Using eDNA and dissolved oxygen data to identify species-specific responses to hypoxic events

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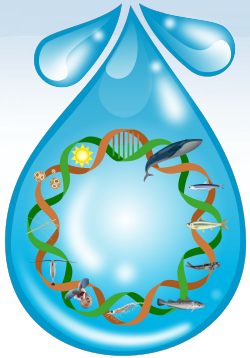
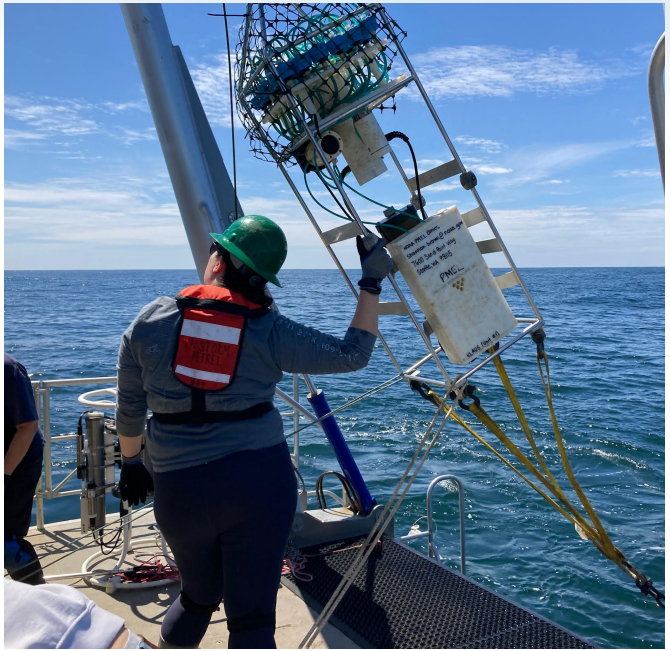
11/10/2024

Background

- **Environmental DNA (eDNA):** Genetic material shed into the environment by organisms
  - *We sequence this to detect species in water*
- **Hypoxia:** Low oxygen concentration
  - *20% saturation and lower harmful*
  - *2 mg/L and lower harmful*



Automated sampler deployed at TH042 mooring for summer 2021-24



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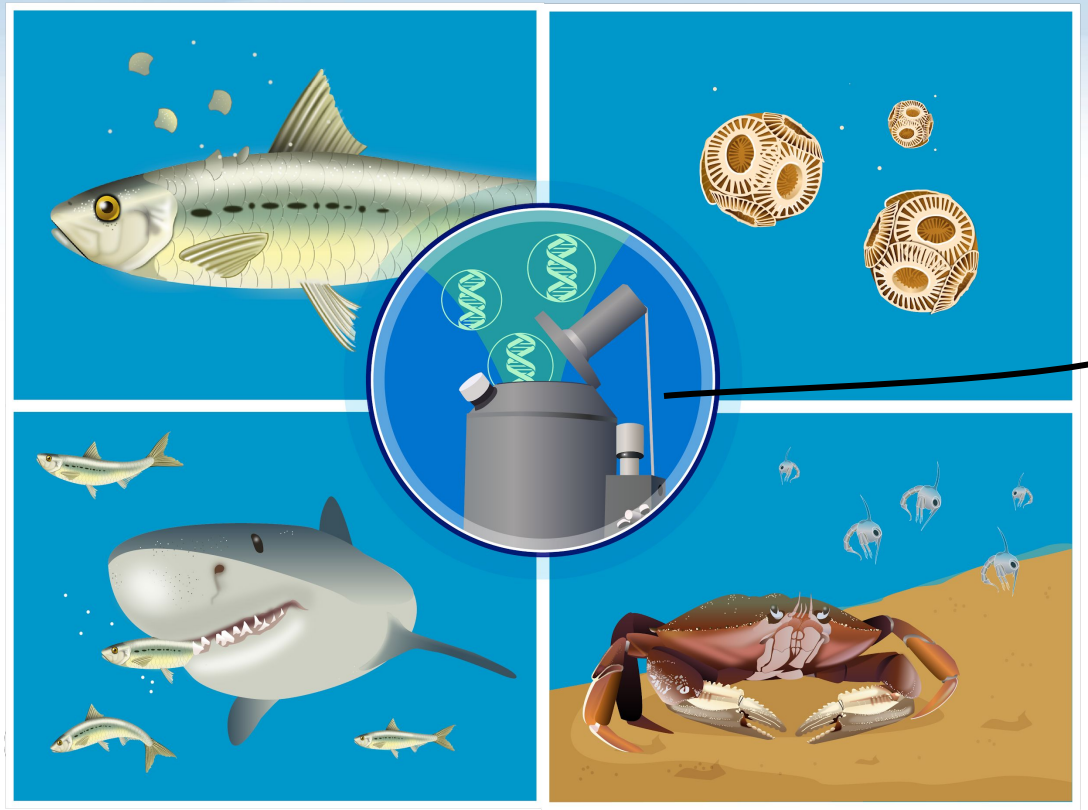
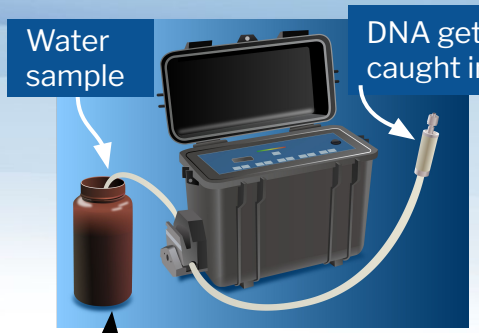
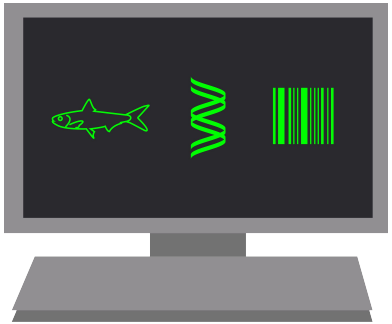
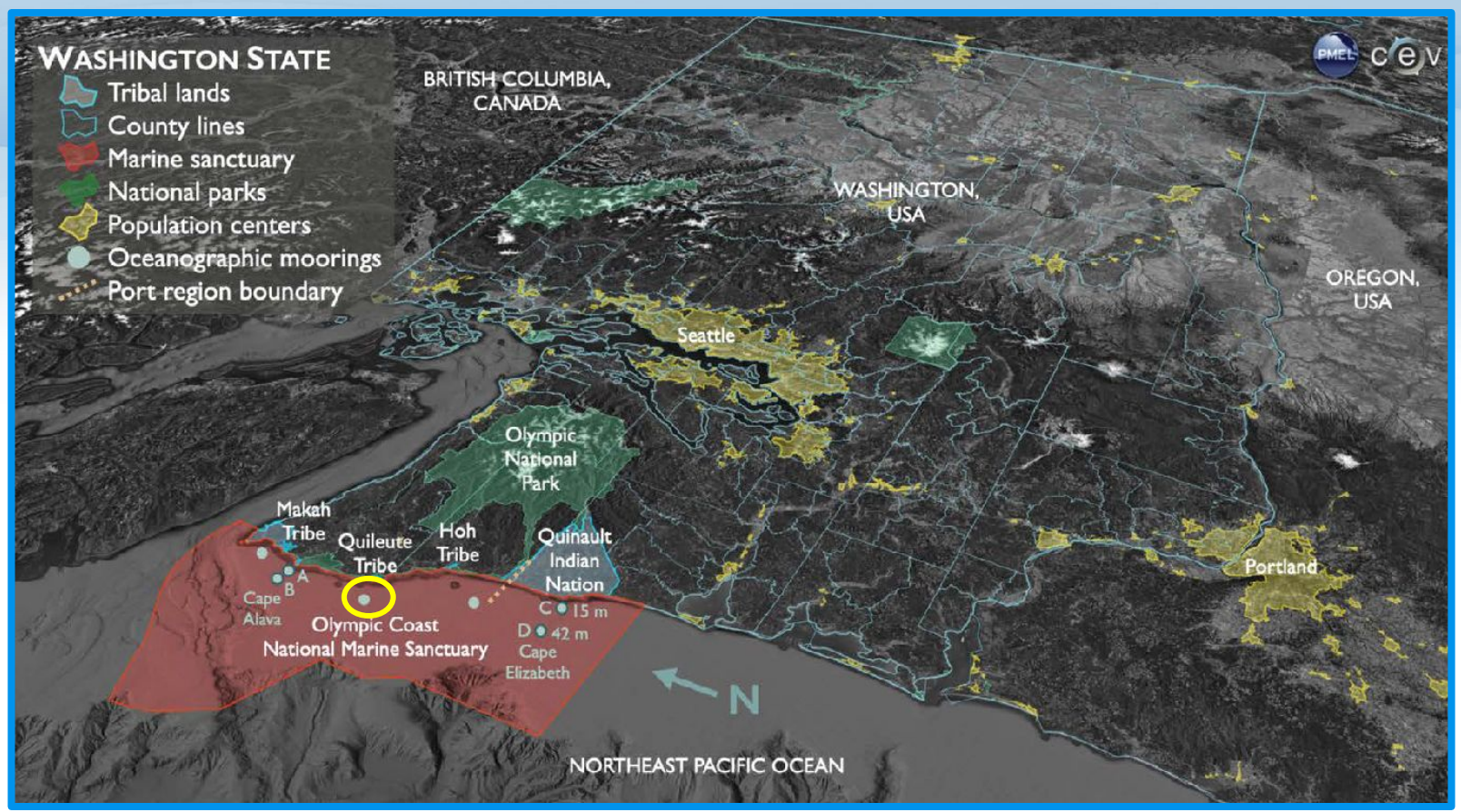
eDNA sampling









