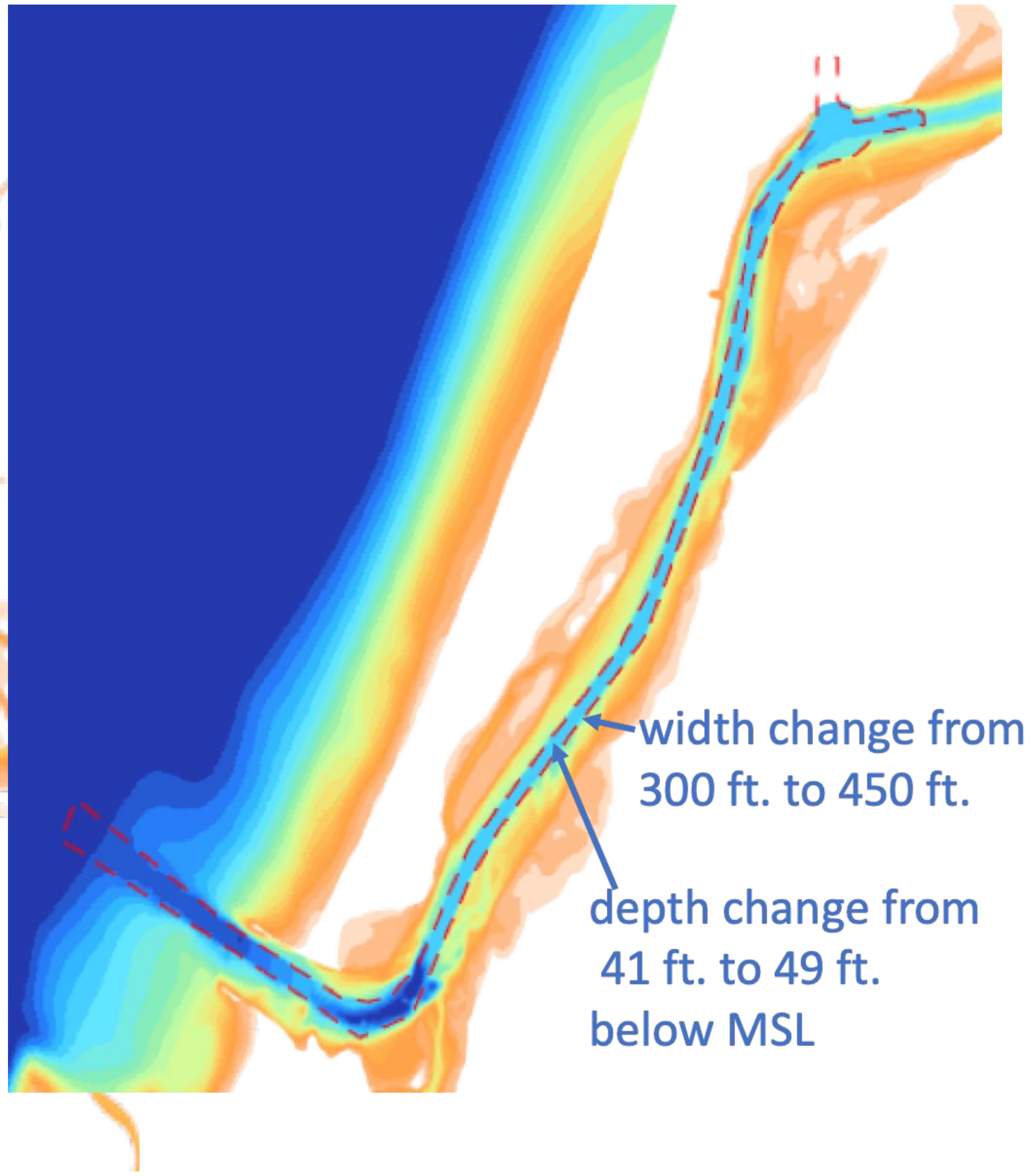
80% of present volume
114% of present area
West channel depth ~22 ft

