

Salinity in the Willamette River? Seriously?!?

Estuarine tales of rising seas, seismic subsidence and uncertainty

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Context

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- The CR estuary and plume are highly variable in response to river flow, tides and (for the plume) coastal winds
- This variability deeply influences ecosystem function, and is frequently accounted for in the region's policy and management
- Less well understood are the effects of potentially transformative long-term changes

Today's focus

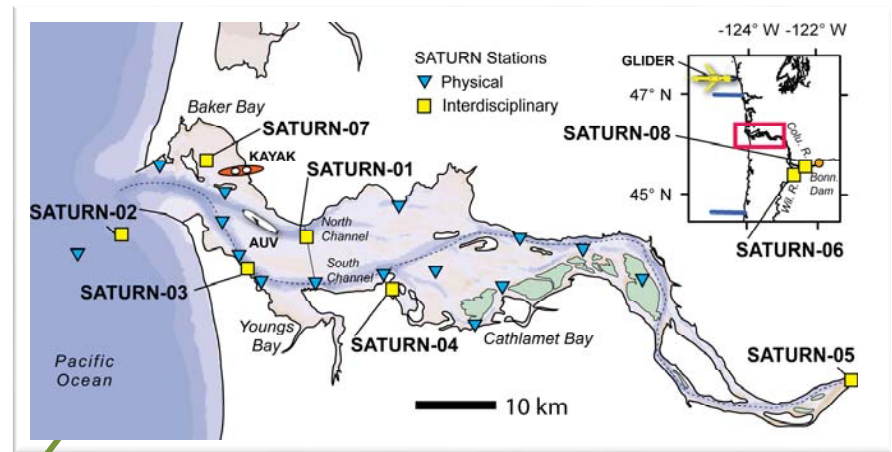
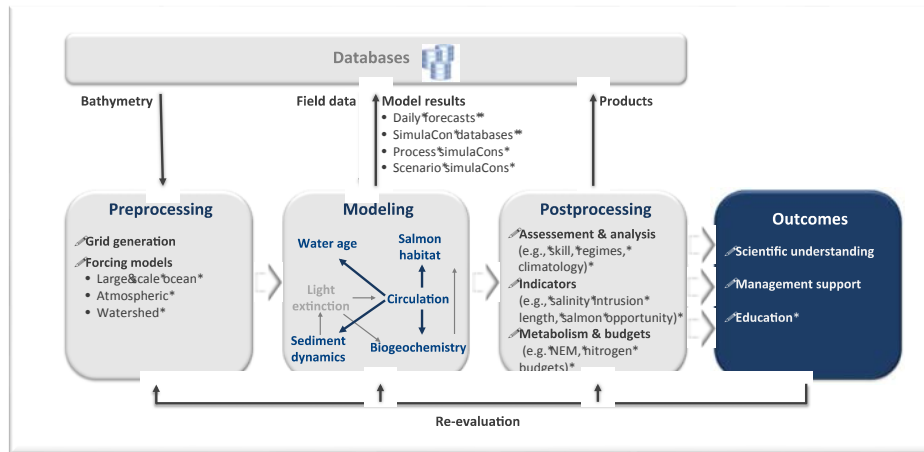
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- How significant could impacts of sea level rise (SLR) be?
 - Are there threshold behaviors of note?
- As scaled by SLR, how significant could impacts of a CSZ event's subsidence be?

Methods

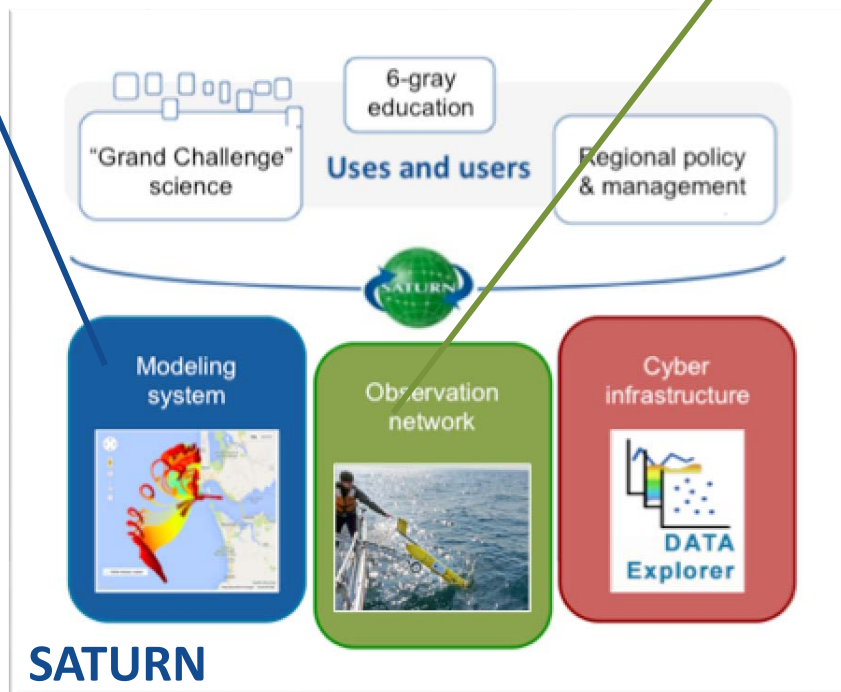
Baptista et al. 2015, *FES*

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Modeling system: Virtual Columbia River

