



Apr 5th, 2:30 PM - 2:45 PM

Predicting Puget Sound's organic carbon—and why we need enhanced monitoring

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Figueroa-Kaminsky, Cristiana; Ahmed, Anise; McCarthy, Sheelagh; Pelletier, G. J.; Mohamedali, Teizeen; and Gala, John, "Predicting Puget Sound's organic carbon—and why we need enhanced monitoring" (2018). *Salish Sea Ecosystem Conference*. 358.

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Speaker

Cristiana Figueroa-Kaminsky, Anise Ahmed, Sheelagh McCarthy, G. J. Pelletier, Teizeen Mohamedali, and John Gala

Predicting Puget Sound's organic carbon—and why we need enhanced monitoring

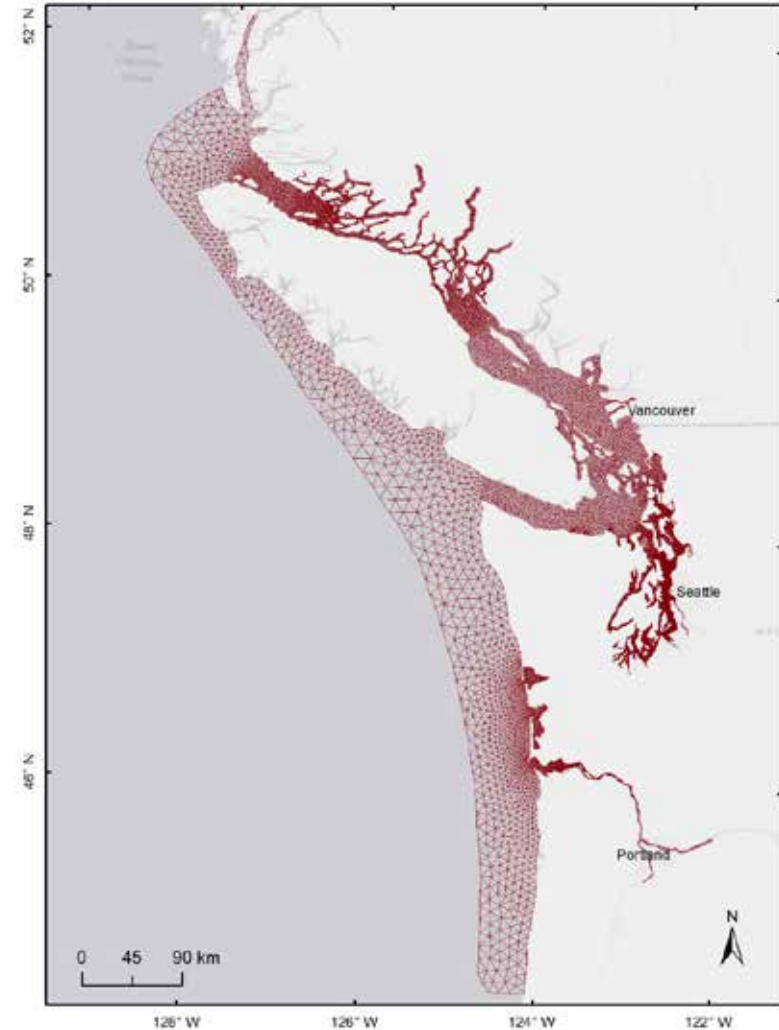
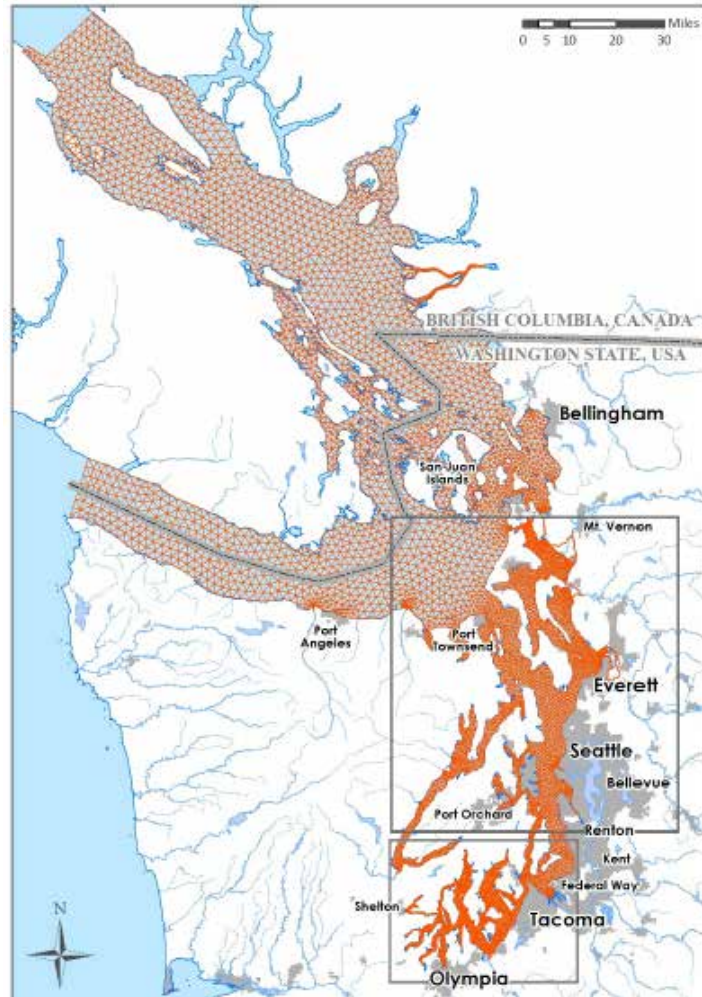
Presented at the Salish Sea Ecosystem Conference
April 5, 2018



Cristiana Figueroa-Kaminsky

With contributions from: Anise Ahmed, John Gala, Sheelagh McCarthy, Teizeen Mohamedali, Greg Pelletier, and Sandy Weakland

Salish Sea Model: 3-D hydrodynamic circulation model coupled with water column and sediment biogeochemistry.

