

Be a Claw Abiding Citizen:

Learn how Ocean Acidification could Affect Dungeness Crab

October 17, 2018
3 pm Pacific / 6 pm Eastern



Dr. Shelly Trigg

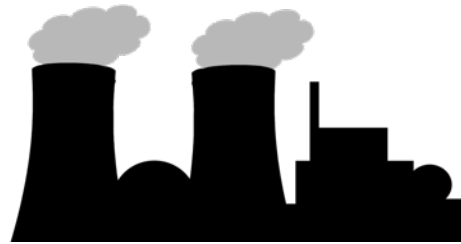
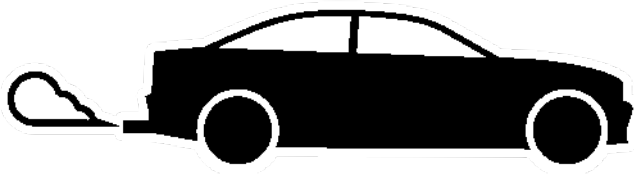
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Webinar Outline

- I. Ocean acidification background
- II. Dungeness crab background
- III. NOAA Dungeness crab research
 - Past and on-going
- IV. Toolkit overview

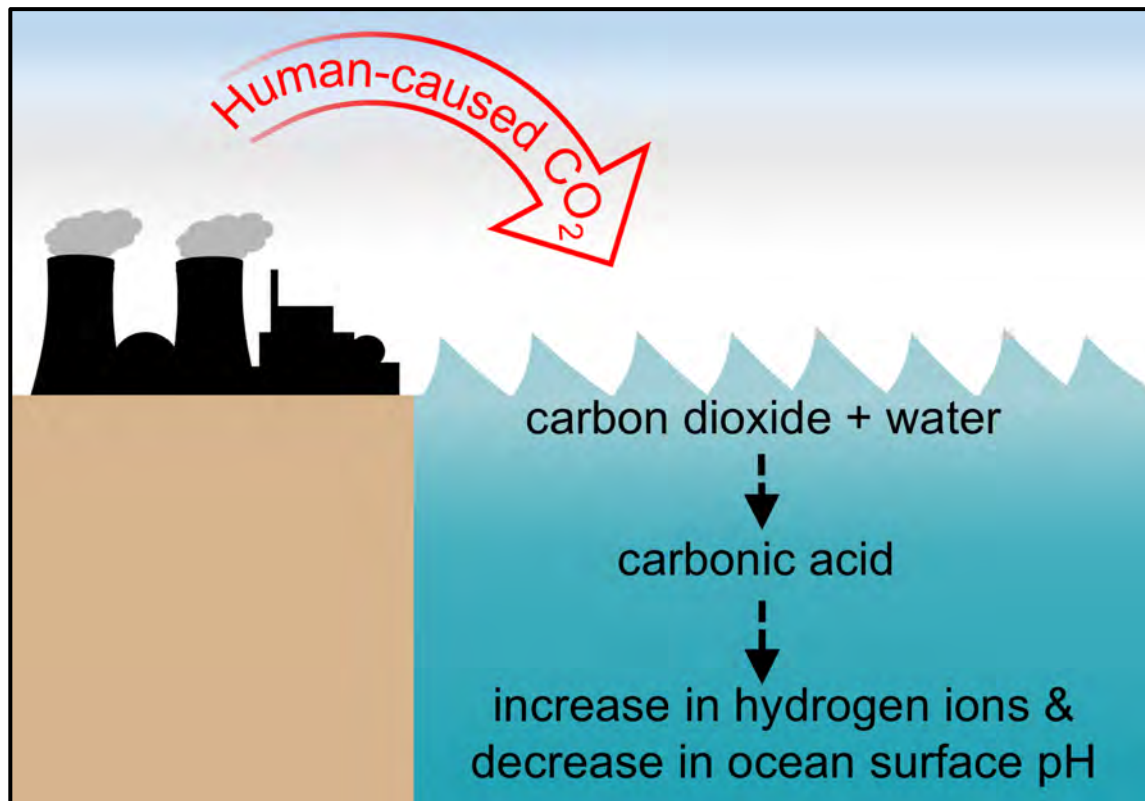
Ocean chemistry is changing

Since the industrial revolution, the concentration of carbon dioxide in the atmosphere has increased due to the burning of fossil fuels such as coal, gas, and oil, along with deforestation.