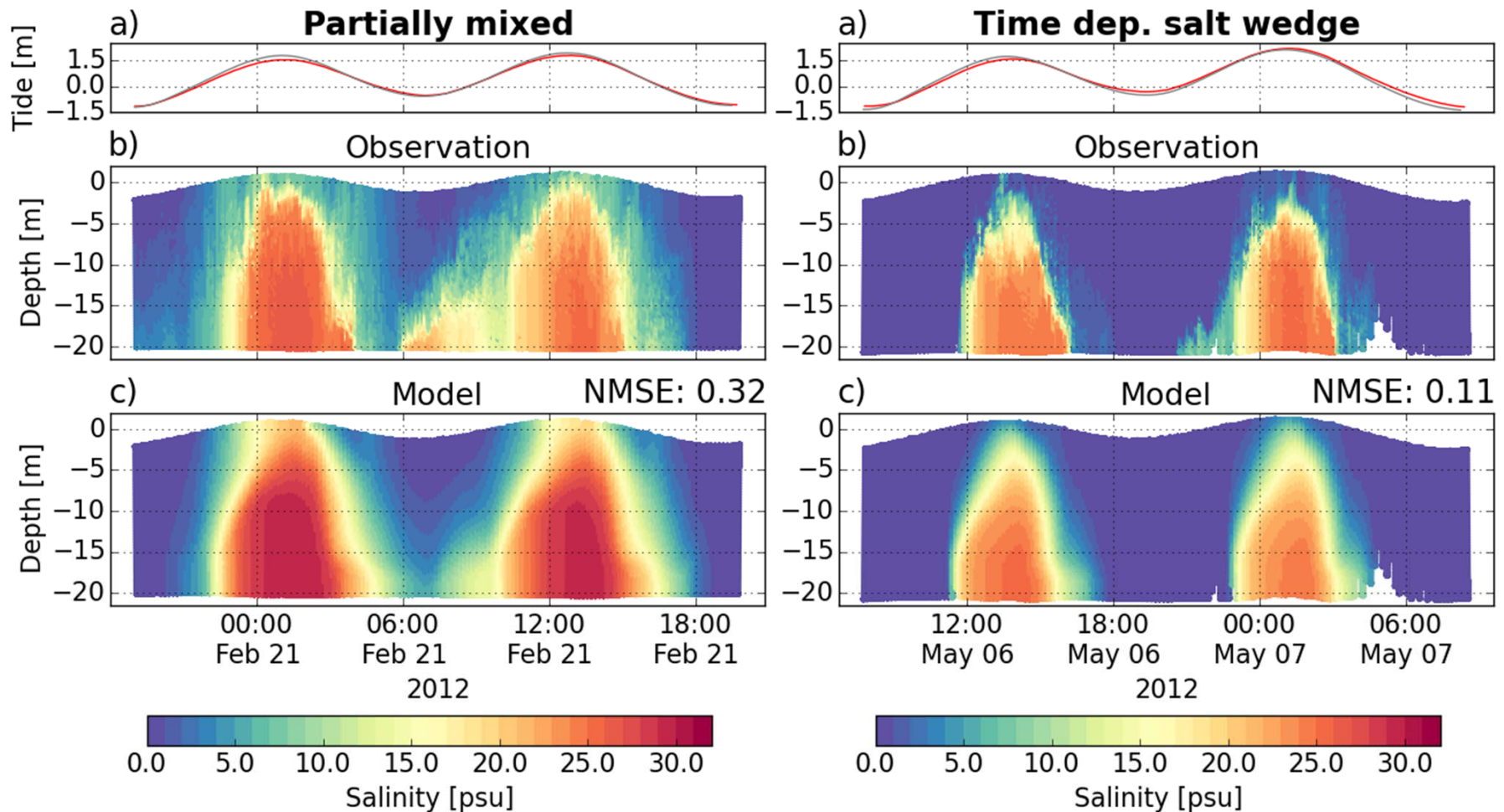
Observation network



To address these questions, we are using the Virtual Columbia River, which is a modeling system built for collaborative science and management

Methods

The circulation model of the Virtual Columbia River has been skill assessed against an extensive set of contemporary observations

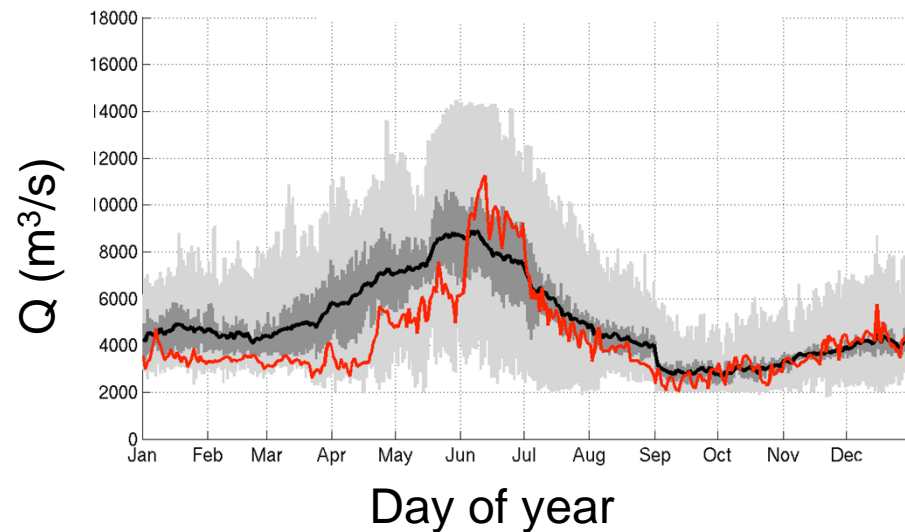


Methods

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Using year-long simulations for “2010” as reference, we contrasted contemporary conditions with:

- multiple scenarios of SLR
- a single scenario of CSZ subsidence

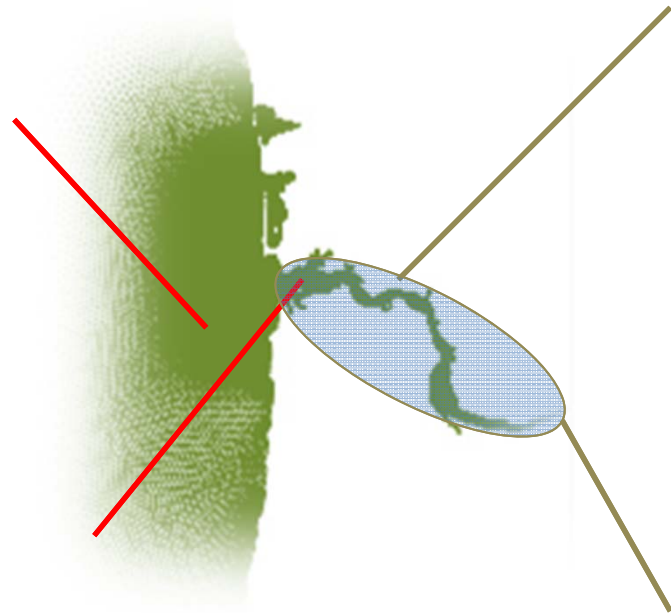


Contrasts were based on estuarine and plume metrics commonly used to support regional decisions

Physically-based metrics ...

Plume volume (PV)

Relevance:
Miller et al. 2013,
2014



Salmon Habitat (SH)

Relevance:
Bottom et al. 2005,
others

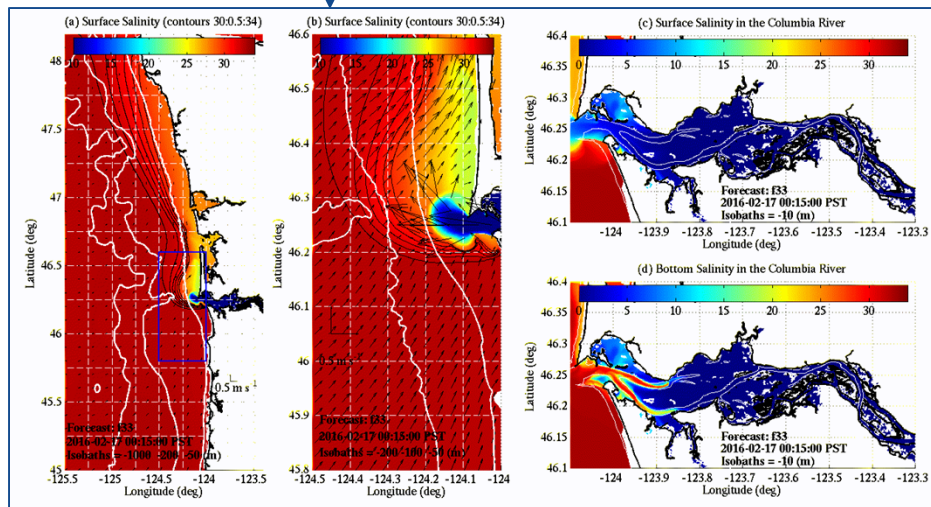
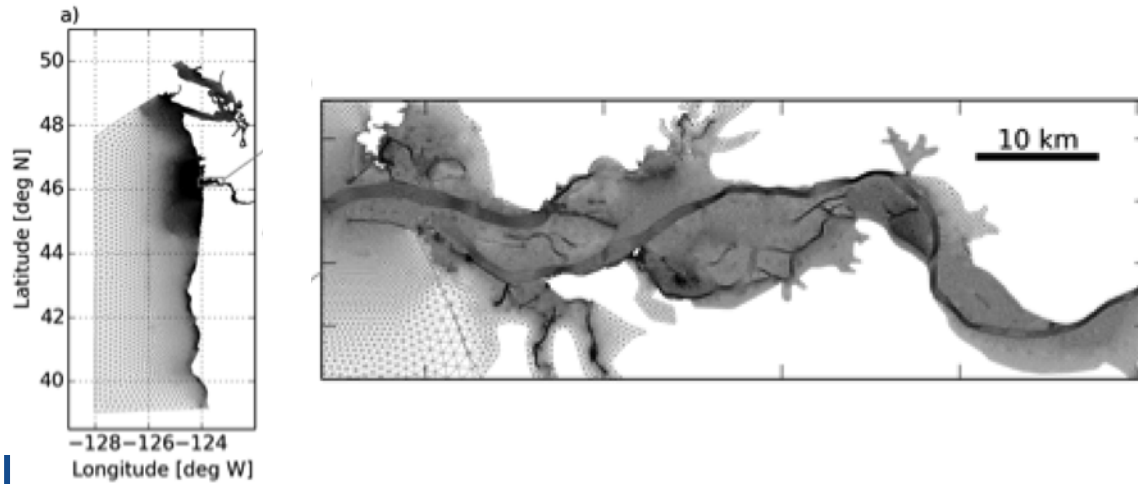
Salinity Intrusion Length (SIL)

