Wave wash-over poses threat to endangered sea turtle nests and hatchlings

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Researchers from the Florida State University Department of Earth, Ocean and Atmospheric Science have found that powerful ocean waves pose a significant threat to sea turtle nests, with wave exposure potentially affecting egg incubation and hatchling productivity. Credit: Matt Ware.

Waves breaking and hitting the shore are a familiar sight to any

beachgoer, but these powerful acts of nature play a big role in whether sea turtle nests thrive in their coastal surroundings.

Researchers from the Florida State University Department of Earth, Ocean and Atmospheric Science have found that powerful ocean waves pose a significant threat to sea turtle nests, with wave exposure potentially affecting egg incubation and hatchling productivity.

"This study was motivated by the significant number of nests along the northern Gulf of Mexico, and nesting beaches around the world, lost each year as a result of wave exposure, inundation and erosion during storms and high tides," said Matt Ware, a coastal ecologist and FSU postdoctoral fellow.

Sustained exposure to waves may affect an embryo's viability as well as a hatchling's locomotive function, size and sex—key elements that dictate whether the turtle will make its crucial first trip to the sea and indicators that it will survive into adulthood, said Ware.

Ware, who earned his doctorate in biological oceanography at FSU, worked with Associate Professor of Oceanography Mariana Fuentes on the study, which was published last month in *Remote Sensing*.

"This project assesses wave exposure across the Florida Panhandle and is an extension of a similar project I conducted during my doctoral studies," Ware said. "My original research, based on nests in Alabama's Fort Morgan Peninsula, is more proof-of-concept, whereas the current project is geared toward application."

Ware's initial work demonstrated that empirical wave runup models could be used to inform sea turtle conservation management by identifying potentially high-risk nest locations. The current study uses these models, alongside data on beach slope, beach elevation and

offshore wave height to map areas of high wave exposure and predict sites of wash-over and inundation.

Fuentes noted that though their research was specific to sea turtles, the information they gathered can be helpful to wildlife and conservation specialists in general.

"Understanding how coastal areas will be inundated can aid the management of other coastal species, like sea birds and beach mice, that may use those areas," Fuentes said. "These results can be used to create more effective coastal development policies to better protect endangered coastal species, such as sea turtles and others."

Nesting beaches along the 200-mile-long Panhandle coast most at-risk from wave exposure include St. Joseph Peninsula, St. Joseph Peninsula State Park, St. George Island, Cape St. George Island and Cape San Blas. Combined, these beaches represent 60 percent of loggerhead sea turtle nesting in the Panhandle and about 300 at-risk nests each year.

About 96% of nests along this coastline are temporary homes for endangered loggerhead sea turtle eggs, and the remaining 4% of nests belong to other endangered species: green, leatherback and Kemp's ridley sea turtles. Over the three years surveyed, 2016 to 2019, almost half of the loggerhead nests experienced some degree of wave exposure during their two-month incubation period.

"Sea turtle eggshells are soft and leathery, which allows oxygen, carbon dioxide, water and other elements to be exchanged between the embryo and surrounding nest environment. The embryos can 'breathe' in a sense," Ware said. "When waves wash over the nest, or during heavy rain from storms and high tides, the exchange of elements is altered or stopped completely."

Prolonged submersion can result in altered hatchling locomotor function, size, sex ratios or death if the nest isn't simply swept into the sea. Washed-over nests produced 46 percent fewer hatchlings than undisturbed nests, and almost 20 percent of the sea turtle nests studied were partially or completely eroded away by wave activity.

However, the research also discussed sublethal levels of wave exposure, which may be beneficial in the long run. Sea turtles have temperature-dependent sex determination—warm nests produce more female hatchlings. Wave wash-over and heavy rainfall can cool nests, producing more male hatchlings than dry nests, so as nesting beaches continue to warm and produce more female turtles, exposure may be important to ensure adequate hatching of males.

"This modeling approach isn't just sea turtle-specific—by understanding how beaches respond to storm events or how likely a given beach's response is to shift over decades, efforts to conserve different shore and sea species can be drastically improved," Ware said.

Fuentes and Ware are currently conducting a follow-up project on St. George Island to further investigate the effects of beach erosion and wave exposure on sea turtle nesting ecology, specifically examining embryonic tolerance under different conditions. Their research helps recommend management actions or interventions necessary for the protection of endangered coastal and beach species.

Other contributors to the study include Simona A. Ceriani from the Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission and Joseph Long from the Department of Earth and Ocean Sciences at the University of North Carolina at Wilmington. This study was funded by the Sea Turtle Grants Program.

More information: Matthew Ware et al, Exposure of Loggerhead Sea

Turtle Nests to Waves in the Florida Panhandle, *Remote Sensing* (2021).
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