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Climate-linked Mechanisms Driving Spatial and Temporal Variation in Eelgrass (*Zostera marina* L.) Growth and Assemblage Structure in Pacific Northwest Estuaries

RONALD M. THOM, SUSAN L. SOUTHARD, AND AMY B. BORDE

Marine Sciences Laboratory
Pacific Northwest National Laboratory
Sequim, WA

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Main Messages

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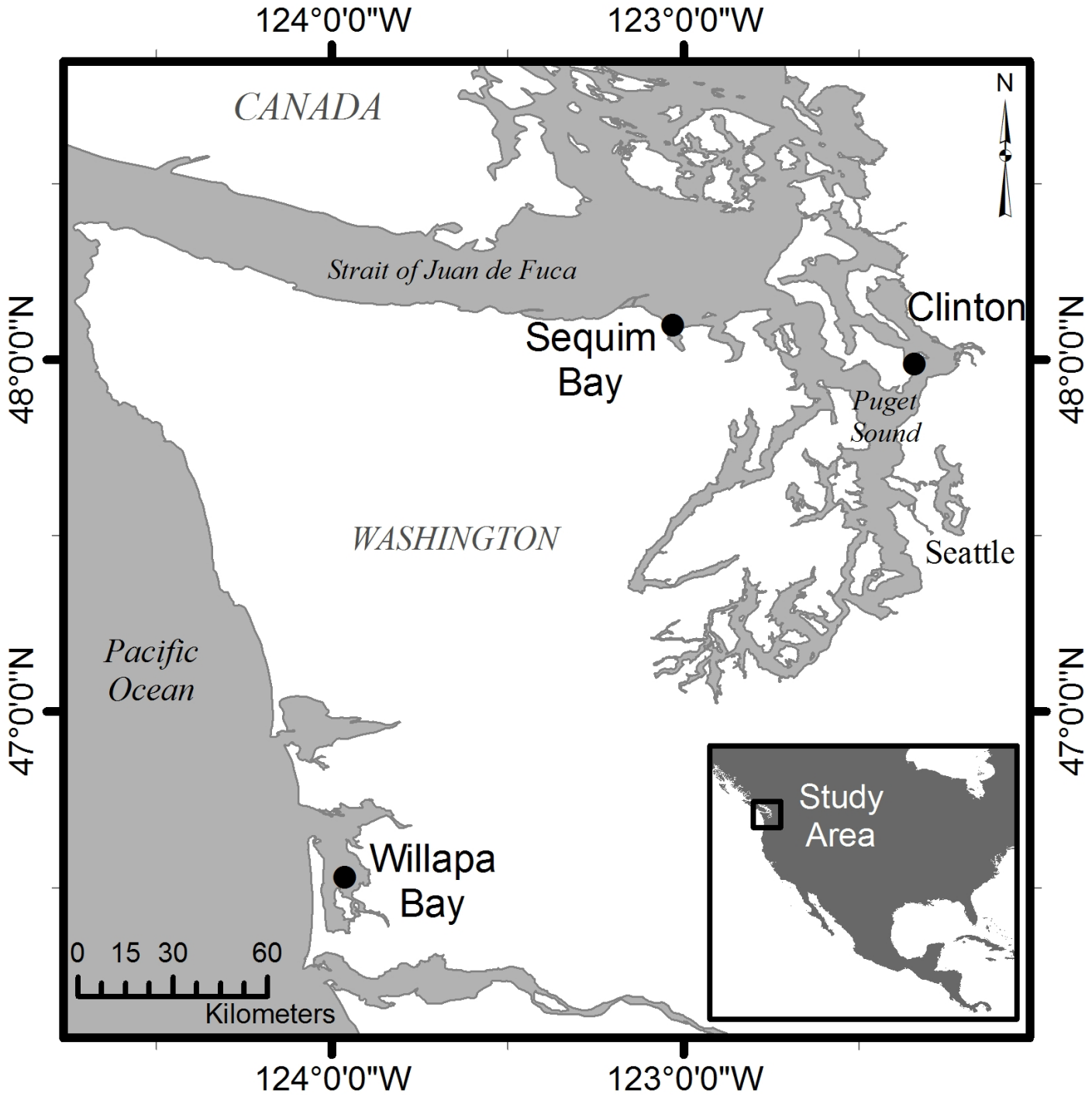
- Variations in climatic conditions force temporal and spatial variability in eelgrass (the most widespread of ~60 species of seagrass)
- Trends in water level and temperature forced by climatic/ ocean conditions can be mechanistically connected to variation in eelgrass
- There have been global losses of seagrasses, many blamed on human impacts (BioScience & PNAS papers)
- Plans to restore eelgrass must consider the natural variation, and factors contributing to this variation



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Three Study Areas:

- *Sequim Bay*
- *Clinton*
- *Willapa Bay (Westcott Bay)*

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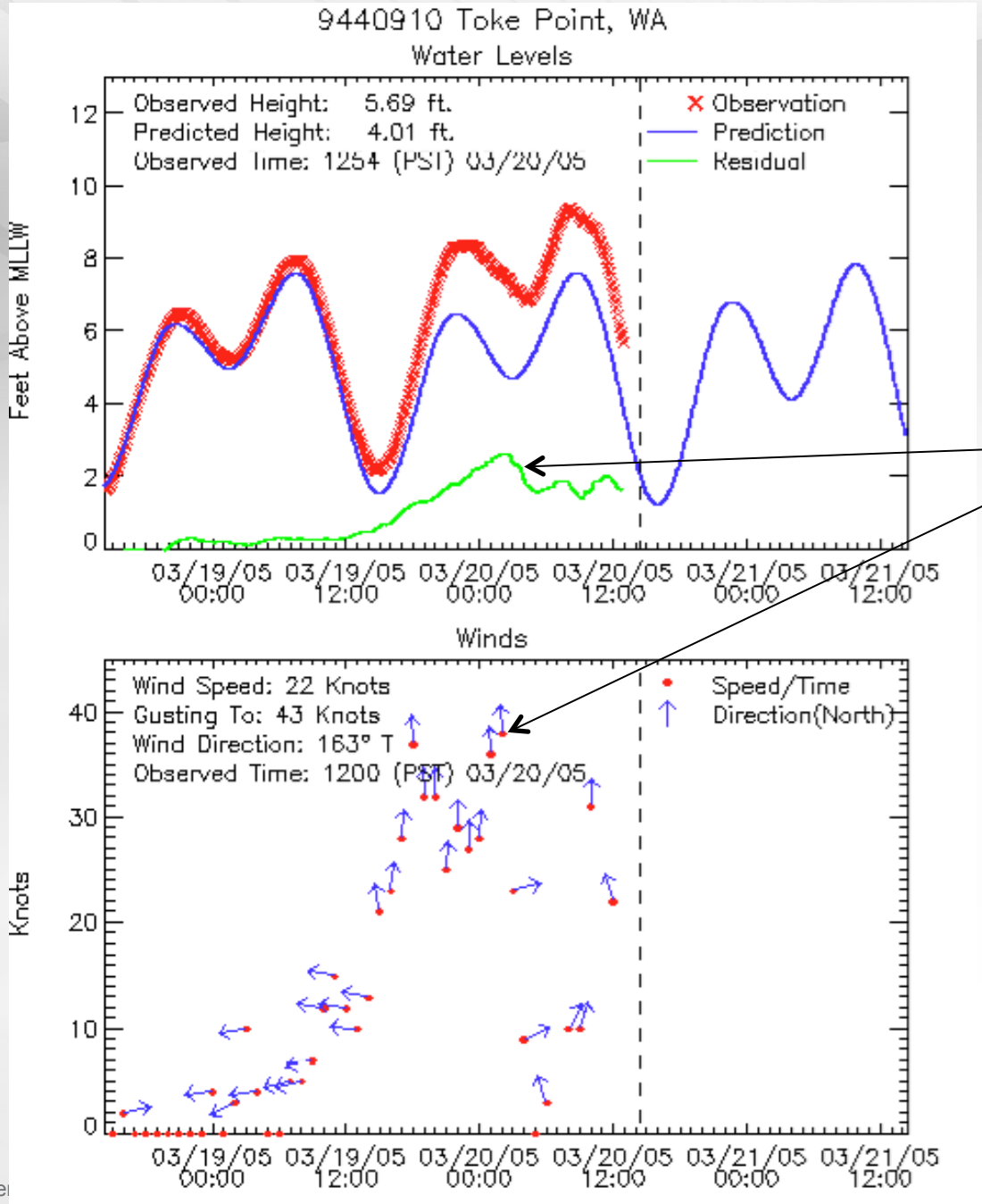
Short-term Extreme Sea Levels

