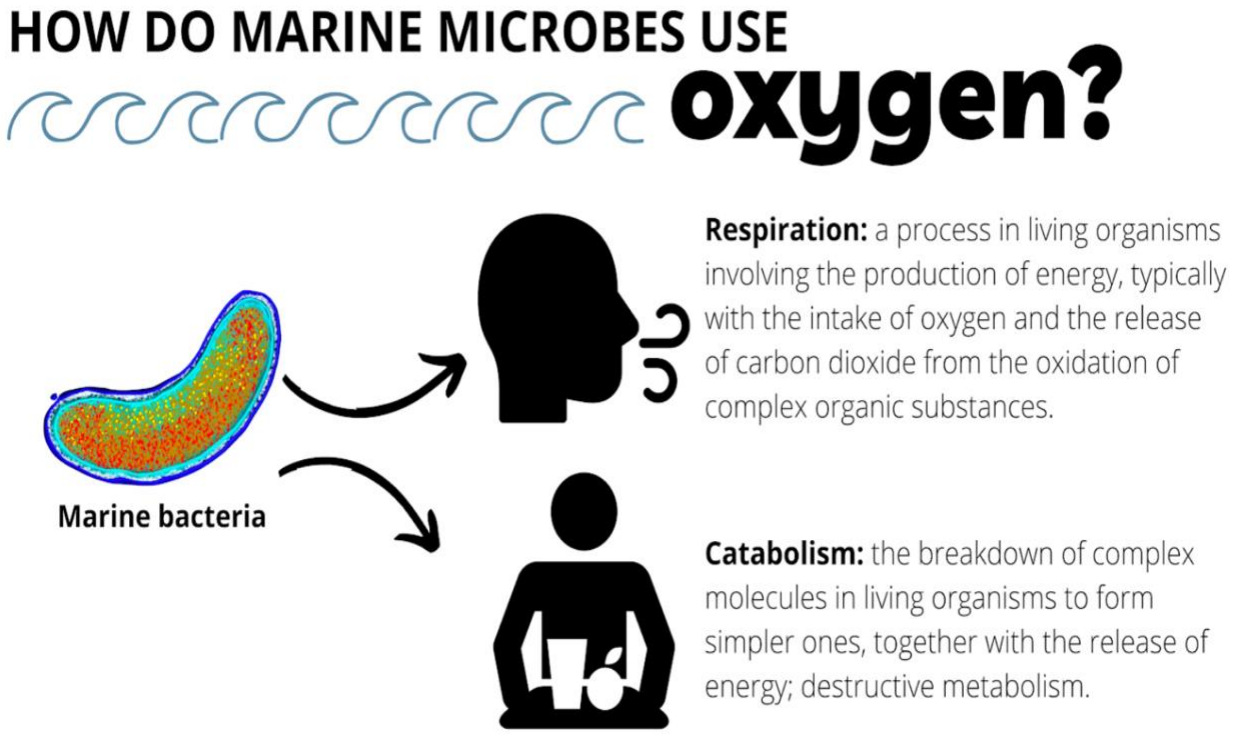
STATION 4

ocean oxygen

Now you know about **Dr. Seeksalot's** expertise in marine microbes and what the environment is like, let's think about other factors that may be contributing to the problems that **Crabbins** is encountering. Mentioned before, **Rep. Wordsmith** has been a strong advocate for ocean data collection and marine science on the Oregon Coast. Researchers in Oregon have been funded to monitor things like oxygen and temperature of the coast on a regular basis. This data has been put into online databases for other scientists and the public to access.

Oxygen makes up about 21% of Earth's atmosphere. But there's also dissolved oxygen in ocean water, and it's constantly being produced by microscopic phytoplankton. Scientists estimate that 50-80% of Earth's oxygen production comes from the ocean! As you learned at the last station, marine plants use sunlight energy to create oxygen through photosynthesis. Though they are invisible to the naked eye, they produce more oxygen than the largest redwood trees!!

