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Declines in Puget Sound sediment-dwelling communities and a new focus on climate, nutrient, and other ecosystem stressors

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Weakland, Sandra; Partridge, Valerie; Dutch, Margaret; Burgess, Dany; and Eagleston, Angela, "Declines in Puget Sound sediment-dwelling communities and a new focus on climate, nutrient, and other ecosystem stressors" (2018). *Salish Sea Ecosystem Conference*. 530.

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Regional Declines in Puget Sound Benthic Communities

Washington State Department of Ecology
Marine Sediment Monitoring Team



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Monitoring of Marine Benthic Communities Reveals

- Species abundance and diversity changes.
- Chemicals measured do not explain distribution of benthic communities, spatially or temporally.
- Laboratory tests may be pointing out changes in biogeochemistry rather than toxicity from priority pollutants.

Why Benthos Are Important

- Food web – benthic and pelagic
- Biogeochemical processes
- Release of nutrients to the water column
- Commercial value



Assessing the Condition of the Benthos

Sampling Frequency

- Long-term - annually for 28 years
- Regions - twice over 20 years

Supporting Parameters

Physical characteristics

- Depth, Grain Size, Total Organic Carbon

Chemistry

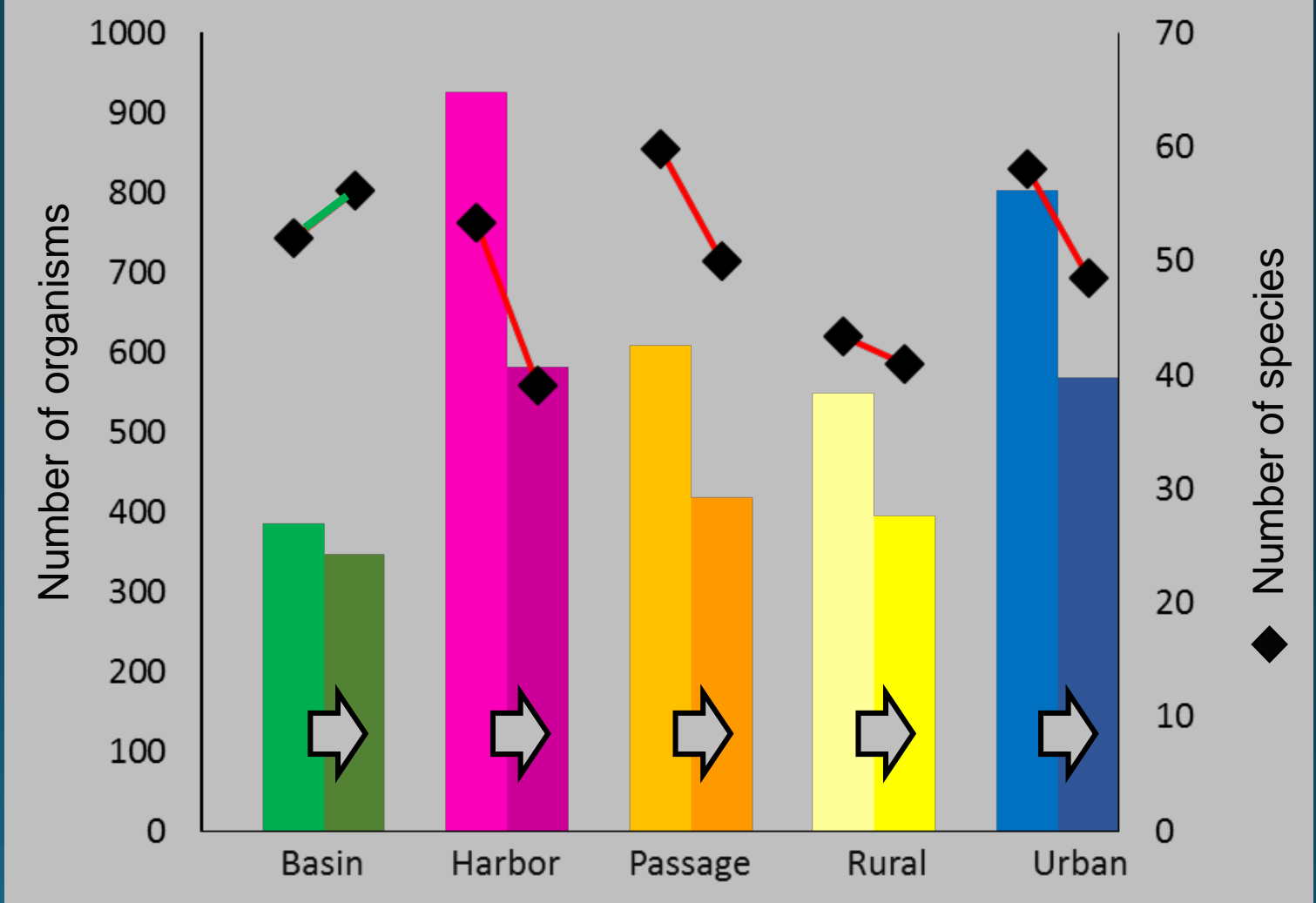
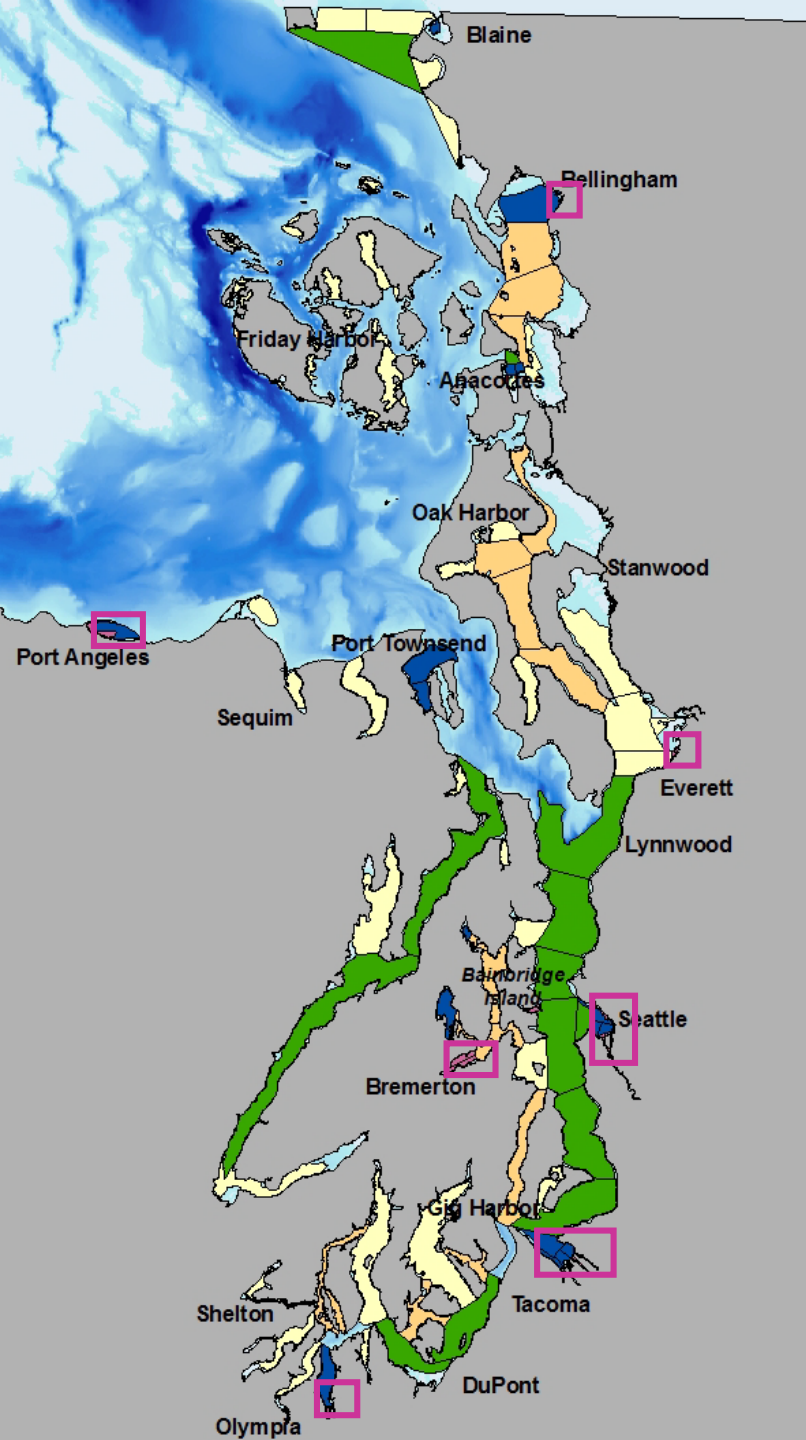
- Metals, PAHs, PCB, PBDEs, Phthalates

