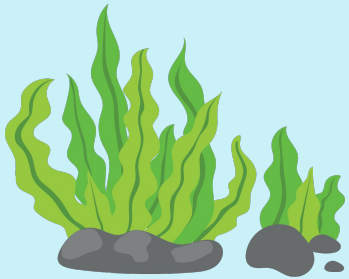


# Hypoxia effects on *Hemigrapsus oregonensis*

GG Foster, Will Mixon, Maddy  
Glasser, Erik Bengtson



Background:

**How are hypoxic water  
masses forming and how  
will it affect crab fisheries?**

# Background

## Climate Change and Hypoxic Water Masses

### Water Transport

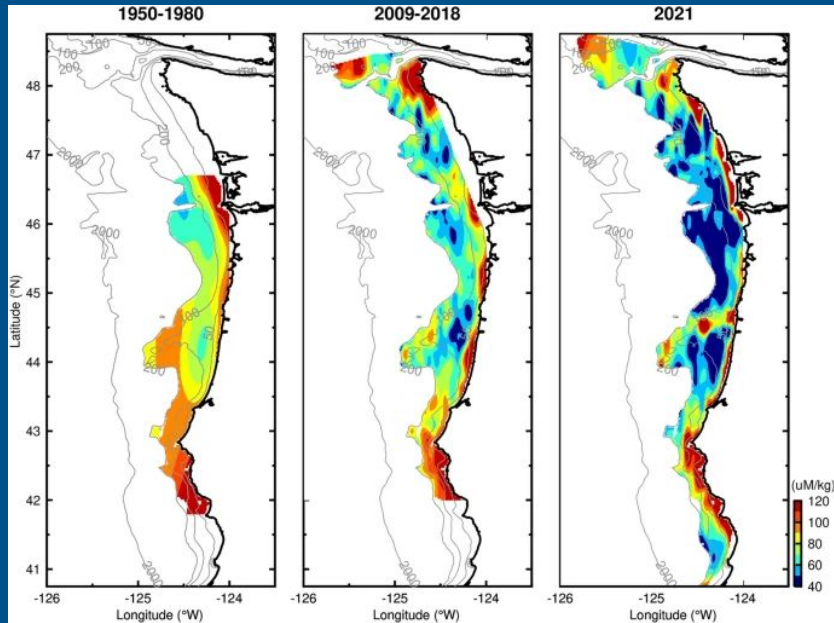
- Increasing with changing wind and temperature regimes
- Creates a seasonal pattern of hypoxic conditions

### Eutrophication

- Driven by rising temperatures and nutrient runoff
- Lead to massive respiration-photosynthesis imbalances

# Water Transport

## Upwelling

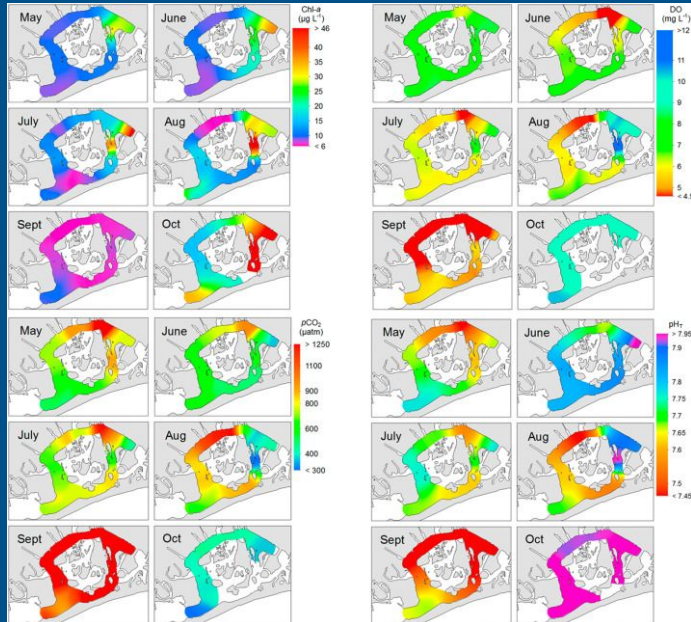


- Wind changes are occurring due to evolving land-sea temperature differences
- Spring-summer transportation of cold, hypoxic water to shallower coastal habitats
- Fraction of transported water that is hypoxic has increased dramatically in the last 70 years