Relevance: Surrogate for estuarine hypoxia and acidification, and ocean influences in general

Shallow Water Habitat (SWH)

Relevance: USACE customary metric

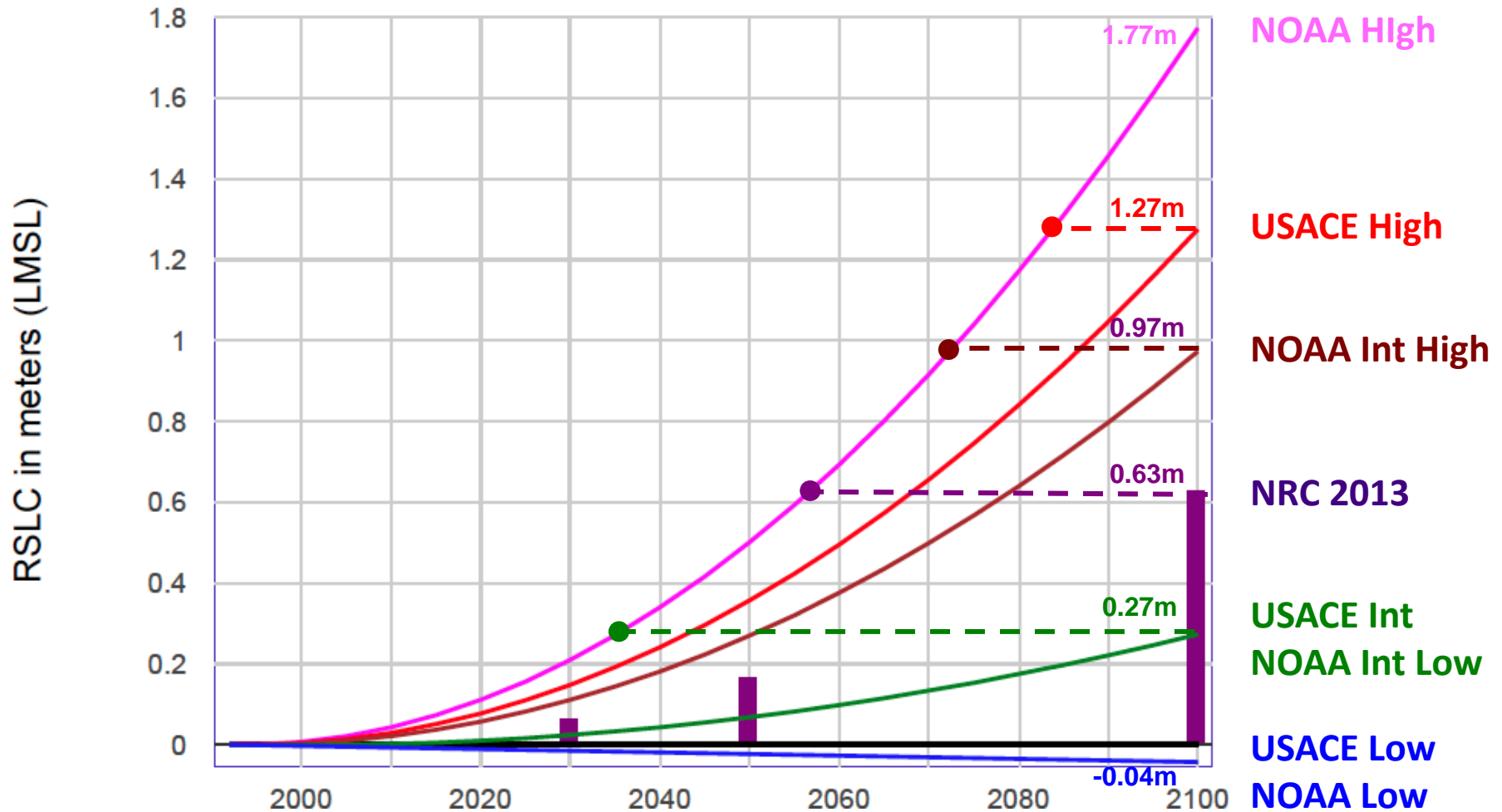
... obtained by “filtering” circulation fields