Laboratory Toxicity tests

- Amphipod 10 day survival
- Urchin Fertilization

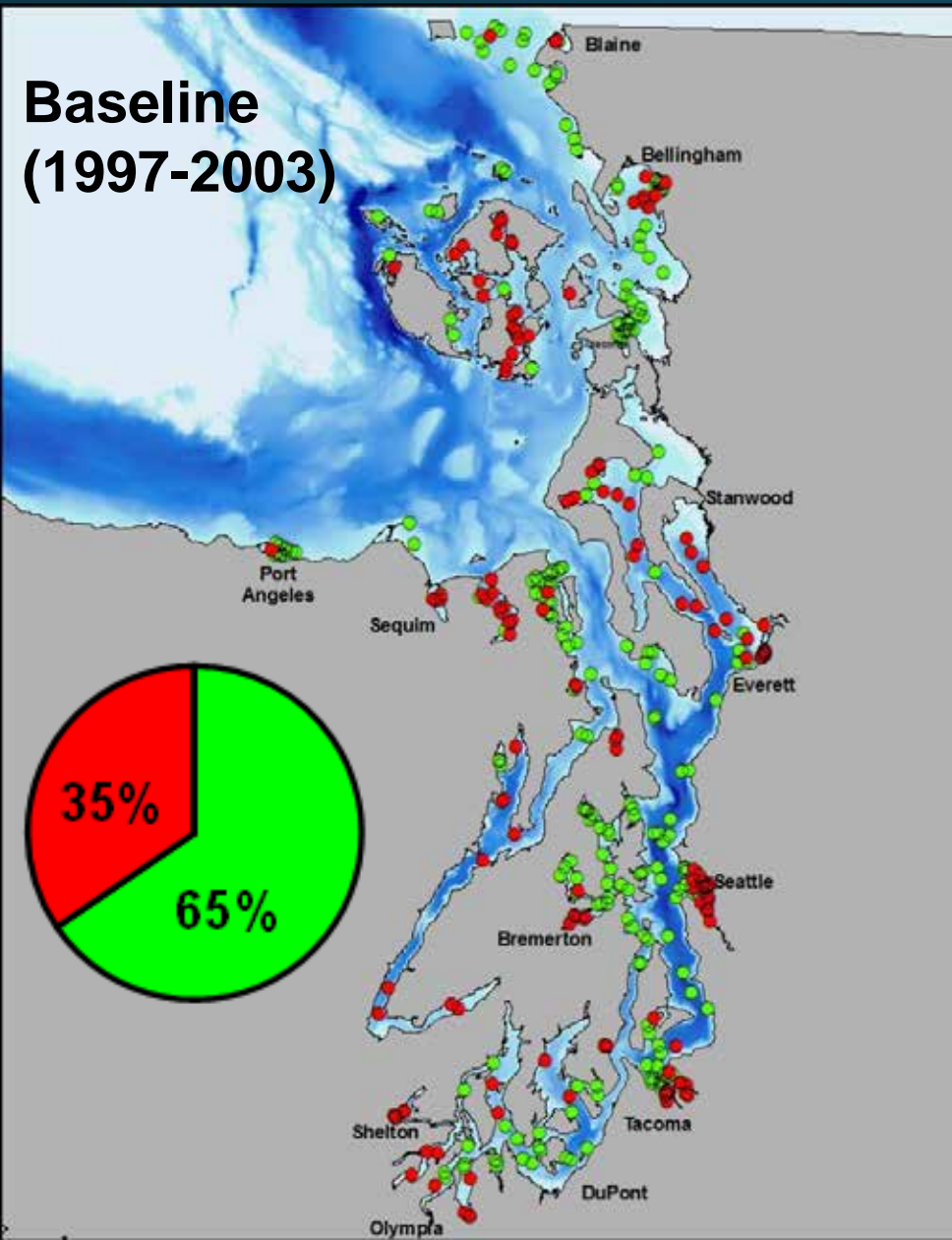


Declining Benthos Across Habitats

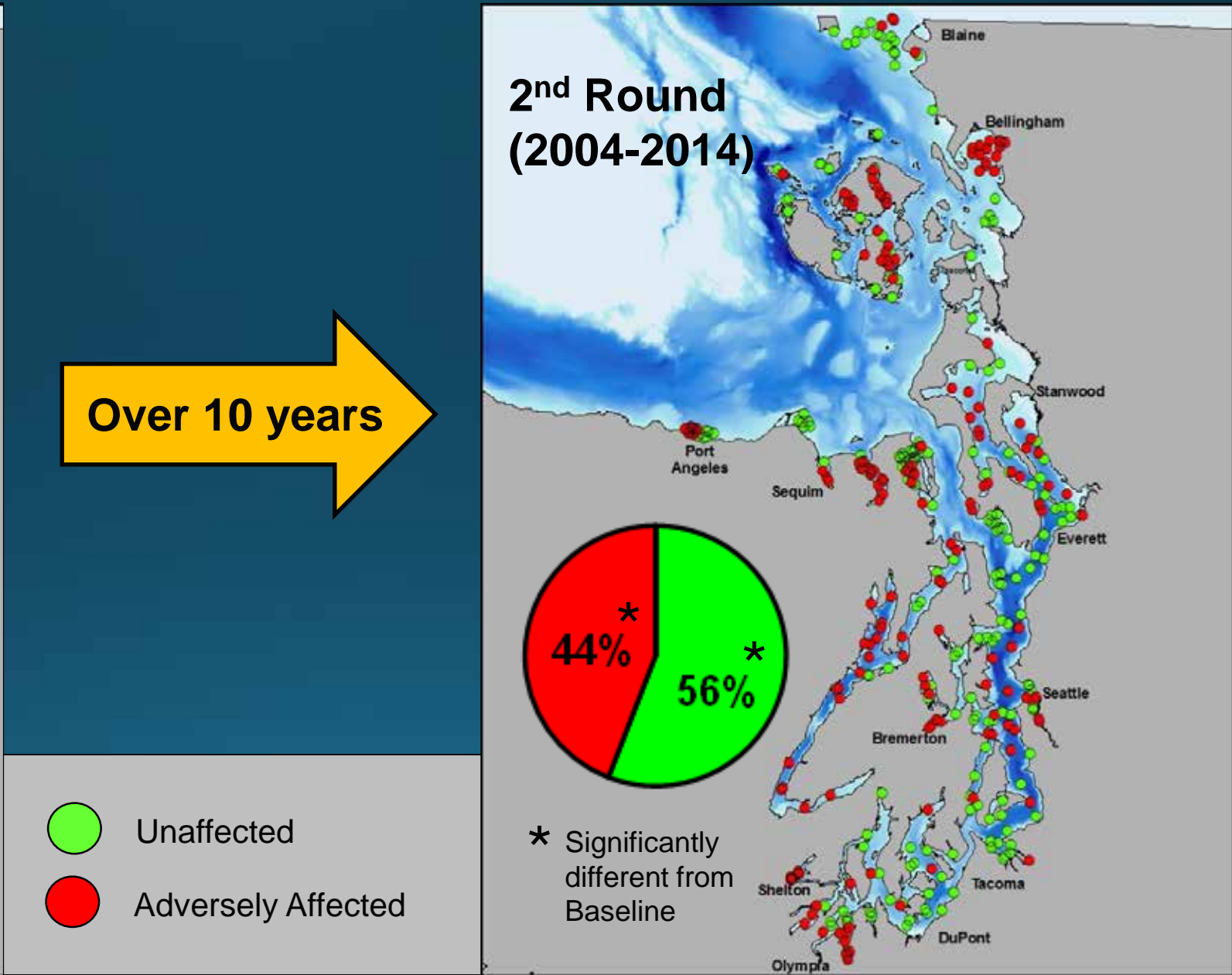


Baseline (1997-2003) vs 2nd Round (2004-2014)