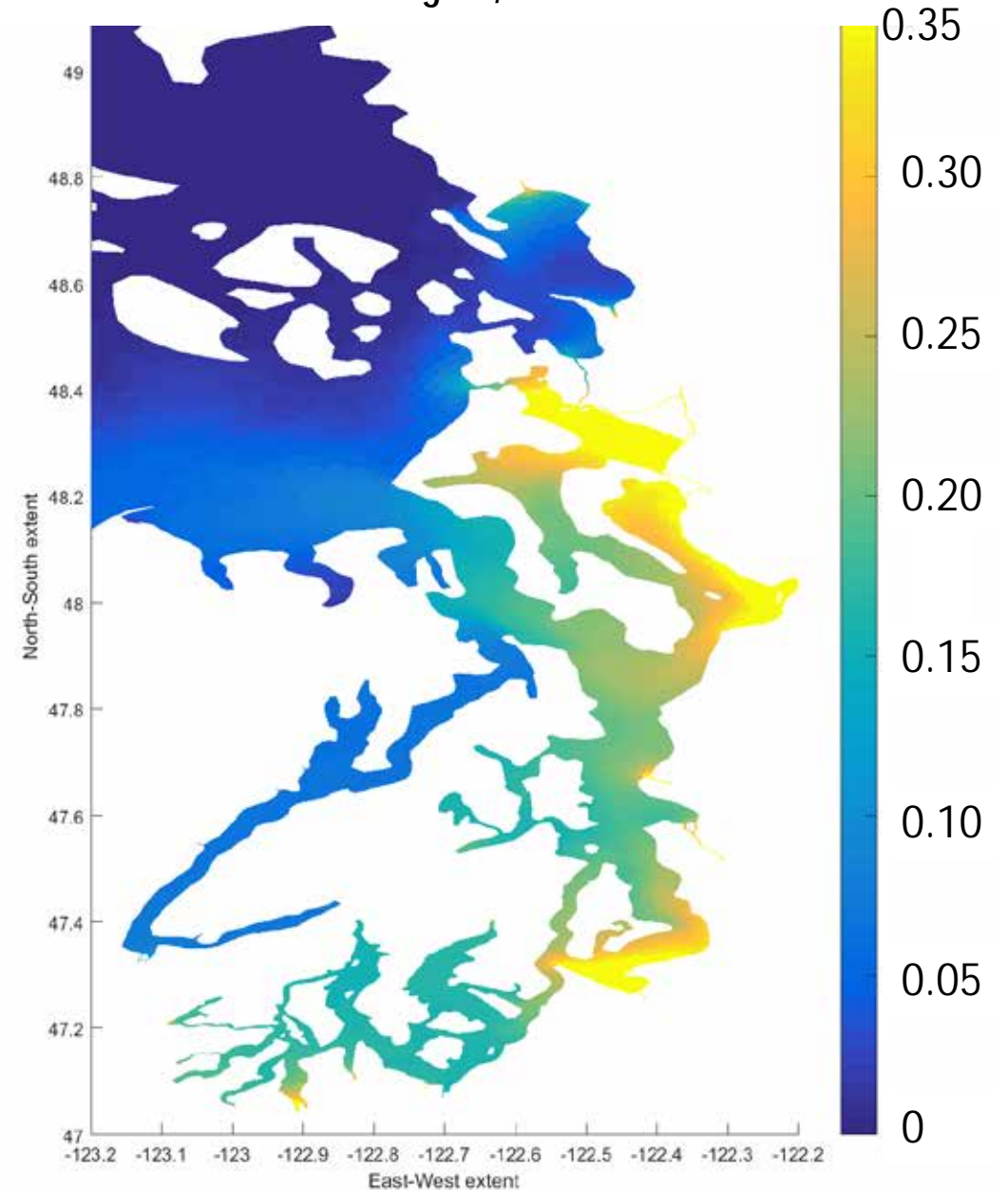


Based on **Salish Sea Model** implementation as described in:
Bianucci *et al.* 2018 (<http://doi.org/10.1525/elementa.151>) and
Khangaonkar *et. al.* 2018 (manuscript in review)

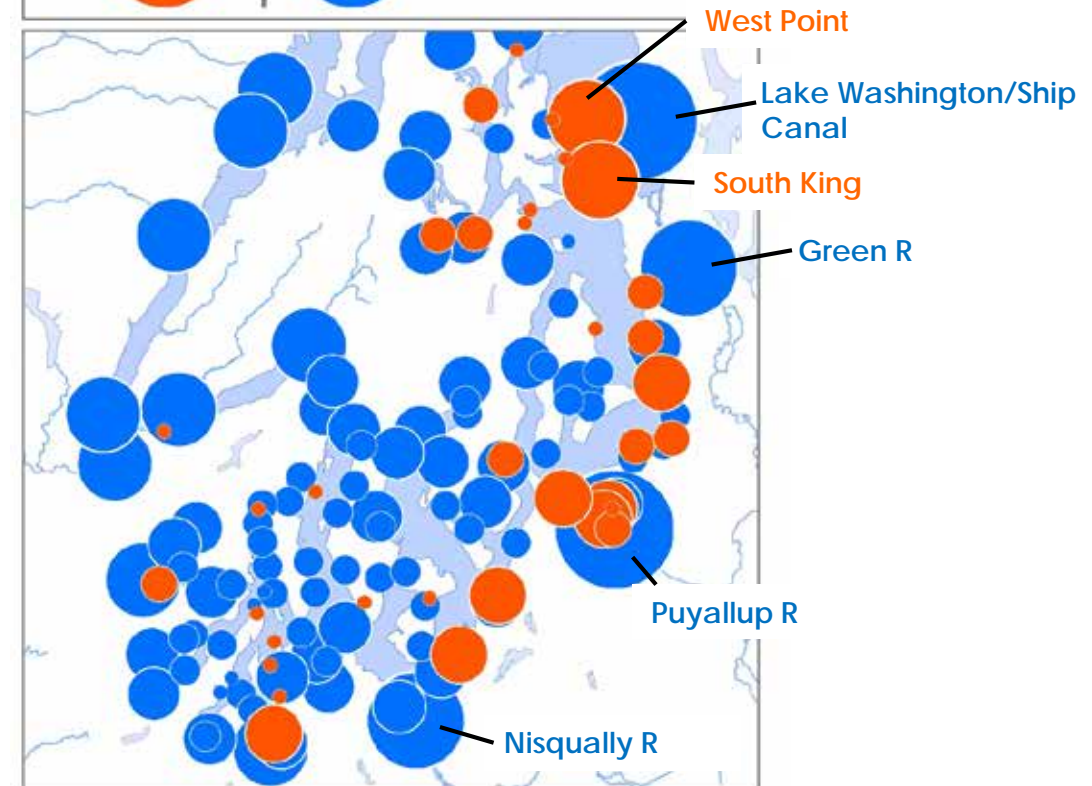
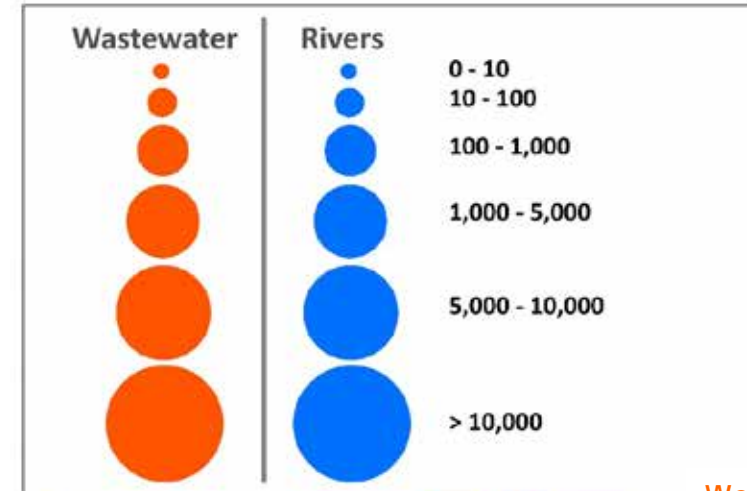
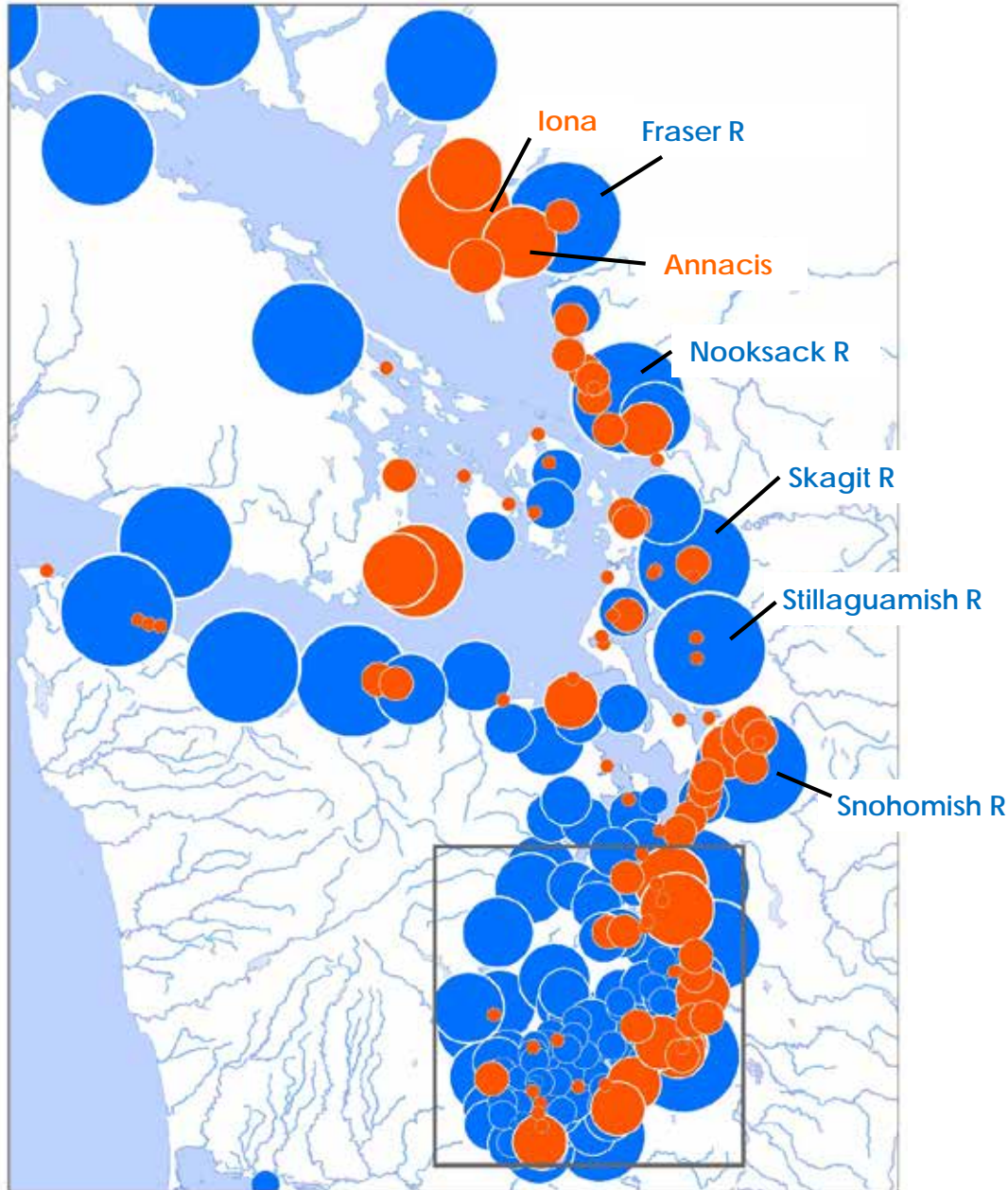
Predicted Fraction of Anthropogenic Non-algal Organic Carbon August, 2008