Filters



Sea level rise scenarios

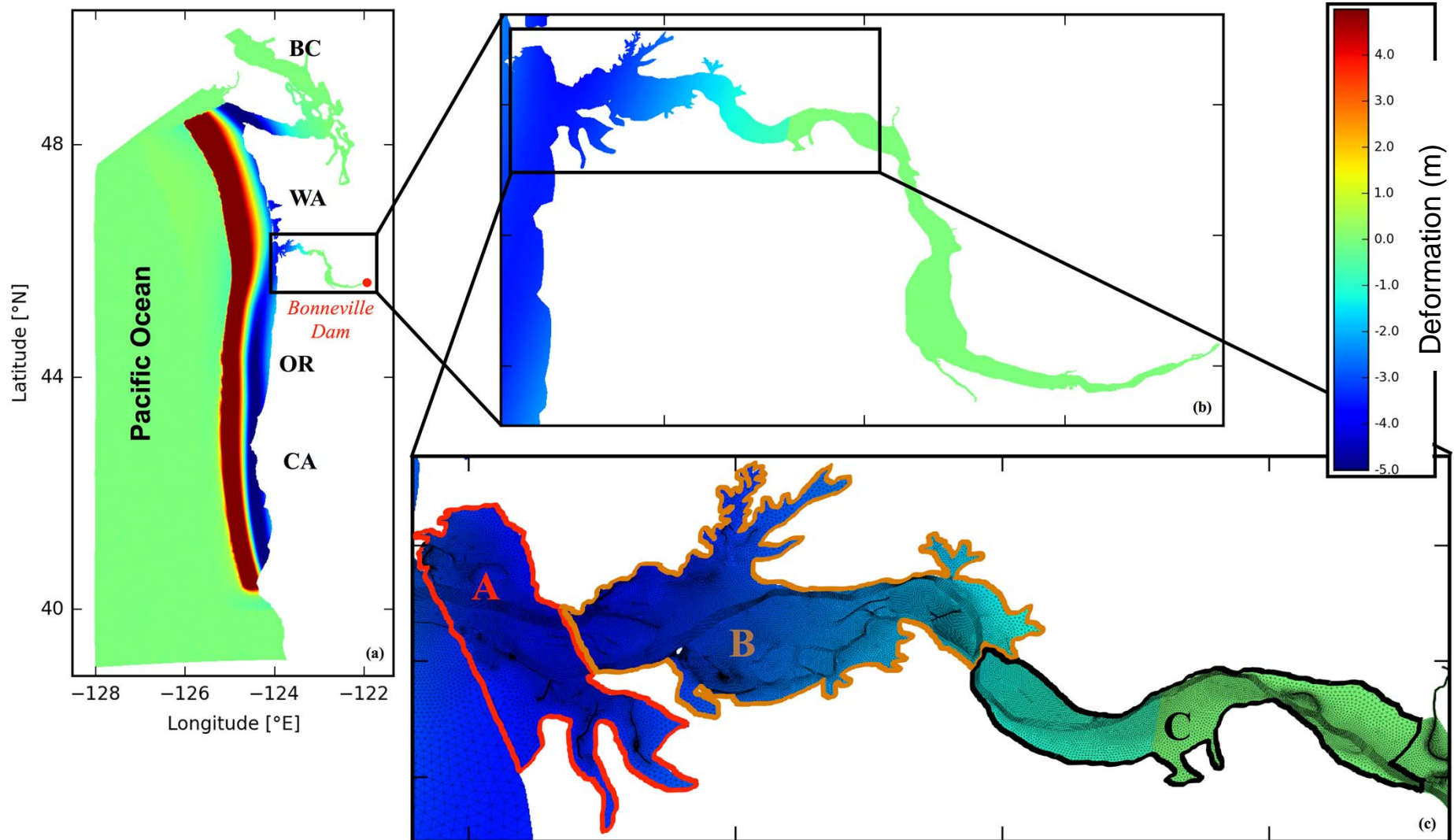


Scenario generating tool courtesy USACE

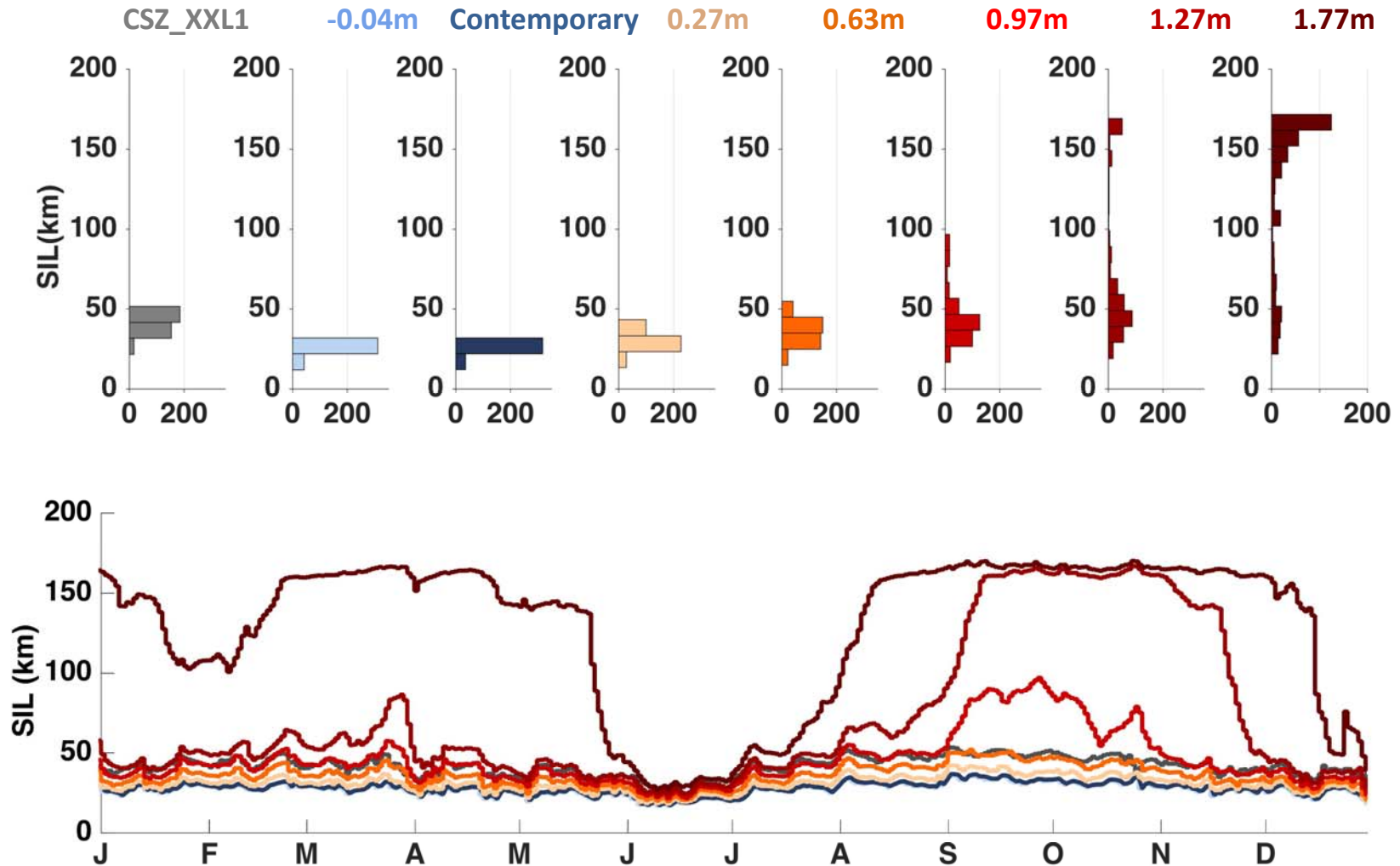


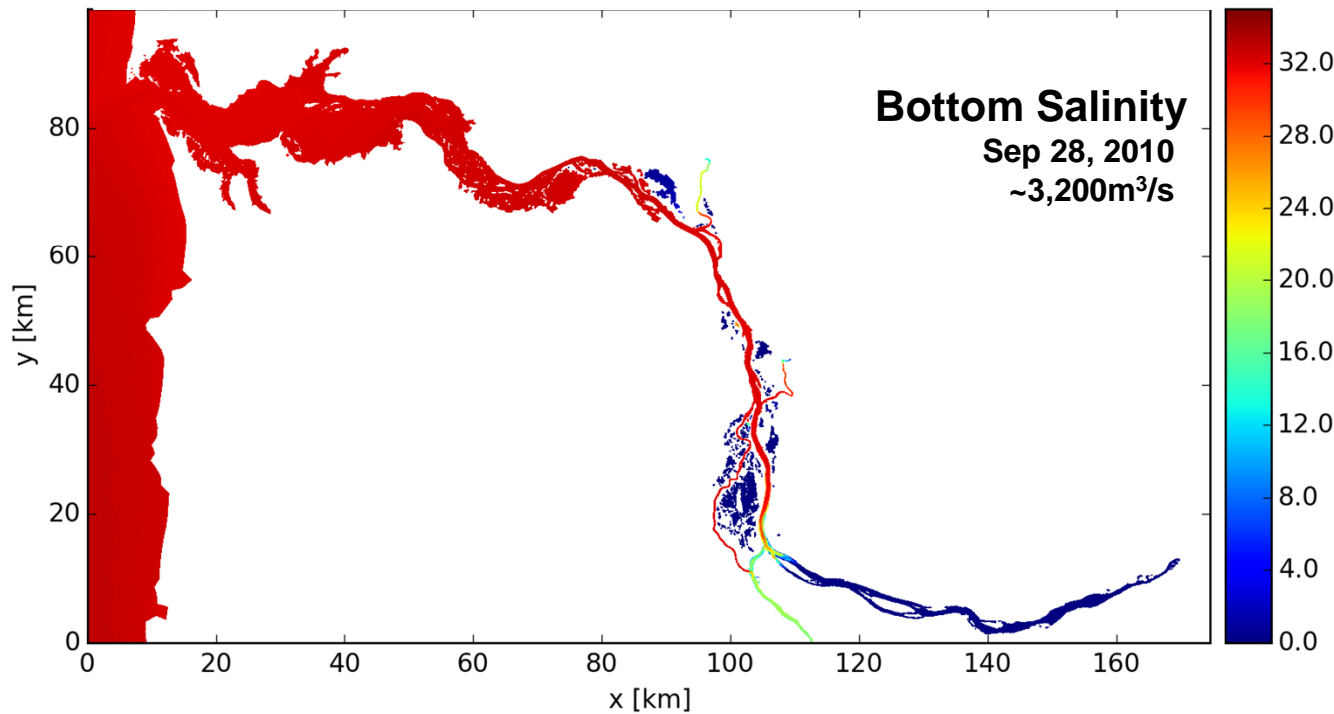
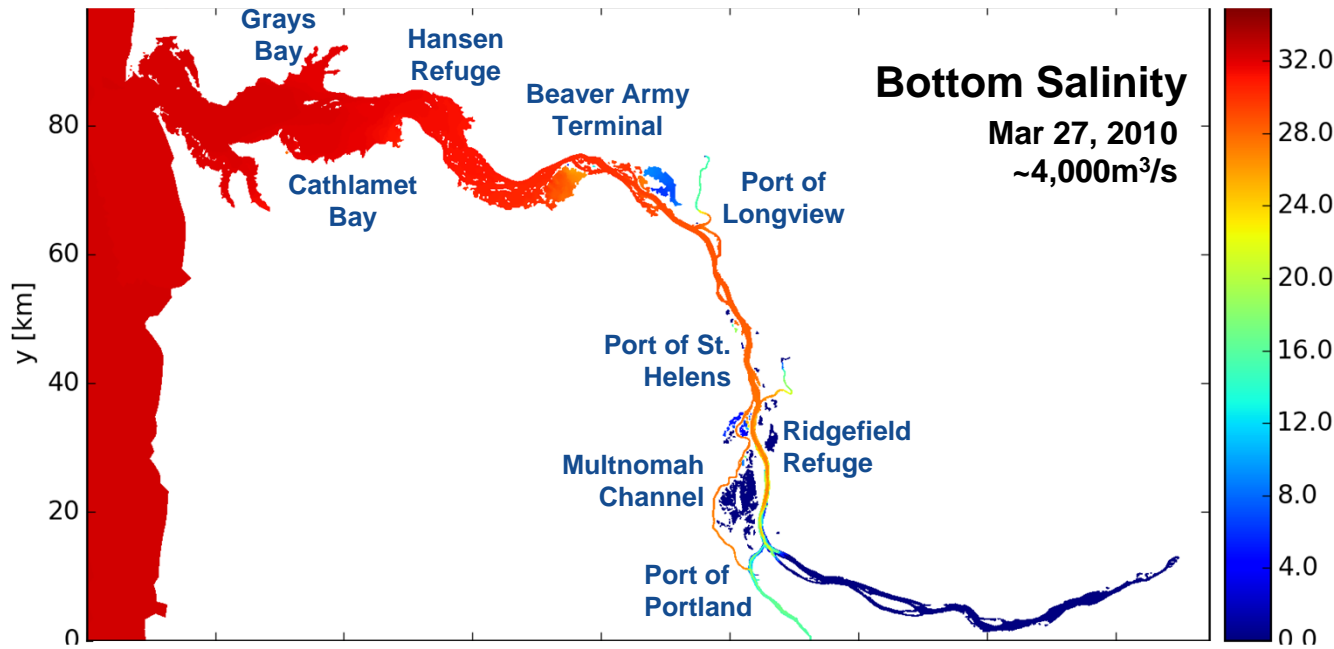
Cascadia Subduction Zone scenario

