Carbonated Communities

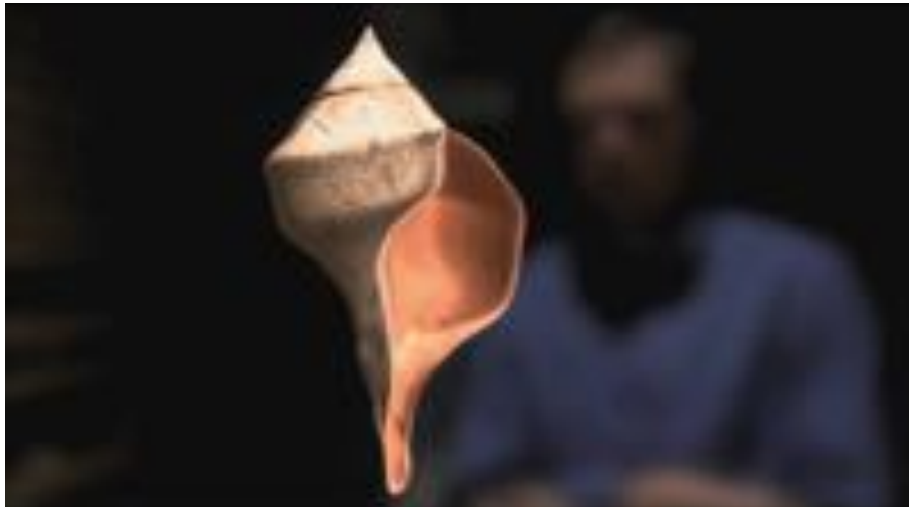
HOW IS LOWER pH (ACIDIFICATION) AND RISING TEMPERATURE AFFECTING OCEAN ORGANISMS IN THE INTERTIDAL?

Carbonated Communities
Part Two

YOUR JOB

- Watch a video exploring how shells grow.
- Analyze and interpret data collected by Dr. Lord and Dr. Barry.
- Make an evidence-based claim answering: *How does climate change (lower pH and higher temperatures) affect feeding, growth and interaction between species in the intertidal?*

Watch *Mollusc Animation: Shell Repair* and *Arthropods: Blue Crab Molting*



https://www.shapeoflife.org/video/mollusc-animation-shell-repair

https://www.shapeoflife.org/video/arthropods-blue-crab-molting

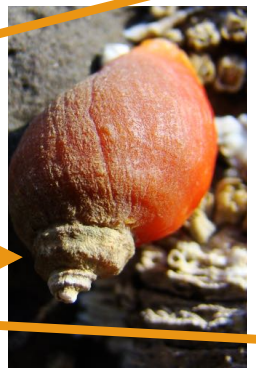
- How might lower pH and higher temperature affect shell building and repair in the investigation species (abalones, whelks, mussels)?
- How might that be similar or different to effects on exoskeletons and molting in crabs?

How does lower pH and increased temperature affect feeding, growth and interactions between these species?

