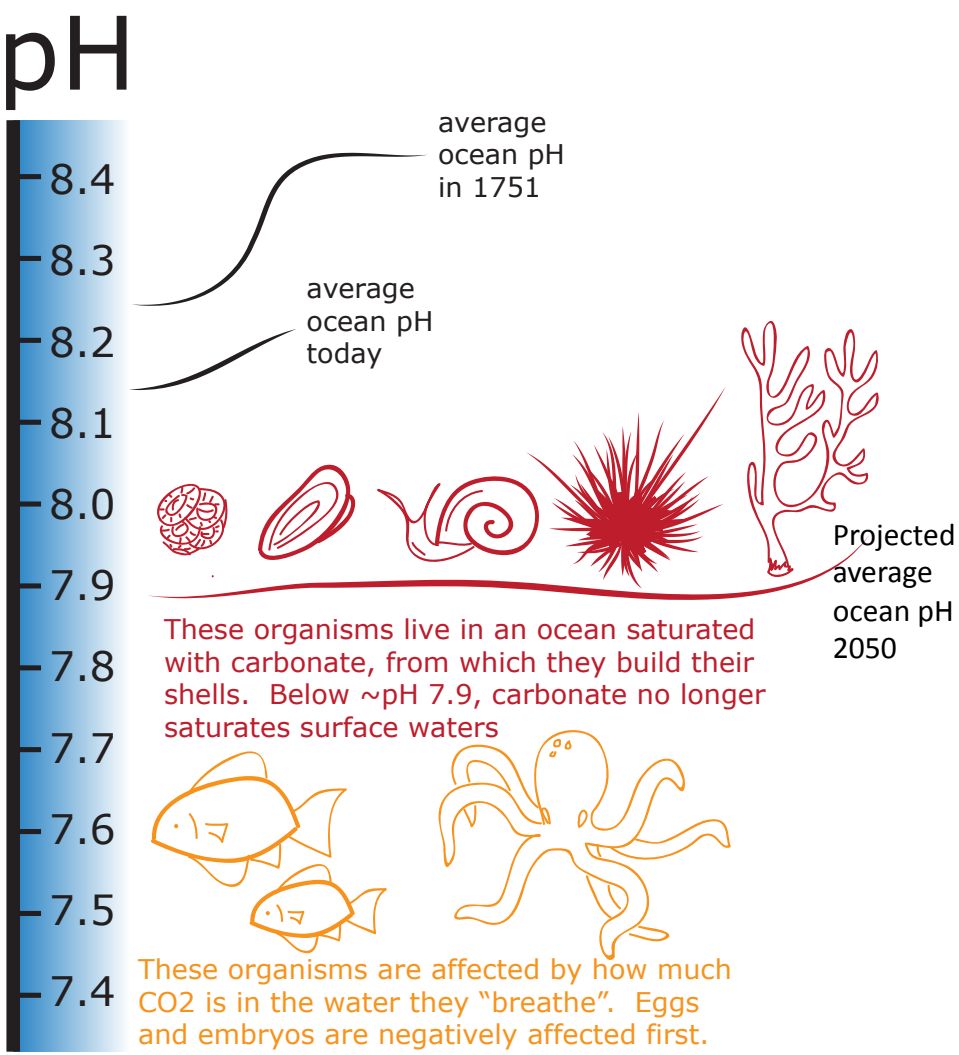
The **pH scale** is what mathematicians call a logarithmic scale. A change of one unit (say from pH 7 to pH 8, or from pH 7 to pH 6) represents a change in ten times the amount. A solution with a pH of 6 has ten times the acidity of neutral water (pH 7). A solution with a pH of 8 has one tenth the acidity of neutral water. The chart below shows how much the acidity increases for different decreases in pH. Note that as pH goes down, acidity goes up.

