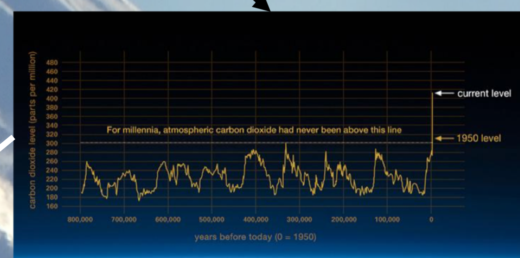
What's Your Proof?

The Fate of Antarctic Fishes

Click on each link to learn more

Antarctica Fun Facts

The Underwater Environment in the Ross Sea



Article on relationship of CO_2 to Temperature

Learn about energy budgets

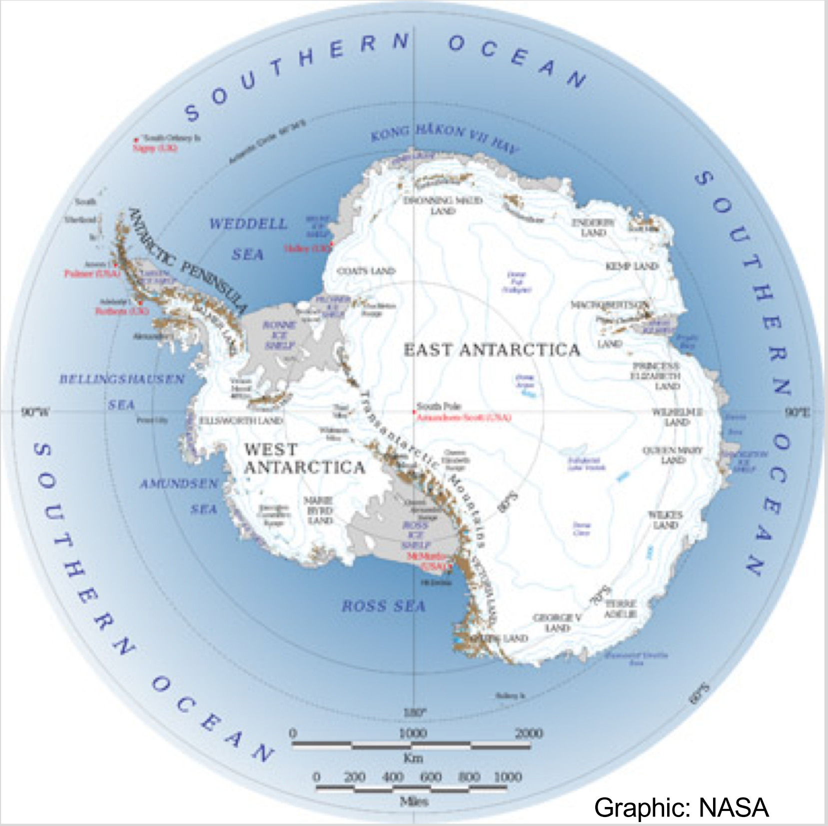
Results: Survival Data

Results: Respiration under stress

You count: Collect your own data

Your Work: Claim Evidence Reasoning

Link to Graphic organizer



Graphic: NASA

Antarctica Fun Facts

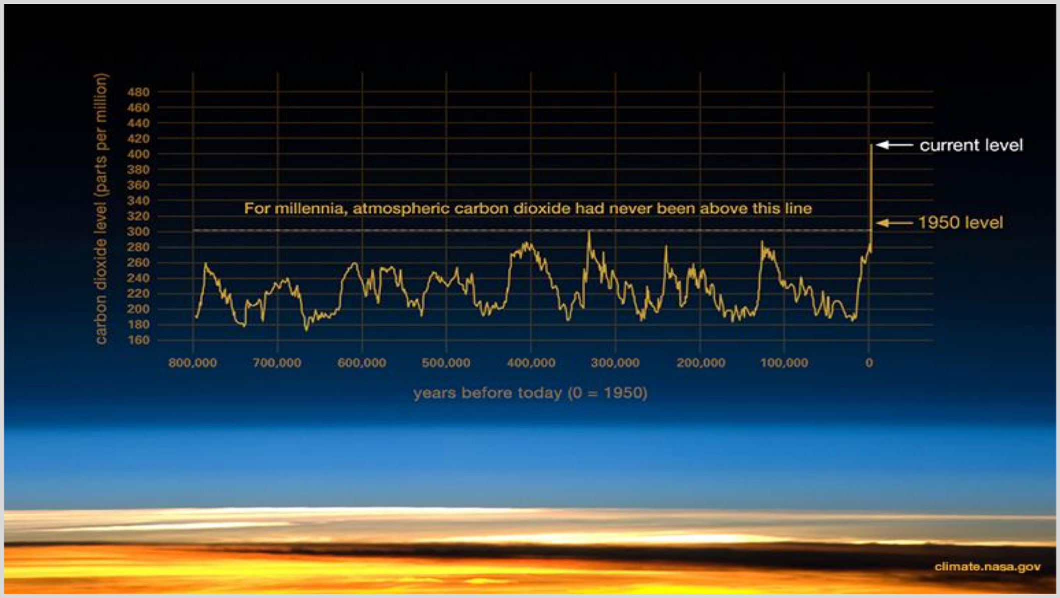
- Antarctica is located at the bottom of the Earth.
- It s a frozen continent surrounded by the Southern Ocean
- It is 1 ½ times the size of the United States
- It is the coldest(-128.6F), driest, emptiest, highest place on Earth
- If all of Antarctica’s ice melted, global sea levels would rise by 230 feet.
- A treaty protects it from being claimed by any nation. It is to be used only for science.


Mt Erebus
Photo Credit: Amy Osborne

The Ross Sea's Underwater Habitat

While above the surface, Antarctica is one of the harshest climates on Earth. Only a handful or organisms call this continent at the bottom of the world home. However, under the frozen sea ice, the ocean creatures thrive in both abundance and diversity. Remarkably, their cold, undersea environment with an average water temperature of 28.65 Degrees F has not changed in millions of years. Until now. Climate change is reaching into selective areas around the continent. Changes observed include both an increase in temperature and a decrease in pH(Acidification). These changes are predicted to only accelerate in the coming years.

