

# SEA CHANGE



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OVERFISHING OF  
OUR COASTAL  
WATERS HAS  
OCCURRED FAR  
LONGER, AND  
WITH MORE DIRE  
CONSEQUENCES,  
THAN ANYONE  
SUSPECTED.



"INDIANS FISHING" BY JOHN WHITE, 1586/THE BRITISH MUSEUM

flocks of migratory ducks blacken the horizon. Dolphins frolic in the channels, tearing through thick schools of menhaden like grinning Ginsu knives. In a deep cove near the Neuse River's mouth, a gray whale guards her calf.

**Just imagine.**

**Just imagine.** The Pamlico Sound is teeming with fish—shad, herring, striped bass, flounder and swordfish. Red drum can be taken by the barrelful. Abundant hammerhead sharks prowl for the easy fish dinners. Even sturgeon are so bountiful that Native American fishermen pluck them as easily as berries.

The water is so clear that stone crabs on the sound's sandy bottom are visible 10 feet below. It is the work of the vast oyster reefs. The filter feeders take just three days to clean the entire sound of mud, sediment, bacteria and other microscopic organisms such as the larvae of dinoflagellates.

Not just fish abound in the pristine Pamlico. Alligator snouts poke above the brackish surface of the estuaries. Manatees and sea turtles graze the underwater prairies of seagrasses. Thick



Anyone familiar with North Carolina's coastal waters might dismiss that scenario as science fiction. But it's historical fact.

"According to fisheries records going back to the colonial era, the western side of the Pamlico Sound was full of anadromous fishes," said Charles Peterson, a marine scientist with the University of North Carolina at Chapel Hill. "Not only that, but there were sharks, rays—you can go a whole lifetime without seeing any of those in the sound now. The sea turtles were so numerous, some of the historical records say you could practically walk to shore on their backs."

North Carolina's coastal ecosystem has changed drastically in the last few centuries. The Pamlico Sound, second in size to Chesapeake Bay, remains a major fish nursery on the East Coast. But many species have either disappeared or are hanging on tenuously. The great oyster reefs were long ago knocked down and harvested, opening the sound to navigation and providing profit

for an unsustainable commercial fishery. Without the constant filtering by numerous oysters, the water isn't clear so much as opaque—or semiopaque outside the river mouths, where upstream land clearing, wetlands drainage, sewage discharge and agricultural runoff combine to pour mud and pollutants into the delicate estuaries.

But pollution by itself isn't to blame for the coast's environmental afflictions, said Peterson. He and several other marine ecologists are just now beginning to see the whole picture—the forest for the trees, or the Sargasso for the seaweed. And one dimension of the picture unobserved until now has been time.

#### HISTORY LESSONS

Overharvesting of marine food species has been a leading culprit in the collapse of fisheries worldwide over the last century. A few decades of data-gathering by marine scientists have drawn some convincing links between declining fisheries and overfishing.

Peterson and 18 colleagues from around the world have uncovered some new links, some of which were thousands of years in the making. The team of marine biologists, ecologists, anthropologists, geologists and historians jointly published an article last summer in the prestigious academic journal *Science*. They concluded that overfishing is not just a recent phenomenon, and that its consequences can be catastrophic. They even showed that overfishing and pollution are not wholly separate phenomena.

"We saw the same patterns emerging, in different places and at different times," Peterson said. "In every instance of altered coastal ecosystems we looked at, we found overfishing preceded everything else: pollution, loss of habitat, invasive species, climatic change—all the human-caused things we normally associate with ecological disturbance."

From the Mediterranean Sea to the Australian Pacific, coastal societies tend to overfish down the food chain—depleting species at the top of the chain, then overfishing the next level, then the next level. And not just industrialized people take fish faster than they can replenish. Contrary to the romantic notion of indigenous peoples living in perfect harmony with nature, researchers have unearthed numerous examples of early fishermen creating ecological problems. Shell middens for Algonquian Indian settlements along the mid-Atlantic coast, some dating back thousands of years, show oysters growing smaller after intense harvests.

State archeologist Steve Claggett said coastal North Carolina's Algonquian fishermen were both adept and efficient, using tools from bone hooks to nets. Some even lit fires to attract fish at night. "The hard evidence we have from archeological deposits is they captured and ate all kinds of fish, large and small, [as well as] certainly a lot of shellfish and some we would consider offshore species, which we might find surprising," Claggett said.

