

Regional Declines In Puget Sound Benthic Communities

Washington State Department of Ecology

Marine Sediment Monitoring Team



Sandra Weakland



Valerie Partridge



Maggie Dutch



Dany Burgess



Angela Eagleston

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

Stations

Annually sampled for 28 years

Geospatial twice over 20 years

Supporting Parameters

Physical characteristics

Depth, Grain Size, Total Organic Carbon

Chemistry

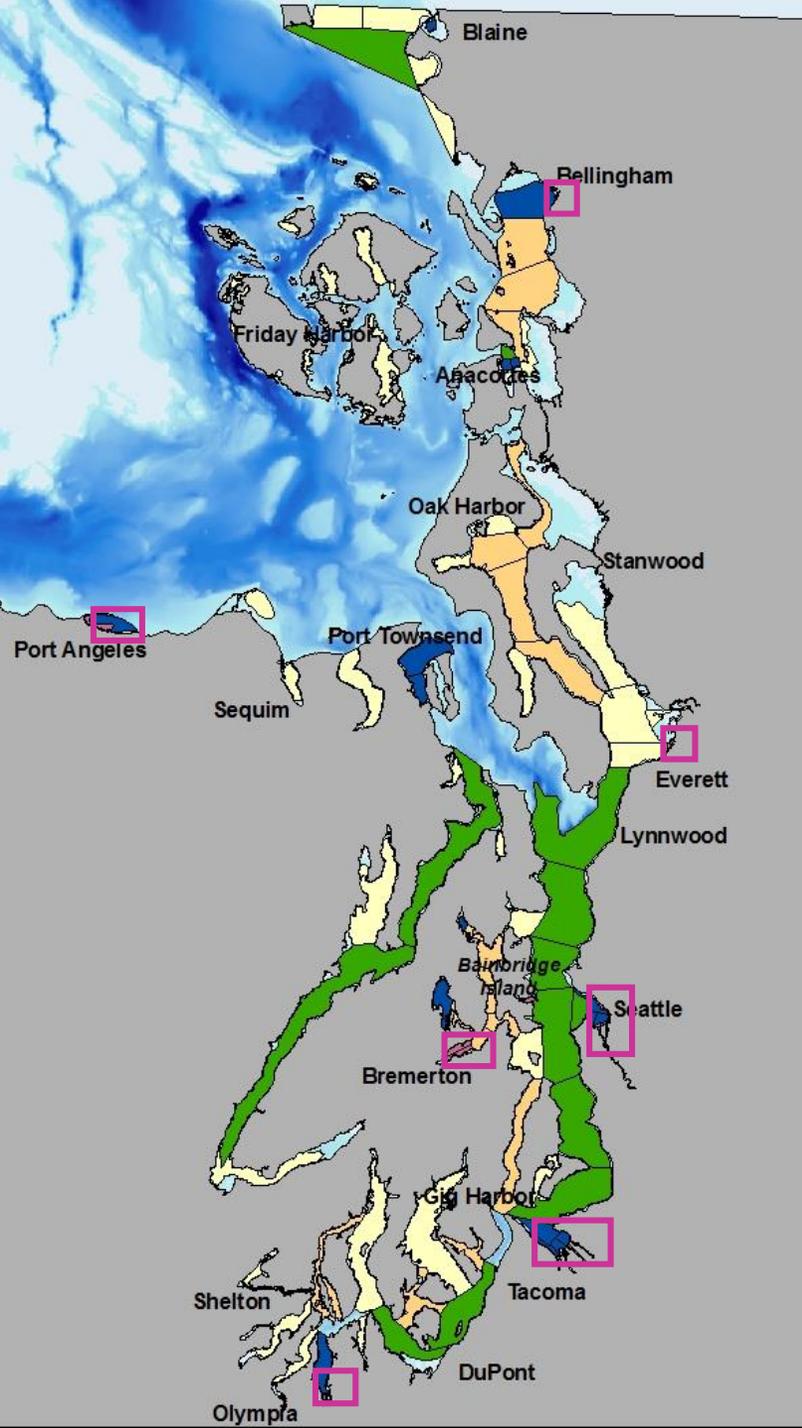
Metals, PAHs, PCB, PBDEs, Phthalates

Laboratory Toxicity tests

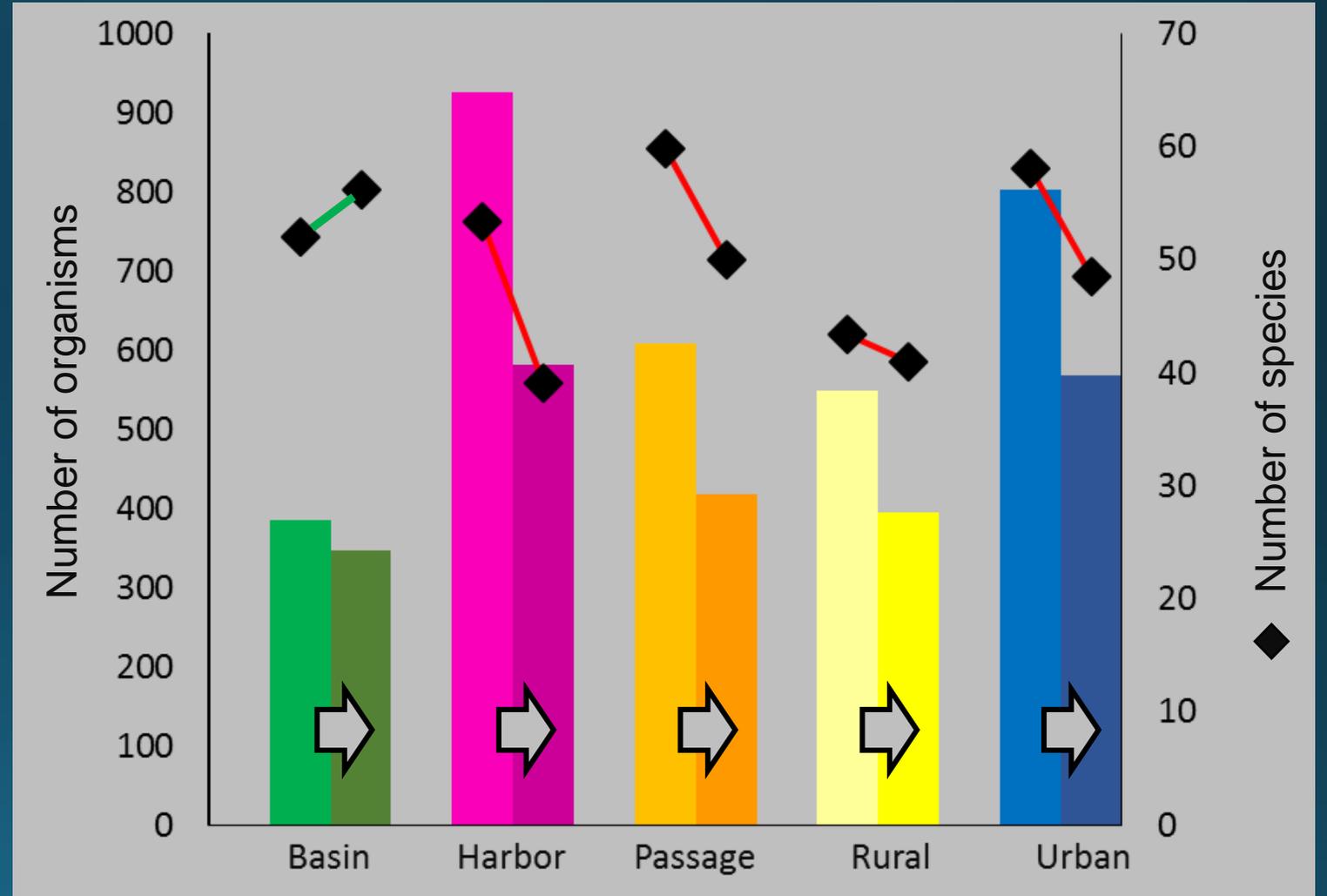
Amphipod 10 day survival

Urchin Fertilization



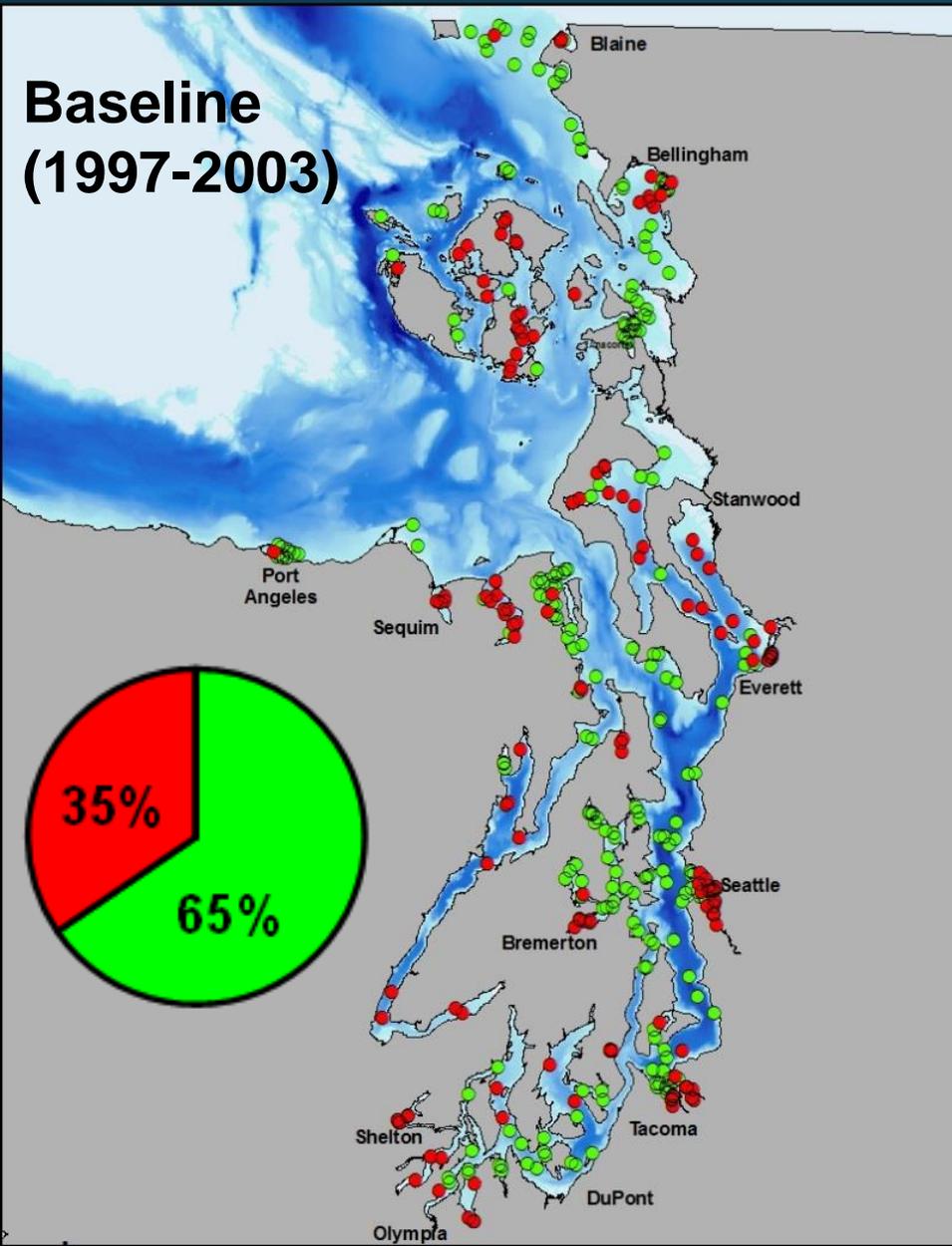


Declining Benthos Across Habitats

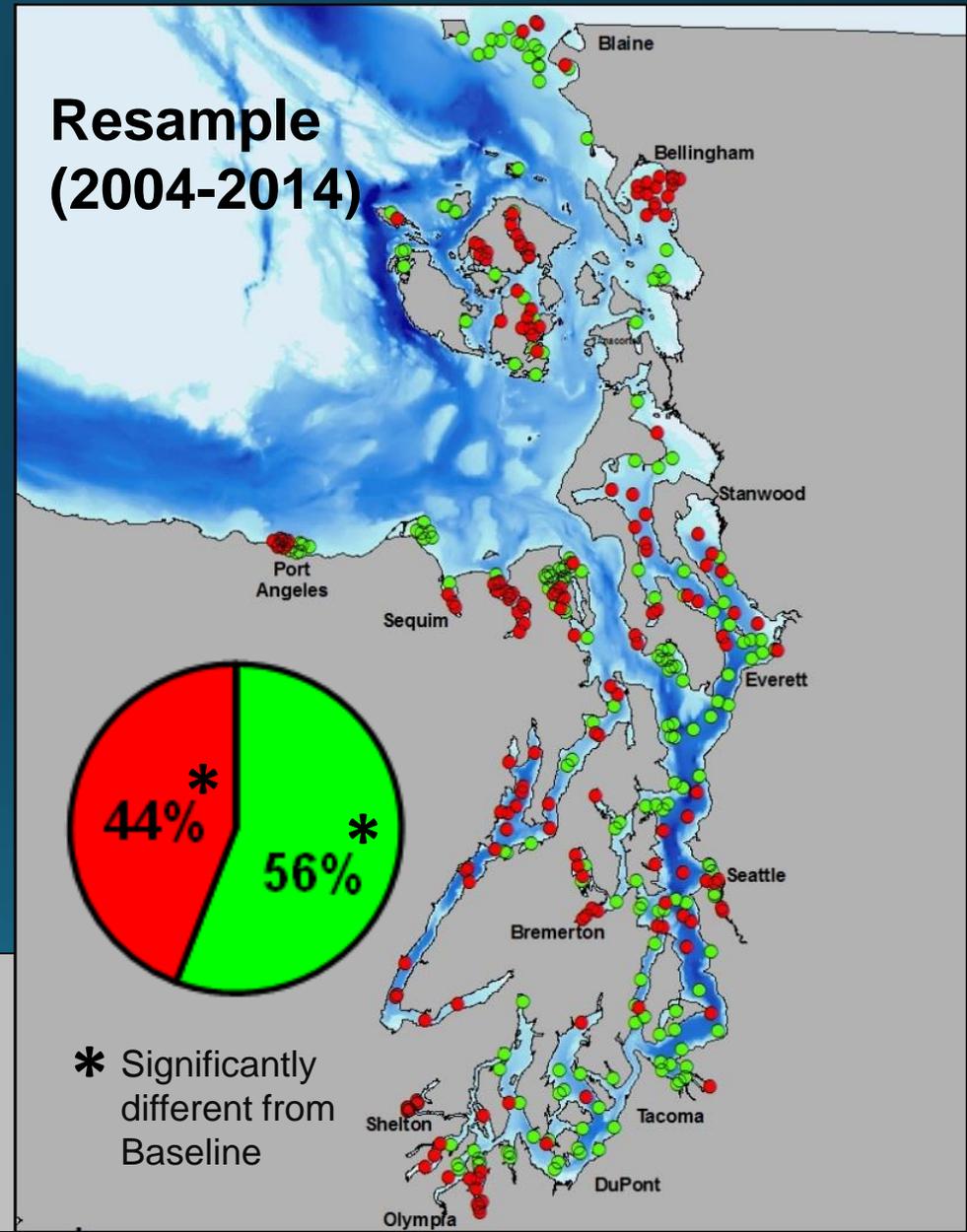


Baseline (1997-2003) vs Resample (2004-2014)

