Wetlands, Icecaps, Unease: Sea-Level Rise and Mid-Atlantic Shorelines

Author: Nash, Steve

Source: BioScience, 58(10) : 919-923

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/B581004

Wetlands, Icecaps, Unease: Sea-Level Rise and Mid-Atlantic Shorelines

STEVE NASH

Governmental agencies, nongovernmental organizations, and academics are pumping out reports about the potential impacts of rising sea levels. Action plans are beyond the horizon, for now.

It's a balmy evening on isolated, somnolent Pickering Beach, Delaware. The full moon looms, the late-spring tide is high, and thousands of horseshoe crabs make their ponderous way ashore to spawn. Their big shells look like science-fiction army tanks, and colliding gently in the shallows, they click like billiard balls.

That is a pleasant sound for Stewart Michels, a state biologist who supervises the annual survey of these animals and is out sampling their numbers. Populations seem to be making their way back to healthier levels after curtailment of years of overharvesting.

The recovery may be comparatively short-lived. Pickering Beach is one of those places where the gearwheels that drive sea-level rise—greenhouse gas emissions, a warming planet, melting icecaps—are engaged and accelerating. Horseshoe crabs normally spawn on sandbars and beaches like this one. But here and along most of the eastern coast, low-lying shorelines and wetlands are slowly going under.

Some scientists, from wildlife biologists to climate modelers, are unsettled by that prospect. "We really need to start focusing on some of these larger issues," Michels says. Several new studies of the effects of the sea-level rise (SLR) on the mid-Atlantic coast signal that many researchers agree with him.

State of Delaware biologist Stewart Michels examines mating horseshoe crabs at Pickering Beach. Photograph: Steve Nash.

A battering nor'easter, out of season and outsized, had come through Pickering Beach only a week earlier, bringing the second highest tides on record. More than a meter of water inundated the 38 houses that front the slender beach, heavily damaging some. National Guard rescuers in boats evacuated residents, starting at about 3 a.m. The receding waters revealed that the storm had taken a little of the beach with it.

"Sea-level rise in combination with other factors is already starting to have significant effects on the coastal zone," according to an 800-page, multiagency study led by the Environmental Protection Agency under the auspices of the US Climate Change Science Program (USCCSP), which is still in draft form. "Flooding of low lying regions by storm surges and spring tides is becoming more frequent and causing more damage and disruptions. Around the Chesapeake Bay, wetlands are being submerged, fringe forests are dying and being converted to marsh...."

Much of the mid-Atlantic coastline from Montauk Point, New York, to Cape Lookout, North Carolina, is subsiding. As a result, these waters have risen faster against the land—about 30 to 40 centimeters (cm) during the past century—than the global average.

For the future, scenarios modeled by climate scientists are shifting uncertainly

now. There's a wild-card question to cope with: How fast and how much will the polar ice sheets melt? Predictions of global SLR by the year 2100 range from 18 cm—the low end of some widely questioned predictions of the Intergovernmental Panel on Climate Change—to a highly conjectural 5 meters. An apparent, perhaps temporary, consensus among climate scientists hovers around 60 to 90 cm, a rise that by all accounts would bring enormous changes to mid-Atlantic coastal ecosystems. These include the possible loss of more than 2000 square kilometers of dry land and most tidal wetlands.

Sparrows or cruzeiros

The Delaware Bay shelters the largest spawning population of horseshoe crabs in the world. Their sandbars and strands "are diminishing at sometimes alarming rates," the USCCSP study notes, and other research estimates that the Delaware Bay could lose 90 percent of its spawning habitat. But the crabs will abide, even if in sharply reduced numbers. The species has, after all, persisted through two or three hundred million years and innumerable changes of climate.

They are emblematic, however, of the loss of biodiversity that is expected to occur if mid-Atlantic wetlands and shorelines are submerged by SLR too quickly or too deeply. "I'm not particularly worried about them. I think there are other species we should be worried about a whole lot more," Horseshoe Crab Research Center director Eric Hallerman says. The greenish egg masses left in the sand by the fecund crabs—each female deposits about 90,000 eggs per season—are a major source of protein for nearly a million shorebirds migrating through the region each spring.