Intertidal Habitat

Mussels,
Mytilus galloprovincialis

Lined shore crab,
Pachygrapsus crassipes



Whelk,
Nucella ostrina

Abalone,
Haliotis rufescens

Sea Lettuce,
Ulva lactuca

Claim-Evidence-Reasoning

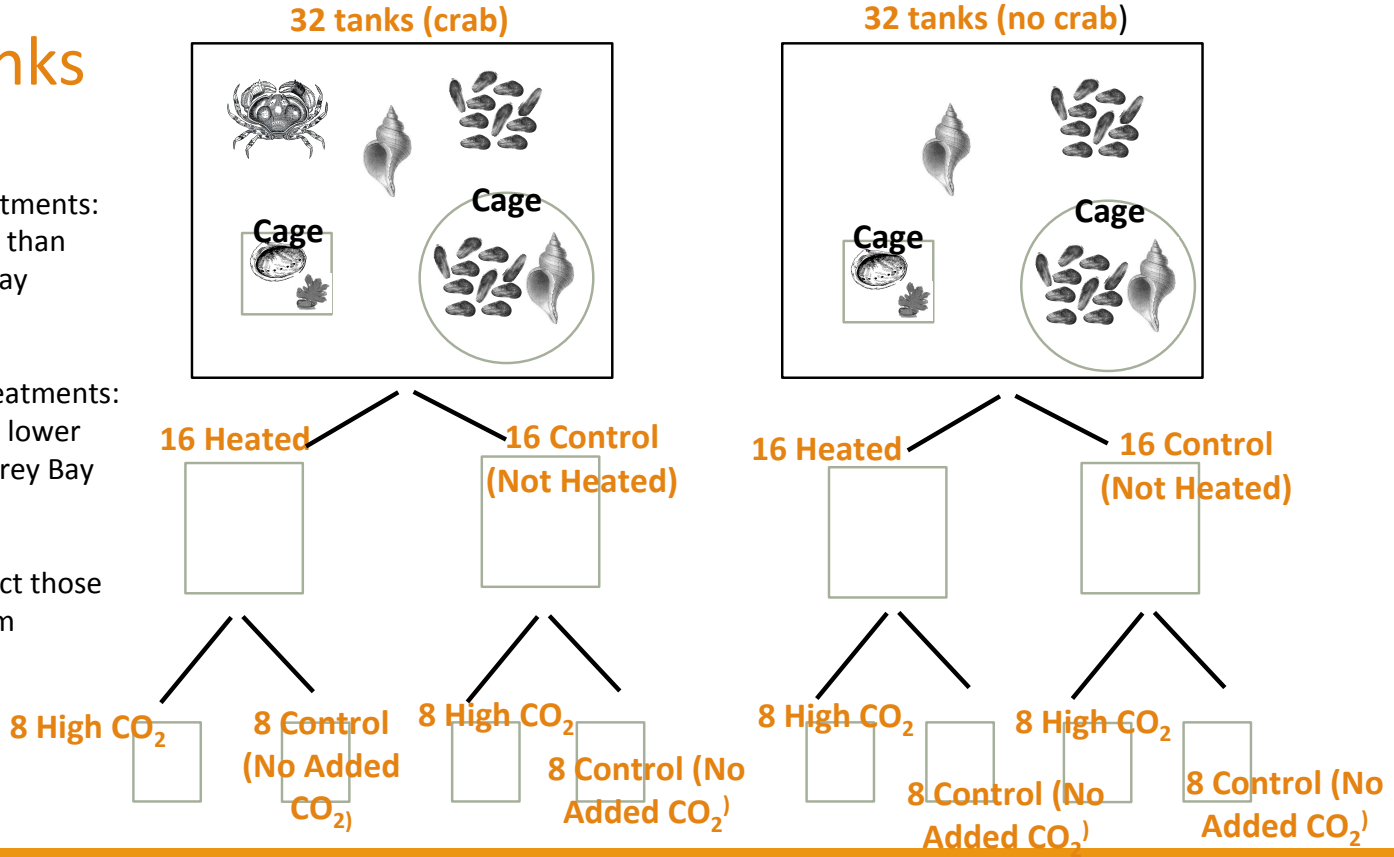
Investigation: Experimental Set-Up

64 tanks total

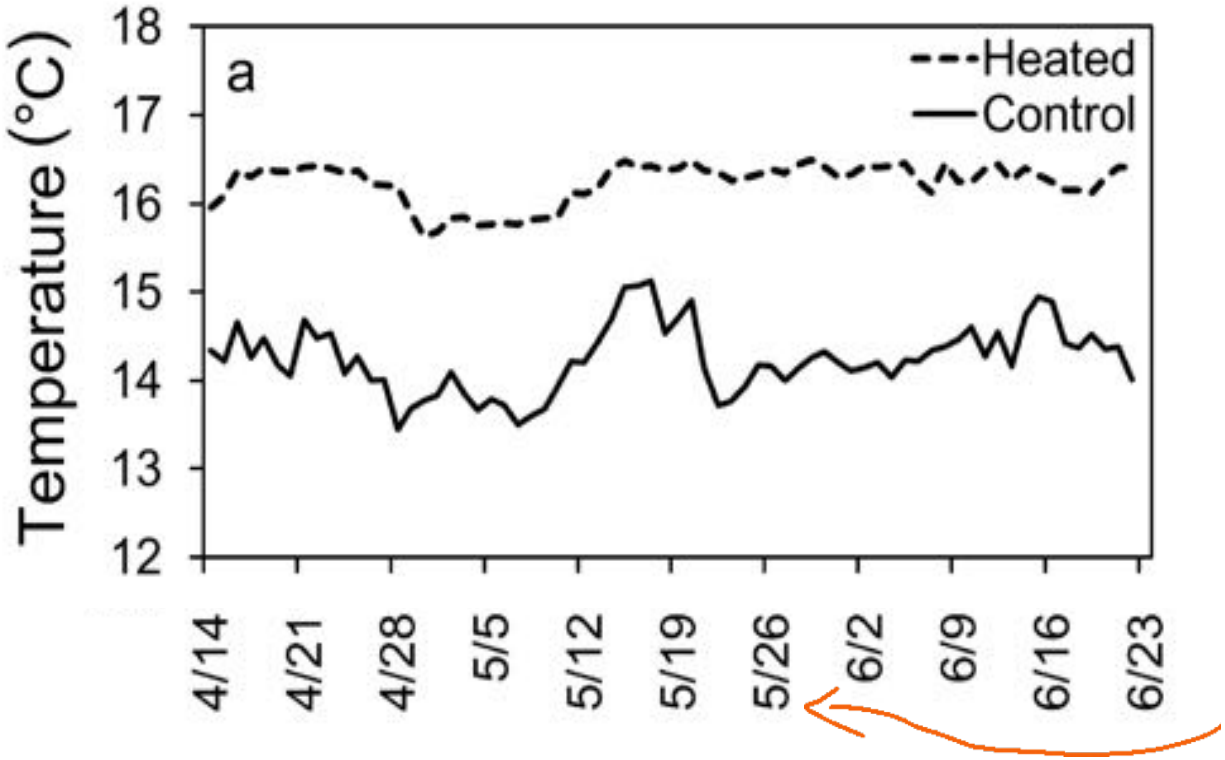
Heated treatments: 2°C warmer than Monterey Bay seawater

High CO_2 treatments: 0.3 units pH lower than Monterey Bay seawater

Cages protect those animals from predators.



Analyzing Data: Identify and Interpret (I^2)



What Do I See?

What Does it Mean?

What I see: x-axis shows dates-every week from April 14-June 22

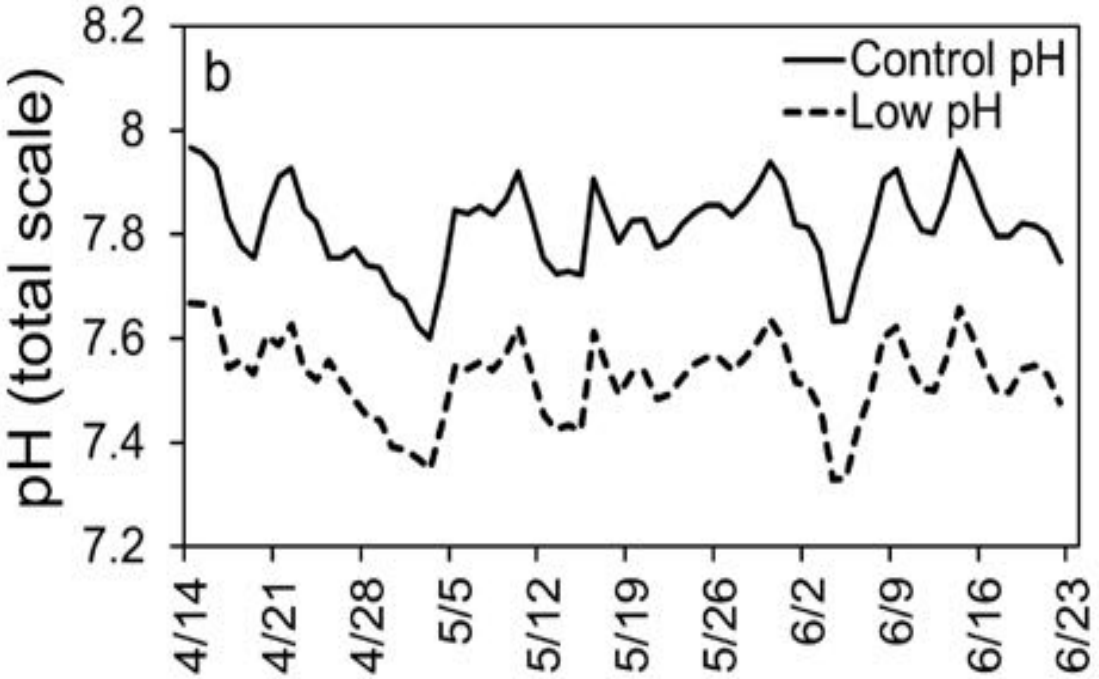
What it means: temp of sea water was measured over time from April 14-June 23