Benthic Index Over Time



Over 10 years



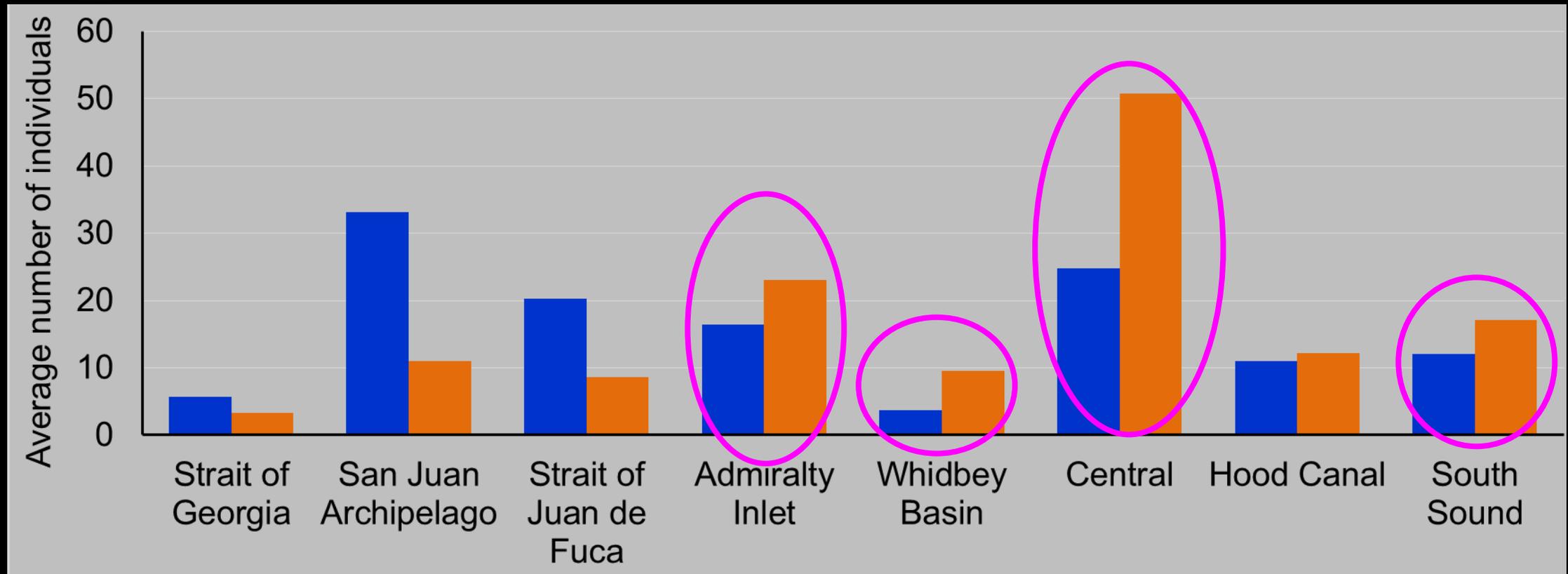
- Unaffected
- Adversely Affected

Systematic Change and Potential Indicators



Parvilucina tenuisculpta

Average Abundance of Parvilucina

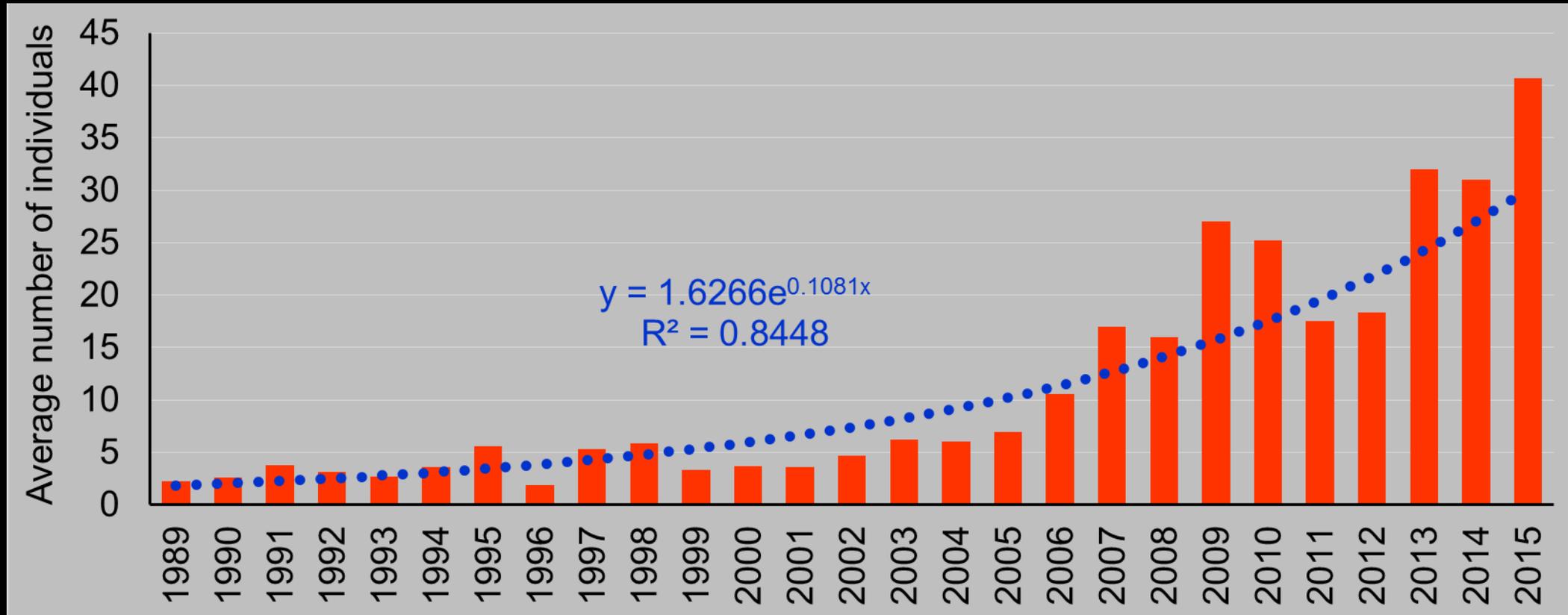


Baseline (1997-2003) vs Resample (2004-2014)