Modern



West channel depth ~37 ft

Proposed



103% of present volume
West channel depth 41-49 ft

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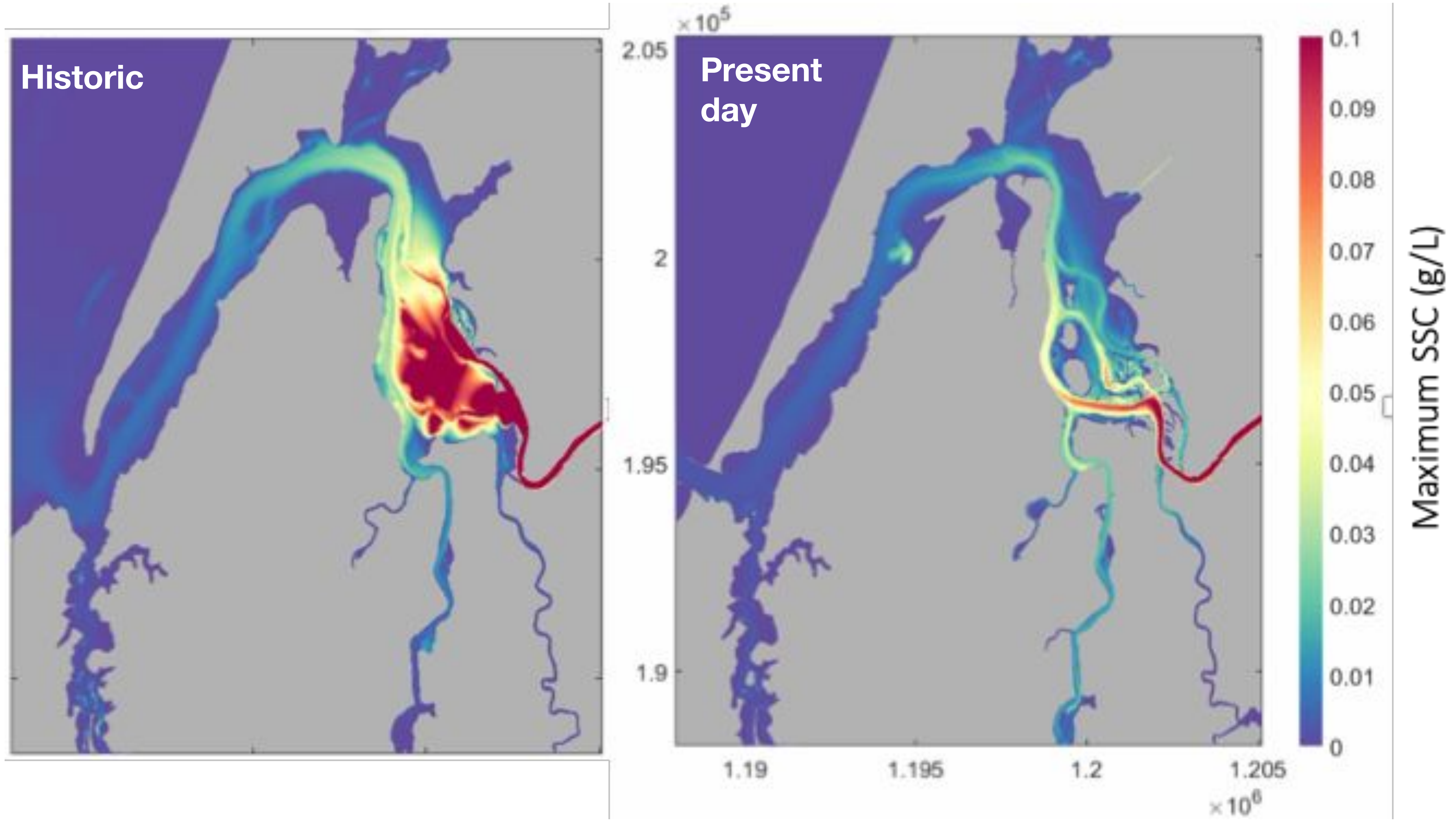
Changes in sediment transport (mid-1800s to present)

Sediment is preferentially routed into the navigation channel (historically, it was broadly distributed across the intertidal flats)



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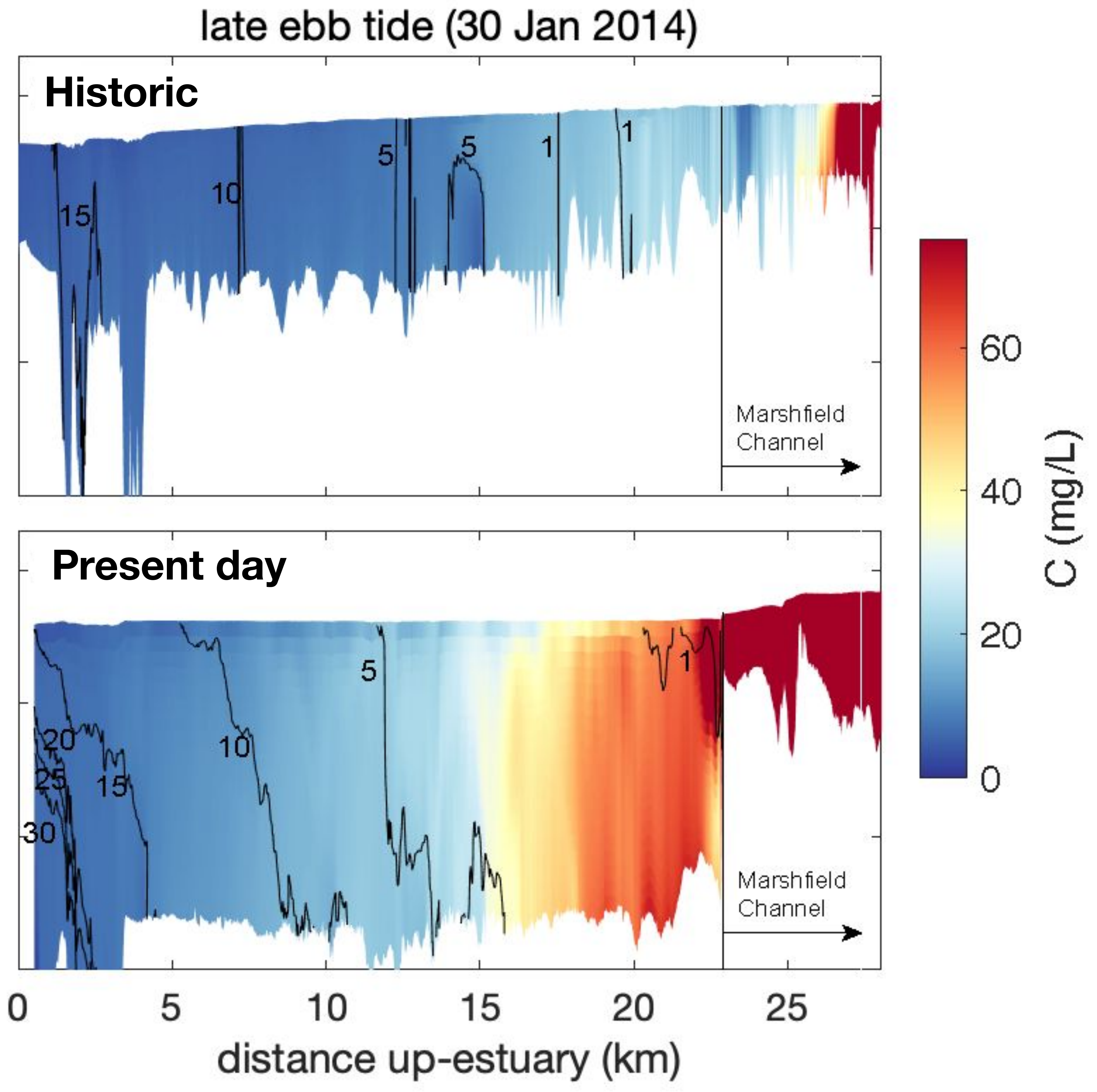
Changes in sediment transport (mid-1800s to present)