Human activity results in an increase of:

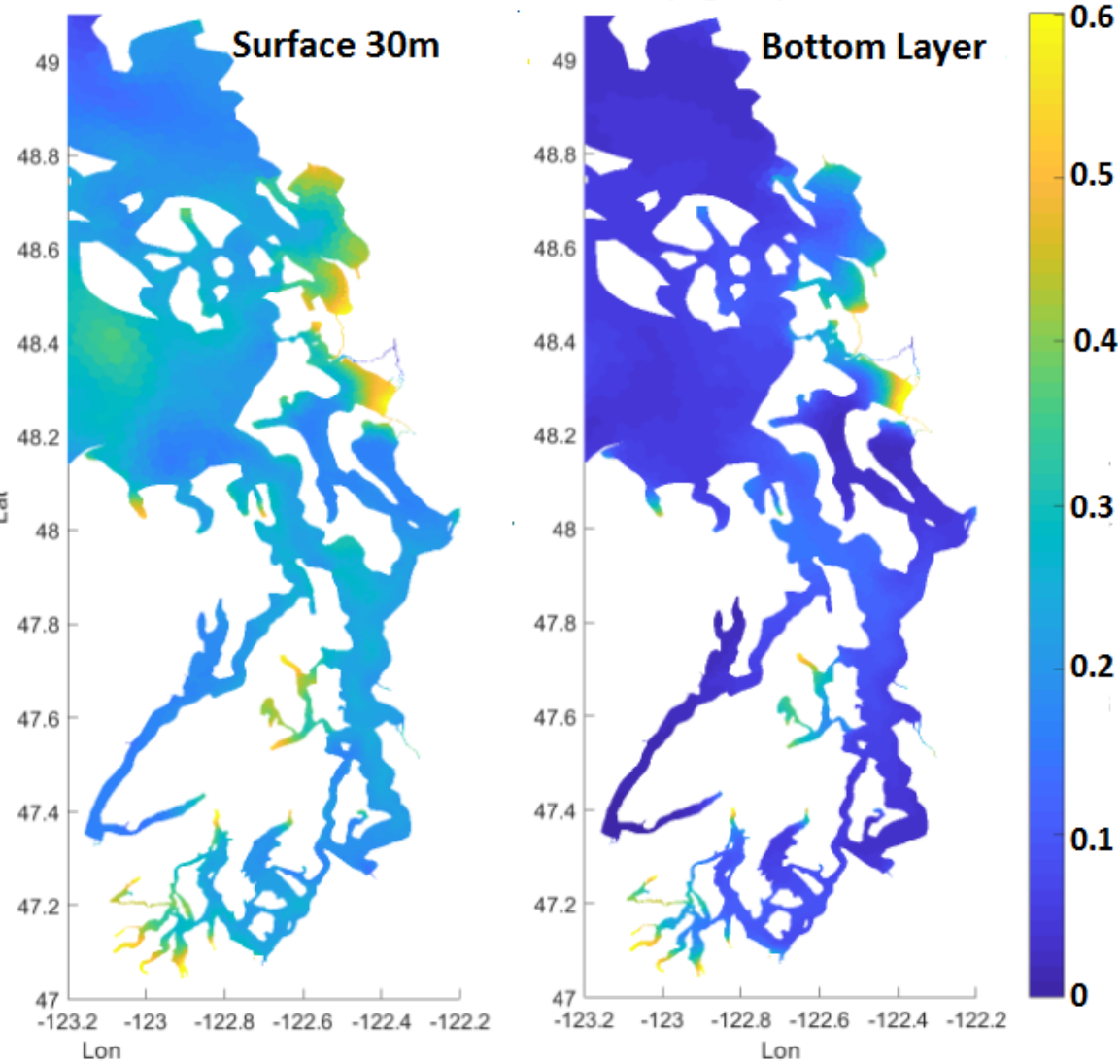
- Autochthonous organic detritus derived from increased productivity, and
- Allochthonous carbon from direct loading.



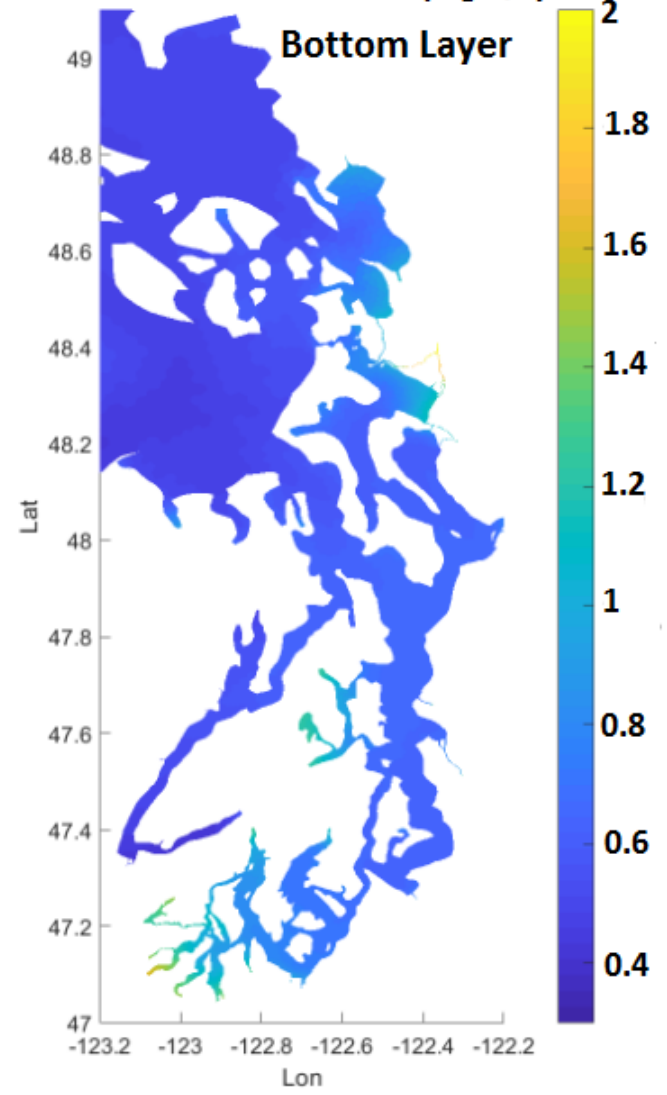
Dissolved Organic Carbon (DOC) loads in kg/day: 1999-2017 annual averages