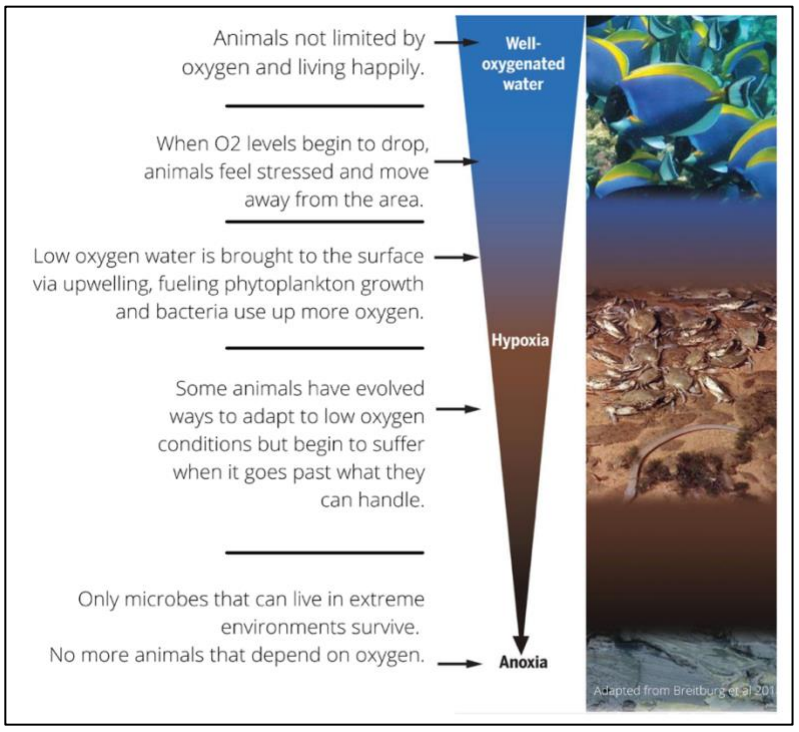
Both microorganisms and larger marine organisms require oxygen to function. It's been reported that ocean oxygen levels are declining due to global climate change. How does this affect microbes? And how does this affect larger organisms like crabs, sharks, or other types of fish? Is this happening in Oregon?



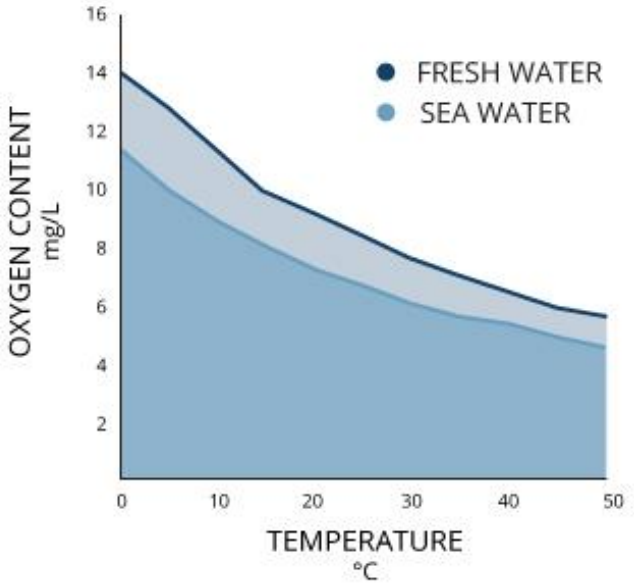
But what happens to the ecosystem (and larger organisms) when oxygen drops?

