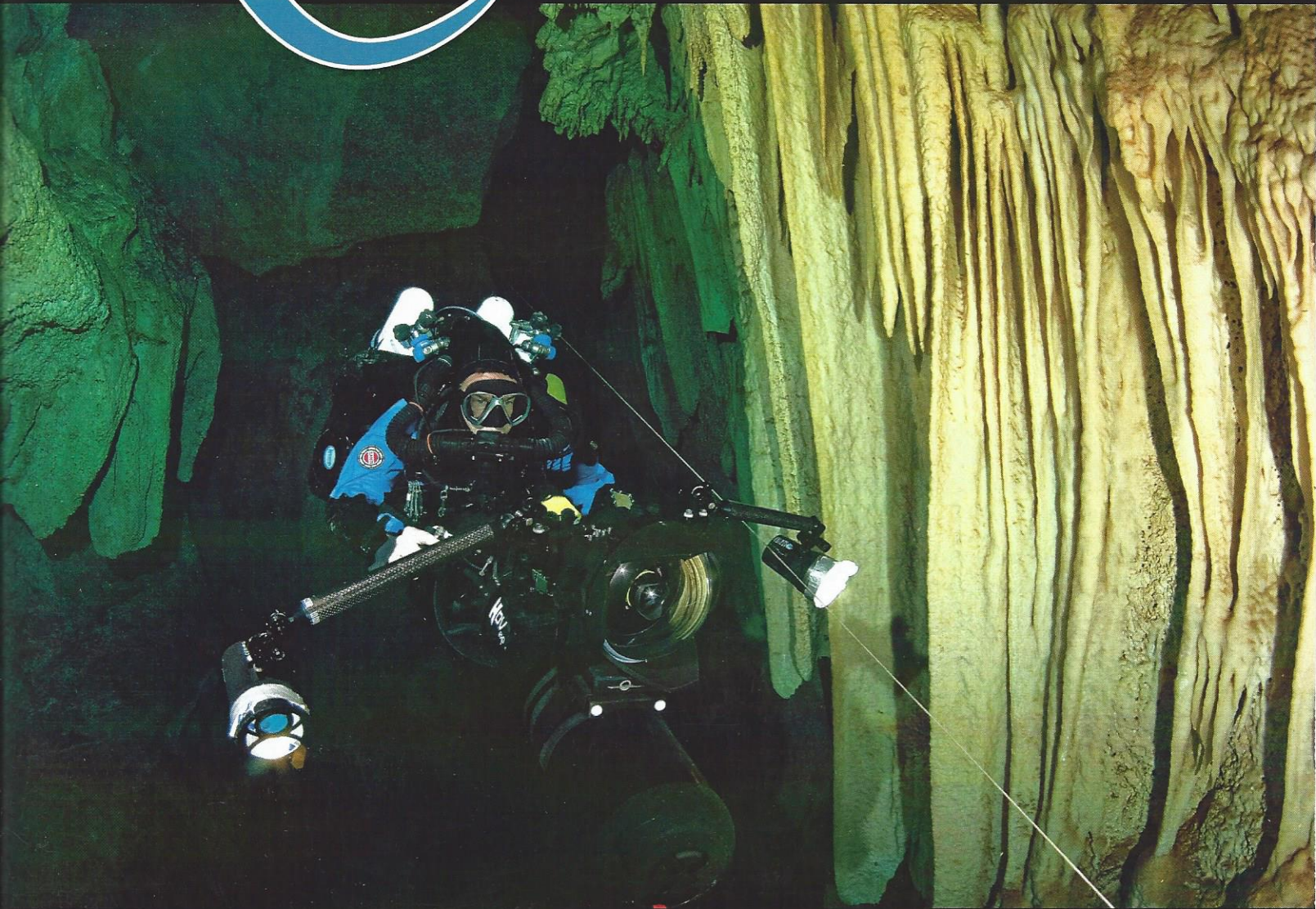


The Journal of Global Underwater Explorers

Quest

Vol. 15, No. 2



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Investigating the Effects of Shoreline Development and Climate Change on Loggerhead Nesting Habits