Although not a contributor to the *Science* article, Claggett said its findings jibe with what archeologists have observed about Native American hunting and fishing. "If they had the technology, [coastal indigenous peoples] could have caused a lot more dam-

age. It's probably human nature. We see it with the Late Woodland Indians, advancing from spear to bow and arrow, then to the deer drives where they'd set a fire and, when the deer ran out of the woods, kill them all—or as many as they could."

Watercolors by John White, an early colonial governor of North Carolina, depict the indigenous people of Roanoke Island using spears, dugout canoes and weirs, or wooden fish traps (see page 7). White's paintings, which have been praised for their accuracy, also lend credence to the modern marine scientists' hypothesis that the Pamlico Sound was full of sturgeon, hammerhead sharks, rays, grouper, snapper and other fish now considered rare or declining or wholly offshore species.

Other documentary evidence abounds. Early North Carolina naturalist Mark Catesby wrote in 1712 that "Sharks of the Carolinas are not so numerous, large and voracious as they are between the Tropicks; yet the Coasts, Bays and larger Rivers have plenty of them."

The historical roots of overfishing actually go back to prehistory, said Hunter Lenihan, also a marine sciences professor at UNC and a co-author of the *Science* article. Core samples taken from the bottom of the Pamlico Sound and other major (or once-major) fisheries from around the world show a dramatic difference in fossils and chemical content before human habitation and afterward. After humans settle a coastal area, the entire marine biomass declines.

By itself, overharvesting of a species or two would not alter the local ecology so drastically. But when one layer of a food chain disappears, the rest of the ecosystem is altered. Overhunting whales, for example, creates an overabundance of their favorite foods—jellyfish and tiny krill. Their greater



JODY DUGGINS

*When fish are hauled in faster than the stocks can replenish, more than the overfished species is affected. Overfishing of our oceans and sounds contributes to pollution, habitat destruction and other ecological problems.*

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*Centuries before these spot fishermen off Cape Lookout were hauling in nets, Native American fishermen were having an effect on the environment.*

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*UNC-Chapel Hill graduate student Adam Baukus checks an artificial oyster reef, one of dozens established in Bogue Sound to improve water quality. When the natural reefs were tall and dense enough to make navigation hazardous, oysters completely filtered the sounds and estuaries in a few days.*

numbers cause shortages of animal and plant plankton, the next lowest strata. A decline in plankton hurts animals such as oysters that feed on microorganisms, which can cause a spurt in bacterial growth. So the loss of whales can contribute to the dirtying of coastal waters.

Although whaling is normally associated with New England or the Pacific Ocean, coastal North Carolina supported a whaling industry for a time. “Whales are very numerous on the Coast of North Carolina,” explorer and naturalist John Lawson wrote in 1701. The great whales now merely migrate past, but humpbacks and right whales were once common off the Carolina coast, and Atlantic gray whales once wintered in the Pamlico’s estuaries. Now extinct, Atlantic grays are known to us only through history and paleontology. Of six excavated skeletons, four came from North Carolina waters. Whalers picked off the gentle leviathans in their calving grounds, at the mouths of North Carolina rivers,

until the mid-18th century, when the whale populations tapered sharply. Captains’ logs indicate the last Atlantic gray whale was harpooned in 1786.

#### PEARLS BEFORE SWINE

Seeking links between overfishing and other ecological problems, the scientists-turned-historians found a pearl. Historical fisheries records of Chesapeake Bay and Pamlico Sound contained strong evidence that the usual suspects for environmental degradation—runoff from hog farms and other agriculture, development, municipal sewage and industrial pollution—became a problem at the same time as the collapse of oyster fisheries.

“There was land-clearing and farming throughout the basins for hundreds of years—maybe not on the scale of what we see today,” Peterson said. “The difference is that the oysters [historically] were able to filter the sediment and the nutrients.”

Removing oysters faster than they can replenish hinders their filtering of the water. It becomes cloudy. Sediment buries those oysters that remain, smothering them. Microbes, algae and other microscopic invaders, which the oysters would have filtered, proliferate. The stage is set for ecological disaster.

Chesapeake Bay, now ridden with sediment, pathogens and oxygen-depleting algae, was once crystal-clear. Jamestown, Va., founder Capt. John Smith in 1607 wrote of losing a cannon overboard yet seeing it clearly at the Chesapeake’s bottom, 20 feet deep. Not coincidentally, Smith also wrote that the James River upstream from the bay was so full of oyster reefs that they posed a hazard to navigation. As late as 1900, the remaining oyster reefs could have filtered the entire Chesapeake in just three days. Now there aren’t enough to filter the same volume of water in a year.