How Much the Acidity Increases for Different Changes in pH	
pH Decrease	**Amount of Increase in Acidity**
0.1 pH decrease	25% more acidity
0.2 pH decrease	60% more acidity
0.3 pH decrease	2 times more acidity
0.7 pH decrease	5 times more acidity
1.0 pH decrease	10 times more acidity
2.0 pH decrease	100 times more acidity
3.0 pH decrease	1,000 times more acidity



Credit: pH scale graphic created by Dr. Mary Whelan

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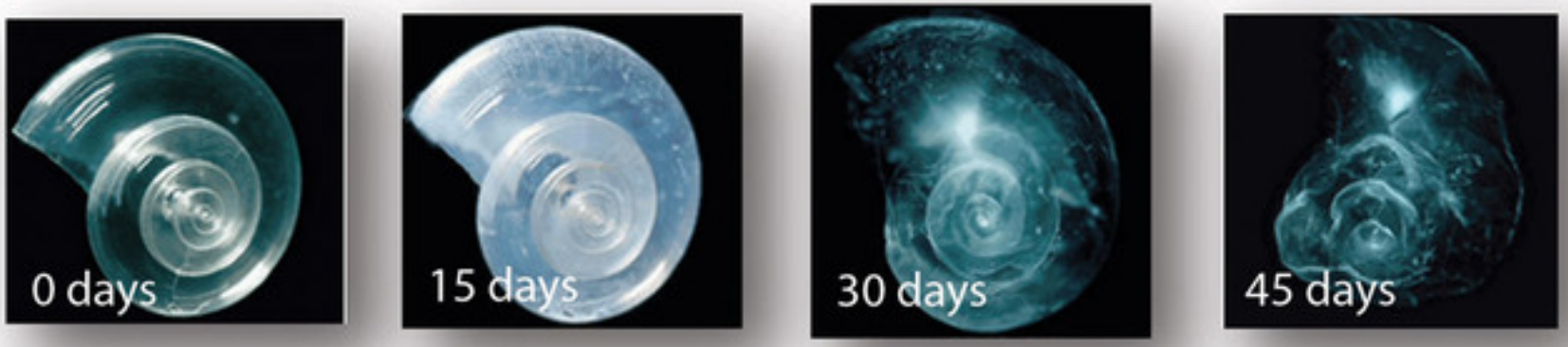
Pteropods

The pteropod, or “sea butterfly”, is a tiny sea creature about the size of a small pea. Pteropods are eaten by organisms ranging in size from tiny krill to whales and are a major food source for North Pacific juvenile salmon. The photos below show what happens to a pteropod’s shell when placed in sea water with pH and carbonate (what pterapods make their shells from) levels projected for the year 2100. The shell slowly dissolves after 45 days.



If pteropods disappear, animals that rely on them—everything from small schooling fishes to commercially important species like Pacific salmon—will be affected in ways no one can predict.

(http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F)

Present day → **Ocean of 2100**
Less acidic **More acidic**

Ocean acidification will impact different organisms differently. In laboratory experiments, most shelled organisms' shells grow weaker and/or dissolve. But some shelled organisms grow stronger, thicker shells.

Credit: www.WHOI.edu

In more acidic water:

Conch shells dissolve; they grow weaker shells

Sea urchin spines fall off and their tests (hard parts) start off weaker

Crustaceans, including some crabs, lobsters and shrimp grew stronger, thicker shells

Shellfish

- In recent years, the majority of oyster larvae have been dying off in both aquaculture facilities and natural ecosystems on the West Coast of the United States.
- Oysters, like other shellfish, make their shells from carbonate available in ocean water. These larval oyster deaths appear to be linked with naturally occurring upwelling events that bring low pH waters with limited carbonate to nearshore environments.
- Lower pH values occur naturally on the West Coast during upwelling events, but recent observations indicate that CO_2 from human industry is contributing to seasonal drops in available carbonate in the ocean.
- Low pH may be a factor in the current oyster reproductive failure; however, more research is needed to disentangle potential acidification effects from other risk factors (occasional excess freshwater, pathogen increases, or low oxygen in the water).
- Oysters are a $100 million a year industry

http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

From top to bottom: freshly harvested oysters from Yaquina Bay, Oregon (Credit: NOAA); plate of shucked oysters (Credit: Claude Covo-Farchi)

Corals

Corals build rocky skeletons from calcium and carbonate, chemicals found naturally in the ocean. But when oceans become more acidic, acid soaks up the loose carbonate. With less of that critical building block, it's much harder for corals to form a reef. (http://www.montereybayaquarium.org/climate/science.aspx)

