The past, present, and future of the Columbia River Inter-Tribal Fish Commission's CMOP Observatory

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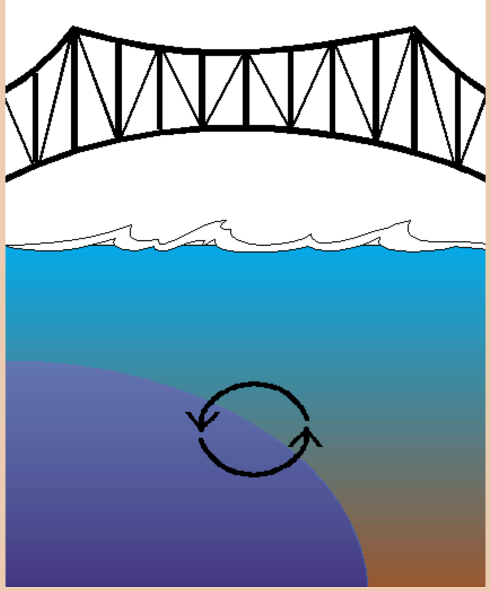
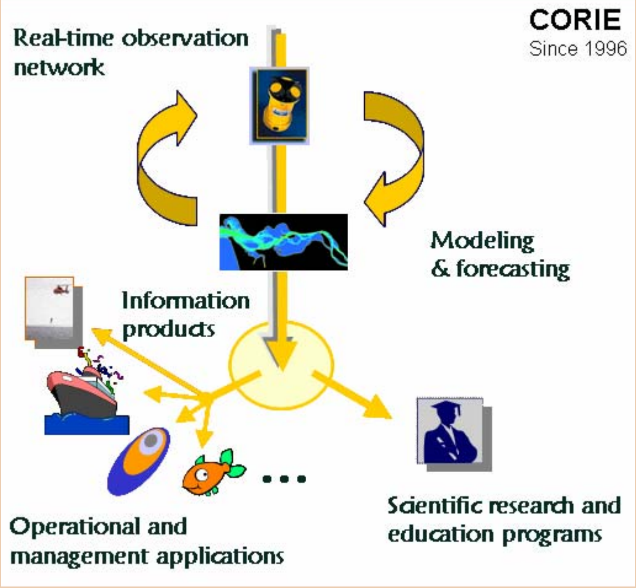
Columbia River Estuary Conference, May 17, 2023

History of the Coastal Margin Observation & Prediction (CMOP) program



1990-2000: Columbia River Estuary Turbidity Maxima LMER



1996-2006: CORIE program housed at OGI → OHSU

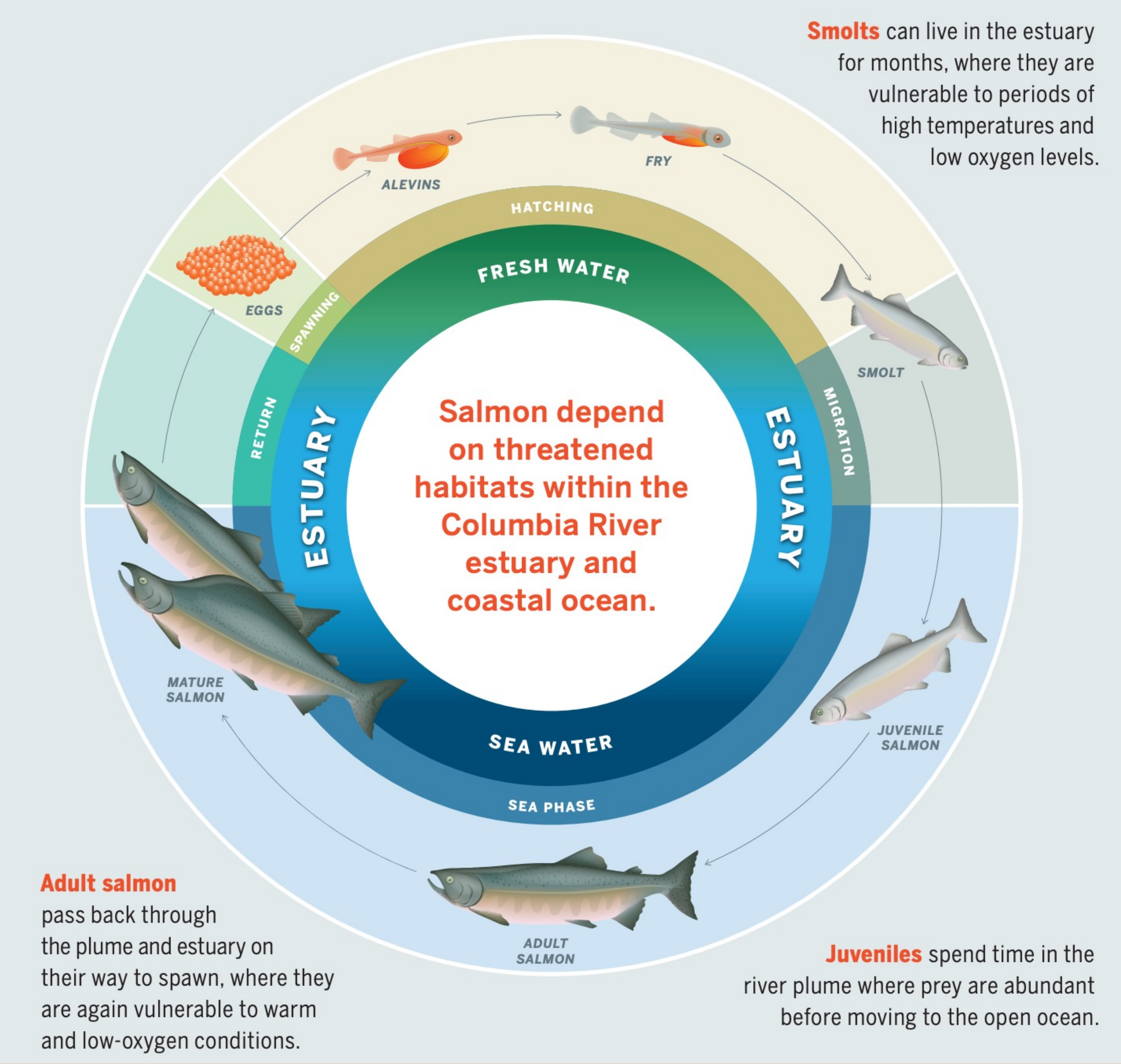
1996: began collecting continuous physical data

2006-2016: CMOP program, (NSF-STC) housed at OHSU

2008: began collecting continuous biogeochemical data

2020 onward: CMOP part of the Columbia River Inter-Tribal Fish Commission

CRITFC acquired CMOP in 2020 to increase engagement in the estuary and ocean and promote climate resilience



CRITFC mission: restore fish runs, protect treaty fishing rights, and coordinate inter-tribal enforcement

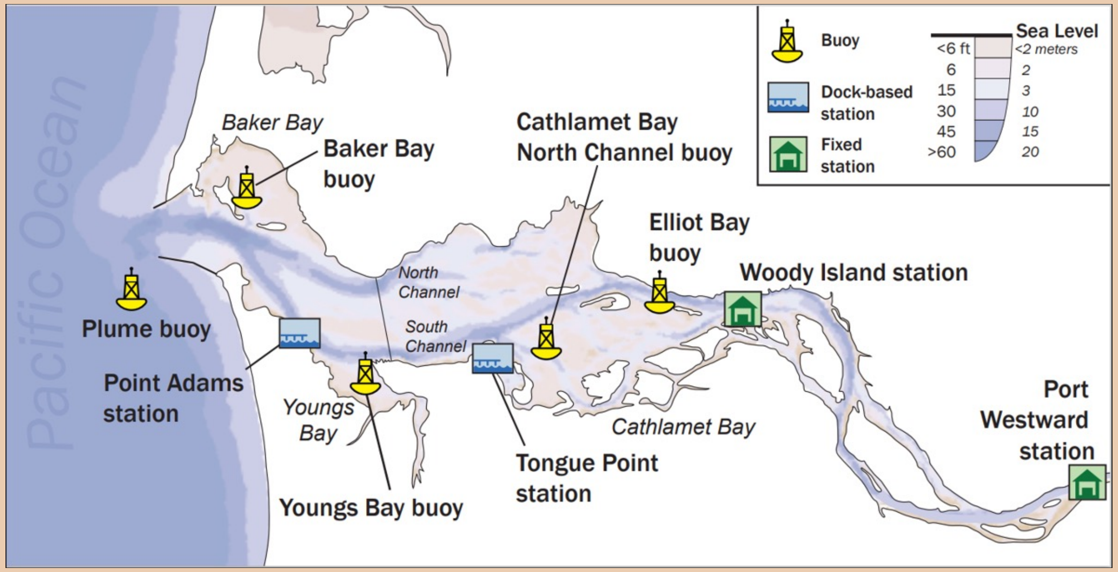
Coastal Margin Observation and Prediction program

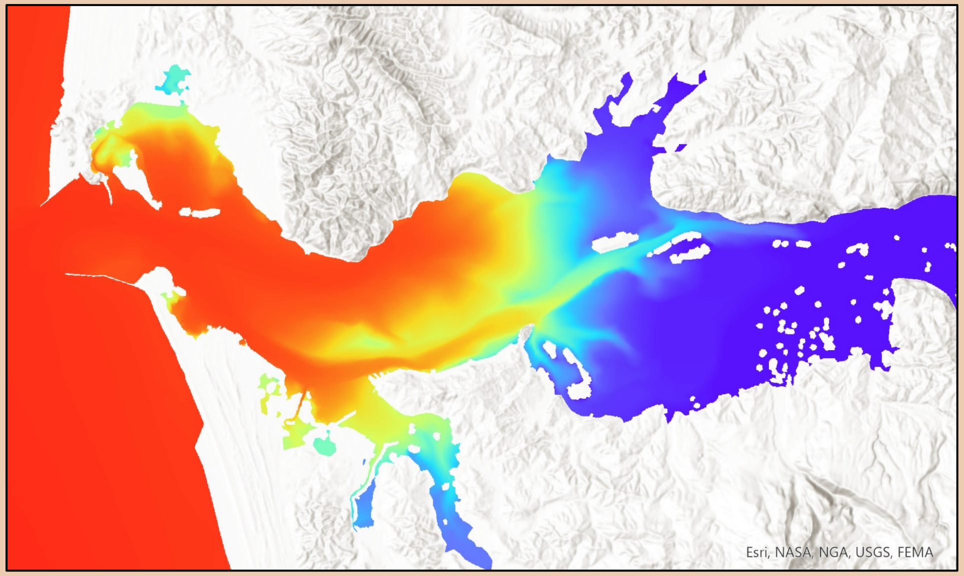
Data and model output used to support region and tribes