Although the Pamlico hasn’t degraded to that point yet, the oyster populations are falling along with water quality. Studies of the Neuse River estuary show that oyster reef heights dropped by nearly 5 feet, or 70 percent, from 1868 to 1993. Many of these oysters were harvested at the end of the 19th century. And they have yet to rebound with continued fishing pressure. (See “Twilight for Oysters,” *Wildlife in North Carolina*, November 1998, for more on the history of North Carolina’s oyster fishery.)

Reducing nutrient loads in the river basins isn’t enough to clean the degraded waters, Peterson said. “Oyster restoration could solve a lot of ills, and it’s practically an off-the-shelf technology.”

Dozens of newly constructed reefs dot Bogue Sound, offshore from Peterson’s lab at the UNC Institute for Marine Sciences in Morehead City. PVC pipes mark them, painted fluorescent orange above the high-tide line. At low tide, the retreating waters reveal oyster reefs 6 feet square, anchored by buried sandbags. Tiny sand crabs scuttle over in search of tinier prey. When the tide rolls back in, thousands of marine creatures, from sea worms to sea bass, will find food and habitat among the clumps of shells.

These artificial reefs were simple to build. A barge was loaded with shells from a local

shucking plant, then floated into the sound. At various points, the empty shells were bulldozed overboard and seeded with live oysters. As the oysters reproduce, they add new layers to the reef—and maybe new life to dying bodies of water, Peterson said.

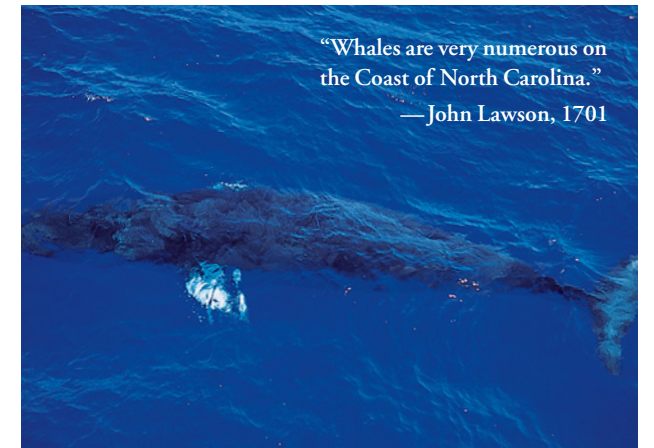
“We in North Carolina are not like New Jersey or Long Island bays, where the oyster has been exterminated. We’ve got ’em, but we’re doing the same sorts of things that other people at other times in other places have done—wiping out their oyster reefs,” he said. “The negatives you hear [about oyster reef restoration] are from the narrow perception of, ‘That’ll never bring back our oysters.’ I think it will. Even if it didn’t, that’s irrelevant because oysters add so much beyond just being a fishery. They enhance water quality; they provide habitat for crabs and red drum and numerous other marine species; and because you’ve got cleaner water and better habitat, that will help restore the fisheries. The fishermen benefit dramatically.”

#### DOOMED TO REPEAT HISTORY?

Over the long term, maybe. In the short term, people who survive on the sea’s bounty would almost certainly suffer.

What Peterson and his colleagues have in mind is the restoration of marine ecosystems to their historical, even prehistorical, levels. The fishing quotas set by state, national and international regulators are designed to maintain statistical benchmarks that were established just a few decades ago—after overfishing had begun to devastate coastal waters.

Nancy Fish, a spokeswoman for the N.C. Division of Marine Fisheries, said much of the data that the agency uses in regulating fish stocks goes back to the 1970s. And while the agency has partially restored several overfished species, it approaches regulation with the goal of creating an “optimum



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*Sediment sampling off Bear Island (below) for fossils and other geological evidence is one of several methods by which marine scientists have developed a portrait of marine life hundreds and even thousands of years ago.*



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yield—how much can be removed and still repopulate,” she said.

Of a restoration on the scale of what the *Science* team proposes, Fish said, “You’re talking about shutting down fishing for quite a while—not just commercial fishing, but recreational fishing. Even with catch-and-release, there is mortality.”