Carbon Dioxide levels from 600,000 years ago to the present



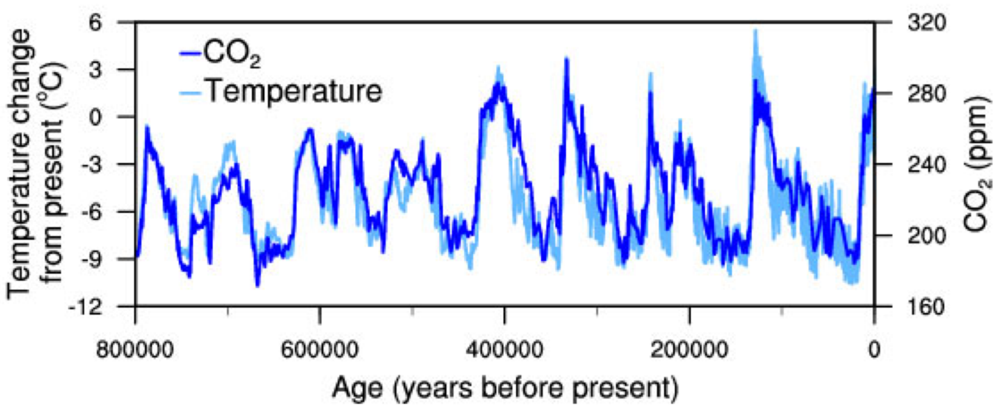
Data from the Vostok Ice Core Petit, J. R. et al. (1999) Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. Nature 399, 429-436.

This graph shows carbon dioxide levels taken from ice core samples. The samples were part of a project called the Vostok Ice Core. A core of ice was drilled out of Antarctic ice pack. The layers of the sample were dated using gas bubbles that were trapped in the ice. They were analysed for carbon dioxide content. The results of this project are displayed above. This graph clearly illustrates the unprecedented increase in carbon dioxide levels that began in the 1900’s. It is projected that this increase will continue, or even worsen, if humans take no action.

Increased levels of carbon dioxide in our atmosphere and oceans cause multiple problems. The most obvious is its role as a greenhouse gas causing a rise in average global temperature.. Another problem happens when the carbon dioxide dissolves in the ocean water. It combines with the water to form carbonic acid. This chemical reaction results in a decrease in pH of the water- making it more acidic. This causes problems with organisms with some types of shells- causing them to dissolve. However, the decrease in pH is also a stress factor for all species, including fish.