The estuary now sees greater propagation of saltwater up the Coos River, and formation of a stronger “Estuarine Turbidity Maximum” (ETM: zone of high concentration) in the primary channel.



Example of modeled sediment concentrations and salinity profiles along the navigation channel and up Marshfield Channel

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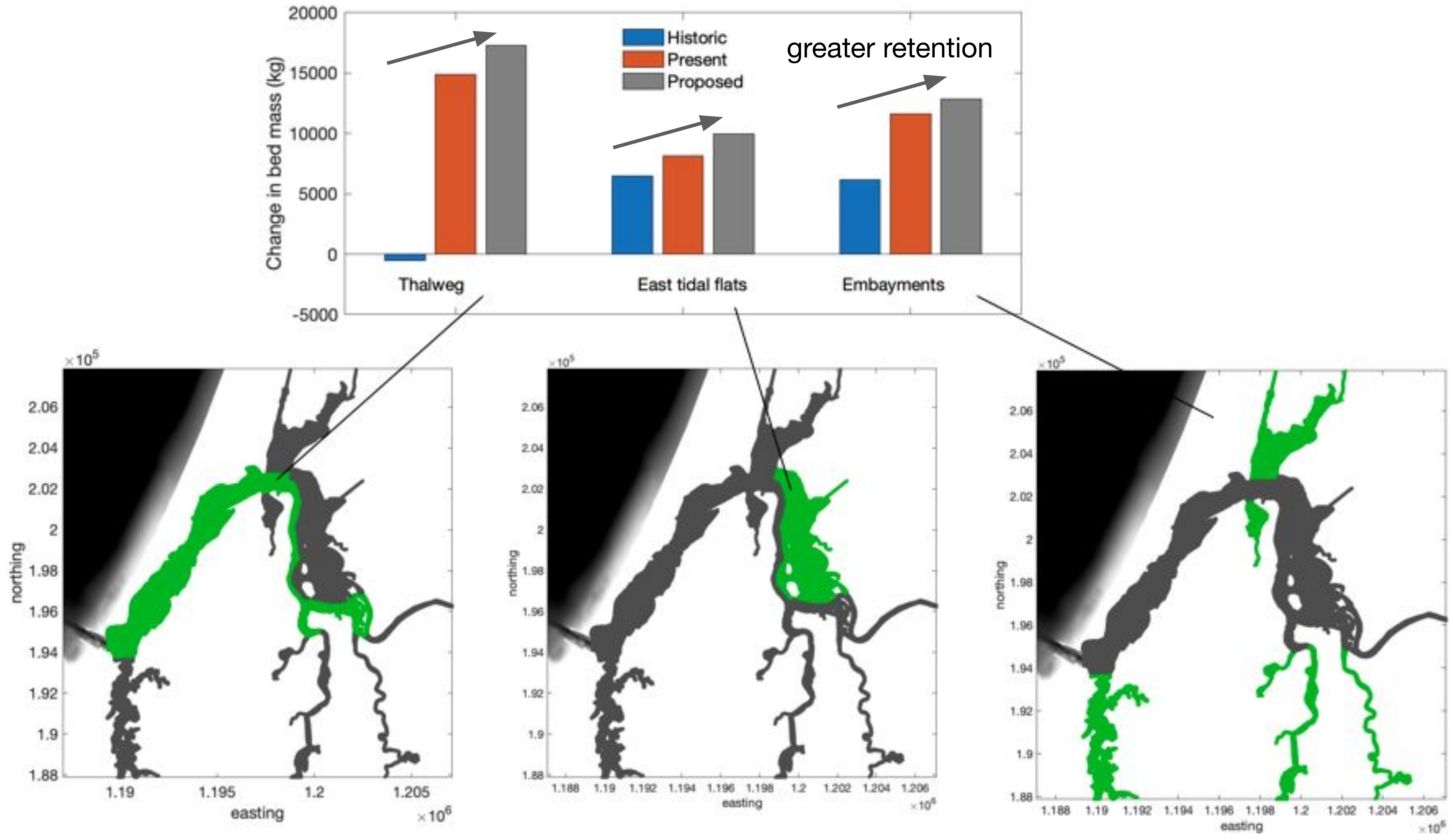
Changes in sediment transport (mid-1800s to present)