Benthic Index Over Time



Over 10 years

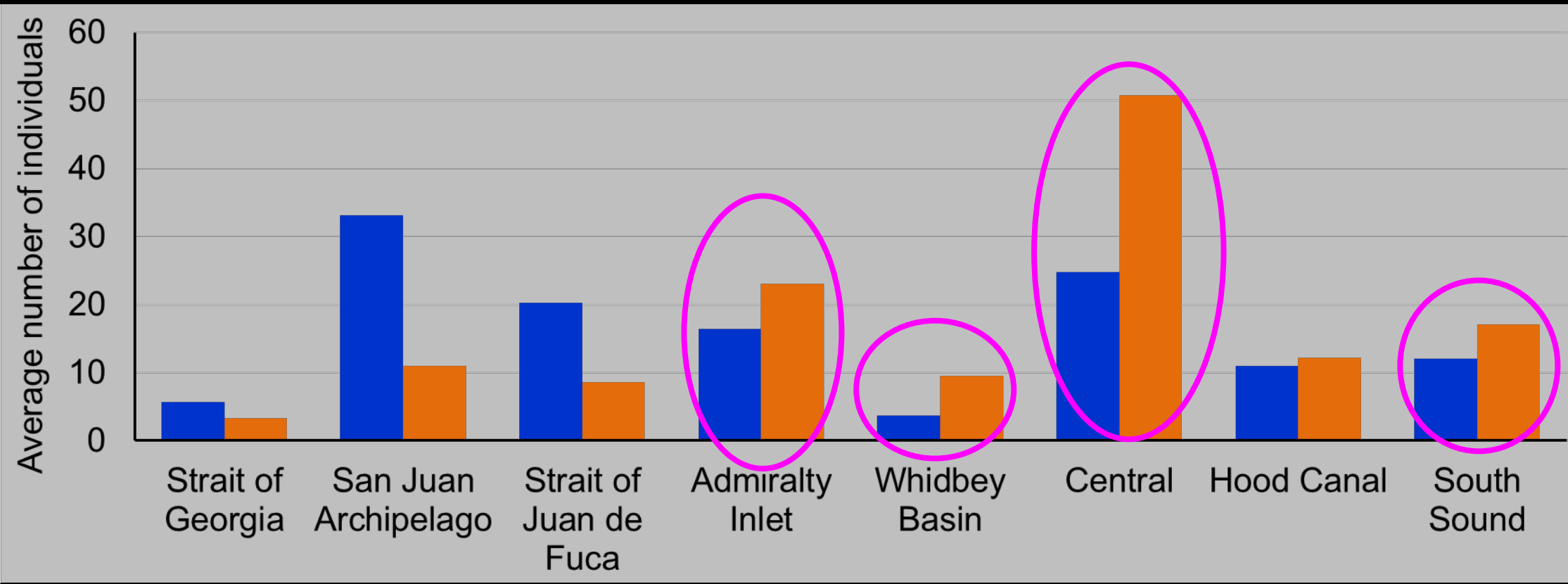




Parvilucina tenuisculpta

Systematic Change and Potential Indicators

Average Abundance of *Parvilucina*



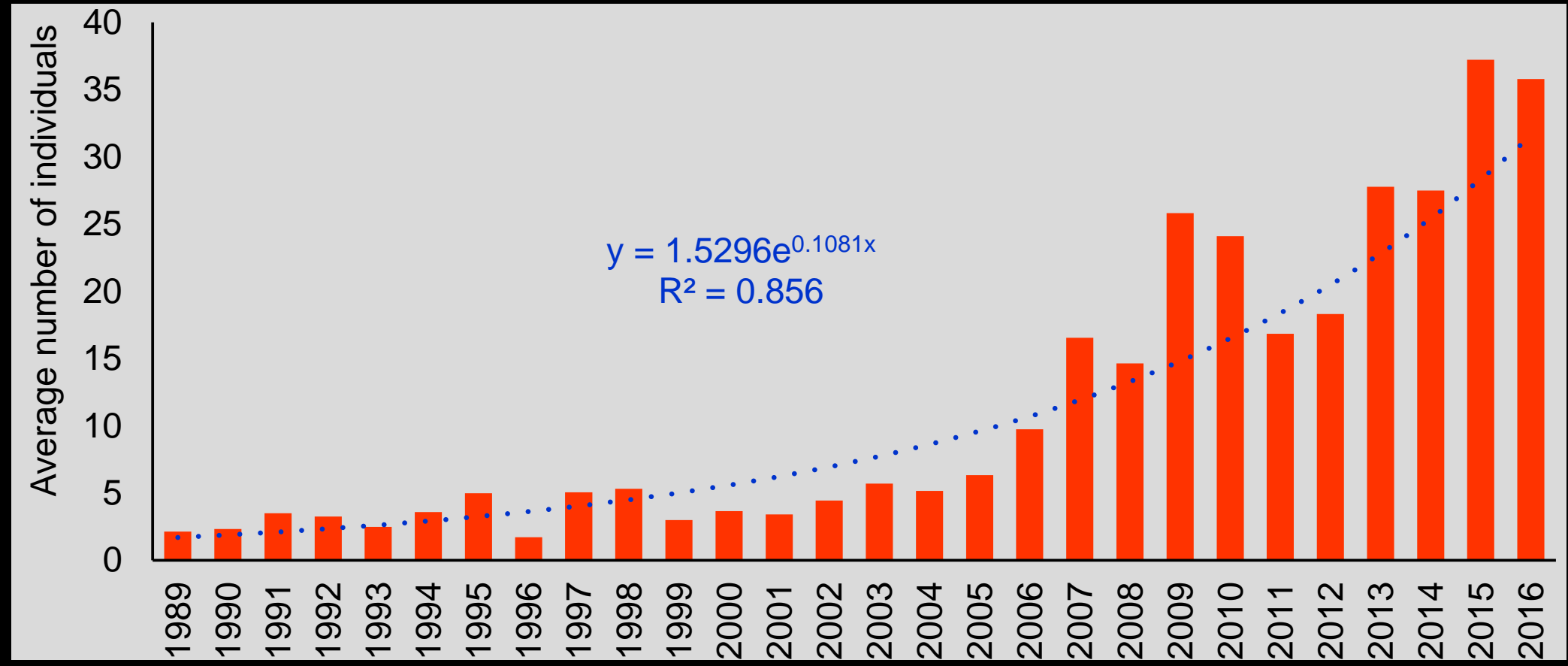
■ Baseline (1997-2003) vs ■ 2nd Round (2004-2014)






Parvilucina tenuisculpta

Systematic Change and Potential Indicators

Average Abundance of *Parvilucina*

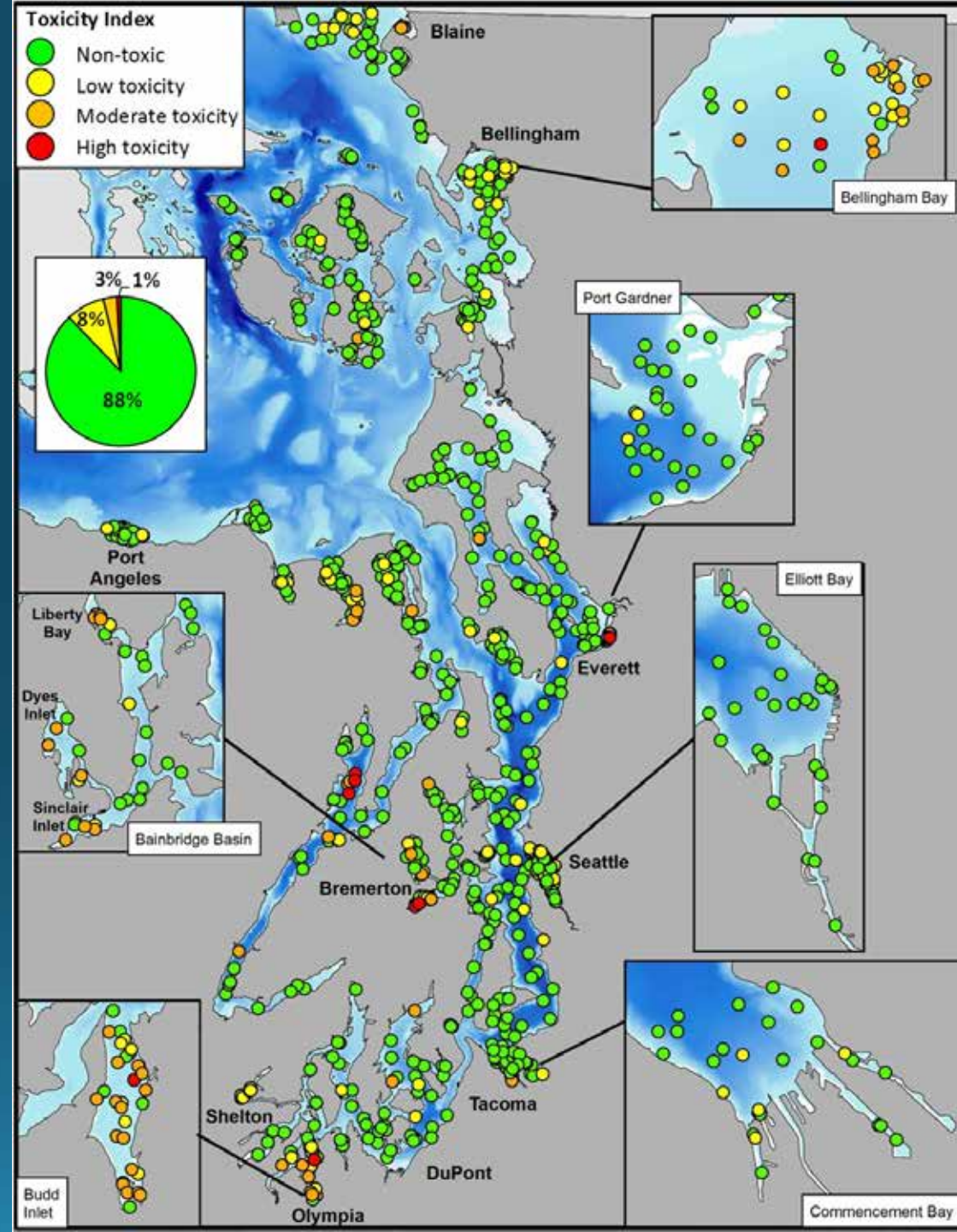


Chemistry Results Do Not Correlate with Benthos

- Detection rate 
- Detected primarily near population/industrial centers
- Concentrations  or 
- Low correlation with benthic community

Toxicity Index

- Toxicity in urban areas less than anticipated
- Greater toxic response in terminal inlets, often in non-urban areas
- *Low* toxicity in transition areas
- Toxicity results not correlated with chemistry results