Alin et al. 2023 *Oceanography*

Objective: Understand how species presence changes with oxygen levels

Overall Ocean Molecular Ecology (OME) lab project: Understand increasingly severe hypoxic events in the Olympic Coast National Marine Sanctuary (OCNMS) and develop autonomous eDNA monitoring systems

Environmental Data

O_2

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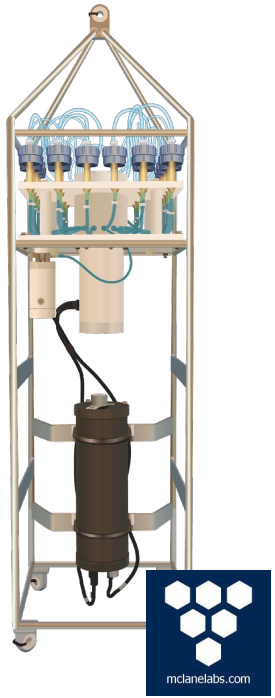
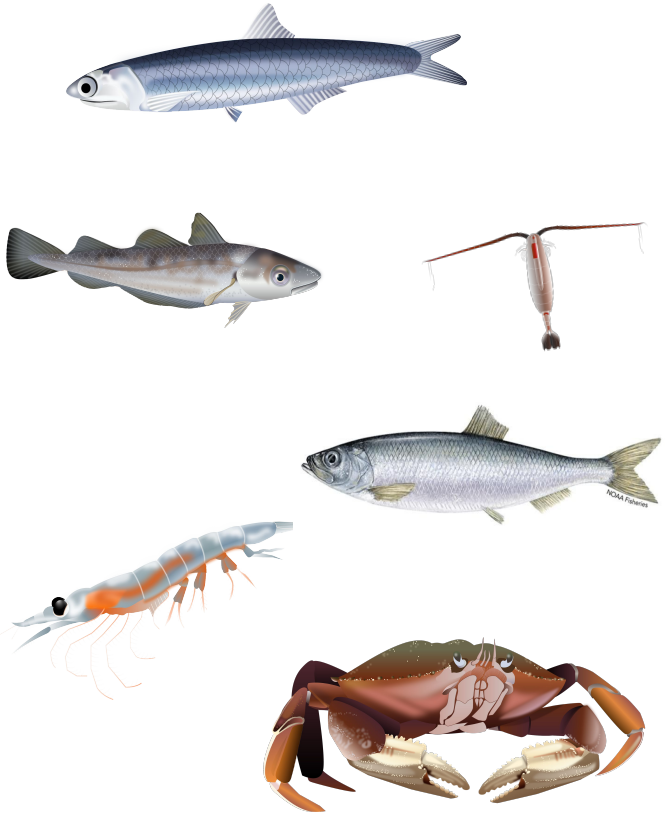
OCNMS Mooring