Based on modeling during high-discharge events, the estuary may retain more sediment now than in the past



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Partnership for COASTAL Watersheds

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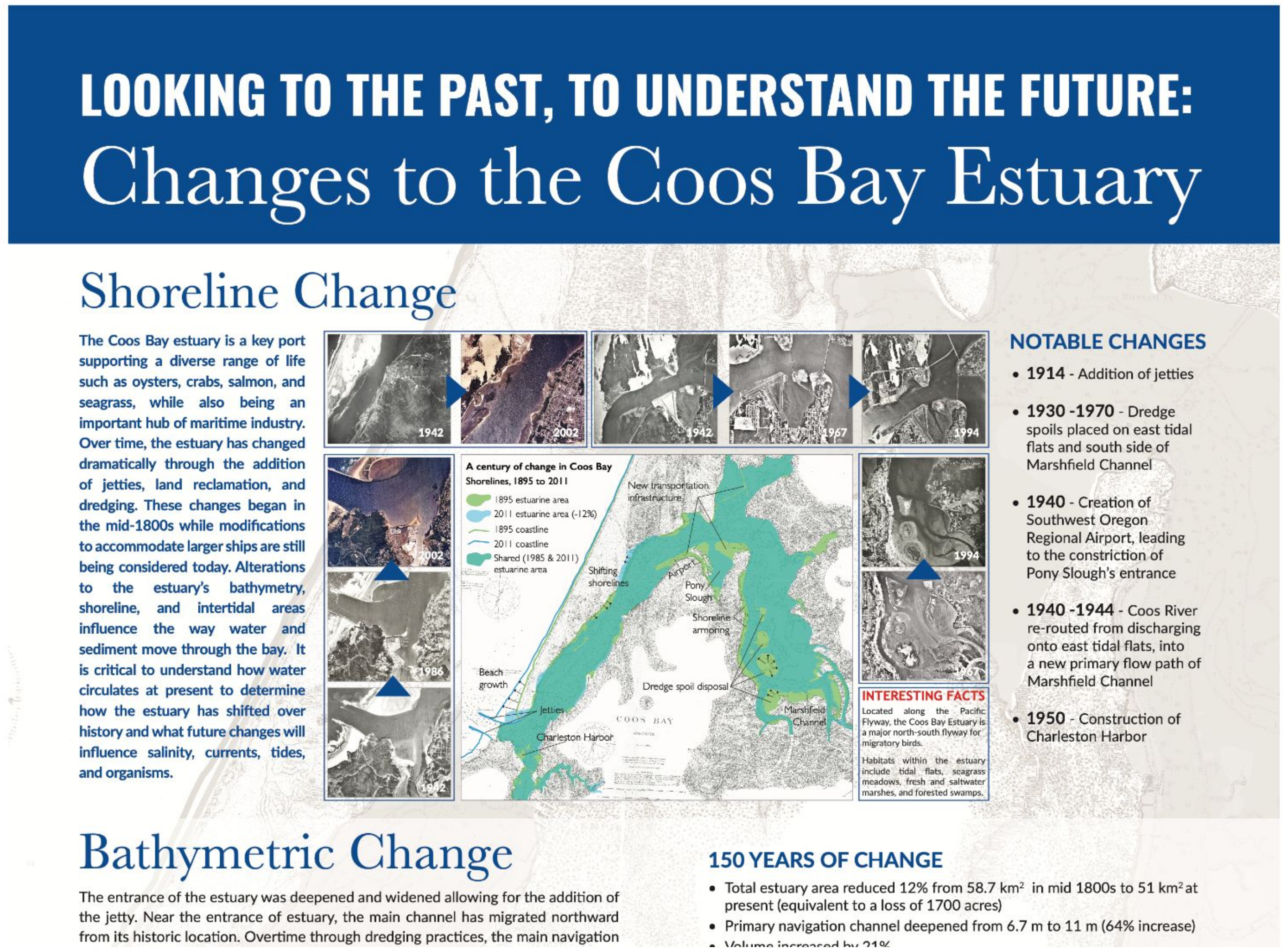
Example project deliverables

➢ GIS maps of salinity levels at select locations or averaged in time
➢ Bathymetric dataset
➢ Exhibit panel at local museum and aquarium in Charleston, OR
➢ Deposition/erosion hotspot locations in South Slough
➢ Effect of proposed dredging on estuarine dynamics
➢ Initial particle tracking simulations to simulate oyster retention
➢ and more…!



➔ Generated many new questions!

➔ How do we deliver on stakeholder needs that came up during project?