March 19-20, 2005, winds force sea level ~2 ft above predicted



Port Angeles Mean Sea Level

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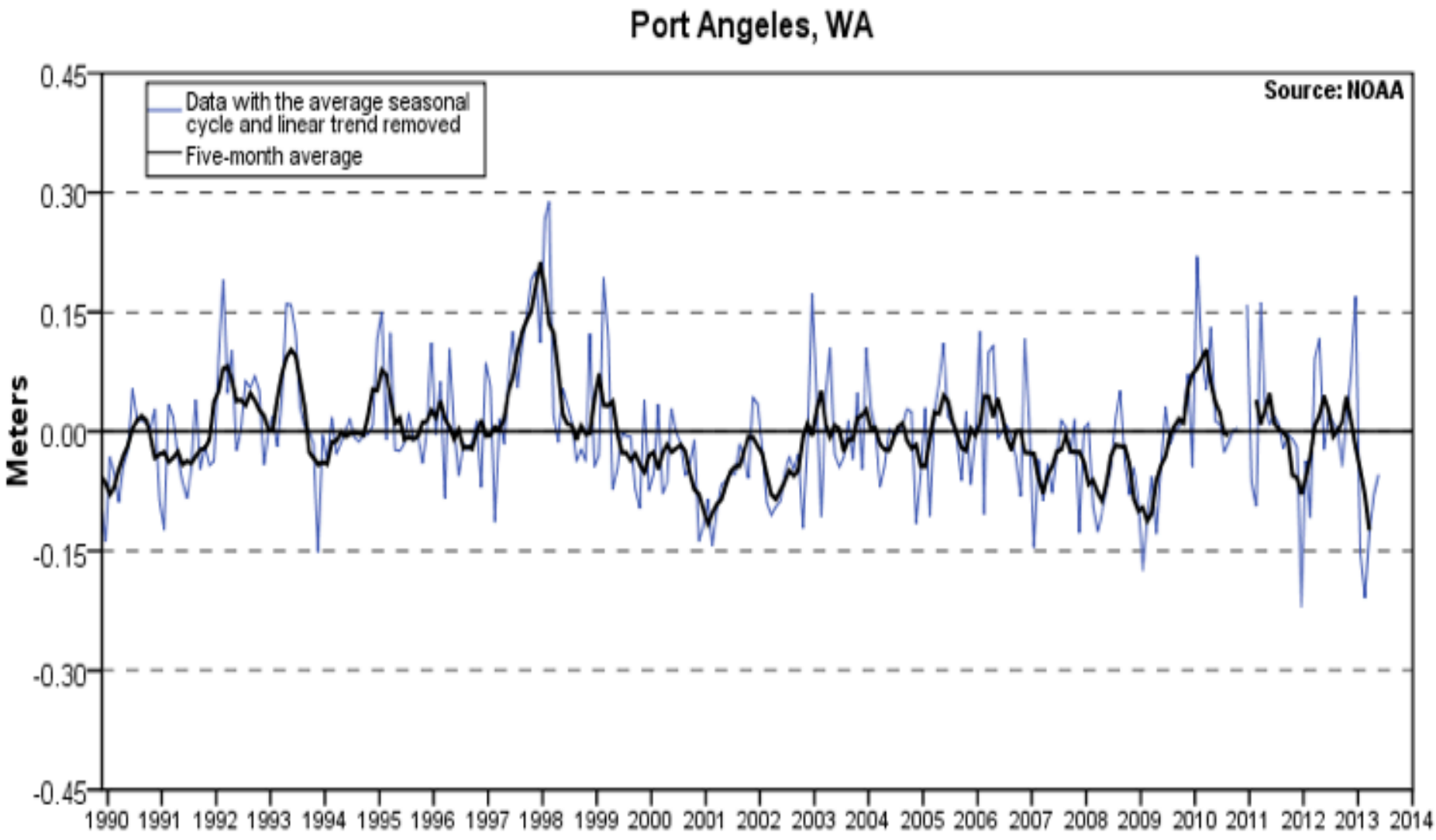
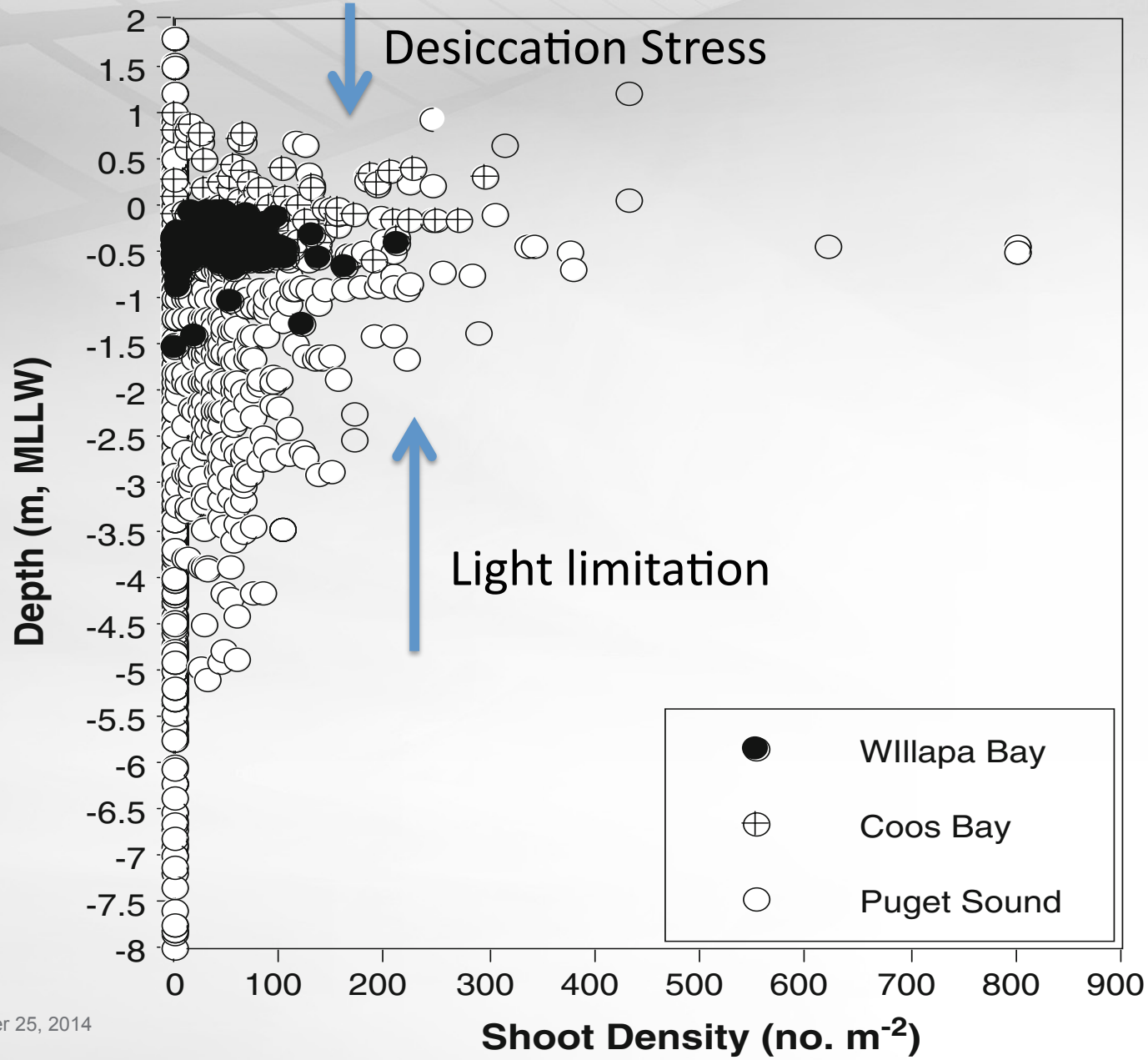


Depth Distribution



Desiccation & Temperature Affects Growth Rate

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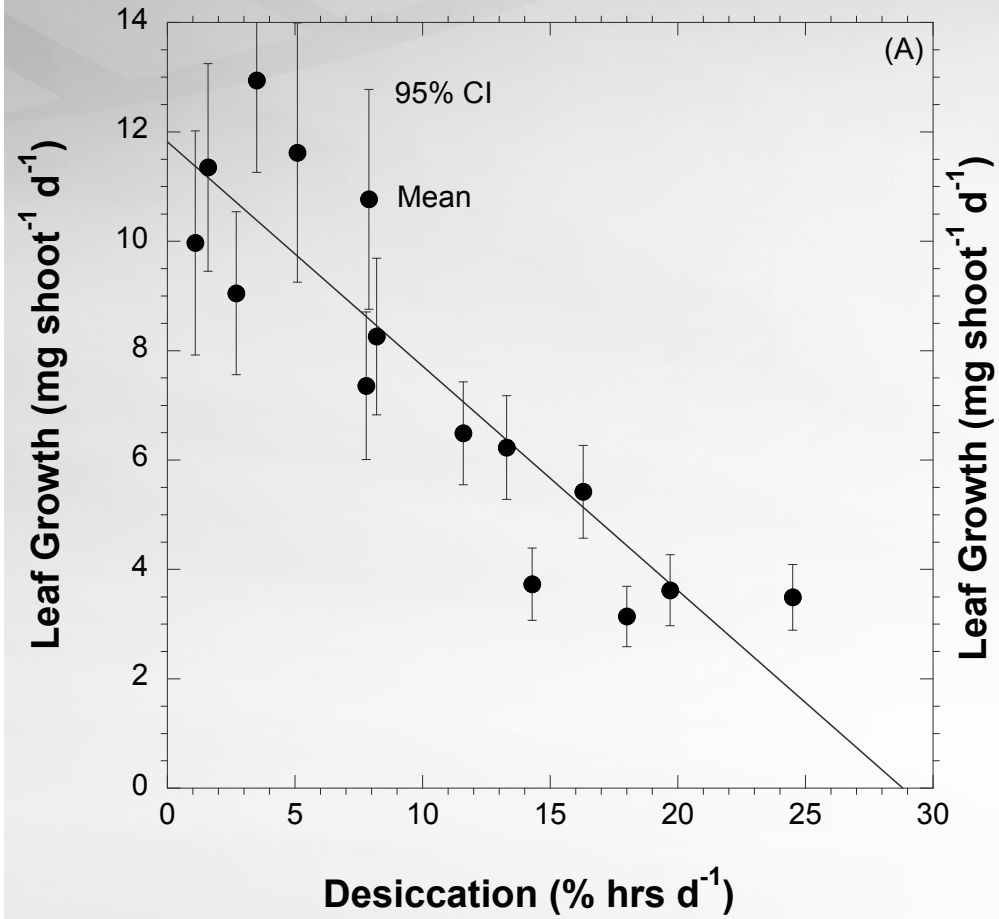

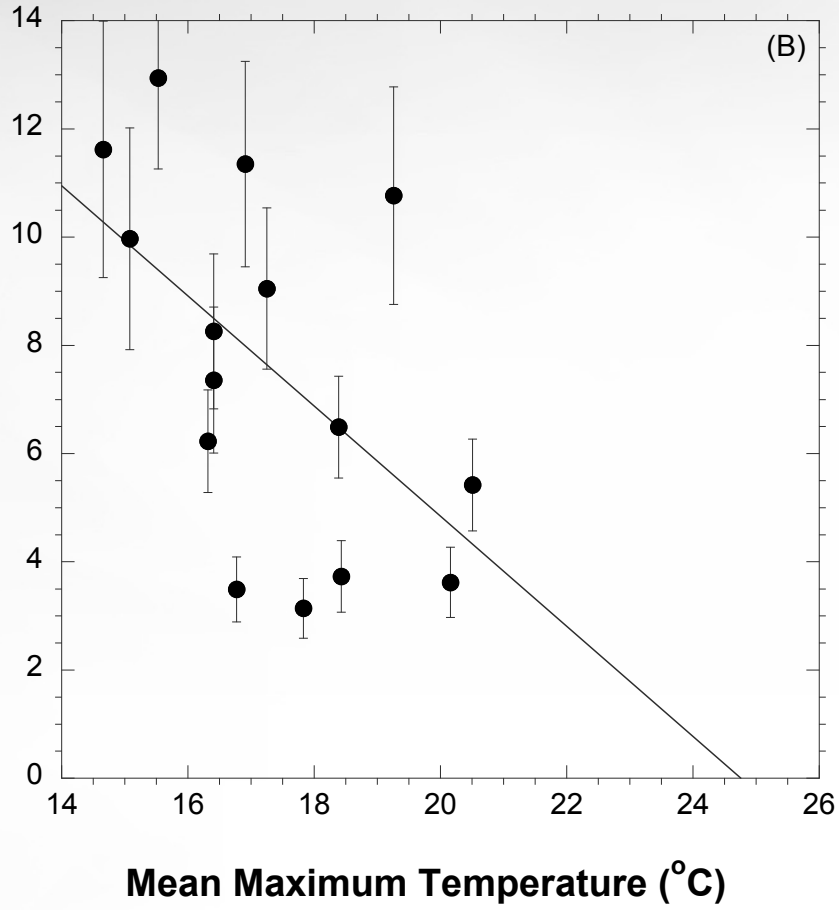

Net Primary Productivity (NPP) and Respiration (R) is Strongly Affected by Temperature (Thom et al. In Press. J. Coastal Research)

