Monitoring capabilities in WA for Ocean Acidification

Presented by Jan Newton,
UW/NANOOS
on behalf of numerous contributors

Overall messages

- Puget Sound does not have an OA monitoring program
  - Some individual pieces exist, there is excellent collaboration (e.g., federal, academic, state, growers); however, sustained funding is lacking, and a spatially complete, coordinated design (physics-chemistry with biology) is needed.

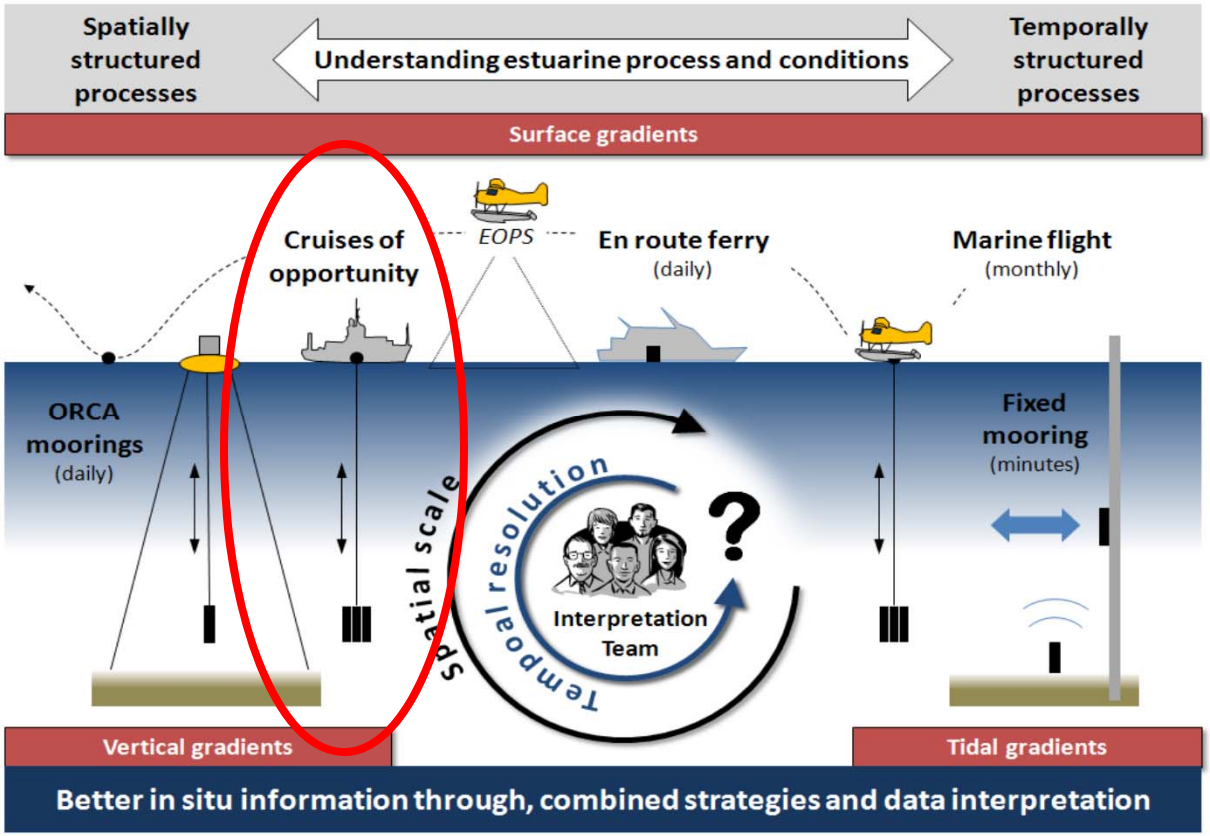
- OA condition in region highly variable, adequate spatial and temporal monitoring is important for effective mitigation (CO_2 and nutrients) and adaptation strategies

WA Marine Environments

- Offshore: coastal ocean dynamic on many scales
- Puget Sound: basins, bays, inlets, nearshore
- Columbia River: salinity gradient
- Small estuaries: shallow and well-mixed
- Shellfish hatcheries: 3 major plus others

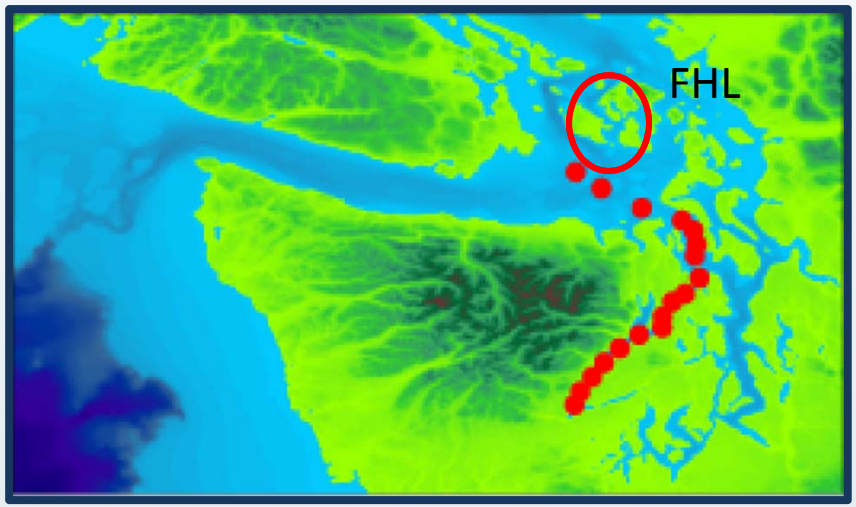
“Overview of existing monitoring efforts, organizations involved”