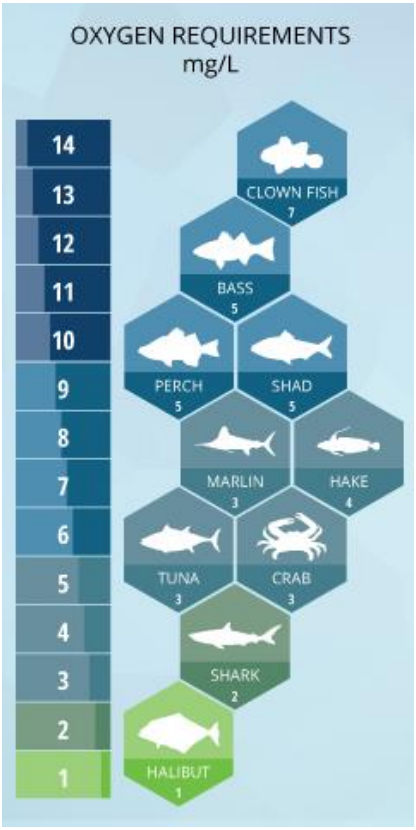
Different organisms have minimum oxygen requirements, this means that below a certain level of oxygen... animals can't maintain their normal functions. On the right you can see oxygen levels change from well-oxygenated water to hypoxia (low oxygen) and anoxia (NO oxygen), organisms suffer and only tiny microbes can survive.

Scientists collect oxygen concentration data on the coast. In chemistry, the term *concentration* refers to the measure of the amount of a substance in a solution. So when we measure oxygen, we are measuring the given amount of oxygen in the seawater.



What do you notice about the oxygen concentration of the water as the temperature increases? How does decreasing oxygen concentrations affect crabs?





Upwelling and oxygen

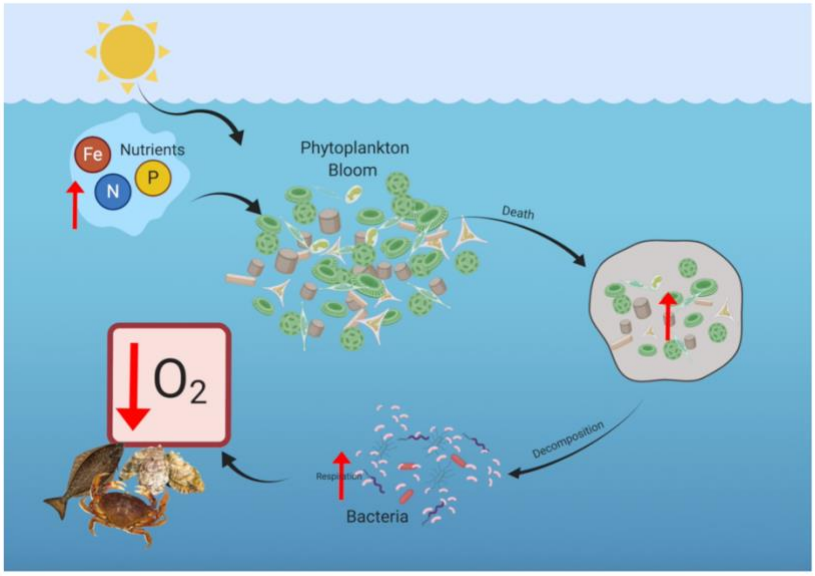
At the previous station, you learned about the physical dynamics of the ocean and how the currents bring water to the Oregon Coast. But how does the water become low in oxygen?

Watch the video below to learn more about coastal upwelling. This is a process that helps phytoplankton grow and maintain the ocean food web. But too much of anything can be bad...

Because of climate change, we are experiencing stronger winds and more sluggish currents. And the water at the surface of the ocean is warmer, this means it's more stratified (more layered). This prevents the water from mixing and warmer water holds less oxygen (as shown on the previous page). When the cold, deep water that's rich in nutrients but low in oxygen gets upwelled onto the shelf, there is a spike in the phytoplankton community (called a "bloom"). A phytoplankton bloom means more phytoplankton die and become food for the bacteria.

Remember how bacteria use oxygen? When they eat organic matter (dead phytoplankton), they use up oxygen in the process. When bacteria use up too much oxygen in the water, what would happen to other organisms who depend on that oxygen to maintain their basic functions?

