The Effects of Crowding on Metabolic Activity in *Hemigrapsus oregonensis*

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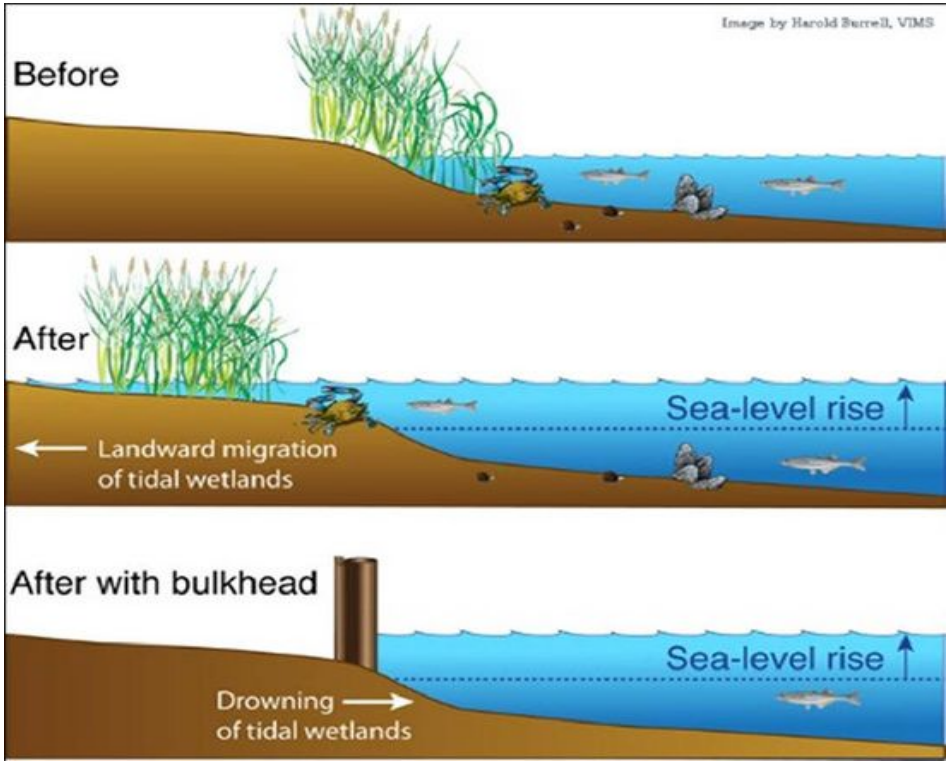
Background

Shoreline Armoring

- 25% of Puget Sound coastline
- 92% of Seattle coastline
- (WA Association of Land Trusts, 2018)

Coastal Squeeze (Pontee, N., 2013)

- Rising sea levels → migration of habitat
- Shoreline armoring reduces intertidal habitat availability (Long et al., 2011)
    - Seawalls
    - Rocks
    - Sandbags



Background

Physical crowding, aggression & metabolic activity

- Higher density increases physical force and defensive displays in hermit crabs (Hazlett, 1968).
- Repeated exposure to intruder conspecifics elevated baseline heart rate in the european shore crab (Rovero et al, 2000).
- Respiration increases during and after agonistic interactions in swimming crabs (Smith & Taylor, 1993).
- Longer fights → greater oxygen demand (Smith & Taylor, 1993).

Water Chemistry, crowding & metabolic activity

- Conspecific chemical cues change the duration and intensity of agonistic interactions in swimming crabs (Smith et al, 1995).
- Shore crab chemical cues can signal mating, predators, and dominance (Hardege, 2002; Trussell, 2003).
- Crowding-related changes in water chemistry increase metabolic stress in shrimp, raising respiration to maintain homeostasis and reducing energy available for growth (Nga et al, 2005).

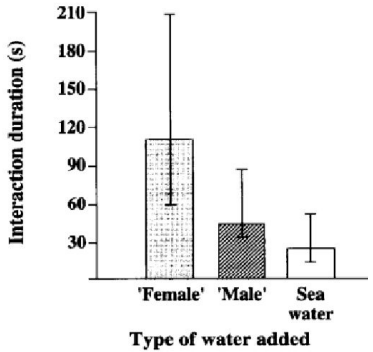


Fig 1: The mean durations of interactions between *N. puher* exposed to seawater (control) or to water conditioned by females and males. Error bars represent 95% confidence intervals).