Data and model output available through cmop.critfc.org and nanoos.org

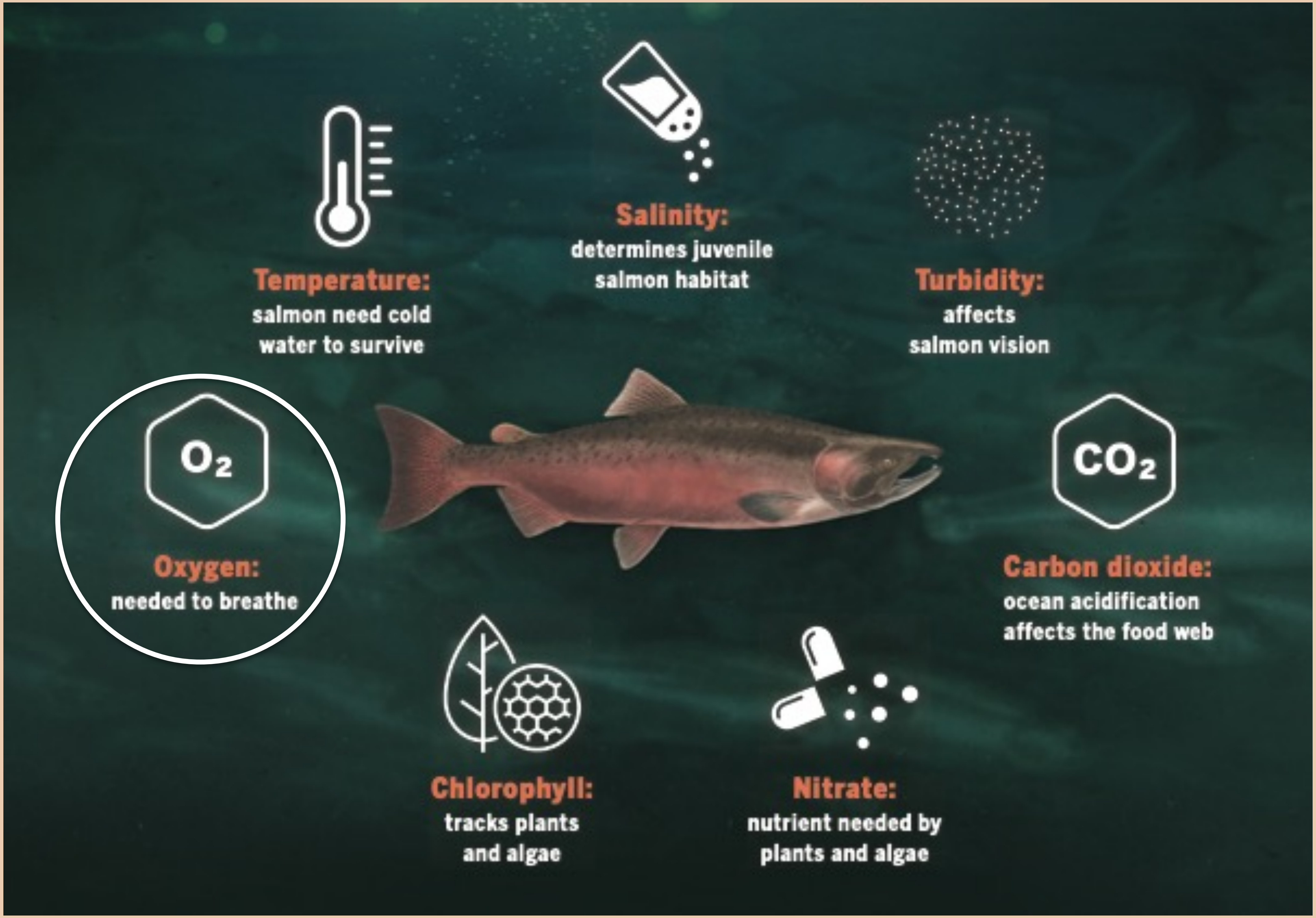
OBSERVATION

PREDICTION

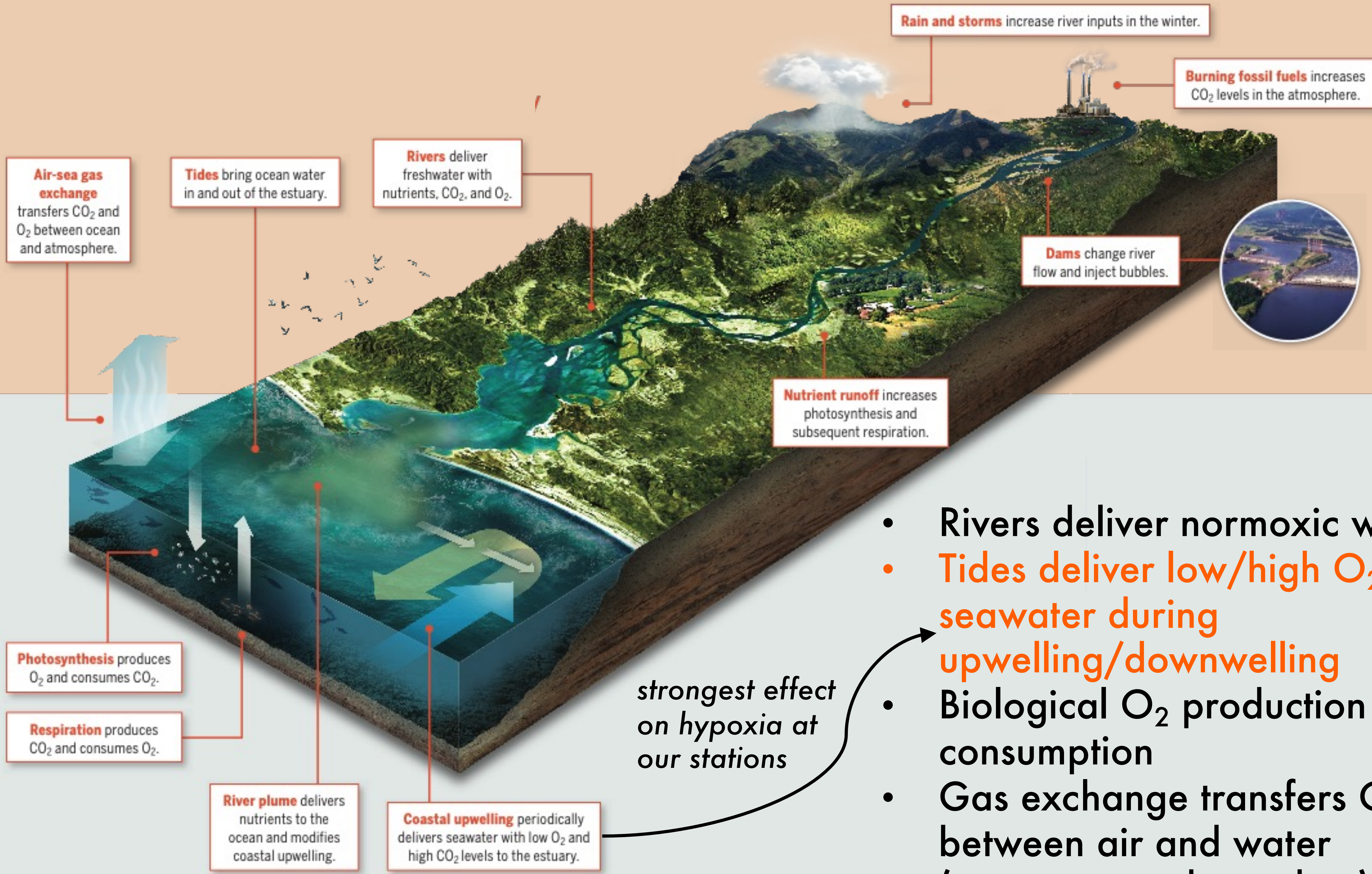




Measurements from the CMOP observatory matter for salmon



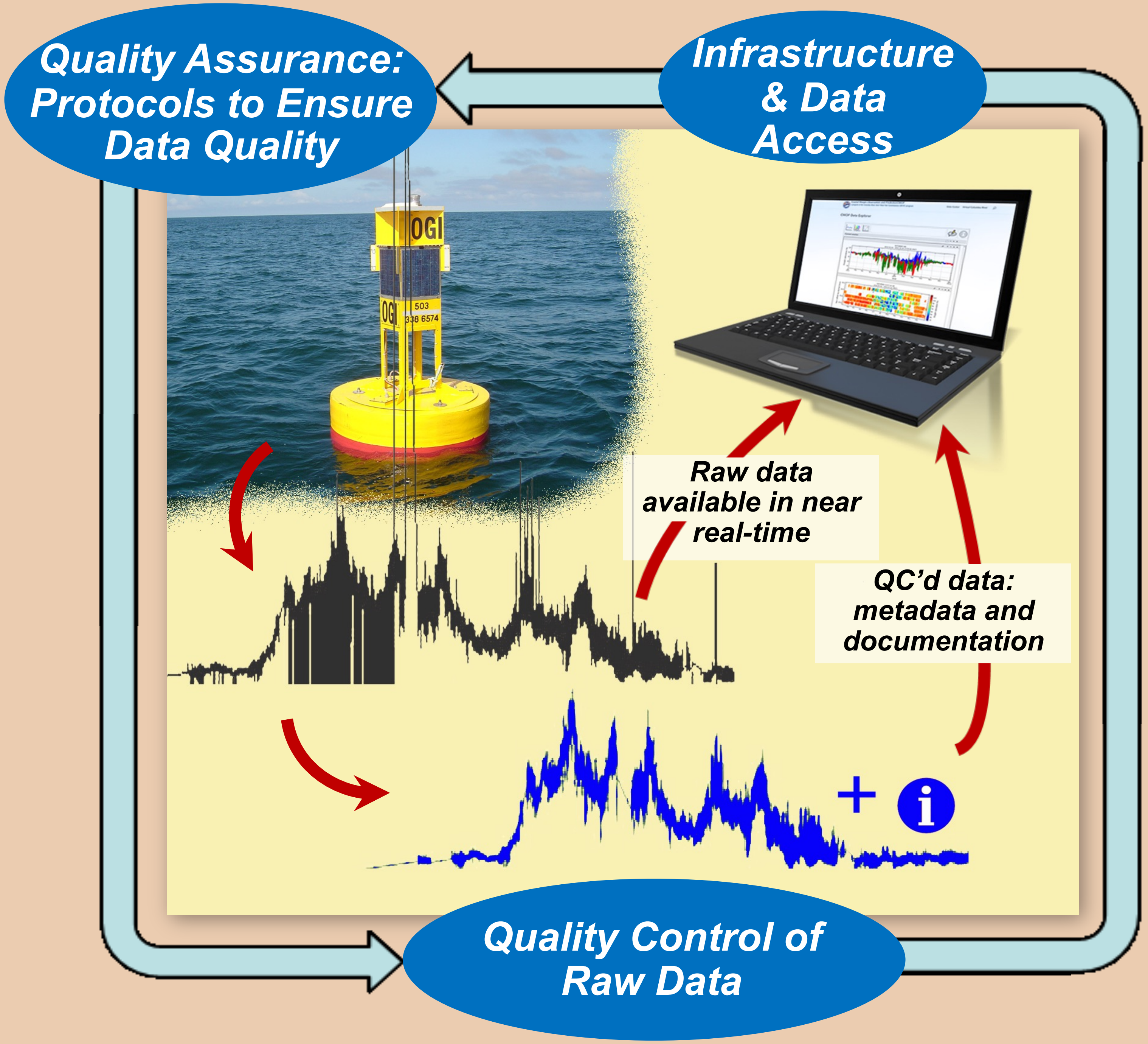
Processes influencing dissolved oxygen in the lower estuary

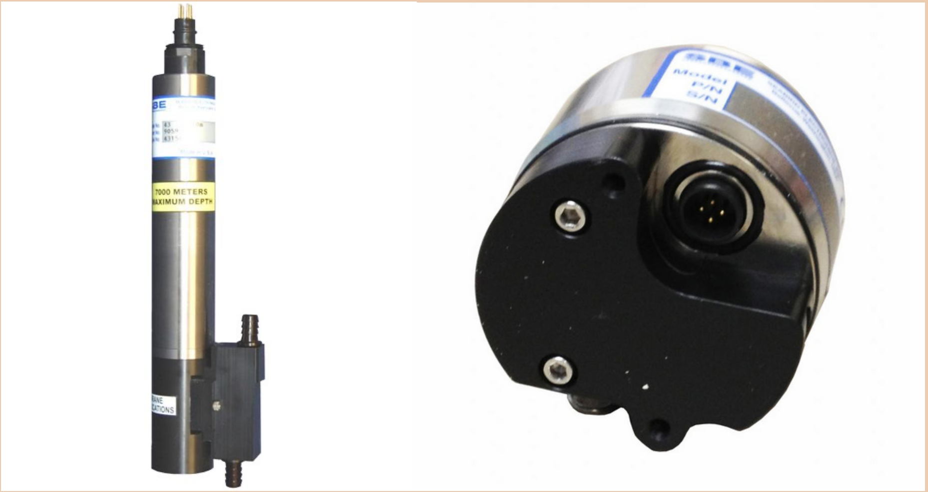


strongest effect on hypoxia at our stations

- Rivers deliver normoxic water
- Tides deliver low/high O_2 seawater during upwelling/downwelling
- Biological O_2 production and consumption
- Gas exchange transfers O_2 between air and water (temperature dependent)

Dissolved oxygen methods





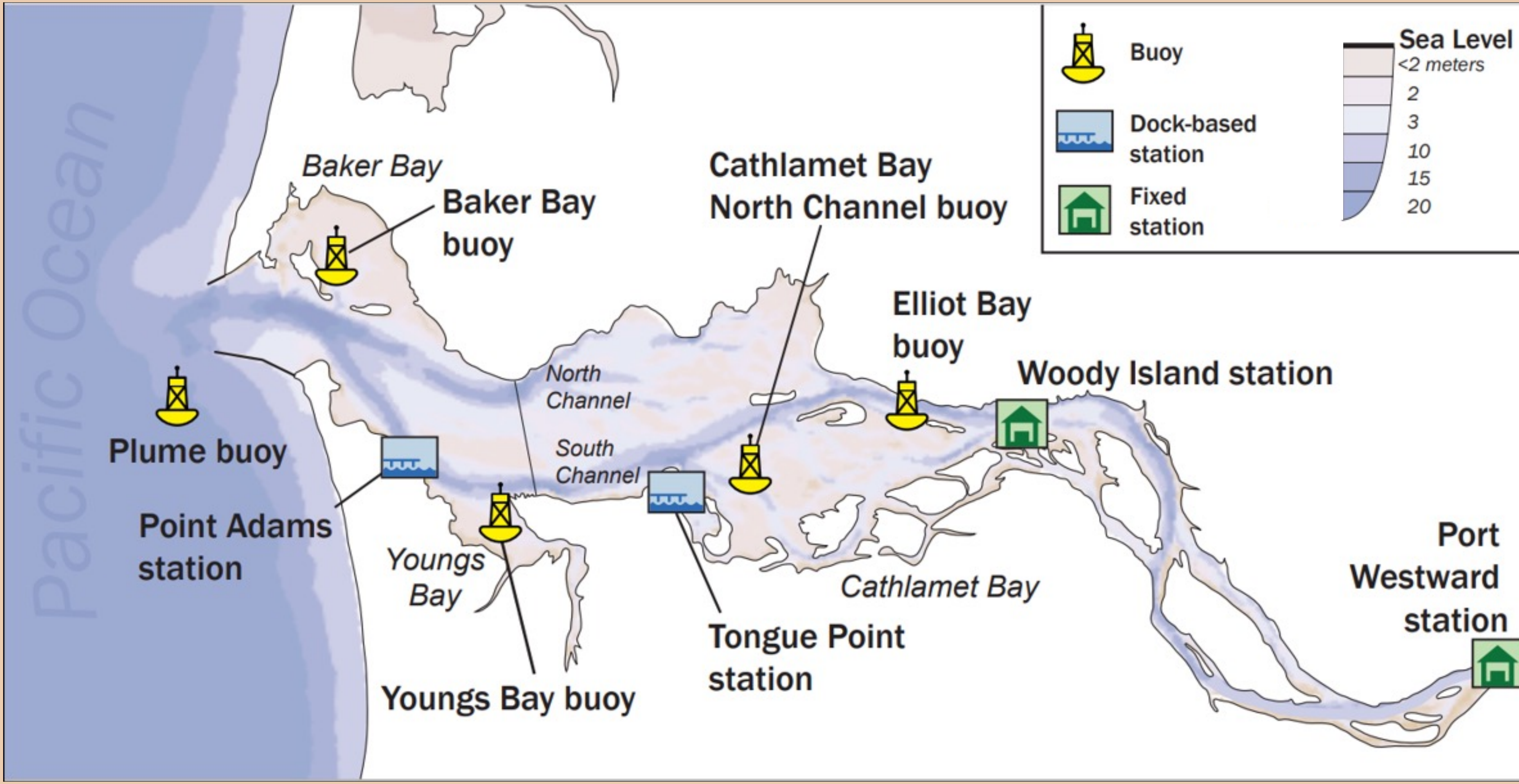
Instruments

- SBE 43 (electrochemical) and SBE 63 (optical)

QA/QC

- Instruments periodically recovered, cleaned, and co-deployed
- Calibrations with bubbled DI
- Raw data QC'd (e.g. drift correct, spikes removed)