Analyzing Data: Identify and Interpret (I^2)

Caption: This line graph shows the temperature of Monterey Bay sea water over the 10-weeks of the investigation. The x-axis shows that temperature was measured over time between April 14 and June 23. The y-axis shows temperature from 12-18 °C (54-64 °F) which the natural temperature of the sea water fluctuated between. There was one peak of warm water between May 12-19. The temperature of the water naturally goes up and down in 2-3°C range.

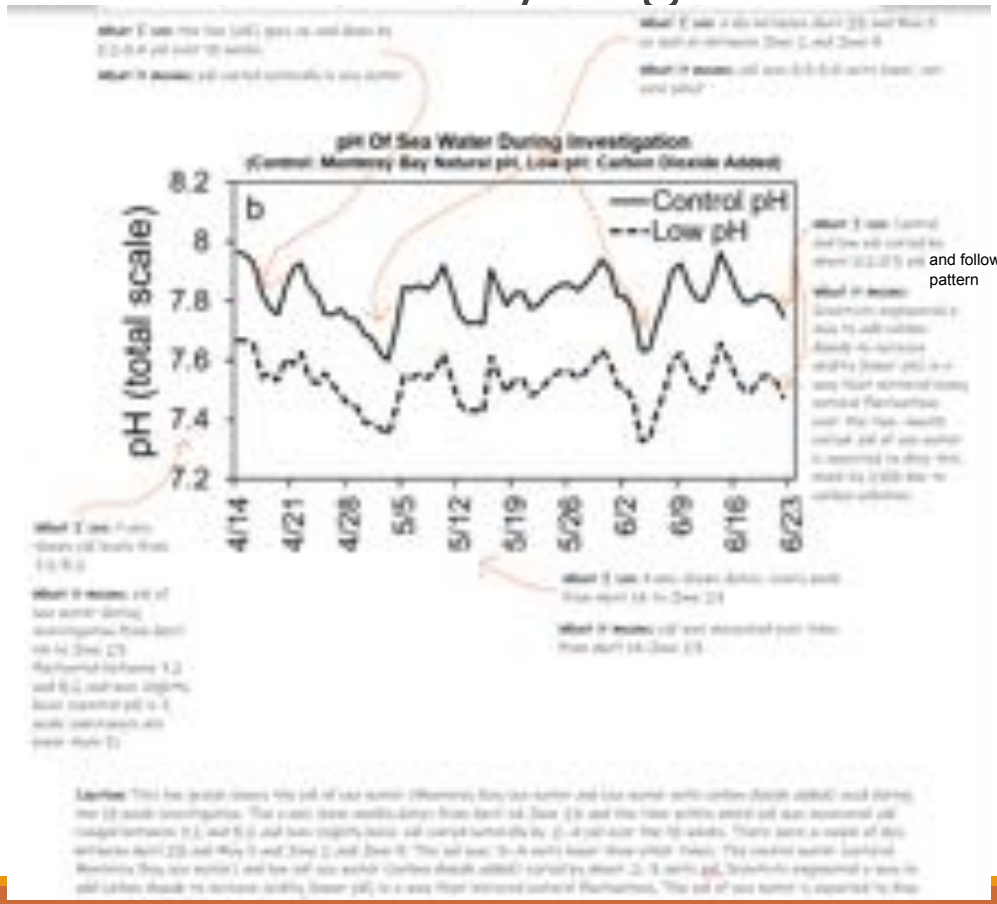
Questions I have: Why does the temperature of the bay naturally go up and down so much? Why was the water so warm between May 12-19?

Analyzing Data: Now You Do It



- What Do You See?
- What Does It Mean?

Analyzing Data: Now You Do It



and followed a similar pattern

- What Do You See?
- What Does It Mean?

Let’s Share Our Claims

Conclusion:
Effects of Lower pH and Higher Temperature on Intertidal Community

All species more affected by pH change (added CO_2) than temperature change (heated water).

Little effect of 2°C increase on all animals. Likely because the temperatures were still within the seasonal range of the animals. (However if temperature was raised during warmest time of year, they may have been more effect.)

Abalones	Whelks	Crabs
Decreased shell growth with CO_2 (feeding and tissue growth weren't affected by elevated CO_2). Temperature and presence of crabs didn't affect significantly.	No response to higher CO_2 (doesn't align with other studies). Differing response than abalone may be due to different shell chemistry. Presence of crabs affected feeding and growth the most.	High mortality and effect on feeding with increased CO_2 Crabs ate more in heated conditions.

Indirect effects on community: Whelks didn't eat as much because they were avoiding crabs. Crabs benefited mussels by reducing predation by whelks.

Debrief Questions

- How might you change/modify the investigation?
- How easy or hard was it to use the identify and interpret (I^2) method to understand the data? To develop an evidence-based claim?
- How does the conclusion compare to your original prediction?
- What was surprising?
- What else do you wonder or want to know?

Conversation with the Scientists (Dr. Lord and Dr. Barry)

BIGGEST SURPRISE…
Weren't expecting such negative effect on the crabs-over 50% mortality in the experiment. Other crab species weren't so affected in other investigations.