Biodiversity



PPS Sampler



Hypoxia in the Pacific Northwest

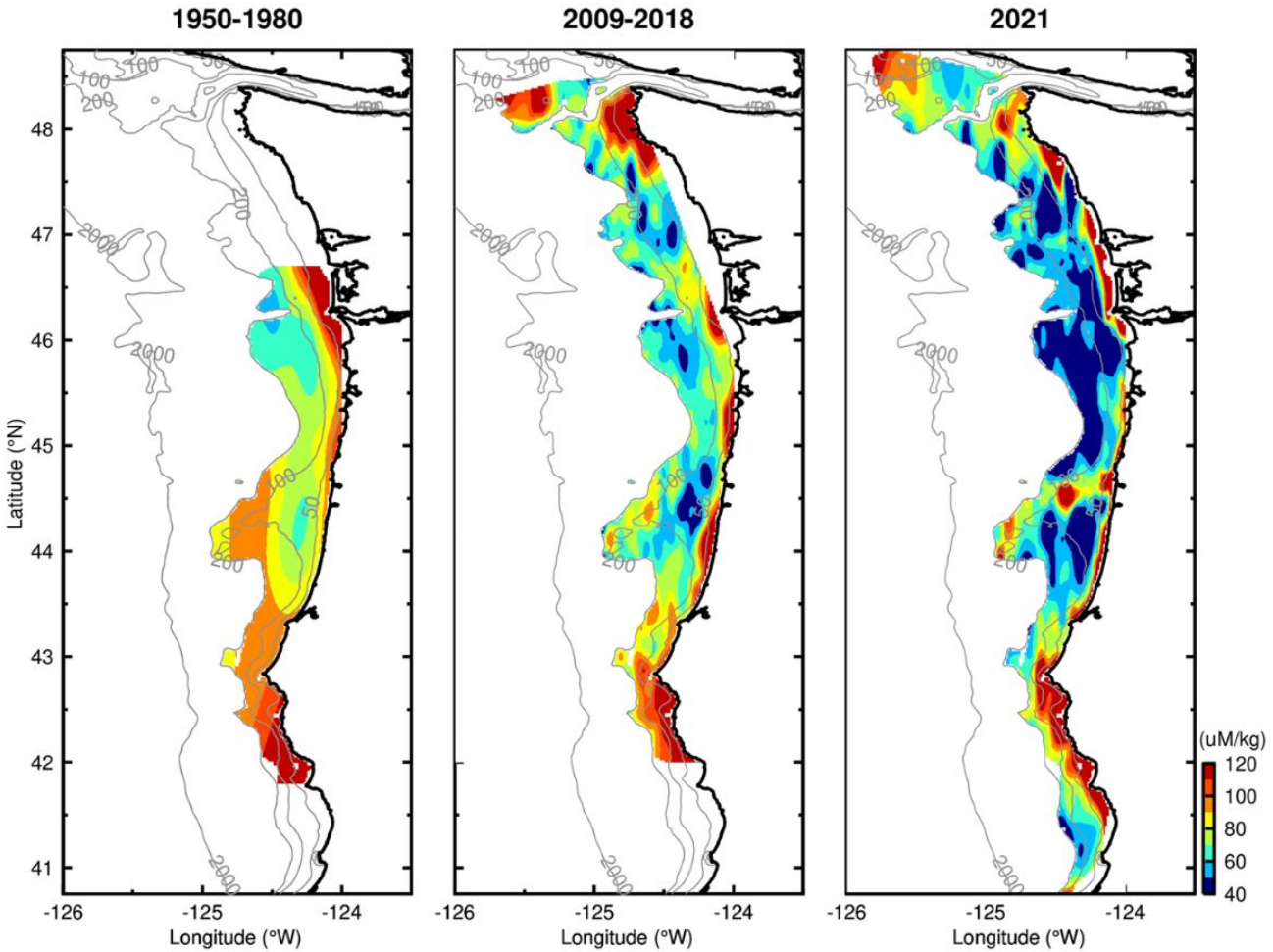


Figure: Barth et al. (2024)

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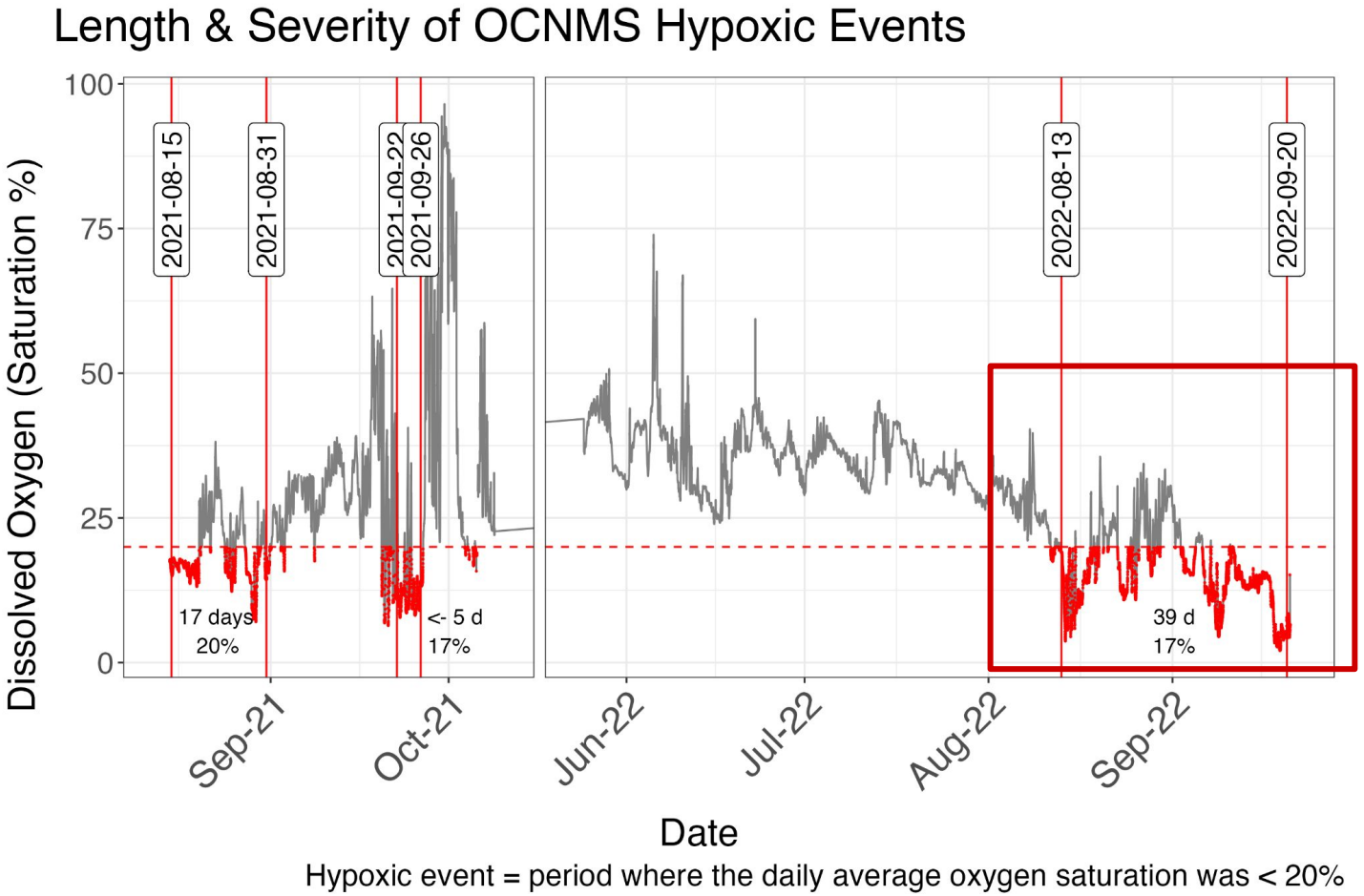
Hypoxic Events