(CSZ_XXL1)



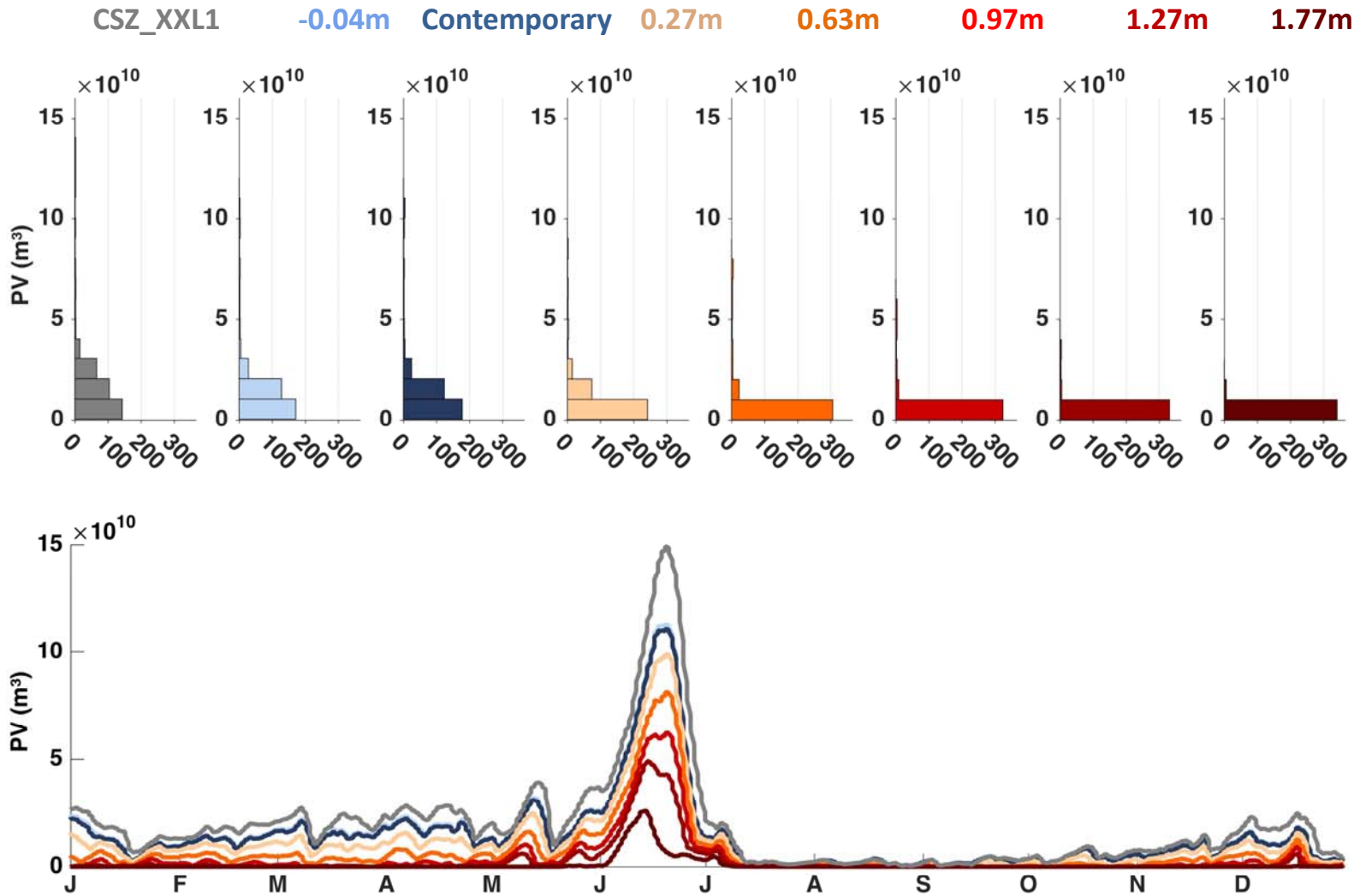
Salinity Intrusion Length (SIL)



