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Giant Killers

Giant kelp forests — those ethereal, swaying columns of seaweed found in the intermediate to deep water zones of cooler coasts along the Pacific Ocean and Southern Hemisphere — provide habitat for a variety of species that spend their lives in kelp's canopies or at the rocky bottoms.

"Giant kelp's complex physical structure that extends throughout the water column and its very high productivity are unique," said Bob Miller, a research biologist at UC Santa Barbara's Marine Science Institute (MSI). "No other species in the kelp forest can replace giant kelp's high capacity to physically modify the environment and produce habitat and food for a myriad of other species." Thus, he said, giant kelp are known as a "foundation species" — an organism that plays a strong role in structuring a community.

While giant kelp are generally able to withstand strong currents, recover after powerful storms and replenish themselves at a rapid rate (about 3 percent of their weight per day), the onslaught of disturbances anticipated as a result of climate change may be more than the species can bear, according to Dan Reed, also a research biologist at MSI. The result could be an upheaval of the ecology of the entire kelp forest.

"One of the expectations of climate change is that many types of disturbances — for example fire, hurricanes and floods — will occur more often or become more severe in their intensity," Reed said. "Ecologists have long recognized the important role of disturbance in structuring natural communities, however, they have yet to resolve

how natural communities respond to increases in the frequency of disturbance versus increases in the severity of disturbance."

The researchers' findings, in a paper titled "*Loss of foundation species: disturbance frequency outweighs severity in structuring kelp forest communities*," are published in the journal *Ecology*.

"We found that the frequency of disturbance was the most important factor influencing kelp forest biodiversity, whereas the severity of disturbance in a given year played a minor role," said lead researcher Max Castorani, a professor of environmental sciences at the University of Virginia.

In this rare long-term study, the researchers counted and measured more than 200 species of plants, invertebrates and fishes in large experimental and control kelp forests off the Santa Barbara coast every three months over a nine-year period. They found that annual disturbances where kelp forests were experimentally cut back and reduced year-after-year, as happens during severe winter storms involving large waves, resulted in a doubling of smaller plants and invertebrates attached to the seafloor (algae, corals, anemones, sponges), but also resulted in 30 to 61 percent fewer fish and shellfish, such as clams, sea urchins, starfish, lobsters and crabs.

"Our findings surprised us because we expected that a single severe winter storm would result in big changes to kelp forest biodiversity," Castorani said. "Instead, the number of disturbances over time had the greatest impact because frequent disturbances suppress the recovery of giant kelp, with large consequences for the surrounding sea life." An unhealthy kelp forest offers less shade and shelter for certain organisms, and the resulting ecosystem would be less complex and productive overall.

Kelp forests along the California coast are already undergoing an attack brought on by factors including El Niño weather patterns, which bring destructive storms, nutrient-poor warm waters and aggressive, seaweed-eating purple urchins into the forests. The loss of underwater foliage has driven out the purple urchins' main kelp-dwelling natural predators and the urchins themselves prevent the regrowth of the kelp, leaving it up to people to try to save the habitat — and by extension their own food sources and livelihoods.

The scientists are continuing to monitor their study plots to determine the trajectory and rate of recovery of the kelp forest community under a natural disturbance regime. “We are also analyzing the results from our experiment to evaluate how the frequency and severity of disturbance alter the overall primary productivity of the kelp forest,” Miller said.

The experiment was conducted at the National Science Foundation’s Santa Barbara Coastal Long-Term Ecological Research (LTER) site. The NSF funds numerous long-term research projects around the world designed to gain a big-picture view of changes to ecosystems over decades and beyond.

“It’s a significant finding that the severity and frequency of disturbances influence kelp bed communities in different ways,” said David Garrison, a director of the NSF’s LTER program, which funded the study. “We need this kind of research to predict what future kelp bed communities will look like, and what ecosystem services they will provide.”

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