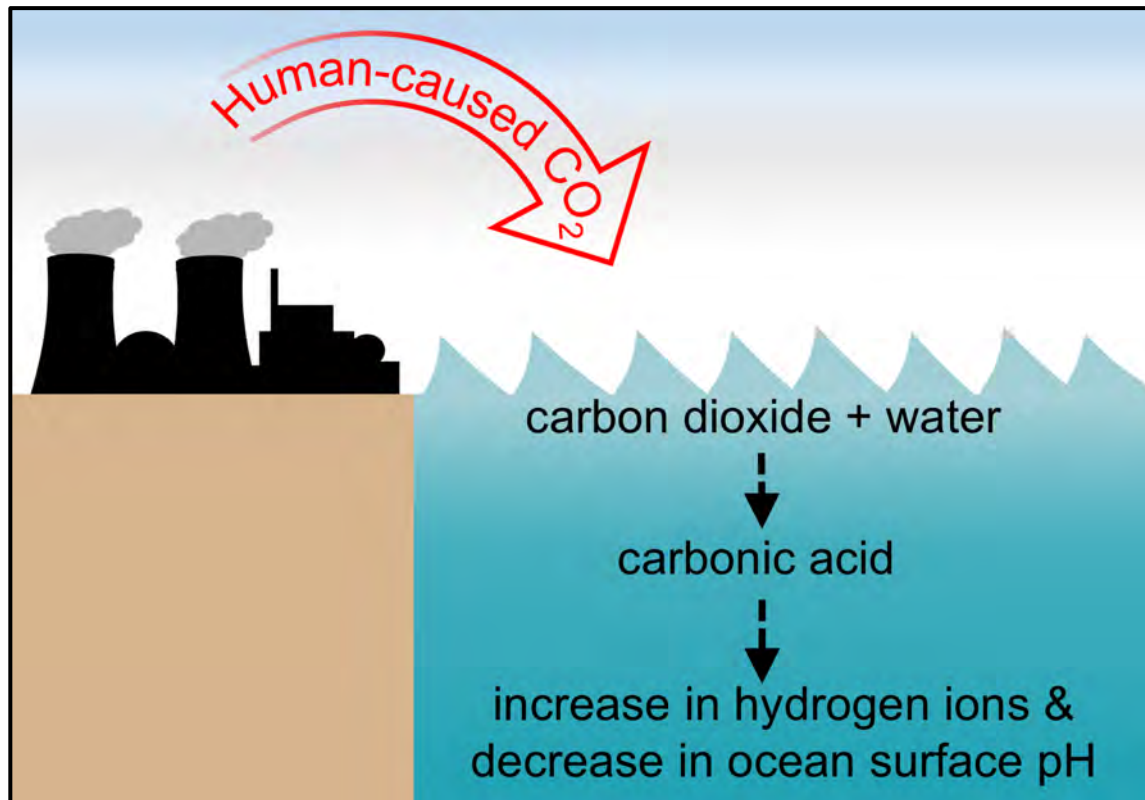
Ocean chemistry is changing

Every year the ocean absorbs about 25% of human-caused carbon dioxide emissions, and this is changing the ocean's chemistry.



Ocean chemistry is changing

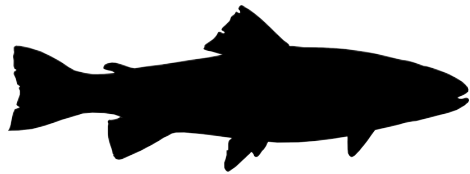
This decrease in ocean pH over time is called ocean acidification.



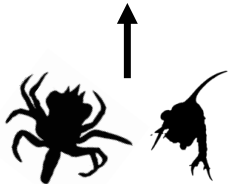
Dungeness crab are important

ECOLOGICALLY:

Dungeness crab, especially during their larval stage, are a major food source for many fish species



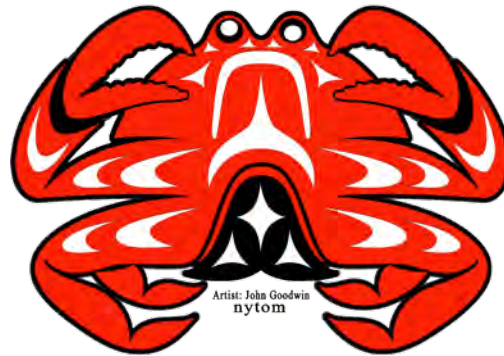
Salmon, rockfish, herring, and other fish species



Dungeness crab

CULTURALLY:

West Coast tribal Dungeness crab fisheries provide food, income, and communal activity for many Native Americans



ECONOMICALLY:

Dungeness crab U.S. fishery is valued at over \$200M annually, and supports the jobs and livelihood of many fishermen, restaurant workers, and seafood retailers