Mooring data



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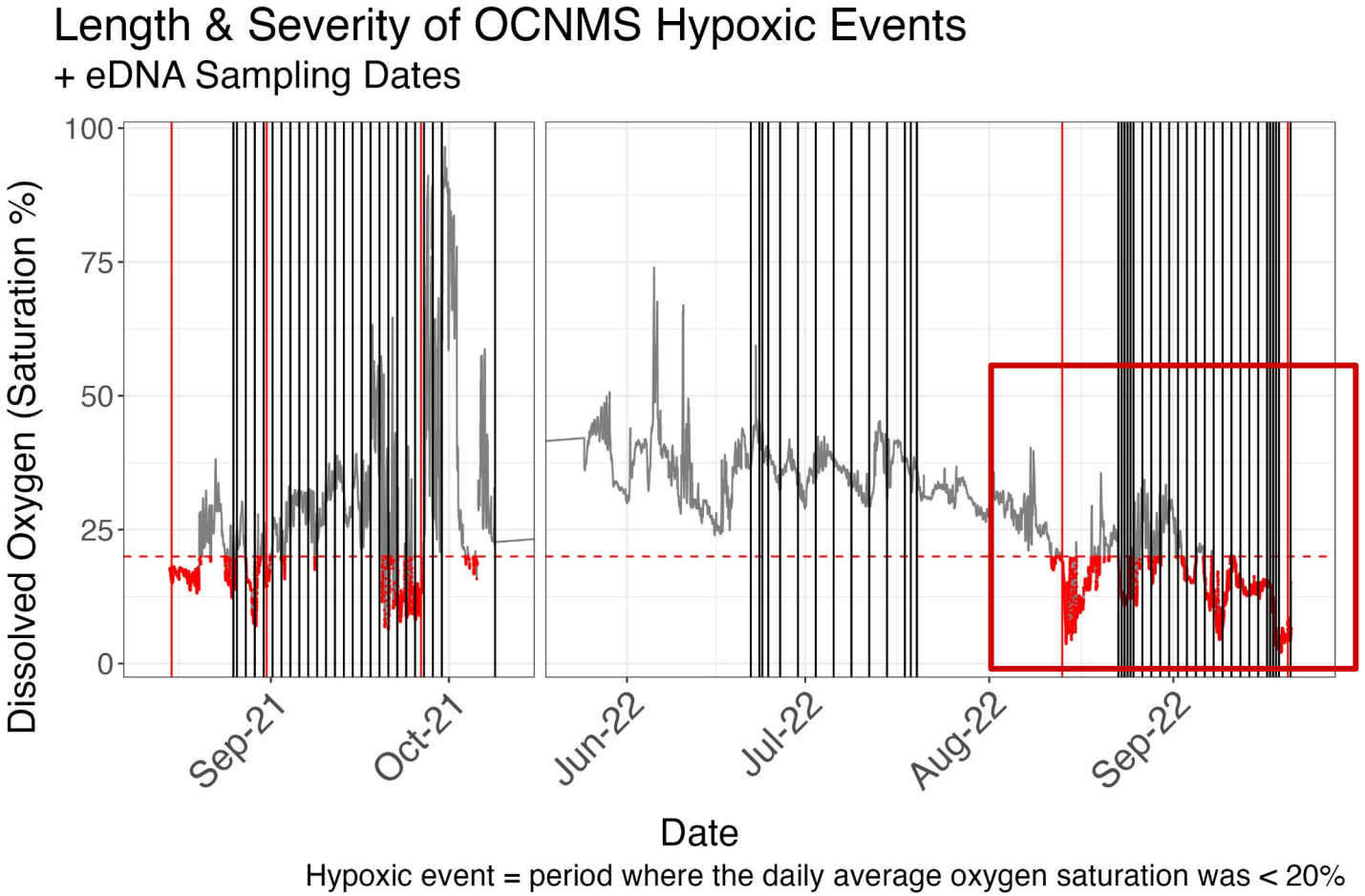
Hypoxic Events

eDNA sample data



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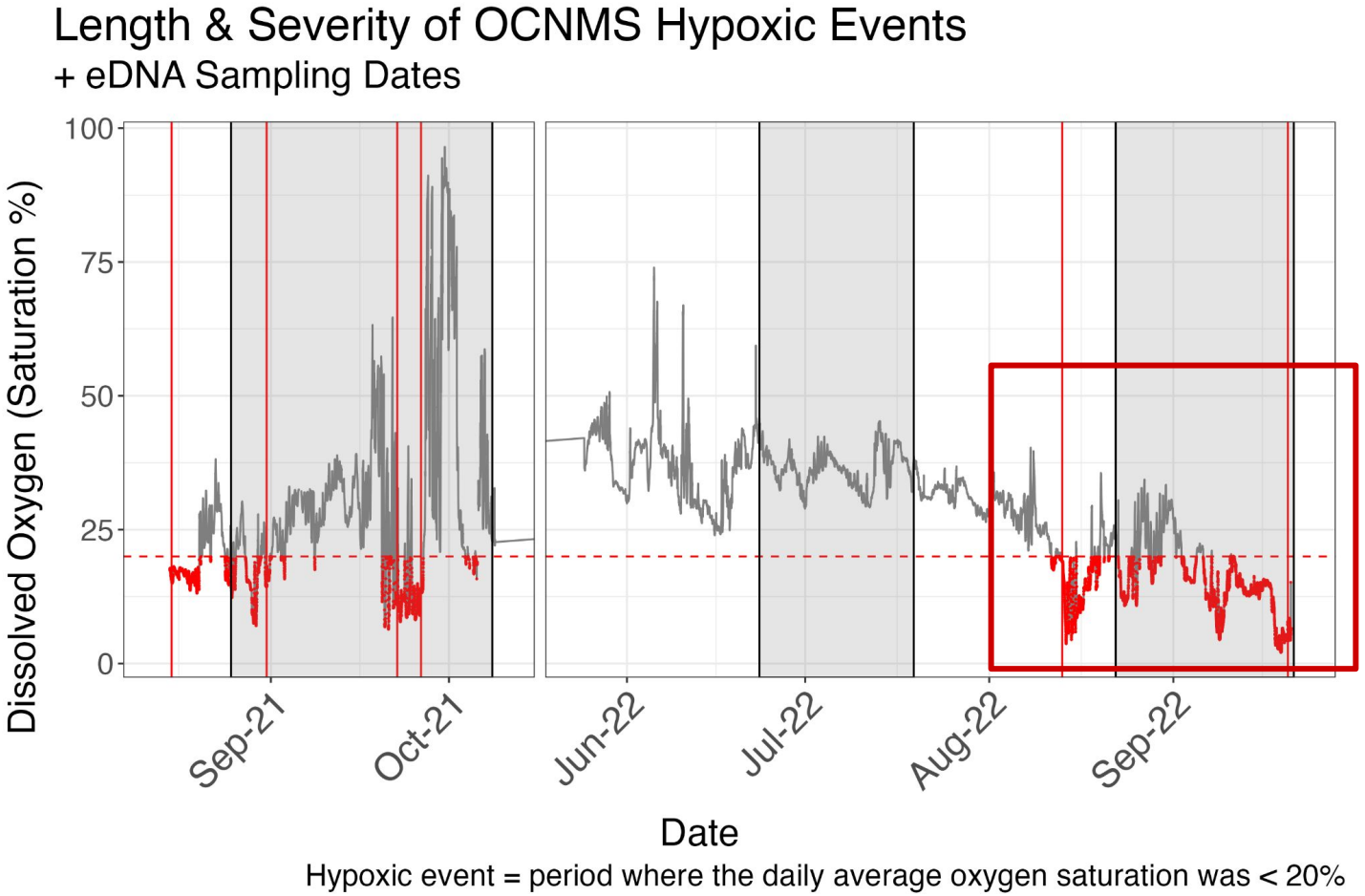
Hypoxic Events

