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The Beach Time Capsule

And to think it was all right there in her garage.

A load of boxes pulled from biologist Dale Straughan's home yielded a veritable treasure trove for UC Santa Barbara researchers studying the impact of climate change on coastal biodiversity in California.

To Jenifer Dugan, a research biologist at the Marine Science Institute (MSI), Nicholas Schooler, a Ph.D. student in the Interdepartmental Graduate Program in Marine Science, and David Hubbard, an ecologist at MSI, Straughan's field notes and data on California beaches were scientific gold. Beginning in 2009, the UCSB team worked closely with Straughan to compare present-day results to her original data sets. They resurveyed a subset of the more than 60 California beaches from Morro Bay to San Diego that Straughan and her colleagues had surveyed on multiple dates from 1969 to 1980.

Because the Earth's climate has changed dramatically since then, the researchers sought to determine whether and how biodiversity had decreased and to explore the processes responsible. Their findings appear in the journal Ecology and Evolution.

"Coastal ecosystems can be valuable indicators of biodiversity responses to anthropogenic and climate change-related impacts," said co-author Dugan. "We used this unique data set from extensive intertidal surveys to evaluate multidecadal change in the biodiversity of the important and widespread coastal ecosystems of sandy beaches."

Co-author Straughan conducted the original surveys for the U.S. Bureau of Land Management following the 1969 oil spill in the Santa Barbara Channel. At the time, she was based at the University of Southern California's Allan Hancock Foundation. One of the sites she surveyed more than 33 times was located in Isla Vista, close to the UCSB campus.

Evaluating impacts to biodiversity requires ecologically informed comparisons over sufficient time spans. One challenge for the UCSB team was calibrating different sampling methods from different decades. They developed a novel extrapolation approach to address data gaps that are common in such long-term data sets by adjusting species richness for sampling style over various time periods. This approach could be useful in addressing similar questions for other understudied ecosystems.

The investigators evaluated changes in intertidal biodiversity over time, using Straughan's results and those from their own recent surveys of 13 of her sandy beach sites, including the one in Isla Vista. Their analyses revealed large increases or decreases in species richness at some beaches, while at others changes were very small or not detectable.

"Our multidecadal comparison of beaches suggests that local processes exerted a stronger influence on intertidal biodiversity than did regional factors," Dugan said. "Intense local scale manipulation — in other words, management practices — made larger trends or gradients in biodiversity difficult to detect."

Digging deeper, the scientists found that upper beach species were disproportionally affected relative to the rest of the intertidal beach animals. However, they also found a positive surprise for this highly vulnerable group. Two beaches exhibited increases in richness, likely due to the fact that off-road vehicle use had been outlawed for at least 15 years. At those two sites, upper beach species showed a promising level of recovery following many years of protection from beach-driving impacts.

Another unexpected result was consistently low species richness on heavily urbanized beaches that have been groomed — mechanically raked to remove kelp — for decades. According to lead author Schooler, lasting impacts to the total community persisted over time at these sites, but the upper beach species continued to decline.

“Our beach site at Isla Vista is a good example of what the future holds as sea level rises against a resistant boundary of either natural bluffs or manmade coastal armoring and buildings like those along urbanized stretches of the coast,” Schooler explained. “We are losing ecologically important intertidal animals, such as beach hoppers and insects, from the upper beach zone, and this is likely to happen to more and more Southern California beaches as sea level rises.”

The bluff-backed Isla Vista beach site had the highest percentage loss of habitat of any beaches the UC Santa Barbara team surveyed. Such beaches experience a phenomenon called coastal squeeze because they have no room to move inland. “We saw a narrowing of the beach and a change in sediment size that was associated with a decline in the whole community, particularly in the upper beach animals,” Schooler said.

Beaches backed by dunes, such as that at Coal Oil Point Reserve less than a mile west of campus, have room to move inland and are projected to be more resilient to sea level change. But, Dugan noted, on bluff-backed beaches and those with man-made seawalls or revetments, the first species to disappear are those that feed on kelp wrack and live in the damp and dry sand of the upper beach zone.

“About 45 percent of the biodiversity of Southern California’s beaches belongs to specialized upper beach species,” she said. “They play a very important role in the coastal ecosystem by providing food for wildlife, such as western snowy plovers and other shorebirds, breaking down the kelp wrack that washes ashore and promoting nutrient recycling that then is potentially available for near-shore surf grass and kelps.

“On a more optimistic note, our research suggests that opportunities for ecosystem recovery from human impacts exist if we change the way some of our beaches are managed,” Dugan added.

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About UC Santa Barbara

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