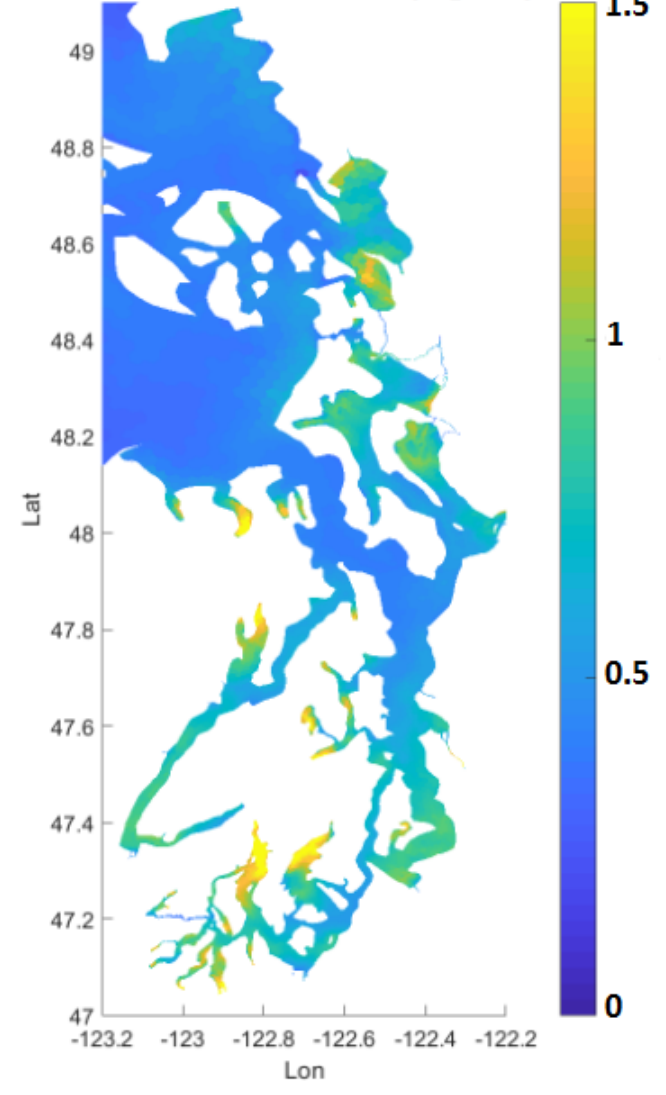
PHYTOPLANKTON (mg C/L)



DISSOLVED OC (mg C/L)

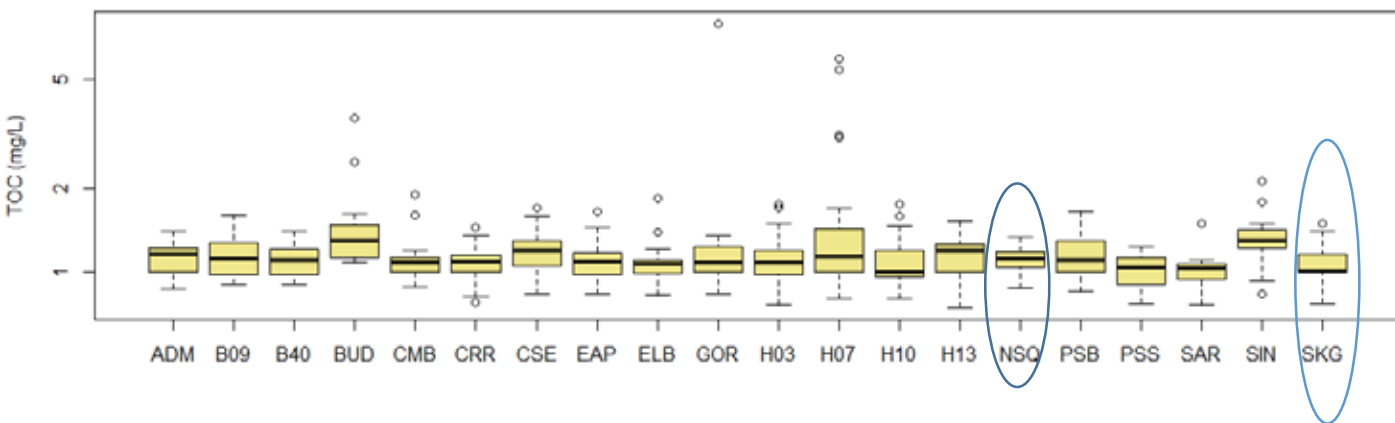


PARTICULATE OC (mg C/L)

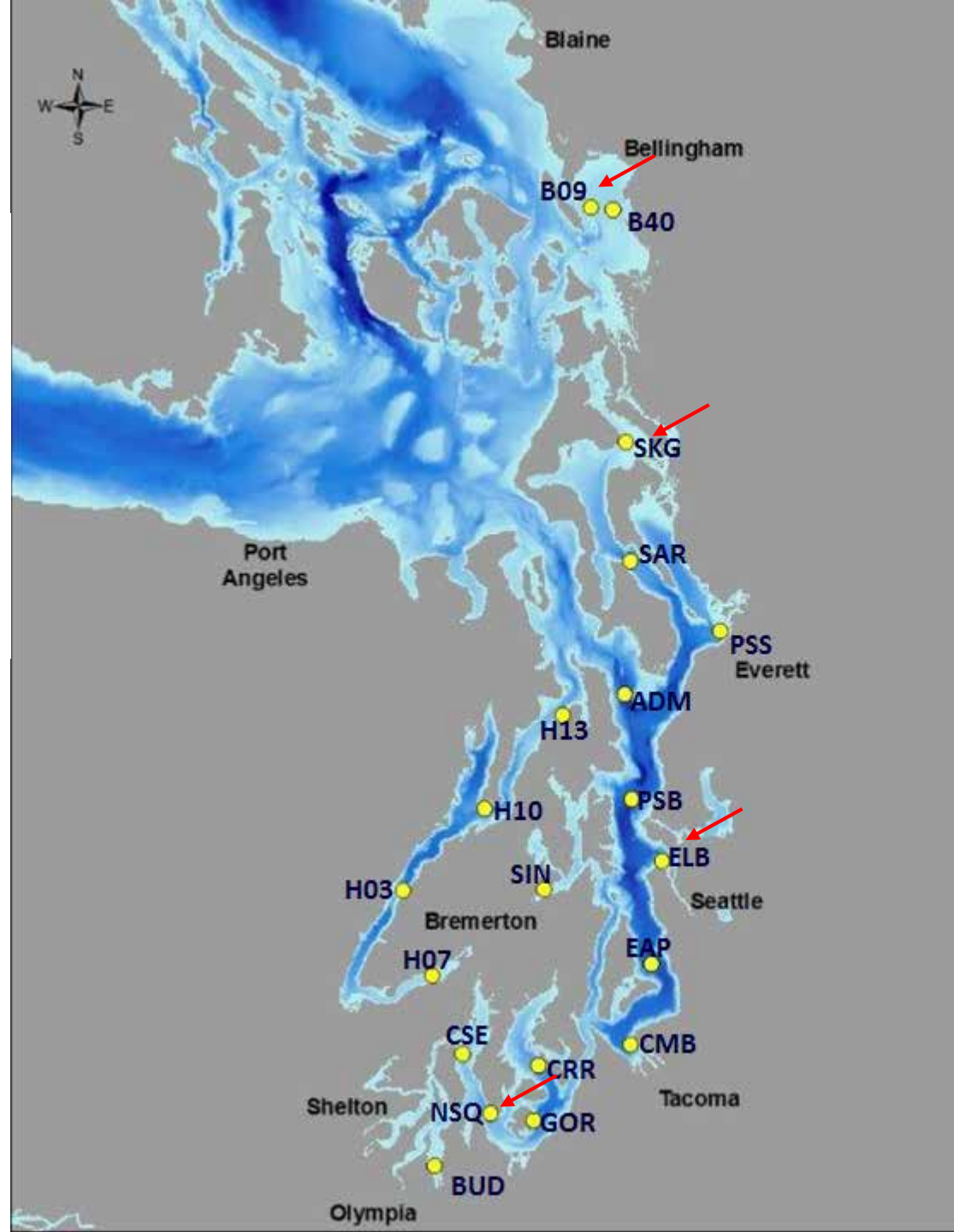
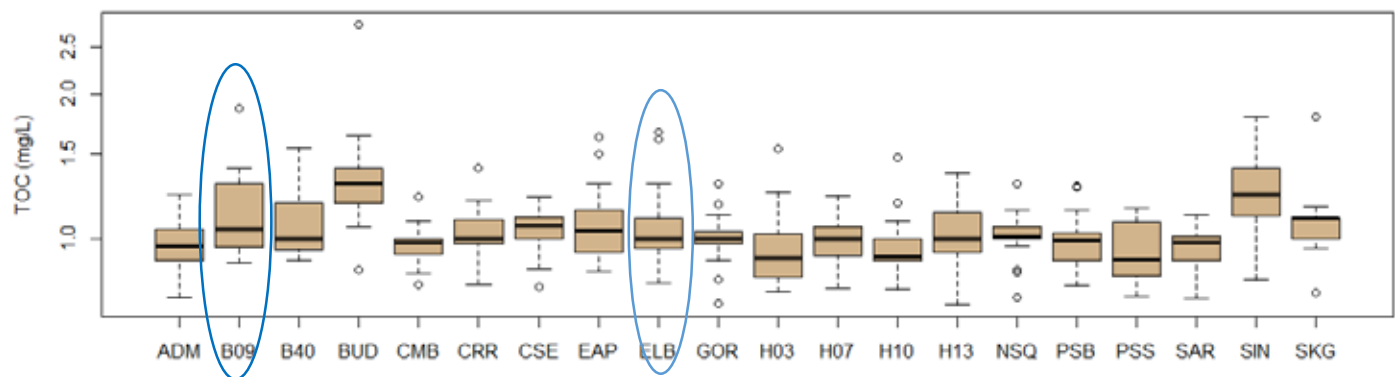