Video: Upwelling

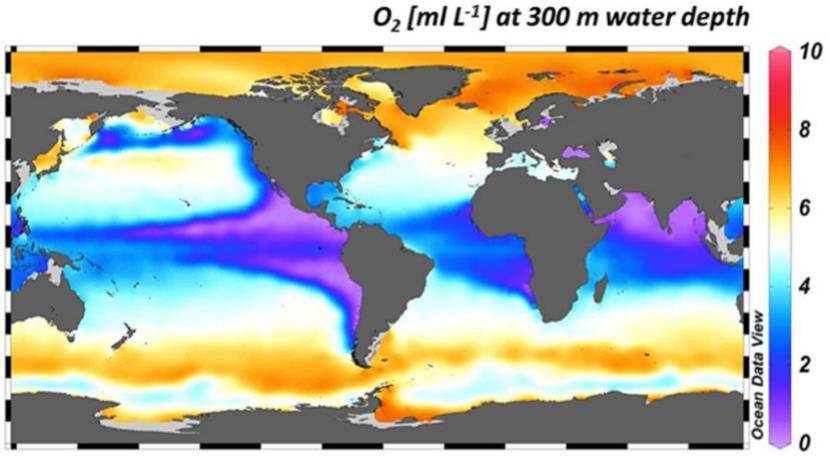


Global Ocean Oxygen

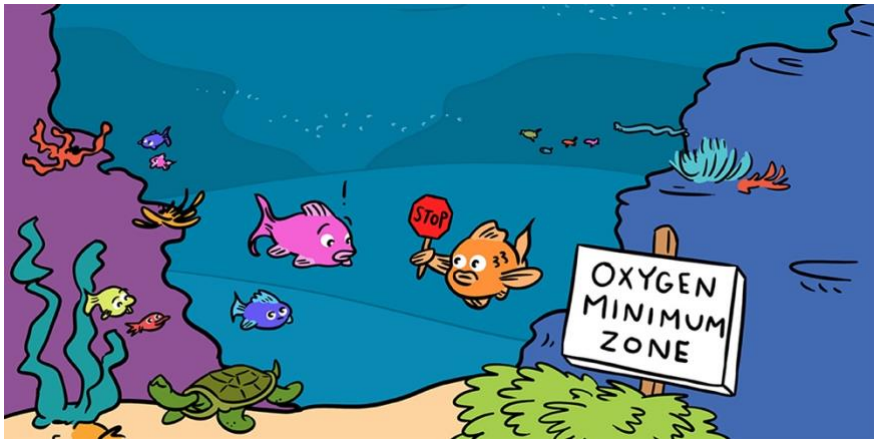
Let's look at the concentrations of oxygen in the ocean on the figure below. The scale on the right shows the oxygen concentration in the water, measured in milliliters of oxygen per liter of water. There are regions in the Ocean where there is a lot of oxygen in the water, mostly in the Polar regions, and this is shown in the orange/red.