CHALLENGING DESIGN…
Dale Graves was the master engineer and designed and built the system that controlled the pH of the sea water. This was tricky because the pH of the water in Monterey Bay naturally fluctuates. The set up had to measure the incoming pH and turn the carbon dioxide gas supply on and off to keep the acidified treatments 0.3 pH units below incoming pH.

ON THOSE HUNGRY CRABS…
The crabs ate more than we expected. Some could eat 30 mussels/day. We had to get creative and call a bunch of aquaculture farms on the west coast. Finally we found one but had to make a few orders-the crabs ate so much!

Conversation with the Scientists (Dr. Lord and Dr. Barry)

ON WORKING TOGETHER…
It's an advantage to have expertise in different fields.

Often there are difficulties in designing experiment or dealing with a challenge, troubleshooting is easier and even fun when working with people who have different ideas or perspectives.

SCIENTISTS HAVE LIVES TOO…
Dr. Josh Lord plays soccer and mountain bikes among other things. Dr. Jim Barry like to surf.

ON SCHOOL AND CAREER…
Find something you care and are passionate about. So many people get caught up doing a job or research they feel they should.

On Climate Change

"What can we do about climate change? We can talk with one another about climate change, vote with the climate in mind and use less energy.

Get out and enjoy the ocean. The more you do, the more you'll want to protect it for generations."

-Dr. Jim Barry

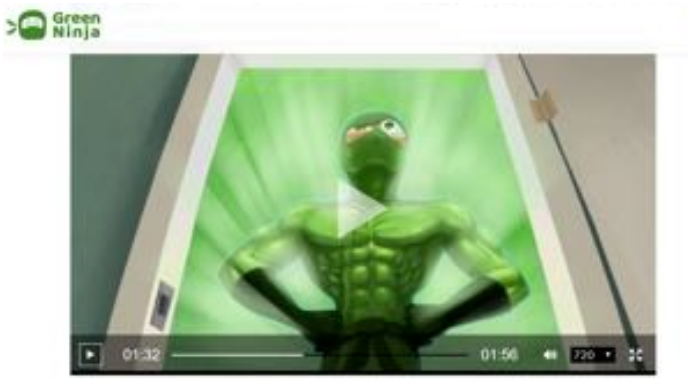
What are people doing about climate change?

UNPLUGGING as often as possible to use less electricity (e.g., soccer instead of a screen)

TALKING TO OTHERS about it

PAYING ATTENTION to the **NEWS/CURRENT ISSUES** and **VOTING** when you can

What are people doing about climate change?



Green Ninja,
www.greenninja.org
https://greenninja.org/Green_Ninja_Show/31

Alliance for Climate Education:
Do One Thing (DOT), www.acespace.org
https://www.youtube.com/watch?time_continue=100&v=37t5UT-39nM

What might be your “DOT” to slow down climate change and help intertidal communities?

Data Sheets-Teacher Keys

Name_____ Period/Class _____ Date_____

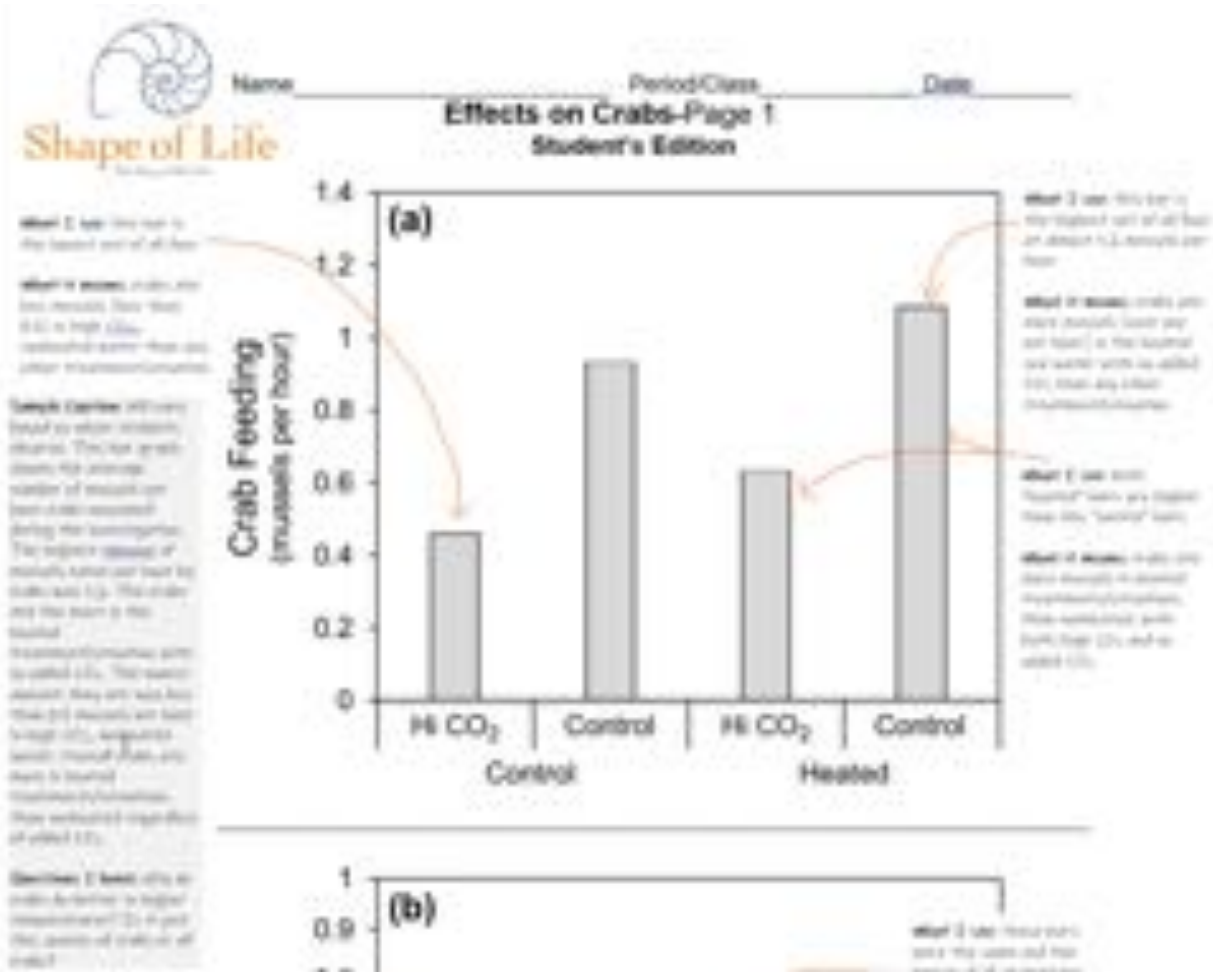
Claim-Evidence-Reasoning-Page 1
Student's Edition