PREDICTED AVERAGES DURING APRIL-SEPTEMBER, 2014

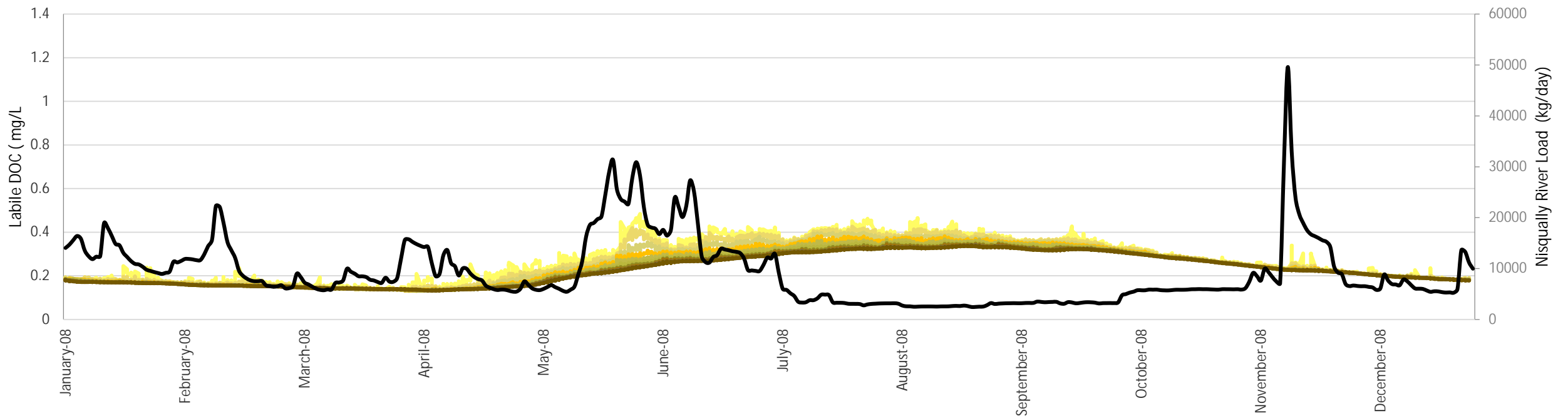
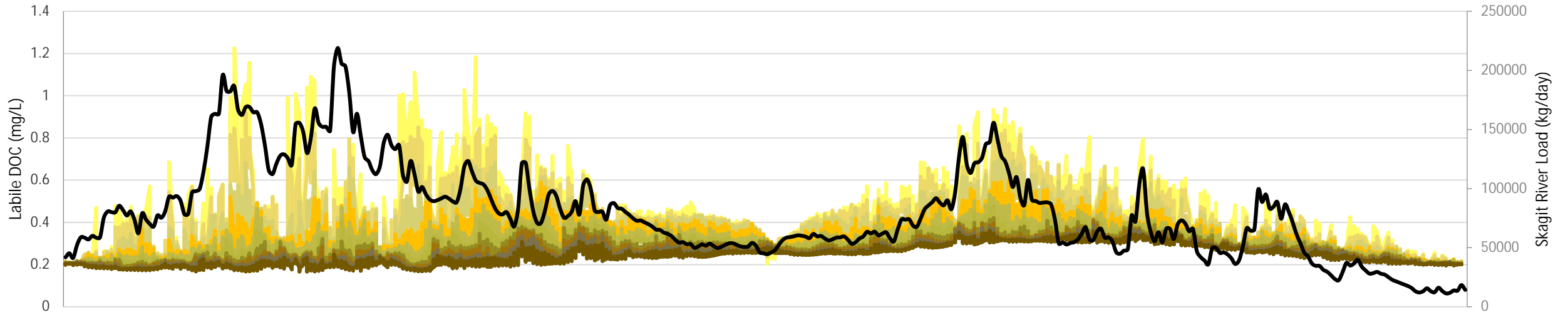
Observed Total Organic Carbon (TOC) Concentrations at Sites in Puget Sound (10 meters)



Observed Total Organic Carbon (TOC) Concentrations at Sites in Puget Sound (Near Bottom)