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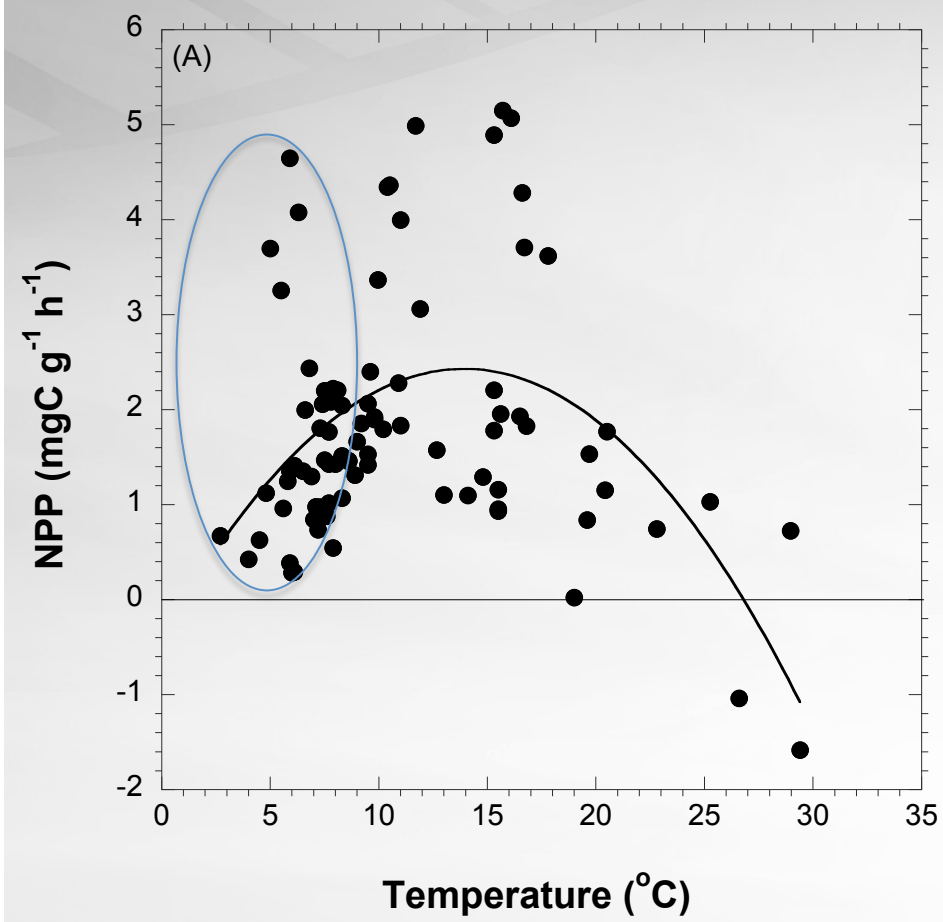
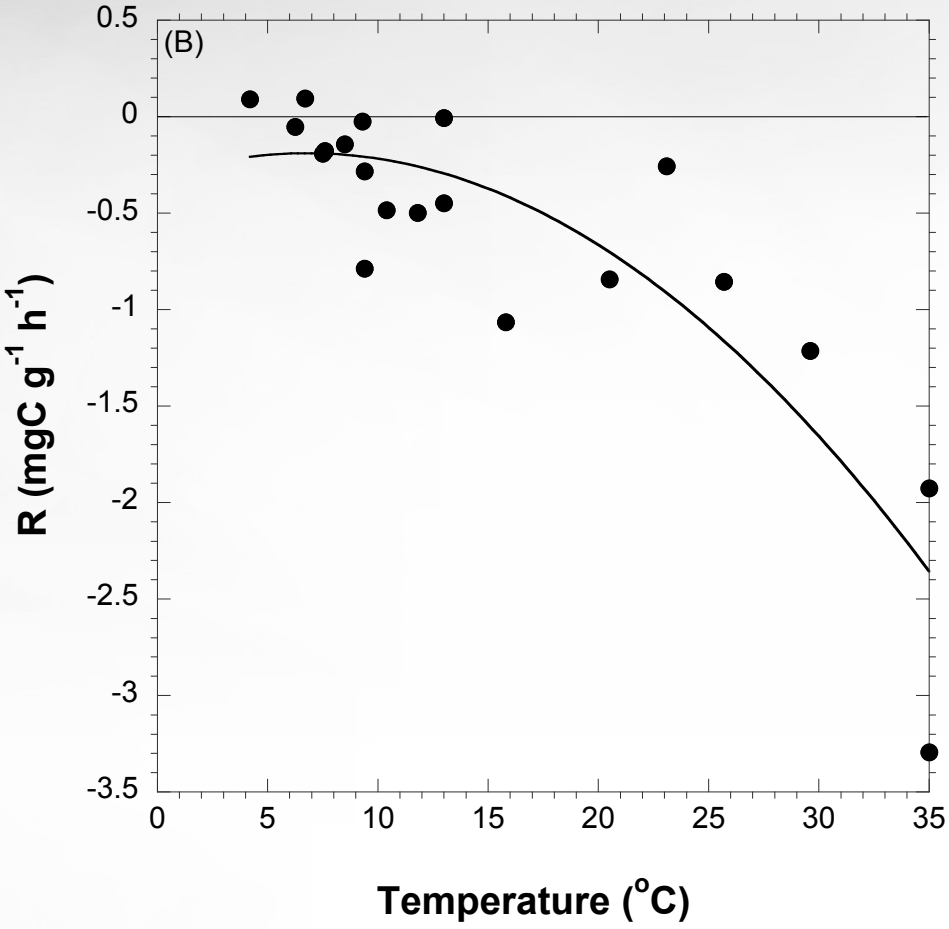
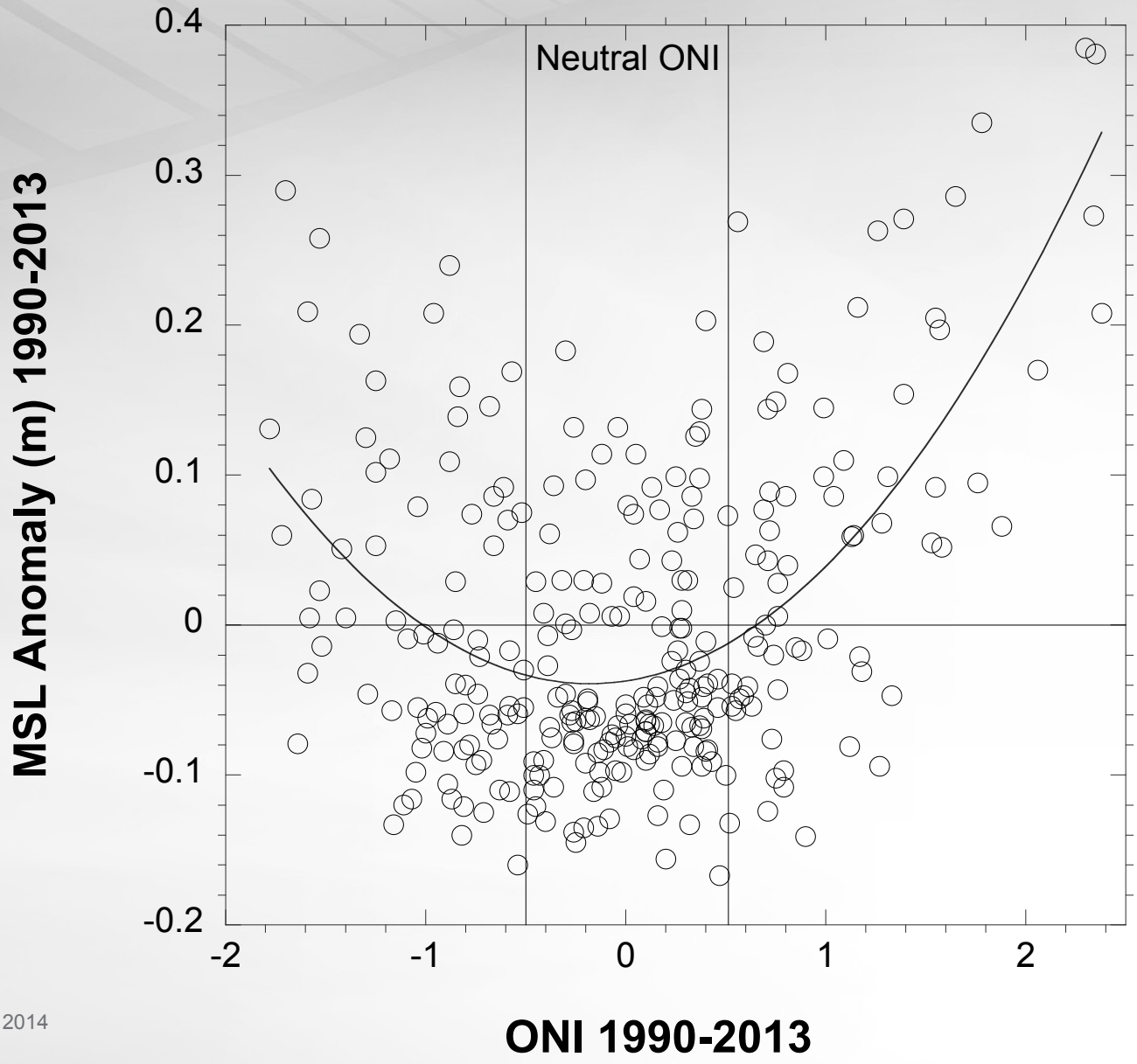
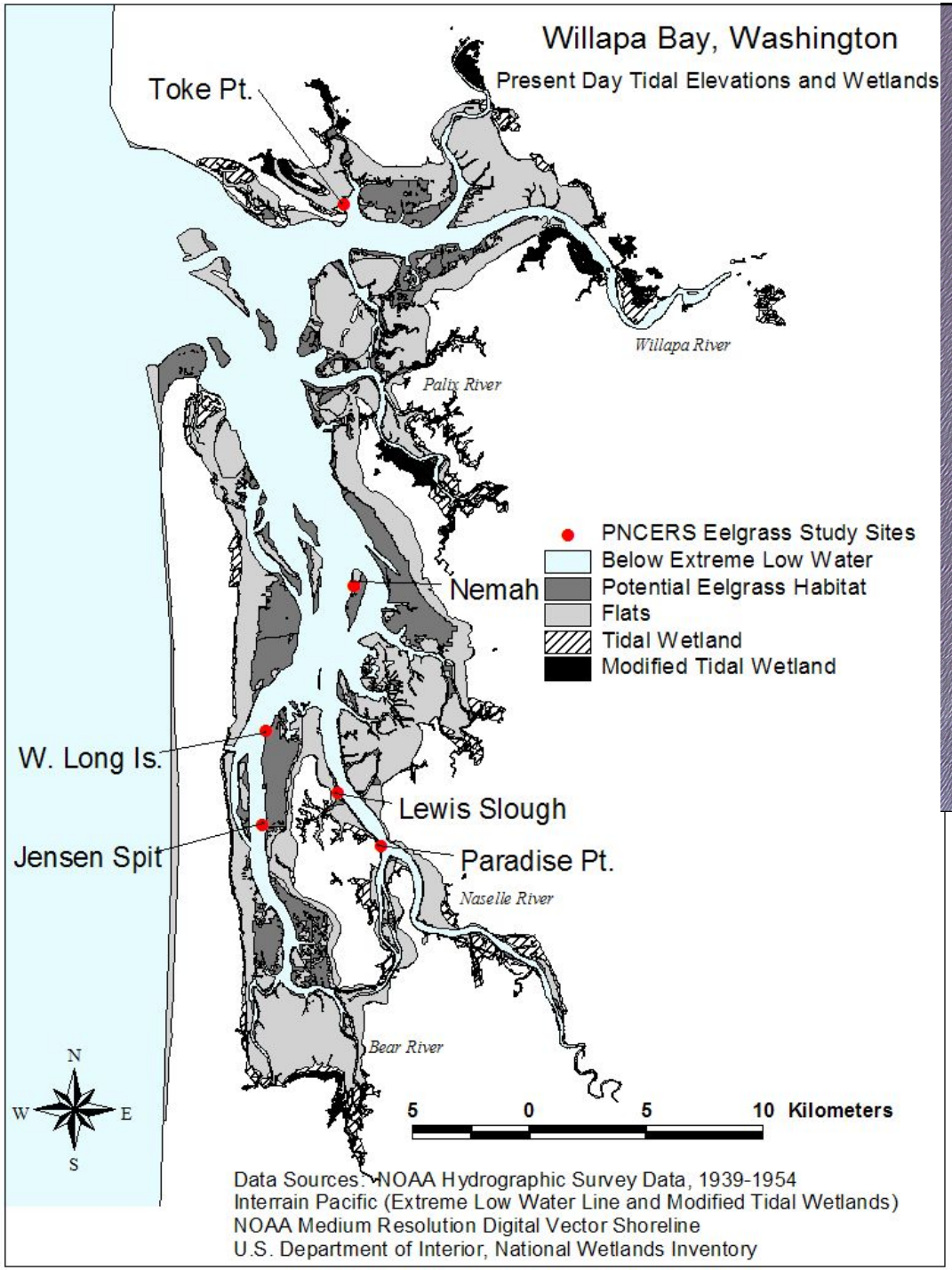