Current CMOP Observatory

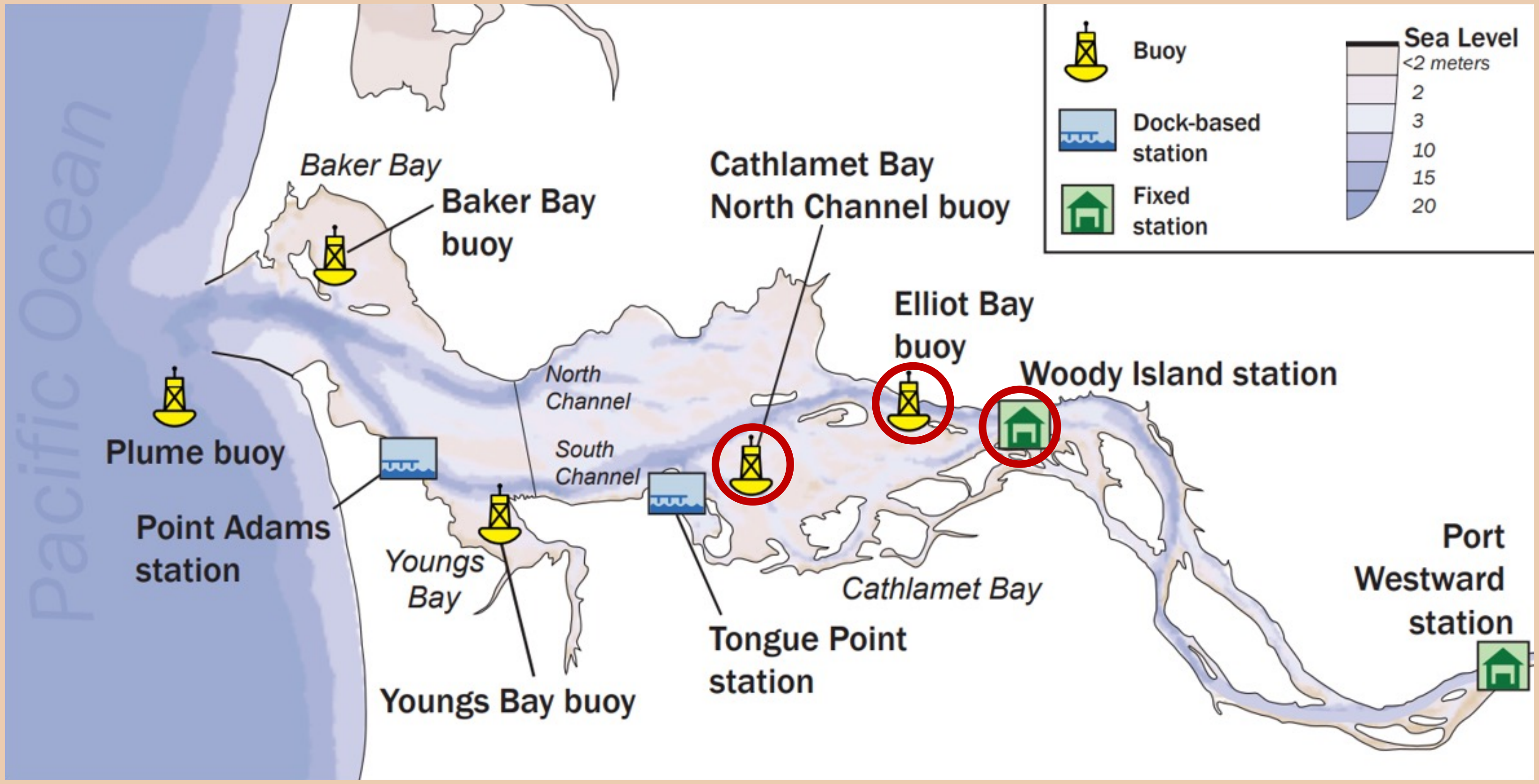


Three physical estuary buoys/stations

Cathlamet Bay (9 m)
- Salinity: 0-15

Elliot Point (13 m)
- Salinity: 0-10

Woody Island (2.4 m)
- Salinity: 0-10

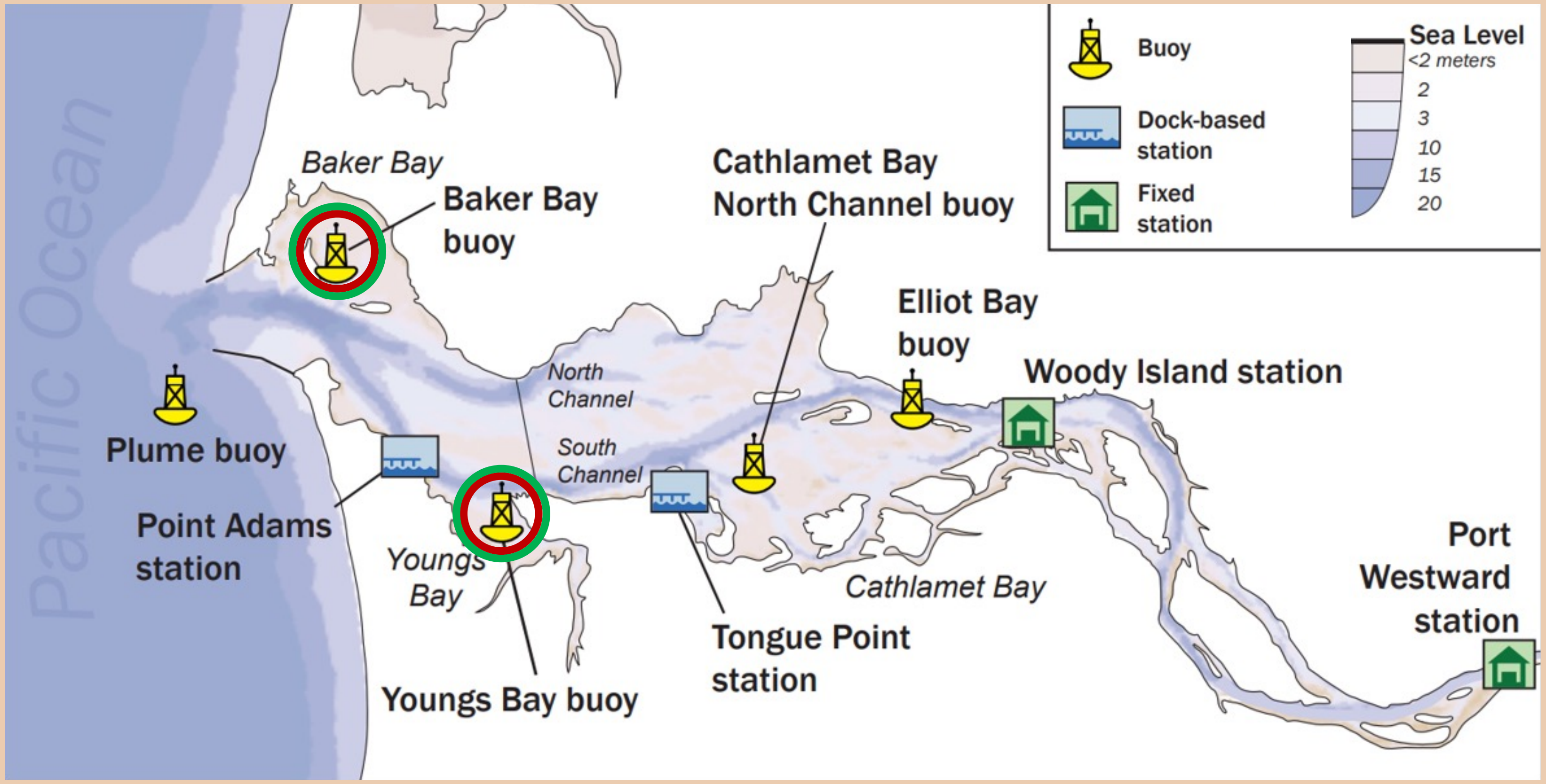


Physical:
- Temperature
- Salinity

Two surface biogeochemical estuary buoys

Baker Bay
Salinity: 2-20
Oxygen: 3.5-9 mL L^{-1}

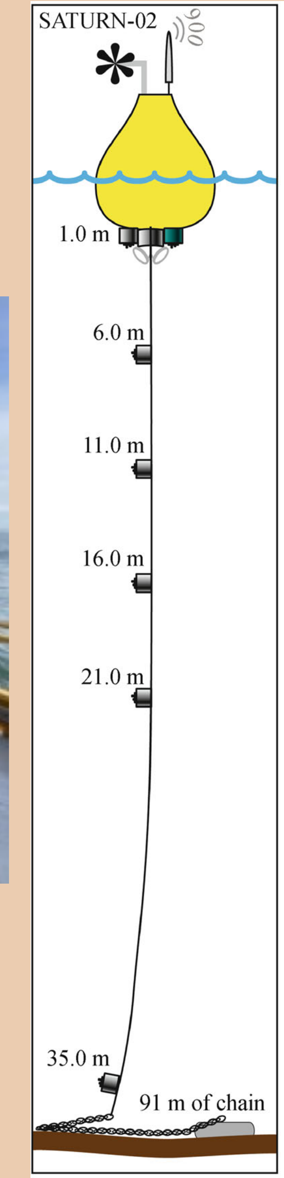
Youngs Bay
Salinity: 0-14
Oxygen: 4-10 mL L^{-1}



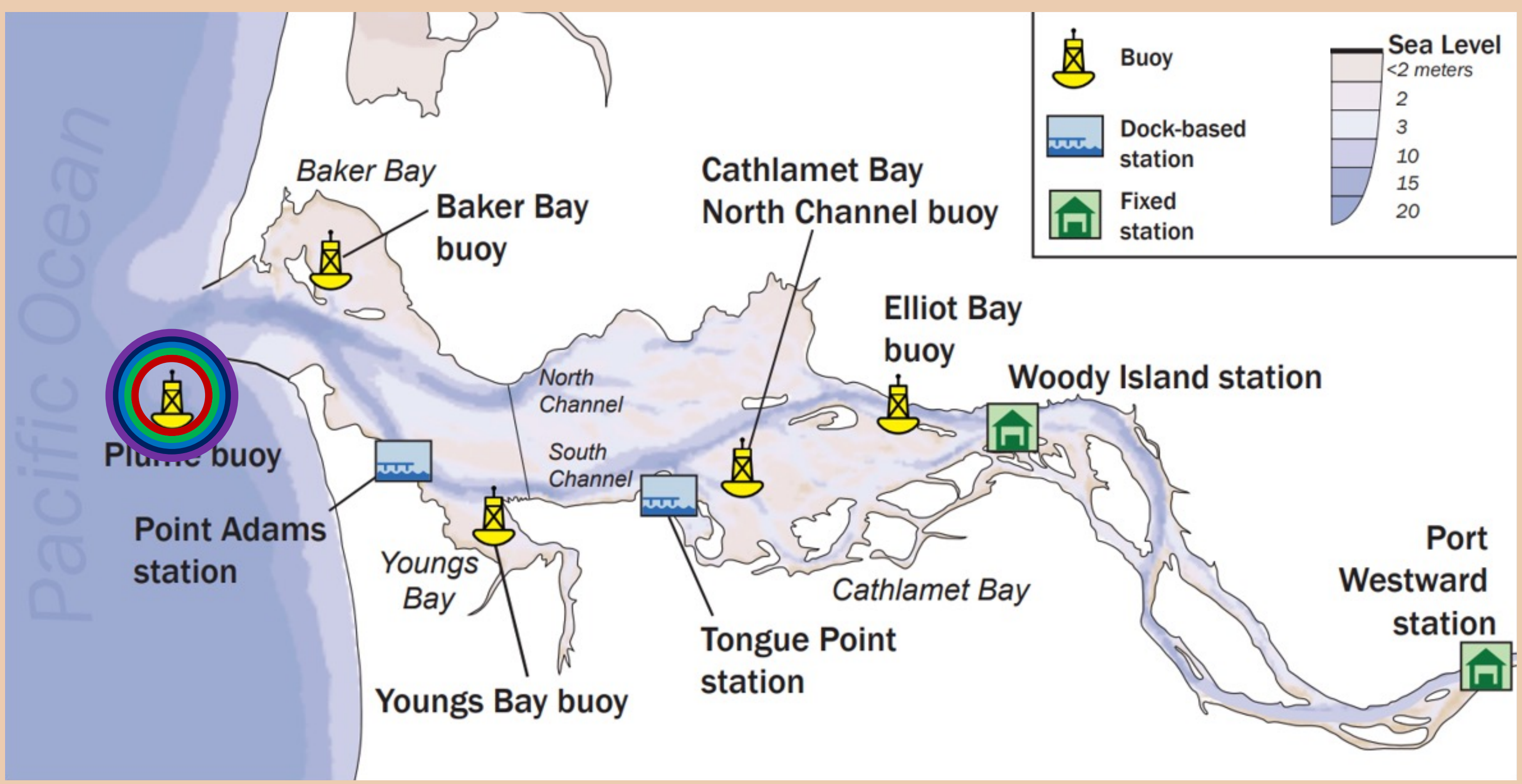
Physical:
- Temperature
- Salinity

Biogeochemical:
- Oxygen
- Turbidity
- Chlorophyll
- Phycoerythrin
- CDOM

One multi-depth biogeochemical ocean buoy



Plume buoy:
6 depths
Salinity: 10-34
Oxy: 0.5-10 mL L^{-1}



Physical:
- Temperature
- Salinity

Biogeochemical:
- Oxygen
- Turbidity
- Chlorophyll
- Phycoerythrin
- CDOM
- Nitrate
- Quantum yield
- Multi-excitation fluorescence

Meteorological & currents:
- PAR
- Wind
- Barometric pressure
- Air temperature
- Currents

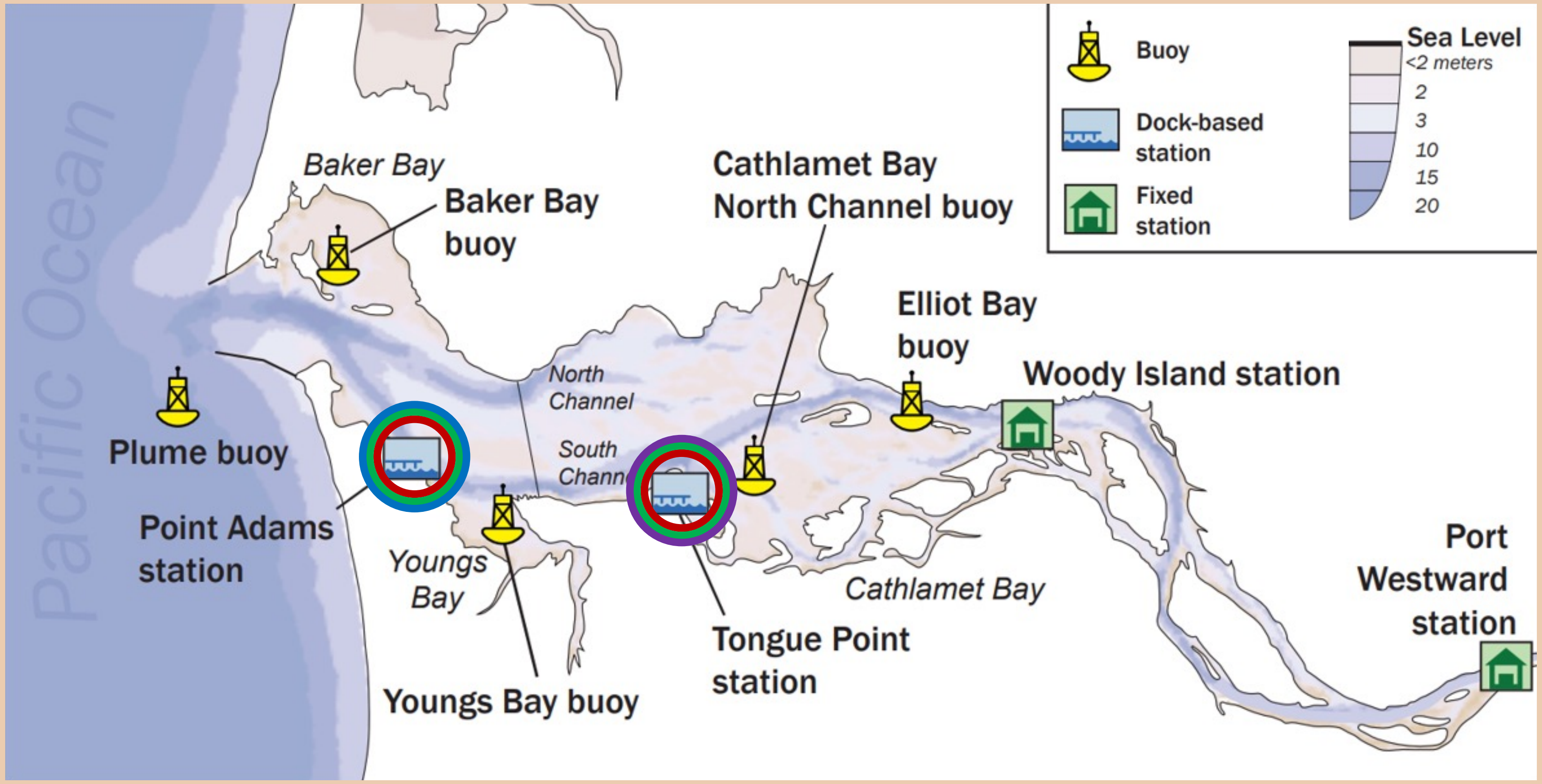
Two multi-depth biogeochemical estuary dock-based stations