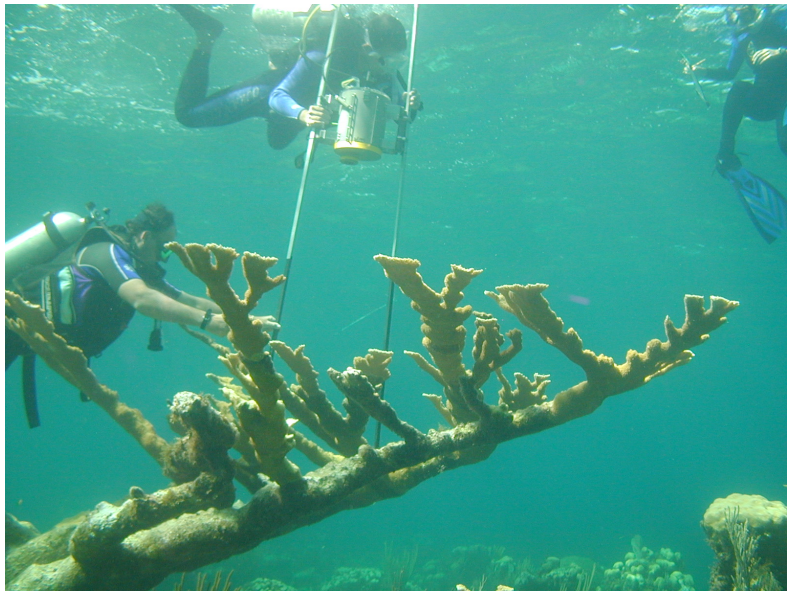


Photo credit: NASA

Plankton that build shells

Plankton are animals and plant-like organisms that drift with currents. Most plankton are very small and form the base of ocean food webs. Many plankton build shells from calcium **carbon**ate. Ocean acidification may have drastic impacts on shell-building plankton, which could impact all ocean food webs.