Surveys

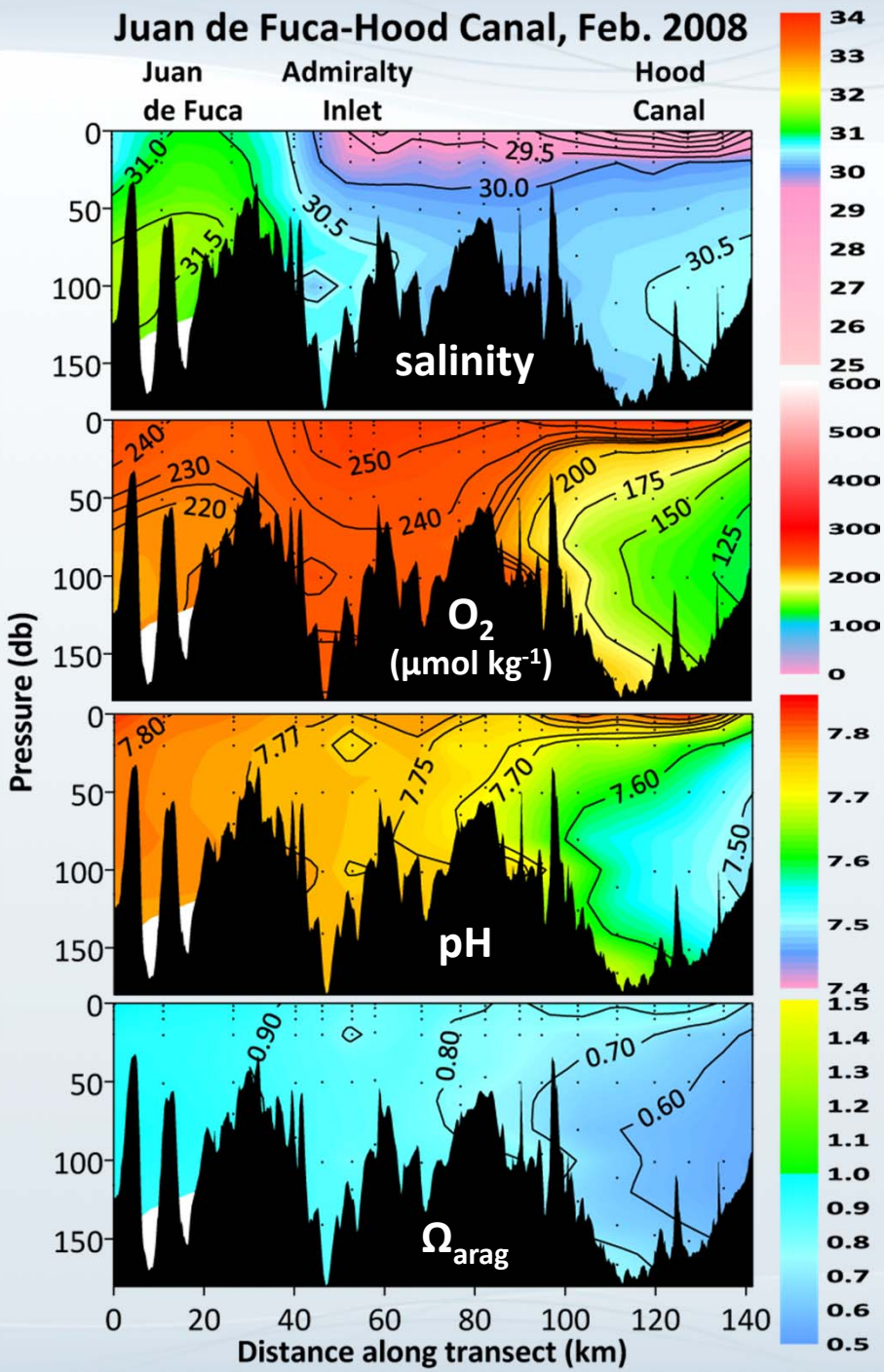


University of Washington
PRISM/NANOOS annual cruises:
UW, NOAA, Ecology, others

Winter 2008 transect: Juan de Fuca Strait to Hood Canal



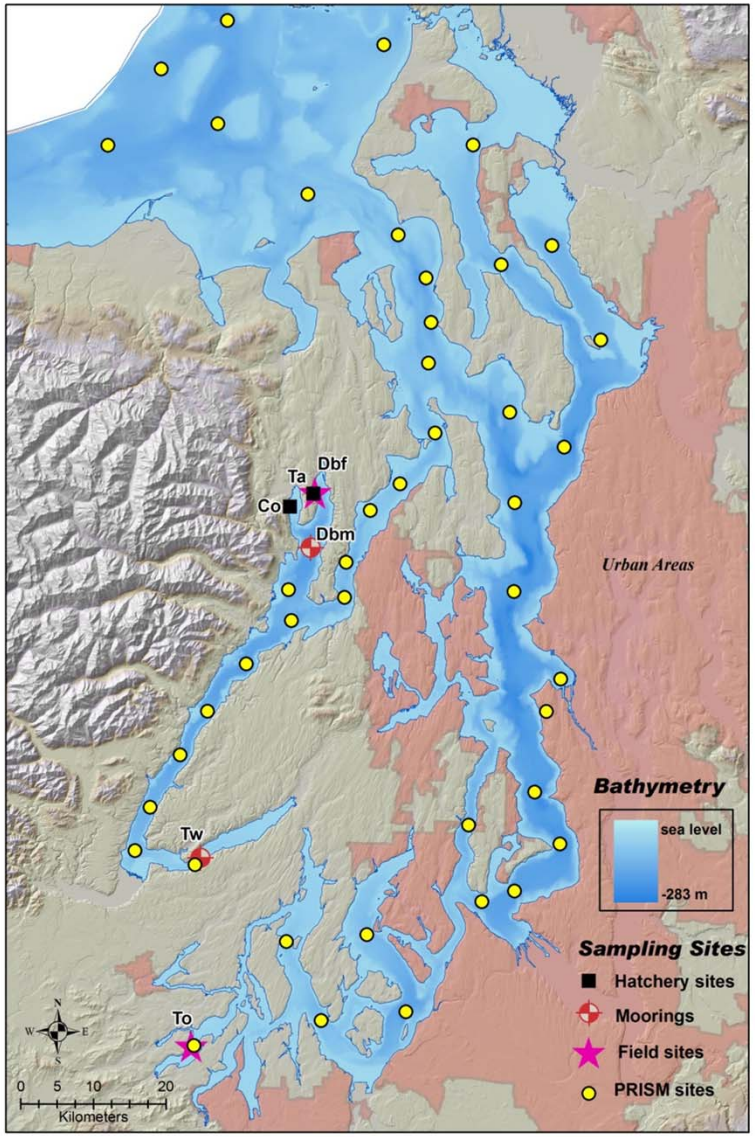
Corrosive undersaturated (Ω<0.9) water occurs throughout the water column in Winter with pH as low as 7.5

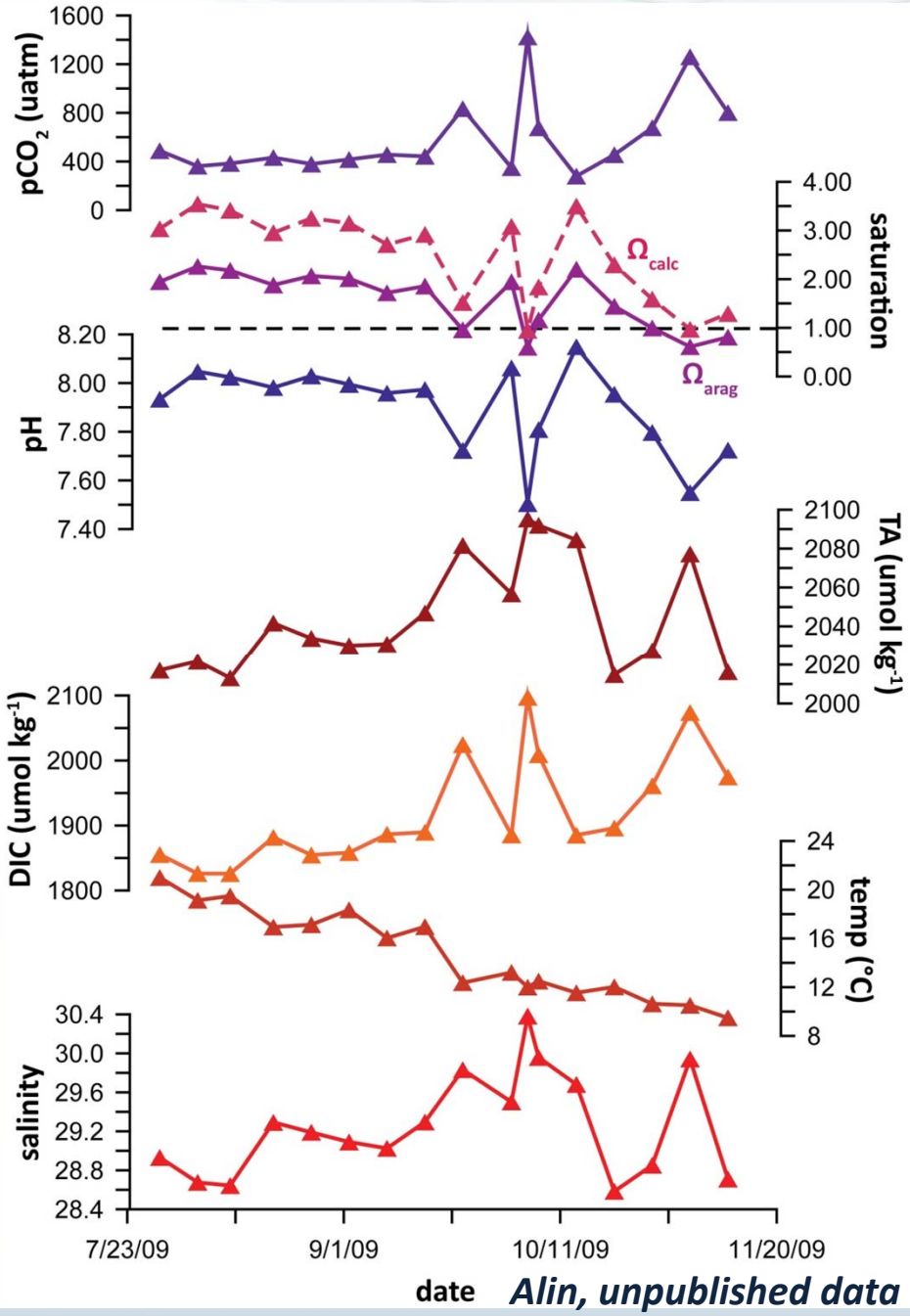


Feely et al. (2010)