Point Adams

3 depths
Salinity: 0-33
Oxygen: 0.9-9.6 mL L^{-1}

Tongue Point

2 depths
Salinity: 0-22
Oxygen: 3.5-10 mL L^{-1}



Physical:
- Temperature
- Salinity

Biogeochemical:
- Oxygen
- Turbidity
- Chlorophyll
- Phycoerythrin
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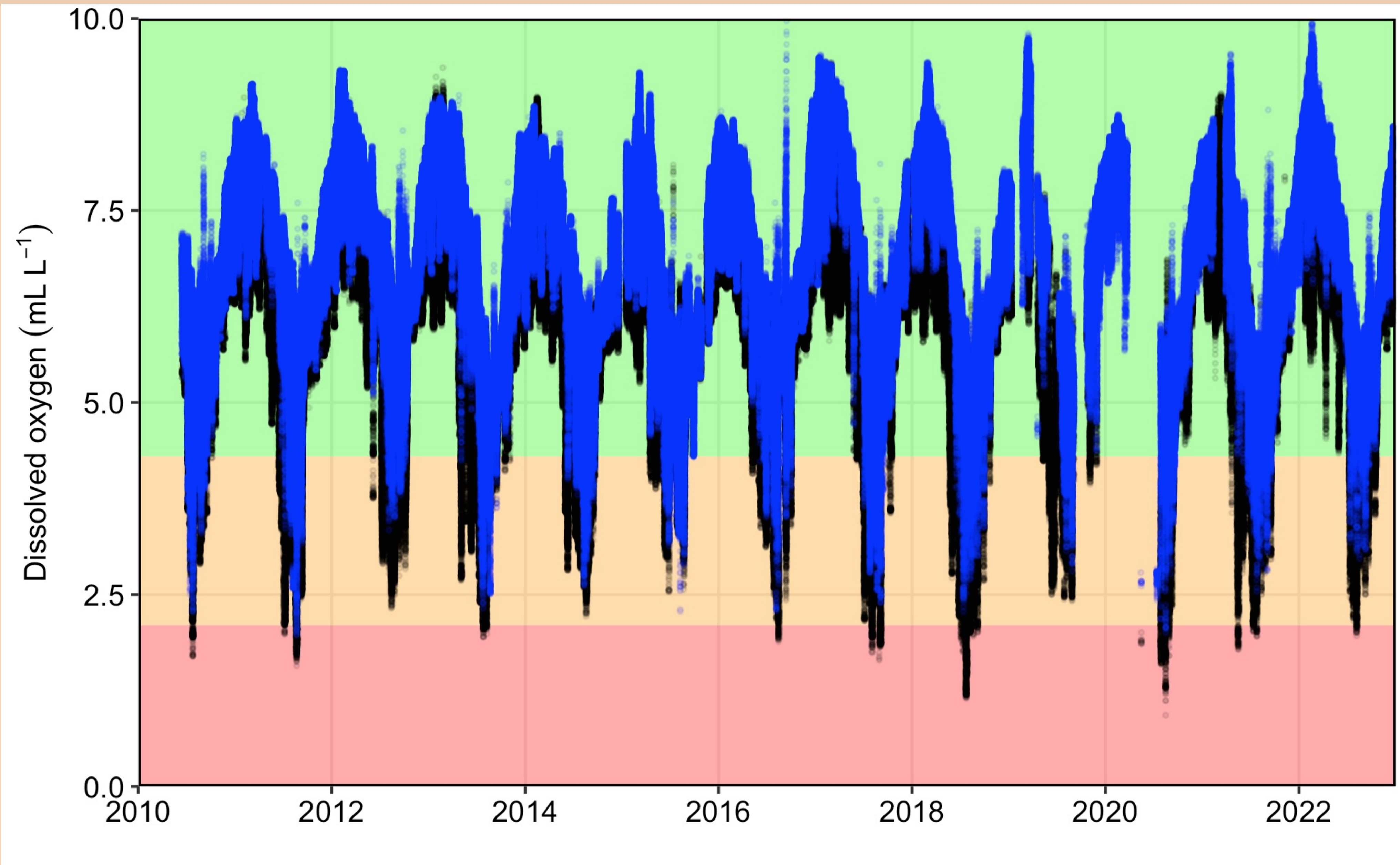
- Nitrate
- Quantum yield
- Multi-excitation fluorescence

Meteorological & currents:
- PAR

13 years of oxygen data from Point Adams

Seabed (13m) Near-surface



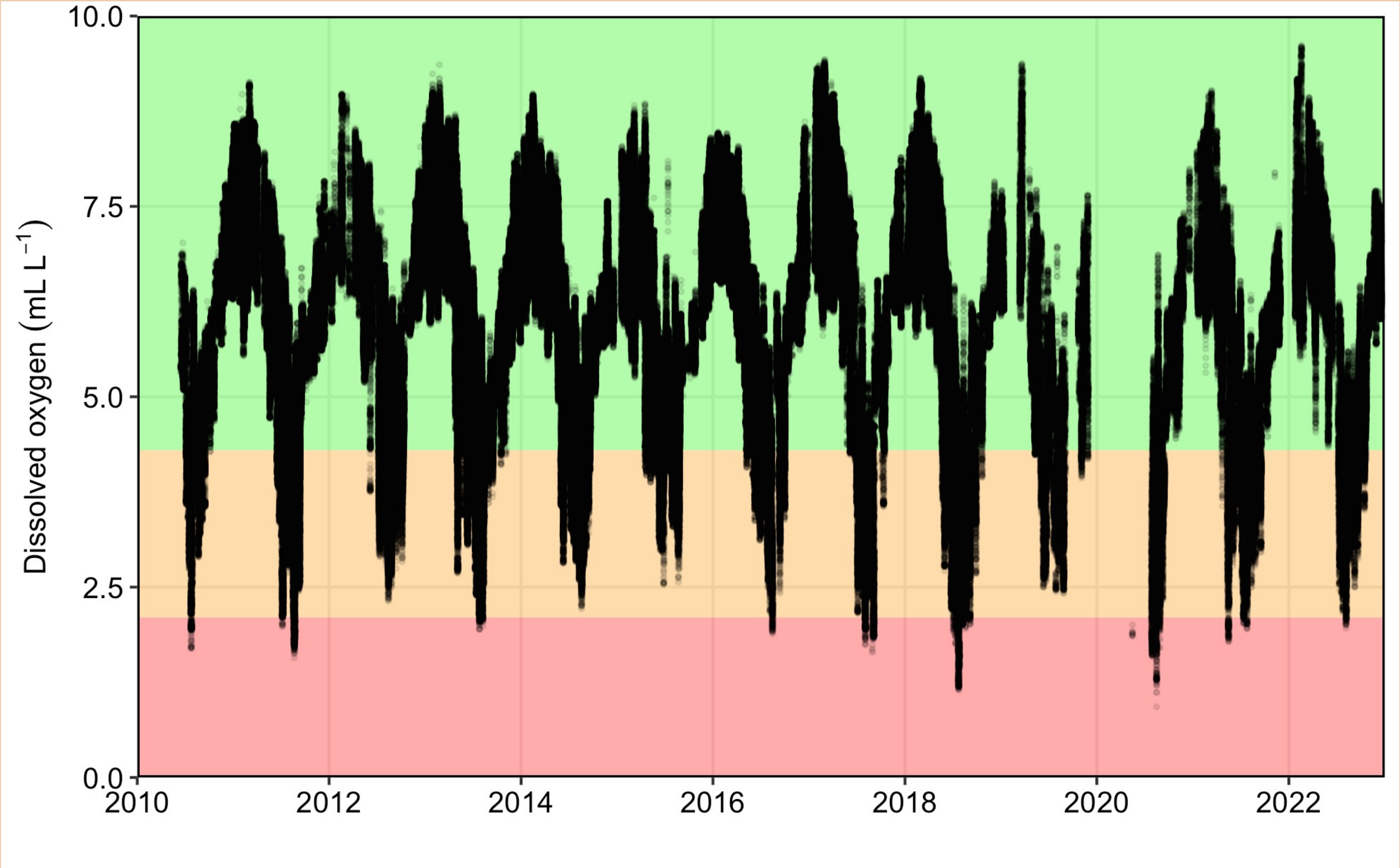
< 4.3 mL/L:
Physiological stress
(Davis 1975)

< 2.1 mL/L:
Upper limit for
acute mortality
(EPA 1986)

13 years of oxygen data from Point Adams

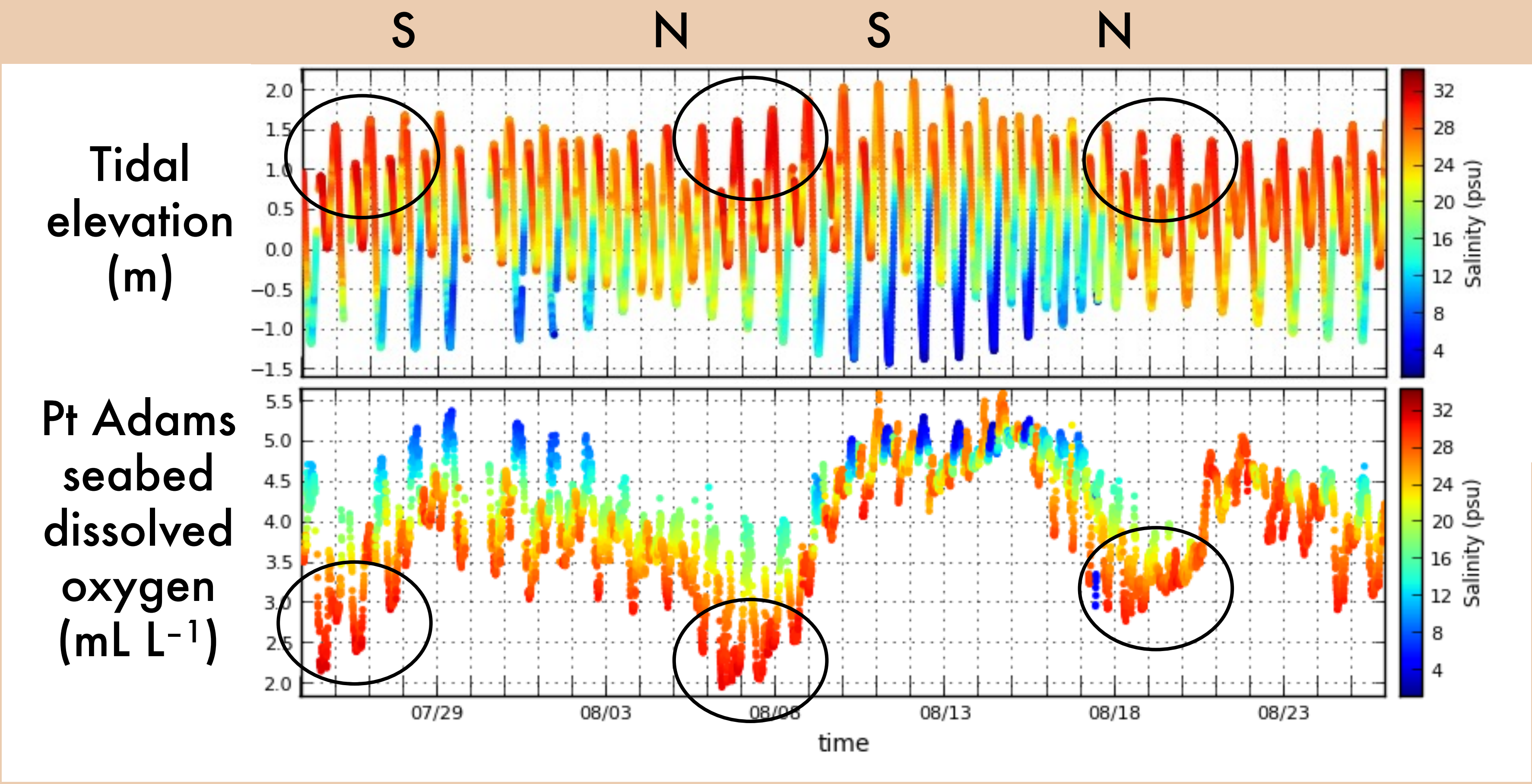
Interannual variability

Seasonal variability



Tidal variability

Tidal variability in oxygen at Point Adams: late summer 2022 example



Low dissolved oxygen often comes with:

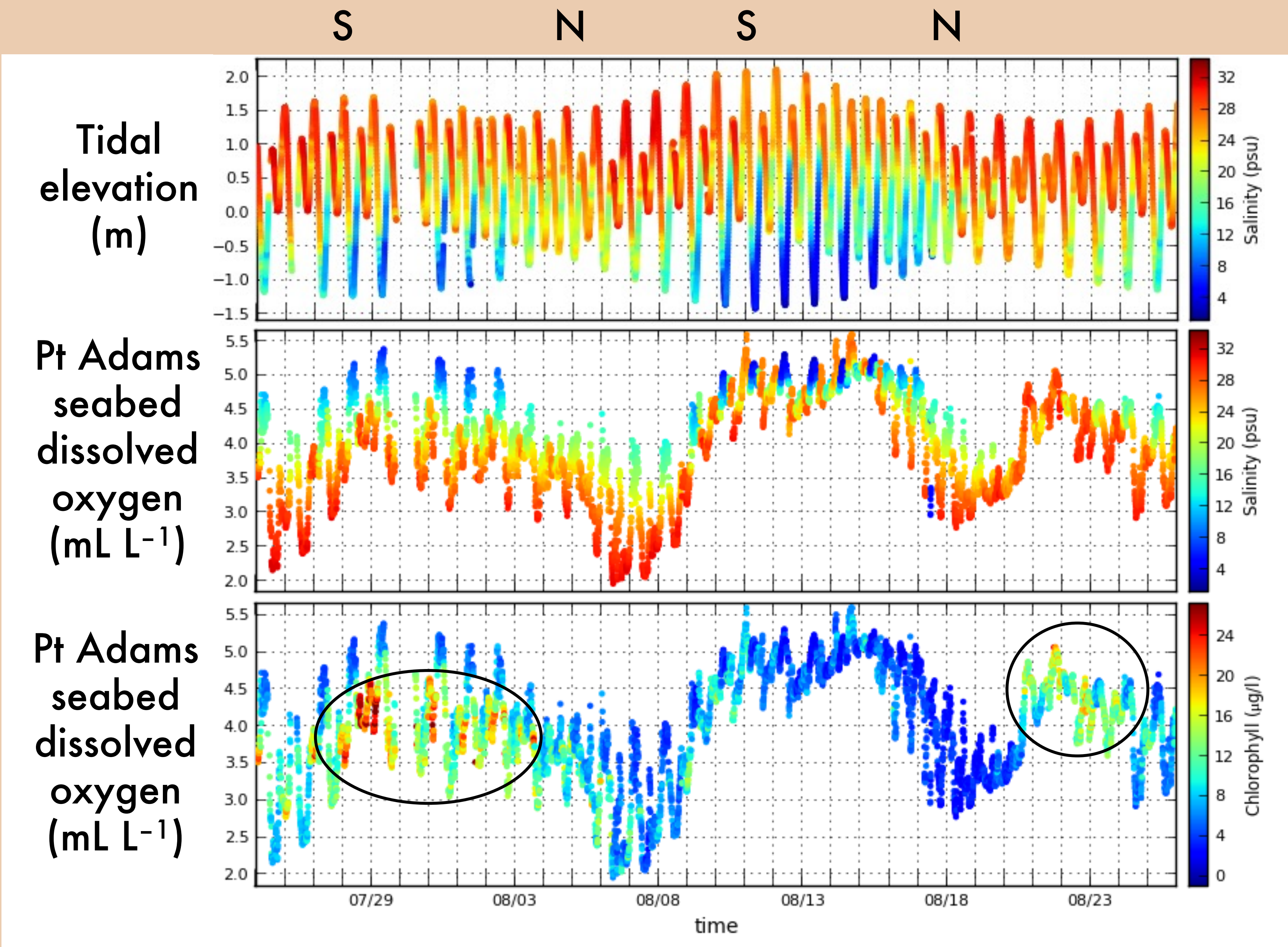
- High salinity
- High tide
- Neap tide

High dissolved oxygen often comes with:

