

# *FISH 460 Project Proposal*

## **Investigating the Predatory Stress Response of *Hemigrapsus oregonensis* to the *Carcinus maenas* in Warming Environments**

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## Relevant Background:

- European Green Crabs (*Carcinus maenas*) are invasive in intertidal habitats across the West Coast, and are increasing in abundance in Puget Sound (Turner, 2025)
- Green Crabs prey on and reduce habitat and food availability for Hairy Shore Crab (*Hemigrapsus oregonensis*) (Fisher, 2024)
- Temperature is the most important factor in determining Green Crab distribution, which will be exceedingly important as the effects of global warming intensify (Nielsen et al, 2025)
- As water temperature increases, oxygen concentration decreases, which impacts the crabs by either reducing their metabolic rate and/or increasing their respiration rate.
- Lack of research regarding interactions between Shore Crabs and Green Crabs, specifically surrounding the predator/prey relationship and induced stress.

# Research Question

How does an increase in temperature influence behavioral and physiological stress responses in Hairy Shore Crabs (*Hemigrapsus oregonensis*) during predator encounters with the European Green Crab (*Carcinus maenas*)?

# Hypotheses

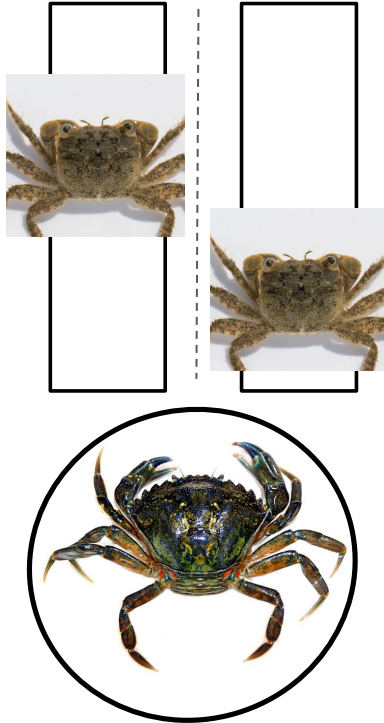
## **Null:**

- 1: There will be no significant difference in respiration rate between the two treatments of HSC (*hemigrapsis oregonosis*)
- 2: There will be no change in righting time or distance travelled away from EGC by the HSC across the two treatments.

## **Alternative :**

- 1: There will be a difference in respiration rates between the two treatments of HSC.
- 2: There will be a change in righting time or distance travelled away from EGC by the HSC across the two treatments.

# Experimental Setup - Design



## Behavioral Tests:

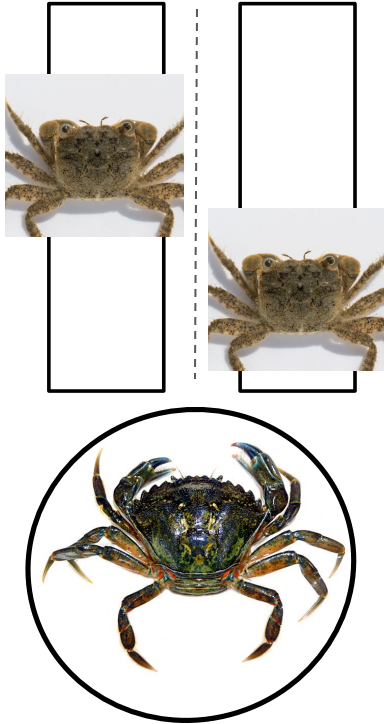
### Distance Traveled over Time

- Place crabs within narrow chambers, blinder between chambers
- Different temperature water if needed for comparing treatments
- Time will be decided by available time per day and based on week 1 baseline

### Righting Time

- Flip shore crab over, measure how long it takes to flip back
- Stress implications + confounding factor

# Experimental Setup - Design



## Behavioral Tests:

### Distance Traveled over Time

- Place crabs within narrow chambers
- Different temperature water if needed for comparing treatments

### Righting Time

- Flip shore crab over, measure how long it takes to flip back
- Stress implications + confounding factor