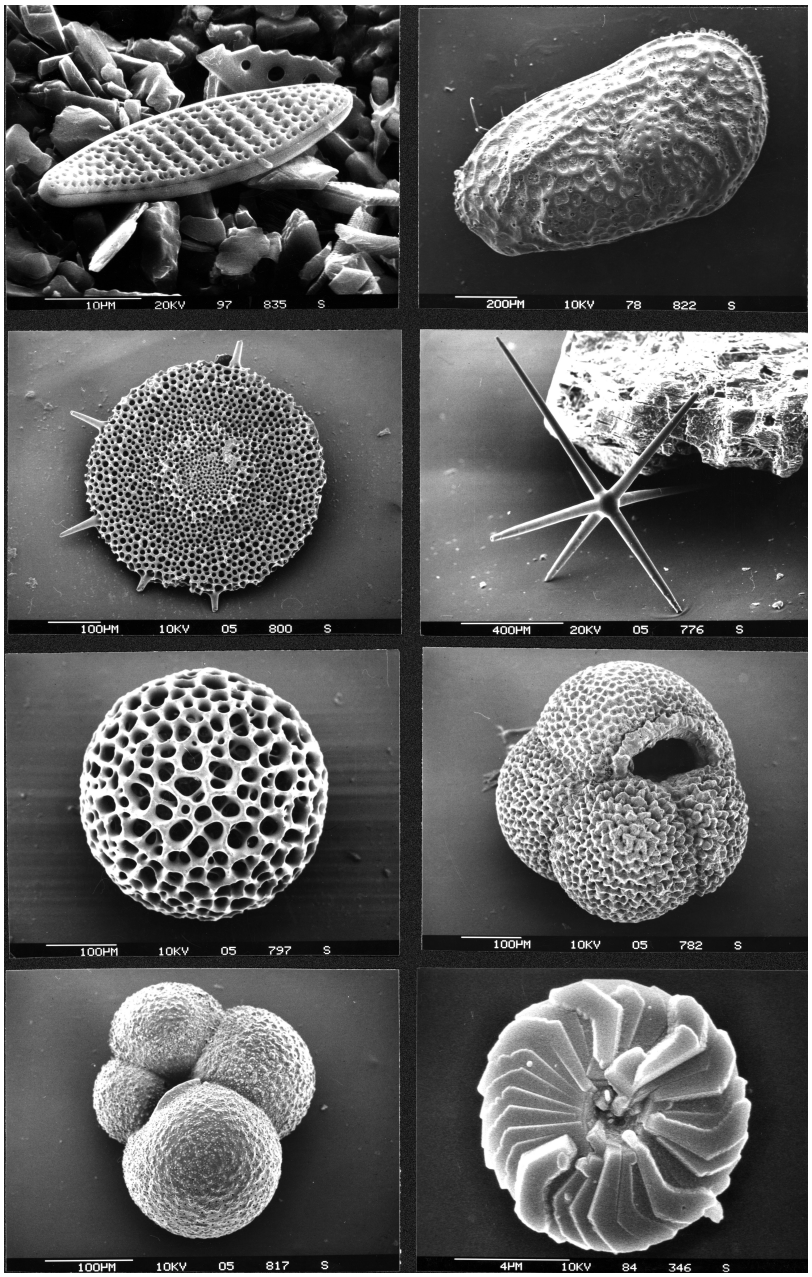


Image credit: Hannes Grobe/AWI

Jellyfish

Jellyfish thrive in acidifying ocean conditions. Scientists are also starting to learn that they quickly bring carbon from the surface to the deep ocean.