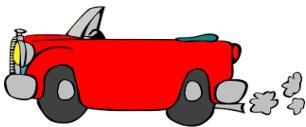
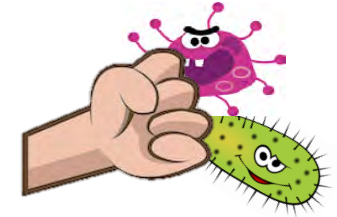
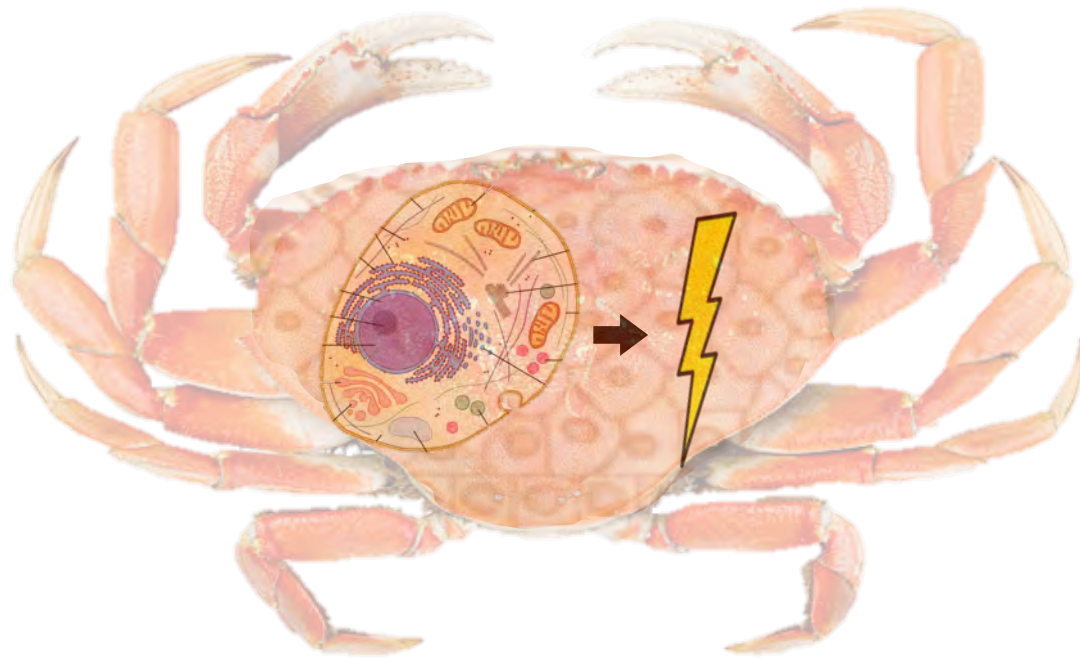
Ocean chemistry is changing

Ocean acidification stresses calcifying animals like the Dungeness crab, making it more challenging for them to thrive.



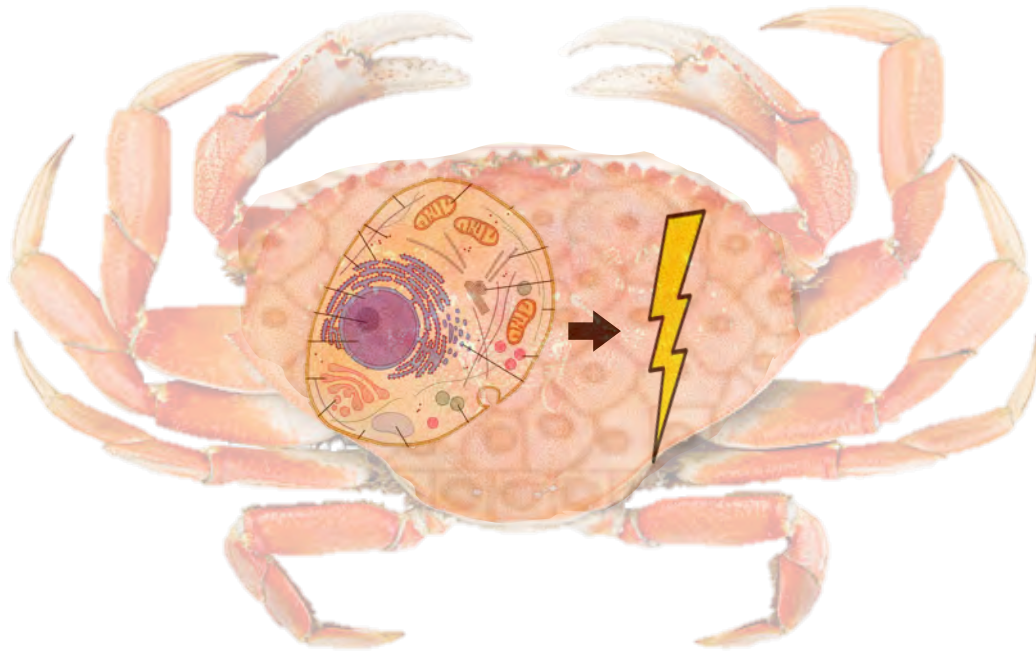
Photo credit: Paul Hillman, NOAA Fisheries

Cells have an energy-making capacity

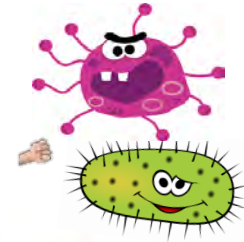


Environmental stress diverts energy

Ocean acidification



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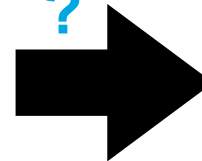
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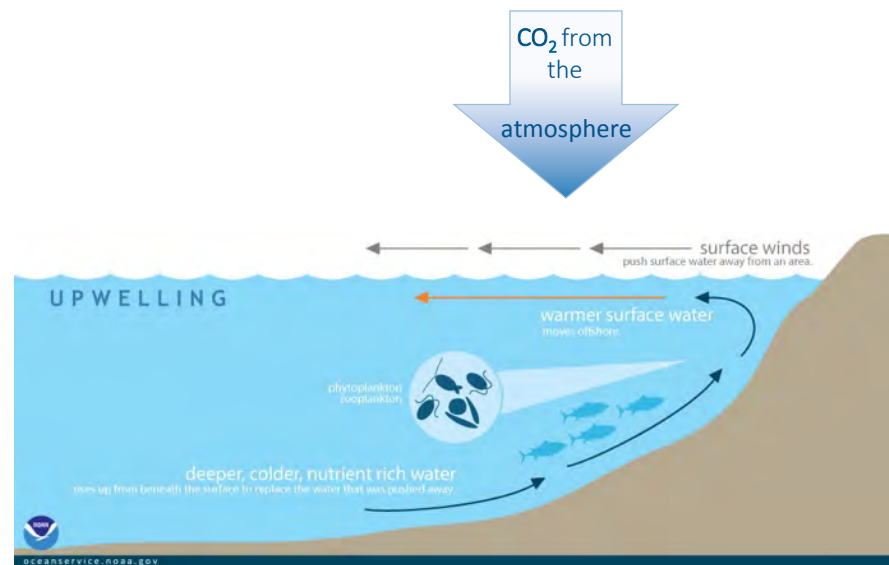