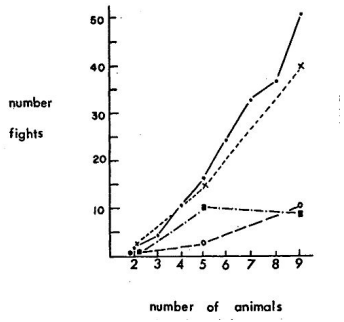


Fig 2: Number of agonistic encounters as a function of density in hermit crabs

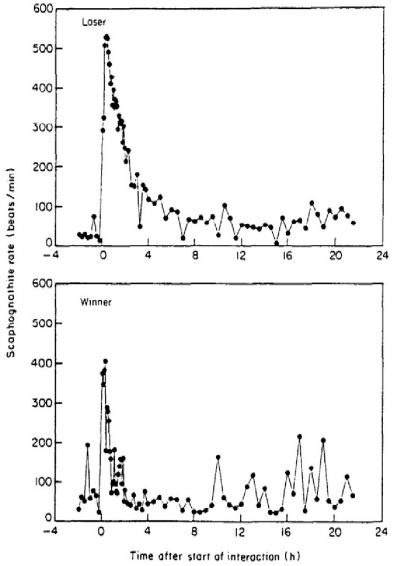


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Fig. Example of scaphognathite rate changes of *N. puber* during an agonistic interaction and recovery from it. The interaction started at time 0 and lasted 38 min (from Smith & Taylor, 1993).

Background

Hairy Shore Crab (*Hemigrapsus oregonensis*)

- Model species for intertidal crab studies
- Range: Resurrection Bay to Alaska to Baja California (Visser et al. 2004)
- Habitats: Common intertidal areas like mudflats, bays, estuaries, seagrass beds, open beaches (Visser et al. 2004)

Behavioral Traits & Density

- Typically remain in or near their individual burrows and display aggressive behavior toward other crabs during encounters, especially when foraging outside burrows (Visser et al. 2004)
- Reported densities (Jensen et al. 2002):
  – Avg. 472 crabs/m² under boulders (Puget Sound, WA)
  – Max 624 crabs/m² under oyster shells (Bodega Bay, CA)

Research Questions

How does crowding influence the metabolic activity of *H. oregonensis*?

How does altered water chemistry from crowded conditions influence the metabolic activity of *H. oregonensis?*

Physical Crowding Hypotheses

Null Hypothesis (H_0): Physical crowding does not significantly affect the metabolic activity of *H. oregonensis*.

Alternative Hypothesis (H_1): Physical crowding significantly affects the metabolic activity of *H. oregonensis*.

- Alternative Hypothesis (H_{1a}): Physical crowding significantly increases the metabolic activity of *H. oregonensis*.
- Alternative Hypothesis (H_{1b}): Physical crowding significantly decreases the metabolic activity of *H. oregonensis*.

Water Chemistry and Crowding Hypotheses

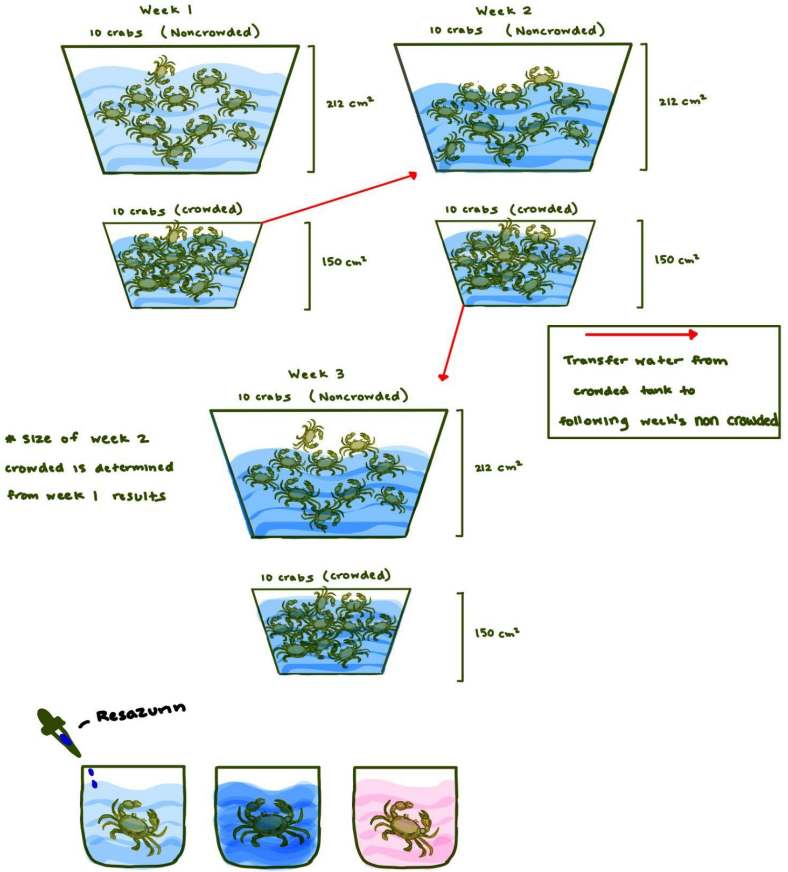
Null Hypothesis (H_0): Altered water chemistry from crowded conditions does not significantly affect the metabolic activity of *H. oregonensis.*

Alternative Hypothesis (H_1): Altered water chemistry from crowded conditions significantly affects the metabolic activity of *H. oregonensis*.