Summary of Findings

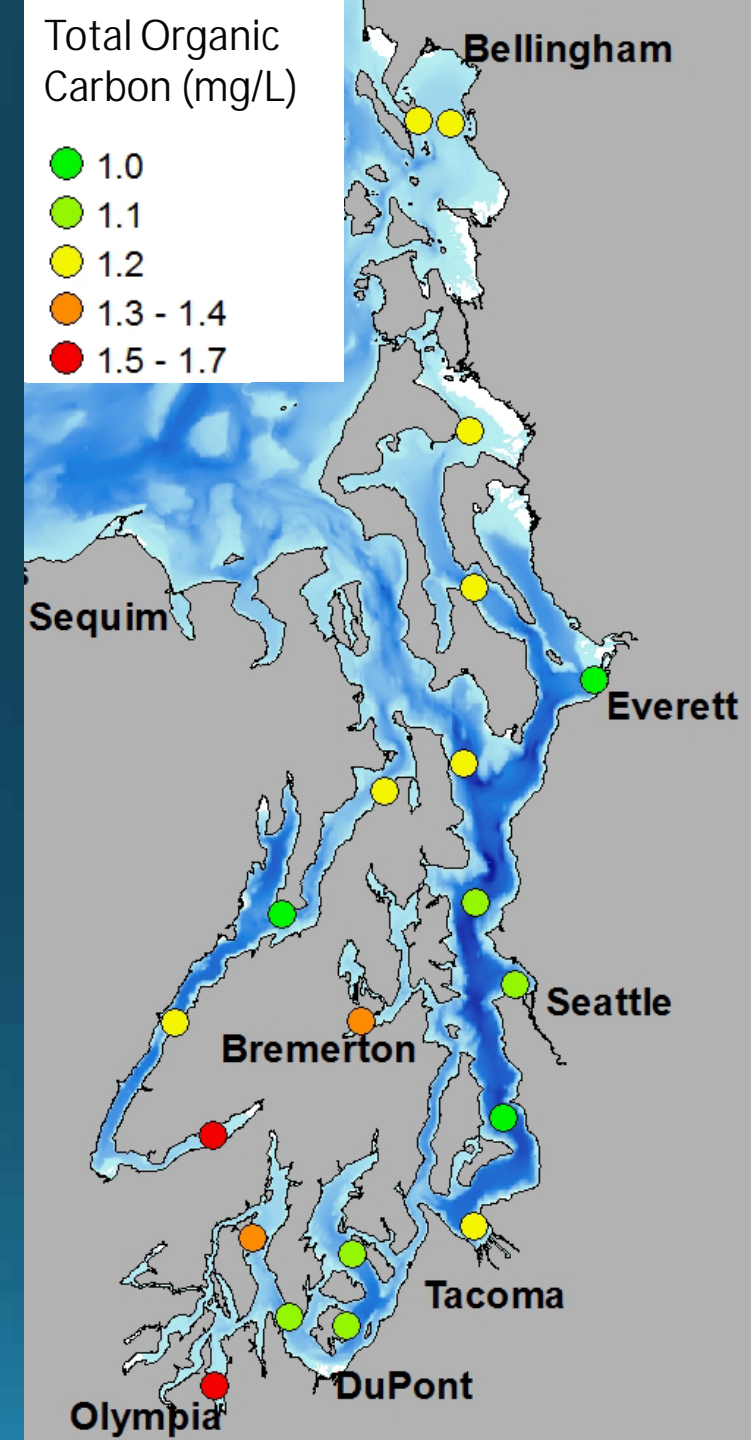
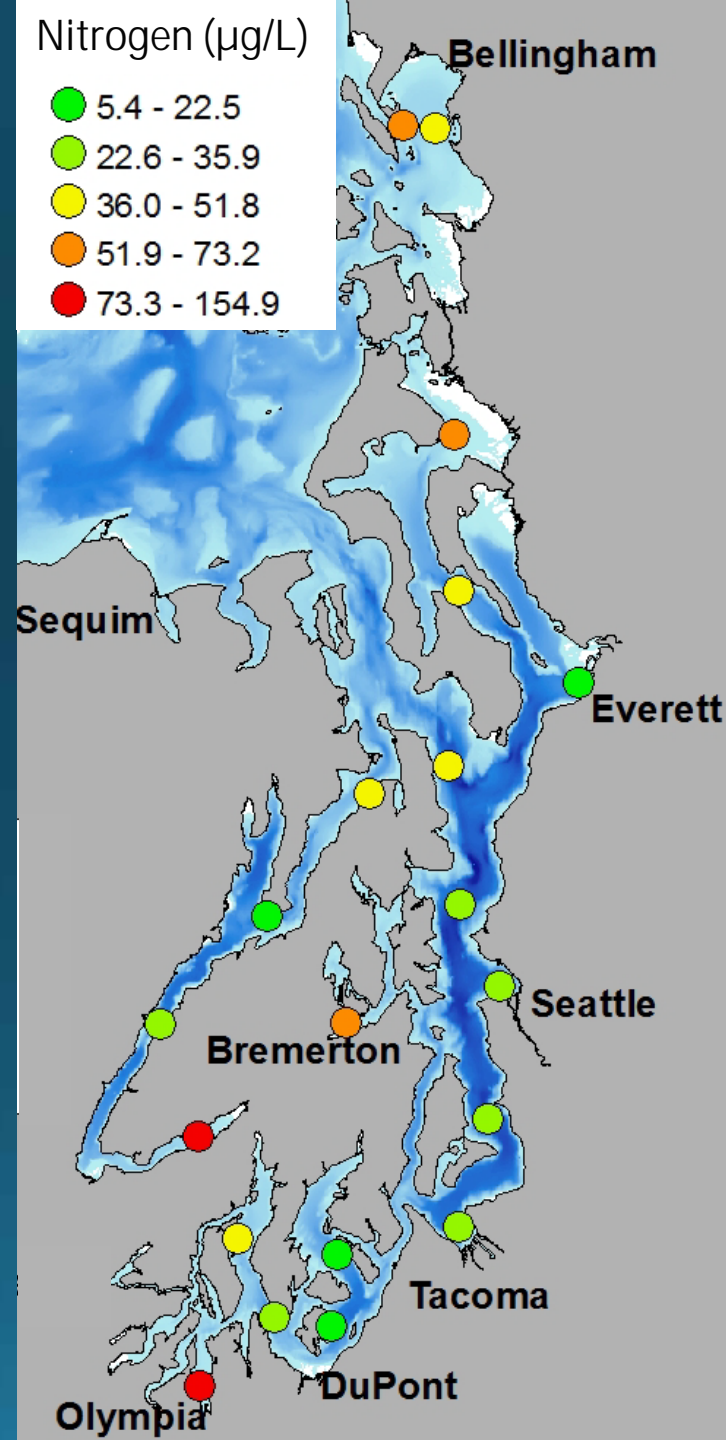
- Benthos declining over time
- Benthos are adversely affected in terminal inlets
- Increase of pollution/hypoxia tolerant species
- Higher toxicity in terminal inlets
- Laboratory chemistry and toxicity tests do not correlate well with the benthic community

