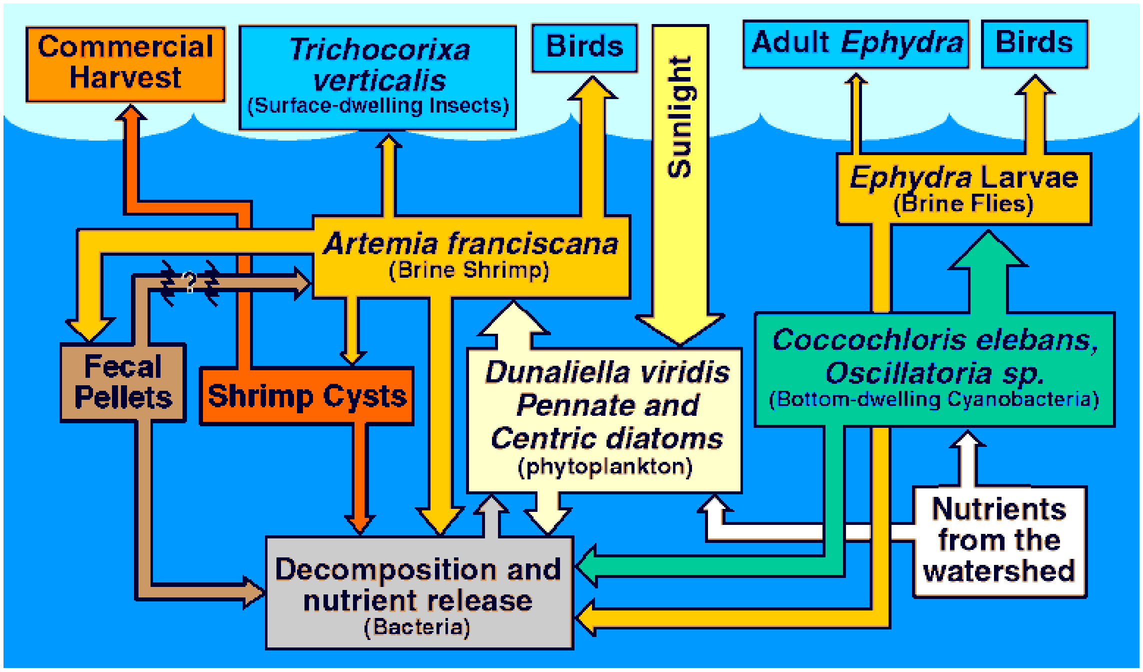
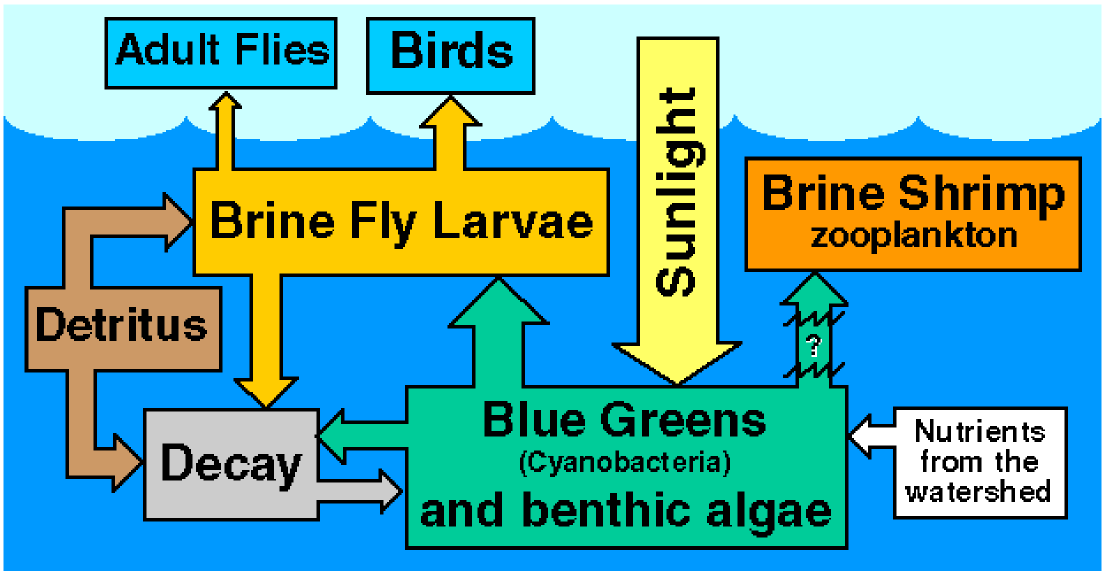
Great Salt Lake—Planktonic and Benthic Habitats