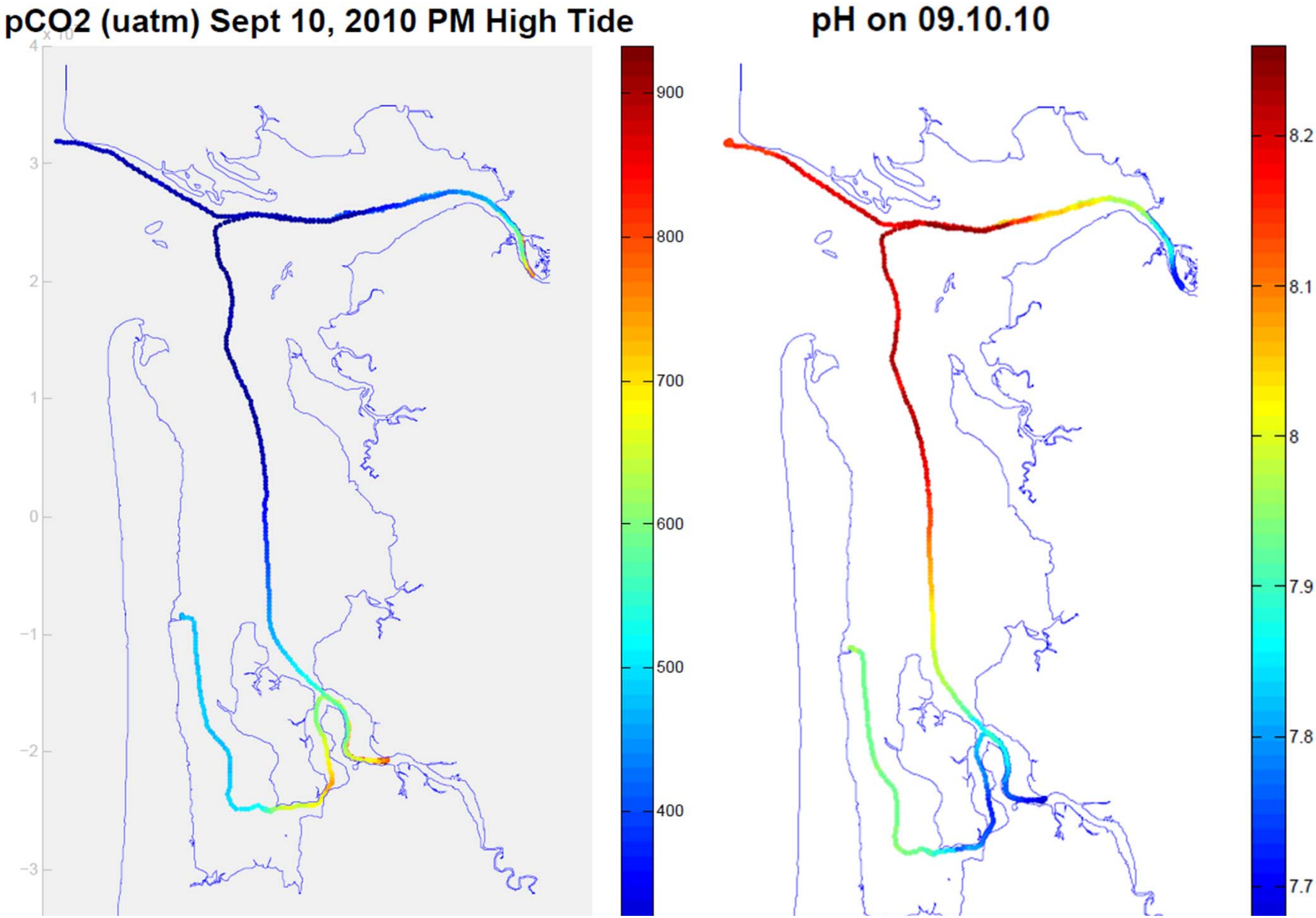
Dabob Bay Summer 2009

Puget Sound Partnership
funded a 2-y study:
NOAA, UW, PSI, Taylor, PSRF





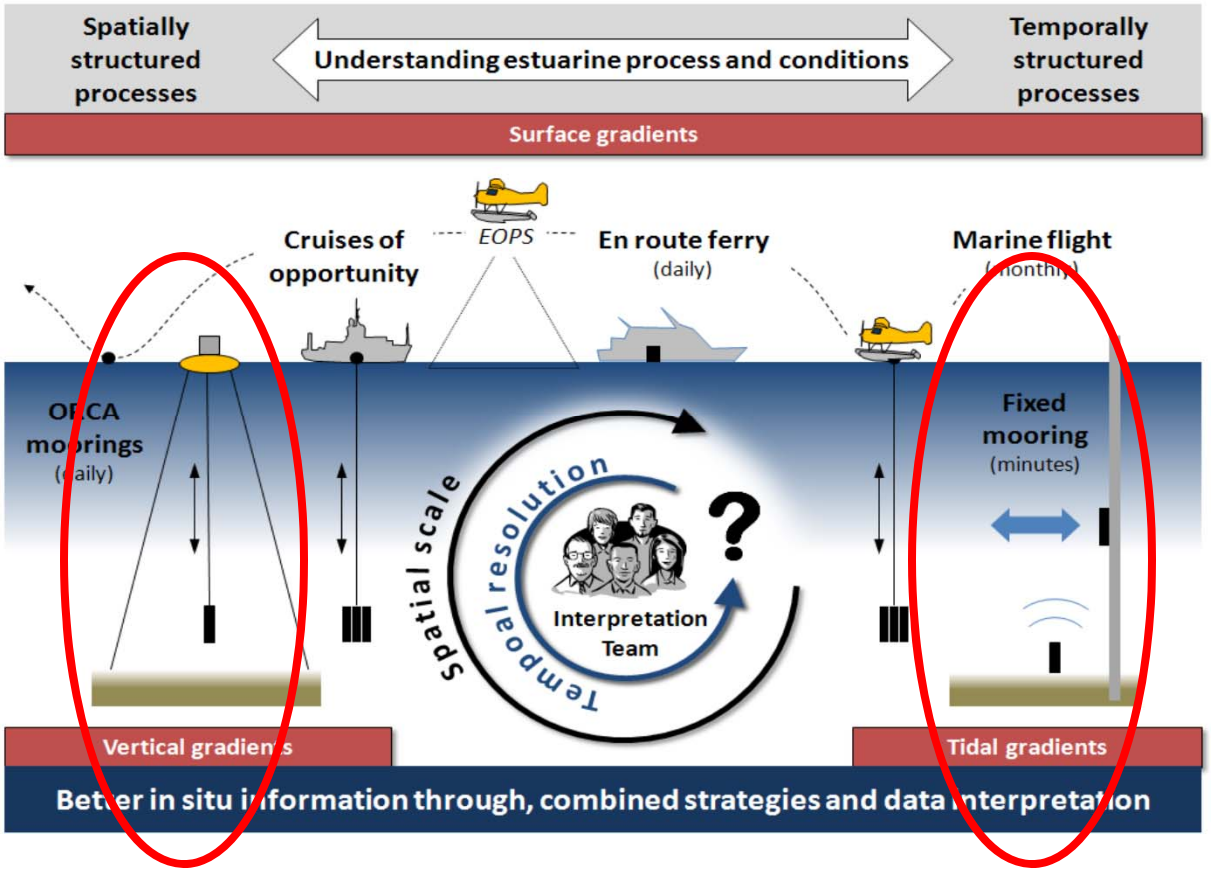
Alin, unpublished data

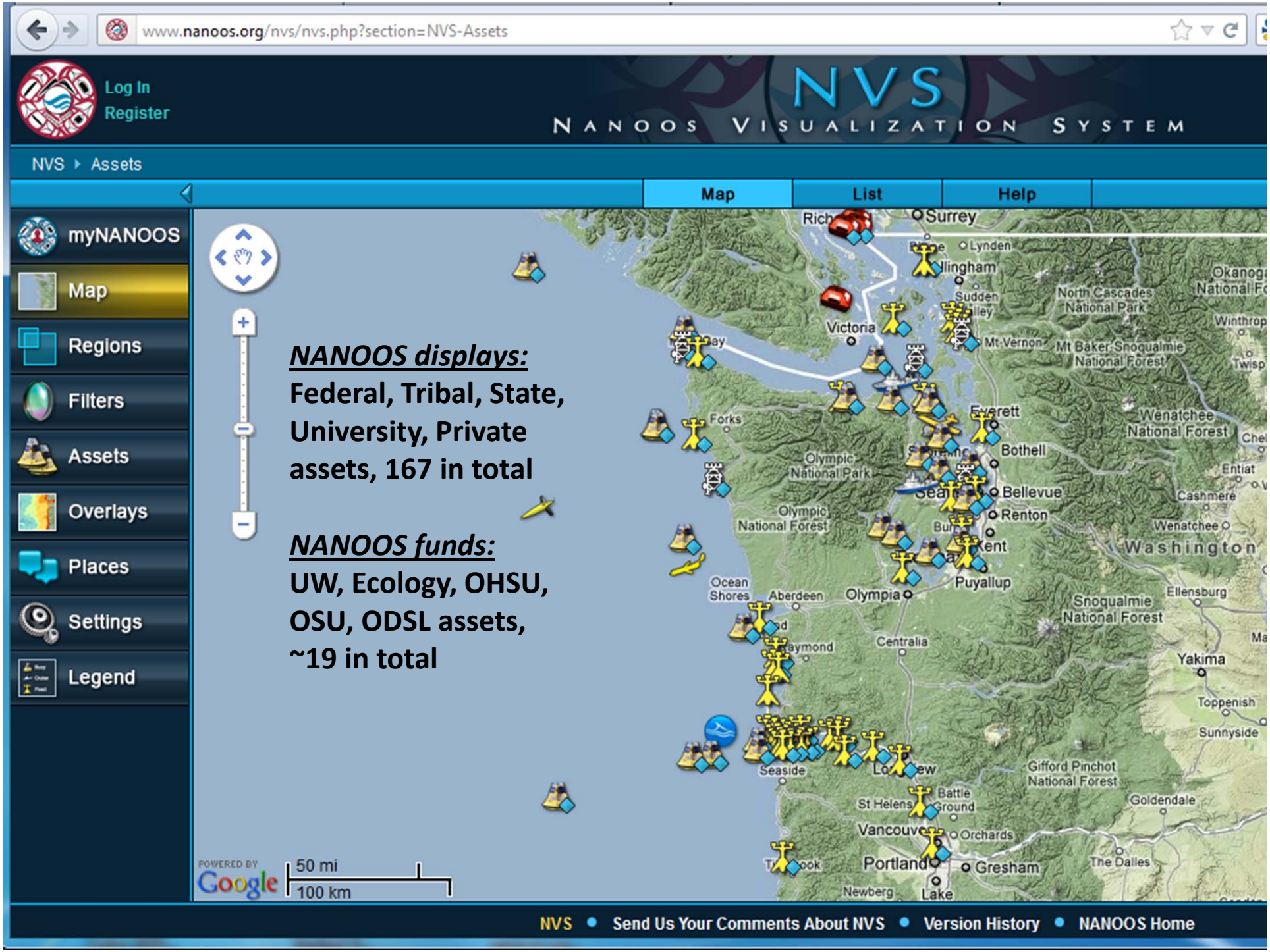


Within-estuary sampling for pH and pCO_2 occurred in summer 2009-2010 in Willapa Bay and documented watershed carbon inputs (Ruesink and Trimble, unpublished).