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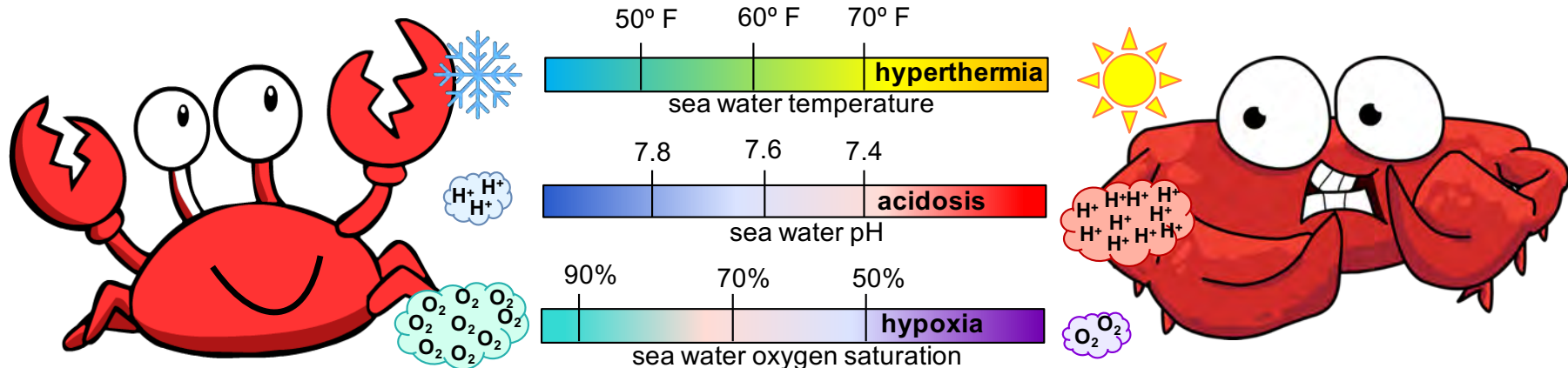
How will ocean acidification affect Dungeness Crab?

- Dungeness crab are commonly found from Alaska to southern California
- They live in seagrass beds or on the sandy ocean floor commonly from the seashore to over 300 feet deep
- The Pacific Northwest coast is naturally more acidic than other coastal regions
- Regional wind currents cause local upwelling of seawater high in CO_2 and low in pH
- Ocean acidification in this region will lead to more extreme conditions



Will Dungeness crab be able to tolerate global ocean change?

Like humans, crabs are sensitive to environmental conditions. When pushed beyond their limits, they can become stressed.