à No obvious answer

Spatial Patterns in Particulate Carbon and Nitrogen

Terminal Inlets

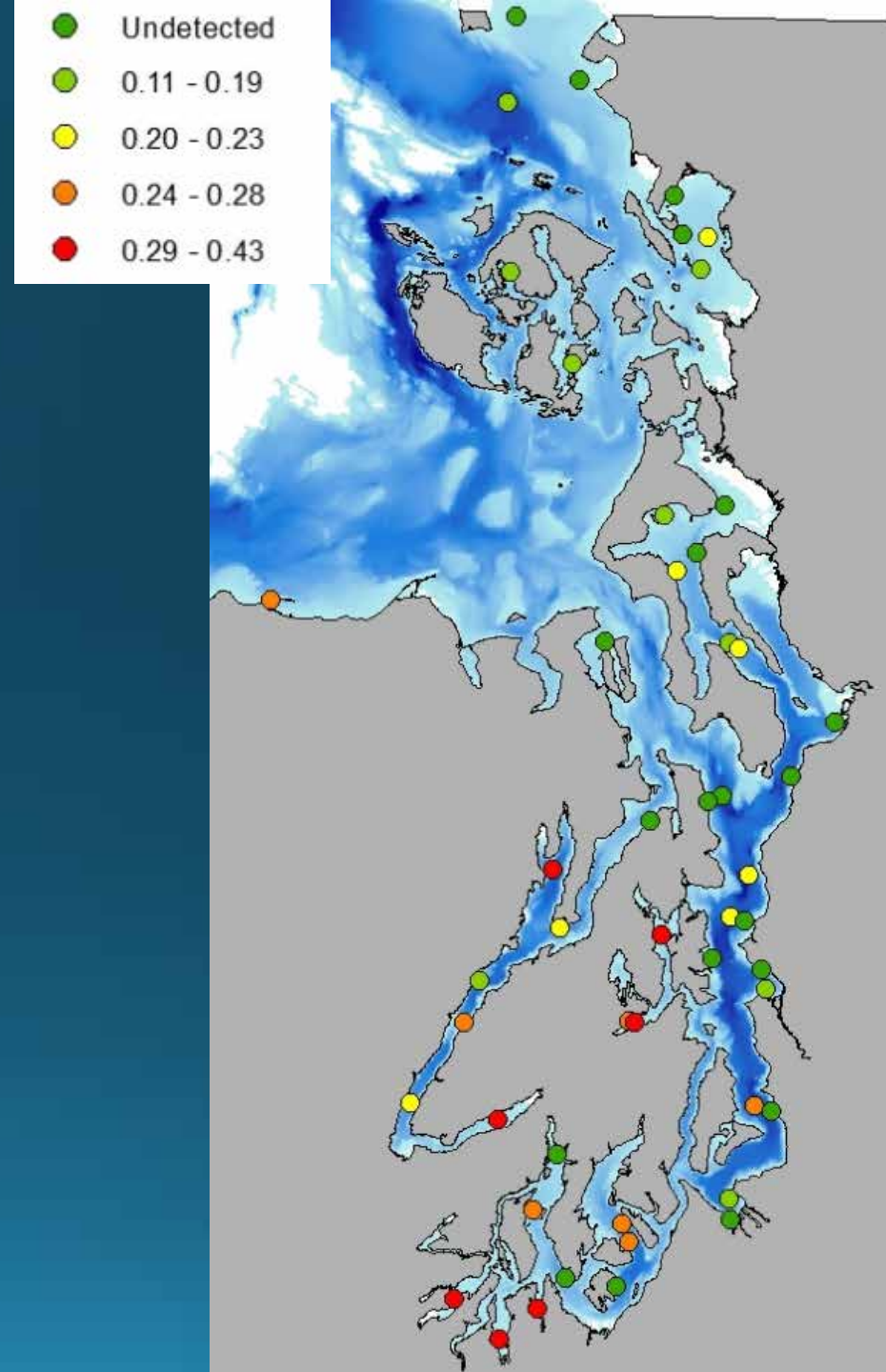
- Bainbridge Basin
- South Sound
- Hood Canal



Spatial Patterns in Sediment % Nitrogen

Terminal Inlets

- Bainbridge Basin
- South Sound
- Hood Canal



Sluggish Water Exchange Increases Human Burden on Oxygen Model and Monitoring Results Agree



