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Santa Monica Beach dune project shows promise for coastal resilience

Nine years ago, UC Santa Barbara researchers and collaborators faced an intriguing question: Could an urban sandy beach—typically groomed flat and stripped of vegetation—be restored with minimal intervention? Could it reclaim its natural dunes and native plants while also buffering against rising seas and intensifying storms?

Their inquiry opened the door for a novel endeavor, a dune restoration pilot project on Santa Monica Beach, one of Los Angeles's most popular urban beaches. In the project, led by nonprofit environmental group The Bay Foundation, a 1.2 hectare plot was fenced on three sides and seeded with native dune plant seeds. Soon the natural processes of wind, waves, vegetation and sand were working to create a dune system.

Early results from the UCSB scientists' extended monitoring efforts were positive, with native dune plant species readily trapping sand and building dunes on a beach that had been flattened by decades of intensive grooming. But the question remained: how much resilience will these young dunes provide?

"The initial question was 'Would dunes form in the first place if we try to restore them on beaches that haven't had dunes for decades?'" said Kyle Emery, an assistant researcher at UCSB's Marine Science Institute and lead author of the paper that appears in Shore & Beach, a journal of the American Shore & Beach Preservation Association. "And we know that worked."

The result was a system of dunes that averaged 0.3 meter (1 foot) in height over the entire area, with elevations as high as 1 meter (3 feet) along the sides and the ocean-facing foredune ridge.

But while the new dunes looked promising, Emery said, “there had not really been a good opportunity to assess how well these dunes perform under some sort of disturbance event.”

That was until late December 2023, when storms battered the California coastline with waves as high as 10-20 feet in the Los Angeles area for several days, prompting coastal flood warnings and evacuations across the state. The waves on Dec. 31, 2023, according to Emery, were in the top 15 wave height days over the last 24 years.

Shortly after the storm passed, the research team conducted a survey to assess the new dunes’ response. The result? Waves that weren’t held back by the dune system — the ones that crashed on the flattened, groomed sections of the beach — ran an average of 13.6 meters (roughly 45 feet) farther up the beach toward the Pacific Coast Highway than waves that were intercepted by the restored foredune. The key, according to the scientists, was the added elevation, and the sandy mounds created by the foredune ridge.

“The young foredune acted as a natural barrier to this wave energy,” Emery explained, “by facilitating the seaward progression of higher elevations on the beach. That higher sand elevation prevented the wave runup from extending as far up the beach as it did in the groomed beach outside of the restoration project.” While more intense storms and wave action are anticipated as the world’s climate continues to warm, observing the effects of storms like the one in December 2023 is also “a good proxy” for the slower-onset effects of sea level rise, he added. Southern California in particular is predicted by some models to lose up to 24-75% of its sandy beaches by 2100 to sea level rise without intervention.

In Southern California, and at many urban sandy beaches throughout the world, beach grooming is a practice that keeps the sand litter- and seaweed-free for

visitors. However, the practice of raking and sieving the top layers of sand also flattens natural formations and prevents vegetation from taking hold, while also impacting the animal communities and food webs that rely on sandy beaches. As coastal municipalities and beach communities reckon with encroaching seas, letting nature take over to allow dunes to form could be a viable defense for some stretches of coast, and an alternative to hard structures, according to the researchers. The added benefit for nature-based solutions such as this is that the dunes may also be able to self-repair after a disturbance event, like a storm.

“Our observation is the young dunes were not damaged much by this wave event,” said co-author Jenny Dugan, a Marine Science Institute researcher. “The plants survived and everything needed to continue to build the dunes was maintained through this event.” It’s important to note that not all coastal dune restoration sites will respond in the same way, she added, which is why site evaluations like this are essential.

The researchers will continue to monitor the project and how it performs in the face of disturbances and add to their growing body of knowledge on nature-based coastal resilience measures — knowledge that could be applied to other places along the California coast and perhaps eventually, worldwide.

“Any opportunity to evaluate these projects after actual disturbance events, can provide so many valuable insights,” Dugan said. “Modeled predictions on effects of disturbance are very useful, but when you can actually get out and measure what happens during a disturbance event, you gain a wealth of information about site performance.”

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