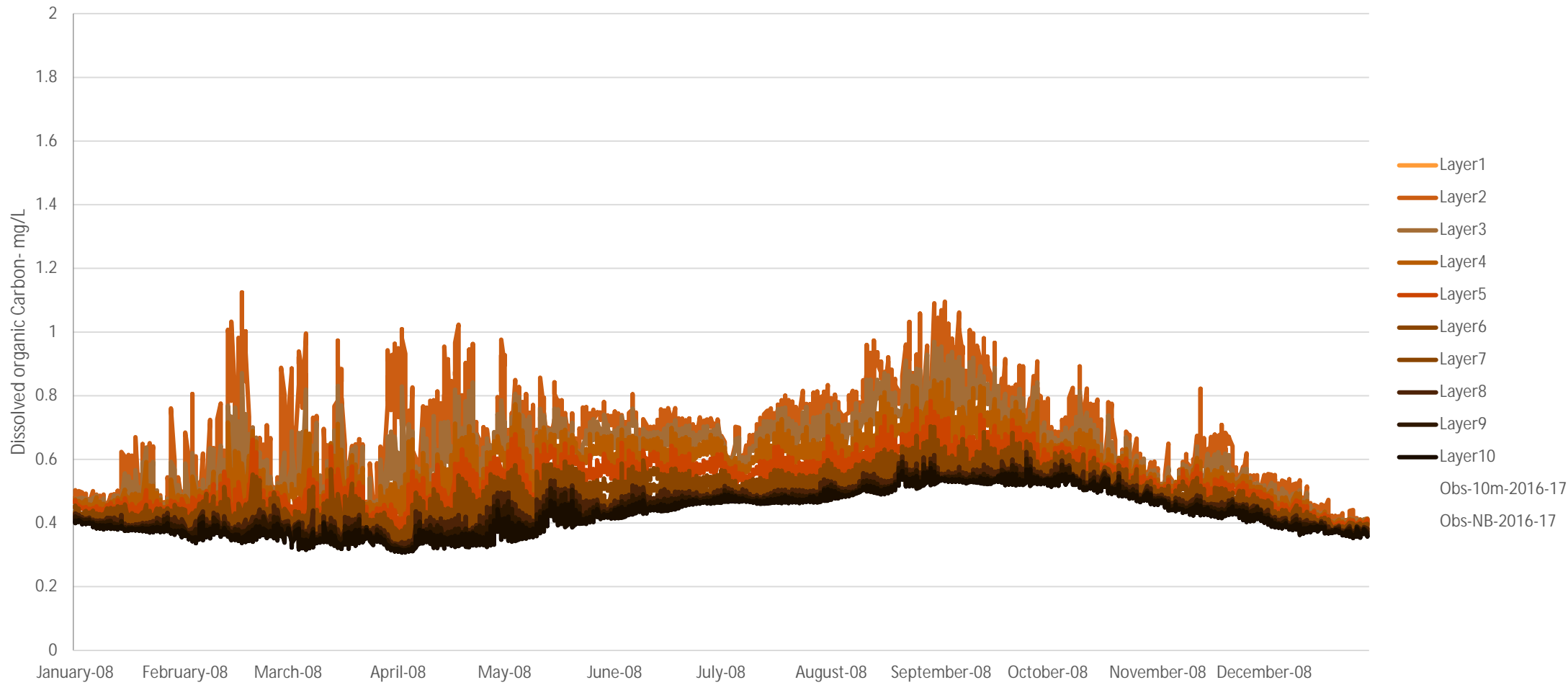


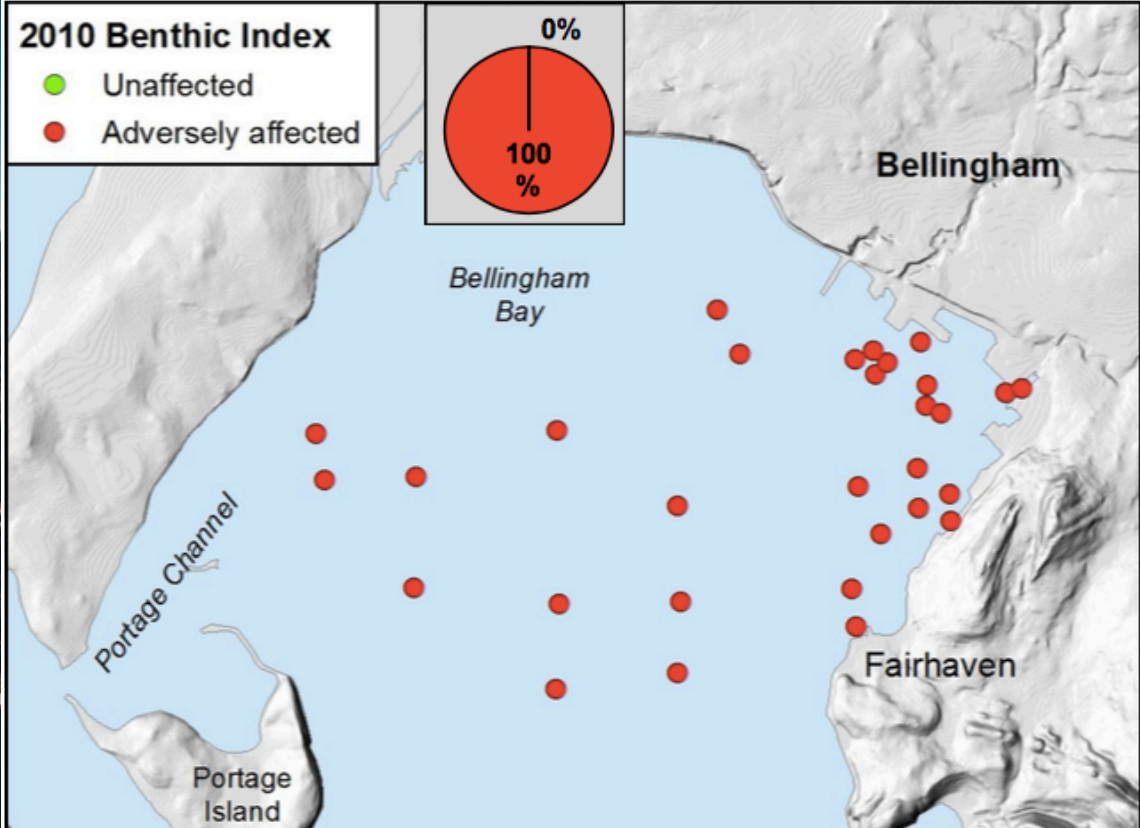
Predicted Labile DOC Concentrations at Skagit Bay (SKG003) and Nisqually (NSQ002) Compared to River Loads



— LLayer1 — LLayer2 — LLayer3 — LLayer4 — LLayer5 — LLayer6 — LLayer7 — LLayer8 — LLayer9 — LLayer10 — R (kg/day)

Comparison between Predicted (2008) and Observed (2016-17) Dissolved Organic Carbon at Skagit Bay





Comparison of Predicted (2008) Particulate Organic Carbon and Observed (2016-17) at Bellingham Bay - near Pt. Frances (BLL09)

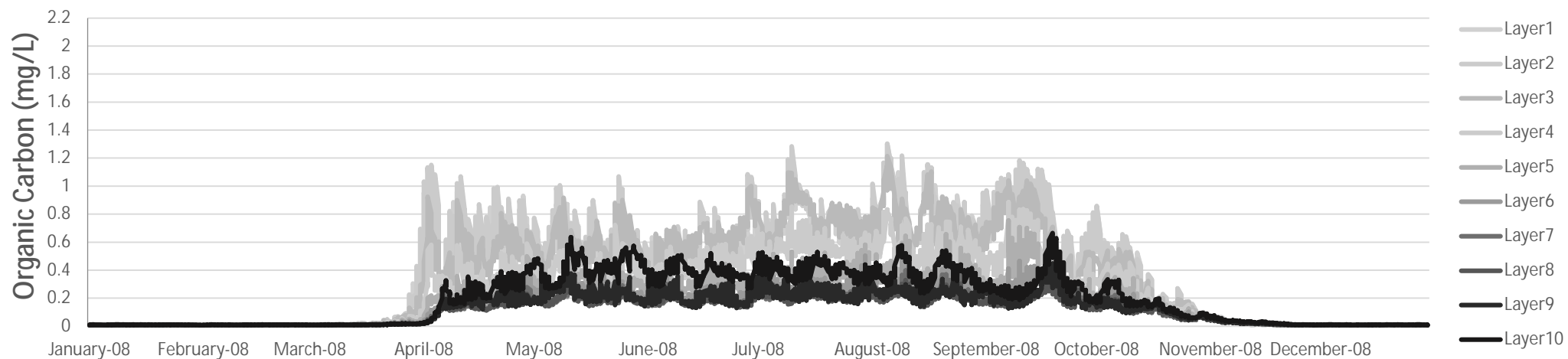


Photo credit: Nick Kelly
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Comparison of Predicted (2008) and Observed (2016-17) Particulate Organic Carbon at Elliot Bay (ELB015)

