Carbonated Communities

HOW IS ACIDIFICATION AND RISING TEMPERATURE AFFECTING OCEAN ORGANISMS IN THE INTERTIDAL?
Carbonated Communities
Part One

YOUR JOB

• Explore a phenomenon affecting ocean animals.

• Learn how scientists are understanding this phenomenon’s effect on ocean animals.

• Examine relationships between intertidal species.
Watch *Molluscs: Pycnopodia Chases Abalone*

Consider:

- What are examples of natural animal behaviors and interactions?

- What challenges face ocean animals?

https://www.shapeoflife.org/video/molluscs-pycnopodia-chases-abalone
What are examples of natural ocean animal behaviors and interactions?

What challenges do organisms face in the ocean? (natural- and human-caused)
Unusual Behavior

Clownfish often stay very close to coral reef, their home.

But some clownfish are wandering farther and farther from home.
Hermit crabs retreat into shell for protection. But some aren’t hiding as quickly as normal.

Unusual Behavior

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Abalone, giant sea snails, attach to rocks to withstand heavy waves.

When dislodged, some aren’t righting themselves and reattaching as quickly. Some even turned towards predators claws.
Human-Released Carbon Dioxide (CO₂) in the Atmosphere

- **CLIMATE CHANGE**
  - Global warming; leads to sea level rise and higher ocean temperatures
  - Melting glaciers, heavier rainstorms, more frequent drought, etc.

- **OCEAN ACIDIFICATION**
  (LOWER OCEAN pH)
How might lower pH (ocean acidification) and higher water temperatures affect behaviors and growth of ocean animals?
Ocean Temperature Warming

In ocean surface waters, TEMPERATURE is expected to RISE an average of 3 to 5°C by 2100. (IPCC 2014)
Effects of Ocean Warming

- CORAL REEF BLEACHING and damage
- DISRUPTED MIGRATION patterns (e.g., tuna, sharks, whales, turtles, etc.)
- CHANGES to organism GROWTH, REPRODUCTION, FEEDING patterns, etc.
- And MORE...
Lower Ocean pH

Ocean surface waters have **INCREASED** in **ACIDITY 30%** since pre-industrial times (before 1850s).

In ocean surface waters, pH is expected to drop an average of 0.3 units by **2100**. That is a **99% INCREASE IN ACIDITY**. (IPCC 2014)
How Does Ocean Acidification Work?

Alliance for Climate Education’s Science Short: Ocean Acidification

https://www.youtube.com/watch?v=6SMWGV-DBnk
Effects of Lower Ocean pH (acidification)

**CHANGING OCEAN COMMUNITIES.** Some species, like jellies, may thrive while others struggle.

**DISRUPTED FOOD WEBS.** Pteropods form the basis of some marine food webs. Their shells dissolve over 30 days in seawater with 7.8 pH.

**REDUCES ABILITY** of reef-building corals to PRODUCE THEIR SKELETONS. IMPACTS GROWTH AND REPRODUCTION of other organisms too.

**ECONOMIC EFFECTS** for shellfish fisheries and consumers. Oysters, abalone, clams and mussels have a harder time building shells and staying alive.
MOST RESEARCH on effects of higher temperature and acidity have focused on INDIVIDUAL SPECIES.

But WHAT ABOUT OCEAN COMMUNITIES, like in the intertidal?
These Scientists Decided to Investigate

**DR. JOSH LORD**: Painting the edge of a whelk (snail) shell with nail polish. This helps him measure how much a shell grows.

**DR. JIM BARRY**: Surfing in Santa Cruz and observing a tank of abalones in the lab.
How does CLIMATE CHANGE (lower pH and higher temperatures) affect FEEDING, GROWTH AND INTERACTION between species in the INTERTIDAL?
Investigation Setting

**Location:**
Rocky shore intertidal zone, Monterey Bay, CA

**Intertidal**=
Area between the high tide and low tide mark (above water at low tide and underwater at high tide)
Species Studied in Investigation

- Intertidal Habitat
- Mussels, *Mytilus galloprovincialis*
- Lined shore crab, *Pachygrapsus crassipes*
- Whelk, *Nucella ostrina*
- Abalone, *Haliotis rufescens*
- Sea Lettuce, *Ulva lactuca*
Inves.ga.on: Experimental Set-Up

64 tanks total

Heated treatments: 2°C warmer than Monterey Bay seawater

High CO₂ treatments: 0.3 units pH lower than Monterey Bay seawater

Cages protect those animals from predators.
Investigation: Experimental Set-Up

Tanks with Animals

Carbon Dioxide Tank
Inves.g. on: Experimental Set-Up

Coolers Contain Aquarium Heaters: tubing carrying sea water coils through each heater and continues down to heated tanks
How do these species NORMALLY feed, grow and interact (relationships between species)?

How might LOWER pH (higher levels of CO$_2$) and TEMPERATURE AFFECT feeding, growth and interactions?
Dr. Lord and Dr. Barry’s Hypothesis

Lower pH (added CO₂) and higher water temperature will have:

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<thead>
<tr>
<th>DIRECT EFFECTS</th>
<th>INDIRECT EFFECTS</th>
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<tr>
<td><em>Crabs</em>: minimal effect</td>
<td><em>Whelks</em>: eat less mussels</td>
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<td>because less calcified than molluscs</td>
<td><em>Abalone</em>: eat less seaweed</td>
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<tr>
<td><em>Whelks &amp; Abalone</em>: reduced</td>
<td>Overall decline in whelk and</td>
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<td>shell growth due to decrease</td>
<td>abalone populations due to</td>
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<td>in carbon saturation states</td>
<td>robust response of crabs and</td>
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