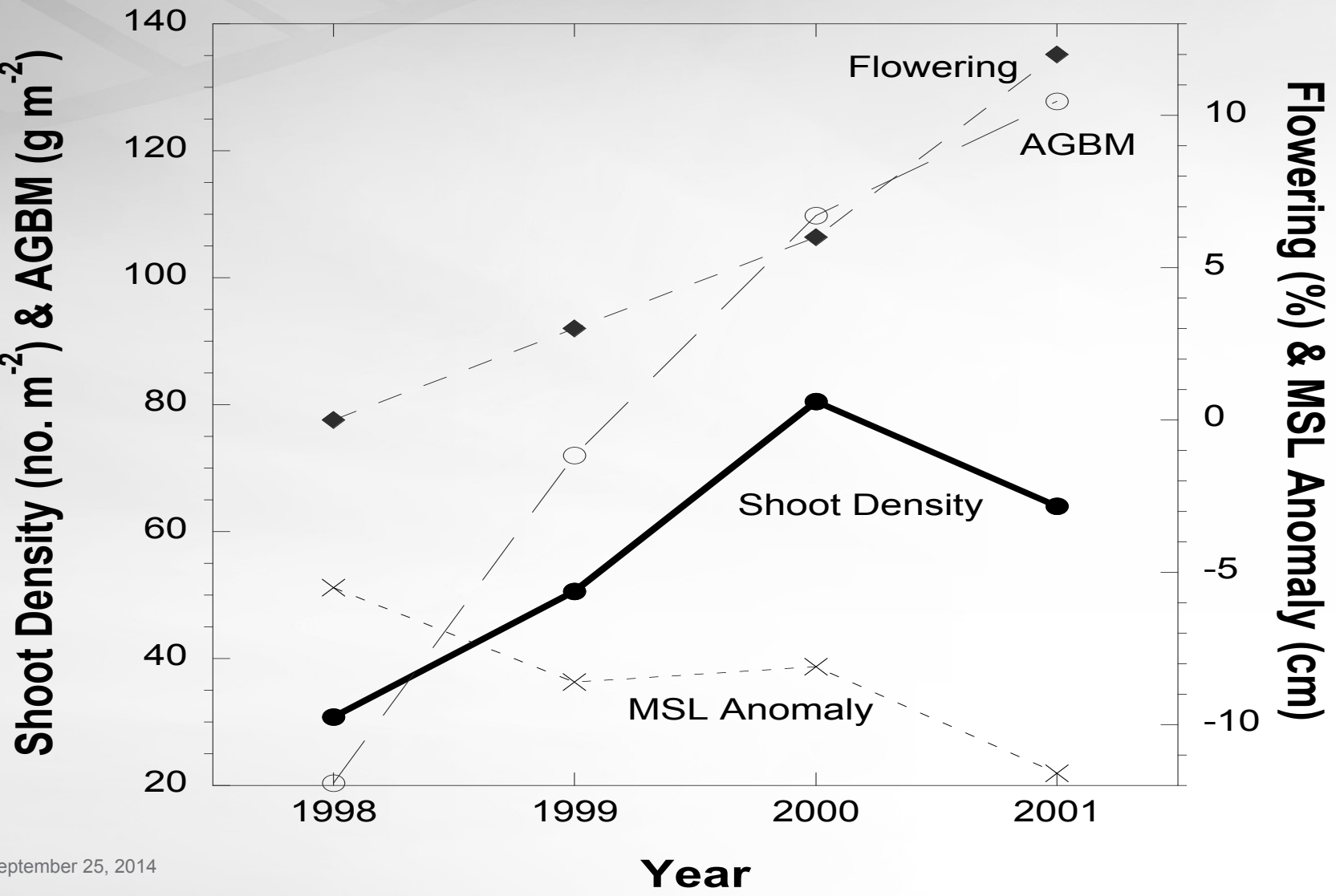
Conditions at the Equator 'Indicate' a Response in Puget Sound (Oceanic Niño Index, SST at Niño 3.4)