Jerry Schill, president of the N.C. Fisheries Association, said restoring fish to historical levels “would have very serious negative consequences for North Carolina’s fishing community.”

“The management agencies are already using in some cases draconian measures, so it’s hard to imagine them ratcheting down further,” Schill said. “If the management agencies decided to enforce or embrace this





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philosophy of bringing stocks back to what somebody thinks is the appropriate historical level, it would be decimating to the management system itself. The credibility of the process would be hurt.”

Commercial fishermen “begrudgingly accept the restrictions and the regulations,” he added, “because they’re convinced down the road it’s best for everybody. Because

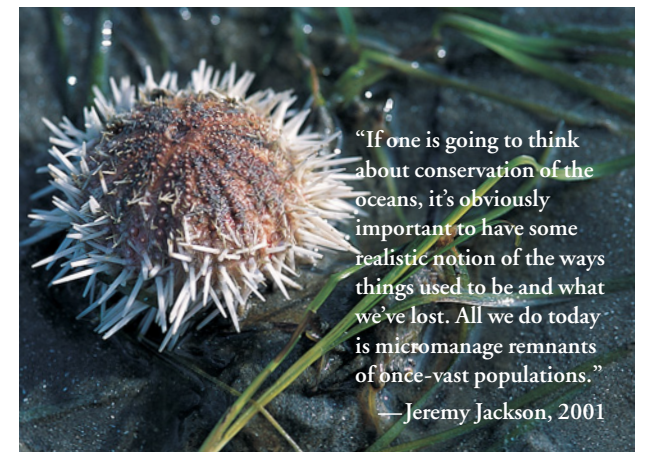
*Restoring the sea’s bounty could conflict with commercial fishing for herring (left) and many other species.*

we’re cooperating and sacrificing, the stocks are rebounding. We’re starting to see the light at the end of the tunnel. And now this crowd of academics is coming up and saying, ‘What we really need is to go back to where we were not decades, not centuries, but hundreds of centuries ago.’”

If those academics are right, it may come down to a choice between the suffering of fishing communities and the suffering of everyone. Fish now provide one-sixth of the world’s overall animal protein, according to the United Nations Food and Agriculture Organization. And as the world’s population

grows, people will turn even more to the sea than to farmed-out lands and inefficient grazing stock. But already, 47 to 50 percent of global marine fisheries are either fully or overexploited, according to the FAO.

Last year, the National Marine Fisheries Service issued a report stating that 31 species of the fishes it manages are at risk of extinction. That’s because in many cases, fish stocks are so depleted and habitat so degraded that they cannot recover.



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—Jeremy Jackson, 2001

Jeremy Jackson, lead author of the *Science* overfishing article, described the multidisciplinary study as a wake-up call.

“If one is going to think about conservation of the oceans, it’s obviously important to have some realistic notion of the ways things used to be and what we’ve lost. It’s really hard to make plans or develop policy and alternatives if you don’t have a sense of that,” said Jackson, a California oceanographer. “All we do today is micromanage remnants of once-vast populations.”

Those who fail to learn from history are doomed to repeat it, an old adage professes. If we consider the devastation that overfishing has wrought in the past, and that continues to this day, we must realize that failing to reverse it could doom us to more than another history lesson.

“We all tend by nature to rely on our own experiences, or maybe our fathers or grandfathers—rarely further than a couple of generations. I don’t know if it’s arrogance,” Peterson said. “It’s astonishing the effect we’ve had on the earth.”