Hypersaline lakes are often regarded as "simple" ecosystems because they typically have fewer species than freshwater lakes. Although fewer species are capable of tolerating the stress of a salty lake, those species that are present interact on many levels to efficiently use the food and energy resources available. There is an open water (planktonic) habitat and a bottom-dwelling (benthic) habitat in Great Salt Lake.

The planktonic habitat is dominated early in the year by phytoplankton (algae) blooms. These often occur in January when the water temperature is only a few degrees Celsius (36 degrees Farenheit). In the last few years, the green alga, Dunaliella viridis, has bloomed at this time and been followed by blooms of several species of diatoms.

Brine shrimp (Artemia franciscana) hatch from cysts in early April and within a month or so intensely graze the phytoplankton crop. If sufficient nutrients are available later in the summer and enough of the brine shrimp die from lack of food, there may be fall blooms of diatoms. The phytoplankton crop provides much of the food for the shrimp to grow and reproduce during the summer. Large numbers of local and migratory birds feed on brine shrimp during the spring and summer. A small water bug known as a corixid also eats shrimp nauplii (larva) and adult shrimp in the lake. As phytoplankton become scarce, the shrimp may reprocess fecal pellets produced earlier in the year or graze on algae and blue-greens (sometimes called algae, but recognized to be a separate group) that grow on some areas of the lake bottom. The shrimp also may graze on diatoms that colonize cast-off exoskeleton parts from shrimp molts. When the shrimp are stressed by lack of food or harsh environmental conditions, they switch from producing live young to producing cysts. Some of these cysts are commercially harvested and some remain in the lake to start the shrimp population the following year. Graphic of ecosystem.



The Benthic habitat relies on photosynthesis by the blue-greens and other benthic algae to produce much of the food needed by benthic grazers. Additional food comes in the form of detritus that settles from the water. In the springtime, after the shrimp have grazed the phytoplankton from the water, light penetrates to the bottom of the lake in many areas and provides energy for benthic photosynthesis by algae and the blue-greens. Living in close association and feeding upon detritus and the blue-greens are two species of brine fly (genus Ephydra).These small insects spend their larval existence on the bottom of Great Salt Lake. They emerge from the lake as adults in early summer and form dense clouds that cover the beach and everything on the beach. Although they may be annoying, they do not bite.

Although the planktonic and benthic habitats seem to be separate, they are linked. Both habitats require nutrients entering from the watershed around the lake, brine shrimp feed on algae and organic material in the benthic habitat and contibute nutrients back to the benthic habitat, several kinds of bacteria and protozoa occur in both habitats and recycle nutrients between them, and brine-fly larvae and pupae released from the bottom enter the planktonic habitat prior to emerging from the lake.

http://ut.water.usgs.gov/greatsaltlake/plankton/

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Basics

How oceans take up carbon dioxide

The most important greenhouse gas, apart from water vapour, is carbon dioxide (CO_2). Levels have changed over time both naturally and because of humans. Much of the carbon dioxide produced by humans does not stay in the atmosphere but is stored in the oceans or on land in plants and soils. By far the largest carbon store on Earth is in sediments, both on land and in the oceans, and it is held mainly as calcium carbonate ($CaCO_3$). The second biggest store is the deep ocean where carbon occurs mostly as dissolved carbonate (CO_3^{2-}) and hydrogen carbonate ions (HCO_3^-). We think that about a third of the carbon dioxide from fossil fuel burning is stored in the oceans and it enters by both physical and biological processes.

Physical processes

Carbon dioxide dissolves more easily in cold water than in warm water. It also dissolves more easily in seawater compared to pure water because seawater naturally contains carbonate ions.