“Overview of existing monitoring efforts, organizations involved”

Buoys/Fixed sensors

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Legend
NANOOS displays:
Federal, Tribal, State, University, Private assets, 167 in total
NANOOS funds:
UW, Ecology, OHSU, OSU, ODSL assets, ~19 in total
Surrey
Lynden
Victoria
Mt Vernon
North Cascades National Park
Mt Baker-Snoqualmie National Forest
Forks
Everett
Bothell
Bellevue
Renton
Olympic National Park
Olympic National Forest
Wenatchee National Forest
Washington
Ocean Shores
Aberdeen
Olympia
Puyallup
Snoqualmie National Forest
Ellensburg
Centralia
Yakima
Toppenish
Sunnyside
Seaside
Gifford Pinchot National Forest
Goldendale
St Helens
Battle Ground
Vancouver
Orchards
Portland
Gresham
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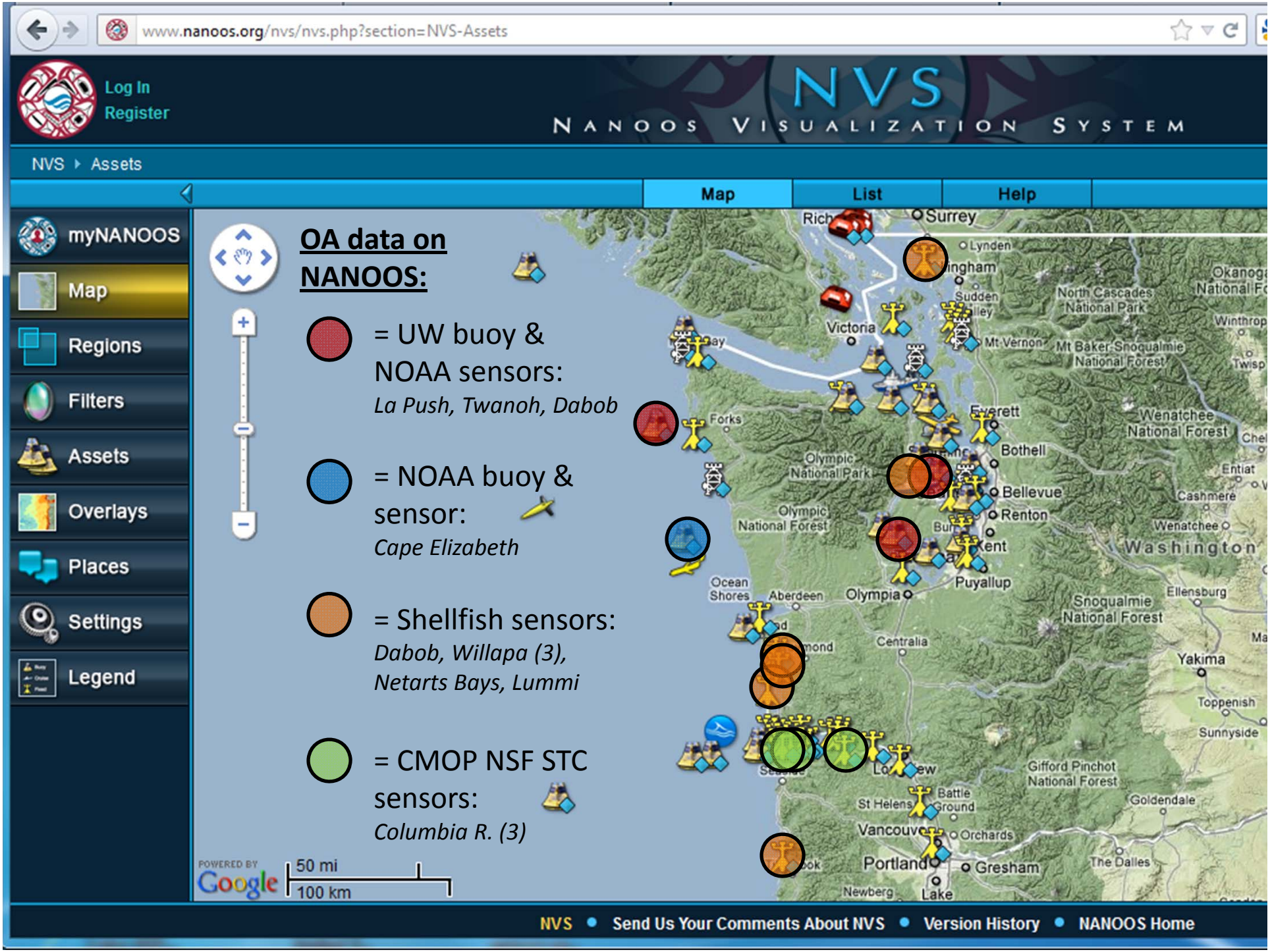
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Legend
OA data on NANOOS:
= UW buoy & NOAA sensors:
La Push, Twanoh, Dabob
= NOAA buoy & sensor:
Cape Elizabeth
= Shellfish sensors:
Dabob, Willapa (3), Netarts Bays, Lummi
= CMOP NSF STC sensors:
Columbia R. (3)
POWERED BY Google
50 mi
100 km
Surrey
Victoria
Everett
Bothell
Bellevue
Renton
Kent
Puyallup
Olympia
Aberdeen
Ocean Shores
Forks
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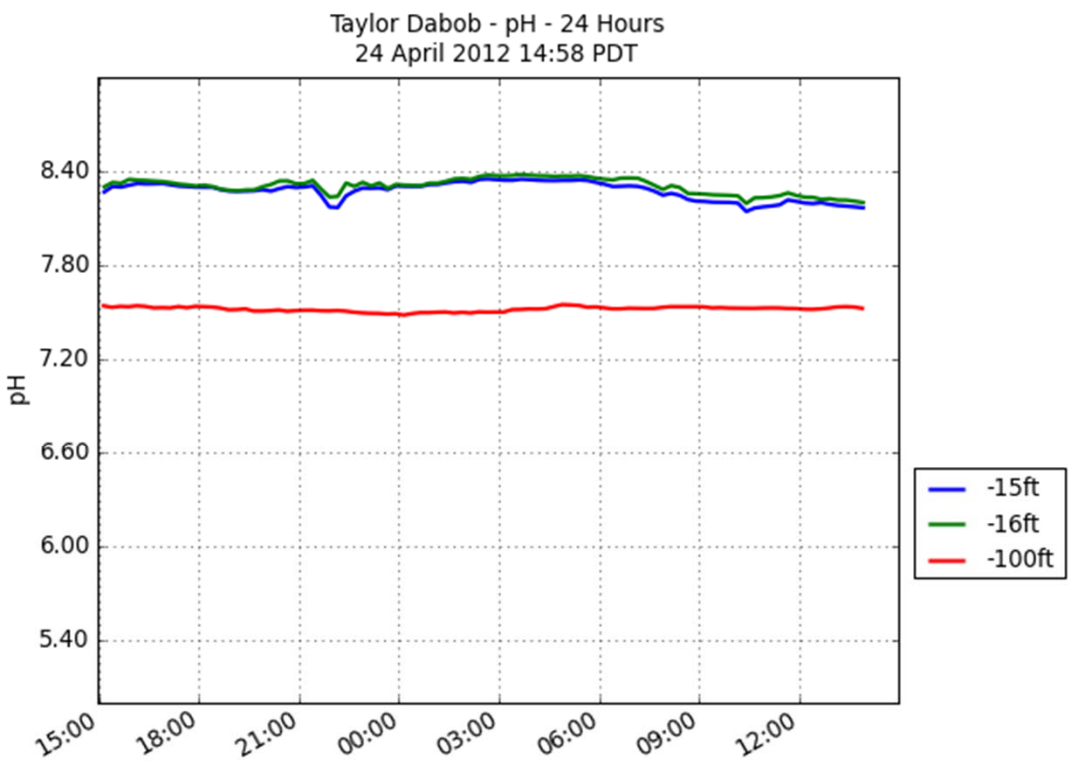
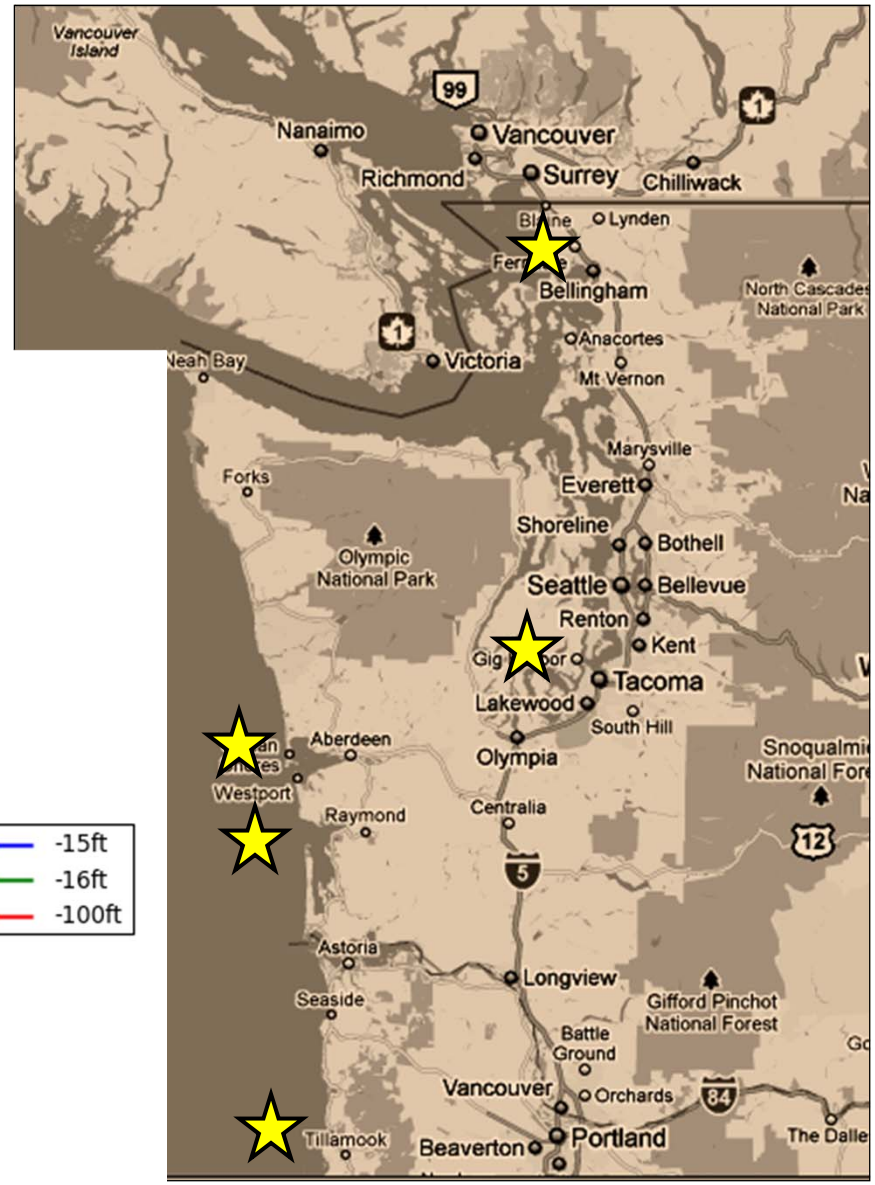
Shellfish Hatcheries

