Hypoxia effects on Hemigrapsus oregonensis

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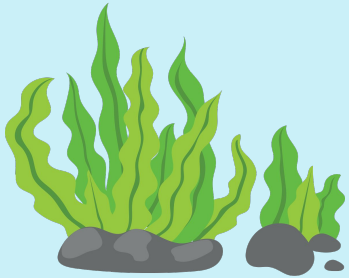


Background:

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

Background

Climate Change and Hypoxic Water Masses

Water Transport

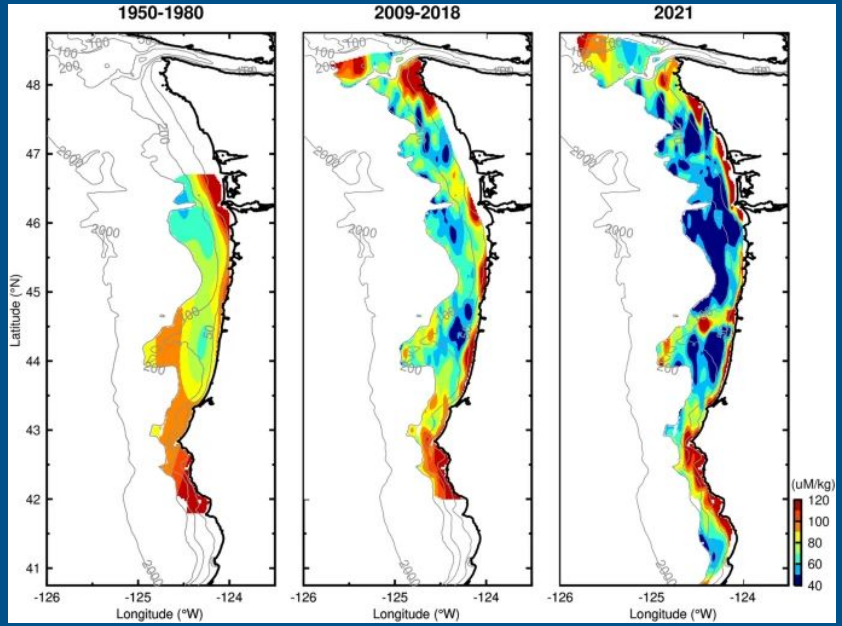
- Increasing with changing wind and temperature regimes
- Creates a seasonal pattern of hypoxic conditions

Eutrophication

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

Water Transport

Upwelling

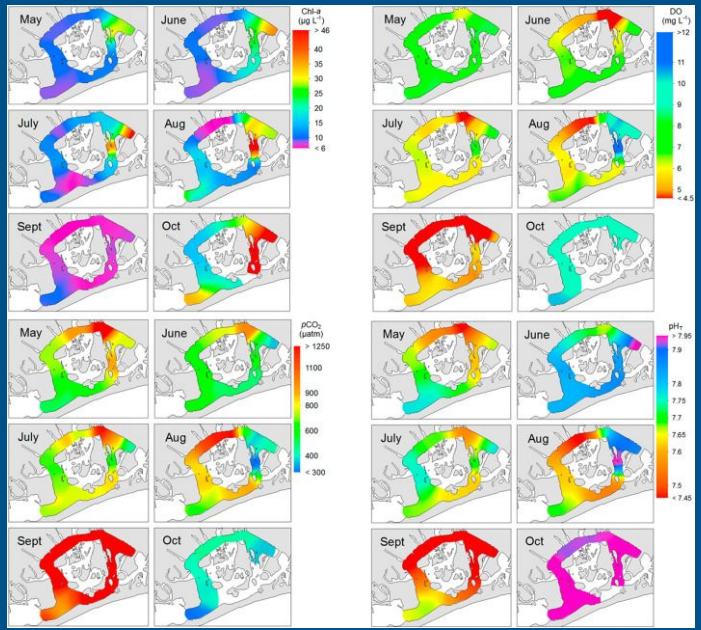


- Wind changes are occurring due to evolving land-sea temperature differences
- Spring-summer transportation of cold, hypoxic water to shallower coastal habitats
- Fraction of transported water that is hypoxic has increased dramatically in the last 70 years

Barth et al, 2024

Eutrophication

Algal Blooms



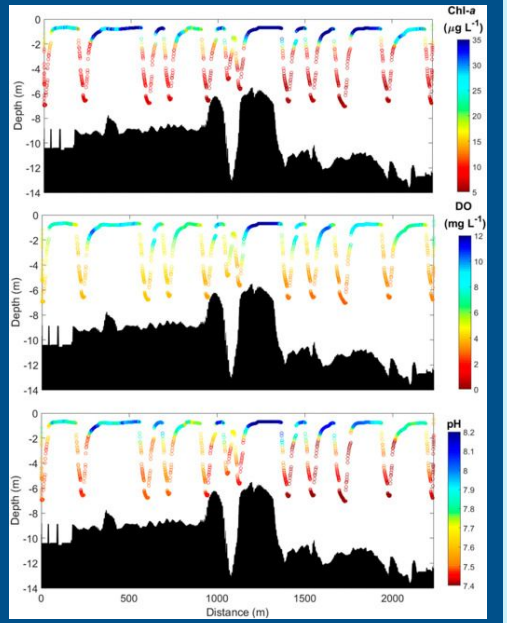
- Algal blooms form as temperatures rise during the spring
- Raised nutrient concentrations due to runoff fuel overwhelming growth
- As nutrients are consumed, algae begins to die and decompose