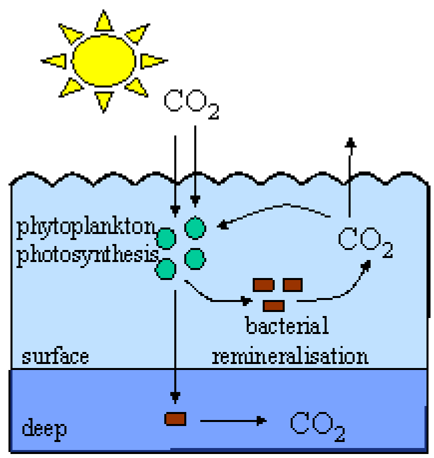
$$CO_2 + CO_3^{2-} + H_2O \rightleftharpoons 2HCO_3^-$$

Reaction of the carbon dioxide with carbonate produces hydrogen carbonate. Because of this reaction, only 0.5% of the inorganic carbon in seawater occurs as carbon dioxide gas. Since levels of carbon dioxide are so low in seawater, more carbon dioxide can enter the oceans from the atmosphere (the chemists will recognise this as an example of Le Chatelier's Principle). If the water stays at the surface and warms up as it moves around the globe, the carbon dioxide will relatively quickly escape back to the atmosphere. However, if the water sinks to the deep ocean, the carbon can be stored for more than 1000 years before ocean circulation returns it to the surface. Cold waters sink to the deep ocean at high latitudes in the Southern Ocean and in the Nordic and Labrador Seas in the North Atlantic Ocean. These regions are therefore the major physical carbon dioxide removal areas of the ocean.

Biological processes

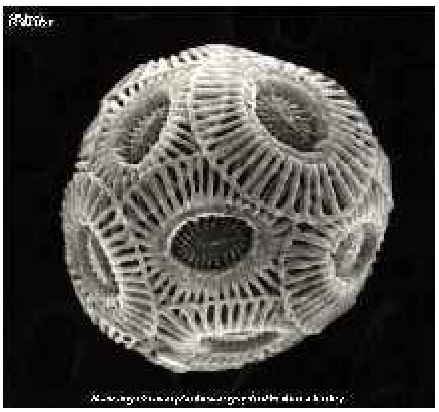
As well as physical removal, carbon dioxide is also taken up by phytoplankton in photosynthesis and converted into plant material. Land plants and marine phytoplankton take up about the same amounts of carbon dioxide as each other but marine phytoplankton grow much much faster than land plants.

Most of the carbon dioxide taken up by phytoplankton is returned to the atmosphere when the phytoplankton die or are eaten but some is lost to the deep sea sediments in sinking particles. The sinking of this plant material is known as the biological pump because it acts to pump carbon dioxide from the atmosphere into the deep ocean. Most of this loss is at high latitudes because the phytoplankton which live there are large enough to sink out of the surface waters into the deep ocean when they die.



1. This picture gives a very simple idea of how the biological pump operates. Phytoplankton take up carbon dioxide during photosynthesis. Bacteria eat the phytoplankton and, in doing so, release nutrients and carbon dioxide back into the water. This process is known as remineralisation and we will discuss it more in Unit 2 of the Basics Section.

Remineralisation mostly happens in the surface waters and the carbon dioxide is either used again by the phytoplankton for photosynthesis or released back to the atmosphere. If the phytoplankton die and sink into the deep waters, the carbon dioxide released by remineralisation is stored for centuries in the deep ocean reducing the impact of global warming. Author: Lucinda Spokes.



2. An electron micrograph of the phytoplankton* Emiliania Huxleyi *with its calcium carbonate skeleton. Thanks to NOAA for the image.

Computer models suggest that human activity may alter the types of phytoplankton in the ocean. Humans, therefore, could change how much carbon is stored in the deep ocean. For instance, some phytoplankton produce calcium carbonate skeletons, particularly the very abundant *Emiliania Huxleyi*. In making their skeletons, these phytoplankton actually cause the release of carbon dioxide and this reduces the overall uptake of atmospheric carbon dioxide by seawater.

$$Ca^{2+} + 2HCO_3^{-} \rightleftharpoons CaCO_3 + CO_2 + H_2O$$

At the moment, we don't know all the reasons why certain phytoplankton species grow in particular ocean regions. This means we can't predict whether future human activity will change the abundance of phytoplankton which produce calcium carbonate skeletons and, if so, what impact this will have on our climate.

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