PCSGA Monitoring Program 2011 Monitoring Stations

Pacific Coast Shellfish Growers Association

- ★ Bellingham, WA- Lummi Hatchery
- ★ Dabob Bay, WA- Taylor Shellfish Hatchery





NANOOS

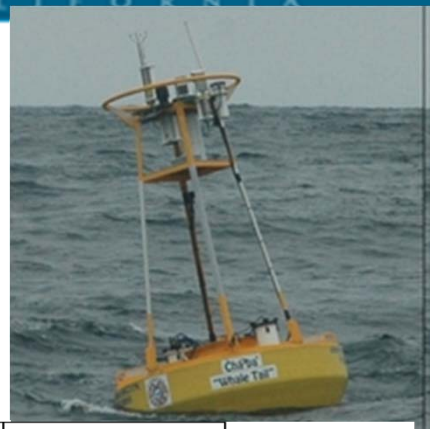
Northwest Association of Networked Ocean Observing Systems

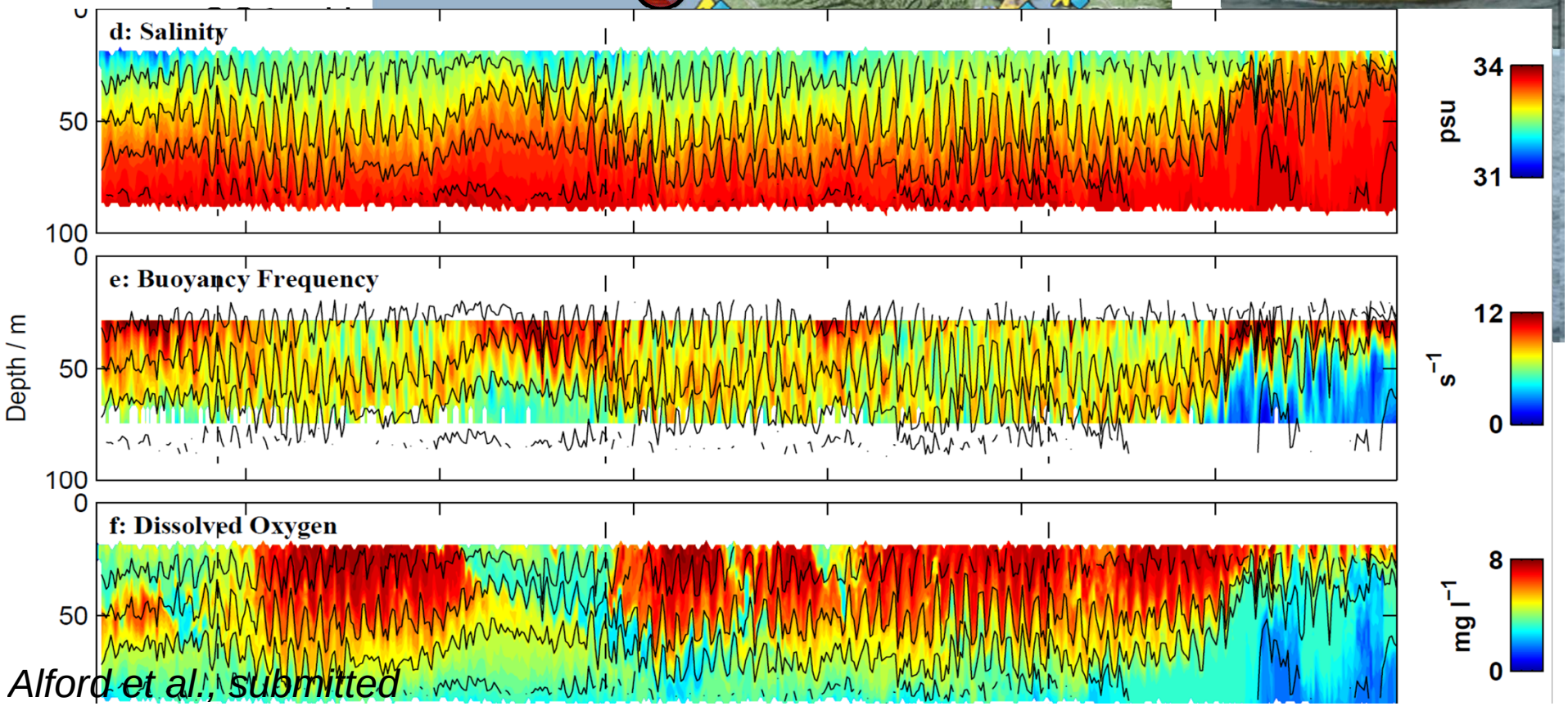
Washington - Oregon - Northern California

Coastal Ocean

Assets by:

UW w/ NOAA (IOOS/OAP)





Alford et al., submitted

NANOOS

Northwest Association of Networked Ocean Observing Systems

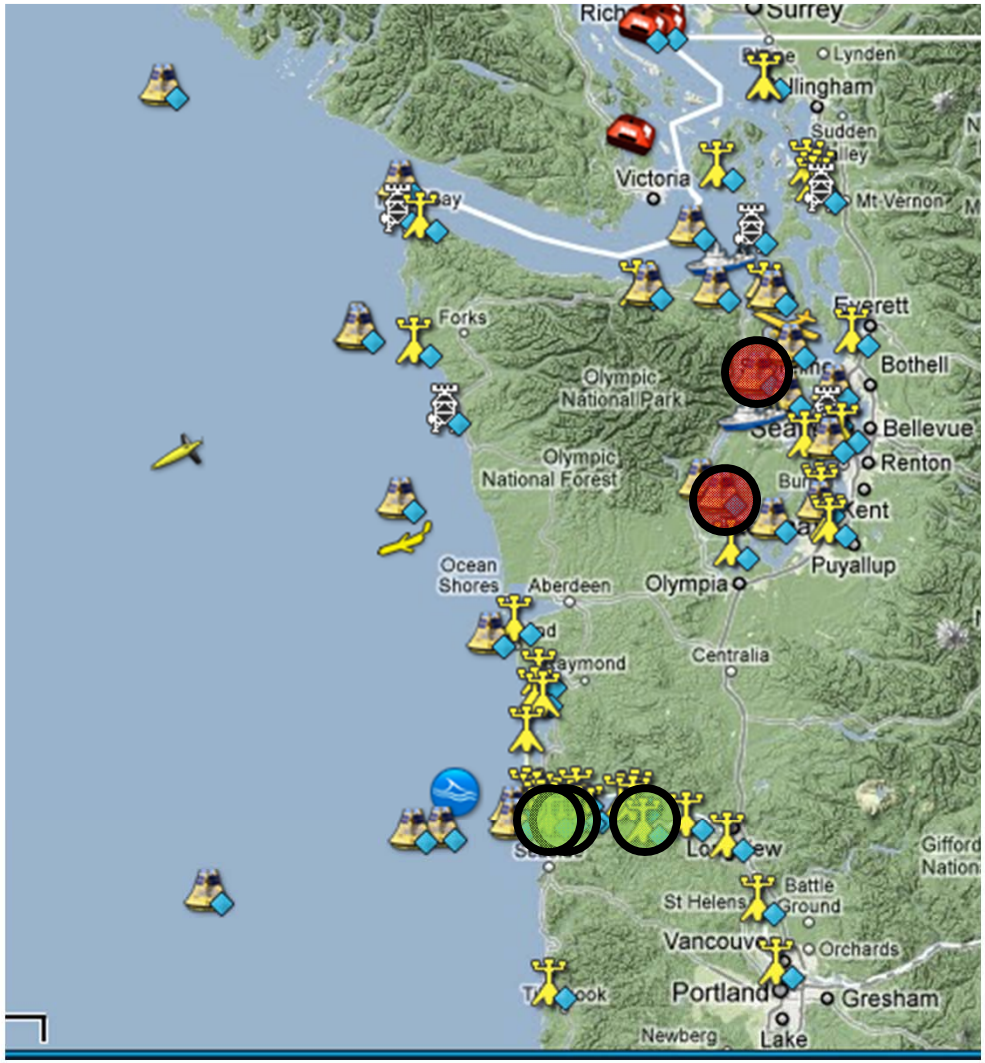
Washington - Oregon - Northern California