Question: *How does climate change (lower pH and higher temperatures) affect feeding, growth and interaction between species in the intertidal?*

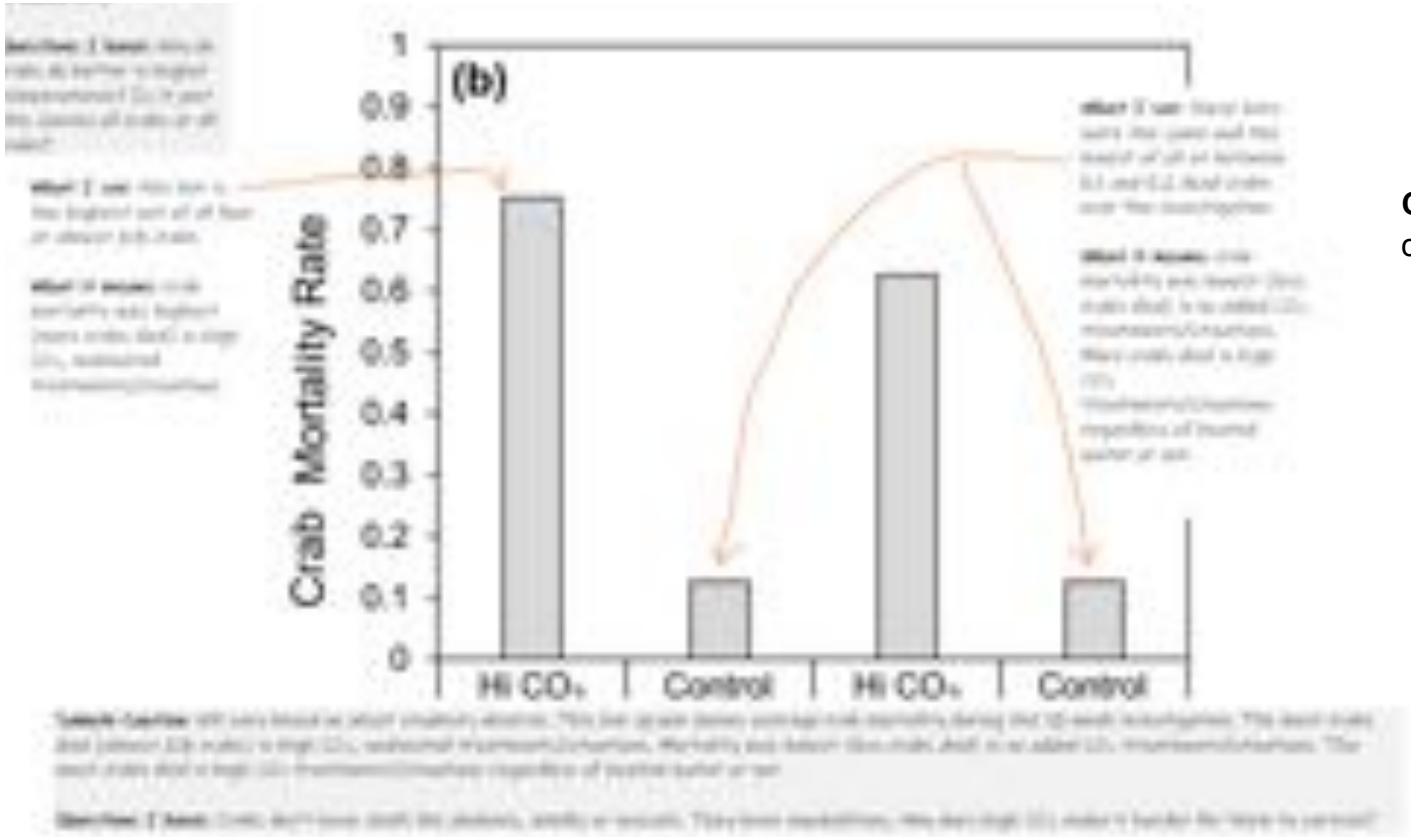
Claim (answers the question)	[illegible]			
Evidence (scientific data that supports the claim)	Crabs	Whelks	Abalone	
	Feeding [illegible]	**Feeding** [illegible]	**Feeding** [illegible]	
	Mortality More crabs died [as in [illegible]] at high CO_2 conditions than other conditions. At least [illegible] crabs died in control conditions.			
			Shell growth [illegible]	
Reasoning (describes why the evidence supports the claim)	[illegible]			

Reasoning (describes why the evidence supports the claim)