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 decliens**
  - 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 DO2 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

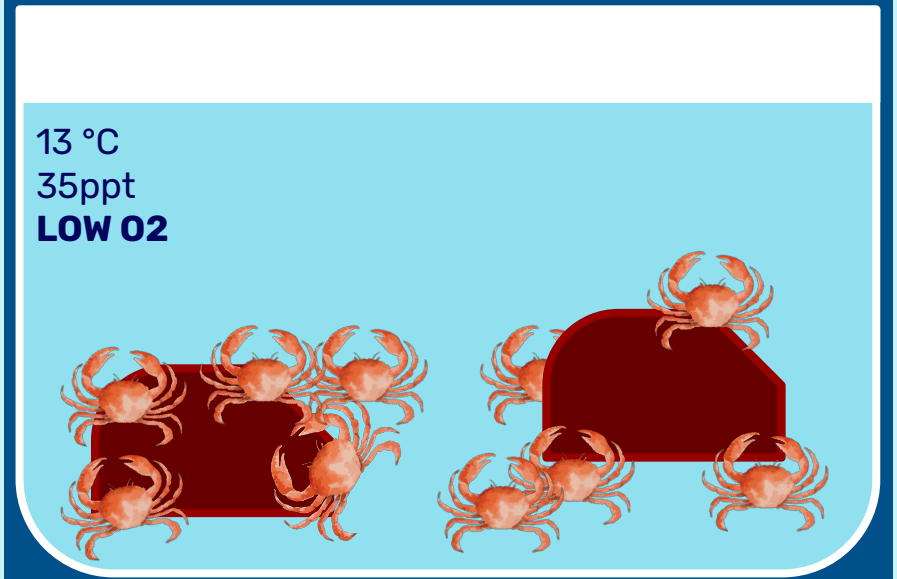
Manipulated variables

Tank 1

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

Manipulated Variable:

- **No air stone ↦ low DO2**



Experimental Design

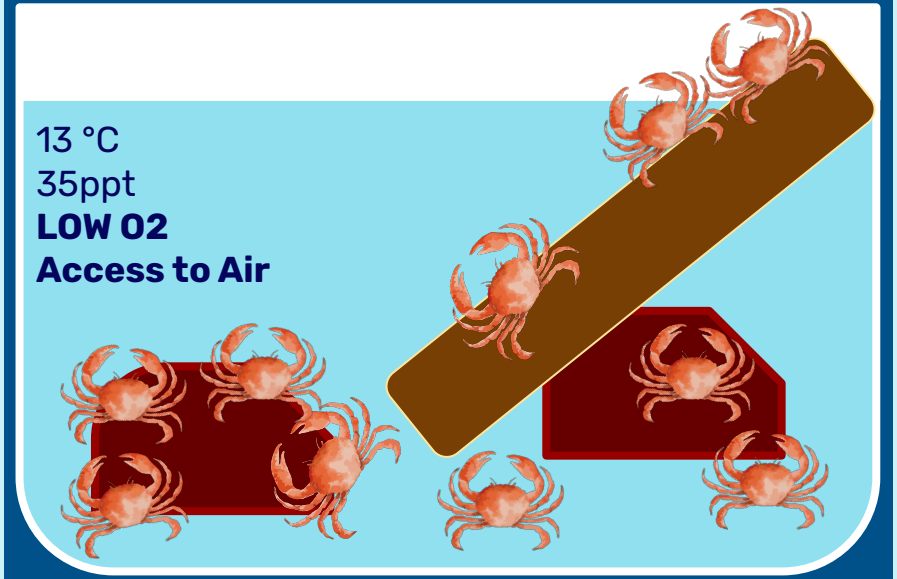
Manipulated variables

Tank 2

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

Manipulated Variables:

- **No air stone ↦ low DO2**
- **Access to air**



Experimental Design

Experimental Timeline

After One Week in Tanks:

- ½ of crabs given non-lethal stress tests.
- Tested crabs marked with nail-polish and returned to tanks.

Non-Lethal Stress Tests:

- Respiration ↦ resazurin
- Lethargy ↦ 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.

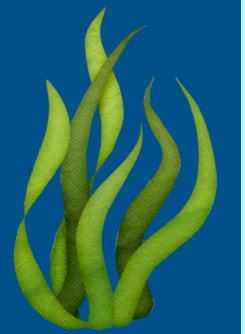
Crabs experiencing hypoxia for at least a week will be lethargic and may not be able to right themselves.

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?