> Alternative Hypothesis (H_{1a}): Altered water chemistry from crowded conditions significantly increases the metabolic activity of *H. oregonensis*.
>
> Alternative Hypothesis (H_{1b}): Altered water chemistry from crowded conditions significantly decreases the metabolic activity of *H. oregonensis*.

Experimental Design

- Subject:
  - 10 crabs per tank
- Treatment Groups:
  - Non Crowded condition: Crabs housed in a larger tank (212 cm²).
  - Crowded condition: Crabs housed in a smaller tank (150 cm²) to simulate crowding stress.
- Setup:
  - Week 1: 10 crabs are assigned to either crowded or non crowded conditions with fresh water.
  - Week 2 & 3: Randomly selected crabs from each treatment are used. Water from the previous week's crowded treatment is transferred to the non crowded tank of the following week.
- Measurement:
  - Resazurin
    - Time it takes for dye to turn pink and fluorescence using fluorometer
  - Mass of crabs before and after treatment
  - Conditions of water (pH, salinity) before and after treatment



* Three crabs from each tank, along with their corresponding tank water, will be removed for respirometry measurements.

Expected Results

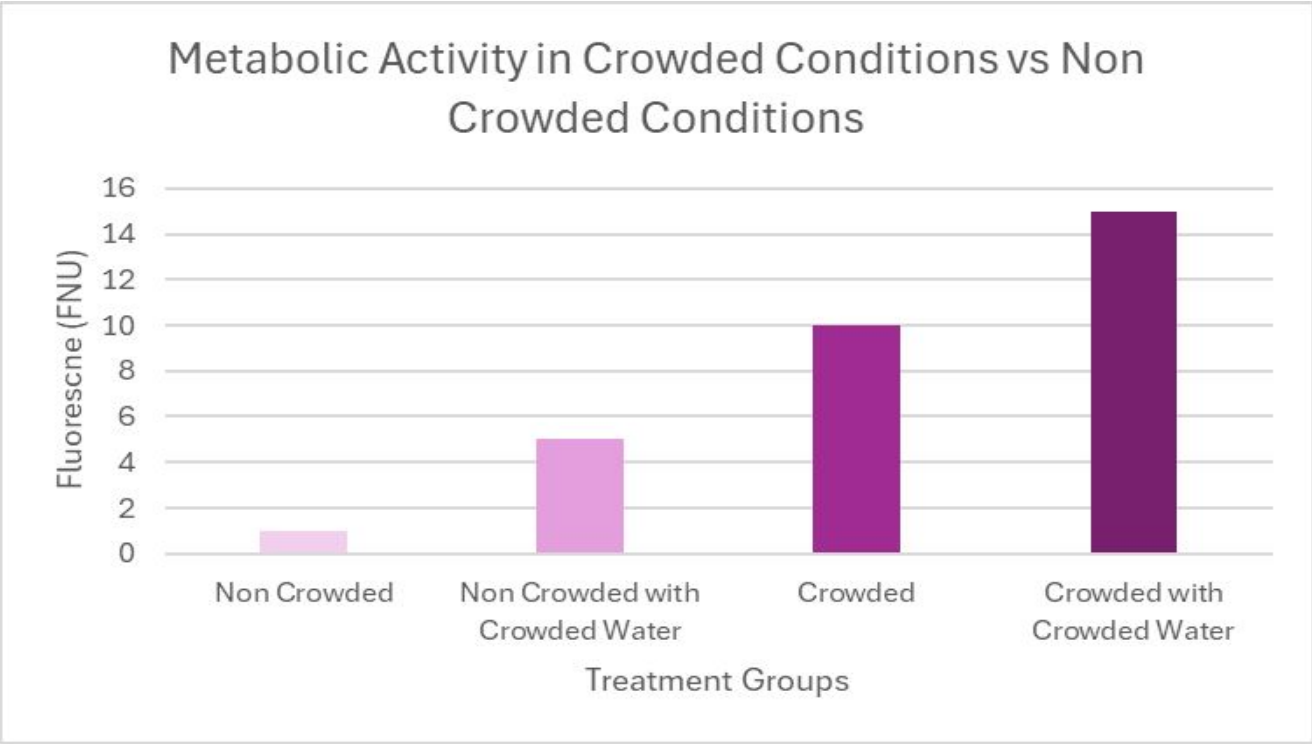


Fig 4: Average fluorescence of resofurin in each treatment group, indicating aerobic respiration per crab.

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