- Low salinity
- Low tide
- Spring tide

These patterns agree with Roegner et al. (2011)

Tidal variability in oxygen at Point Adams: late summer 2022 example



Low dissolved oxygen often comes with:

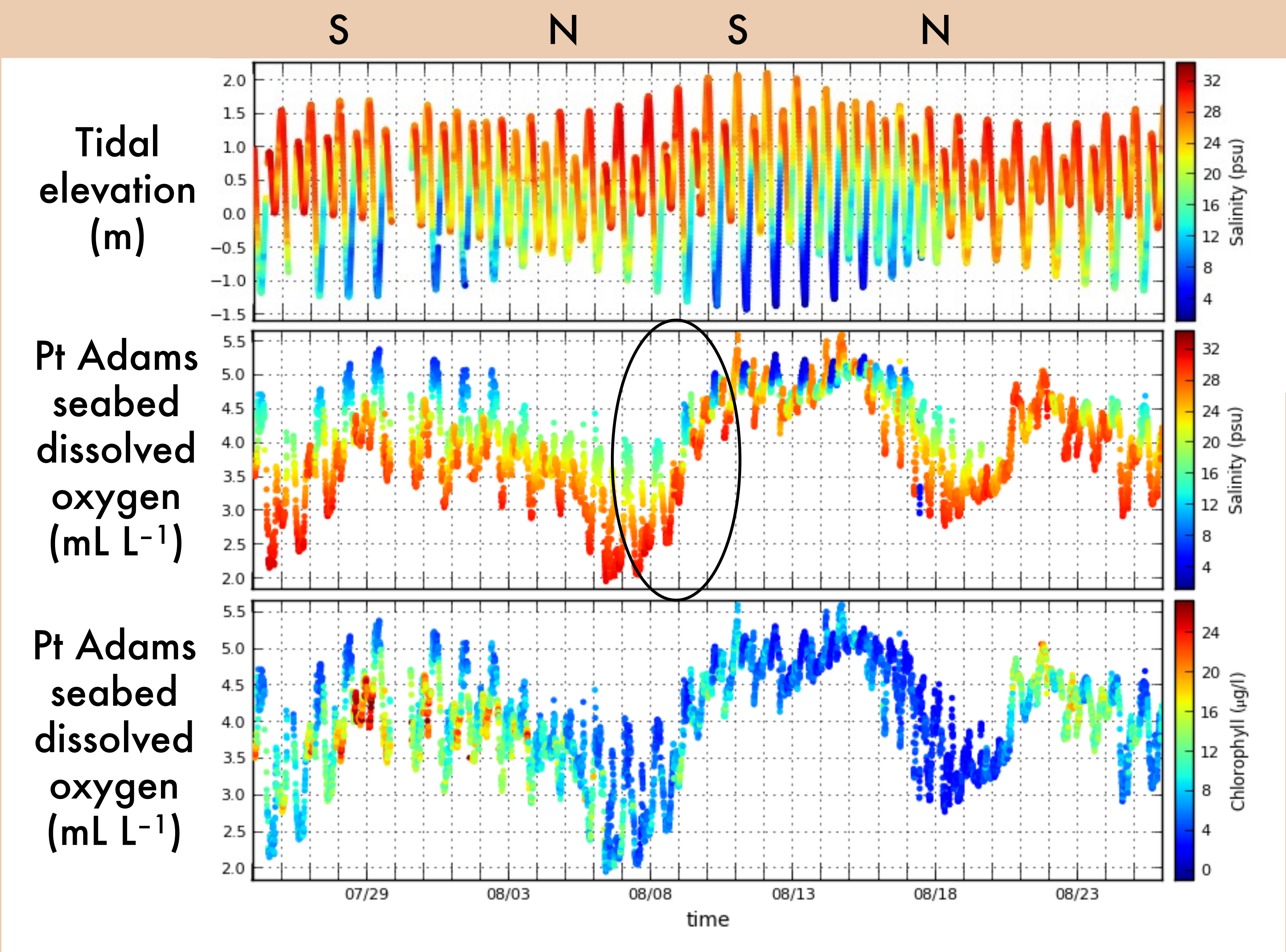
- High salinity
- High tide
- Neap tide

High dissolved oxygen often comes with:

- Low salinity
- Low tide
- Spring tide
- High chlorophyll (periodically)

These patterns agree with Roegner et al. (2011)

Tidal variability in oxygen at Point Adams: late summer 2022 example

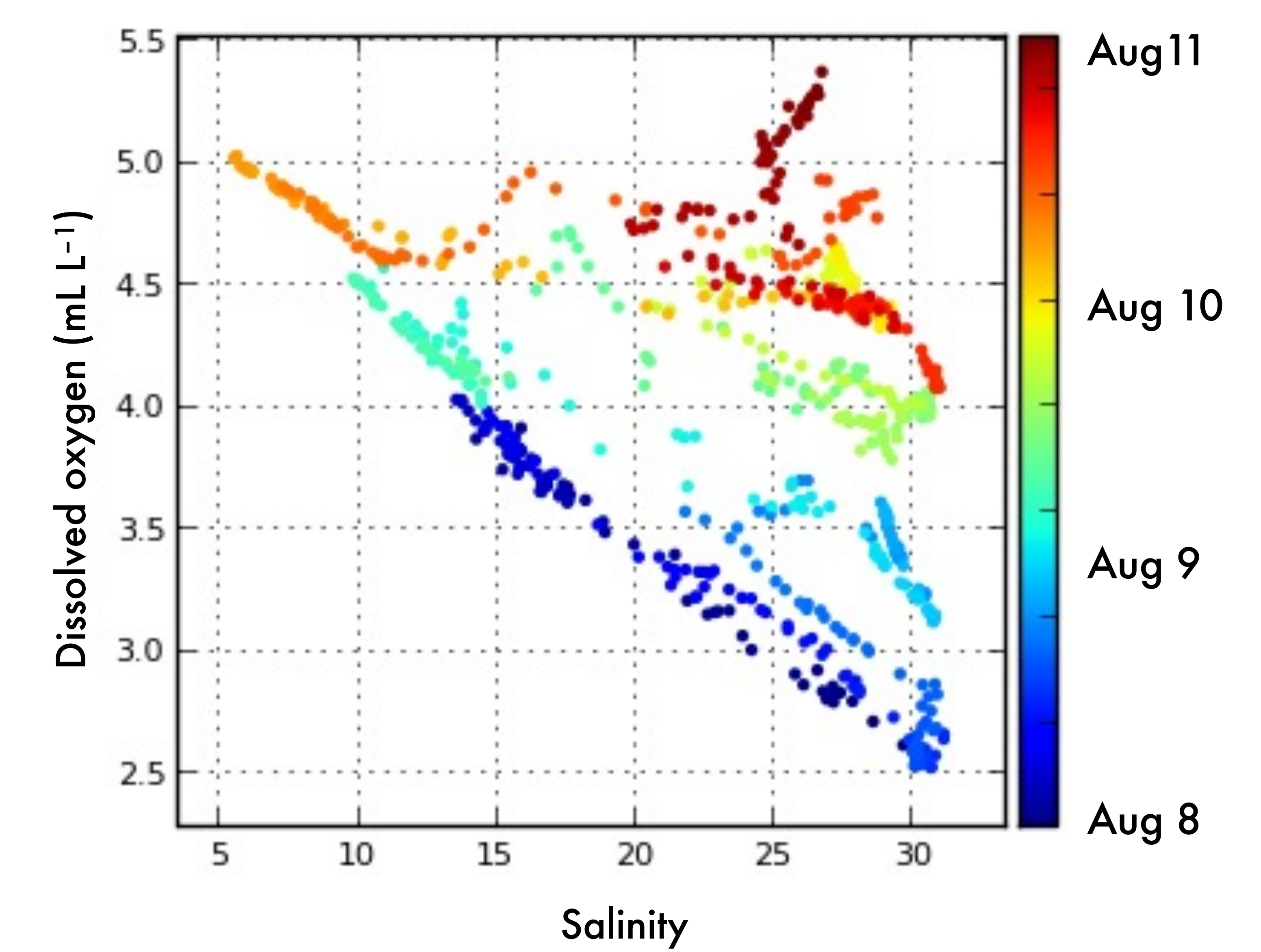


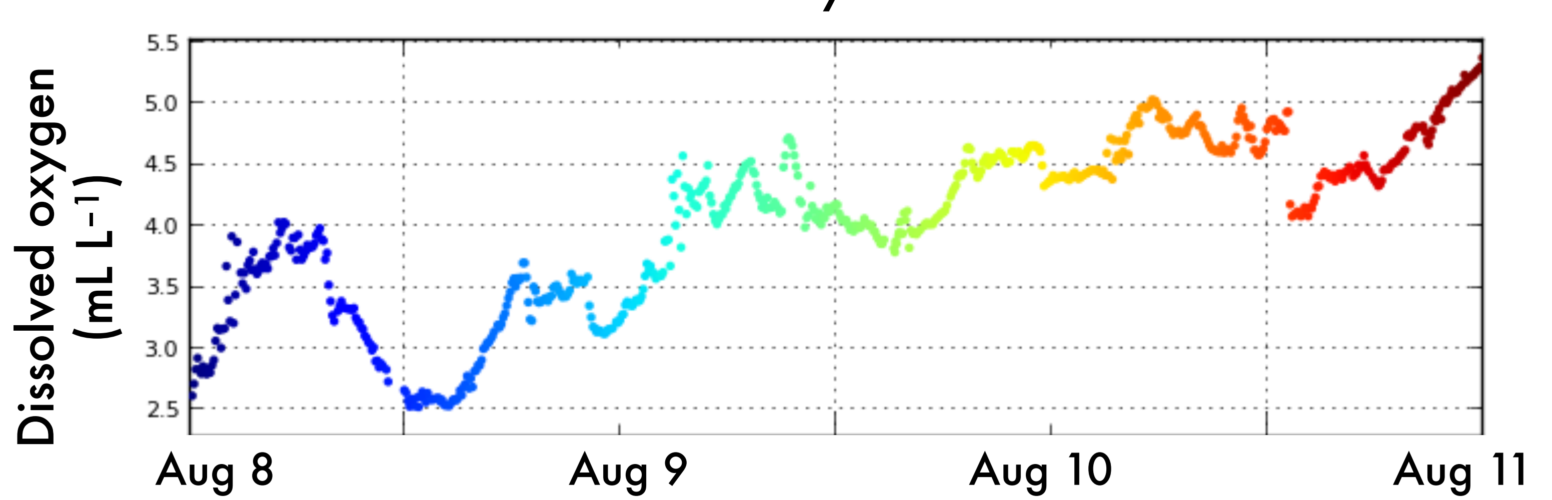
Low dissolved oxygen often comes with:

- High salinity

Varies with ocean source water

Tidal variability in oxygen at Point Adams: late summer 2022 example





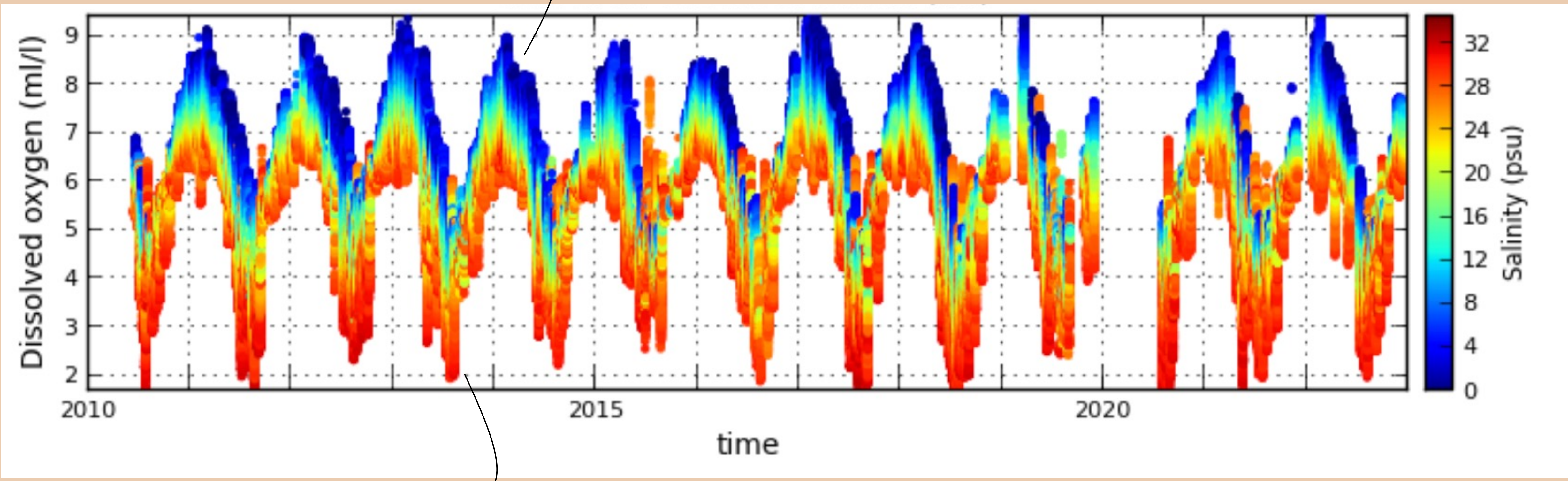
Low dissolved oxygen often comes with:

- High salinity

Varies with ocean source water

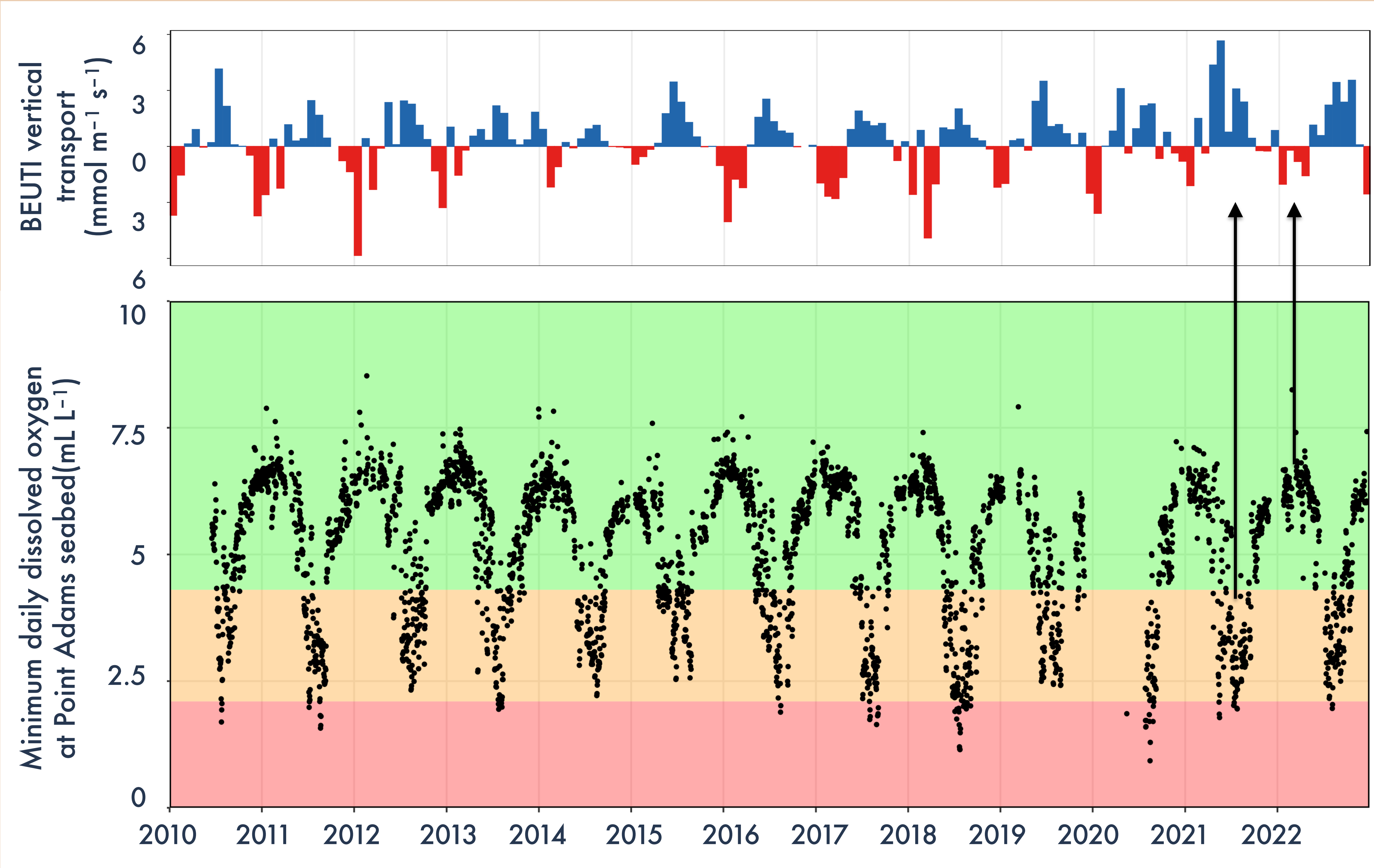
Strong relationship between salinity and dissolved oxygen

More high-oxygen fresh water in winter

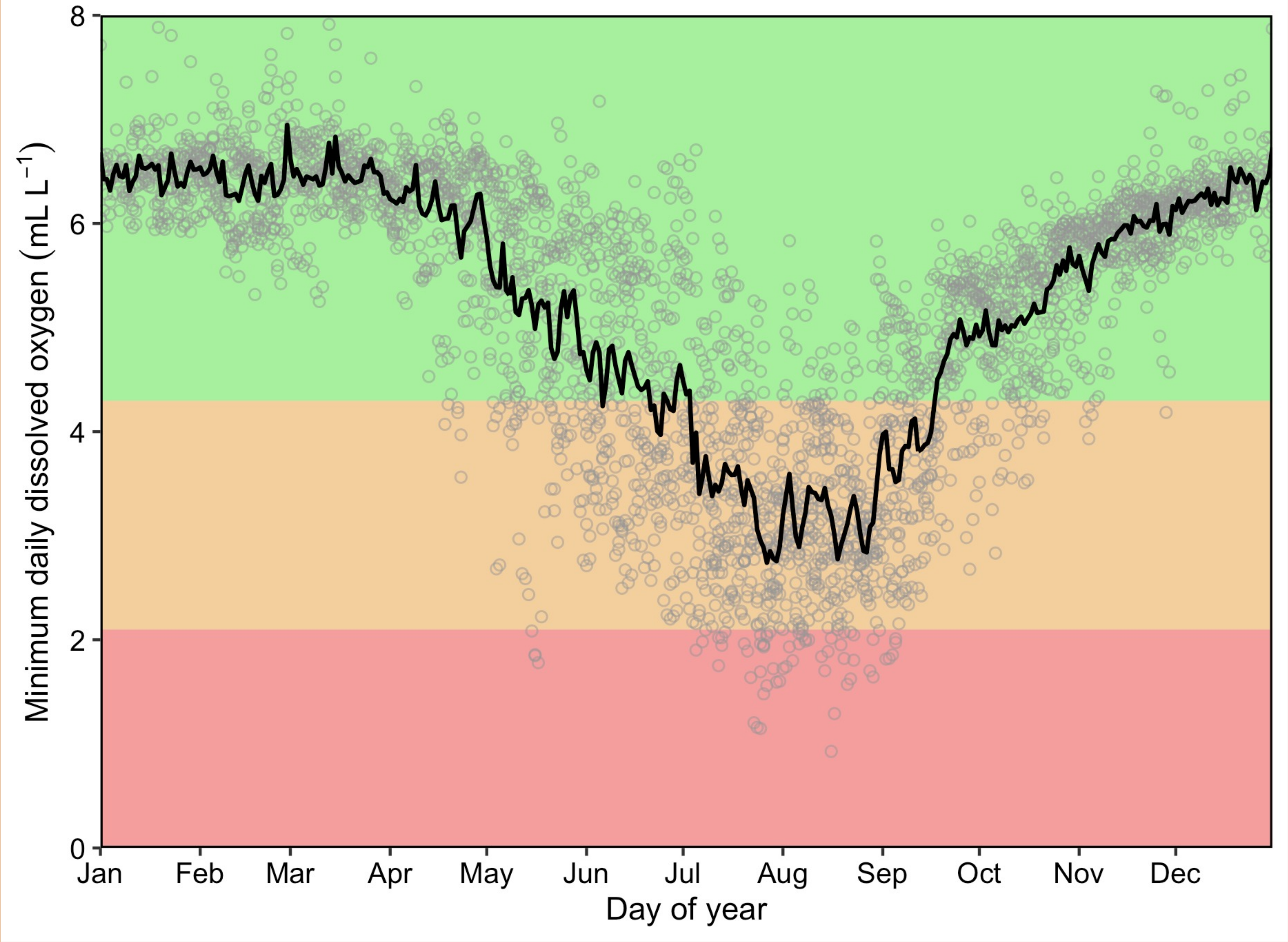


More low-oxygen, high-salinity water in summer

Coastal upwelling drives seasonal pattern of estuary hypoxia



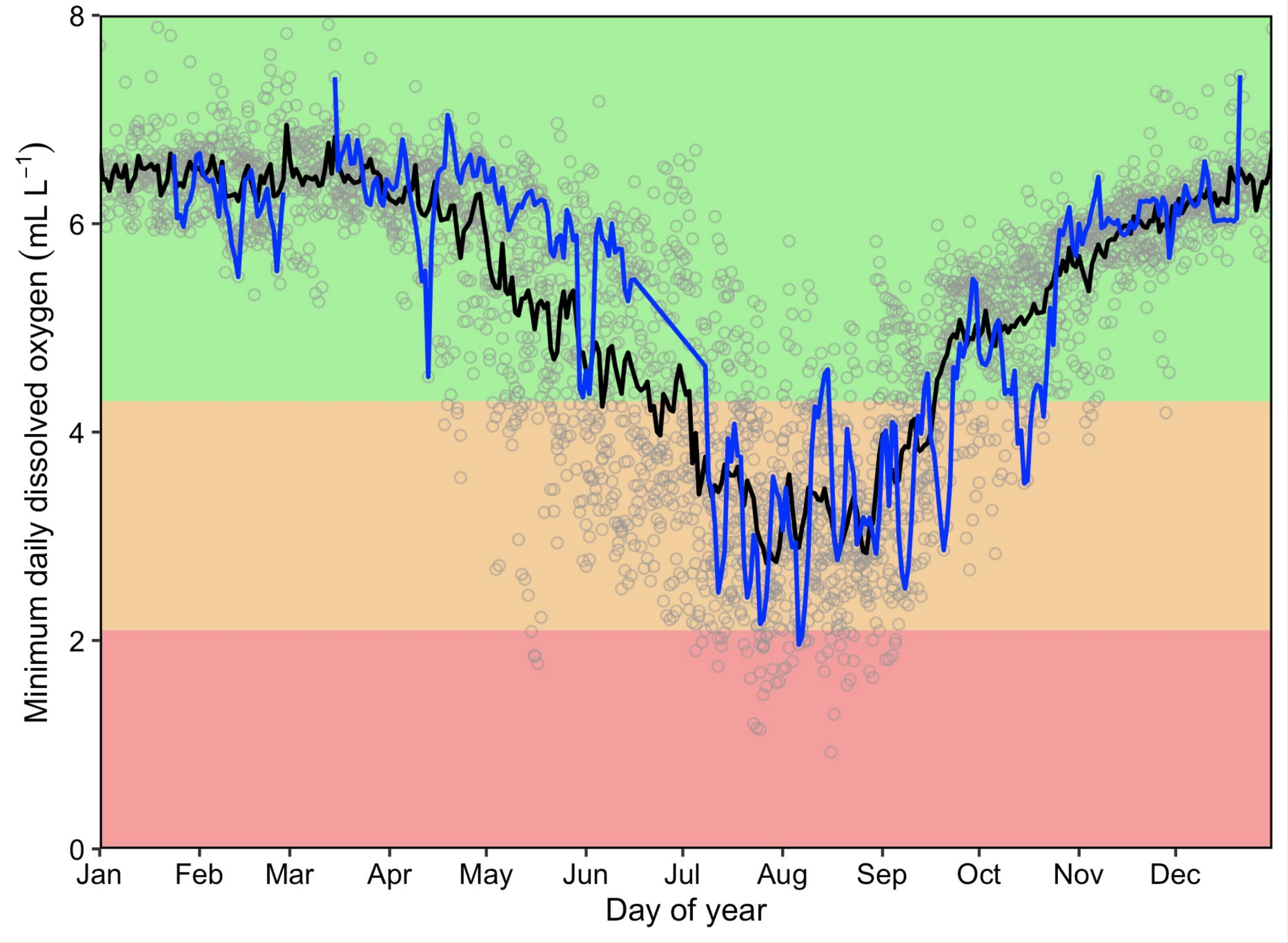
A closer look at the past two years



Point Adams seabed

Average (2010-2022)
All (2010-2022)

A closer look at the past two years

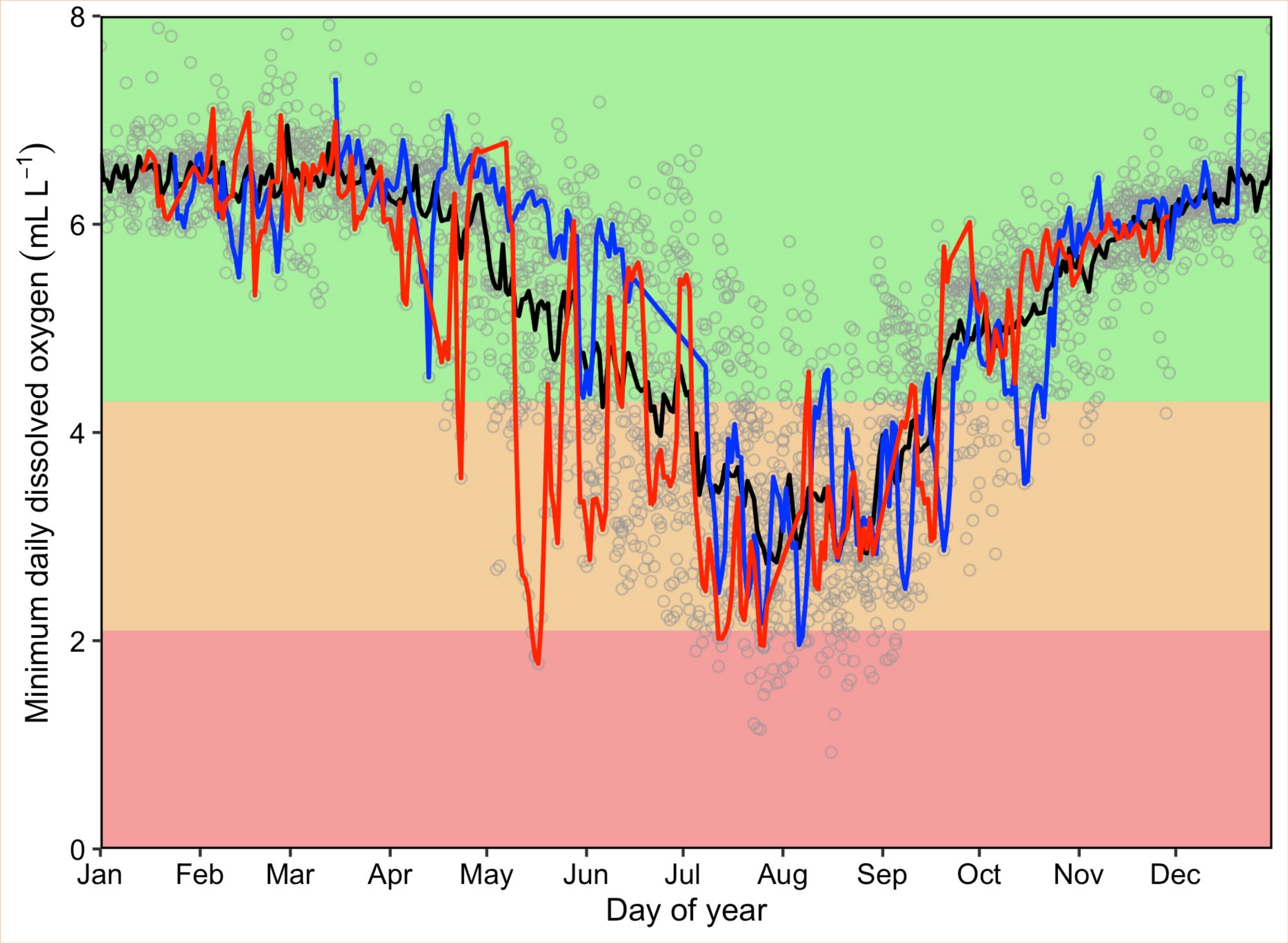


Point Adams seabed

Average (2010-2022)
All (2010-2022)