Puget Sound and Columbia River

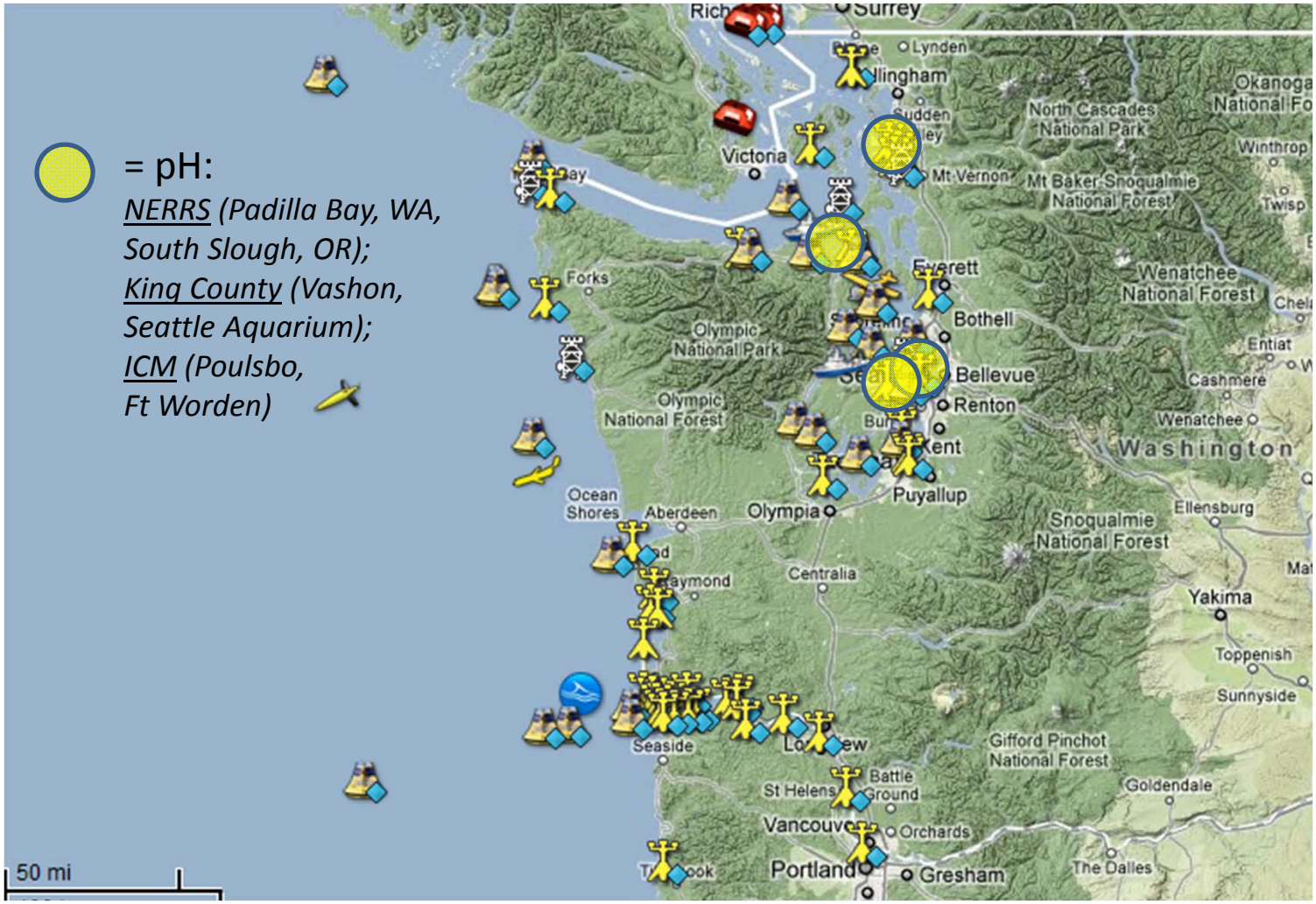
Assets by:

UW w/ NOAA
(some IOOS)
pCO2

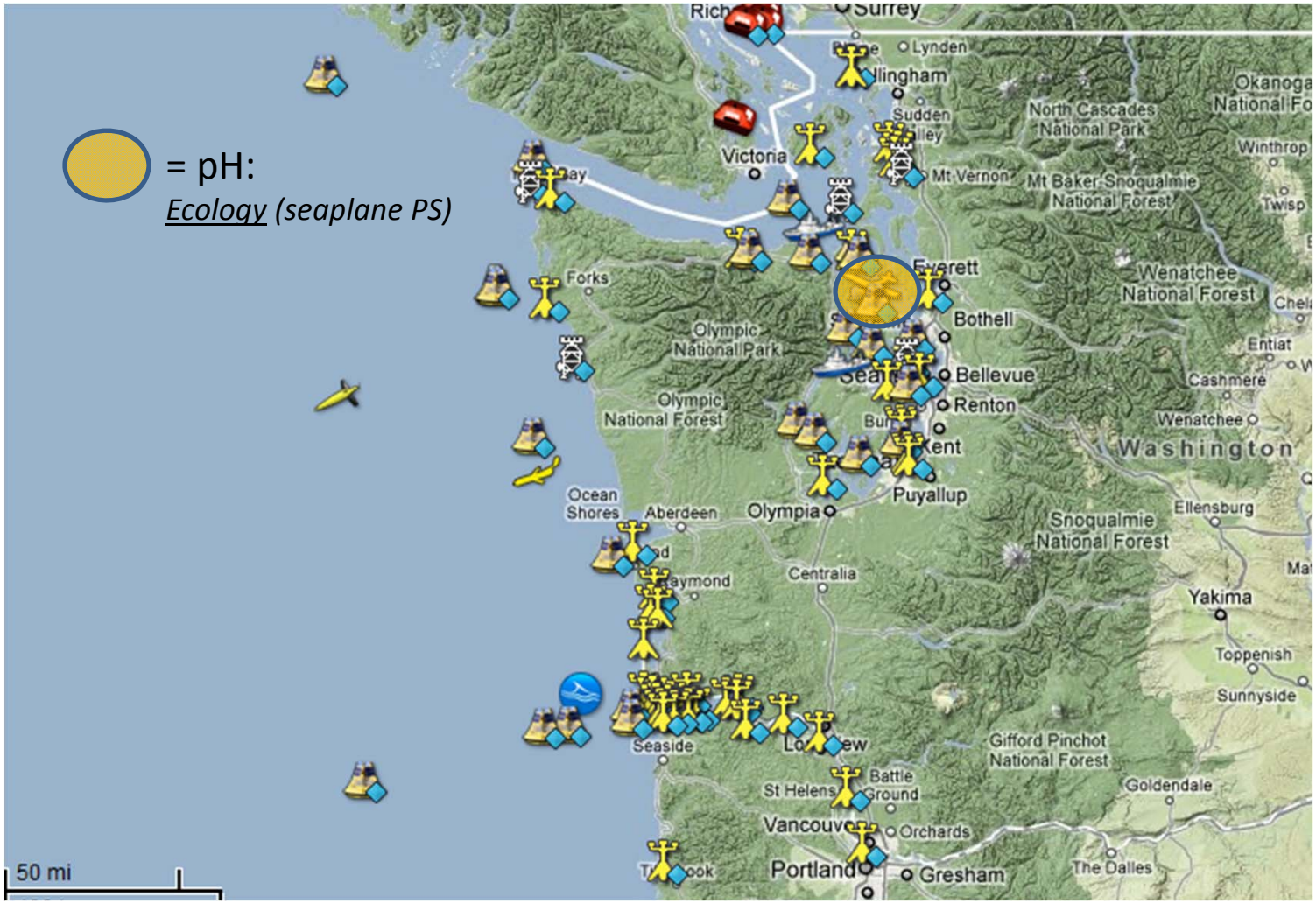
OHSU (CMOP
and some IOOS)
pCO2, pH



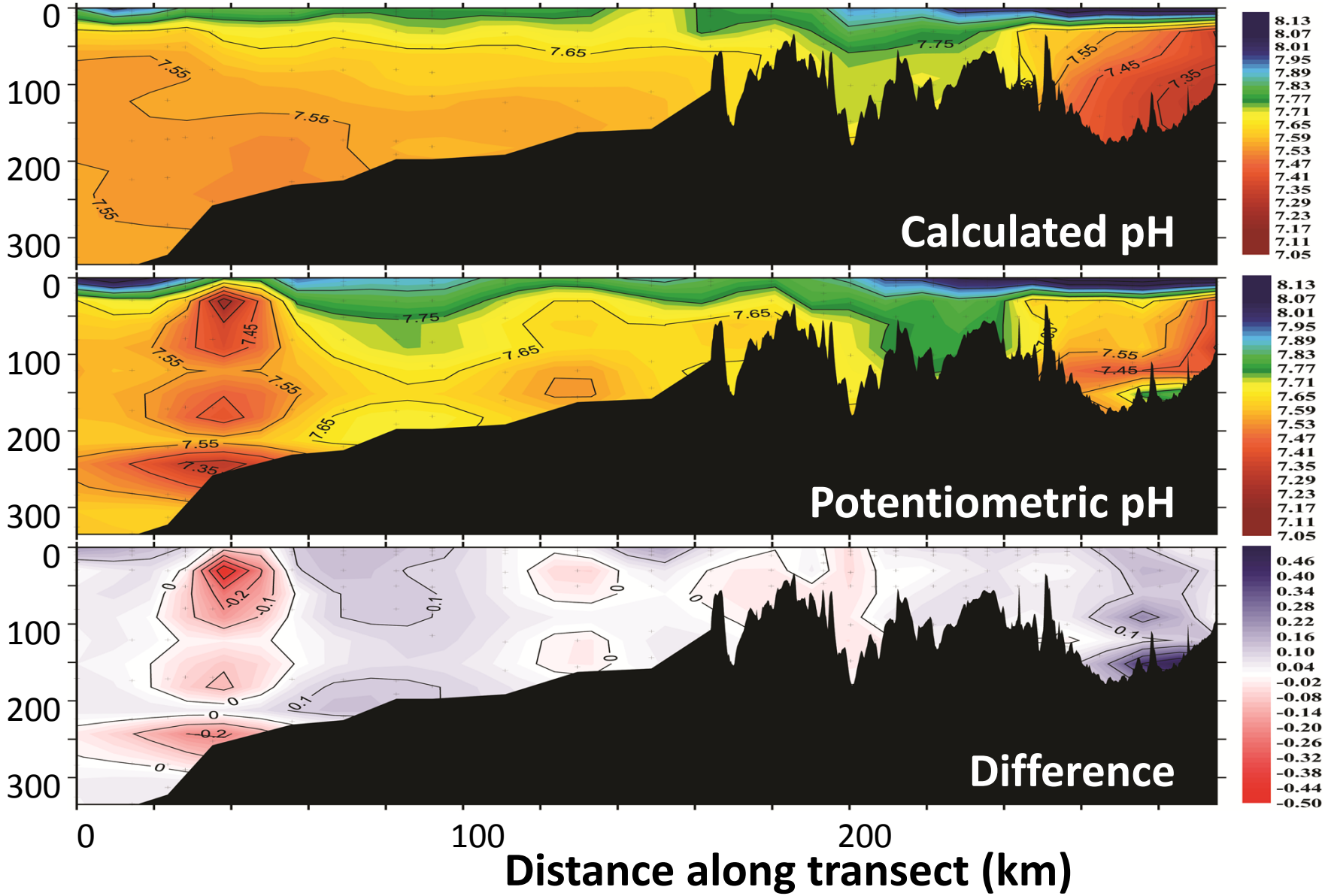
Other Puget Sound



Other Puget Sound



pH method comparison



Alin, NOAA, unpublished data

"Overview of existing monitoring efforts, organizations involved"

Marine Observations

- Offshore coastal ocean:
  -La Push pCO2 and pH: NOAA OA & IOOS (NANOOS) Programs
  -Annual NANOOS cruise, but no carbon analysis funding

- Puget Sound basins, bays, inlets, nearshore:
  -Dabob and Twanoh only…pCO2 only, insufficient NANOOS funding
  -Annual NANOOS cruise, but no carbon analysis funding
  -FHL timeseries but no sustained funding

- Columbia River:
  -3 stns along salinity gradient pCO2 and pH: CMOP & NANOOS

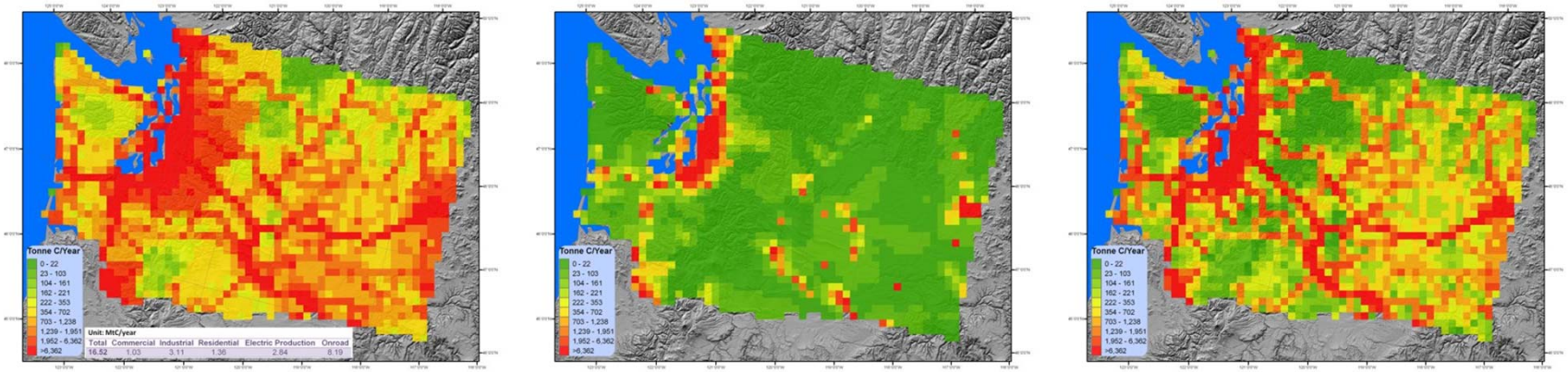
- Small estuaries shallow and well-mixed:
  -Willapa (PSI): PCSGA

- Shellfish hatcheries and other shore-based stations:
  -Dabob (Taylor), Lummi (LNR), Netarts, OR (WC): PCSGA
  -Seattle Aquarium, NOAA

"Overview of existing monitoring efforts, organizations involved"

Terrestrial Observations

- Vulcan Project: Modeling based on US EPA data
  -Arizona State University lead (NASA-DOE funded)

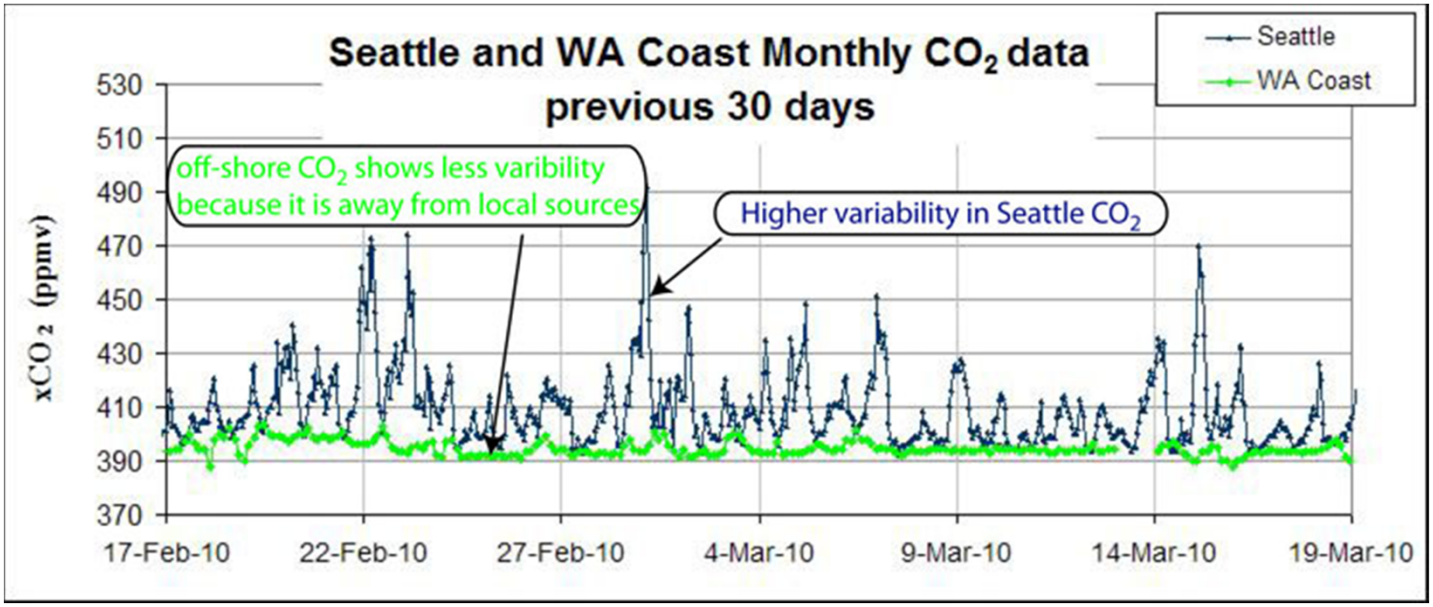


Total (tonne C/y) Residential (tonne C/y) Mobile (tonne C/y)

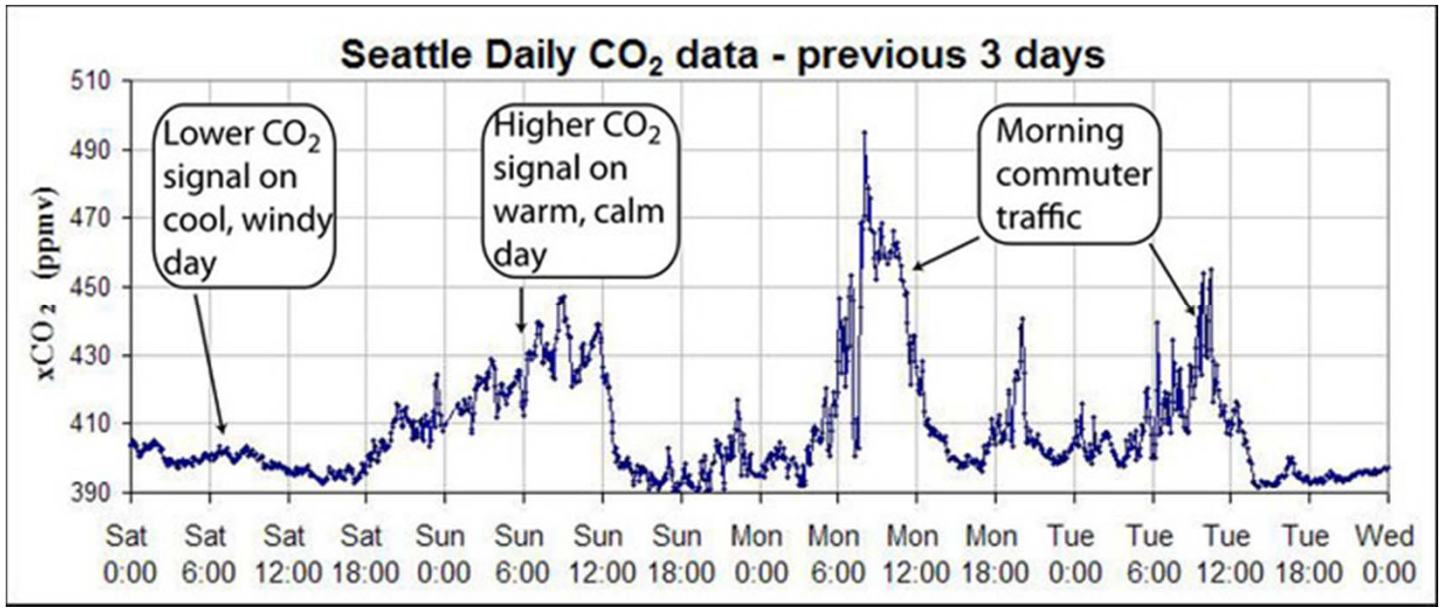
- Seattle Space Needle:
  -NOAA PMEL and Pacific Science Center