eDNA sampling windows



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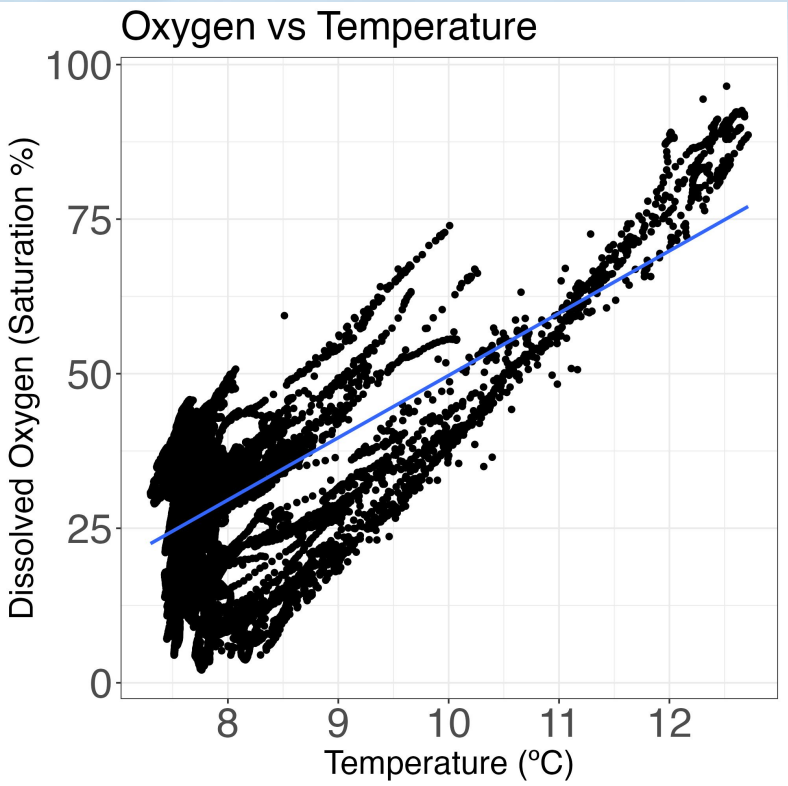
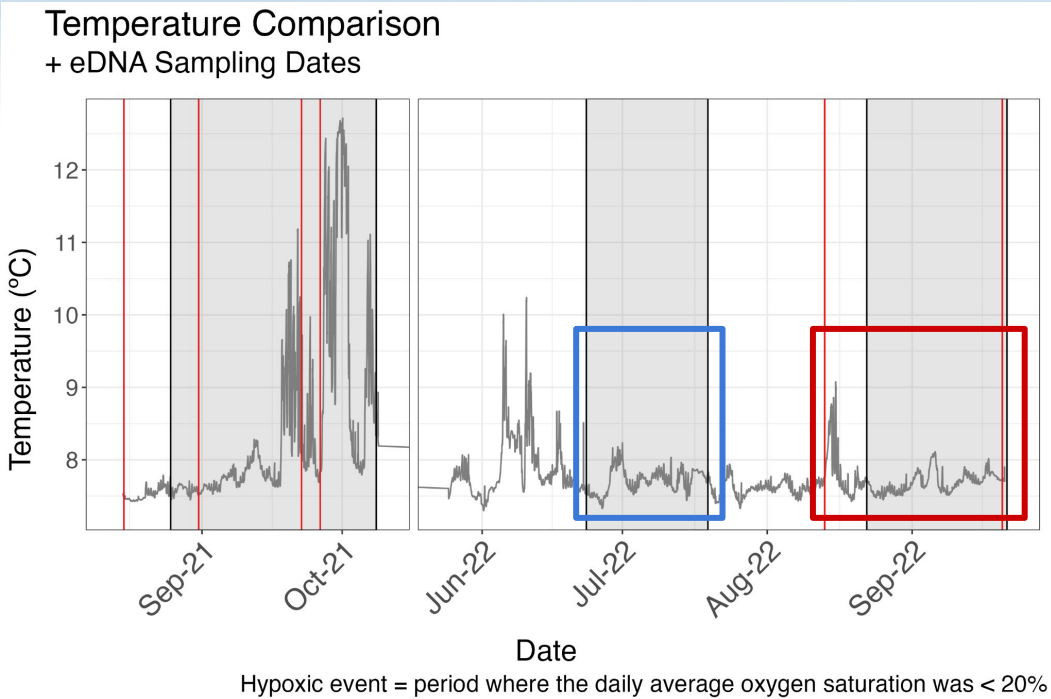
Temperature & Oxygen

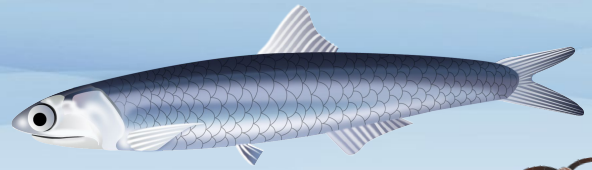


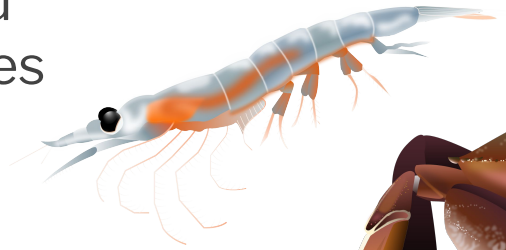


Hypoxic event = period where the daily average oxygen saturation was < 20%

Results

- 79 eDNA samples taken in 2021-22
- 2 barcode regions used
- 8,228 unique gene sequences detected
- 674 species detected
- 64 species of interest identified by OCNMS + coastal treaty tribes
- 24 species of interest detected