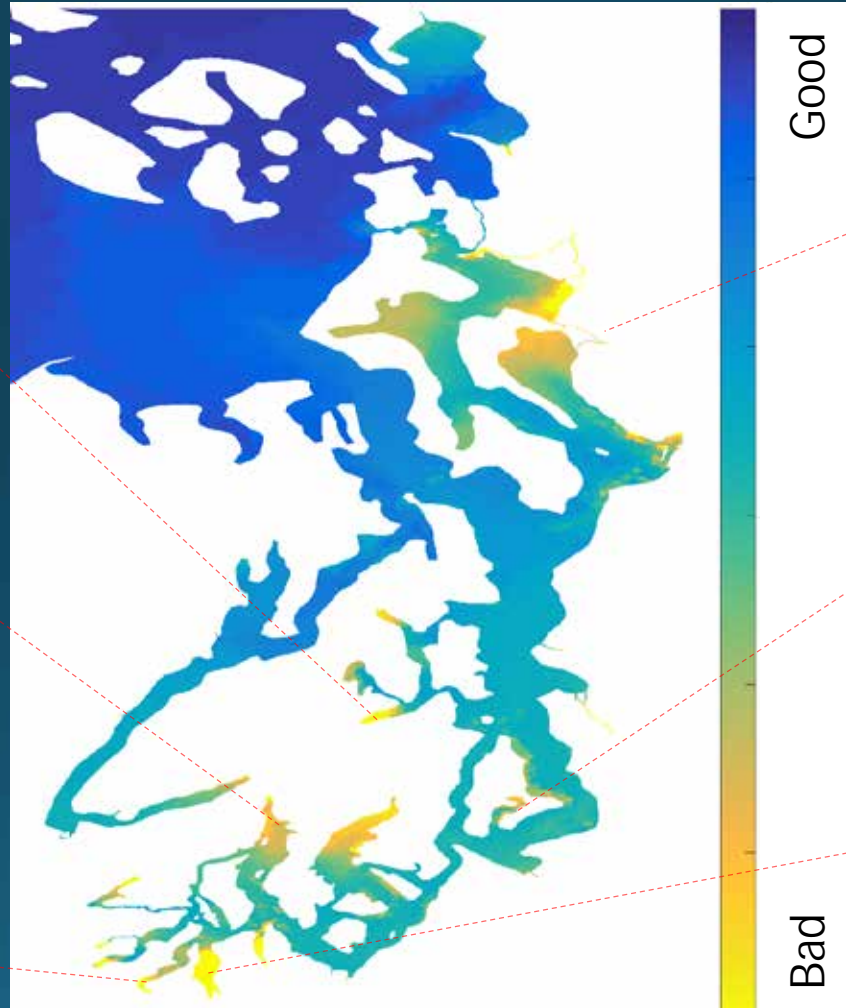
Sinclair Inlet



Case Inlet



Eld Inlet



Eutrophication Indicators



Bainbridge Basin