Today's typical ocean for Dungeness crab

44 – 54° F temperature range

8.1 – 7.5 pH range

105 – 80 % O₂ saturation range

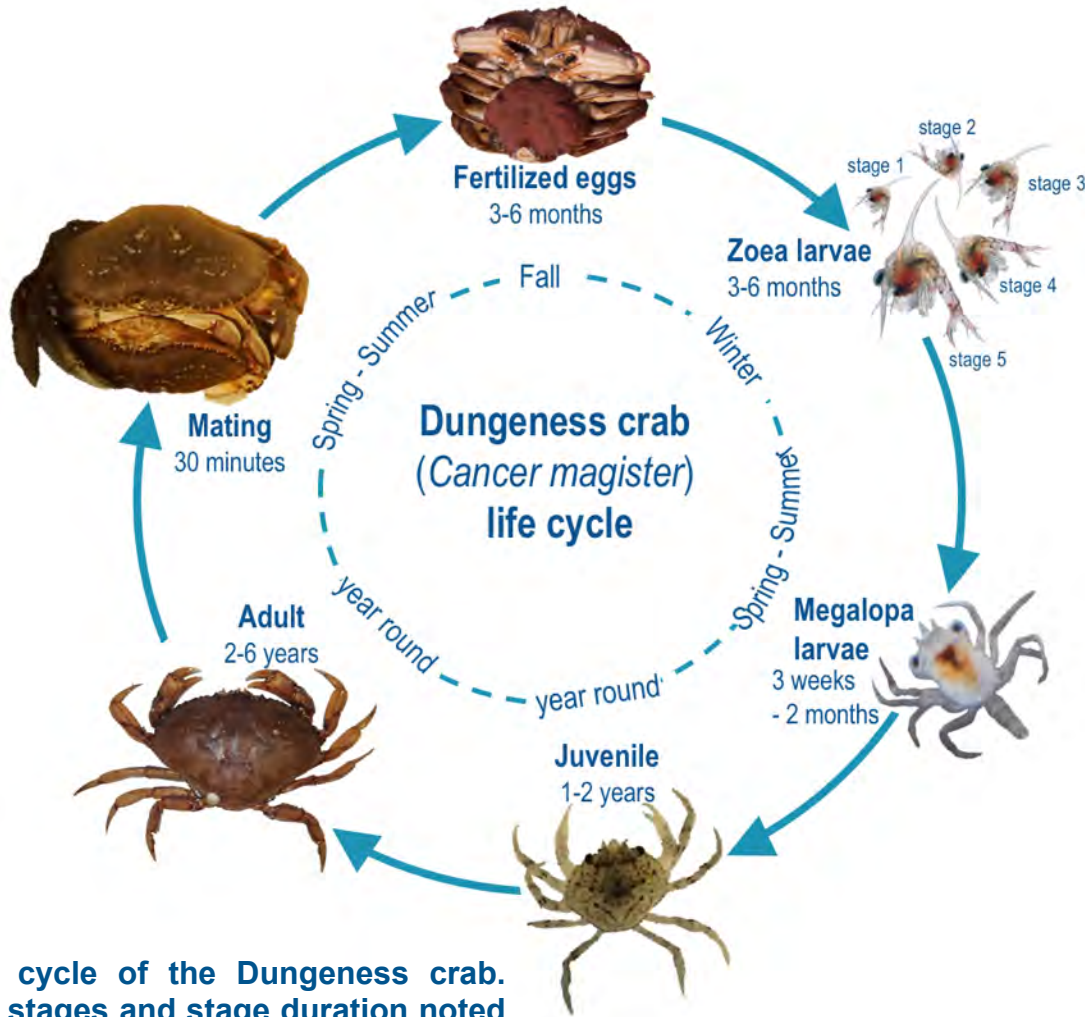
Year 2100 ocean projections

3.6 – 6.2 °F temperature rise

0.2 – 0.3 pH drop

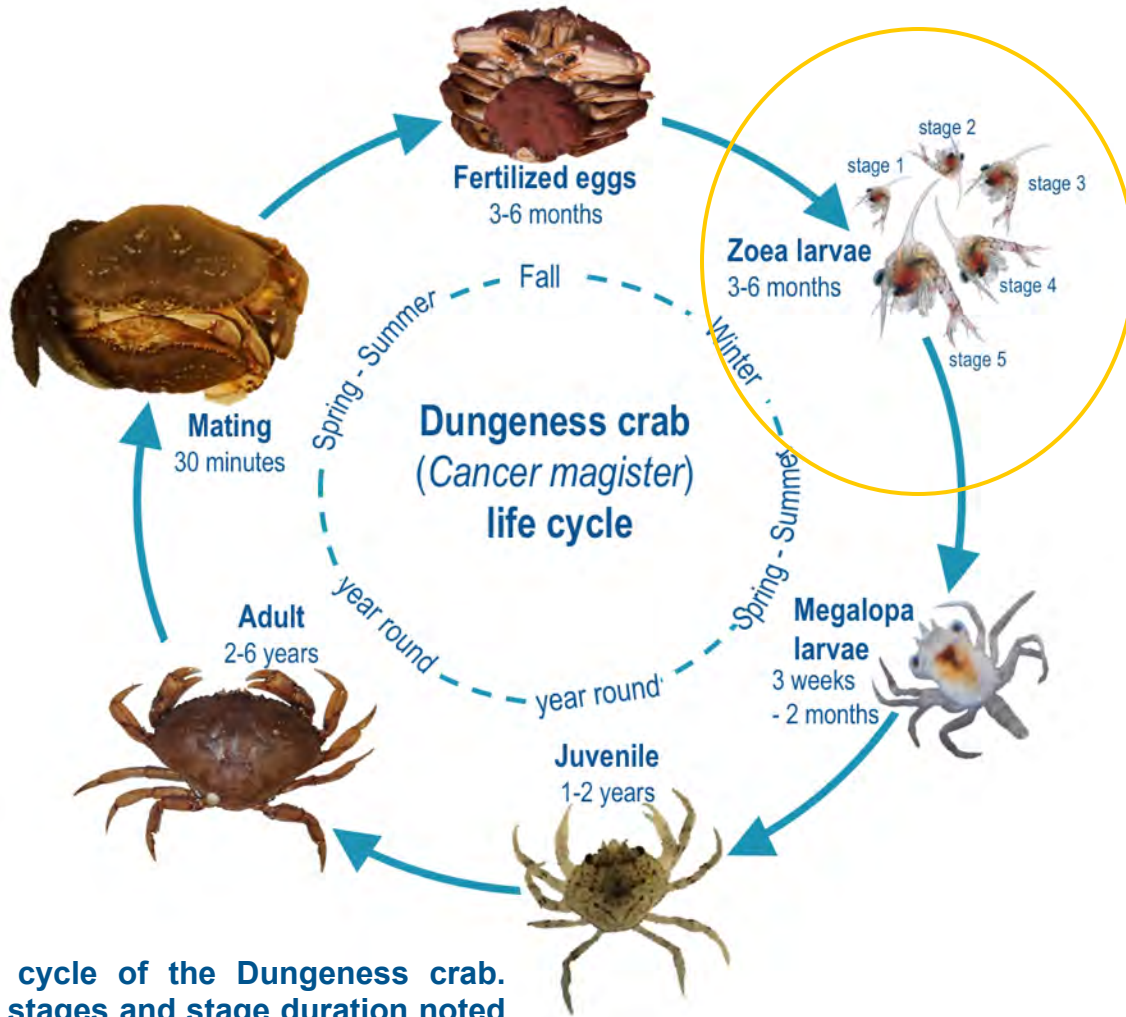
2.4 – 17 % O₂ saturation drop

Will Dungeness crab be able to tolerate global ocean change?