2022

A closer look at the past two years



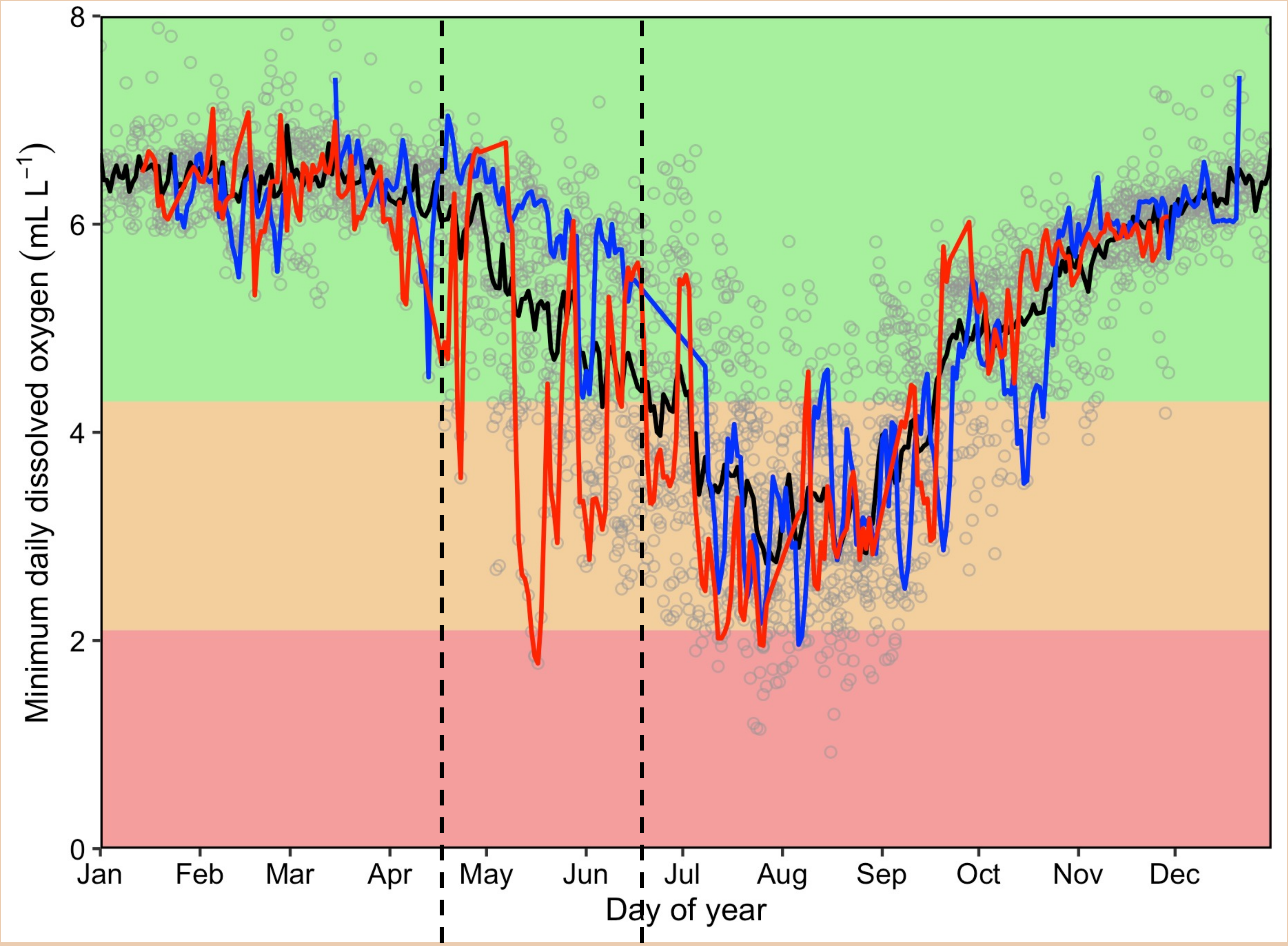
Point Adams seabed

Average (2010-2022)
All (2010-2022)

2022

2021

A closer look at the past two years



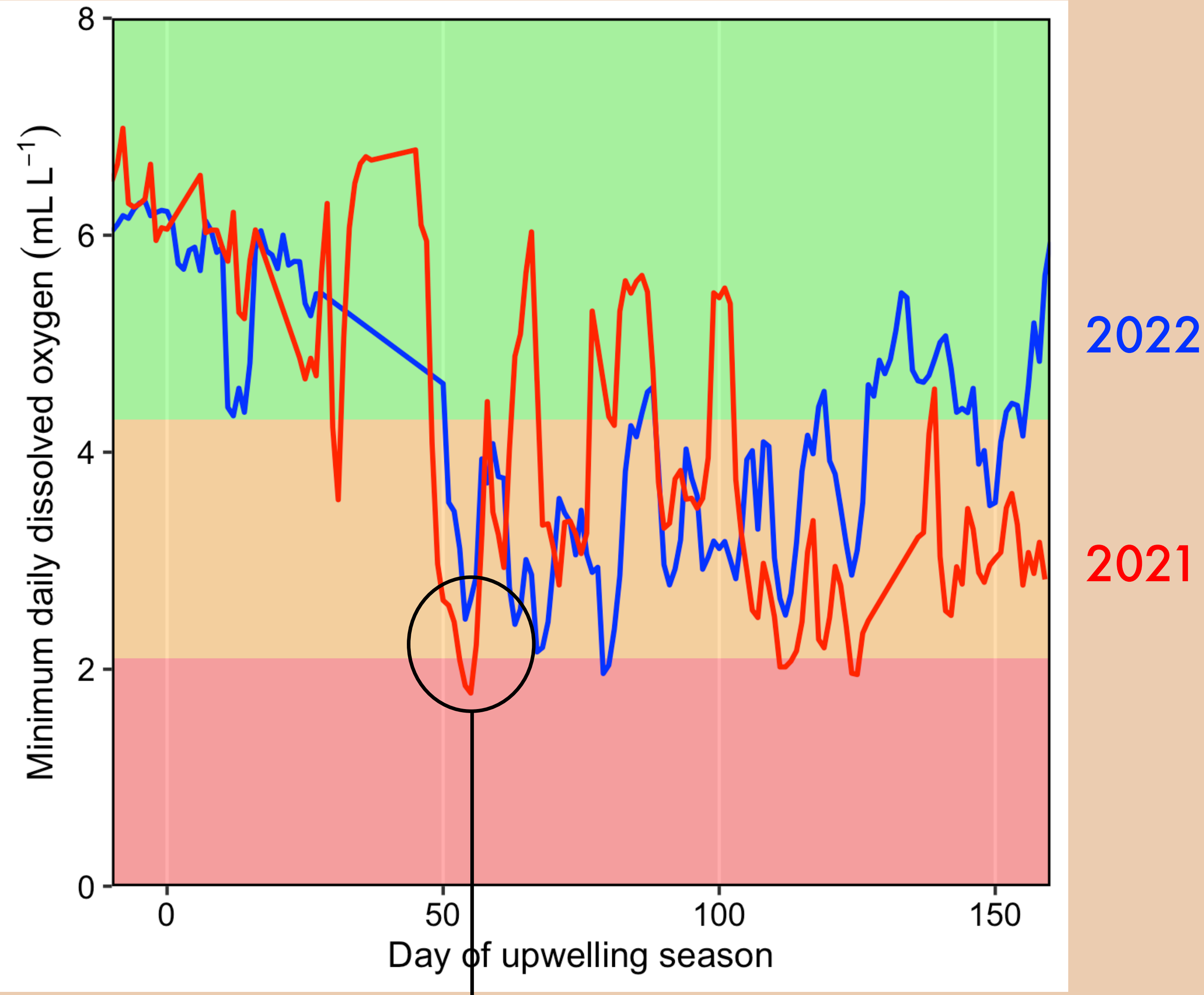
Spring transition:

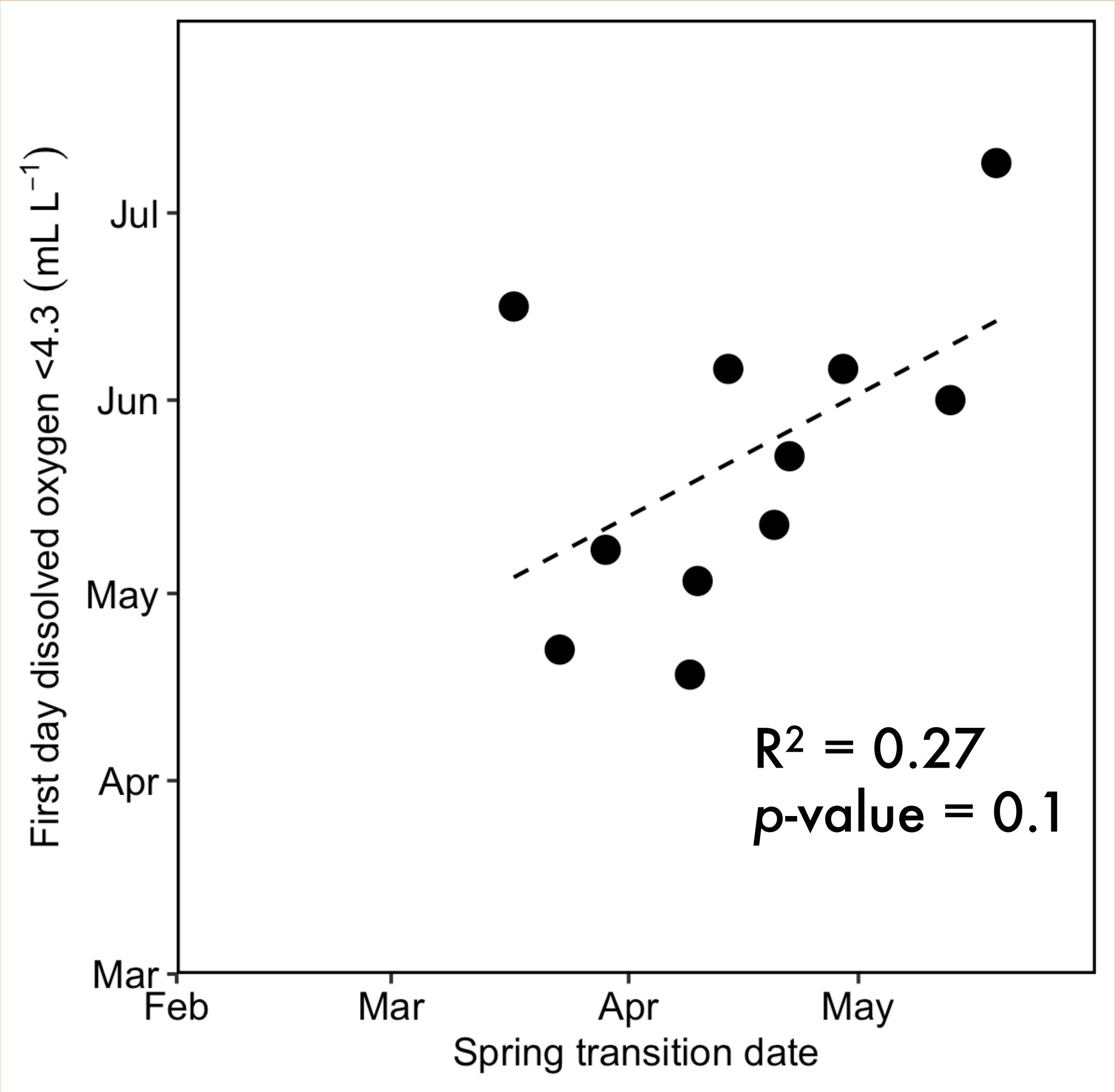
Average	April 12
2022	May 19
2021	March 23

Peak outmigration time for
Spring Chinook and Steelhead

Spring transition timing helps explain onset of low dissolved oxygen

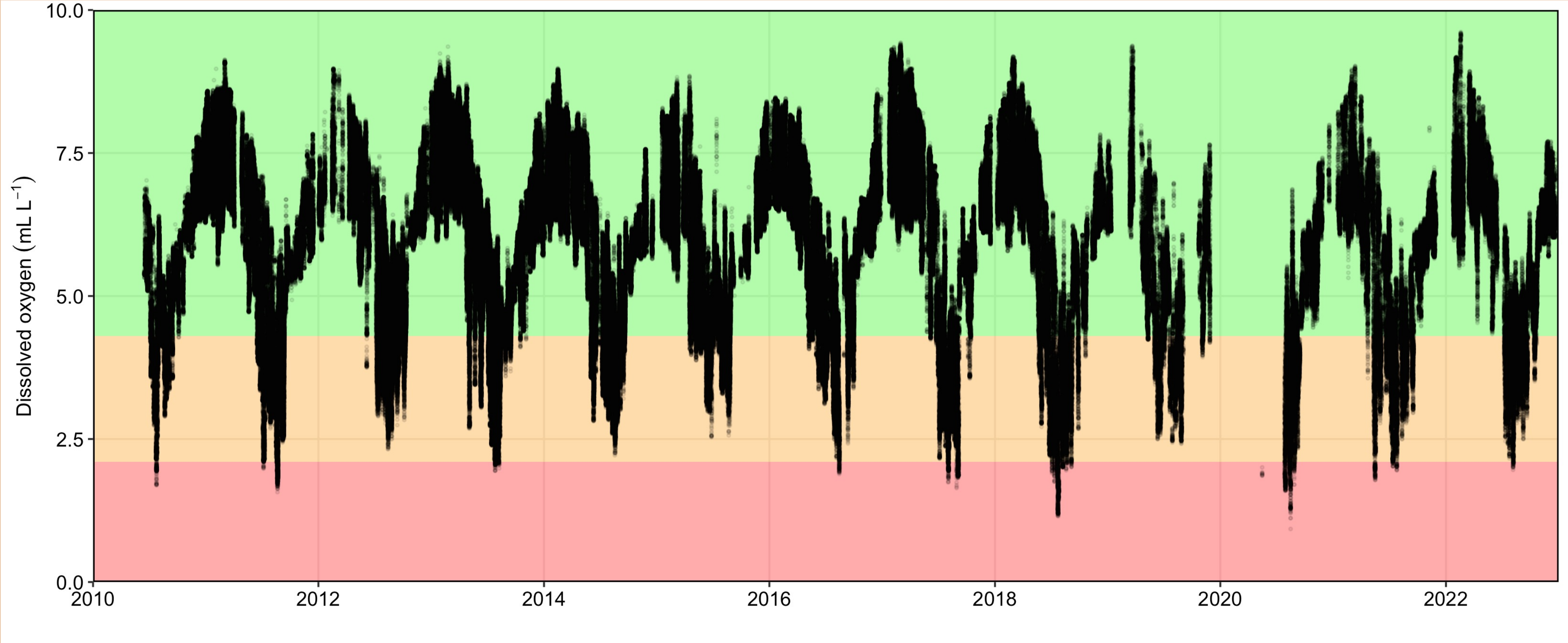
Plotted by day of upwelling as in Adams et al. (2013)