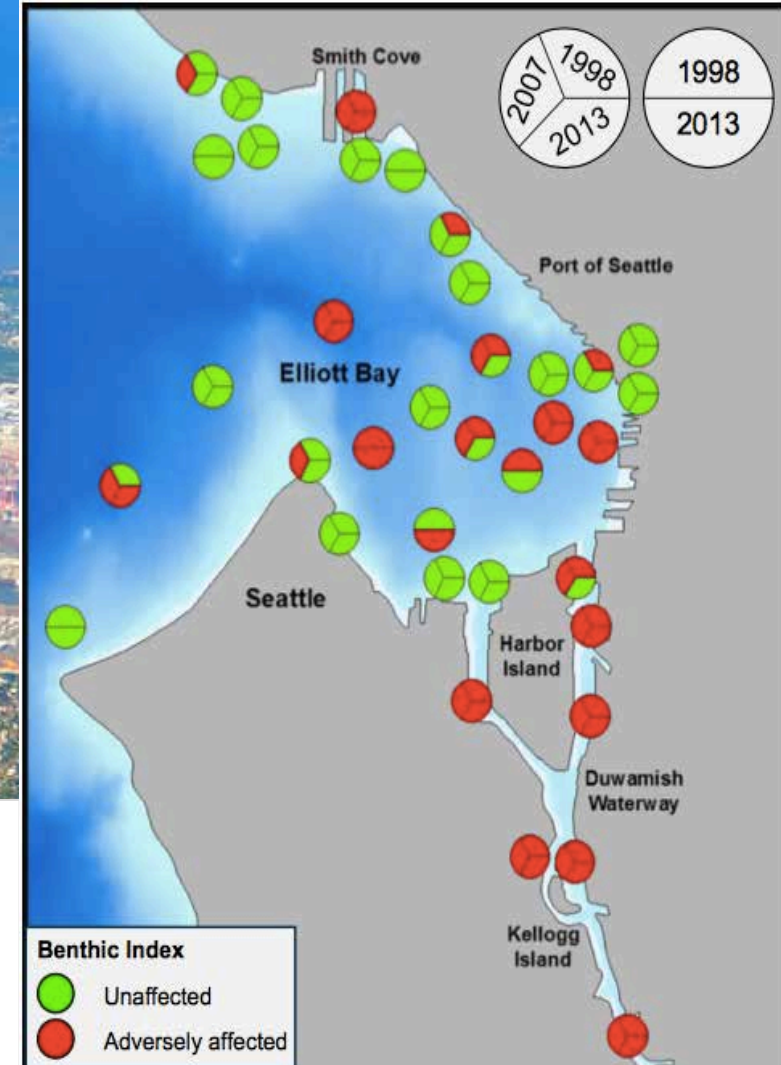
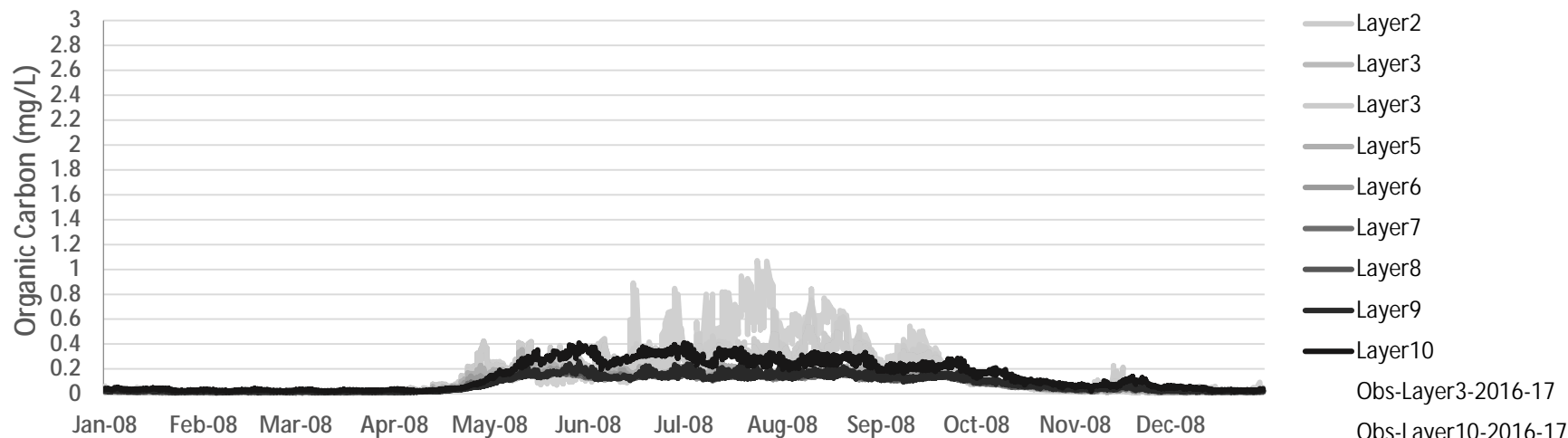
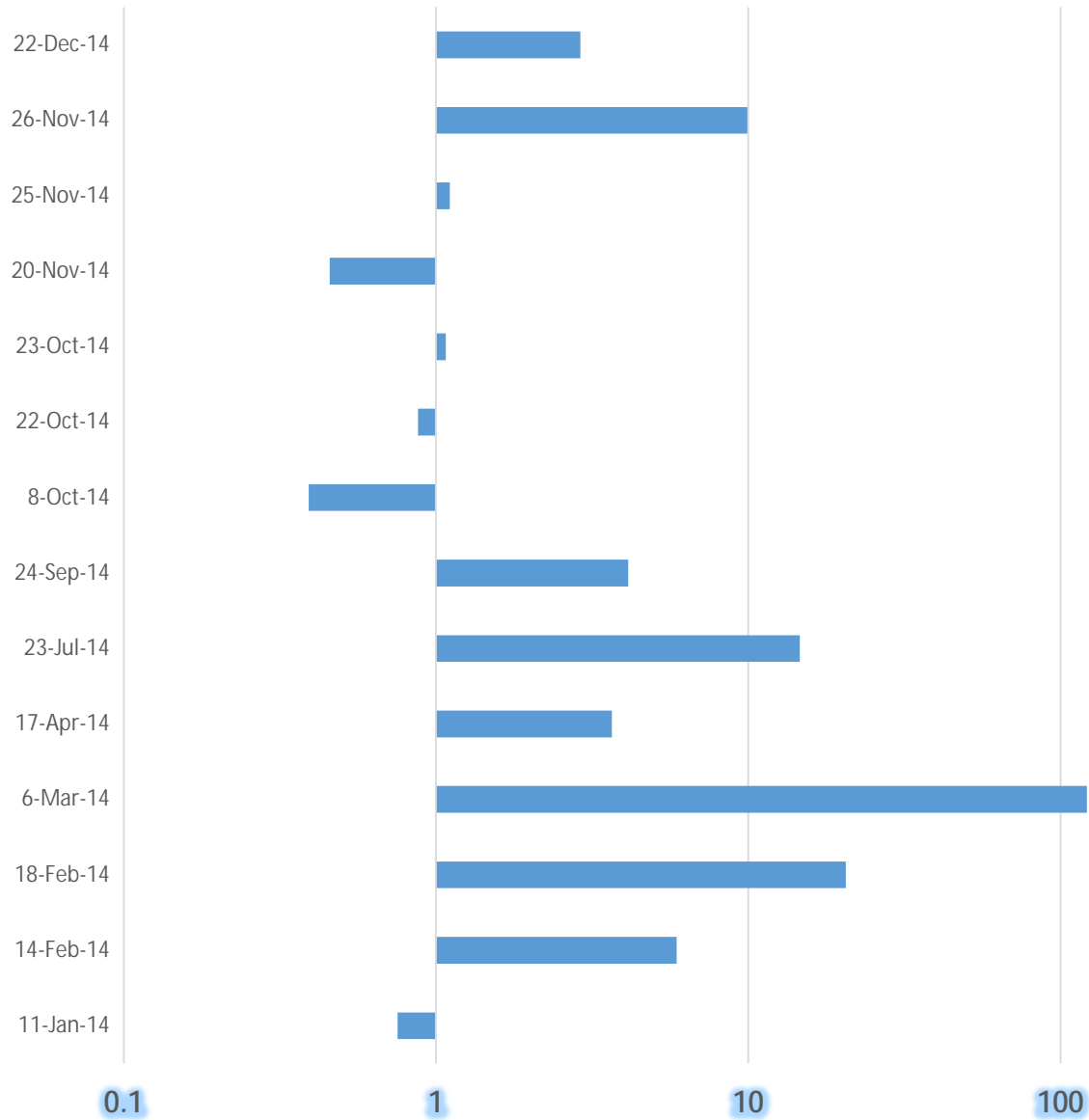


Photo credit: Michael Brophy
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Comparison of POC observations to regression estimates based on monthly data for the Duwamish River



Data source and Photo Courtesy: Conn, K.E., et. al. 2015, Chemical concentrations and instantaneous loads, Green River to the Lower Duwamish Waterway near Seattle, Washington, 2013–15: U.S. Geological Survey Data Series 973, 46 p., <http://dx.doi.org/10.3133/ds973>.

During storm and dam release events, observed particulate organic carbon concentrations were up to 120 times higher than regression estimates (based on monthly observations) for those dates.

Conclusions

- We highly recommend including organic carbon in the suite of parameters measured in the long term monitoring program.
- Rivers deliver larger organic carbon loads to the Salish Sea than point sources discharging directly into marine waters.
- Terrestrial organic carbon loading inputs to the model may be low, particularly at river mouths delivering loads during storm events and downstream from dams.
- Data with higher temporal resolution at river mouths is needed to address the above deficiency.
- Observed and predicted data suggest that, due to riverine impacts, DOC patterns can deviate substantially at specific sites from expected patterns due to algal production.
- Further work is needed to understand the linkages between particulate organic carbon, delivered at river mouths or produced in marine waters, and resulting sediment quality including potential impacts to the benthos.



Questions?