Graphics provided by Ellen Lettvin, Pacific Science Center: Vulcan Project data, exhibited in Pacific Science Center CO_2 kiosk and in collaboration with Chris Sabine NOAA PMEL

Seattle vs. Coast

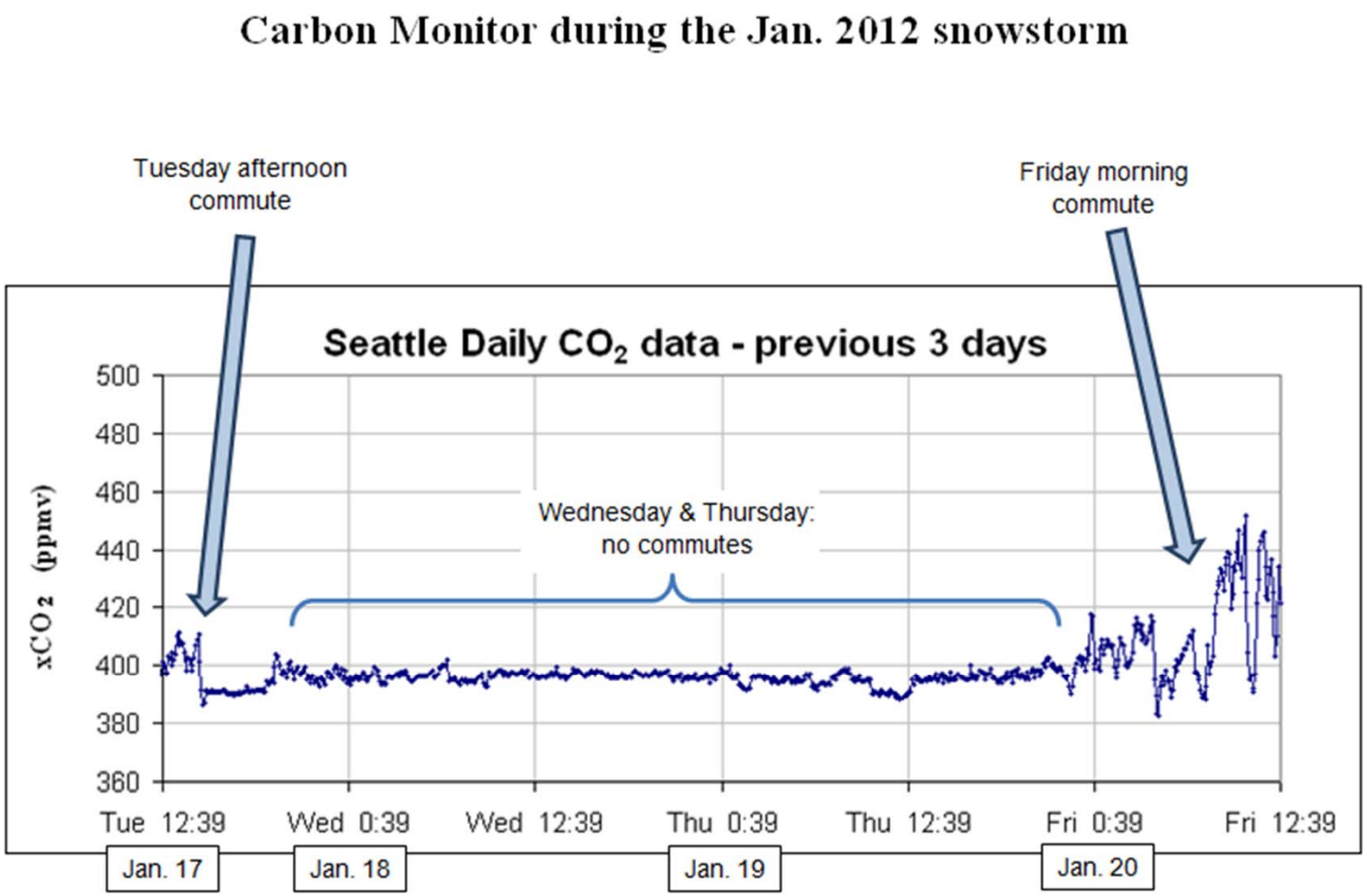


Weather and Traffic



Graphics provided by Ellen Lettvin, Pacific Science Center: NOAA-PMEL data, exhibited in Pacific Science Center CO_2 kiosk and in collaboration with Chris Sabine NOAA PMEL

Space Needle CO_2 observations during "snowmagedon"



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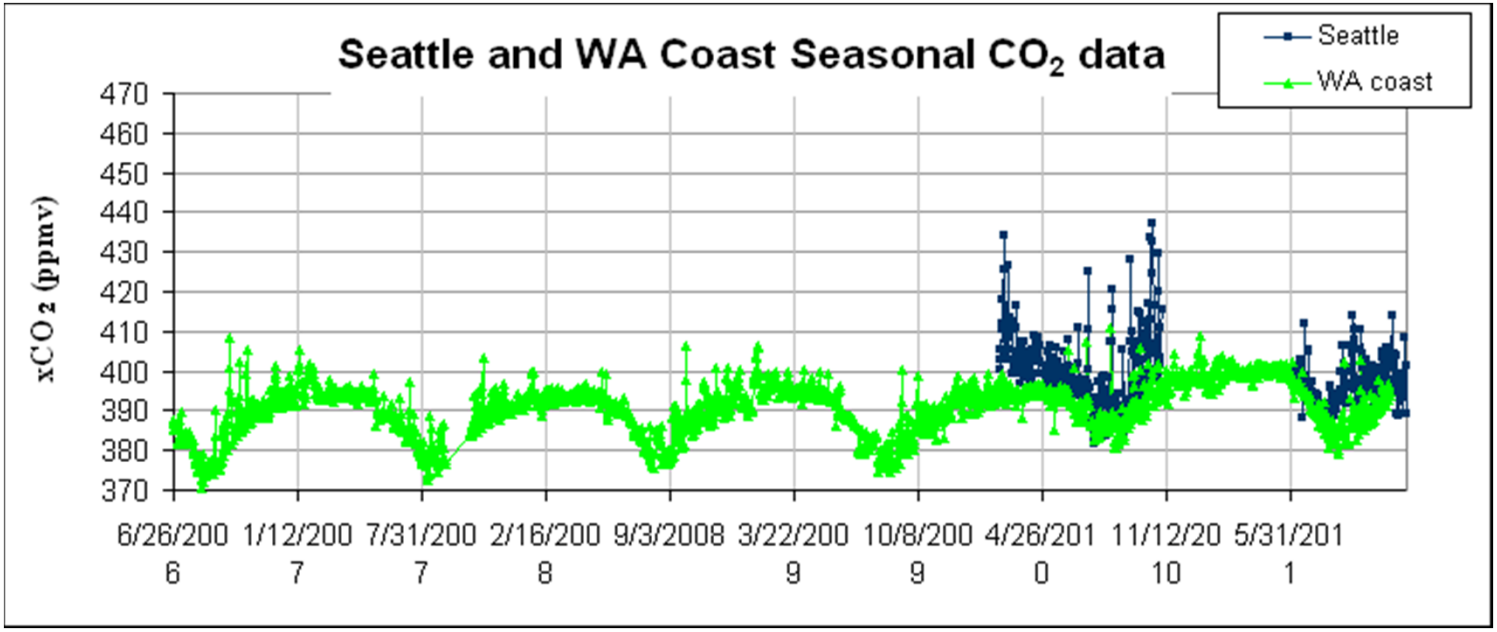

Note that coast has apparent upward trend with time…

Graphics provided by Ellen Lettvin, Pacific Science Center: NOAA-PMEL data, exhibited in Pacific Science Center CO_2 kiosk and in collaboration with Chris Sabine NOAA PMEL

"What additional monitoring could be done with tweaks to the existing network and what new monitoring might be required?"

- **Biannual cruises throughout all of Puget Sound**
  - Highest quality data: 3 carbon variables; spatially defined measurements for algorithm development
- **Work with Ecology to develop new measurement capabilities to their monitoring for WA State (seaplane water volume issues)**
  - Higher temporal (monthly) resolution than cruises
- **Instrument moorings w/C sensors in key existing and new locations, e.g., Bellingham Bay, Skagit basin**
  - High resolution temporal (hourly) measurements for understanding mechanisms of variation, input to predictive models
- **Expand shore-based monitoring systems (e.g., Marine Sci Ctrs)**
  - Monitor nearshore conditions affecting nearshore biota