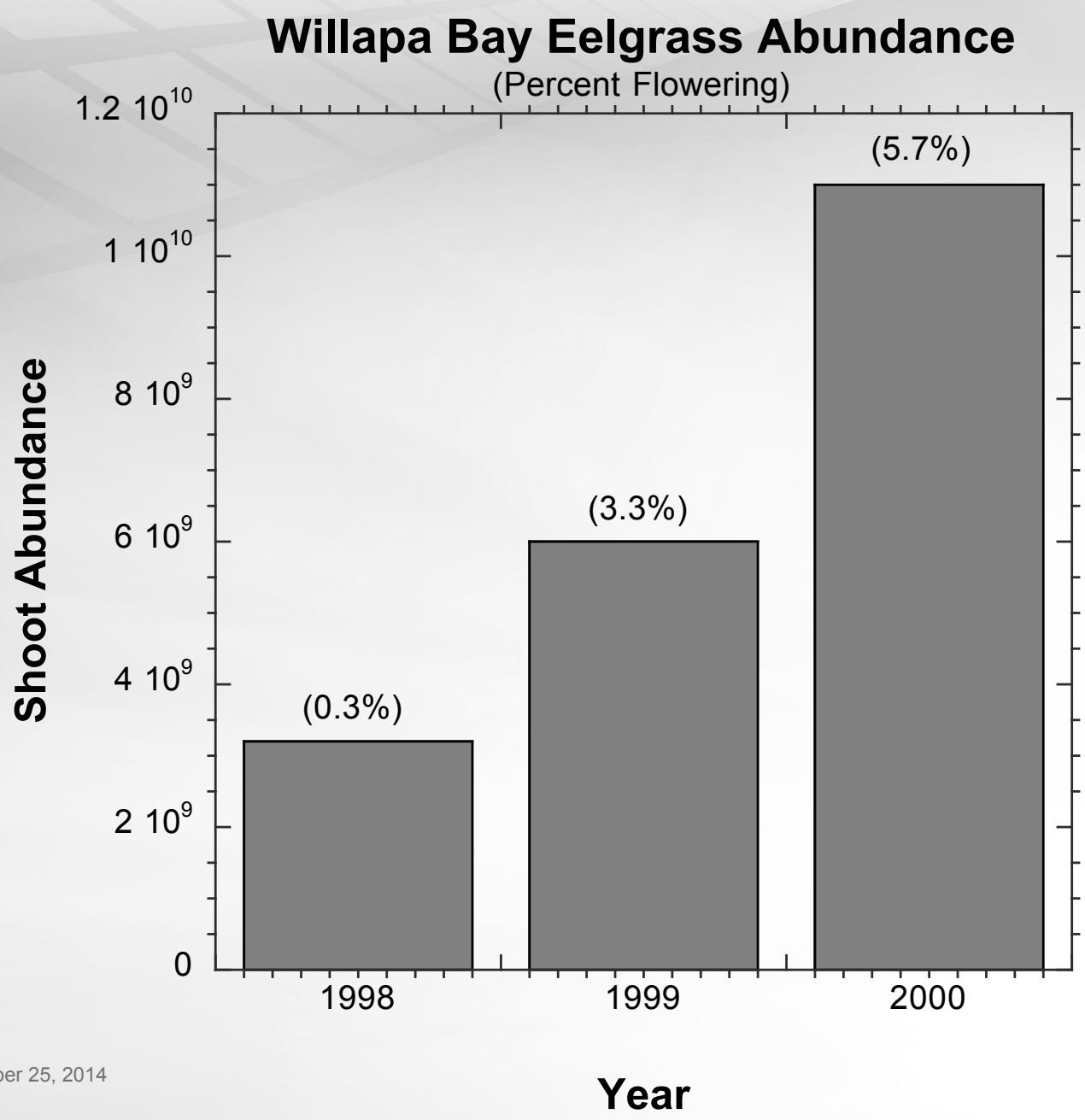




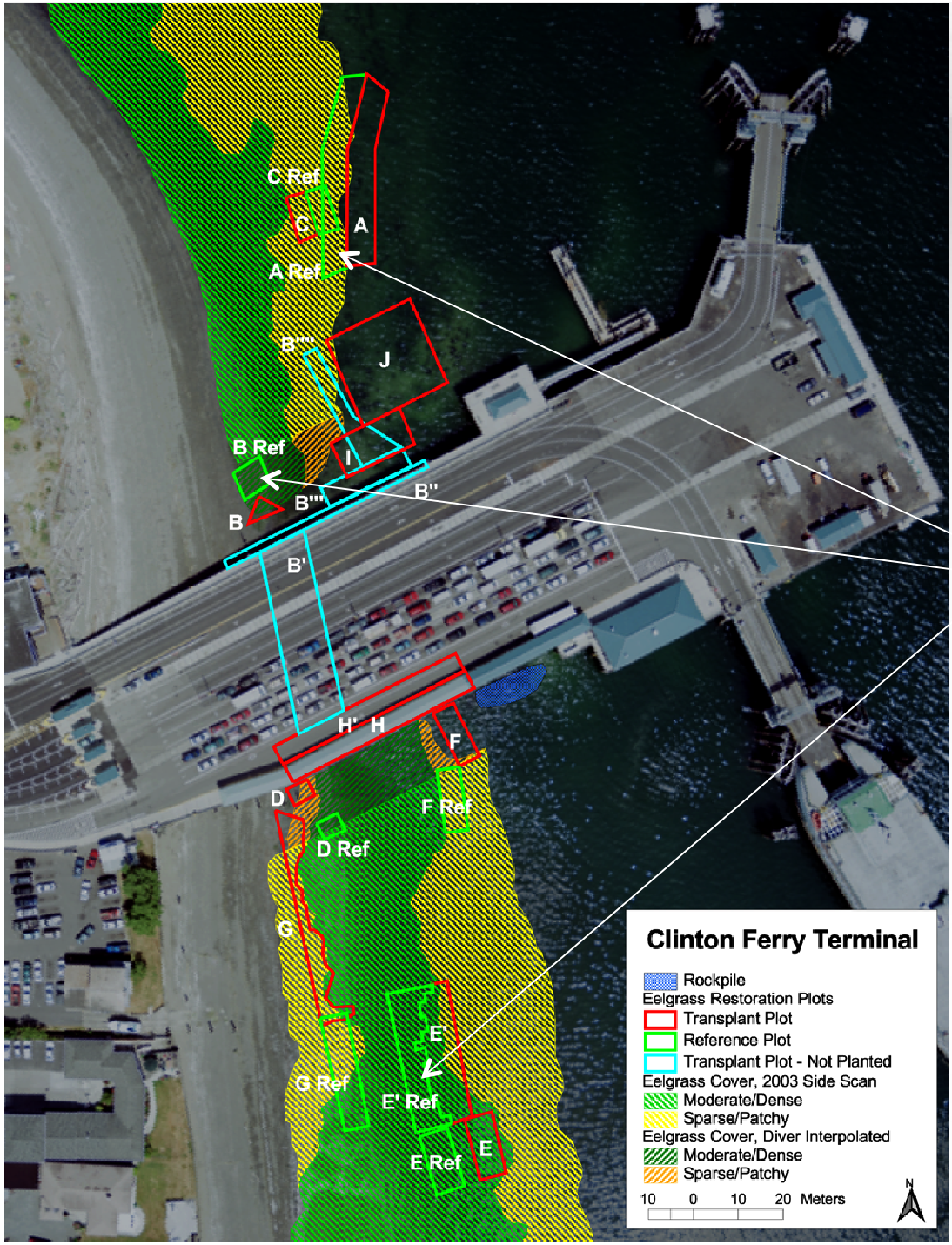
Willapa Bay – very broad flats, with eelgrass on the edge (Borde et al. 2003. *Estuaries* 26:1104-1116)

Willapa Bay Eelgrass Showed Major Changes During the ENSO Event (Thom et al. 2003. *Estuaries* 26:1117-1129)





(Thom et al. 2003. *Estuaries* 26:1117-1129)



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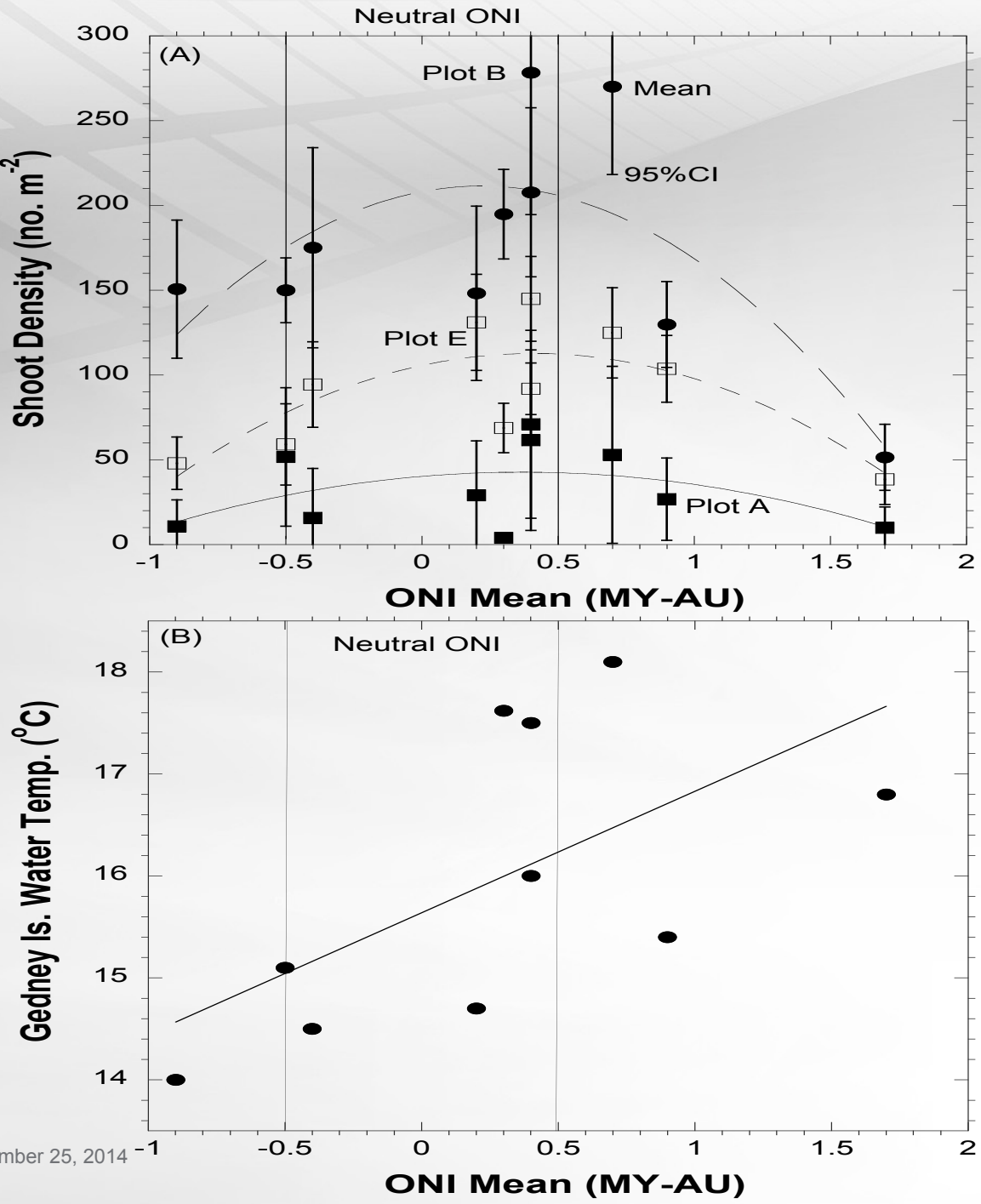
Clinton Ferry Terminal Eelgrass Plots

Reference plots, 10 years of monitoring



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Eelgrass Density Varied Relative to ONI, Water Temp.

ONI Neutral Years had Highest Density


Entrance to Sequim Bay
Study Site
113 m
2005
Google earth
Imagery Date: 7/5/2013 48°04'49.94" N 123°02'39.75" W elev 1 m eye alt 578 m

Sampled Eelgrass Growth Rate During 19 of 23 Summers between 1991-2014

Leaf Growth over 3-5 two-week periods June-August

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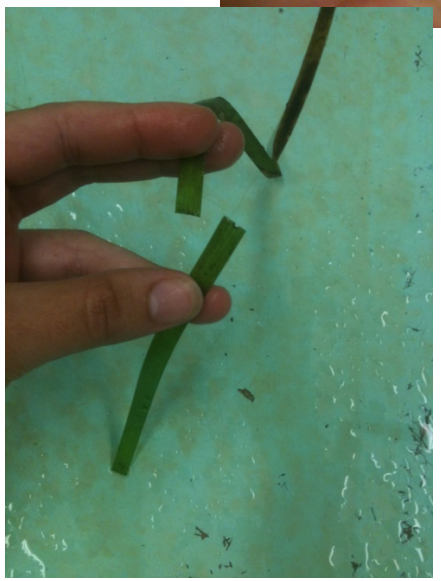