NOAA: Temperature Change and Carbon Dioxide Change

One of the most remarkable aspects of the paleoclimate record is the strong correspondence between temperature and the concentration of carbon dioxide in the atmosphere observed during the glacial cycles of the past several hundred thousand years. When the carbon dioxide concentration goes up, temperature goes up. When the carbon dioxide concentration goes down, temperature goes down. A small part of the correspondence is due to the relationship between temperature and the solubility of carbon dioxide in the surface ocean, but the majority of the correspondence is consistent with a feedback between carbon dioxide and climate. These changes are expected if Earth is in radiative balance, and they are consistent with the role of greenhouse gases in climate change. While it might seem simple to determine cause and effect between carbon dioxide and climate from which change occurs first, or from some other means, the determination of cause and effect remains exceedingly difficult. Furthermore, other changes are involved in the glacial climate, including altered vegetation, land surface characteristics, and ice sheet extent



Graph of temperature change and carbon dioxide change measured from the EPICA Dome C ice core in Antarctica Temperature change (light blue) and carbon dioxide change (dark blue) measured from the EPICA Dome C ice core in Antarctica (Jouzel et al. 2007; Lüthi et al. 2008).

Other paleoclimate proxies help us understand the role of the oceans in past and future climate change. The ocean contains 60 times more carbon than the atmosphere, and as expected, the changes in carbon dioxide in the atmosphere were paralleled by changes in carbon in the ocean over the past several hundred thousand years. While the ocean changes much more slowly than the atmosphere, the ocean played an essential role in past variations in carbon dioxide, and it will play a role in the future over thousands of years. Finally, paleoclimate data reveal that climate change is not just about temperature. As carbon dioxide has changed in the past, many other aspects of climate changed too. During glacial times, snow lines were lower, continents were drier, and the tropical monsoons were weaker. Some of these changes may be independent; others tightly coupled to the changing level of carbon dioxide. Understanding which of these changes might occur in the future, and how large those changes might be, remains a topic of vigorous research. NOAA's Paleoclimatology Program helps scientists document the changes that have occurred in the past as one approach to understanding future climate change

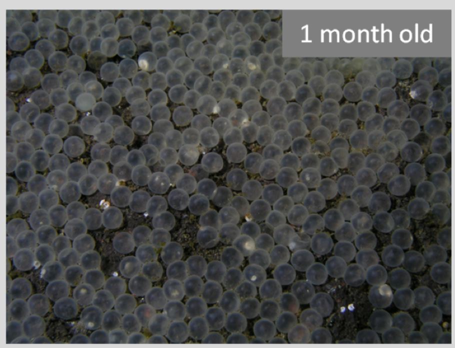
.https://www.ncdc.noaa.gov/global-warming/temperature-change#:~:text=When%20the%20carbon%20dioxide%20concentration,goes%20down%2C%20temperature%20goes%20down.

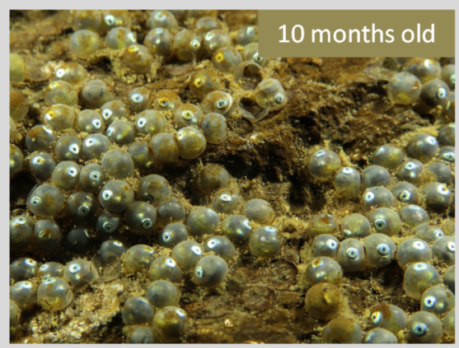
Meet the Fishes!

Many species of fish call the Southern Ocean home. Among the species in the shallower waters of McMurdo Sound are members of several genuses- including Dragonfish and Cod icefish. They occupy different niches that make up this amazing ecosystem. Some are cryo pelagic and prefer to hide and forage under the sea ice. Others are more benthic, choosing to spend their time mostly on the seafloor. They are all well adapted to the very cold, stable environment where they live. Most have a special protein in their tissues that prevents ice crystals from forming- so they don't freeze.The average water temperature is 28.65 degrees F and does not change much throughout the year. These small fish species are generally slow growing and long lived. They play an important role in the marine Antarctic food web. They eat almost anything smaller than themselves, including other fish, krill, all types of larva, and even algae. Bigger fish, penguins and Weddell seals are their predators. Some of the more abundant species around Ross Island, Antarctica that have been studied are:

Naked Dragonfish- Gymnodraco acuticeps

Learn more at: https://animalia-life.com/fishes/naked-dragonfish.html

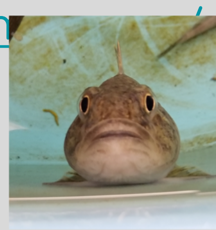


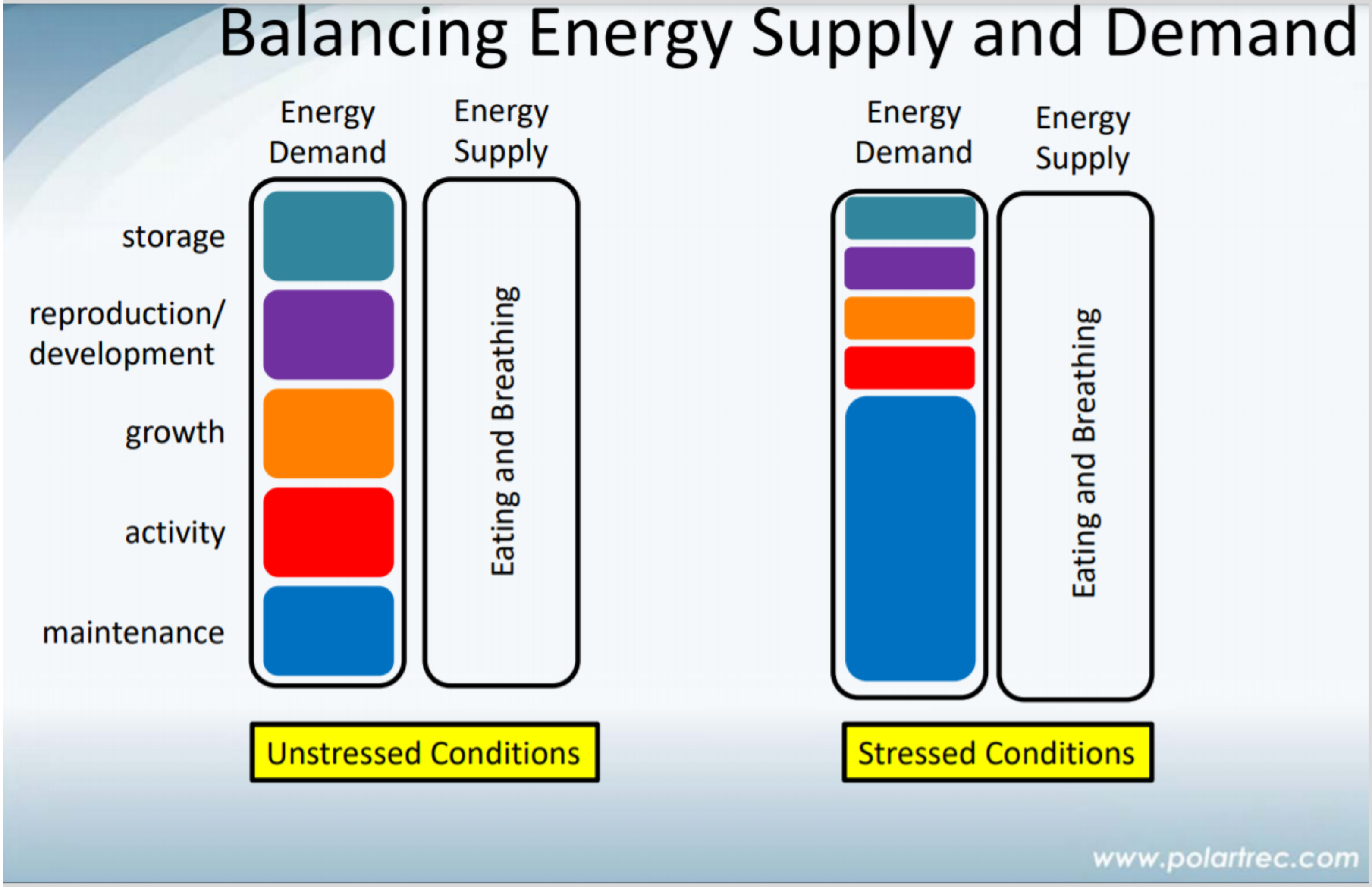


Cod Icefish- genus Trematomus

Species studied include: borchgrevinki, pennellii, nicolai, newnesi, bernacchi

Learn more at:
https://ww[illegible]gen[illegible]/nsf/fguide/chordata--fish.pdf



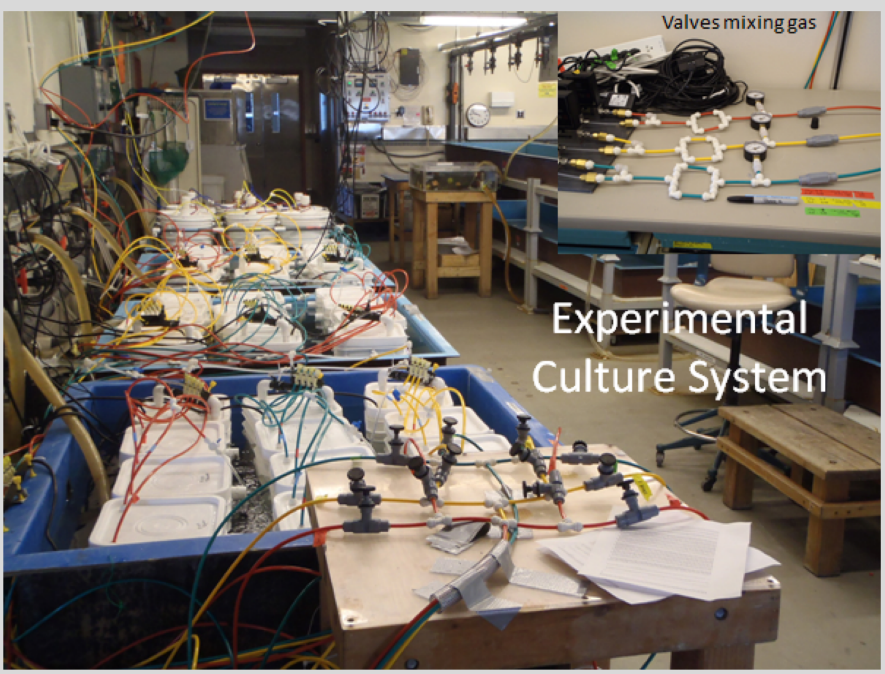


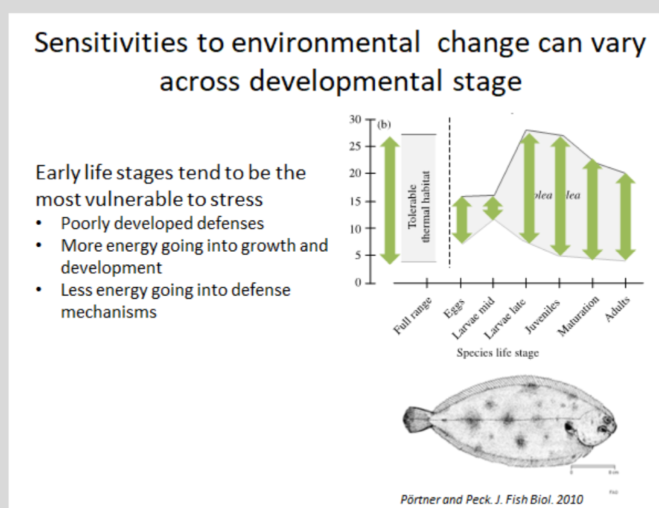
The amount of energy organisms have available is limited by the amount of food they can eat, as well as the amount of oxygen they take in. They divide up this energy in order to meet all of their requirements. This is called their energy budget. This graphic shows energy use both under normal and stressed conditions. As you can see, when organisms are under stress, they require more energy for maintenance. This leaves less energy available to perform other life functions, such as growing and reproducing. How they use this limited remaining energy could mean the difference between successful adaptation to changing environmental conditions, or extinction of their species.