Life cycle of the Dungeness crab. Life stages and stage duration noted in outer circle. Seasonal abundance noted in Inner circle.

Will Dungeness crab be able to tolerate global ocean change?



Crabs are most likely vulnerable during these stages.

Molting from one stage to the next and carrying fertilized eggs require a lot of energy, as does dealing with stress from ocean chemistry change.

Life cycle of the Dungeness crab. Life stages and stage duration noted in outer circle. Seasonal abundance noted in Inner circle.

NOAA field and laboratory experiments

Field Experiments

- compare crab population that live in environments that differ in pH



Laboratory Experiments

- track how individual crabs respond
- fine-tuned control over pH, temperature, dissolved gases, etc.

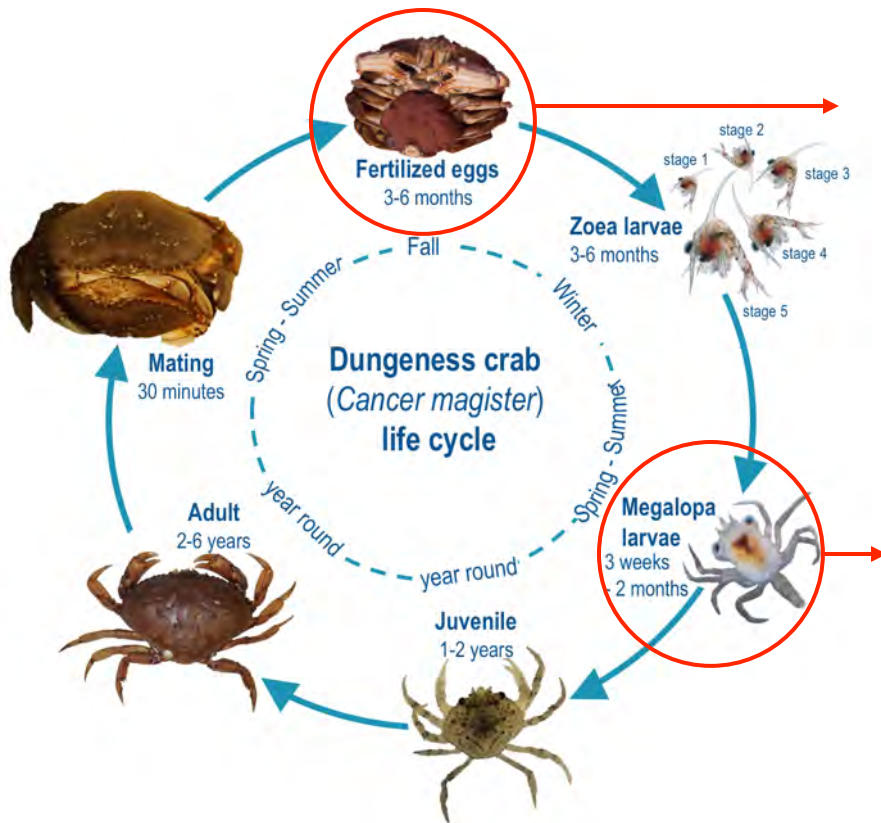


Photo credit: Austin Trigg, NOAA Fisheries

MOATS: Mobile Ocean Acidification Treatments Systems

NOAA CO₂ sensitivity experiments to assess Dungeness crab response

1) Collect crabs



Egg-bearing females – January 2017



Megalopa catch – June 2017

An ocean time machine

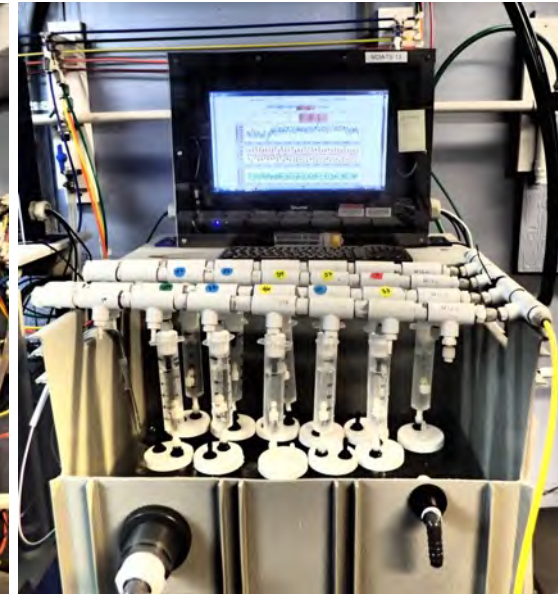
2) Rear larvae in lab simulated ocean acidification conditions

MOATS = Mobile Ocean Acidification Treatment Systems

- MOATS act as an ocean time machine, where past, current, and future ocean chemistry conditions can be simulated over a period of time.
- Observations can then be made, like counting the number of surviving crabs in each condition.