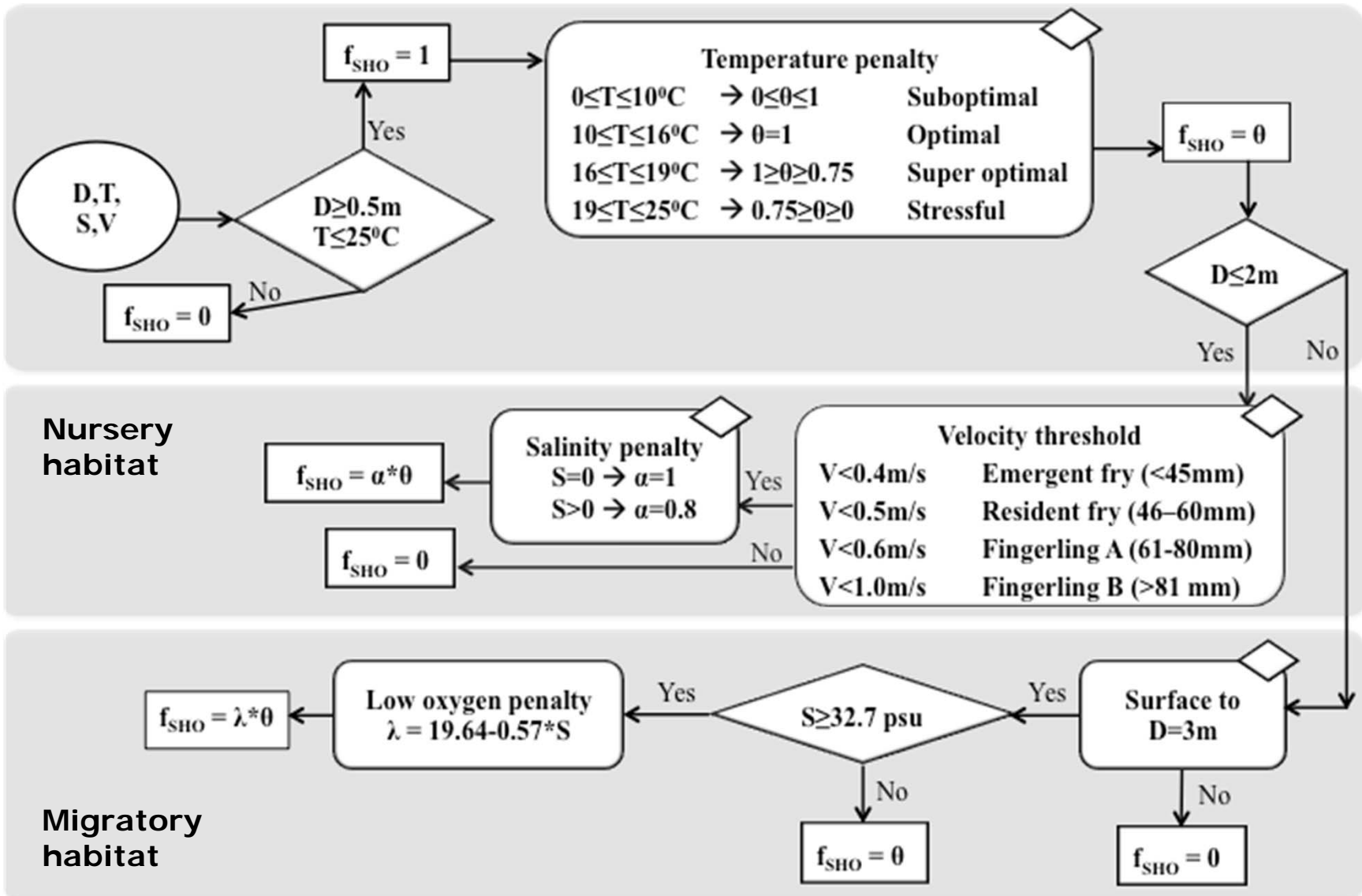


- Current condition
- CSZ-XXL1
- Current condition
- SLR -0.04 m
- SLR 0.27 m
- SLR 0.63 m
- SLR 0.97 m
- SLR 1.27 m
- SLR 1.77 m

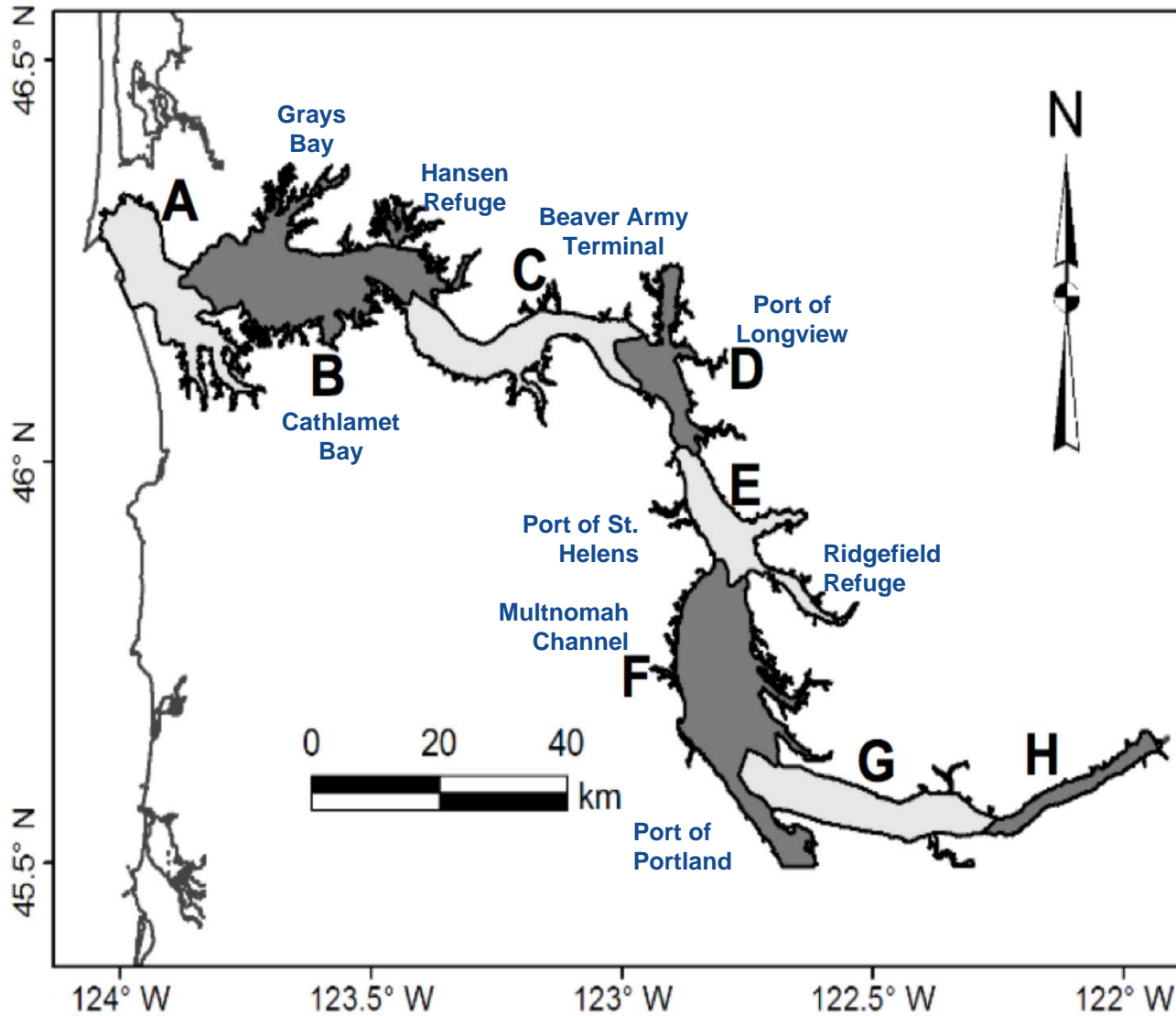
Plume volume (m³)



Juvenile Chinook salmon habitat (SH)