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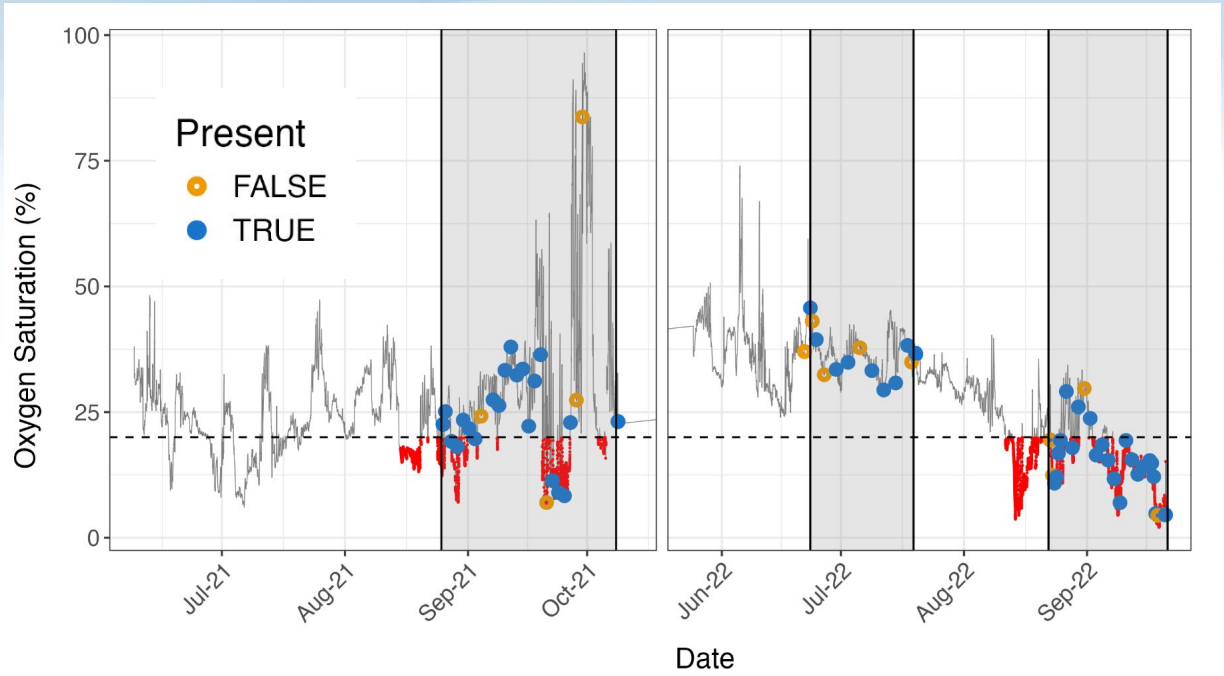
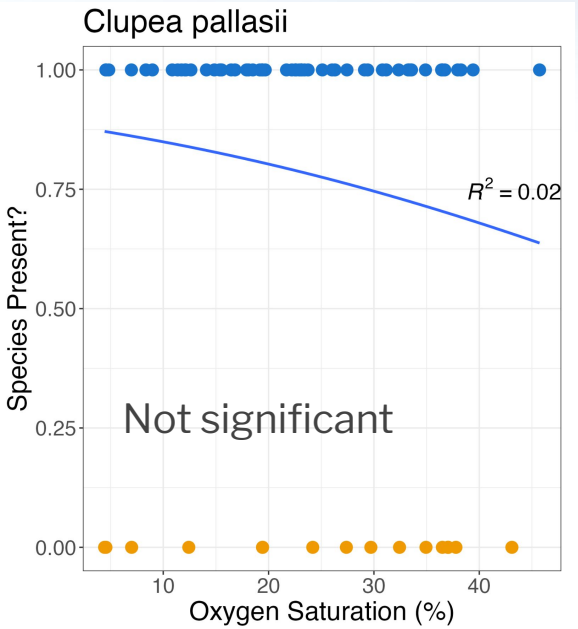
Results

Clupea pallasii
Pacific herring





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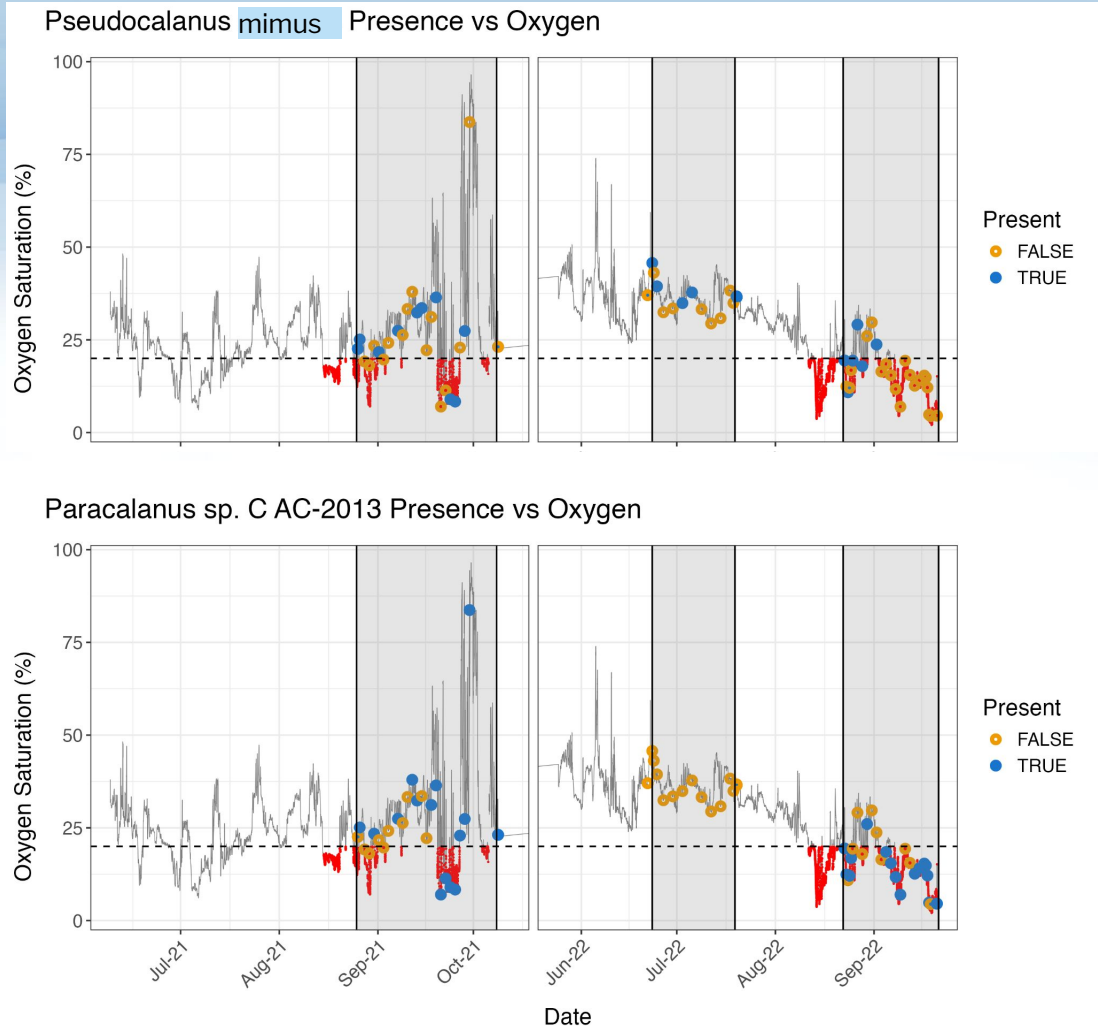
Copepods

Indicator species used in OCNMS

P. mimus: Northern copepod

Paracalanus sp.: Southern copepods

Opposite hypoxic responses



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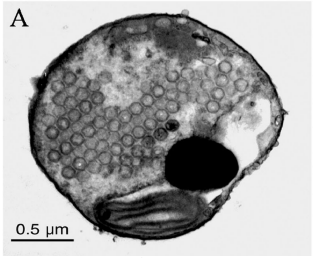
Results

- Wider strategy
  - Any species with large or significant hypoxia effect
- Identified affected species
  - Pacific sanddab
  - *Aureococcus anophagefferens* (Harmful algal bloom)