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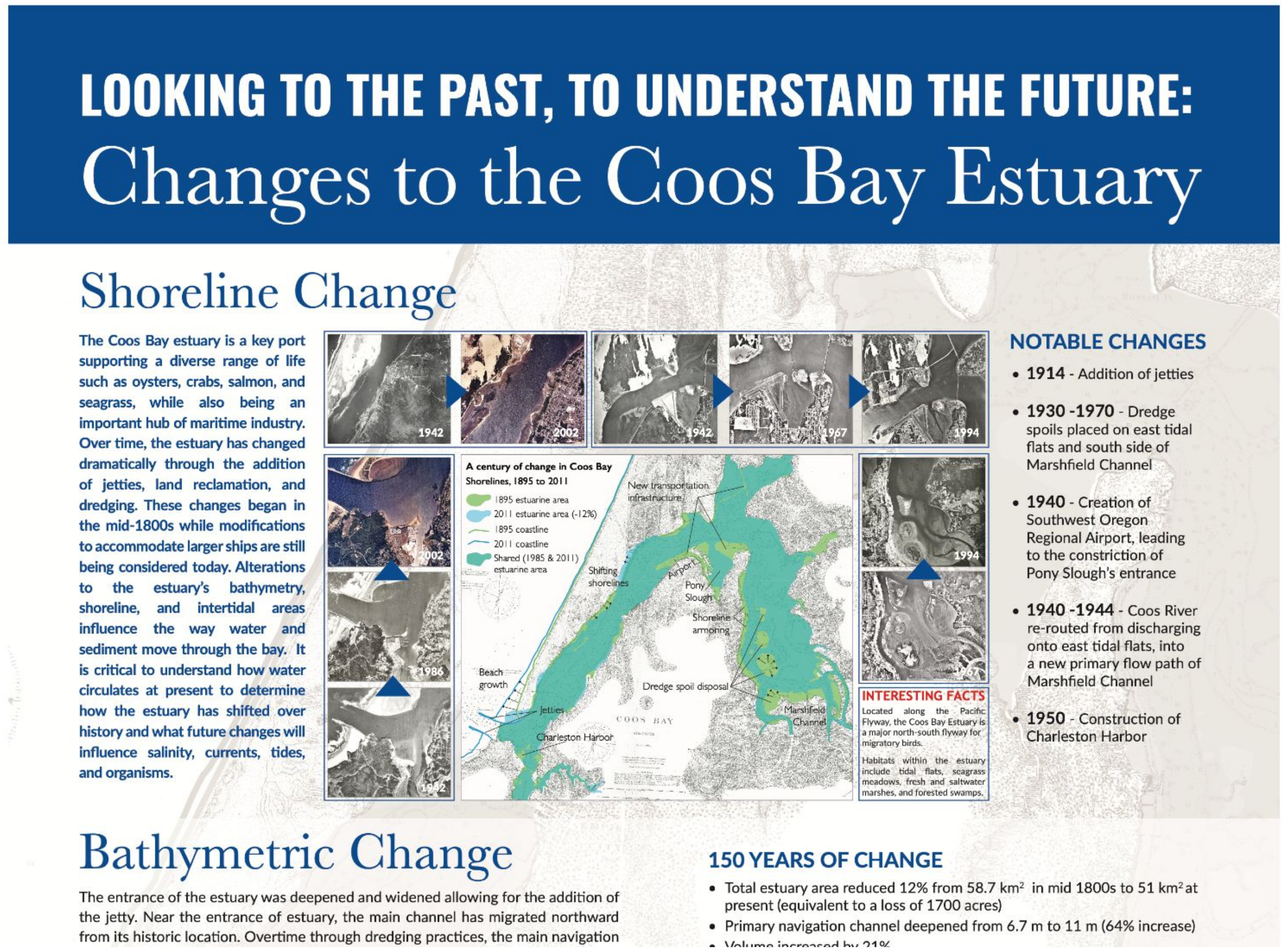