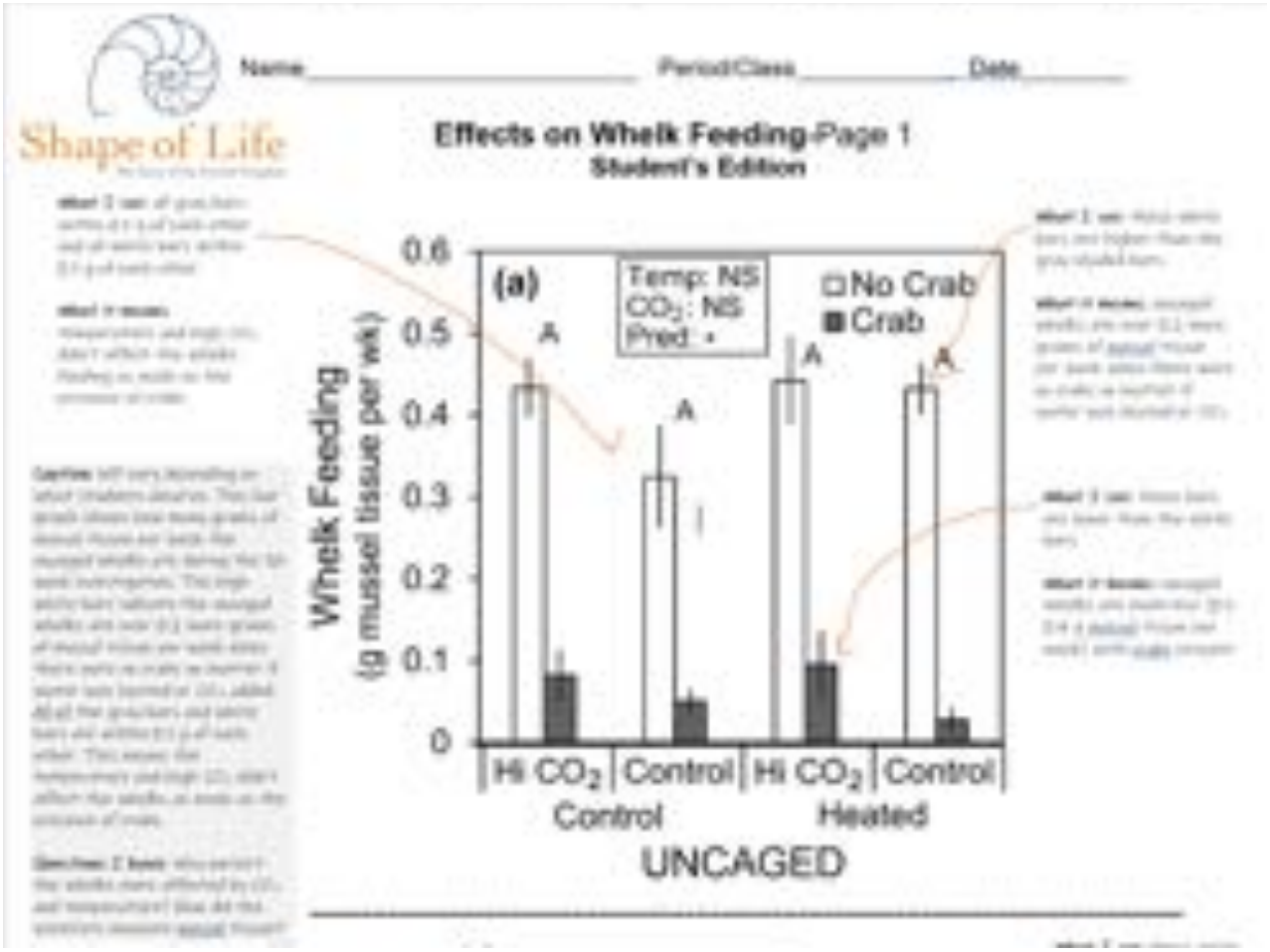
[illegible]



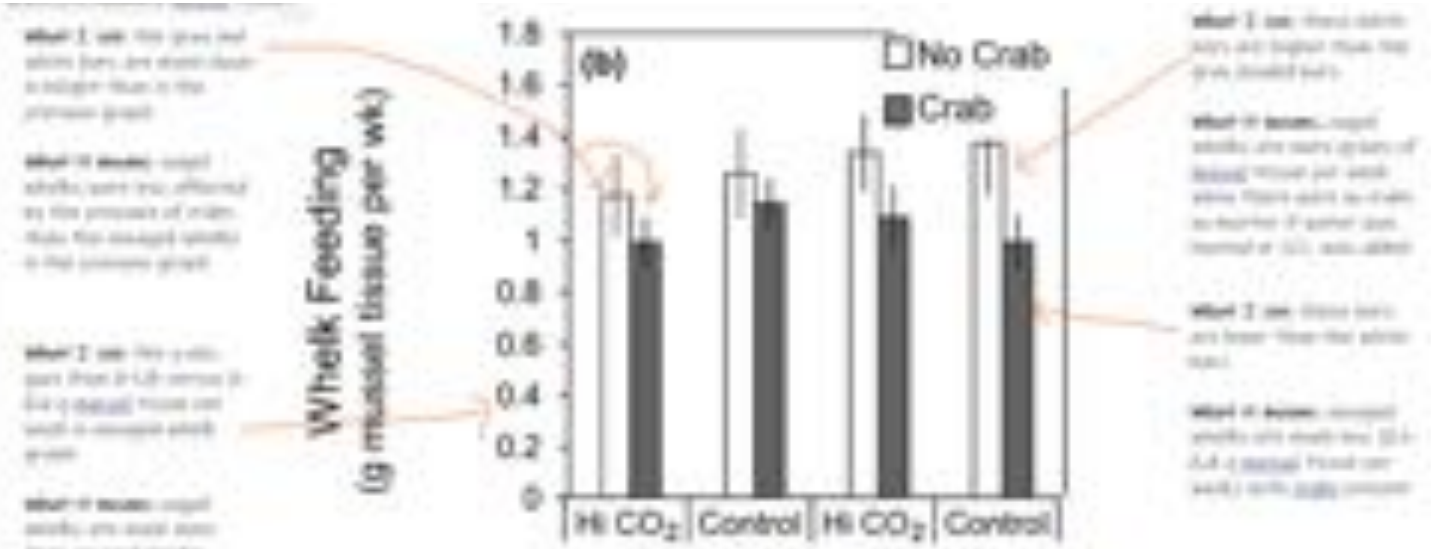
Crab Feeding: Crabs ate more in heated conditions. They ate less in lower pH (added CO_2) conditions.



