New research unlocks the mystery of New England's beaches

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Woodruff's team making a transect of a rocky New England Beach. Credit: Jon Woodruff

Millions of Americans will visit New England's beaches this summer to cool off, play in the waves and soak up the sun. Until now, the factors governing which beaches slope gradually to the sea and which ones end abruptly in a steep drop-off have been largely unknown. However, new research from the University of Massachusetts Amherst reveals, with unprecedented detail, how the grain size of beach sand relates to the slope of the beach itself. These new findings are critical to understanding how New England's beaches will respond to both rising sea levels and increased storm activity.

Many of New England's beaches are made up of a mixture of sand and small stones. Or, to be more precise, the grain sizes on these beaches are "bi-modal"—composed of very large pieces of gravel, from 10 to 64 millimeters, and medium-to-coarse sand, from .25 to 1 millimeter, but with very little in between.

"I challenge you to find a handful of grains from a New England beach that are about 5 millimeters (or just under one-quarter of an inch) in diameter," says Jon Woodruff, a professor in UMass Amherst's department of geosciences and lead author of a recently published paper in *Marine Geology* that details his team's research. "There just aren't many."

It turns out the grain size is one of the crucial determinants of a beach's slope, and researchers have long known that the finer the sand, the more gradually pitched the beach—up to a point. "The relationship between grain size and slope falls apart for coarser-grained beaches," says Woodruff. Though many New England beaches are typically made up of coarse-grained particles, they still slope gradually to the water's edge. Until now, no one knew why.

"Past researchers have always focused on either the mean or median grain size," says Woodruff. It's a method that works well for finer-

grained beaches. But in a bi-modal, New England beach, the median grain size falls right in that gap between 1 and 10 millimeters. Woodruff and his team took over 1,000 samples from 18 beaches in Massachusetts from which they assembled the largest, publicly available dataset on New England beaches.

The UMass research group also included Steve Mabee and Nick Venti from the Massachusetts Geological Survey, as well as an army of students led by UMass co-authors Doug Beach and Alycia DiTroia. What Woodruff's team discovered is that in bi-modal beaches, it's only the finer-grained sand that determines a beach's slope. "That smaller handful of sand grains," says Woodruff, "is why beachgoers have a place to sunbathe in New England."

This new research, which was conducted in partnership with the Massachusetts Office of Coastal Zone Management and supported by the federal Bureau of Ocean Energy Management and the Northeast Climate Adaptation Science Center, has implications far beyond your next summer vacation. "Understanding how beach sand grain size influences the makeup of our beaches is critical for making projections as to how beaches will respond to storms and sea-level rise," says Woodruff. "Especially given the attempts to preserve beaches from erosion, which cost many millions of dollars every year, we need to know what determines the shape and defining grain size characteristics of these beaches."

More information: Jonathan D. Woodruff et al, Grain size and beach face slope on paraglacial beaches of New England, USA, *Marine Geology* (2021). DOI: 10.1016/j.margeo.2021.106527

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