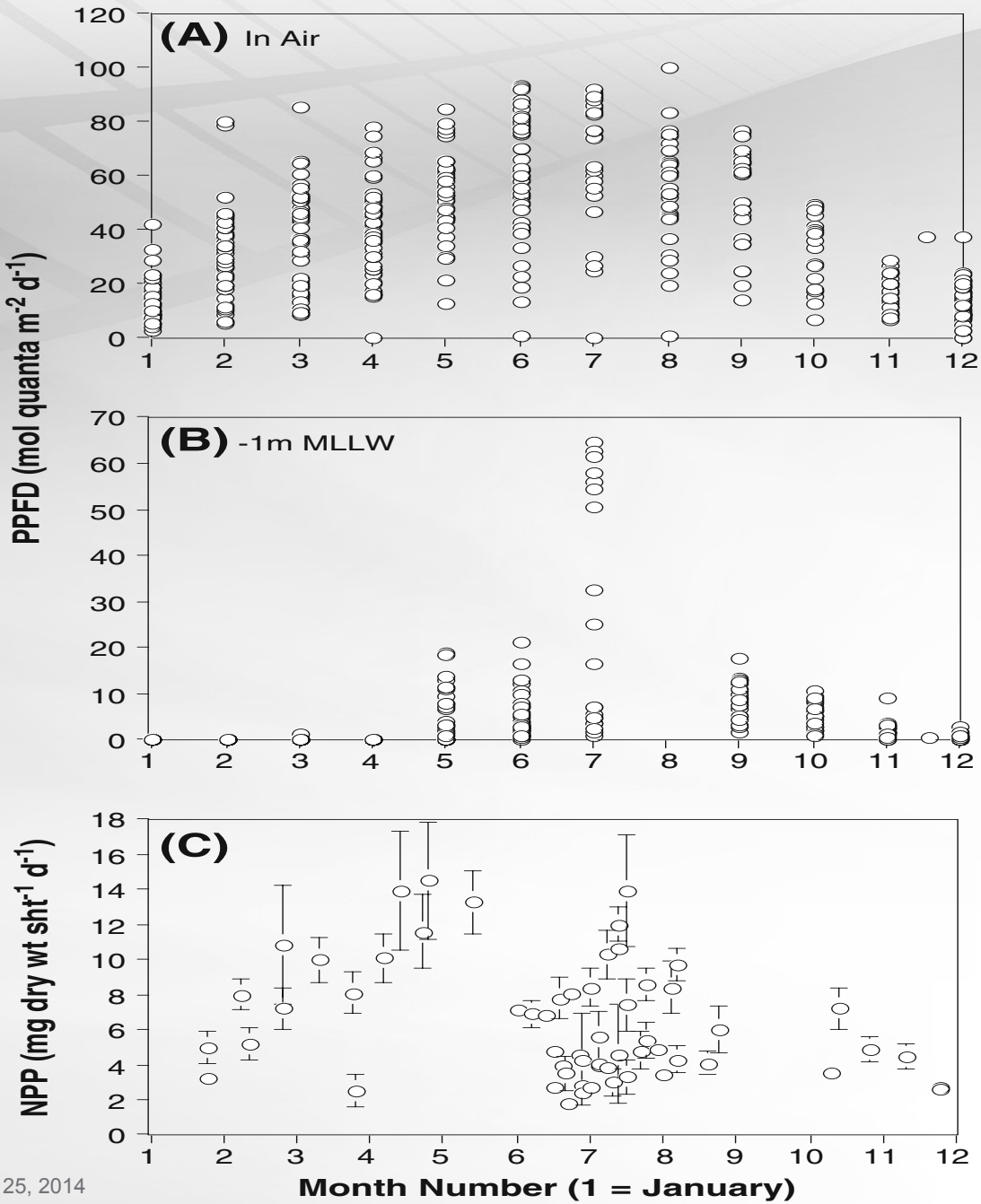

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Growth was greatest in April-May when low tides occur during daytime, and water is still cool (Thom et al. 2008. ***Estuaries and Coasts*** **31:969-980.)**

Leaf Growth Rate (Summer) – *Sequim Bay*

(Thom et al. In Press. J. of Coastal Res.)

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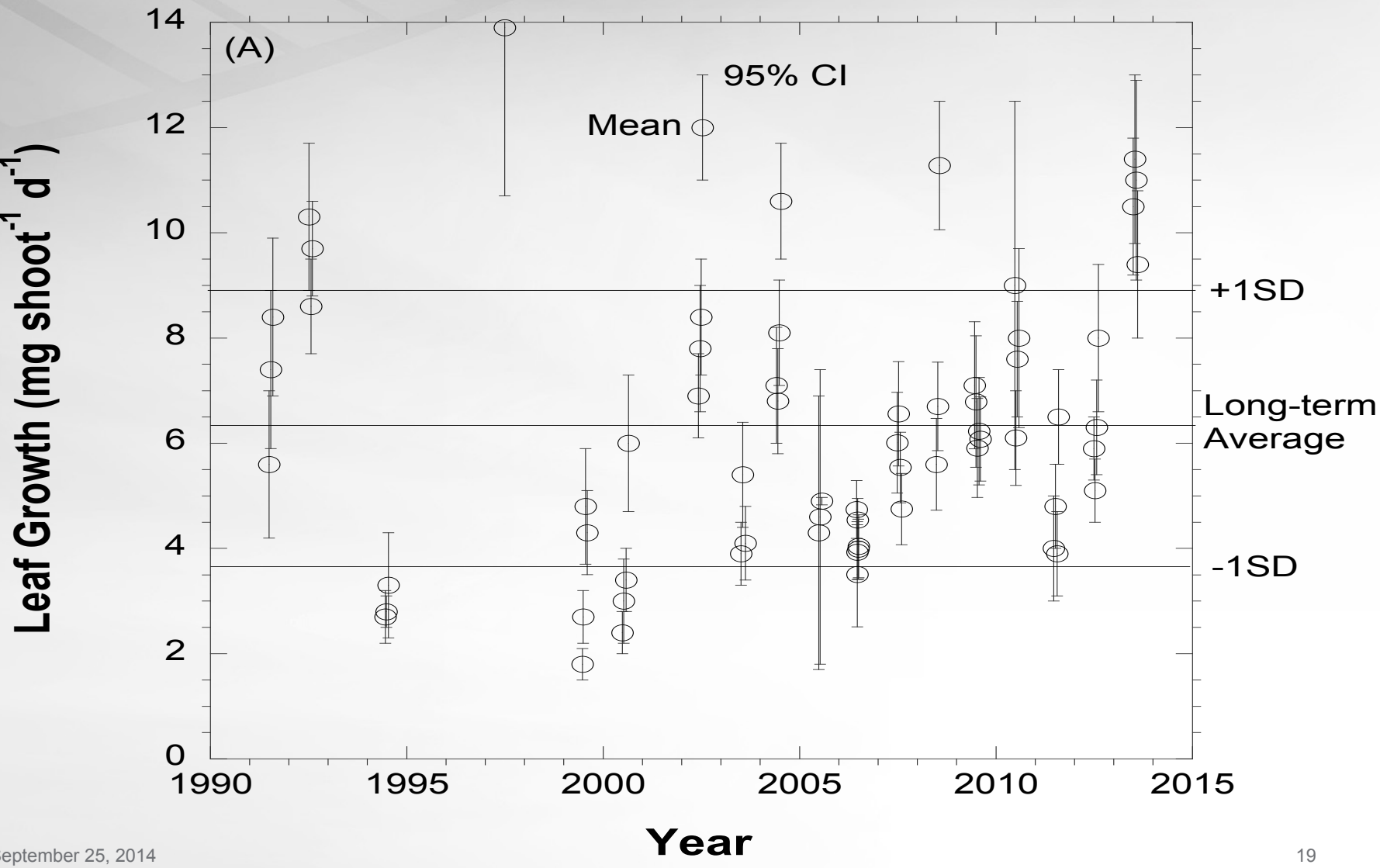
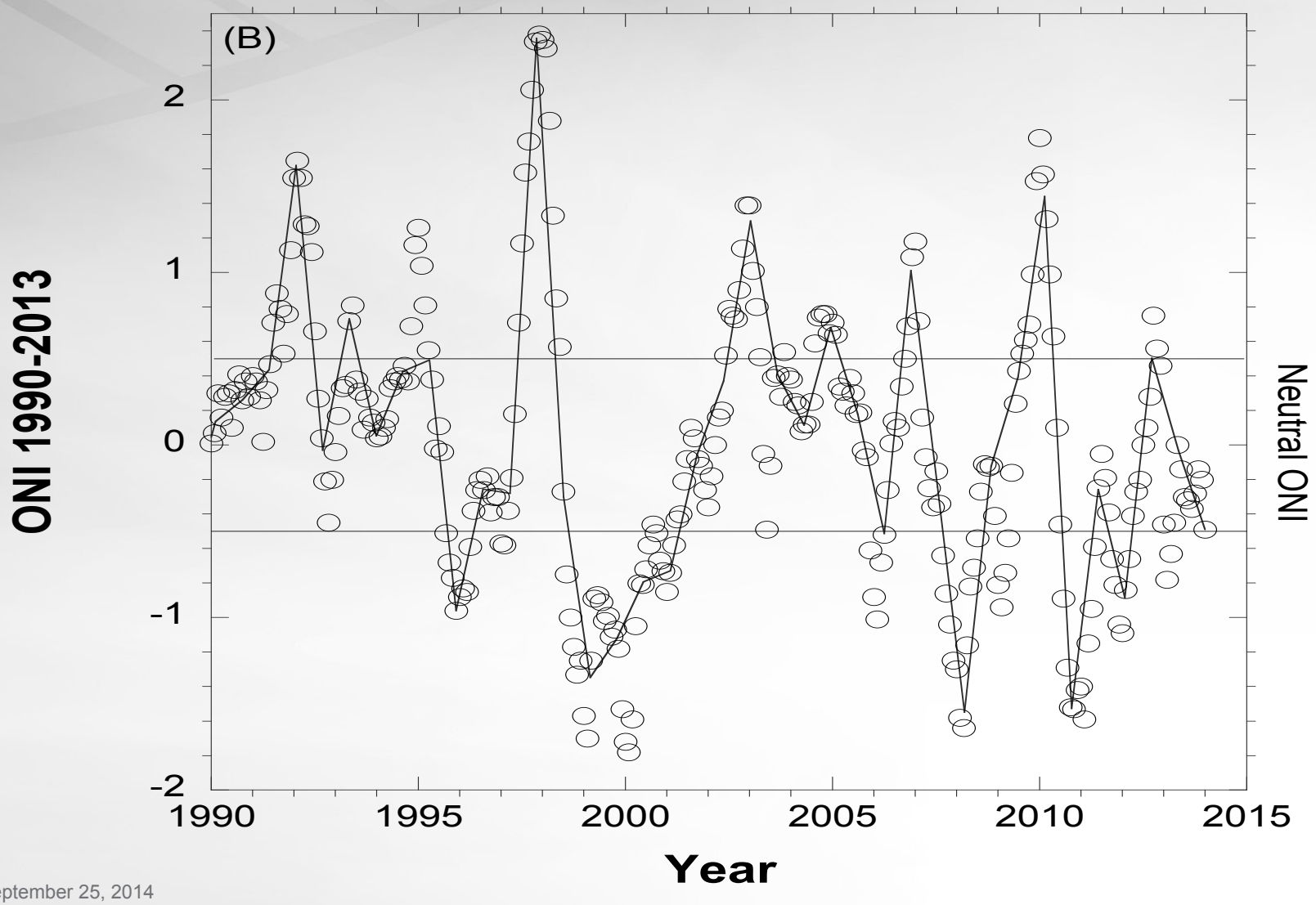