Barth et al, 2024

# Eutrophication

## Algal Blooms



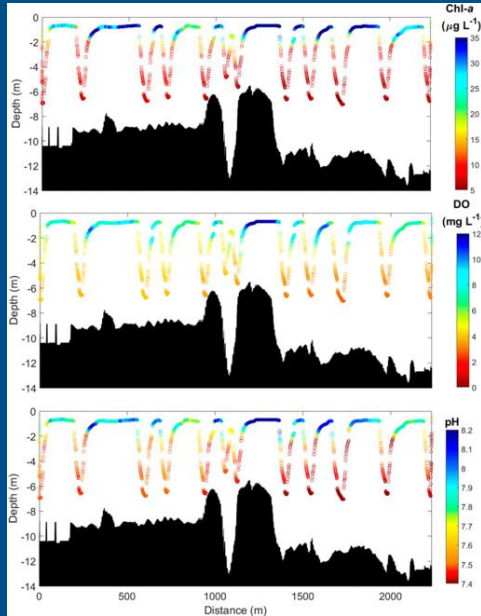
- Algal blooms form as temperatures rise during the spring
- Raised nutrient concentrations due to runoff fuel overwhelming growth
- As nutrients are consumed, algae begins to die and decompose

Wallace and Gobler, 2021

# Eutrophication

## Algal Blooms

### Continuous Underway Towing Profile



- As algae die, they sink and decompose
- Decomposition consumes oxygen and leads to lower concentrations of DO at depth even as DO remains high at the surface

Wallace and Gobler, 2021

# Background

## Implications of Climate Change to Crabs

### **Stress Physiology**

- Hypoxic environments leading to change in crab behavior
- Application to other marine invertebrates

### **Commercial Crab Industry**

- Impacts to commercial crab industries
- Decline in revenue and job opportunities

# Stress Physiology

## What can be tested

- **Effects on respiration**

- **Lactate** - shift to anaerobic metabolism causes increased lactate production in the hemolymph
- **Respirometry with Resazurin** - blue dye that when exposed to metabolically active cells reduces it to resorufin (becomes pink) by consuming oxygen; faster the change in color → more oxygen consumption, would expect a slower consumption

- **Energy**

- **Glucose** - can show signs of change in metabolic rate, feeding, and energy costs from adjusting to environment
- **Triglyceride** - the stored lipids in crabs can show energy reserve, the building or depletion of fat stores, can indicate if stressors are causing energy depletion



# Stress Physiology

## What can be tested

- **Other signs of stress / impacts from hypoxia**
  - **BCA Protein** - low levels of hemolymph protein levels can indicate chronic stress / metabolic depletion; under stress they can begin to break down proteins for more energy
  - **Righting Test** - Can indicate the energetic ability of the individual (do they have the energy to flip themselves back over)
  - **Gill Tissue Wasting** - Atrophic gill filaments or deteriorated gill filaments is a common result of prolonged hypoxia exposure
  - **Death** - strong indicator that the conditions led to high stress and physiological changes

# Commercial Crab Industry

## Threats to the commercial crab industry due to climate change

- **Sudden increase in hypoxic conditions leading to crab declines**
  - Instances of severe hypoxic conditions from harmful algal blooms has significantly increased in the last few decades and impacts commercial fisheries abilities to catch crabs / enough
- **Poor management to counteract impacts**
  - Many fisheries do not have the management in place to combat these declines
  - Need to find the balance between working with those relying on crabbing for their livelihood and researchers which can prolong implementation of management
- **Overall revenue decline**
  - Loss of crab abundance leads to overall revenue loss, impacting companies and individuals who rely on crabbing