## Respiration Tests:

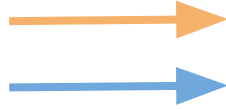
### Resazurin

- Following procedural guidelines, expose shore crabs to the resazurin for an hour before and during predatory stimulus

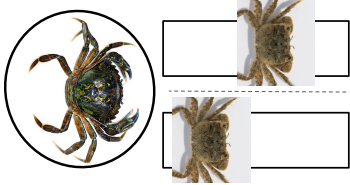
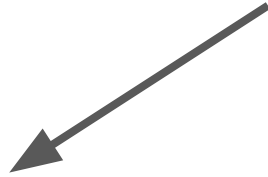
# Experimental Setup - Week 1



*Hairy Shore Crab*



Measure  
respiration rate



Measure  
Behavioral  
Baseline



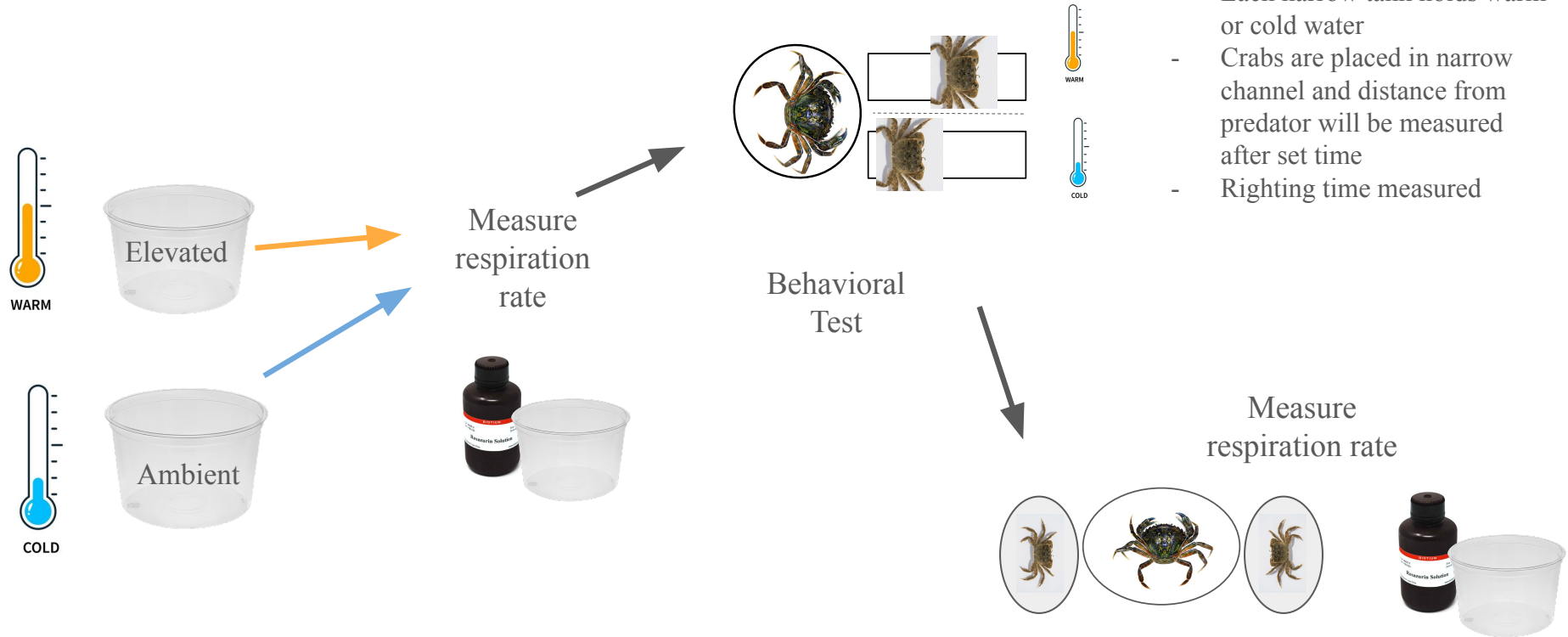
Measure respiration  
rate again  
(tentative)