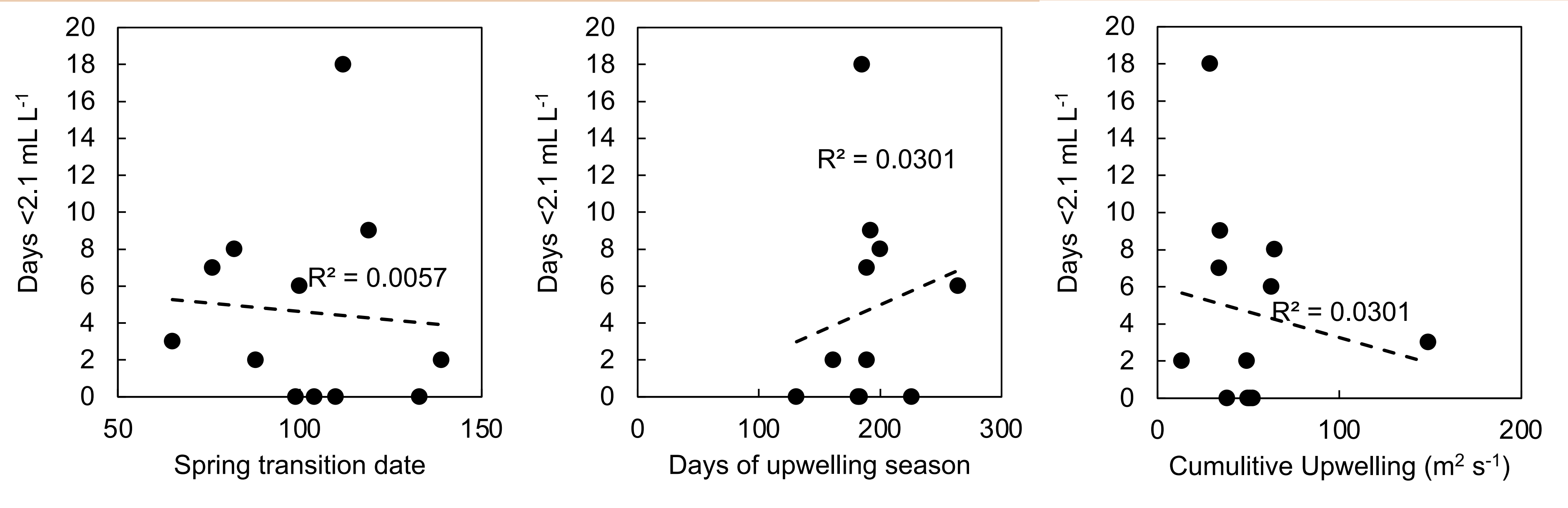


Low dissolved oxygen after ~50 days of upwelling

Complex links between coastal upwelling and estuary hypoxia



Timing of spring transition may explain some interannual variability in timing of estuary hypoxia



Weak and insignificant relationships between time below oxygen threshold and upwelling season properties

Complex links between coastal upwelling and estuary hypoxia

- Upwelling wind stress
- Upwelled water quality
- Shelf remineralization

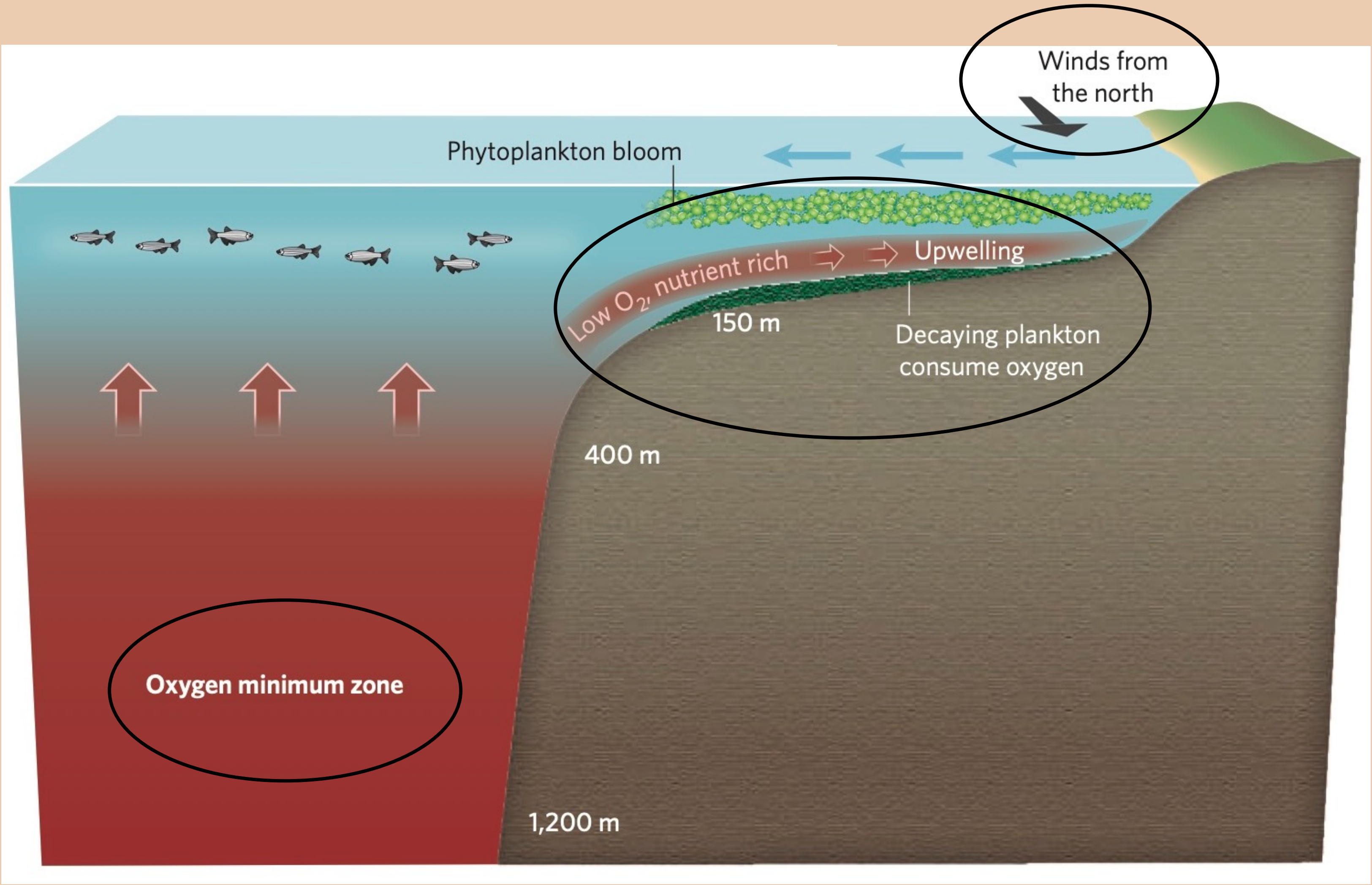
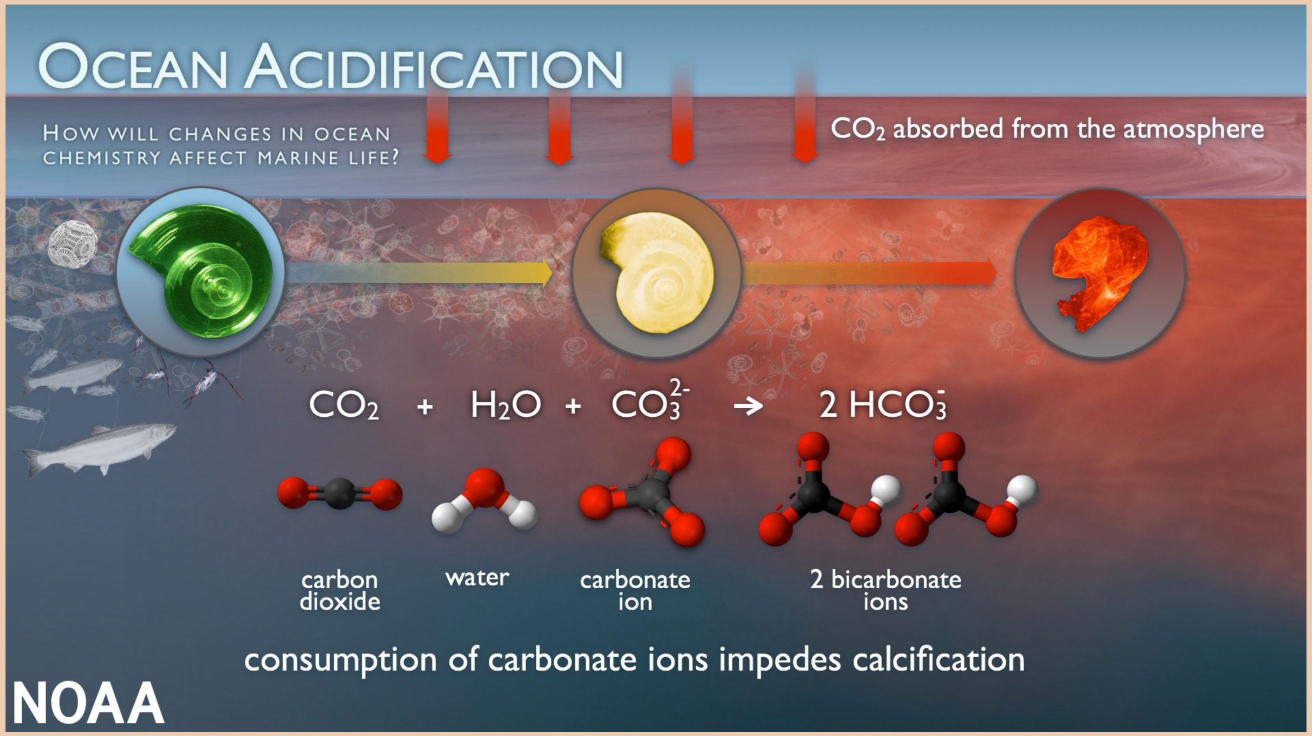


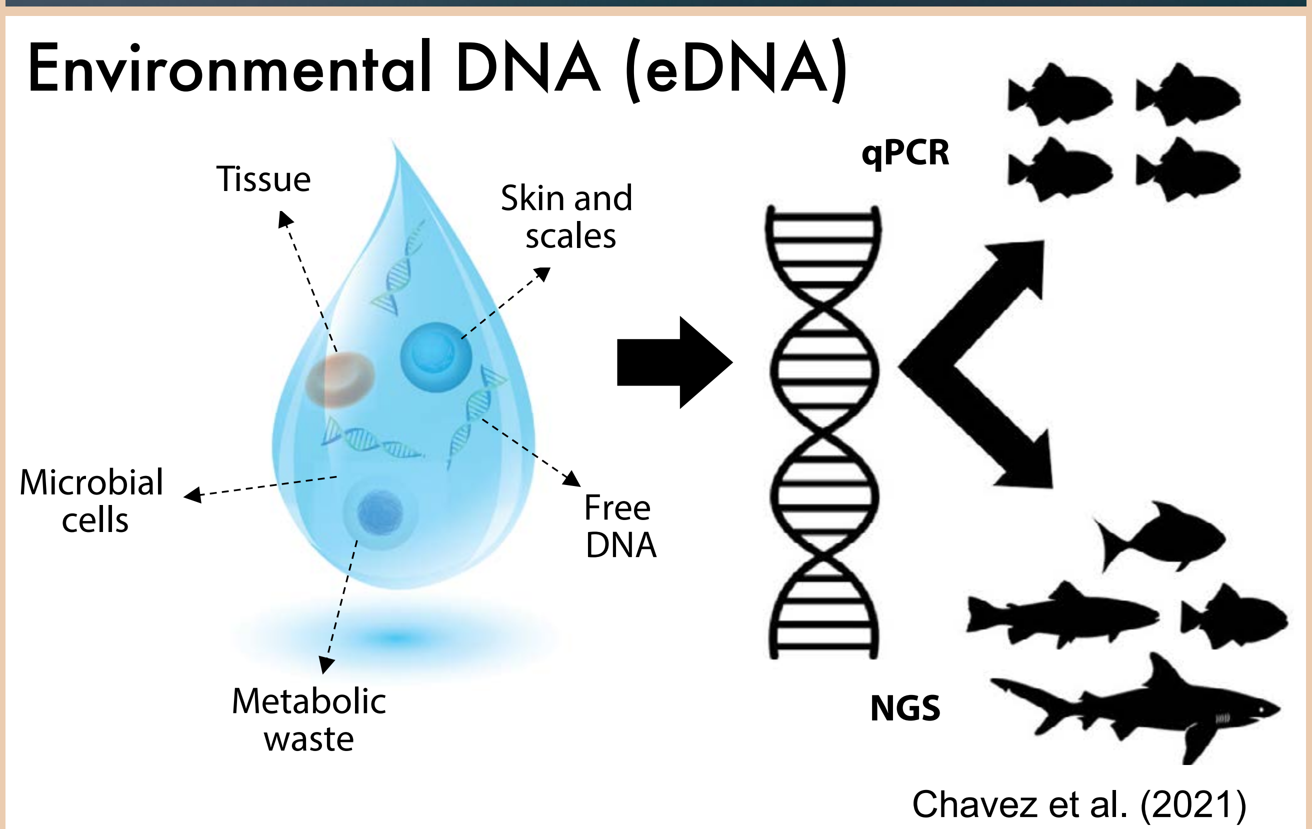
Diagram from Gewin 2010

Climate change may intensify hypoxia due to:

- Increased wind forcing (latitude-dependent, IPCC AR6)
- Expanded OMZ (Stramma et al. 2008)
- Possible changes in upwelling timing and biological feedbacks

What's next for the CMOP Observatory?

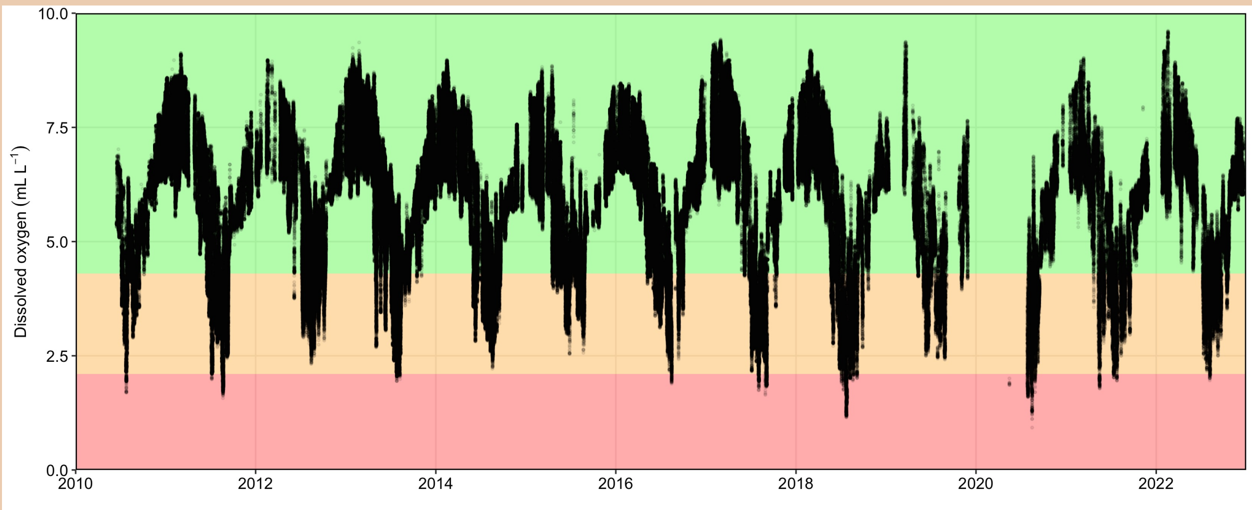




- Monitor ocean acidification in the estuary
  - Continuous pCO_2/TCO_2 analyzer at Point Adams station
- Seeking funding for eDNA pilot study
  - Ecological monitoring of salmon food web
- Exploring more ways to use our observatory data to support salmon conservation and management
- Please reach out if you'd like to collaborate!

Thanks for listening!

My time with CMOP



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- Support from CRITFC leadership, including Laura Gephart, Jeremy Fivecrows, and Aja DeCoteau
- Funding support from NOAA-IOOS/NANOOS, NOAA-OAR, the Bureau of Indian Affairs, and the National Science Foundation
- Data access: cmop.critfc.org and nanoos.org
- Contact: rgradoville@critfc.org