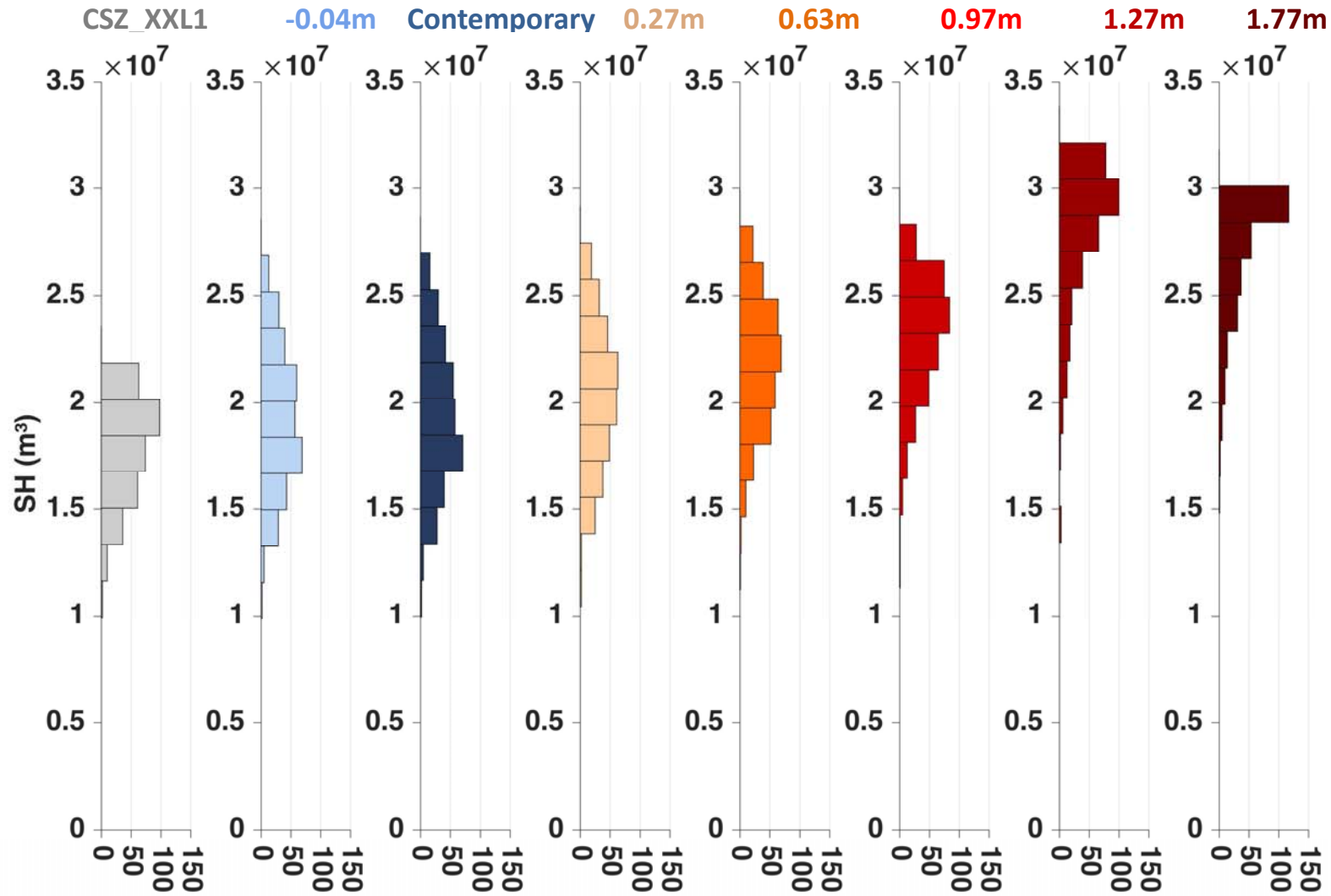
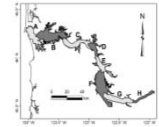


Reaches

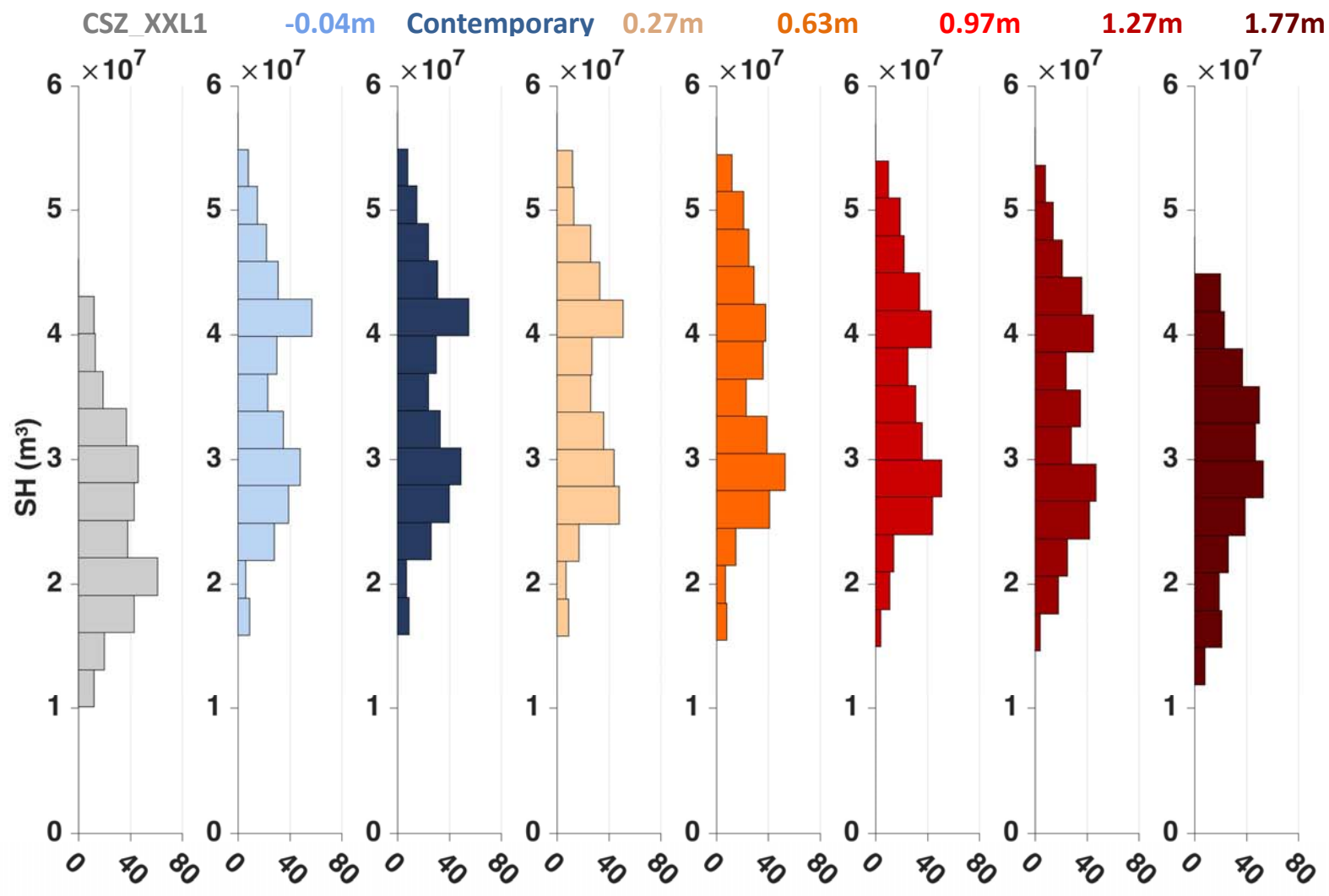
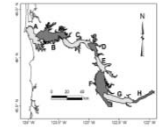


