

**The effect kelp, bivalves, and sea urchins have on coastal restoration.**

Rayleen DeHonor and Ivy Lee  
Regenerative Aquaculture Program  
December 11, 2022

### **Abstract**

The paper examines the effect that kelp, bivalves, and sea urchins have on coastal restoration. Coastal restoration is defined as the remedies that society undertakes to reinvigorate parts of the coastal environment that have been lost. The addition of kelp into coastal waters aids in restoration because it has the ability to restore ecosystems and avoid ocean acidification. The presence of bivalves promotes clean water, species diversity, and serves as a natural barrier to coastlines- creating a healthier environment. Sea urchins are important because they graze on algae and help keep the ocean clean. Because of the benefits that kelp, bivalves, and sea urchins have on coastal restoration, people are working to maintain the balance of these species in coastal water. While there are efforts to restore the population of kelp and bivalves, people are working to combat the overpopulation of sea urchins.

*Keywords:* kelp, bivalves, sea urchin, coastal restoration

Kelp is a large brown algae. There are around 30 types of kelp around the world. Kelp grows in what can be called an “underwater forest”. Interestingly enough, kelp thrives in cold water and is unable to survive in other places (National Oceanic and Atmospheric Administration, n.d.). The “stipe” is the stem of kelp. The “holdfast” is like the roots except they don’t connect deep into the ground, instead they lock onto rock, cobble, or gravel. The holdfast also doesn’t absorb nutrients. Attached to the stipe are leaves or “blades”. The leaves are where photosynthesis takes place. Photosynthesis is when sunlight is captured by a plant, and the energy particles in sunlight create a chemical reaction that produces sugar. The sugar created becomes the food for the plant. The ability that plants have to photosynthesize is extremely beneficial to humans because it provides oxygen into our environment (University of Southern California Sea Grant program, n.d.). Embryophyta typically only have the capability of photosynthesis in the leaves, but plants that live underwater photosynthesize throughout all parts. Therefore, giant kelp starts out as a tiny single blade, and can eventually amount to over 200 feet tall (Rocchio, n.d.).

Kelp is essential to coastal restoration because it provides wave protection,  $O_2$  production,  $CO_2$  absorption, food, and homes for marine organisms. A way that kelp provides wave protection to the coast, marine life, and even boats is by slowing down and lowering the impact of the current.  $O_2$ , or oxygen, is created through photosynthesis that takes place in the ocean and is released into the atmosphere. Humans breathe oxygen so without kelp forests, there would be even loss of oxygen for us to breathe. The ocean is a carbon sink, meaning it takes the Carbon dioxide, or  $CO_2$ , admitted through cellular respiration and uses it to photosynthesize. This is important because when there is too much carbon in the atmosphere, the ocean becomes acidic, the acid in the water poses a major threat to bivalves. A bivalve is a shelled organism.

Some examples include clams, oysters, and mussels (National Oceanic and Atmospheric Administration, n.d.). When there is a lack of kelp in the ocean, carbon isn't being used which turns the ocean acidic. As a result of the acidification, the lifespan of these organisms are shortened, shells become thinner, and death rates rise. (National Oceanic and Atmospheric Administration, n.d.). In order to restore ecosystems and ensure bivalve populations don't decrease, kelp needs to be present.

Some organisms that find shelter in kelp are invertebrates, fish, marine mammals, and birds. Whether they are just taking shelter or living there permanently, kelp provides so much for so many organisms. Kelp is also a part of many invertebrate diets. Some include sea stars, anemones, crabs, and jellyfish. (National Oceanic and Atmospheric Administration, n.d.)

Kelp forests grow along more than a quarter of the world's coastlines, but they have been disappearing due to overharvesting and pollution. This is significant because of kelp's influence on the coast. Kelp forests are one of the most productive ecosystems in the world. They shelter sea life and provide habitat/food to hundreds of species including sea urchins, brittle stars, and birds. As previously mentioned, kelp forests serve as a buffer against waves, which is valuable in preventing coastal erosion. Moreover, they are an important aspect of the marine food web, absorbing nitrogen from the water and making it available to the many species that feed on its blades.

Because of the importance of kelp forests on the coast, there is a need to combat the deteriorating population. The restoration of kelp forests is challenged by many factors including the difficulties of working underwater. However, green graveling serves as a promising solution that overcomes the major challenges in kelp restoration. Green gravel is the product of lining or seeding small rocks with kelp propagules. Once they grow and blades are formed, they are to be

thrown into the ocean and photosynthesis will continue the process from there. This method is a lot more efficient than having highly trained scuba divers involved- it's also cheaper and quicker.

The National Oceanic and Atmospheric Association defines bivalves as organisms that have an external covering that is a two-part hinged shell that contains a soft-bodied invertebrate. (*What Is a Bivalve Mollusk?*, 2021) Bivalve reef restoration has become increasingly common in coasts across the United States and is gaining popularity globally. Oysters, a type of bivalve, are considered to be ecosystem engineers because of their work in protecting shorelines and supporting a diverse habitat. Efforts are being put to artificially create oyster reefs because they have been decimated due to climate change, overharvesting, and worsening water quality.