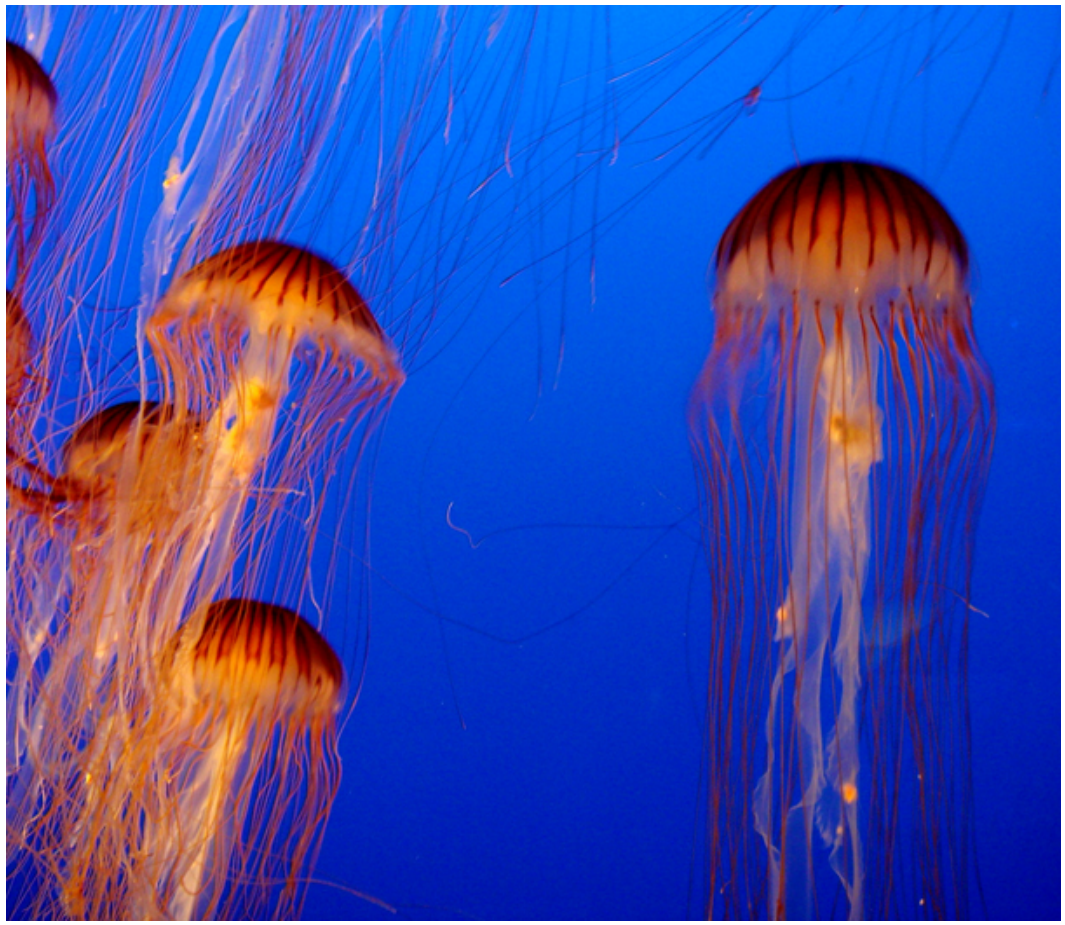
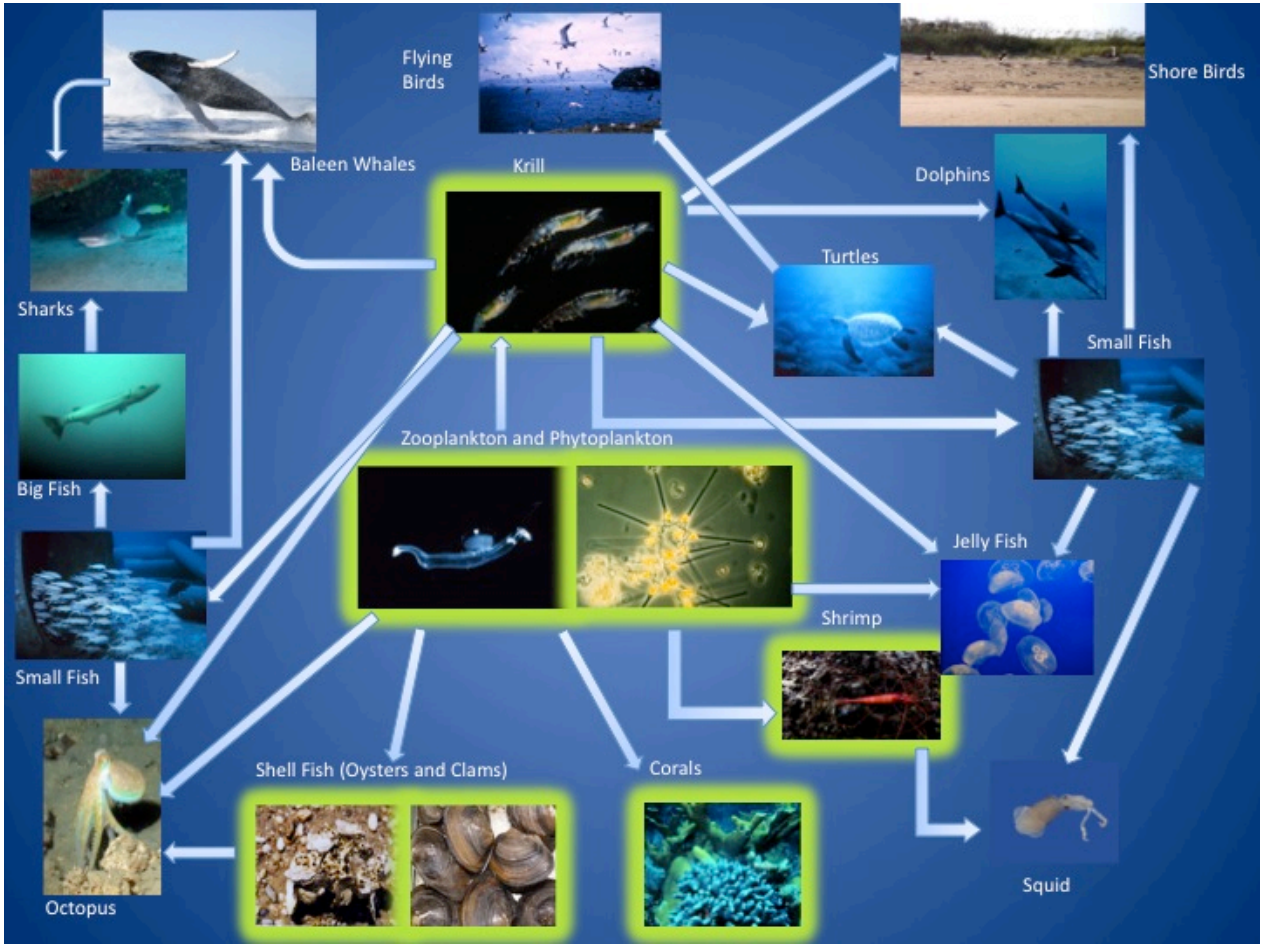


Photo credit: NOAA

Ocean food web

Many organisms at the base of ocean food webs are being negatively impacted by ocean acidification. This will have a big impact on all of the other organisms that rely on the impacted organisms for food.



Organisms highlighted in green will be/are being directly affected by ocean acidification. (Photo credits: NOAA)