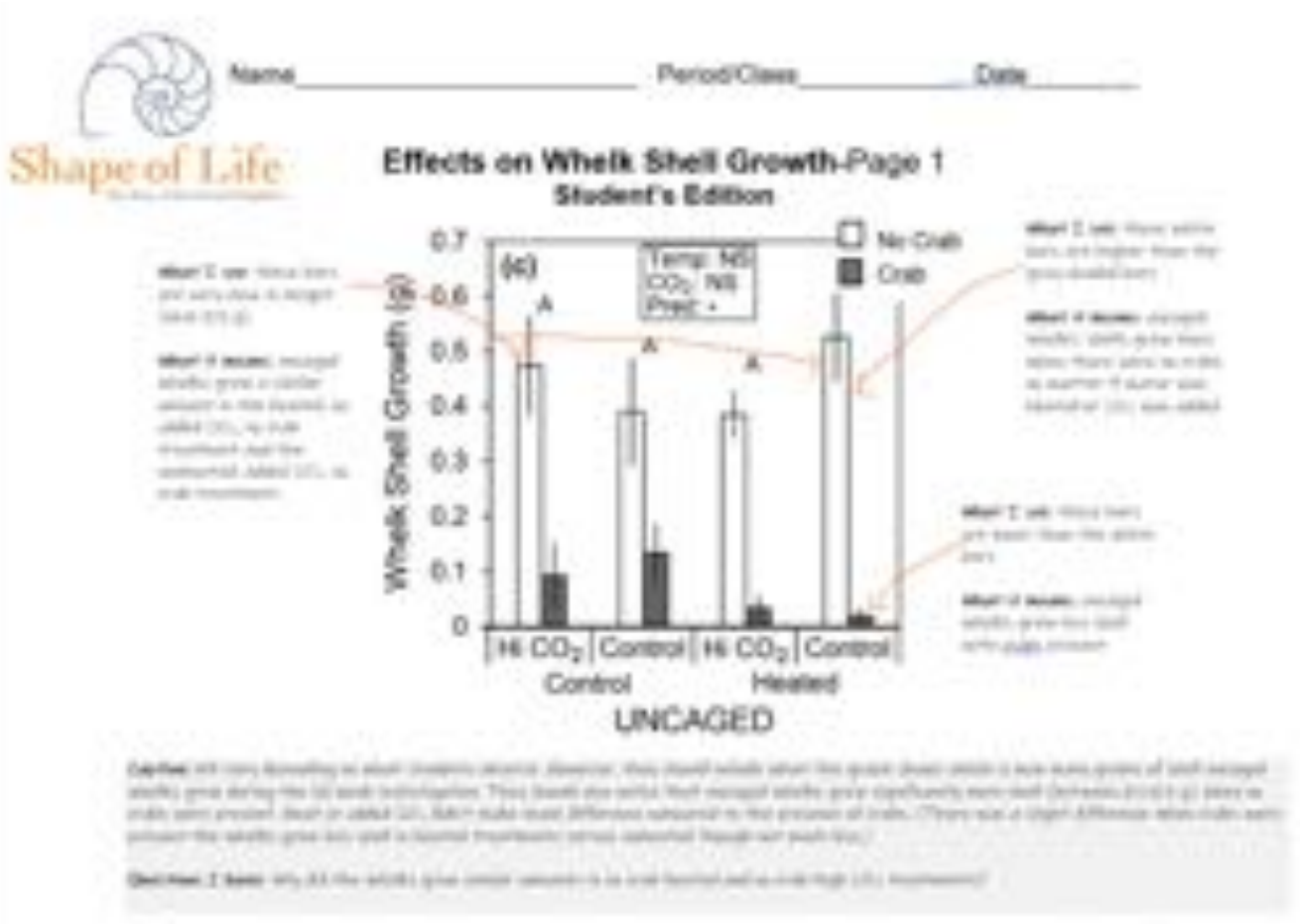
Crab Mortality Rate: More crabs died (higher mortality rate) in higher CO_2 conditions than any other conditions.



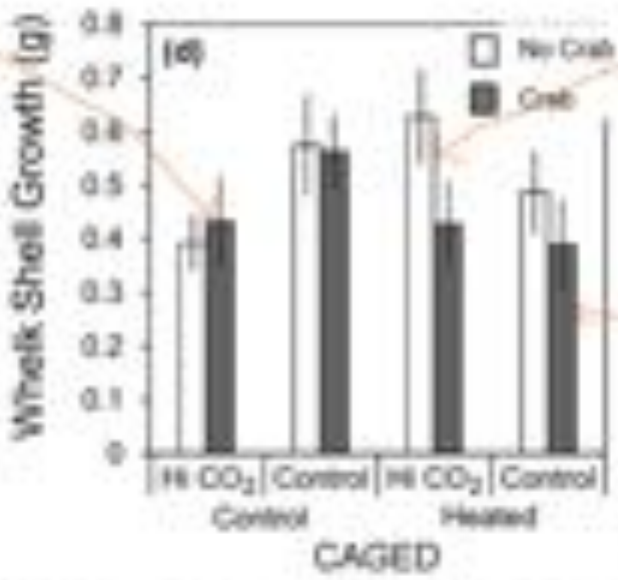
Uncaged Whelk Feeding: Uncaged whelks ate significantly less with a crab present. Lower pH and higher temperatures didn't affect feeding significantly.