Audio file to explain

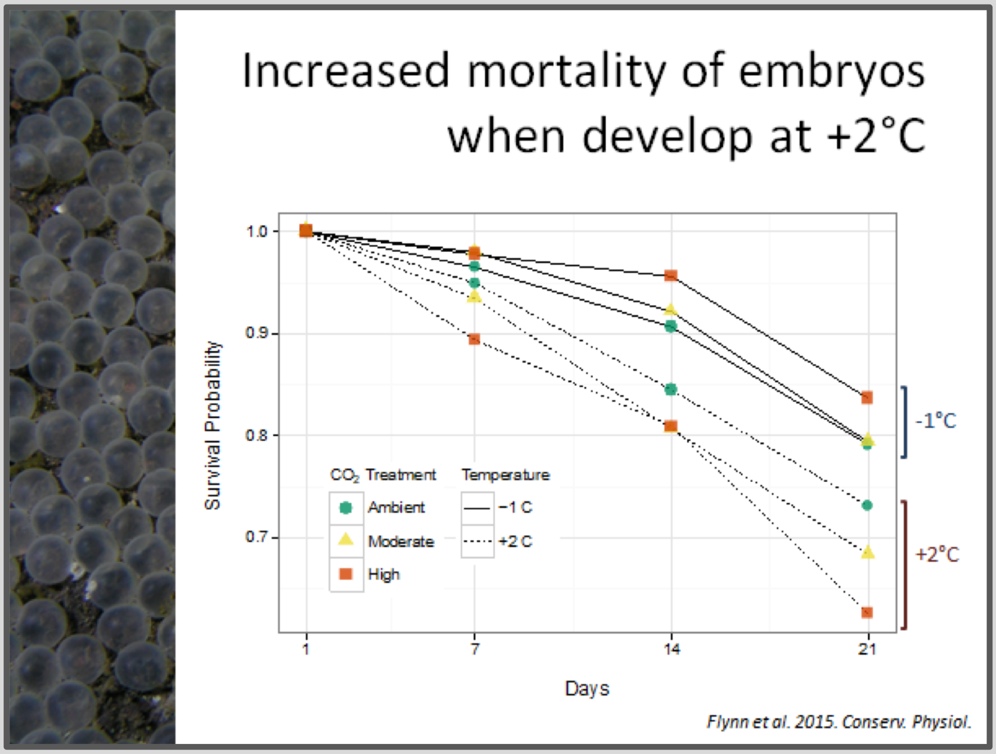
Research scientist, Dr. Anne Todgham, explains her work in Antarctica.- (See video)

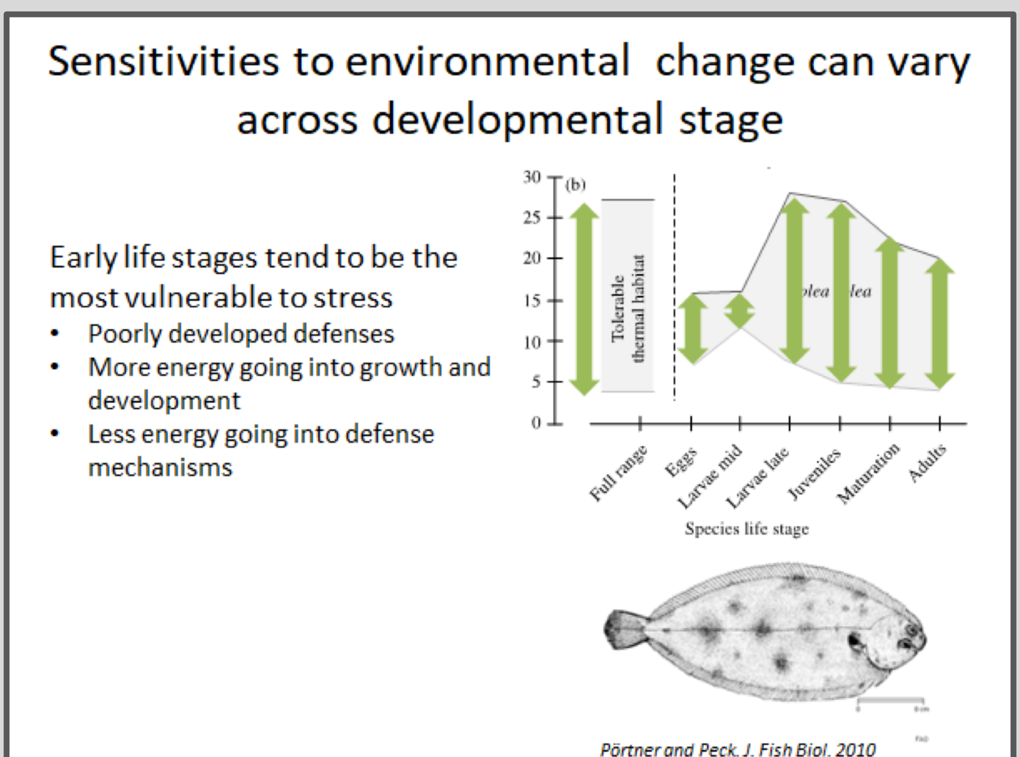
Dr. Todgham is a research scientists and instructor at UC Davis in California. She is an environmental physiologist who is interested in how animals cope with environmental change.