Gregarious jellyfish

Pacific sanddab

A. anophagefferens



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Results

Scientific Name	Common Name	Change With Hypoxia (<20% saturation)
Paracalanus sp. C AC-2013	Southern Copepod	More common
Pseudocalanus mimus	Northern Copepod	Less common
Aureococcus anophagefferens	Diatom (HAB)	Less common
Citharichthys sordidus	Pacific sanddab	More common
Clytia gregaria	Gregarious jellyfish	More common

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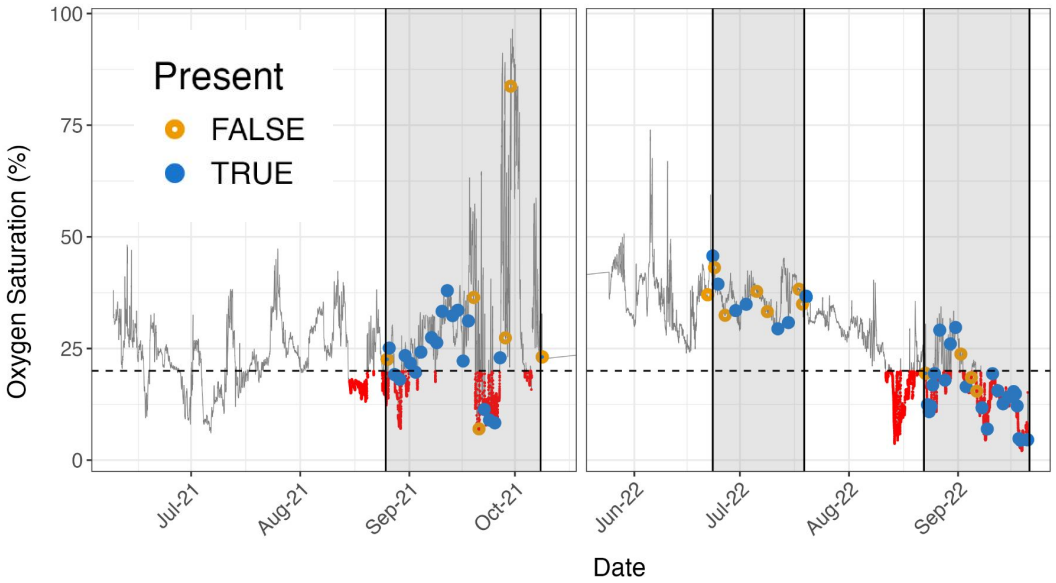
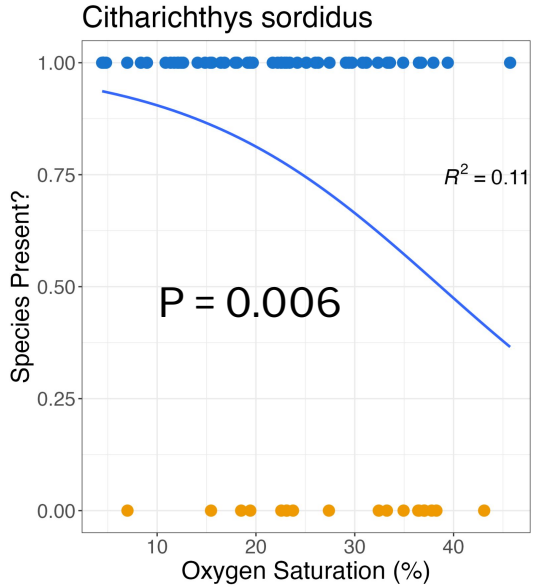
Citharichthys sordidus (Pacific sanddab)

Detected more often in hypoxia

Benthic (seafloor resident) fish

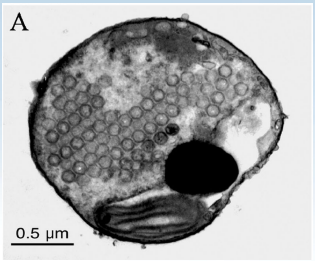


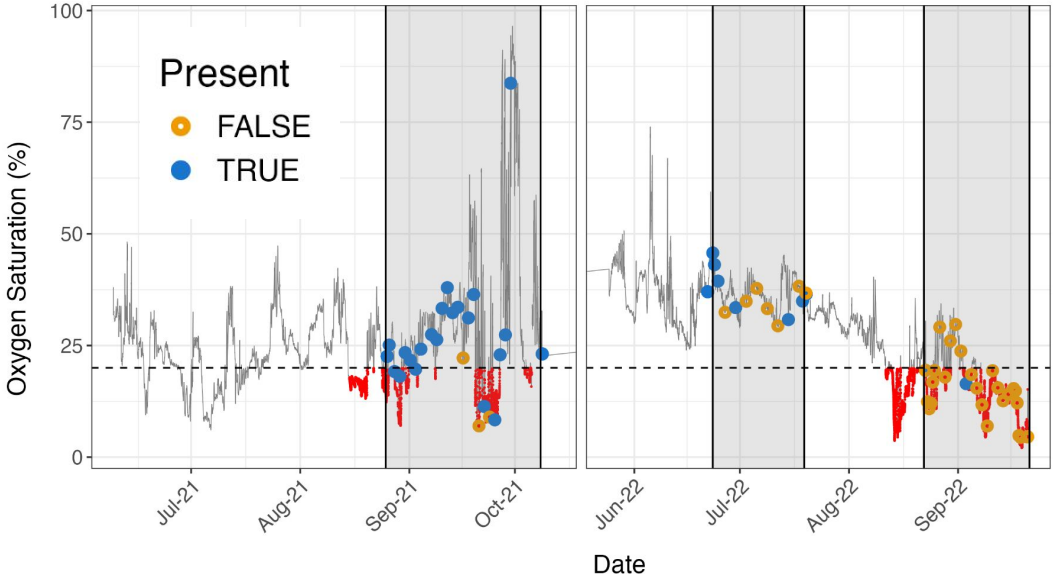


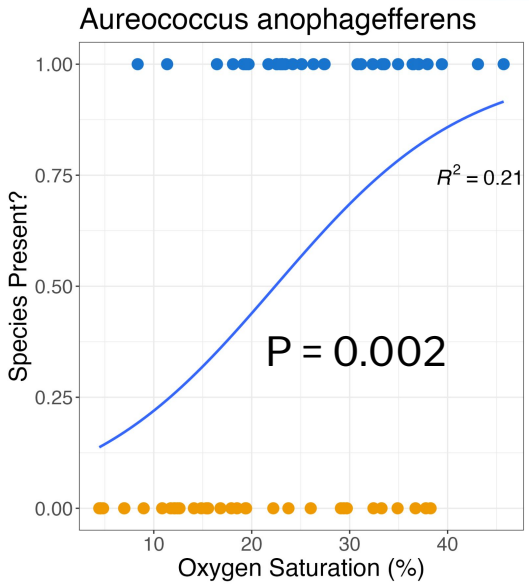
Aureococcus anophagefferens (Diatom)