Oceanic Nino Index



Mean Sea Level Anomaly – *Port Angeles*

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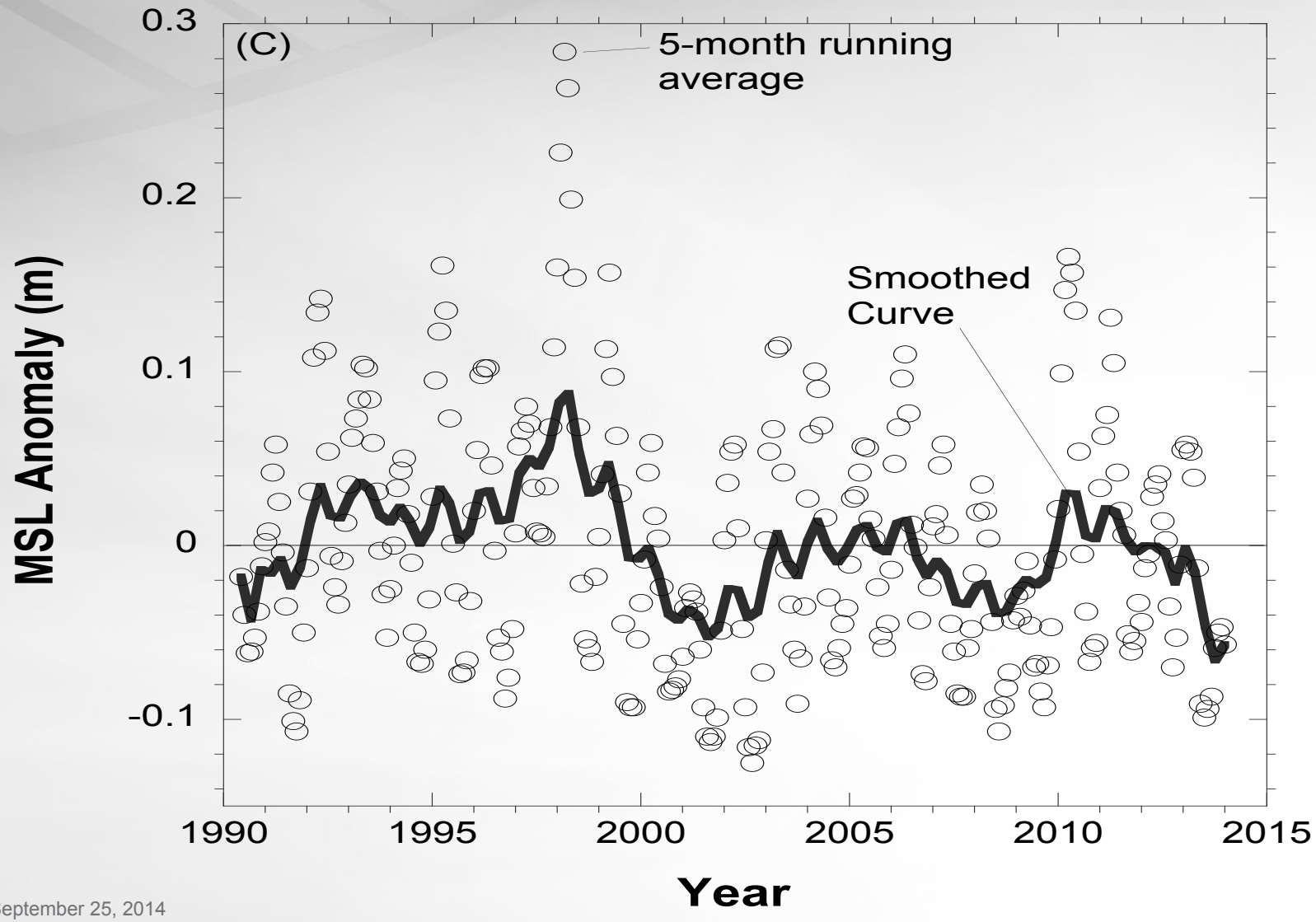

Mean Sea Level Anomaly – *Port Angeles*

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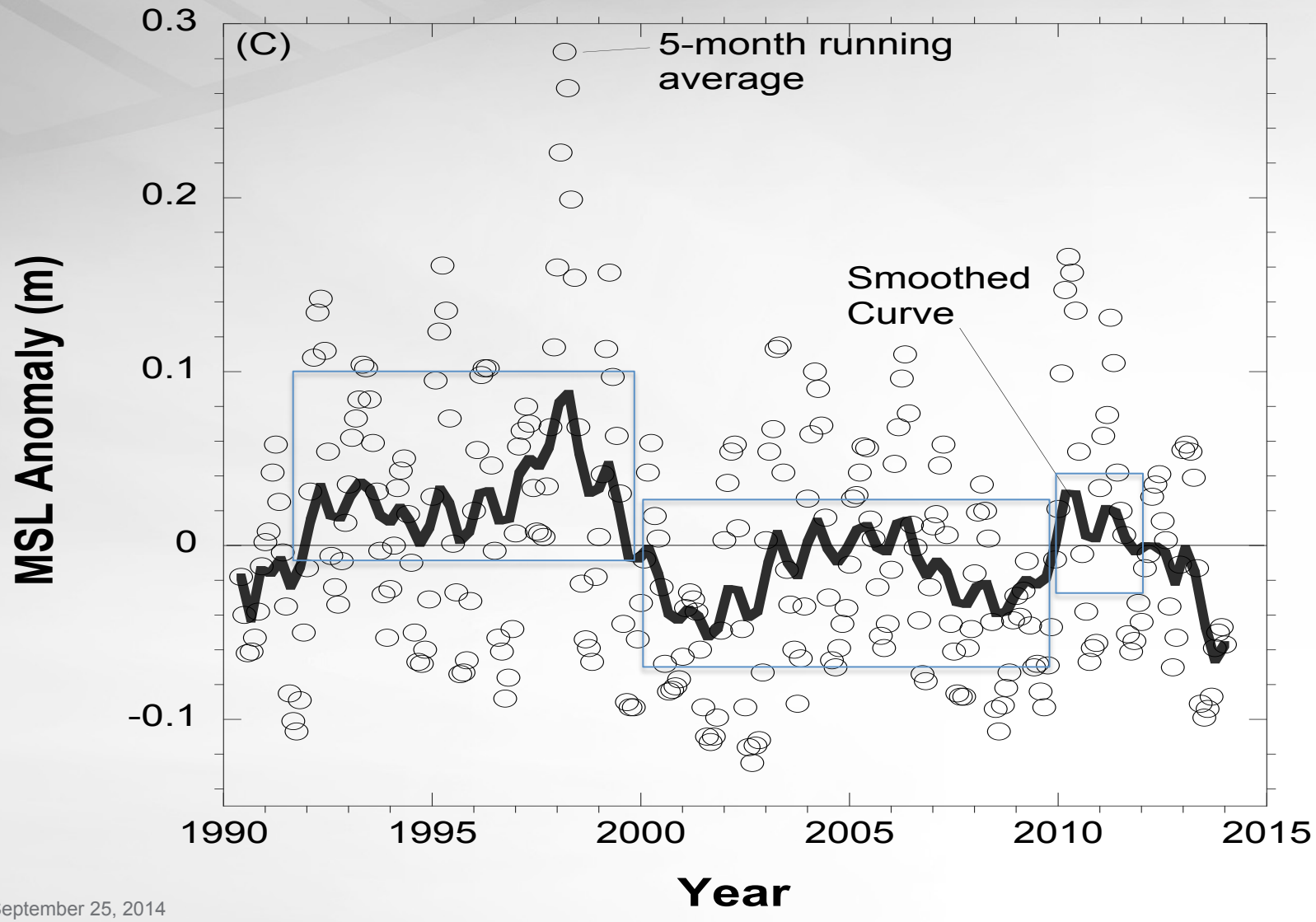

Leaf Growth Rate (Summer) – *Sequim Bay*

(Thom et al. In Press. J. of Coastal Res.)

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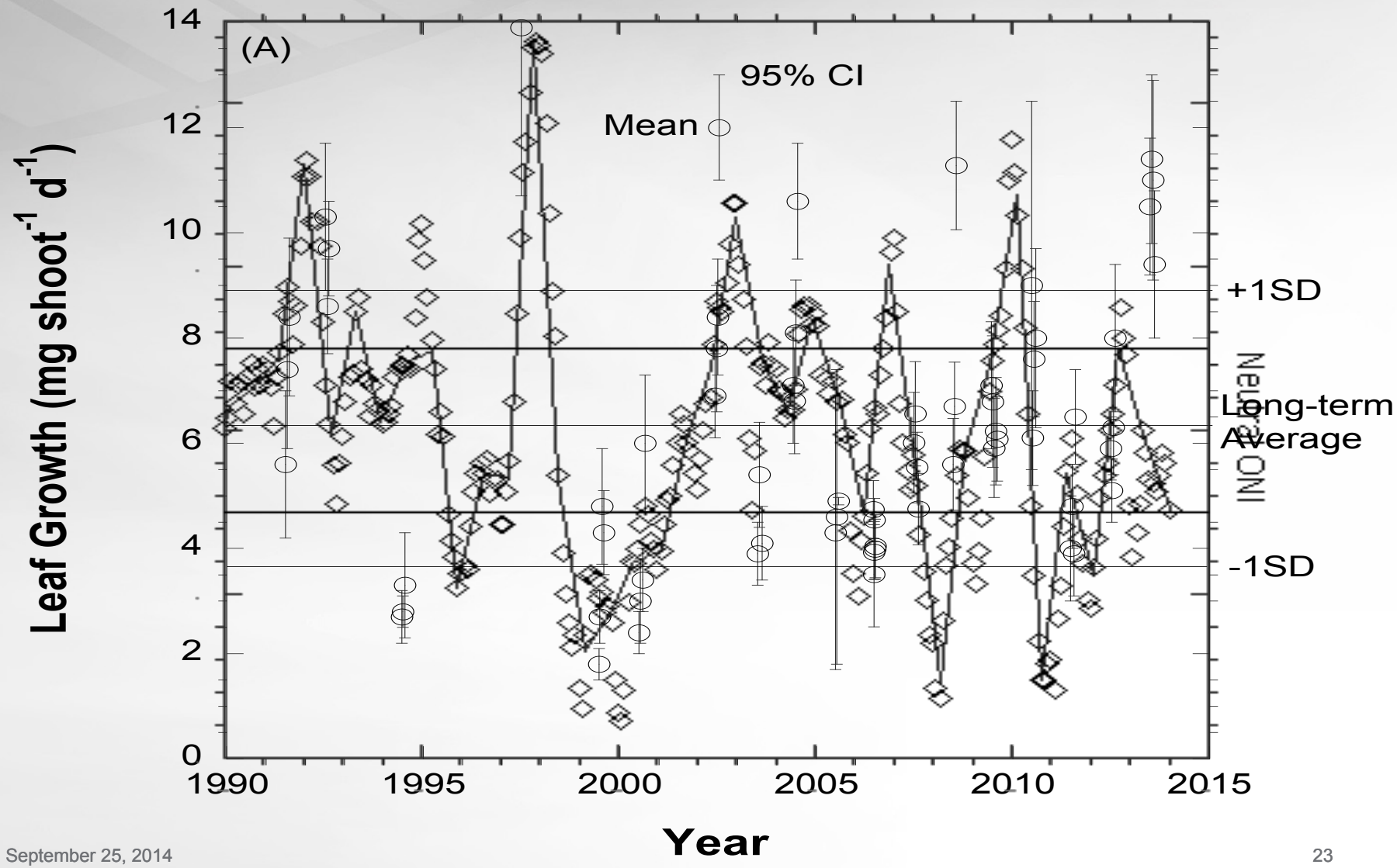