In the past, many harbors were covered in oyster reefs. But, today, due to factors such as climate change and overharvesting, oyster populations have declined. Because oyster reefs provide natural protection and serve as a wave barrier from the ocean, the deterioration of oysters has had an adverse effect on people, especially those living in coastal areas. Additionally, oyster restoration is important because of the ecosystem services that it provides, thus promoting diversity and healthy waters in coasts. For instance, they filter water, remove algae, and increase water clarity. (Wright & Chappell, 2020) Moreover, the reefs that oysters create provide habitats used as shelters by marine animals and birds. Studies have shown that oyster reefs have consistently increased the abundance of fish species and provided habitat. (Renfro, 2014)

Reefs can be artificially rebuilt in order to restore their benefits. According to Smithsonian Magazine, they can be created by dumping a hard substrate, in this case oyster shells, and seed them with larvae. The larvae will then attach and continue to grow. (*Losing Paradise*, 2012) Creating oyster reefs serves as an attractive solution because they grow vertically up to 11 centimeters a year, keeping up with rising sea levels. (Rodriguez, 2014)

Sea urchins are spiky, ball-looking organisms found in the ocean. Sea urchins are echinoderms. Echinoderms are invertebrates that belong to the phylum Echinodermata. They have star-like shapes that are either elongated or spherical. They also have spiny skin, which is fitting because in the Greek language, “echinos” means spiny, and “dermos” means skin (Pawson, 1998). The mouths of sea urchins are called Aristotle’s lantern. This is a muscular system, made up of a jaw and 5 teeth-like structures that can move in different directions. The teeth form in a shape that resembles a star which is referred to as a beak. Using the beak, they are able to consume most things that float by. This includes kelp, algae off rocks, plankton, and sometimes even periwinkle snails, mussels, and barnacles (National Film Board of Canada, n.d.). Their mouth is located on the underside of their body, whereas the anus is located on the top of the body- where waste is excreted.

Urchins live in areas that have rocky bottoms, whether that’d be shallow waters or deep sea floors (Georgia Aquarium, n.d.). One habitat in which urchins can be found is kelp forests, which thrive in cold water. Every part of the ocean has cold water, therefore all parts have kelp and urchins.

Sea urchins are quite interesting because their life span goes hand in hand with their health. They generally live for around 100 years or longer, but if they get sick, it’s likely they’ll die a lot sooner. Because they don’t die quickly, populations increase a lot faster than other organisms do. This is why you’ll hear about keystone species in relation to the health of coastal environments. A keystone species is an animal that is essential to an ecosystem, meaning the ecosystem would increase rapidly or cease to exist altogether. In the case of the kelp forest food web, sea otters are the keystone species and affect the sea urchin populations .

When refocusing on the role urchins play in coastal ecosystems and how they can help coastal restoration, it's important to discuss the symbiotic relationship between urchins, sea otters, and kelp. To put it simply, sea otters eat urchins and urchins eat kelp. But when there are too many urchins a coastal ecosystem can become unbalanced. Data from 1965 shows that as of the year 2000, the population of sea otters decreased by 75% (American Society of Mammalogists, 2003). Because of the decrease, there is an overabundance of sea urchins in the ocean today. This is detrimental to entire ecosystems because urchins eat kelp - when they overgraze, the kelp's entire ecosystems could be wiped out. Sea urchins aren't the only organisms that depend on kelp, therefore the possibility of overgrazing poses a big problem. With that being said, the effect sea urchins have on coastal restoration is that when they are relocated and their population is managed, ecosystems can thrive in a healthy, restored environment.



## References

- American Society of Mammalogists. (2003, February 28). *Sea Otter Population Declines in the Aleutian Archipelago*. <https://academic.oup.com/jmammal/article/84/1/55/2373591>
- Georgia Aquarium. (n.d.). Retrieved December 11, 2022, from <https://www.georgiaaquarium.org/animal/purple-sea-urchin/>
- National Film Board of Canada. (n.d.). *Sea Urchins*. <https://www.who.edu/science/B/people/kamaral/SeaUrchins.html#:~:text=Sea%20urchins%20will%20eat%20just,sometimes%20even%20barnacles%20and%20mussels.>
- Pawson, D. L. (1998, July 20). *Echinoderm | Definition, Characteristics, Species, & Facts | Britannica*. Encyclopedia Britannica. Retrieved December 6, 2022, from <https://www.britannica.com/animal/echinoderm#ref25725>
- Losing Paradise*. (2012, October 29). YouTube. Retrieved December 11, 2022, from <https://www.smithsonianmag.com/innovation/storms-get-bigger-oyster-reefs-can-help-pr>
- Losing Paradise*. (2012, October 29). YouTube. Retrieved December 11, 2022, from <https://www.smithsonianmag.com/innovation/storms-get-bigger-oyster-reefs-can-help-pr>
- National Oceanic and Atmospheric Administration. (n.d.). <https://oceanservice.noaa.gov/facts/kelplives.html#:~:text=Sea%20urchins%20will%20of ten%20completely,anemones%2C%20crabs%2C%20and%20jellyfish.>
- National Oceanic and Atmospheric Administration. (n.d.). <https://oceanservice.noaa.gov/facts/bivalve.html>
- National Oceanic and Atmospheric Administration. (n.d.). Ocean Acidification's impact on oysters and other shellfish. Retrieved December, 2022, from <https://www.pmel.noaa.gov/co2/story/Ocean+Acidification%27s+impact+on+oysters+an>