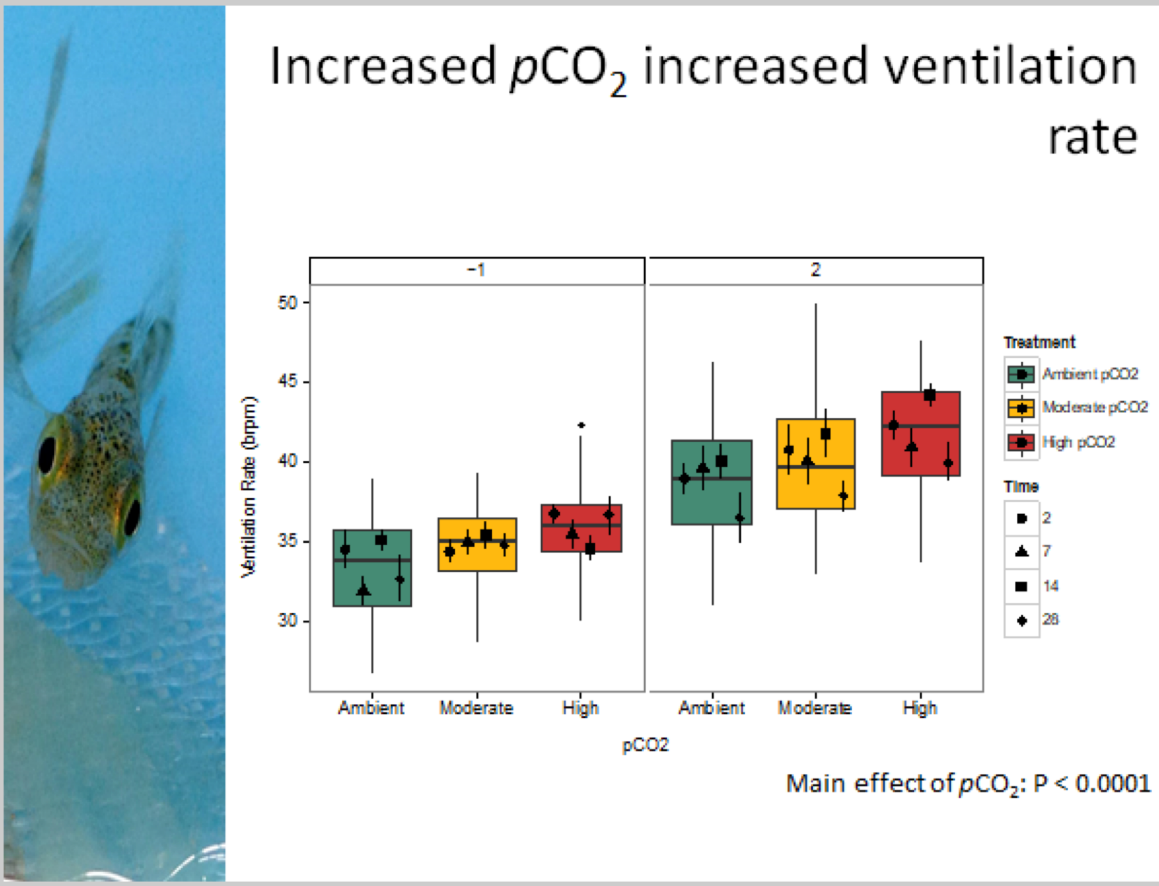


Results:
Survival probability with increased temperatures and carbon dioxide levels





Respiration Rates(ventilation) with increasing Carbon Dioxide Levels



Students Collecting data- Video Analysis

Each video runs for one minute. You can count either the heartbeats, or the respiration rates.

Option 1- count for the entire 60 seconds

Option 2- count for ten seconds, and multiply your number by 6.

Then record as beats/respirations per minute.

The first three videos are for fish held at their normal -1 celsius. In the last three videos, the fish were held at +2 celsius(an increase from their normal water temperature of 3 degrees).