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TOC April-September Averages

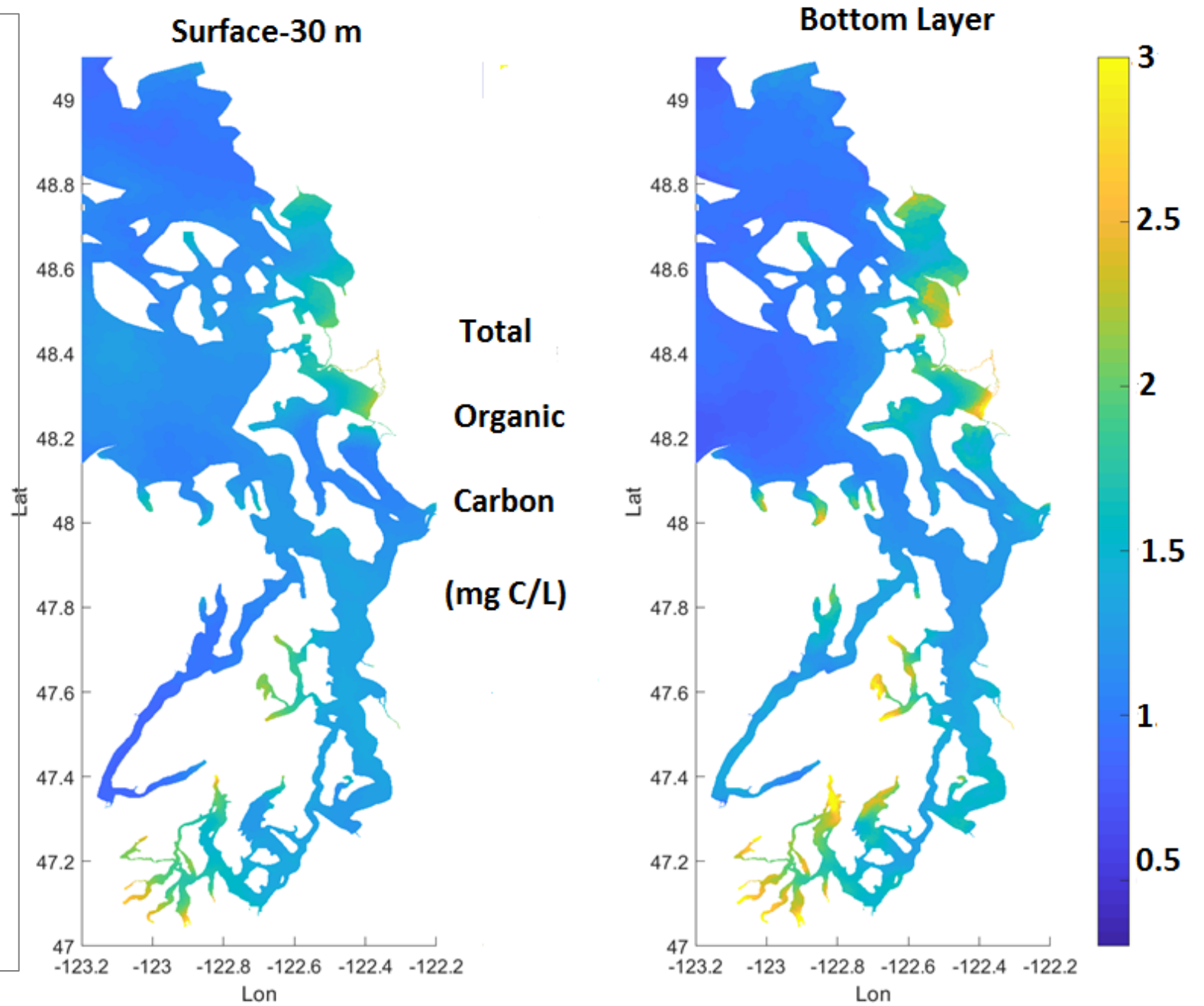
Percentile 0% 50% 100%

Observational Data (2016-17)

Bottom (N=228)	0.8	1.0	2.8
10 m (N=234)	0.9	1.2	5.9

Predicted Data (2014)

Bottom (N=9013 in Salish Sea)	0.6	1.4	5.1
30 m (N=9013 in Salish Sea)	0.7	1.3	3.7



Predicted Averages for April-September, 2014

Comparison of estimated marine fraction organic particulates deposited in the sediment layer and marine POC predicted in the bottom layer

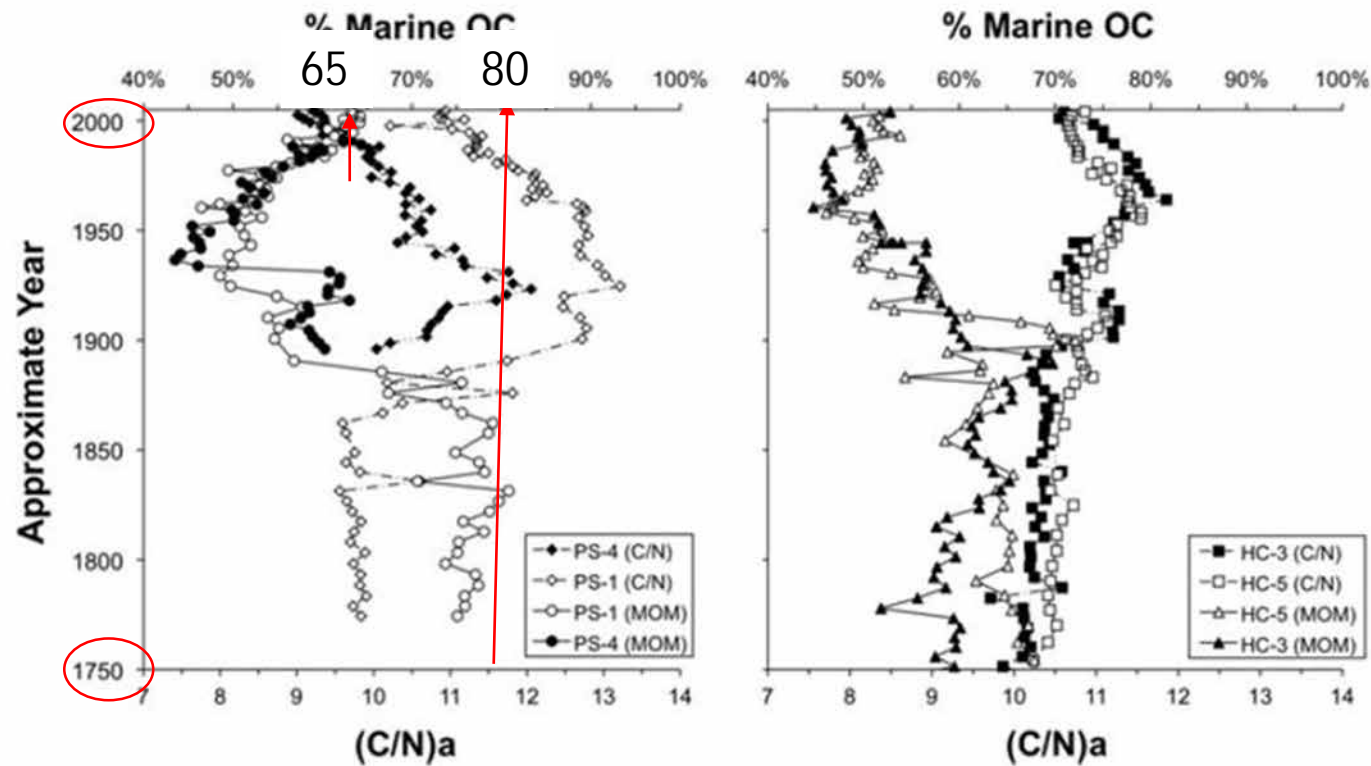


Fig. 5 Proportion of marine organic carbon (MOM) calculated using sediment $\delta^{13}\text{C}$ signatures and the two mixing end-members and the atomic organic carbon to nitrogen ratios ((C/N)a) for Main Basin (PS-1 and PS-4) and Hood Canal (HC-3 and HC-5) sediment cores

Source: Brandenberger, JM, et al. *Natural and Post-Urbanization Signatures of Hypoxia in Two Basins of Puget Sound: Historical Reconstruction of Redox Sensitive Metals and Organic Matter Inputs*, Aquatic Geochemistry, 2011