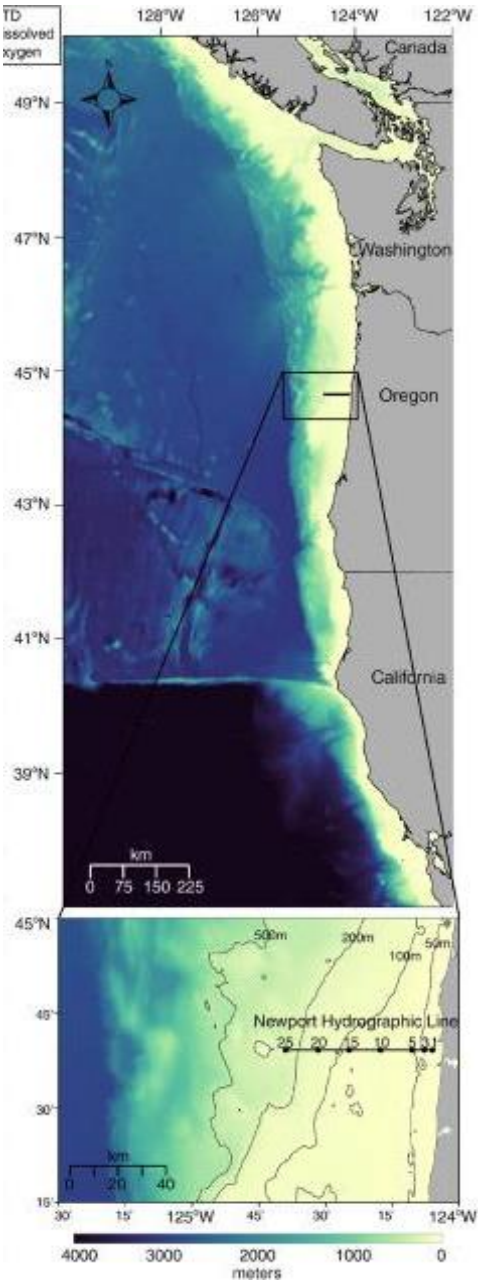
Blue/purple colors mark the regions where oxygen is low. These regions can be called oxygen minimum zones. In large parts of the Pacific and the Indian Oceans, there is barely any oxygen left (shown in purple). Those are the strongest oxygen minimum zones in the Ocean.

Look at North America and find the Oregon Coast. What do you observe about oxygen there?



Source: World Ocean Atlas





Let's look at some data from dissolved oxygen concentrations from the coast near the city of Newport, Oregon.

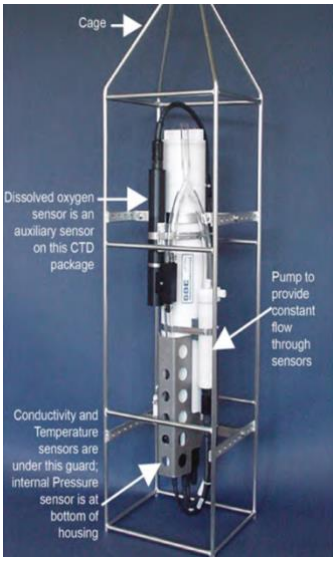
This data is compiled from the years 1997-2021.

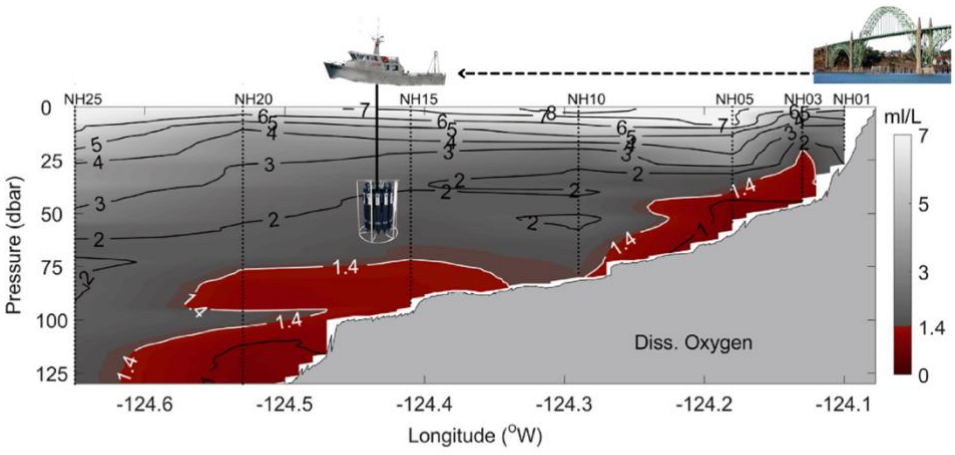
On the top left, you can track the sampling locations along the Newport Hydrographic Line (NHL). Water samples have been collected on a biweekly to monthly schedule from each of the locations along the NHL (labeled as 1, 3, 5, 10, 15, 20, 25). These data are collected using something called a Conductivity, Temperature, Depth (CTD) profiler with dissolved oxygen sensors (image on the bottom left). So when the CTD goes overboard, as it sinks through the depths of the water, it's sensors can collect both data and the "carousel" can trap water from the deep ocean for us to bring back to the lab to do experiments with.

