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Sonia Fernandez

Kelp forests connected to sandy beach food webs

UC Santa Barbara marine scientists are uncovering just how tightly the beach and the nearshore are connected along the California coast. Often treated as discrete ecosystems because of the natural divide between land and sea, the two are subtly linked by physical and ecological processes that couple the extent and condition of the kelp forests to the robustness and complexity of the food web on the shore.

Through a paper published in Nature Scientific Reports, lead author Kyle Emery and colleagues quantify and characterize these connections, which add to our overall knowledge of the importance of the relationship between these adjacent ecosystems. According to the researchers, “the highly coupled nature of these coastal ecosystems increases the likelihood that negative impacts to donor ecosystems will cascade to affect the structure and function of subsidized recipient ecosystems.” This work was supported by the National Science Foundation.

More kelp = healthier beach

It’s easy to assume that the nearshore and the sandy beach have little to do with each other, largely because the environments and the creatures that live there are so different. However, previous research has highlighted the strong, local spatial connections between the two areas through the deposition of kelp, which washes onto the beach. These kelp depositions — also known as “wrack” — provide

nutrients to sandy beach ecosystems, which generally have low amounts of their own primary production at the base of the beach food web.

“The offshore supply of kelp is a good predictor of how much kelp ends up on the beach,” Emery said. “And we know that we have this variability in kelp inputs to beaches along the coast.” The paper extends this connection to investigate the ecosystem impacts of the kelp wrack, Emery explained. “How does the variability in the amount of kelp wrack that ends up on the beach translate to variability in different communities on the beach and various ecosystem processes?”

To find out, the research team surveyed 24 beaches across 100 kilometers of Santa Barbara and Ventura county coastlines, then analyzed data from these locations on factors which indicate the influence of the kelp subsidies to shoreline ecology. They measured the amount of wrack inputs, which comes mostly from nearby kelp forests. Against that they measured several indicators of the contribution of kelp wrack to beach ecosystem functions, including nutrients and carbon dioxide that come from kelp decomposition on the shore. They also characterized the beach food web from bottom to top, accounting for the number and size of kelp eaters and the animals that consume them, from beach hoppers to shorebirds, estimating the amount of energy required to sustain them.

“They’re measures of everything from biogeochemistry to invertebrate and shorebird communities, just all these different kinds of ecological functions that we hypothesized would respond to wrack inputs,” Emery said.

The takeaway, he said, was that the wrack inputs have “strong and direct impacts on the different invertebrate groups,” be that the consumption by kelp eaters, or as habitat for the predators of kelp eaters. These impacts ripple upward to higher level consumers such as shorebirds. “We’re seeing that the variability of these kelp inputs to the beach has a really strong multi-trophic level impact on organisms that live in and consume their resources on the beach,” Emery said. More kelp, more impact, he added, and “we can expect that a reduction in nearshore kelp would translate to negative responses in all these other groups and ecosystem functions on beaches.” The findings here could apply to other beaches around the world, especially temperate beaches that receive wrack subsidies from nearshore kelp forests.

In addition to making more concrete the connections between the nearshore and the sandy beach, the work highlights the larger context of the importance of a “natural” beach, i.e., one that is not groomed flat and free of wrack, like many of California’s urban beaches and many others around the world. Previous research has proved the physical importance of having dunes and dune plants to naturally protect against sea level rise, while this work sheds light on the ecological benefit.

“When you ask people to think of a pristine beach in Southern California, the idea is of a wide, flat, clean sandy beach with nothing on it,” he said. “But in reality, a pristine beach is one that is biodiverse, highly functioning and has lots of kelp wrack with all the invertebrates thriving off those inputs and transferring energy up to higher trophic levels like shorebirds.”

Research on this study was also conducted by Jenifer E. Dugan, David M. Hubbard, Jessica R. Madden and Robert J. Miller at UCSB’s Marine Science Institute, as well as J. Carter Ohlmann at UCSB’s Earth Research Institute.

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Media Contact
Sonia Fernandez
Senior Science Writer
(805) 893-4765
sonia.fernandez@ucsb.edu

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