*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

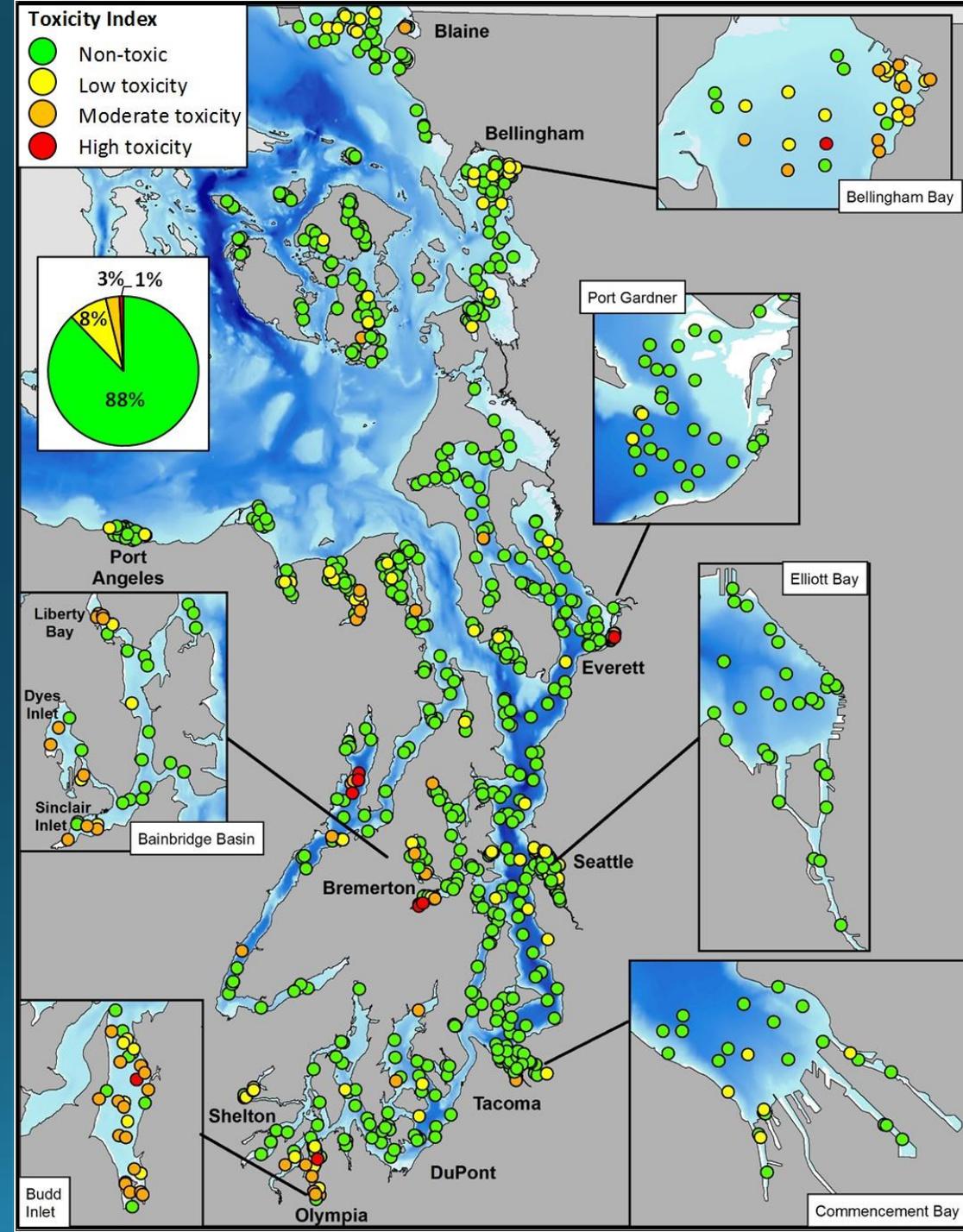
Toxicity Index

Toxicity in urban areas was less than anticipated

Greater levels of toxic response were measured in terminal inlets, often in areas removed from urbanization