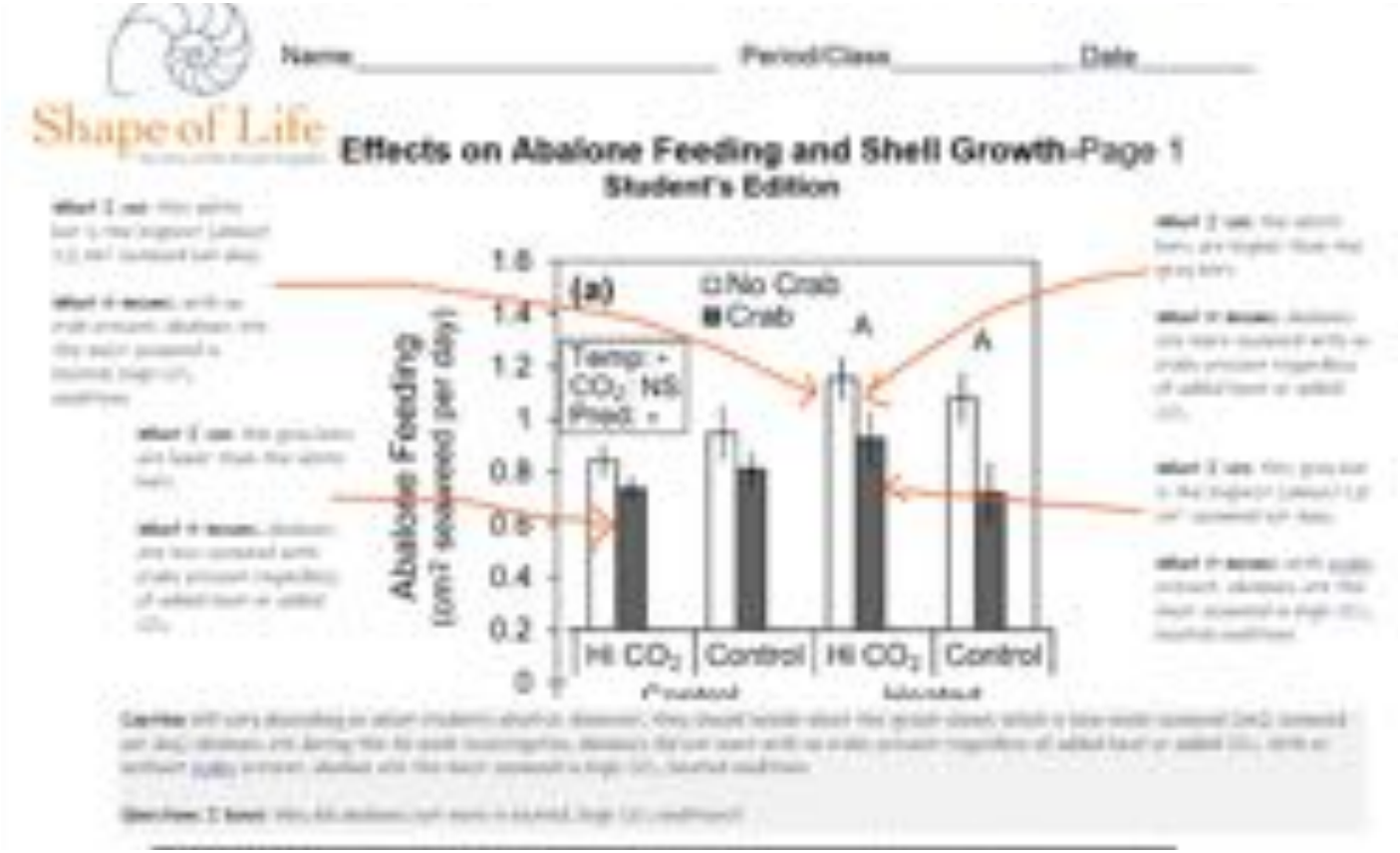
Caged Whelk Feeding: Caged whelks ate more than uncaged whelks with crabs present. Lower pH and higher temperatures didn't affect feeding significantly.



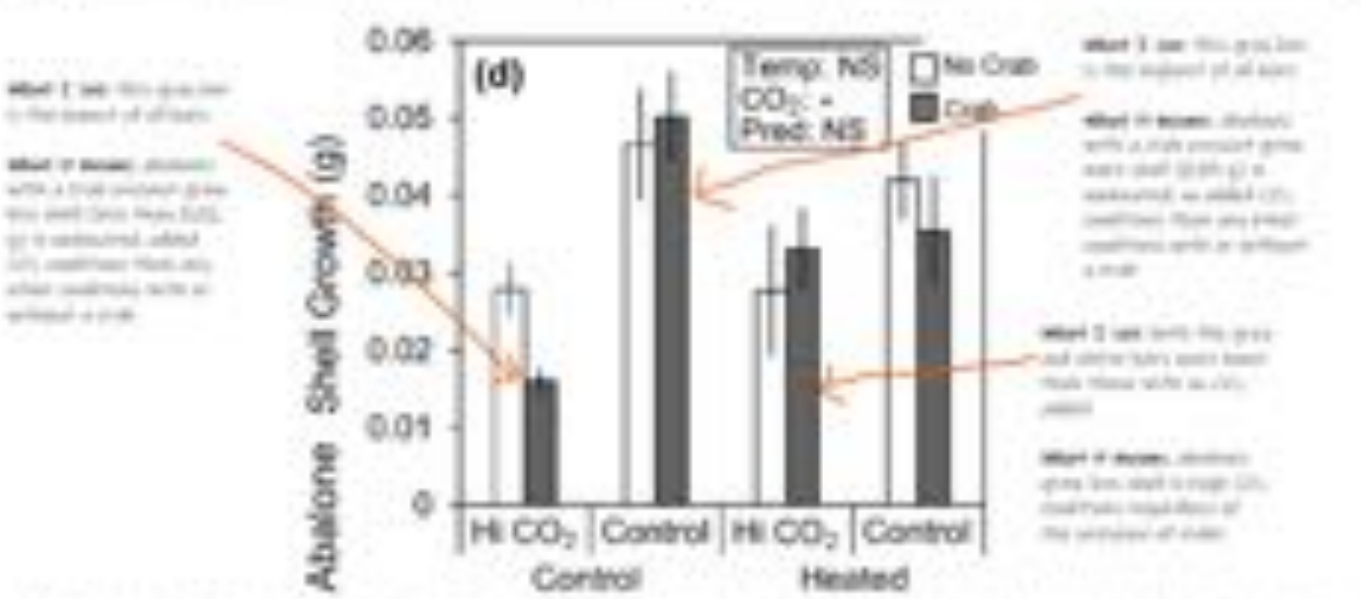
Uncaged Whelk Shell Growth: Uncaged whelks grew significantly less with a crab present. Lower pH and higher temperatures were not as significant.



Caged Whelk Shell Growth: Caged whelks grew significantly more than uncaged whelks with a crab present. Lower pH and higher temperatures were not as significant.



Abalone Feeding:
Abalone ate less in the presence of crabs and more in warmer water. Lower pH didn't have a significant effect.



Abalone Shell Growth: Abalones grew less shell in lower pH (higher CO_2) conditions. Crabs and warmer temperatures were not as significant. However, abalones did grow more shell compared to tissue when a crab was present (this data not included in lesson).