# Experimental Design

## Control Tank

### Control Tank:

- **High DO<sub>2</sub> from air stone**
- **13 °C**
- **35 ppt salinity**
- **Plastic rocks for cover**
- **No access to air**

### Controlled Variables Across Treatments:

- **Temperature**
- **Salinity**
- **Plastic rocks for cover**

# Experimental Design

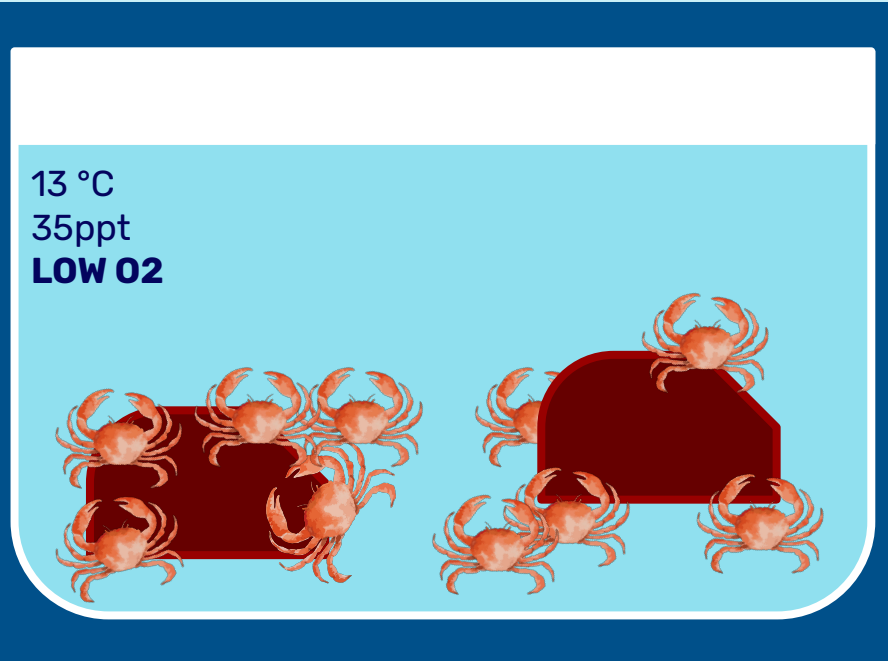
## Manipulated variables

### Tank 1

- Same temp, salinity, and cover as control
- 10 crabs

### Manipulated Variable:

- No air stone  $\rightarrow$  low DO<sub>2</sub>



# Experimental Design

## Manipulated variables

### Tank 2

- Same temp, salinity, and cover as control
- 10 crabs

### Manipulated Variables:

- No air stone  $\rightarrow$  low DO<sub>2</sub>
- Access to air



# Experimental Design

## Experimental Timeline

### After One Week in Tanks:

- $\frac{1}{2}$  of crabs given non-lethal stress tests.
- Tested crabs marked with nail-polish and returned to tanks.

### Non-Lethal Stress Tests:

- Respiration  $\mapsto$  resazurin
- Lethargy  $\mapsto$  self-righting speed

# Experimental Design

## Experimental Timeline

### After Two Weeks in Tanks:

- All crabs given non-lethal stress tests.
- All crabs given lethal stress tests.

### Lethal Stress Tests:

- Gill tissue wasting (dissection)
- Hemolymph Content
  - Glucose
  - Triglyceride

Research Question:

**How will hypoxia affect the  
physiology of hairy shore  
crabs?**



# Hypotheses:

**Crabs with access to air will leave the water to escape the hypoxic conditions and resulting stress.**

**Crabs experiencing hypoxia for at least a week will be lethargic and may not be able to right themselves.**

**Crabs may die from long-term exposure to hypoxic water.**

**Crabs will switch to anaerobic metabolism and lactate in the hemolymph will increase. Hypoglycemia may occur.**

**Energy-consumption will increase as heightened stress levels cause fat stores to be depleted.**

**Gill tissues will deteriorate and BCA levels will be low in the hemolymph.**



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**Thank You for Listening,  
Any Questions?**