NOAA scientists at Mukilteo Research Station



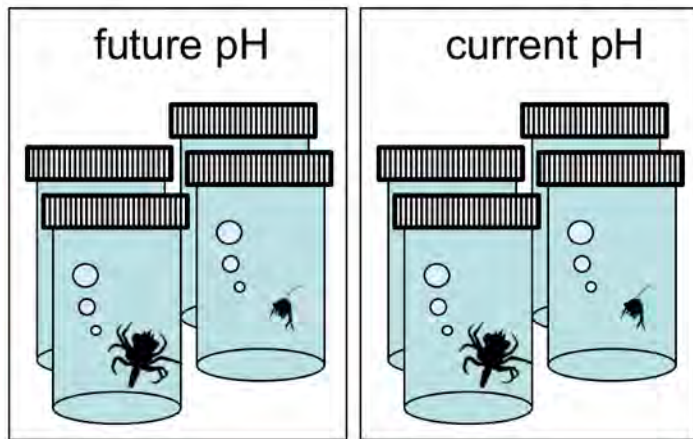
Each jar contains 1 megalopa, or 1-5 zoea

NOAA CO₂ sensitivity experiments to assess Dungeness crab response



NOAA CO₂ sensitivity experiments to assess Dungeness crab response

MOATS 'ocean time machine' experiments



> 45 days

Observations

measure how much energy larvae are producing throughout treatment (metabolic rate)

count survivors, measure size

measure activity of different biochemical pathways (metabolomics)

check DNA for changes (genetics, epigenetics)

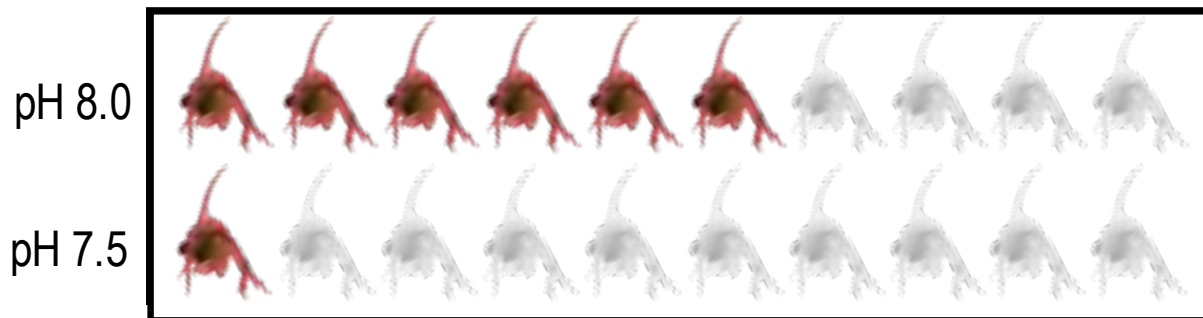
Goal

Make more accurate predictions of whether the species will be able to acclimate

Dungeness crab are likely vulnerable

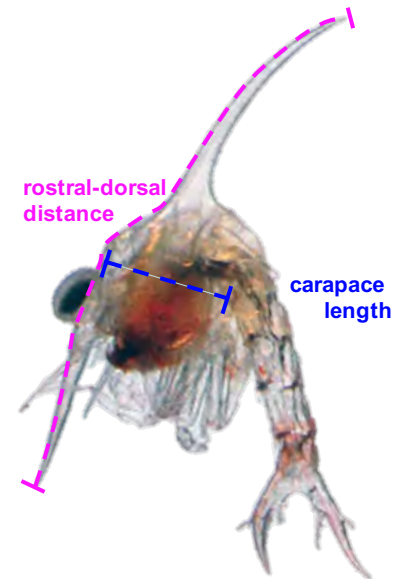
A NOAA study shows low pH decreases Dungeness crab larval survival and development.

Fraction of zoea surviving after 45 days



Graphical summary of data described in Miller *et al.* 2016 *Marine Biology*.

