

Mystic Seaport for Educators
Science on the 38th Voyage of the *Charles W. Morgan*
Lesson 5 of 6: The Whale Pump
Student Reading

Introduction:

In the eighteenth and nineteenth centuries, the seas were dominated by whaling vessels. Whalers would set sail for years at a time in pursuit of these giant marine mammals, harvesting oil, bone, and baleen to produce a variety of valuable products. By the twentieth century, the industry began to fade with the invention of plastic and the discovery of petroleum. Unfortunately, whaling had already taken a toll on whale populations worldwide, some of which were depleted by as much as ninety-nine percent. Though devastating to the whales themselves, this population decline of the sea's largest species also affected its smallest organisms, upsetting the careful balance of the ocean's nutrient cycle.

Plankton are tiny organisms that drift or float in the sea or freshwater. They can be divided into two categories: phytoplankton (plants) and zooplankton (animals). Phytoplankton turn energy from the sun into oxygen in a process known as photosynthesis. Among zooplankton, some are juveniles of large, strong-swimming adults, while others will remain plankton for their entire lives. Because the zooplankton feed on phytoplankton directly, both types live near the top layer of the ocean known as the "photic zone." This is where sunlight is most available for photosynthesis.



*Some whales feed on tiny zooplankton, such as this copepod.
(Copepod - photo by Uwe Kils, via Wikimedia Commons.)*

Plankton are an important part of a “biological pump” that transports nutrients throughout the ocean. In addition to sunlight, phytoplankton require nutrients such as nitrates in order to photosynthesize and grow. These nitrates are commonly brought into coastal waters from runoff on land, or are brought up from the deep sea by the ocean’s currents. After zooplankton enter the photic zone to feed on the phytoplankton, they release waste to the seafloor. Larger vertebrates also produce this waste as they feed on zooplankton. All of this waste contains nitrates, and as it sinks it carries nitrogen away from the surface.

In spite of their size, plankton are not just a food source of other tiny organisms. There are many large species, known as “planktivores,” that feed on this population, including baleen whales. These whales also play an important role in the ocean’s nutrient cycle. Whales need to return to the surface in order to breathe and excrete waste. This waste brings nitrates back to the photic zone, where phytoplankton can use these nutrients to continue photosynthesis. This form of nutrient-recycling is known as a “whale pump.”

Figure 1 shows a model of the whale pump, which was created by scientists Joe Roman and James J. McCarthy. The combination of the “biological pump” and the “whale pump” recycle nitrogen to and from the surface. In other words, whales provide nutrients to their own food source. Unfortunately, because this information was largely unavailable to whalers in the nineteenth century, scientists are only now discovering the effects of whaling on the ocean’s nutrient cycle and food web.

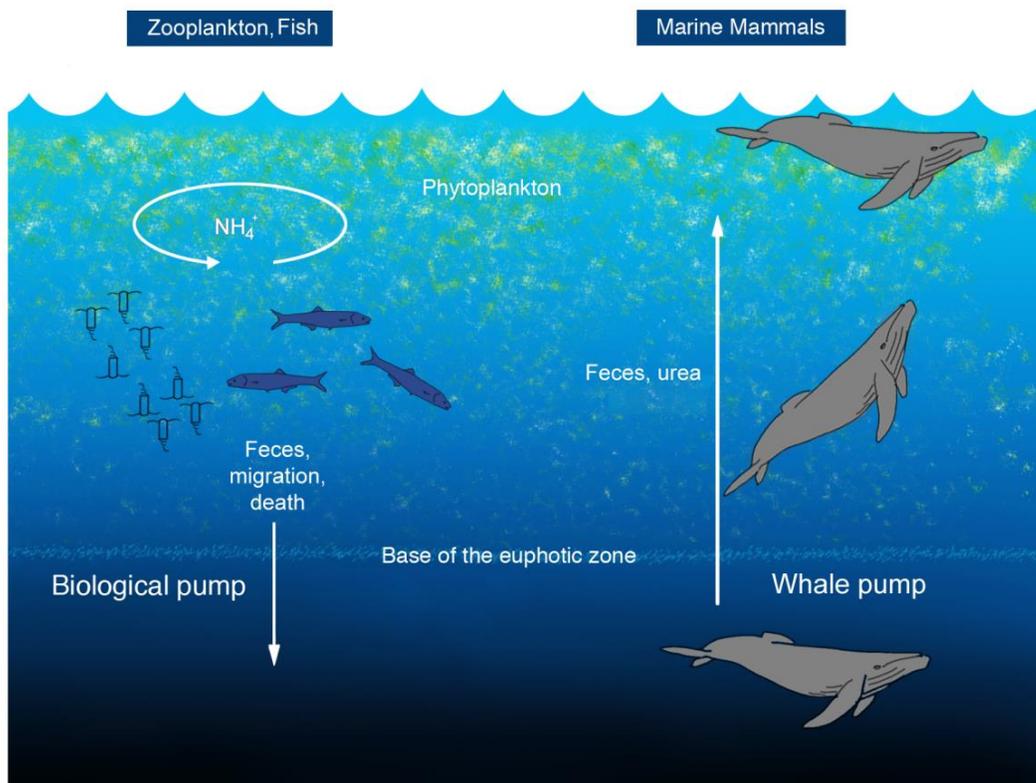


Figure 1. A conceptual model of the whale pump (Roman & McCarthy, 2010).

Key Words:

Petroleum: A substance that can be found underneath the surface of the earth. It is used to produce gasoline and oil.

Nitrates: A type of nutrient that contains nitrogen.

Baleen: A filter-feeding system inside the mouths of whales.