Low toxicity was found in transition areas

Toxicity results do not correlate with chemistry results



Summary of Findings

Benthos declining over time

Benthos are adversely affected in terminal inlets

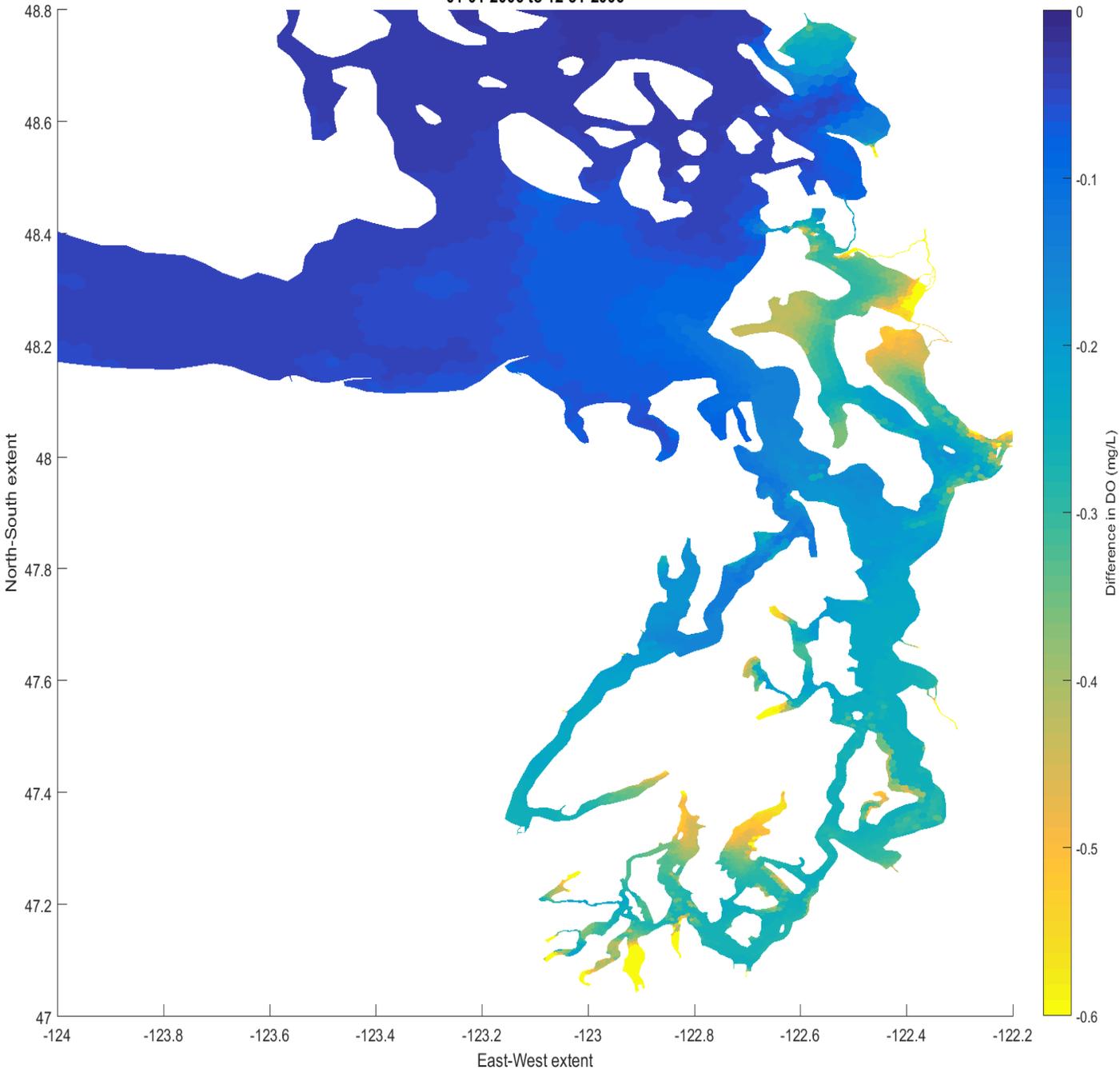
Increase of pollution/hypoxia tolerant species

Higher toxicity in terminal inlets

Laboratory chemistry and toxicity tests do not correlate well with the benthic community → ***no smoking gun.***



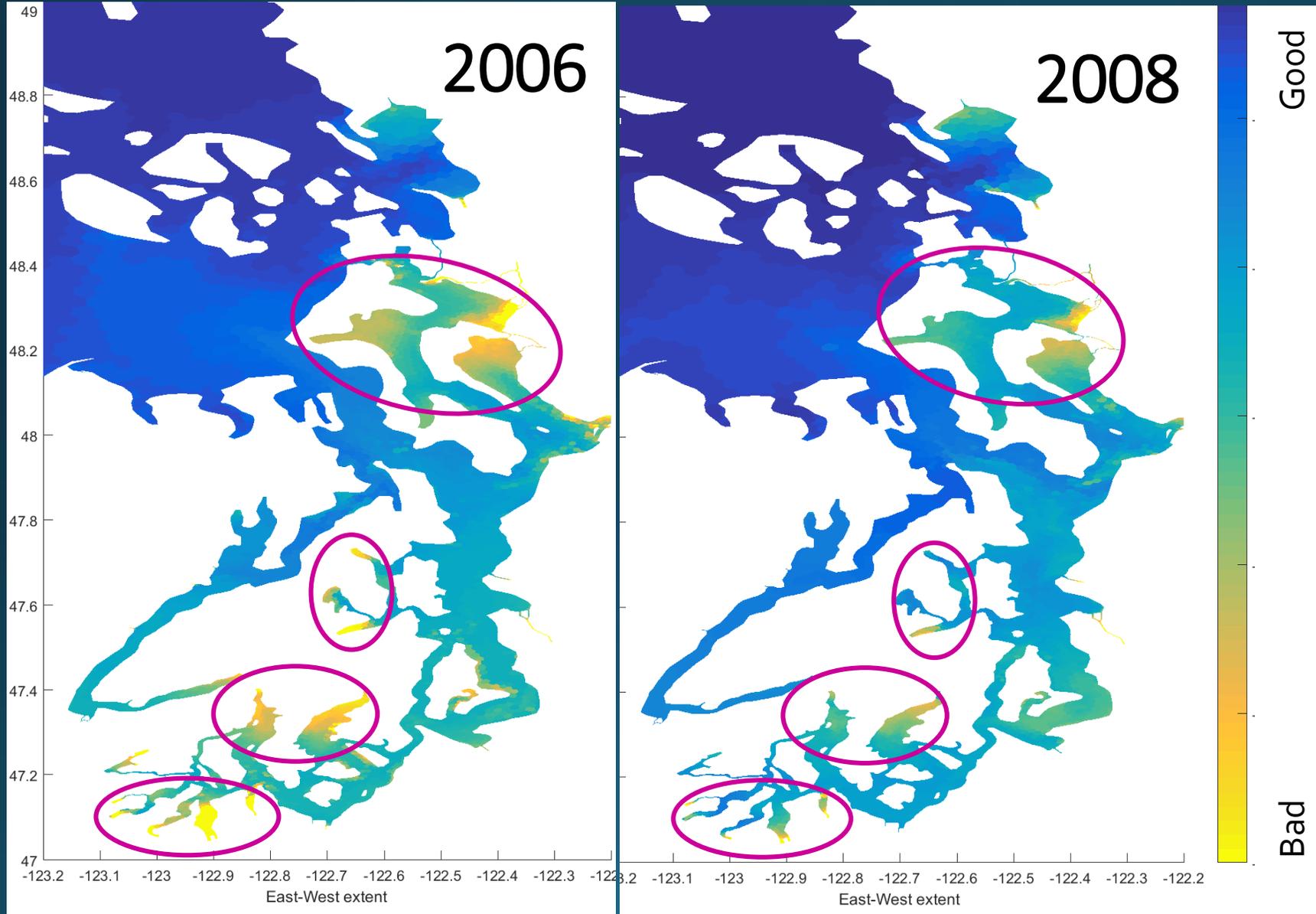
Maximum depletion of DO by regional anthropogenic sources
01-01-2006 to 12-31-2006