➔ **Generated many new questions!**

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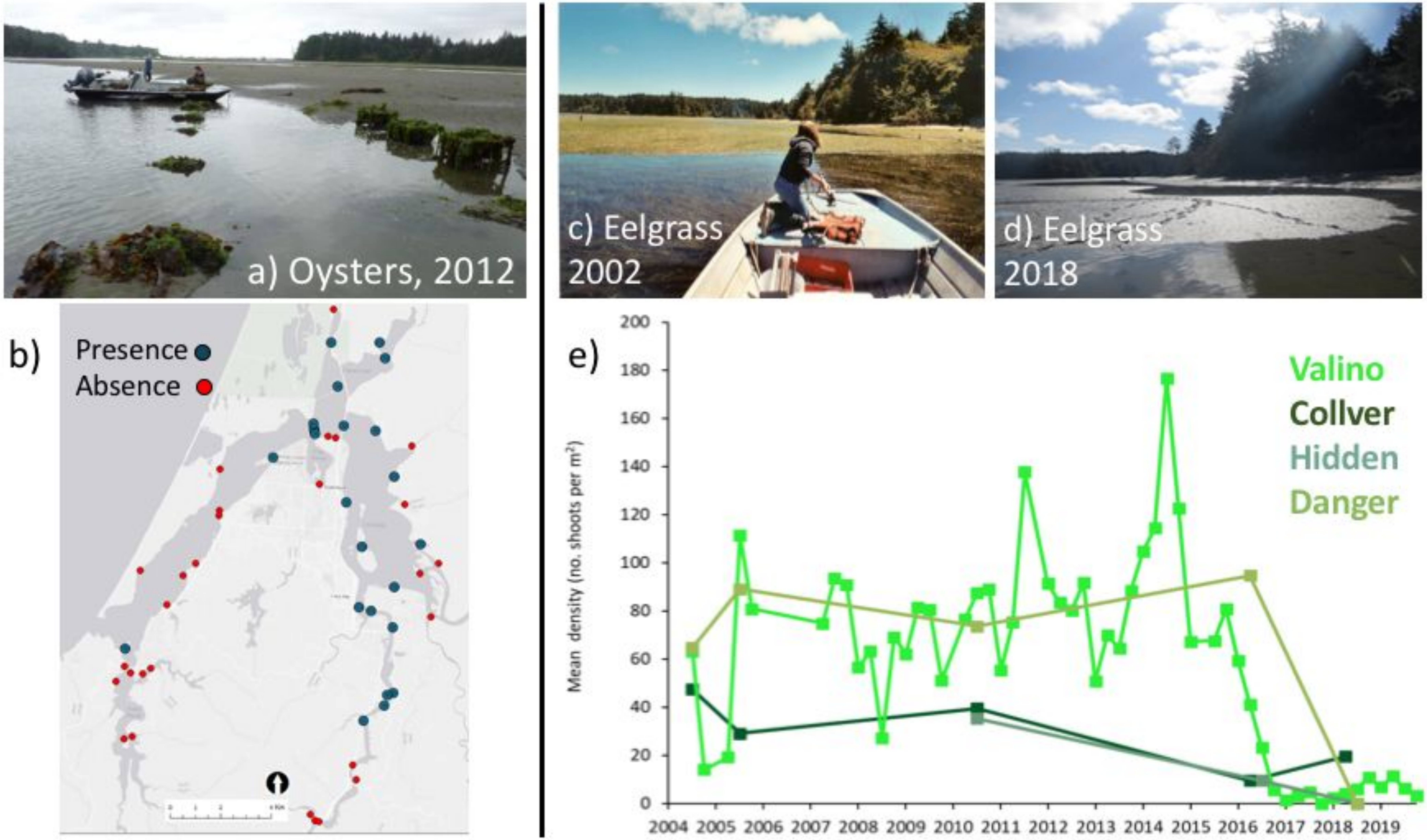
New project: Buried or fried? Understanding sedimentation and temperature effects on native species restoration in the South Slough National Estuarine Research Reserve and the Coos estuary

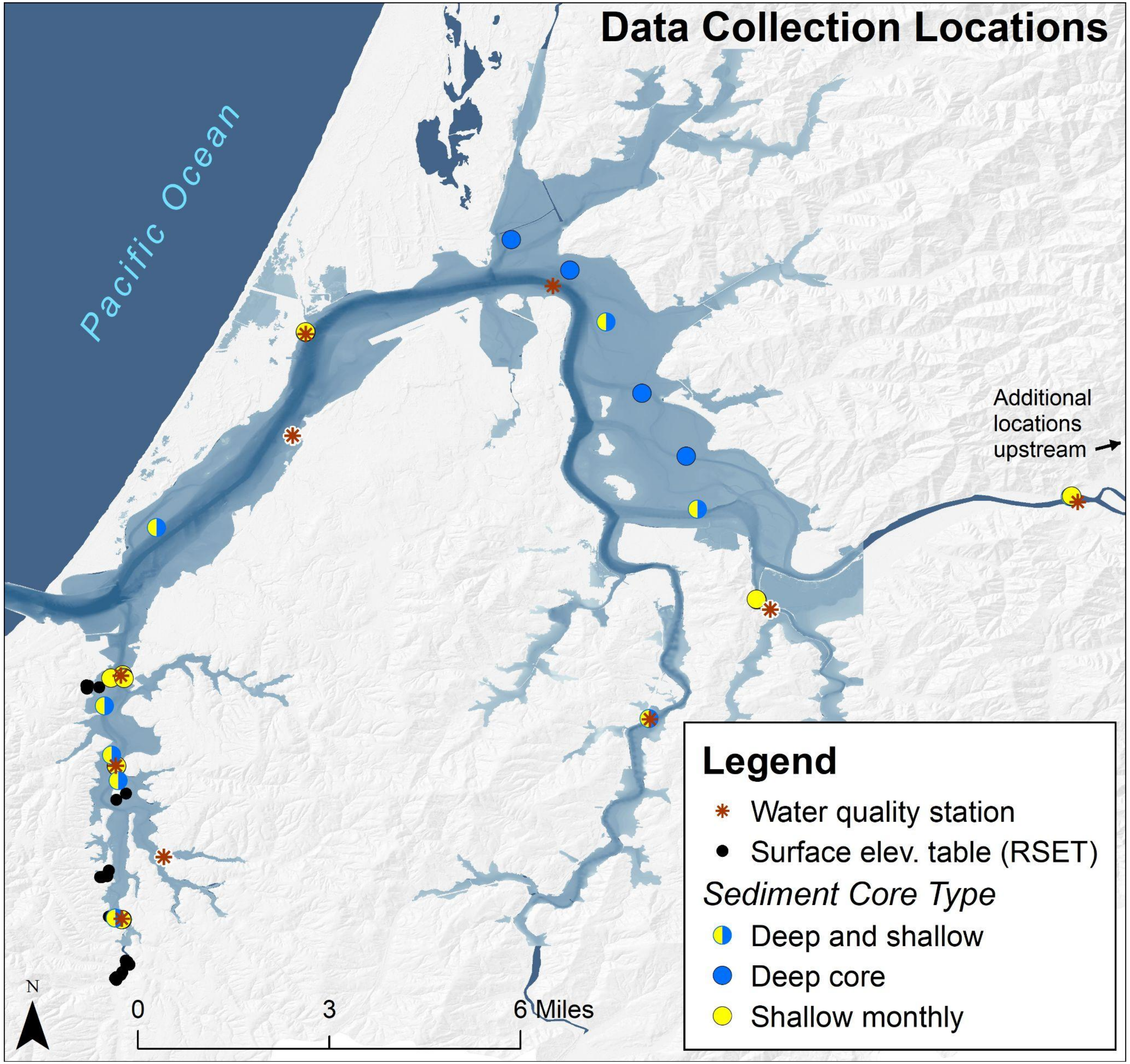


What are we doing?