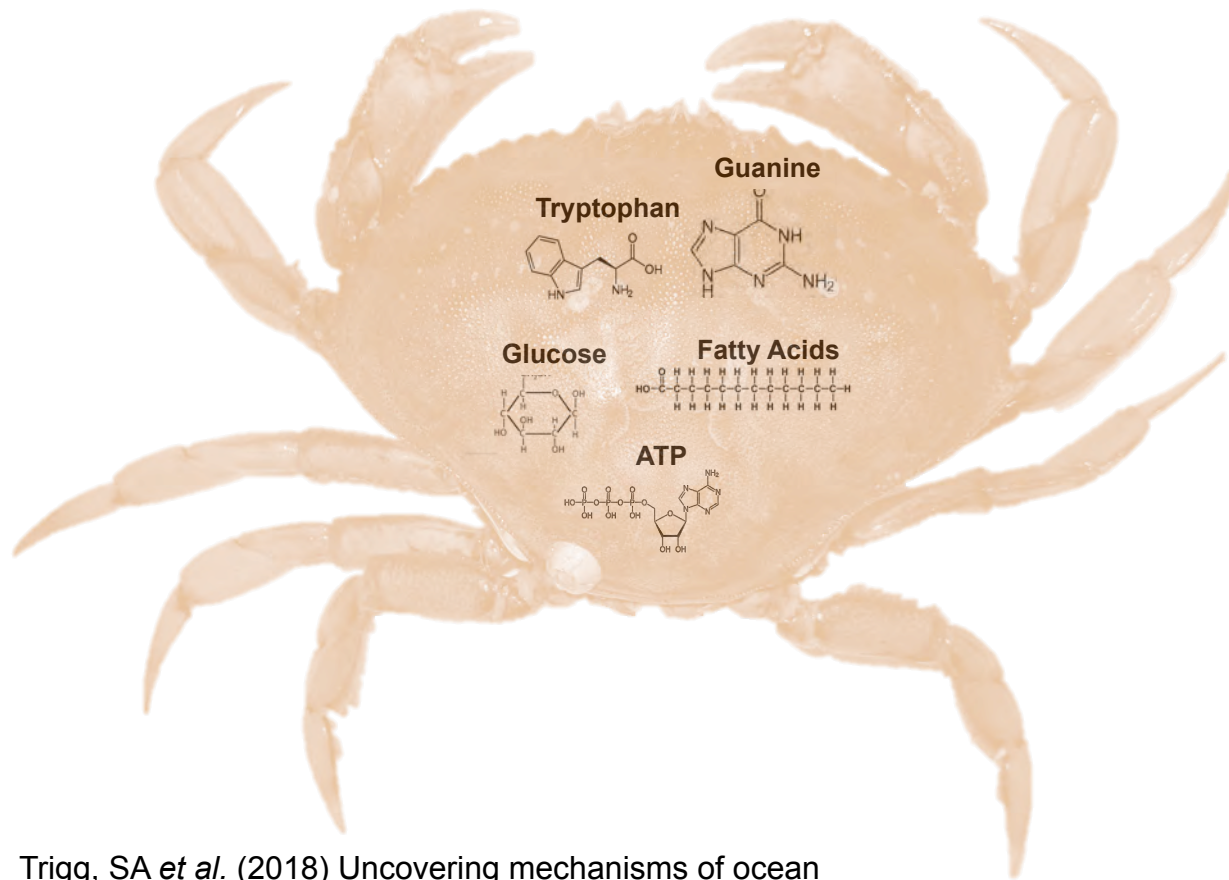
Measuring zoea



Zoea developmental stage and size are determined with a microscope.

NOAA CO₂ sensitivity experiments to assess Dungeness crab response

Measure all metabolites (metabolomics)



low pH response:
citric acid cycle activity
likely increases

In low O₂ response:
hypoxia stress response
is likely induced

**In low O₂ and pH
response:**
low O₂ shows a dominant
effect over pH

On-going research at NOAA NWFSC

2016 West Coast Ocean Acidification Cruise megalopae shell quality study



Multi-generational study



zoea in a well plate

NMS OA Crab Toolkit overview

<https://sanctuaries.noaa.gov/education/crab-toolkit.html>



FACT SHEET

This fact sheet is for a general audience and provides background information on how ocean acidification will affect Dungeness crabs, why Dungeness crabs are so important, and how NOAA is working to help protect this species.

National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Ocean Acidification Impact on Dungeness Crabs

A case study examining how ocean acidification affects Dungeness crab



POWERPOINT SLIDESHOW AND SCRIPT

The PowerPoint provides a case study examining how ocean acidification affects Dungeness crab.

Presentation (PPTX)
Script (PDF)

National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Crabs in a Changing Ocean

How You Can Help




INFOGRAPHIC


This infographic poster shares the Dungeness crab and ocean acidification story visually and can be reproduced for education and outreach purposes.

PUBLIC DOMAIN PHOTOS

Download high-resolution public domain photos that can be used to communicate about ocean acidification research on Dungeness crab conducted by NOAA Northwest Fisheries Science Center. Click each photo to enlarge and then right click to "save as" to your computer. Please ensure that you use proper captions and photo credit with each photo.




Fisherman setting crab traps. (Credit: Austin Trigg/NOAA)



Dungeness crab pile. (Credit: Austin Trigg/NOAA)

National Marine Sanctuaries
National Oceanic and Atmospheric Administration



Dungeness Crab and Ocean Acidification

NOAA Ocean Acidification Resources
http://oceanic.noaa.gov/oa/oa.html

Ocean Acidification Educational Resources
http://oceanic.noaa.gov/oa/oa.html


RESOURCE LIST

This document provides a list of websites and other resources related to Dungeness crab and ocean acidification.



VIDEO B-ROLL

B-roll footage sequence includes: Dungeness crab commonly inhabits the U.S. West Coast (0:20); Crabs eat mussels and other bivalves off the



REFERENCE LIST

References that go along with the fact sheet and PowerPoint slideshow can be found in this document. These references can guide you if you would like to dig deeper into current science behind ocean acidification impacts to Dungeness crab.