Modeling To Evaluate Relative Impacts on Dissolved Oxygen

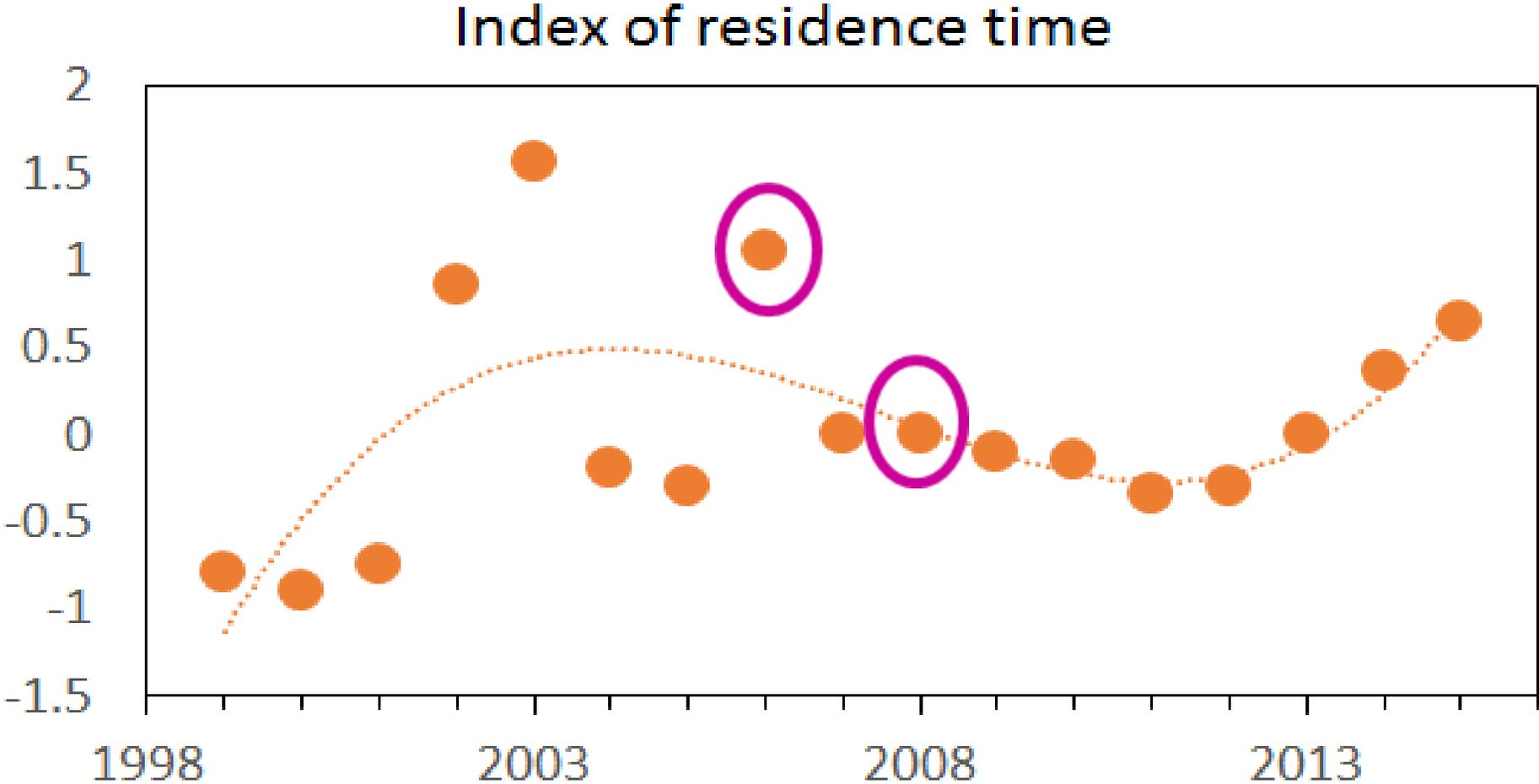
- Whidbey Basin
- Terminal inlets
 - Bainbridge Basin
 - South Sound and
 - Hood Canal