- SWMP time-series analysis
- Adding water temperature as variable in hydrodynamic model
- Collecting new sediment cores near/around existing eelgrass and oyster beds
- Learning from our past projects (and mistakes!)

Identified end-users:

- Charleston Marine Life Center
- Coos County
- South Slough NERR
- CTCLUSI & Coquille Tribes
- OR Dept Fish & Wildlife
- OR Dept State Lands



Summary and lessons learned

- Early and often end-user engagement pays off
- Building basic science tools that are relevant to applied science questions pays off
- But many difficulties remain:
  - Science translation: mismatch between scientific analyses and outputs compared to applied questions
  - Overpromising: focus on simple, realistic goals and deliverables

Please get in touch!

Dave Sutherland, Molly Keogh, Maria Jose Marin Jarrin (UO)
Emily Eidam, Tyler Souza (UNC-CH)
Dave Ralston (WHOI)
Jenni Schmitt, Ali Helms, Keary Howley (CTCLUSI, SSNERR)

Dave: dsuth@uoregon.edu
Emily: efe@unc.edu
Jenni: jenni.schmitt@dsl.state.or.us

Project page: http://www.nerrssciencecollaborative.org/project/Sutherland16

Q&A

Have a question?

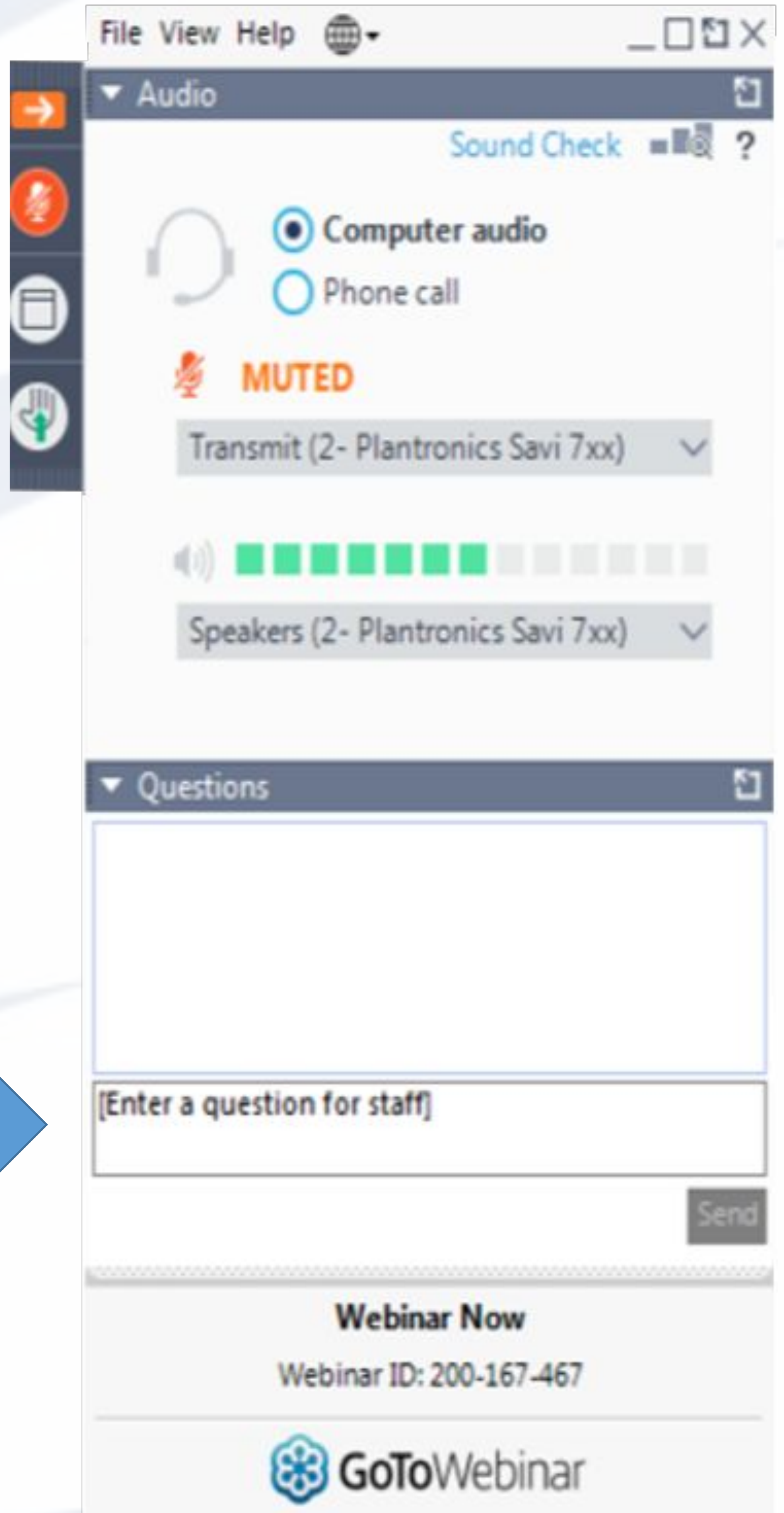
Use the “Questions” function to pose questions throughout the webinar.