Put into  
temperature  
treatments

- Separate Hairy Shore crabs into 2 groups: ambient/cold temperature and warm temperature
- Measure preliminary respiration rates of crabs from each group
- Baseline behavior observations, including distance traveled over time and righting time
- EGC introduction Week 1
- Place into temp. treatment

# Experimental Setup - Week 2 & 3

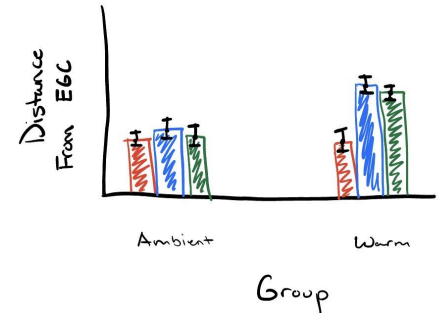
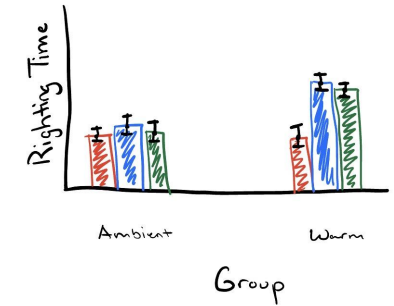
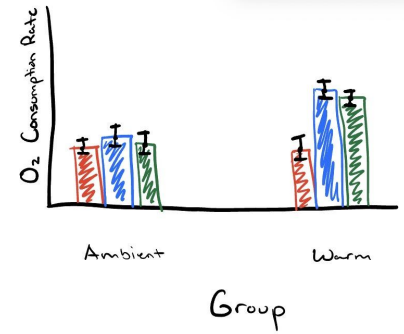


- Two narrow passages are placed perpendicular to the European Green Crab tank.
- Each narrow tank holds warm or cold water
- Crabs are placed in narrow channel and distance from predator will be measured after set time
- Righting time measured



# Data Collection/Reporting

- Quantitative measurements for Oxygen Consumption, Righting Time, and Distance Travelled from EGC
- Plotting and Analysis in R
- Will compile table of qualitative observations of crab behavior for additional context
- Potential plots to compare groups across trials → → →



# Applications of This Project:

- Changing behaviors according with different temperature groups can point to changes in life strategies for HSC
- Changing respiratory rate would affect metabolic rate of Hairy Shore Crabs in the presence of European Green Crabs, implications for energy availability/expenditure
- An increase in either stress response is indicative of a fitness loss for HSC living in proximity to EGC (regardless of if they are being eaten or not)
- Helps to understand tradeoffs in changing conditions
- Changing behavioral and physiological stress response in high temperature environments provides insights to HSC fitness under effects of climate change
  - Answers the question: Will the invasive EGC have an increasingly detrimental effect on HSC fitness under global warming?
- Results can help focus conservation and removal of European Green Crab on areas most vulnerable to warming (if alternative hypothesis is supported)

## Citations:

Fisher, M. C., Grason, E. W., Stote, A., Kelly, R. P., & Litle, K., McDonald, P. S. (2024). Invasive European green crab (*Carcinus maenas*) predation in a Washington State estuary revealed with DNA metabarcoding. *PLoS ONE*, 19(5): e0302518. doi:10.1371/journal.pone.0302518.

Nielsen, M. S., Svendsen, J. C., Wilms, T., Bertelsen, J. L., Kruse, B. M., & Lindegren, M. (2025). Factors influencing the abundance of European green crab (*Carcinus maenas*): Combined effects of temperature, habitat and predator release. *Estuarine, Coastal and Shelf Science*, 322, 109374. doi:10.1016/j.ecss.2025.109374.

Turner, B. C. (2025). European Green Crab Joint Quarterly and Annual Progress Report – April 1 to June 30, 2025, and Fiscal Year 2025 (July 1, 2024, to June 30, 2025). Olympia, WA. *Washington Department of Fish and Wildlife*.

Walker, S., Mozaria-Luna, H. N., Kaplan, I., & Petatán-Ramírez, D. (2022). Future temperature and salinity in Puget Sound, Washington State, under CMIP6 climate change scenarios. *Journal of Water and Climate Change*. 13 (12): 4255–4272. doi: 10.2166/wcc.2022.282.