

# Lab: Sea Otters

(modified from Science Outside)

The sea otter (*Enhydra lutris*) is a marine mammal native to coastal waters within the 22° N to 61° N latitude range of the North Pacific Ocean where protective kelp forests grow and provide shelter. They eat and sleep in the water, and unlike seals and sea lions, they mate and give birth in the water. Sea otters grow to between 14 and 45 kg (30 and 100 lbs.), making them the smallest marine mammals, and they have the densest fur of any mammal on Earth. It is so super-soft, water-resistant, and warm that sea otters do not need blubber to maintain body temperature as most other marine mammals do. Widely known



for playfully frolicking in the water, they are very adaptable, able to walk on land, but also capable of living exclusively in the ocean. Sea otters inhabit nearshore environments, where they dive up to 100 m (328 feet) to forage. They prey mostly on marine invertebrates such as sea urchins, mollusks, crustaceans, and some species of fish. The sea otter's use of rocks to open shells makes it one of the few mammal species to use tools. In most of its range, sea otters serve as keystone species by controlling sea urchin populations that would otherwise inflict extensive damage to kelp forest ecosystems. Without sea otters, the underwater ecosystem they inhabit would be dramatically different.

Anthropological research indicates that local Indigenous communities along the North Pacific coastline hunted sea otters and harvested shellfish successfully for millennia. Sea otters learned to recognize and avoid areas of danger. Indigenous people took advantage of this by utilizing site-specific hunting which resulted in an uneven distribution of sea otter populations along the coast. As a result, shellfish flourished and were easily harvested by humans in areas where sea otters were absent, and sea otters thrived in the remaining areas. Perhaps humans can once again learn to coexist conscientiously with sea otters.

Sea otters are estimated to have had a population of 150,000 - 300,000 prior to the arrival of Europeans in North America. Between 1741 and 1911, they were hunted for their fur, and the population fell to 1,000 - 2,000 individuals living in small pockets of their former range. In 1911, due to the lobbying efforts of conservationists, the Fur Seal Treaty of 1911 was implemented to protect sea otters in international waters. Coupled with reintroduction efforts throughout the next century their numbers have rebounded, and sea otters now occupy about two-thirds of their historic range. Today, it is estimated that there is a worldwide total of approximately 107,000 sea otters. While the recovery of the sea otter is a remarkable success in marine conservation, populations have recently leveled off and even declined in some areas. For these reasons, the sea otter remains classified as endangered on the red list of the International Union for the Conservation of Nature and Natural Resources (IUCN).

1. Where are sea otters found?
2. Describe the fur of sea otters.
3. What is a keystone species and why are sea otters considered a keystone species?
4. Describe the history of sea otter populations along the North Pacific coastline.

Kelp forests are extremely productive ecosystems and form the basis of sea otter habitats. All photosynthetic-based ecosystems depend on a continuous inflow of solar energy in order to maintain their structure and function to power biogeochemical cycles. In terrestrial and near-surface marine communities like kelp forests, energy flows from the sun to producers in the lowest trophic levels and then upward to higher trophic levels.

**Gross Primary Productivity (GPP):** The total amount of chemical energy that is stored by plants as carbon-containing sugars via photosynthesis. Productivity is commonly determined by measuring the uptake of carbon as units of mass per unit area per unit time (e.g., kg C/m<sup>2</sup>/yr). **GPP = NPP + R**

**Respiration (R):** The process by which organisms release chemical energy from oxygen-containing molecules. **R = GPP - NPP**

**Net Primary Productivity (NPP):** The rate of energy storage by photosynthesizers in a given area, after subtracting the energy lost to respiration. This is the available biomass for herbivores. **NPP = GPP - R**

5. The gross primary productivity of a kelp forest ecosystem is 1.95 kg C/m<sup>2</sup>/year. The energy needed by the producers for their own respiration is 1.05 kg C/m<sup>2</sup>/year. Calculate the net primary productivity of this ecosystem. Show all of your calculation steps and include unit labels in each step.
6. The net annual primary productivity of a kelp forest ecosystem is found to be 1,000 g C/m<sup>2</sup>/year. The respiration by the producers is 850 g C/m<sup>2</sup>/year. Calculate the gross annual primary productivity for this ecosystem, in g C/m<sup>2</sup>/year.
7. The net annual primary productivity of another kelp forest ecosystem is found to be 975 g C/m<sup>2</sup>/year. If gross primary productivity by the producers is 2,025 g C/m<sup>2</sup>/year. Calculate the respiratory energy used by autotrophic organisms in this ecosystem.

Positive and negative feedback loops can each play a role in food webs. When one species is removed from or added to a specific food web, the rest of the food web can be affected. Competition can occur within or between species in an ecosystem where there are limited resources. Resource partitioning—using the resources in different ways, places, or at different times—can reduce the negative impact of competition on survival. The primary prey species for sea otters include sea urchins, crabs, clams, mussels, octopi, fish, and other marine invertebrates. Some of these species are also valued by humans as food, sometimes leading to conflicts between sea otters and commercial fishermen (humans). In a predator-prey relationship, the predator is an organism that eats another organism (the prey). On the other hand, symbiotic relationships are close and long-term interactions between two species in an ecosystem. Types of symbiosis include mutualism, commensalism, and parasitism. Parasitism occurs when one organism benefits and the other is harmed. Mutualism occurs when both organisms benefit. Commensalism occurs when one organism benefits and the other is neither helped nor harmed.

8. Draw a kelp forest food web using the following organisms: Kelp, Diatom, Sea Urchin, Mussel, Clam, Anchovy, Sea Bass, Sea Otter, Sea Lion, Orca
9. Describe what is most likely to happen to the biomass of kelp if sea otters were removed from the ecosystem.
10. Identify what type of relationship occurs between sea otters and sea urchins.
11. Sea otters use kelp as an anchor by wrapping themselves in the kelp so they do not float around while they sleep. Identify what type of symbiotic relationship is being demonstrated in this scenario.
12. Sea otters remain listed as endangered on the IUCN Red List. Why should they be protected?