By Dr. Joshua S. Reece and Dr. Reed F. Noss

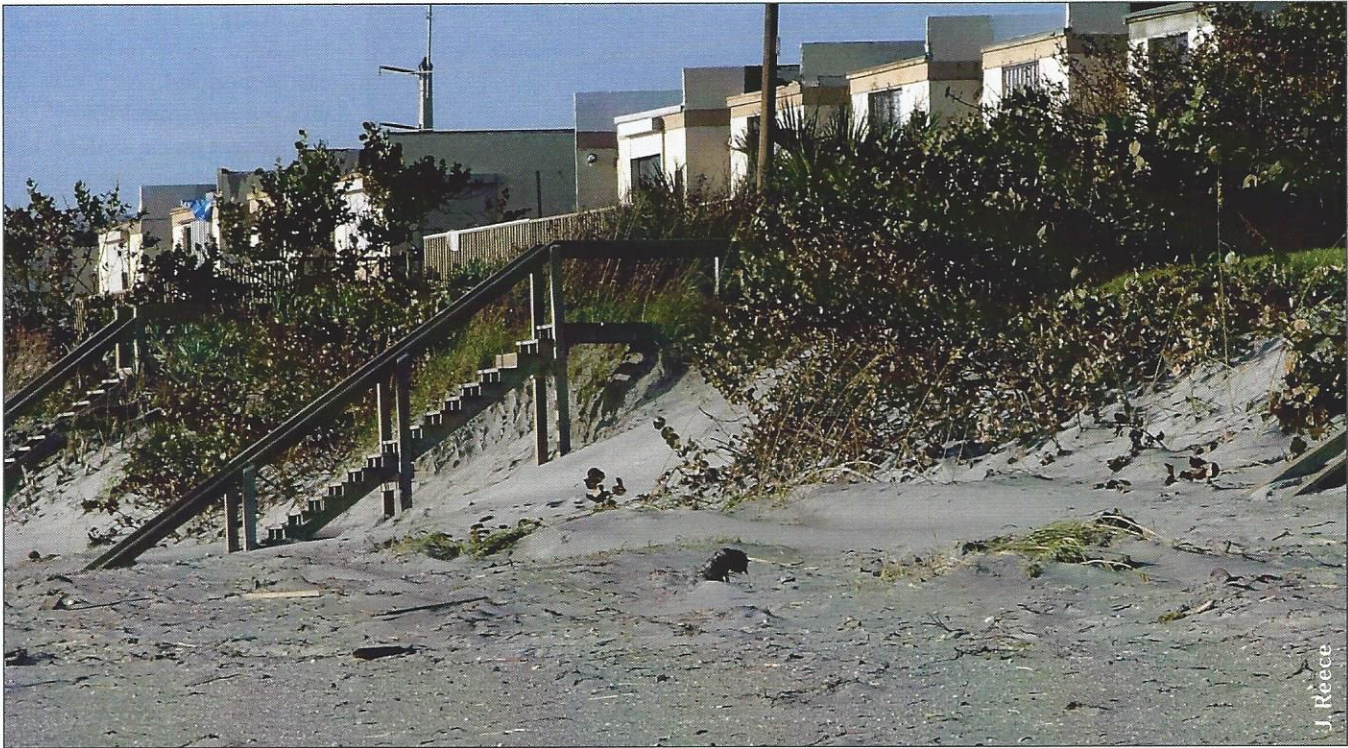


Loggerhead nesting at Masirah Island, Oman

FLORIDA SERVES AS vital sea turtle habitat; five of Earth's seven sea turtle species nest along Florida's coastlines. In 2012 alone South Florida provided nesting habitats for over 1,700 Leatherback turtles, 10,000 Green turtles, and dozens of Kemp's Ridleys and Hawksbills. However, it is the Loggerhead turtle that is most reliant on Florida's coastlines; more Loggerhead turtles nest on the southeastern coast of

Florida than anywhere else along the Atlantic coast. Florida hosts one of the two largest Loggerhead rookeries in the world (the other being the beaches of the Sultanate of Oman in the Indian Ocean). The Archie Carr National Wildlife Refuge created in 1991 and named after the famous University of Florida herpetologist, Archie Carr, is the crown jewel of Loggerhead nesting beaches in Florida. One out of six Loggerhead turtle





Beachfront housing blocking migration of beach habitat (Melbourne Beach, Florida)

nests in the U.S. can be found on the refuge's approximately 13 miles of beaches. However, the number of Loggerheads nesting in the refuge (and throughout Florida) changes from year to year (Figure 1), and trends are difficult to interpret.