Modeled depletion of DO by anthropogenic sources



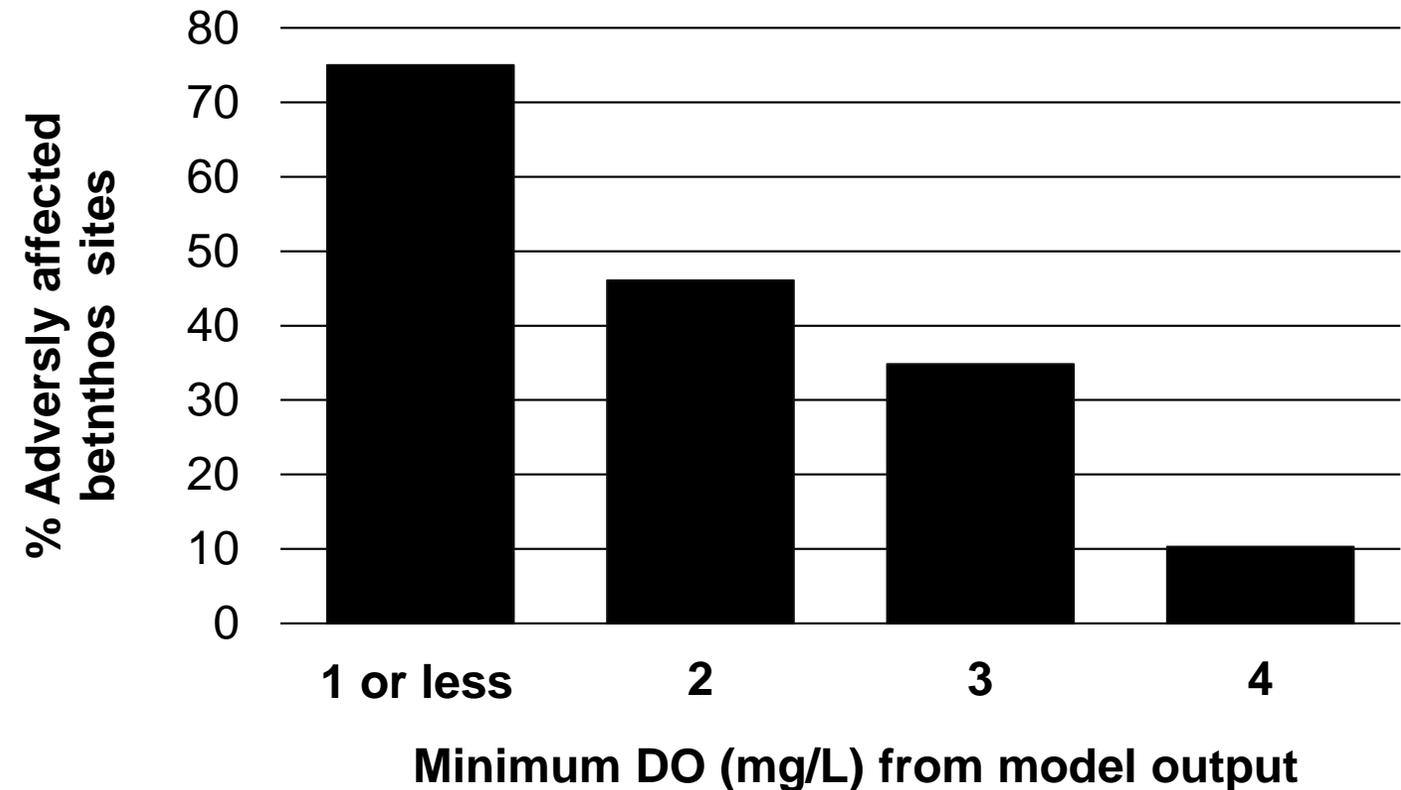
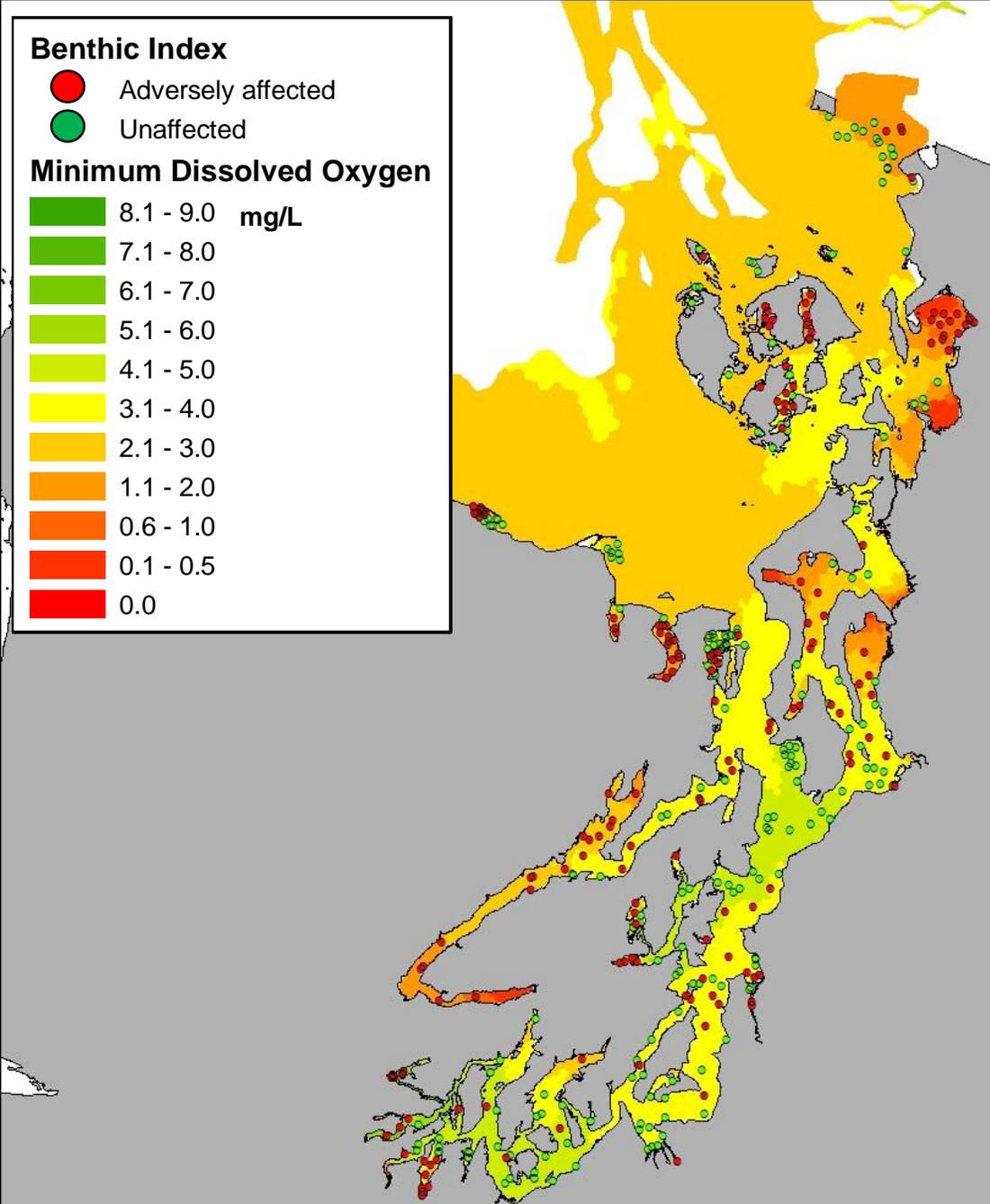
- Some areas of Puget Sound have naturally slow circulation
- The magnitude and spatial extent of DO depletion in 2006 is greater than in 2008