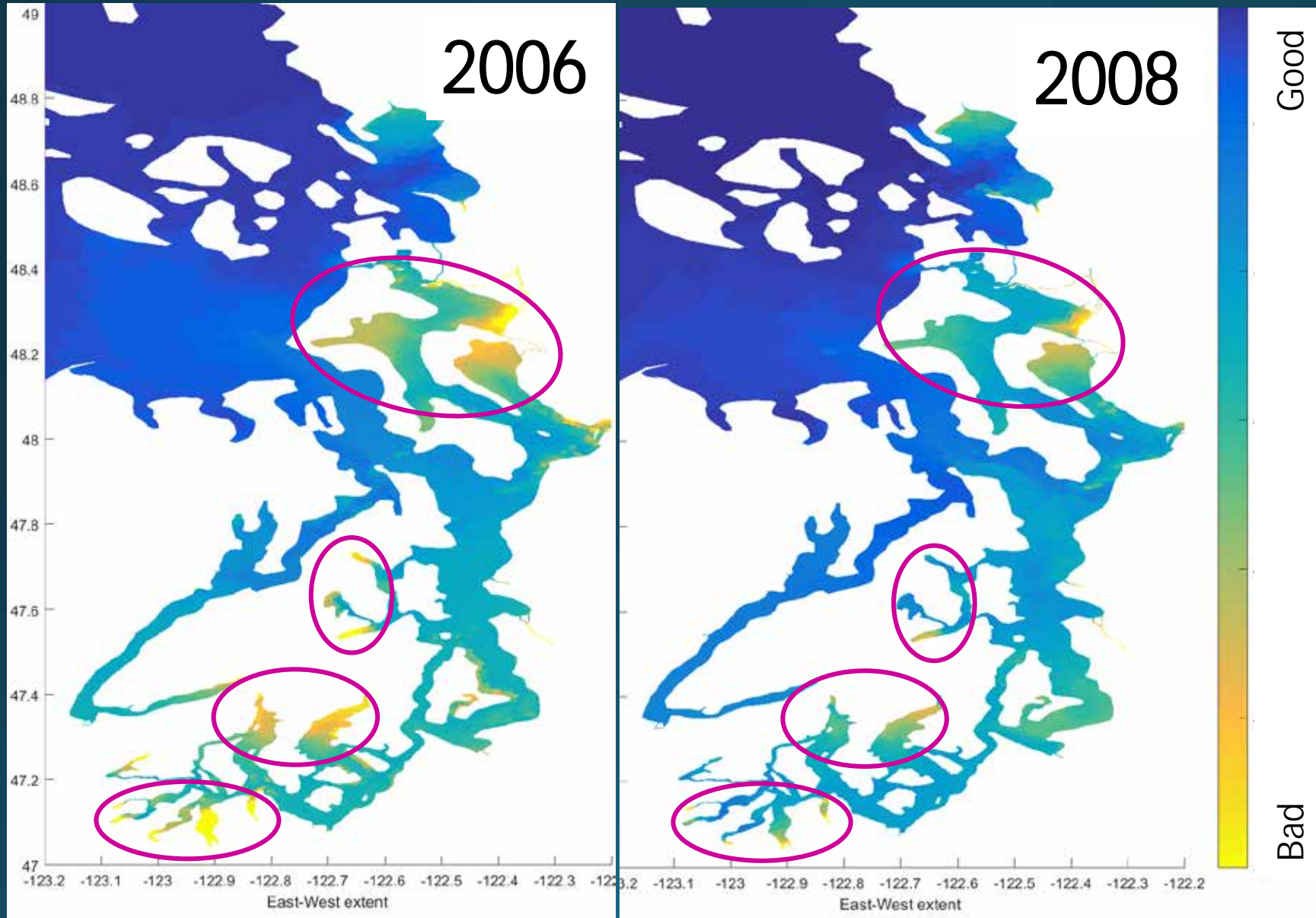


Quartermaster Harbor



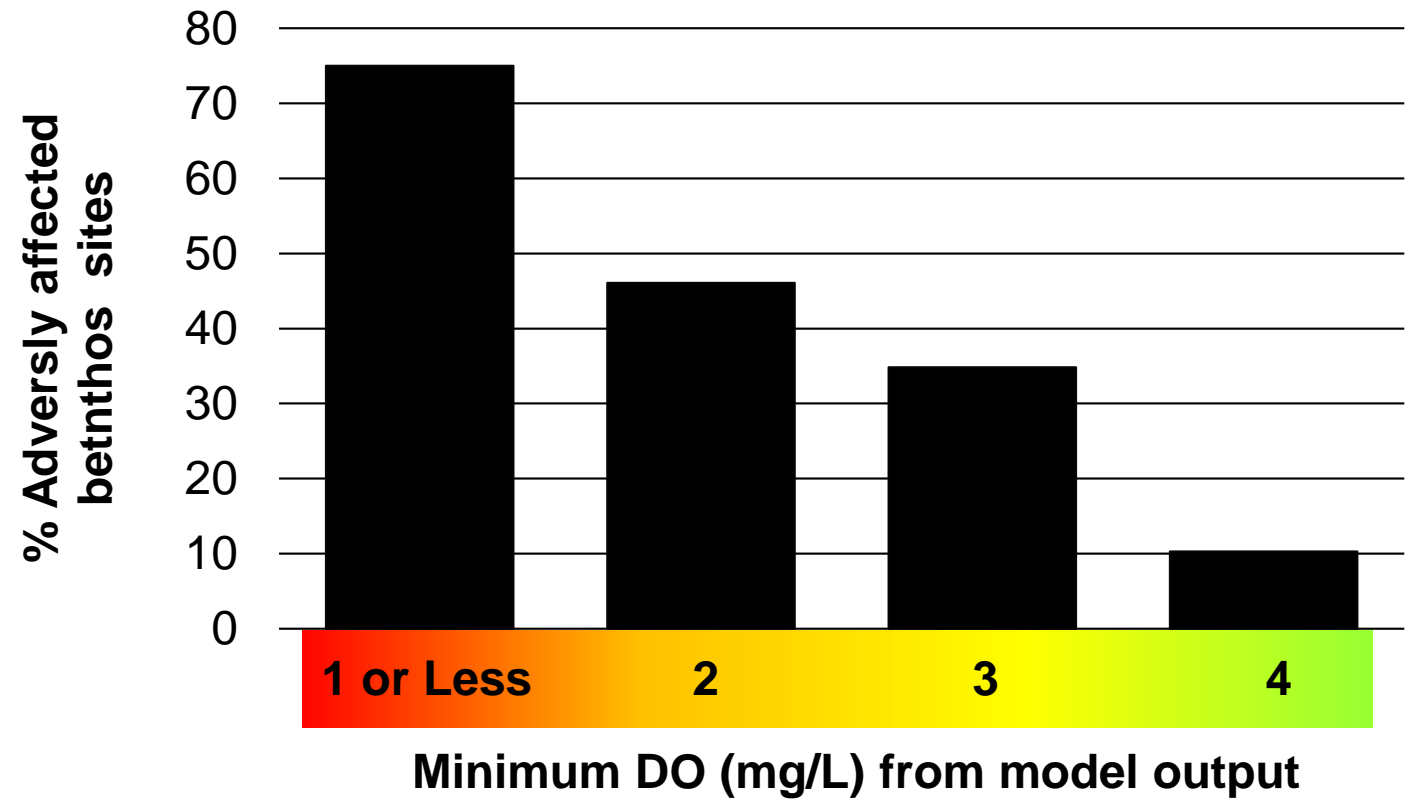
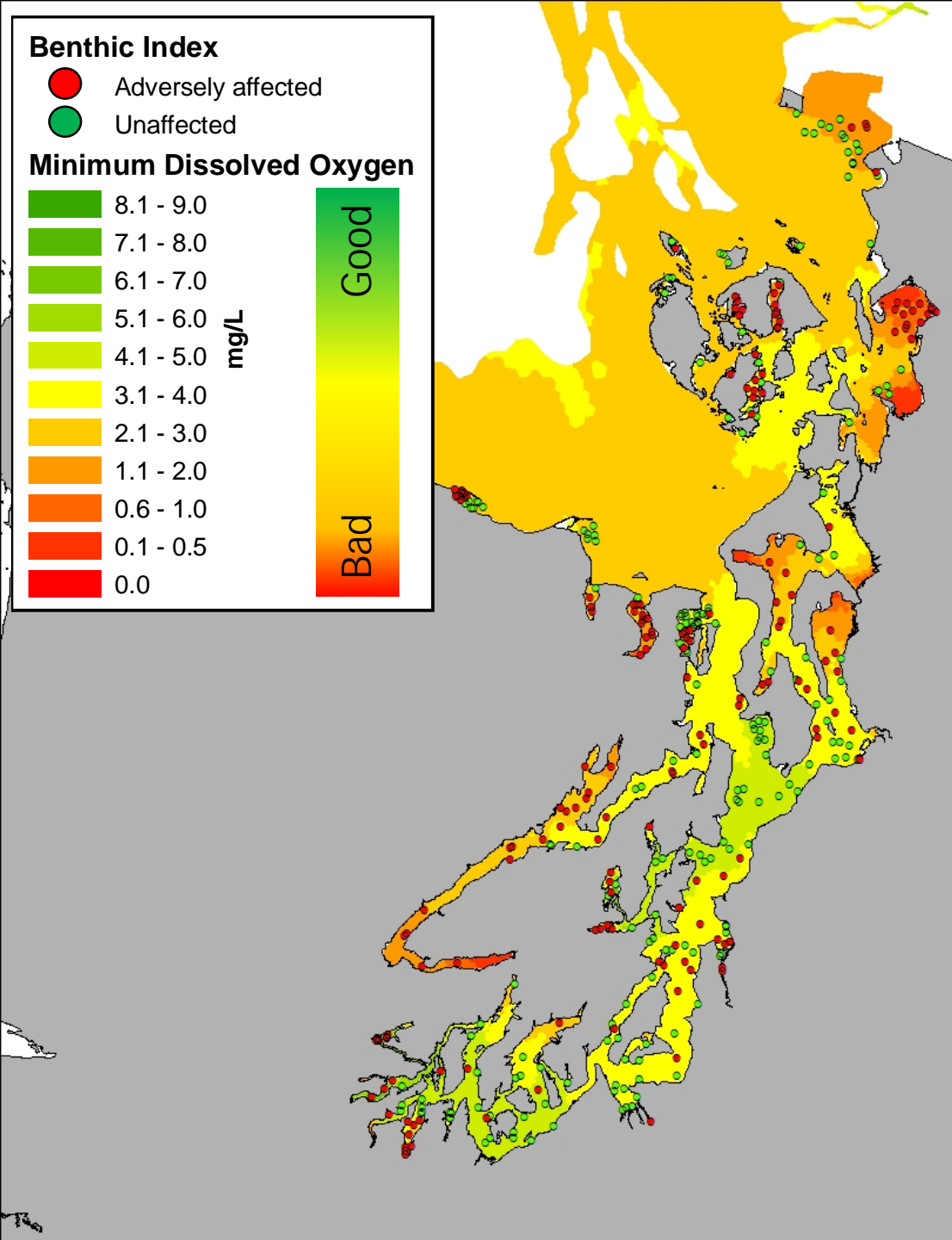
Budd Inlet