David Sutherland
University of Oregon

Emily Eidam
University of North Carolina

Jenni Schmitt
South Slough NERR, OR

David Ralston
Woods Hole Oceanographic Institution



Q&A

For the upstream of Coos River inside the model domain, what is the source for the bathymetry?

- **A**: Jet skis could get fairly far up into the channel. We tried to extend the model domain all the way to the head of the tide. We set a constant depth and didn't try to actually mimic what the real bathymetry or topography would be; this is often something you have to do with a model like this.

Was the salinity related to sediment dynamics?

- **A**: That's a very important aspect of estuarine dynamics and estuarine sediment transport - how salinity affects circulation patterns, stratification, and how that affects turbulence and resuspension of sediment.

I know this is beyond the scope of the project, but I am curious if you had a chance to look into how historical changes in the estuary have affected the hydrodynamics (thinking about the plume as always) and sediment dynamics of the coastal ocean in the region.

- **A**: We didn't try to look outside the estuary mouth, a bit by design. We weren't trying to simulate what was happening in the coastal ocean. What we did look at were changes in hydrodynamics between the historic and present-day case. You can learn more about that in Emily's paper here: https://nerrssciencecollaborative.org/resource/impacts-150-years-shoreline-and-bathymetric-change-coos-estuary-oregon-usa

One difference between the historic and present conditions is the amount of diking that has happened in the Coos River. How does that influence sediment flow?

- **A**: Presumably that would impose some limitation on how much sediment was getting into the bay because some of the sediment might be trapped behind the dikes. If you assume that the majority source of sediment is being flushed from steep hill slopes further up-river, there could be a secondary effect of how those dikes impact circulation within the estuary. There have been other studies related to that where you see local intensification of circulation near the dikes and you can get sediment piling up on the seaward side of those dikes. You could collect sediment cores there to see how it's changed.

Were you able to model erosion of mud flats?

- **A**: To some extent, yes. We put a couple different sediment classes in the model. The one limitation of the model is it's not really resolving processes happening when the water depth is less than 40 cm. We didn't necessarily model every process that's happening, though we have a good sense for the changes in bathymetry and how the river and estuary are delivering sediment to the tidal flats.

What kind of expertise does it take to run this model?

- **A**: The model is open source so getting the code is easy, but the biggest hurdle is getting the computational power to run it. We ran it on University of Oregon's cluster supercomputer. It also takes some knowledge of estuarine dynamics to understand the model and run it properly.

Q&A

As most of our estuaries are undergoing nav channel deepening/widening required to support the local ports, what is your takeaway for impacts and how to avoid/minimize them?

- **A**: The impacts we see are common to a lot of estuaries where you're creating accommodation space for the deposition of sediment, which then necessitates more maintenance dredging. We've certainly seen that in the eastern part of the channel. On the western channel, when the estuary gets deepened it causes a bit of a reduction in tidal current. On the one hand, you might be able to trap sediment more easily, but net migration of sediment there might be more seaward.

  In most of these estuaries, if they're building something new on one part of the estuary, it will probably require a restoration or mitigation effort in some other part of the estuary.

Can you comment on the expected difference in sediment dynamics that may occur in response to: (1) continued maintenance dredging, versus (2) major deepening and widening of the primary tidal channel?

- **A**: That's a fairly complicated thing to try and predict. They would probably need to do continued maintenance dredging just because the estuary is going to continue trying to fill in those channels.

  For deepening and widening, there's evidence to suggest you might get more a bit more sediment accumulation but there are a lot of interrelated hydrodynamic effects occurring too.

When you say that thalweg becomes a sink for sediments, are all parts of the channel equally depositional in the model results?

- **A**: No - the thalweg accumulates little mud within 0-10 km of the estuary entrance (10 km corresponds roughly to the south end of the airport). From 10 km to the intersection with Marshfield Channel (the approximate limit of dredging in the main channel), there is a gradual increase in mud that is deposited. This is likely related to the presence of an ETM in this region, and the settling of fine-grained sediment routed down Marshfield Channel.

From the sediment dynamics model results, it seems indicating the estuary more effectively flushes the sediment concentrations out of the system. Is my understanding correct?

- **A**: In the lower parts of the estuary, the sediment is fairly well-flushed from the system. In the upper reaches (small side embayments and broad intertidal flats), there is likely more trapping in the modern case because of changes in sediment routing and changes in tidal asymmetry (e.g., small embayments are more flood-dominant now, and the intertidal flats now receive sediment sourced from the ETM located adjacent to the north end of the flats).

Comments

- *The channel went through a series of deepenings. Would be nice to apply the model in progression to see increment effects.*
- *Super interesting presentation--thank you so much!*
- *Excellent presentation!*
- *David, thank you for your presentation. Glad to see your model results and enjoyed the presentation.*
- *Excellent presentation. Thank you all.*