Based on Simenstad et al. 2011

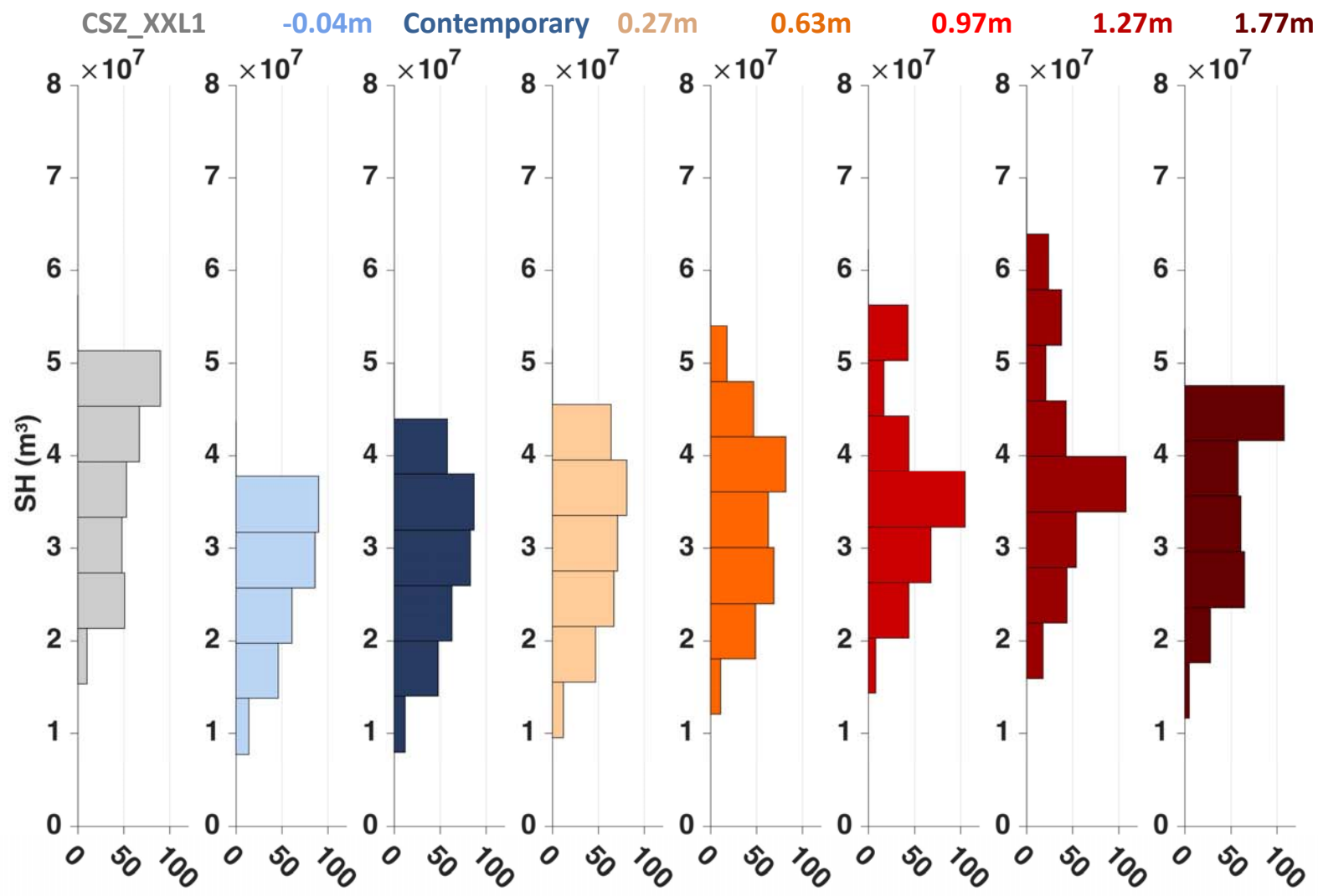
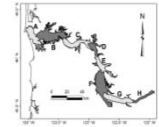
SH (m³) - Reach A



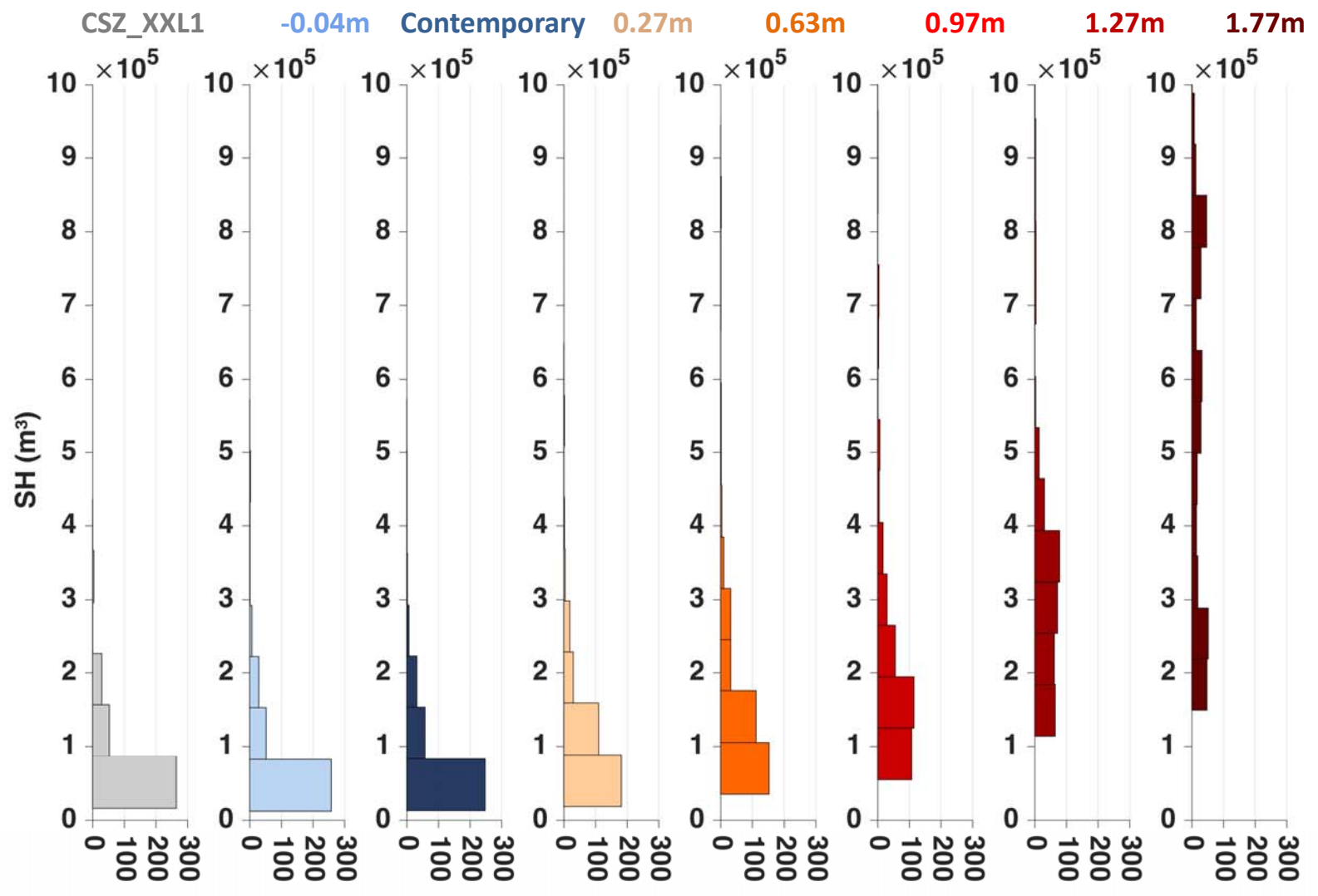
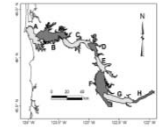
SH (m³) - Reach B



SH (m³) - Reach C



SH (m³) – Reach D



Summary and conclusions

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- Both CSZ and (large scenarios of) SLR lead to substantial changes in the estuary.
- Once certain SLR thresholds (~1m, but regime dependent) are crossed, a vastly transformed estuary emerges, with salinity propagating upstream to and beyond Portland, and the plume “vanishing” as a major oceanographic feature
- If these changes were confirmed, the implications on the ecosystem and salmon populations would be major—with both “winners” and “losers”, and with many regional strategies (e.g., FCRPS operation) needing to be rethought

Summary and conclusions

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- However, there are uncertainties in (especially) the definition and (also) the simulation of scenarios of change
- It is thus imperative to carefully review results—both scientifically and through the scrutiny of regional stakeholders—prior to them being of use for management purposes
- This presentation is part of an evolving review process that is meant to be extensive and broadly encompassing