Leaf Growth Rate (Summer) – *Sequim Bay*

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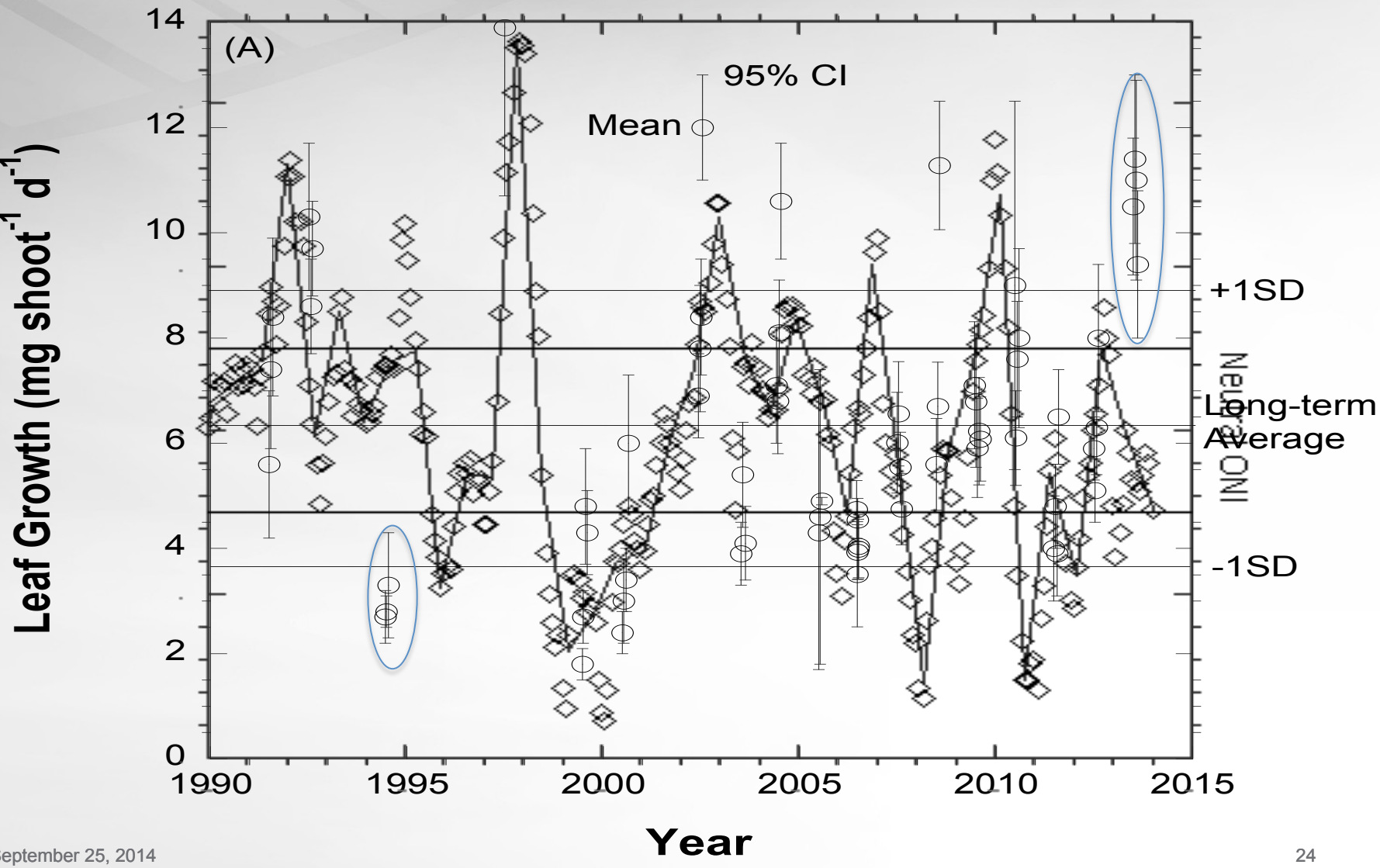
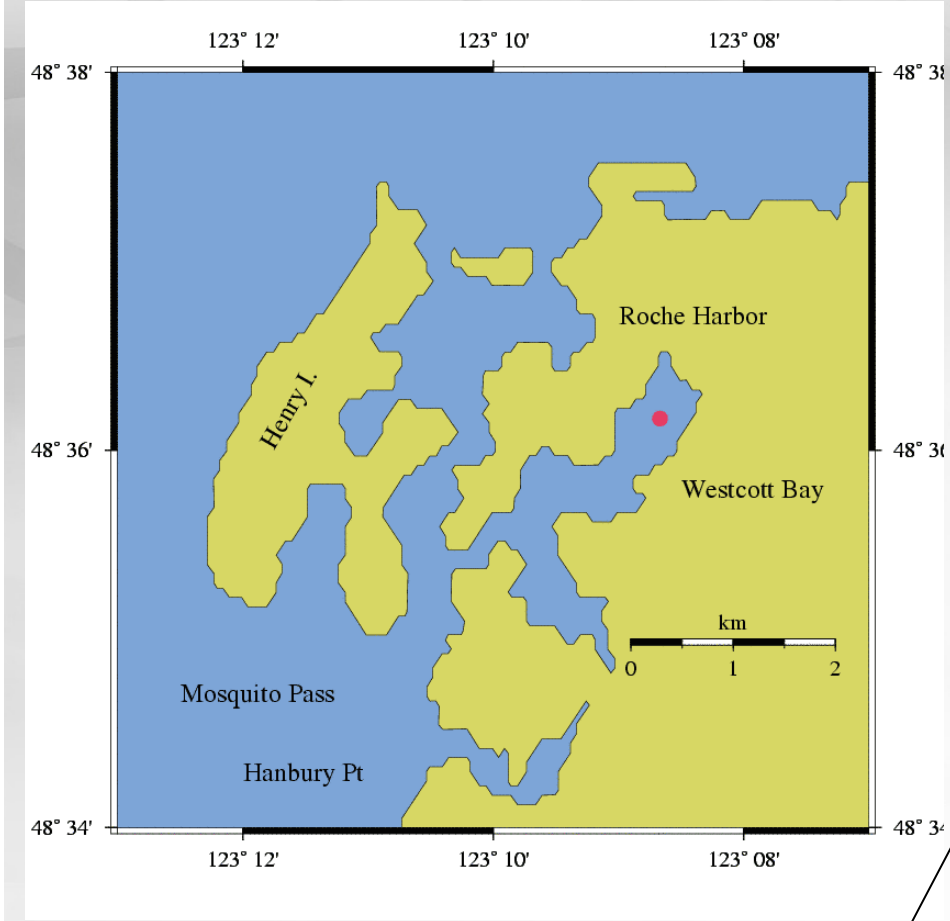
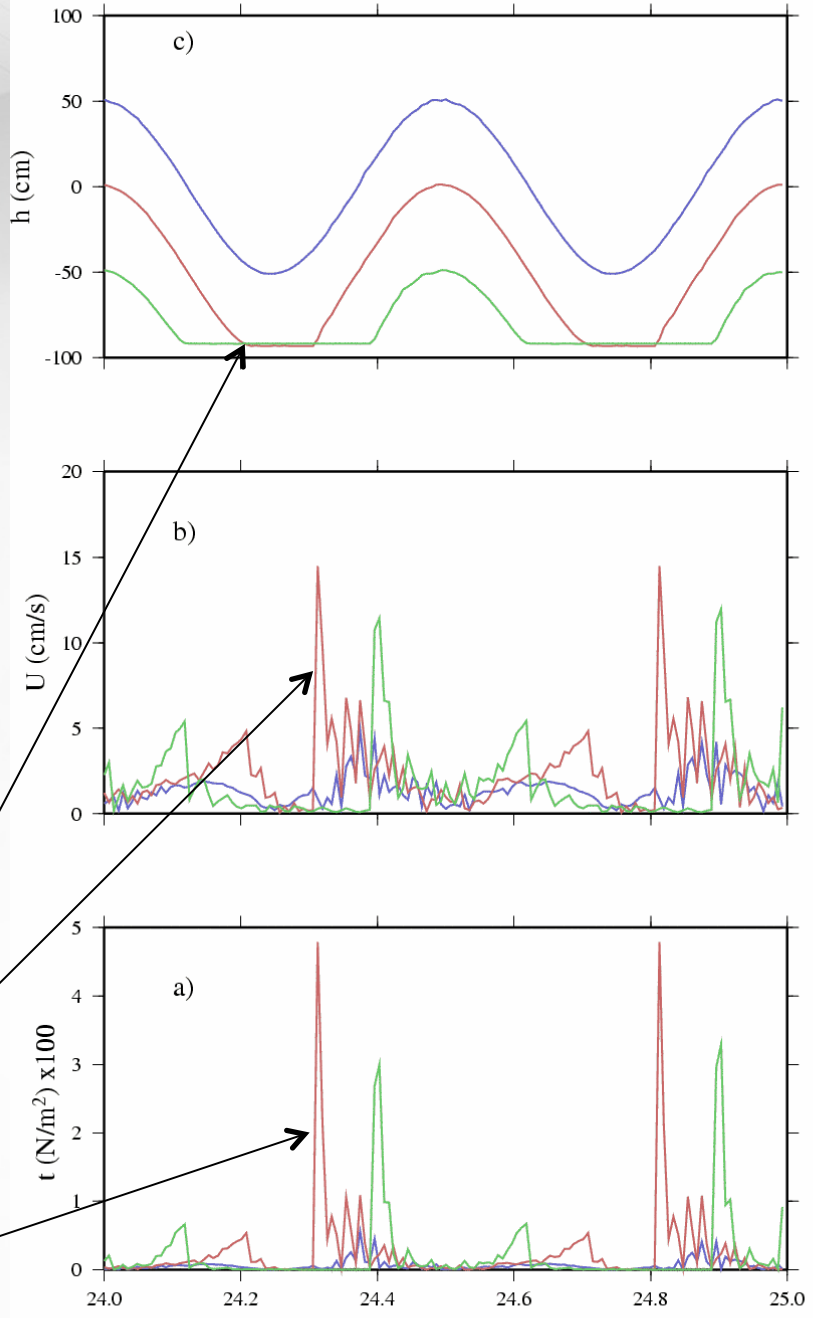


Sea Level & Circulation, Westcott Bay





Tidal Elevations **(curves "bottom out" when model estimates that location is emergent)**

Current Magnitude **(current spikes over shallow areas when depth is lowest)**

Bottom Stress **(spikes when current peaks at shallow depths)**

Take Home Messages

- Substantial inter-annual variation in eelgrass density, abundance, and growth is common in the PNW
- Climate/ocean conditions appear to be significant drivers
- Plans to restore eelgrass must consider the natural variation, and factors contributing to this variation
  - i.e., give restoration efforts *a break*
- Climate change (sea surface temperature, elevation) will affect eelgrass abundance
- Ecosystem services and the species utilizing eelgrass will be affected by these changes
  - e.g., seagrass globally could store up to 19.9Pg C_{org} (Fourqurean et al. 2012. Nature Geosci.)
- Long-term ecological monitoring is rare but critical
- Predictive capability is possible

Acknowledgements

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- USDOE student programs (20 student interns) and Laboratory Directed Research and Development, NOAA PNCERS, and WSDOT.
- Colleagues - J. Southard, G. Williams, D. Woodruff, H. Diefenderfer, M. Blanton, L. Antrim, W. Gardiner, J. Vavrinec, S. Rumrill.
- Peer review – C. Brandt, M. Anderson
- Keith Merkel suggested looking at sea level.

Call for Scientific Sessions & Workshop Proposals

Submission Deadline: 12 Sept 2014

www.erf.org


Thank You for Listening!