Modeled Depletion of DO by Anthropogenic Sources



- Some areas of Puget Sound have naturally slow circulation
- The magnitude and spatial extent of DO depletion in 2006 > 2008

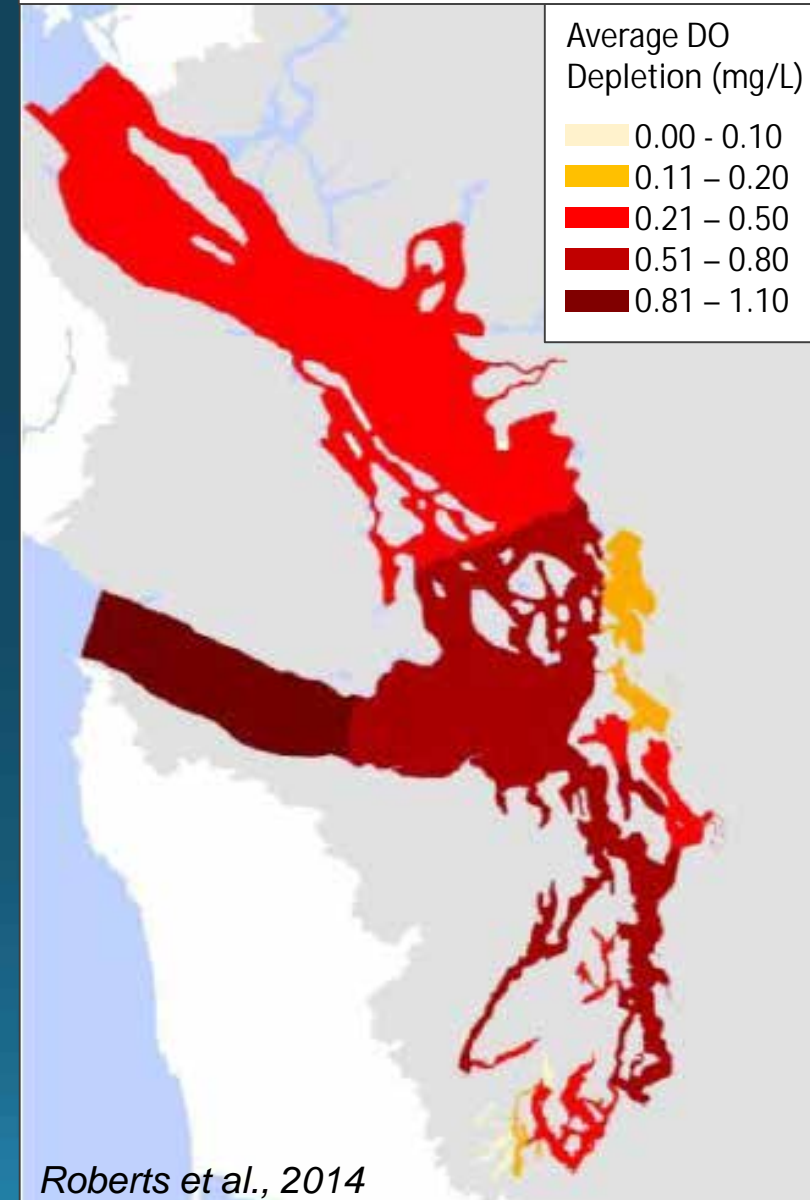
Model Predictions of Low DO Correspond with Affected Communities



What Does It Mean for Future

- Areas with sluggish water exchange will likely increase
- Areas with low oxygen zones will likely increase
- Areas with adversely affected benthos will likely increase
- Altered biogeochemical process
- Changes in food web interactions

2070s Human Sources and Ocean Conditions – Average regional depletion with future circulation



Questions ?



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