Detected less often in hypoxia

Harmful algal bloom (HAB) causer

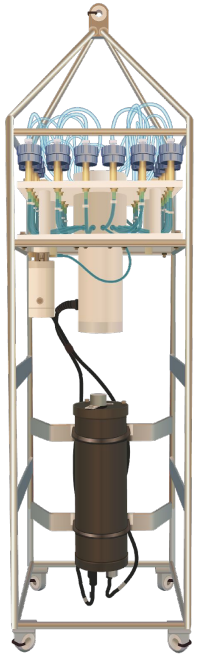


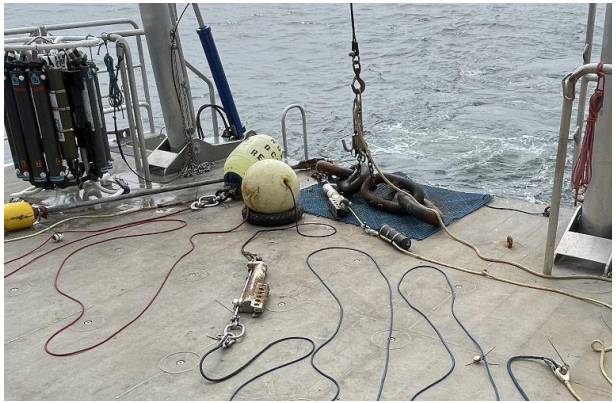


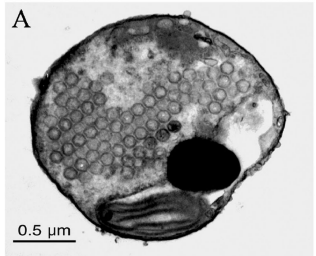


Summary

- Combined eDNA and oceanographic data
  - Co-located datasets
- Evidence of hypoxia **tolerance** in two OCNMS priority species
- Identified other species affected by hypoxia







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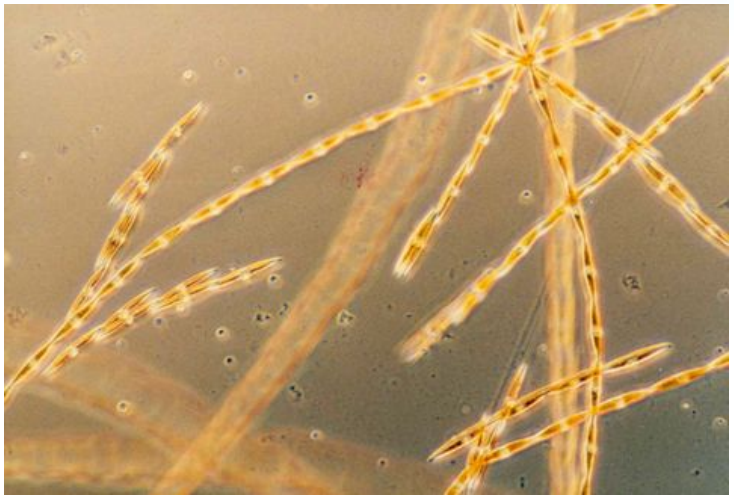
Next Steps

- 2023 data gap
- Community composition
- Relative abundance
- Pseudo-nitzschia (diatom) detection data

Biology senior thesis



Pseudo-nitzschia (NOAA NMFS)

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Acknowledgements

- Ocean Molecular Ecology Group
  - Zachary Gold
  - Shannon Brown
  - Sean McAllister
  - Han Weinrich
  - Samantha Setta
- OCNMS crew: Haley Wilson, Andrew Micks, Kathy Hough, and Hatcher Cox
- Evan Howard (PMEL)
- NOAA Library
- Funding: NOAA Ernest F. Hollings Undergraduate Scholarship Program

Citations

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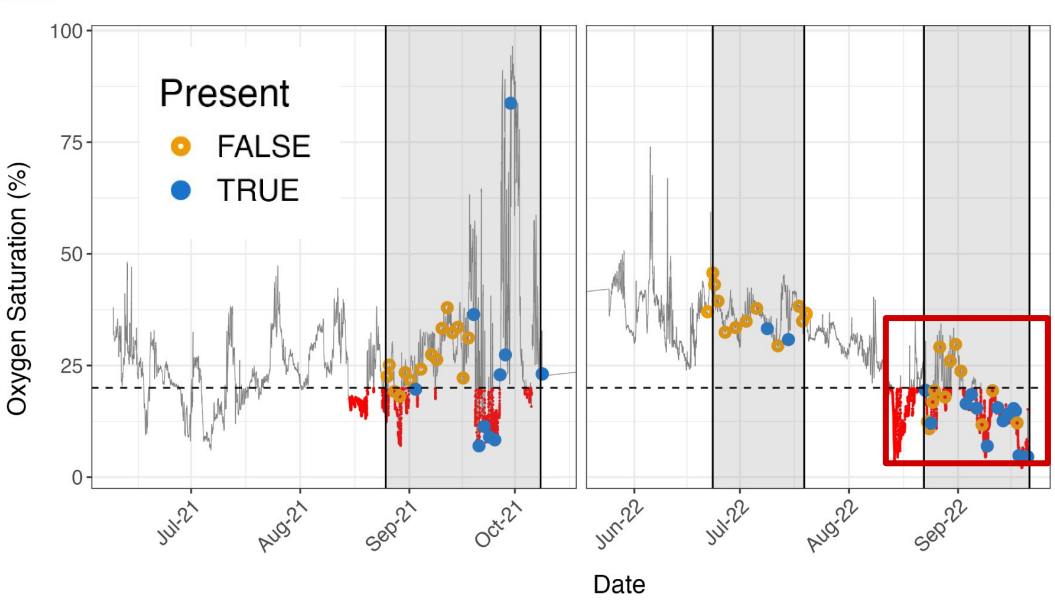
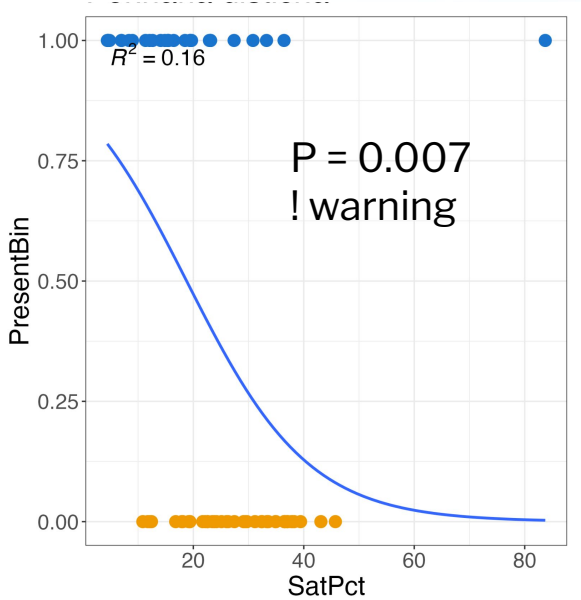
Mystery hydrozoan

Detected more often in hypoxia

DNA sequence could still be used as an indicator





Rate Change

Detection rate (detections/number of samples) in hypoxic conditions

–

Detection rate in non-hypoxic conditions

=

"Rate Change"

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