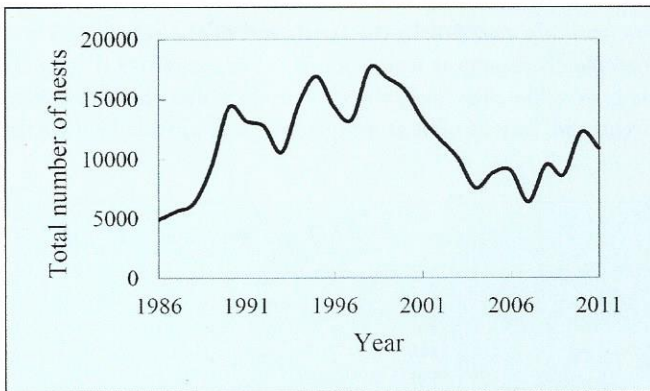


Fig. 1: Loggerhead nesting data

Loggerheads face a number of threats. In addition to nest predation by dogs, raccoons, crabs, and other predators, hatchlings face a gauntlet of bird and fish predators, juveniles face predation by tiger sharks, while adults are harvested for food, killed as bycatch by longline and shrimping fisheries and must also compete for nesting habitat with beachfront-hungry humans. Conservation efforts over the last 30 years have reduced bycatch from fisheries and have also focused on protecting nesting beaches from light pollution and erosion due to seawalls and other man-made structures. In addition to direct human stressors, Loggerheads are also threatened by climate change.

Loggerheads have existed in the Atlantic (and, specifically, Florida) for millions of years, and have adapted to changing climates and sea levels by relocating their nesting habitat depending on environmental conditions: north during warm periods, south during cooler periods, or out of Florida entirely during times of very high sea level. Because of their adaptability to changing climate conditions, the current pattern of global warming and rising sea levels may not appear to be an imminent threat. However, the larger issue is that while coastlines are naturally dynamic, urban environments and infrastructure are not. Before the coastal zone was altered by humans, beaches, dunes, and entire barrier islands shifted with changing climates and sea levels, allowing species that relied on them to move as well. Now, when the climate warms and beach-dwelling species seek cooler, more northern latitudes, they bump into unfavorable habitats that have been altered by humans. Where beaches used to ebb and flow with sea level, sea turtles and other beach creatures are now met with cold, hard cement in the form of sea walls, condominiums, or roads, such as Highway A1A on the east coast of Florida. Another issue is that whereas the borders of protected areas like the Archie Carr National Wildlife Refuge are fixed, the environmental factors that healthy Loggerhead populations depend on, such as sand grain size and beach slope, are dynamic, and as a result, turtle populations also move over time. The Loggerhead turtles that nest in the refuge may move to sandier pastures, but the protections offered by the refuge will not move with them.

Researchers at Valdosta State University (VSU) and the University of Central Florida (UCF) recently collaborated to understand how the Archie Carr National Wildlife Refuge has changed over the span of 20 recent years (1986-2006), and how



The wide beaches of the refuge are ideal for loggerhead nests (Melbourne Beach, Florida).

Loggerheads have responded to those changes by choosing nest sites. We examined three factors: 1) the width of the beaches (turtles prefer to nest on wide, steep beaches where they can lay their nests above the high tide line), 2) the number of beachfront structures (these structures contribute to light pollution that disrupts nesting turtles and their hatchlings), and 3) the north-south distribution of nests (latitude). We expected that between 1986 and 2006, Loggerhead nests would become more dense on wider beaches and less dense on narrow beaches, that fewer nests would be laid in areas with high numbers of beachfront structures, and that nest density would shift north in response to warming temperatures.

Our findings surprised us. First, between 1986 and 2006, the beaches of the Archie Carr National Wildlife Refuge decreased in width by an average of just over 10 feet, corresponding to a 6.5% loss of beach area. Beachfront housing increased 160% as new structures were introduced along the dune line. Temperatures in Florida also increased over this time period, and it is possible that the north end of the refuge warmed less than the south end of the refuge, but this has not been measured on such a small spatial scale. Sea surface temperatures appear unrelated to changes in nest placement.

Loggerheads responded to these changes by shifting their distributions towards narrower beaches (against our predictions), away from beachfront housing (consistent with our predictions), and towards northerly latitudes (a possible response to global

warming). In fact, these relationships were linear and easily modeled. As a test, we used our data from 1986 to 2006 and a linear model of all of these factors (latitude, beachfront housing, and beach width) to predict where nests would be in 2011, and our model predicted the actual distribution with high accuracy (explaining 80% of the spatial variation in nests). Our model effectively predicts how changes in these factors affect where sea turtles deposit their nests.