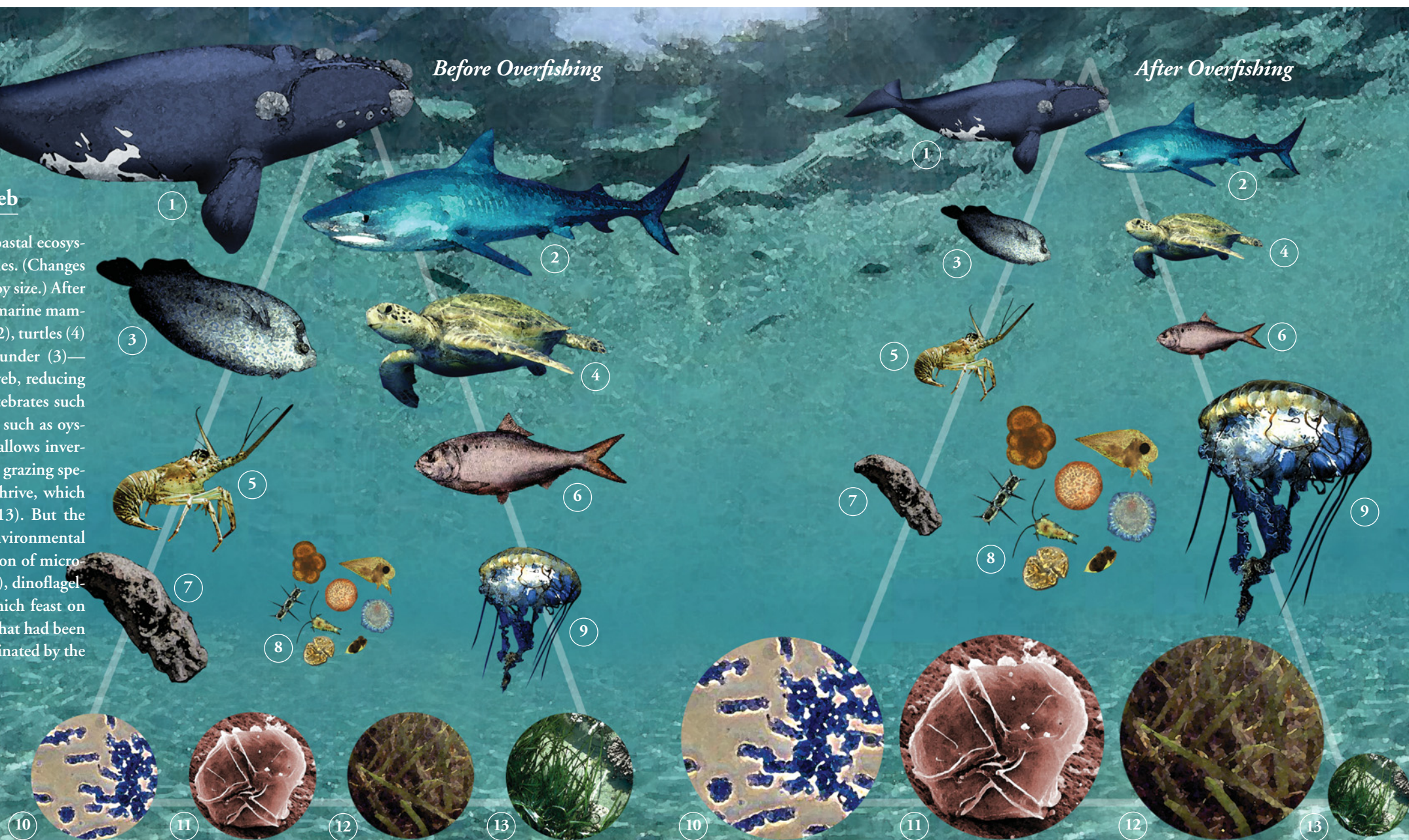
**Just imagine.** The Pamlico Sound teems with signs warning boaters not to eat any of the few fish or shellfish left. For good measure, the signs recommend not swimming, wading or even sticking one’s bare hands into the water. In case of contact, wash with soap and water. If rash, sores, aches or other symptoms develop, seek medical attention immediately.

Bacteria have become the dominant species in the sound, thriving on the stinking die-offs of menhaden and the sewage washing into the estuaries. In summer, dinoflagellates swarm and red tides of algae bloom, fertilized by the nutrients pouring into the sound from the rivers.

The oysters are long gone. The fish are only a memory. **Just imagine.** ☒

## A Ripple in the Food Web

Overfishing ravages an entire coastal ecosystem, not just the overfished species. (Changes in relative abundance indicated by size.) After overharvesting the top layers—marine mammals such as whales (1), sharks (2), turtles (4) and predatory fish such as flounder (3)—humans “fish down” the food web, reducing populations of predatory invertebrates such as lobsters (5) and filter feeders such as oysters (7). The lack of predators allows invertebrates such as jellyfish (9) and grazing species such as menhaden (6) to thrive, which can be ruinous to seagrasses (13). But the bait species soon die off from environmental shocks caused by the proliferation of microscopic organisms—plankton (8), dinoflagellates (11) and bacteria (10), which feast on now-abundant detritus (12). What had been a healthy ecosystem is now dominated by the lower echelons of the food web.



GRAPHIC BY JANE OSIELCO