Residence Time Goes Up As Climate Change Progresses

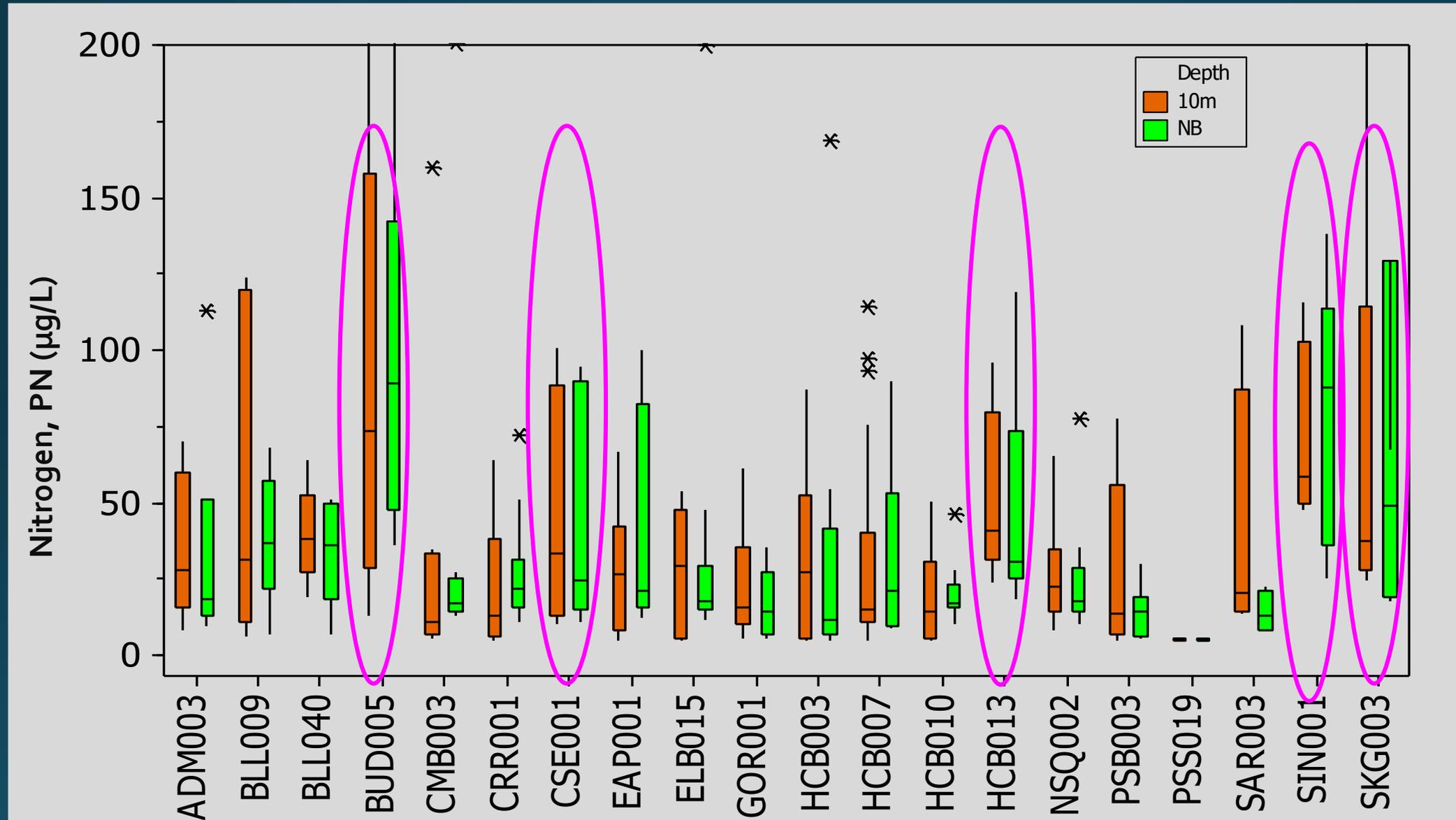


Knudsen Equation – Residence time in Central Sound Skip Albertson in progress

Model Predictions of Low DO Correspond with Affected Communities



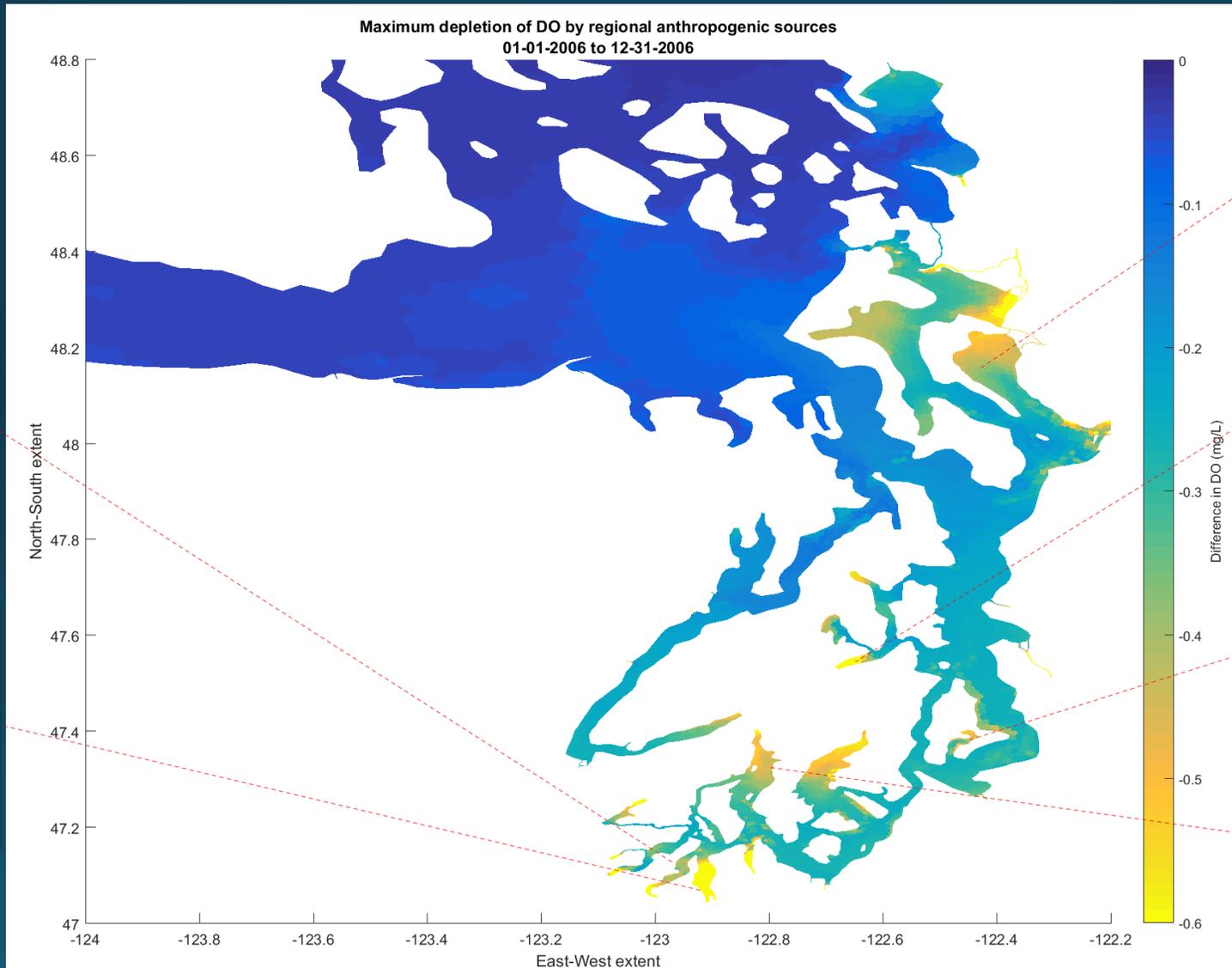
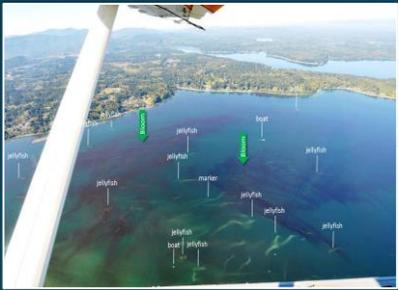
Some Areas are More Productive than Others



Sluggish Water Exchange Increases Human Burden on Oxygen

Model and Monitoring Results Agree

Eutrophication Indicators



What Does it Mean for Future

- Areas with sluggish water exchange will likely increase
- Areas with low oxygen zones will likely increase
- Altered biogeochemical process
- Release of nutrients to the water column
- Areas with adversely affected benthos will likely increase
- Changes in food web interactions

Monitoring into the Future

Invertebrate Communities

- Benthic and Zooplankton

Water Column Particulates

Chemistry

- Priority pollutant metals, organics
- Chemicals of Emerging Concern

Biogeochemistry

- TOC, TIC, TN, C:N ratio
- Sulfides
- Nutrient flux - Sediment core incubations