Next, we collaborated with coastal modelers in the Department of Civil, Environmental, and Construction Engineering at

UCF to predict how recent trends in sea level rise would alter beach widths in the refuge by the year 2050. We used the linear model from our observed data, extrapolations of beachfront housing, a continued shift north in where loggerheads nest, and projected levels of beach erosion to predict where turtles would nest in the refuge by 2050. Our projections are startling. In 1986, Loggerhead nests were rather evenly distributed north-to-south in the refuge, with slightly more nesting in the south. By 2006 they had shifted to higher densities in the north, towards more eroded beaches, and away from high levels of beachfront housing. By 2050, our model predicts that nesting will become increasingly crowded in the north end of the refuge and will completely disappear from some parts of the refuge (Figure 2). It is possible that Loggerheads will continue this northward trend and, instead of becoming increasingly crowded within the

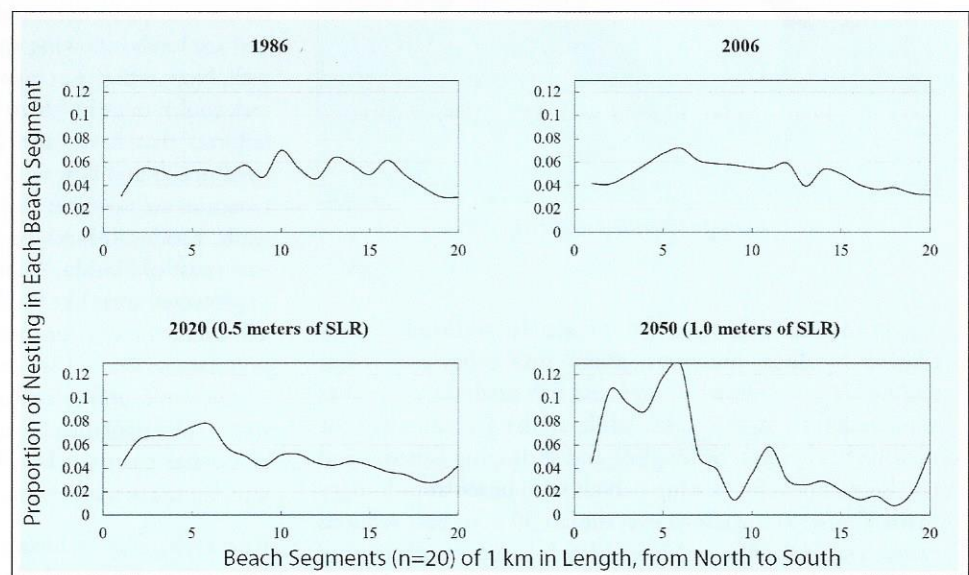


Fig. 2: Proportion of nesting in each beach segment





Eroded parts of the refuge (Melbourne Beach, Florida)

northern part of the refuge, they may shift north beyond the boundary of the refuge. Plenty of (mostly) undeveloped beaches exist north of the Archie Carr National Wildlife Refuge, but they may not have the right combination of environmental factors (beach slope, sand grain qualities, beach width, etc.) that turtles need to construct successful nests.

Our study demonstrates the need to think more dynamically about how to build up and manage coastal ecosystems. First, beaches within refuges may be protected from high-rise hotels, but they are not immune from development. Second, beaches are narrowing as a result of sea level rise and coastal erosion. Whereas historically these beaches would “migrate” inland, now they bump up against intransigent features, such as cement sea walls, houses, parking lots, and roads. When beaches can no longer move inland, they become narrower. This pattern is exacerbated on narrow barrier islands, such as Melbourne Beach (the location of the Archie Carr National Wildlife Refuge). As beaches shrink, turtle nests are squeezed into less and less space, and in combination with other factors, such as light pollution and climate change, turtles may continue to move their nests outside of the refuge and onto unprotected stretches of beach, which may or may not be suitable environments for egg development.

So, what can we do? Are Loggerheads doomed to extinction? Loggerheads have weathered these changes before, and they will likely do so again, but not without major losses. It appears likely that one of the most important refuges for Loggerheads in the world may start to lose nests as these turtles shift their distributions outside of the boundaries of the refuge. We can help to ameliorate these impacts in two ways. First, we can

make lifestyle changes to reduce our carbon footprint, which will help reduce the severity of climate change in the long term. Second, we can encourage local governments to incorporate projections of climate change, sea level rise, and coastal erosion into their land-use planning. We should not let developers build beachfront structures insured by public funds when those structures are doomed to be underwater within the next 20 to 50 years, especially when they harm local wildlife. The sea turtles of Florida’s east coast will thank us!



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