Look below to see a profile for dissolved oxygen. Imagine a research boat was gliding along the top of the water outward from Newport and the CTD sensor was being dropped into the water at different points. The large light gray shape on the bottom right is the “continental shelf”. The shelf is the area of seabed around a large landmass where the sea is relatively shallow compared with the open ocean.

Remember “the drop off” in Finding Nemo? That is where the continental shelf meets the open ocean.

The concentrations are labeled on the left legend with red showing low oxygen (concentrations below 1.4 ml/L) and the gradient of gray showing up to 7 ml/L.

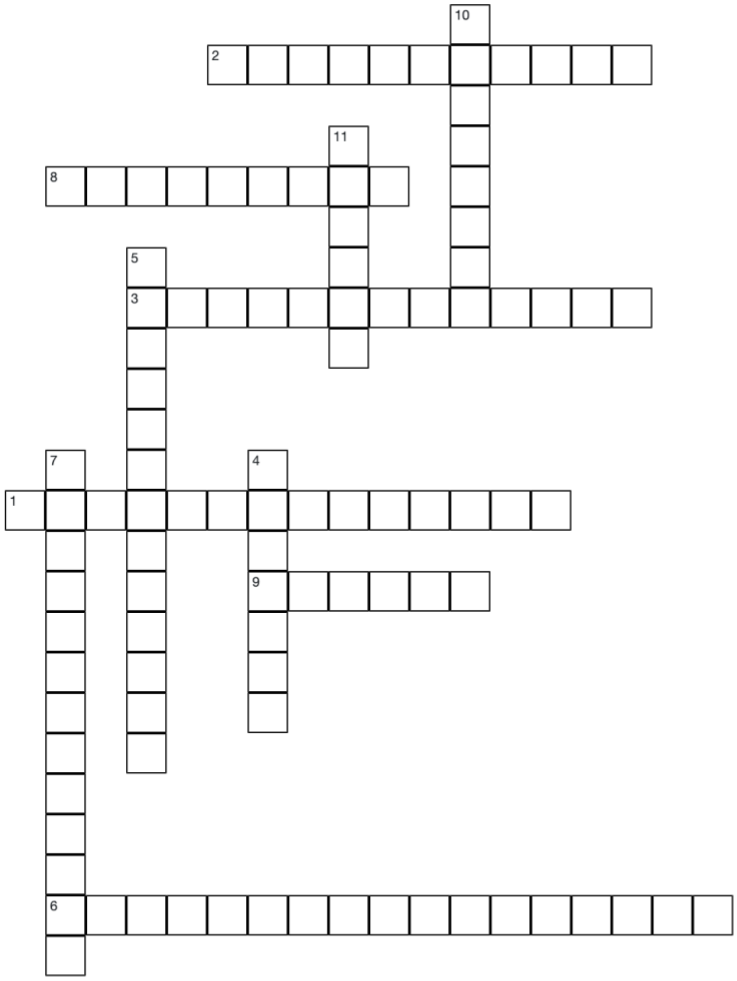




Source: Adapted from Risien et al 2022

Oxygen in the ocean

The crossword below contains words used to describe coastal oxygen dynamics and marine microbial processes.



Created by https://www.crossword-puzzle-online.com

Horizontal

2. A chemical reaction that occurs in all cells using glucose and oxygen while producing carbon dioxide and water
8. Process where deep water is brought up to the surface
3. Matter that comes from living or once living organisms
1. Process by which green organisms use sunlight to make their own food
9. A life supporting gas found in the atmosphere
6. Areas of the ocean with low oxygen with the potential to become dead zones

Vertical

10. Microscopic single celled organisms that exist in all environments
11. Absence of oxygen
5. The amount of a substance in a defined space
7. Photosynthetic organisms that make most of the oxygen we breathe
4. Low levels of oxygen in an environment