"Two dozen species of shorebirds that we know of feed heavily on horsehoe crab eggs, and a few are already imperiled," Hallerman says. "The eggs are a superabundant and energy-packed resource. Marine turtles prey on horseshoe crabs a lot, so a loss of [crabs] might be a significant hit for the marine turtles."

Birds are at risk, too, because they use several different habitats in what are now 5500 square kilometers of tidal wetlands in the region. These include marshes with varying levels of salinity, swamps, rocky shores, riverine wetlands, and muddy tide flats. Even a moderately accelerating rise will cause many wetlands to become stressed, the USCCSP report predicts. If SLR reaches 1 meter by the year 2100, "it is likely that most wetlands would not survive."

One study estimates that a 60-cm rise in sea level over the next century could reduce shorebird foraging areas in Delaware Bay by 57 percent or more. The lower and more vulnerable shoreline of neighboring Chesapeake Bay provides habitat for several kinds of increasingly rare sparrows, black rails, Forster's terns, gull-billed terns, black skimmers, oystercatchers, red knots, and piping plovers. The bayshore also sustains many species of song birds, and tundra swans, Canada geese, herons, snowy egrets, and canvasback, mallard, redhead, and American black ducks.

The conflict between protecting biodiversity and meeting short-term human demands will sharpen if SLR becomes a destructive force, Hallerman believes. "It doesn't even have to get that desperate. If you look at an area that's developing rapidly, whether it's logging or mining or whatever, guys are out there to make dollars or cruzeiros or rupees.... I'm really worried that in our avarice and self-absorption we're going to drive lots of populations, and even species, to extinction. It's one of those things I worry about on nights when I can't sleep."

One climate-change cliché asserts that it will generate "winners as well as losers." For species diversity, it is probable that losses will markedly outweigh gains. "Sharp declines in populations and local extinctions are certainly possible in the mid-Atlantic region," US Geological Survey wildlife biologist Michael Erwin says, though some wintering waterfowl would probably be able to take advantage of more open water.

Lagoonal islands and marshes are the most vulnerable habitat, Erwin says. They don't have the kind of sediment input—which can sometimes create new dry land or wetlands despite SLR—that the barrier islands or the mainlands do. They're important for birds because they're isolated from human disturbance and from predators such as feral cats and dogs, foxes, and raccoons.

"I think this goes beyond the loss of a few species in a few states," Erwin adds. "It's potentially going to affect resources for a good part of the hemisphere. If a lot of the mudflats become unavailable or less productive all up and down the Virginia coast, then something like 30 species of migratory shorebirds will be affected, and several of those have already been listed as candidates for threatened or endangered status."

Erwin has studied birds along the Atlantic for 40 years, as many species and populations have become increasingly imperiled. He wonders whether, as SLR advances, our own species will be moved to take measures to protect shorebirds. "I would say it's unlikely. Almost any wildlife resource, I'm afraid, would be way down on the totem pole compared to all the things that humans hold near and dear: the economic things, for instance."

Hard shores and inertia

A bumper sticker that warns "No wetlands, no seafood!" overstates the case, but not wildly. Invertebrates and small fish feed on decomposing matter in the marshes, and they are consumed in turn by rockfish, menhaden, blue crab, and other larger species. A State of North Carolina coastal habitat study lists 25 different fish species that depend on wetlands as nurseries or for foraging, spawning, or refuge, or as corridors between habitats.

A variety of other recent research also traces these connections: An estimated 66 percent of commercial fisheries' catch depends on the region's coastal marshes for nursery and spawning grounds, including bluefish, flounder, spot, mullet, and croaker. Beaches are important spawning habitat for killifish, mummichog, perch, herring, silversides, and bay anchovy.

North Carolina alone accounts for more than a third—572 square kilometers—of the dry land that is within 1 meter of sea level along the mid-Atlantic now. Those are the coastal areas most vulnerable to the storm surges, high tides, and saltwater intrusion that SLR will

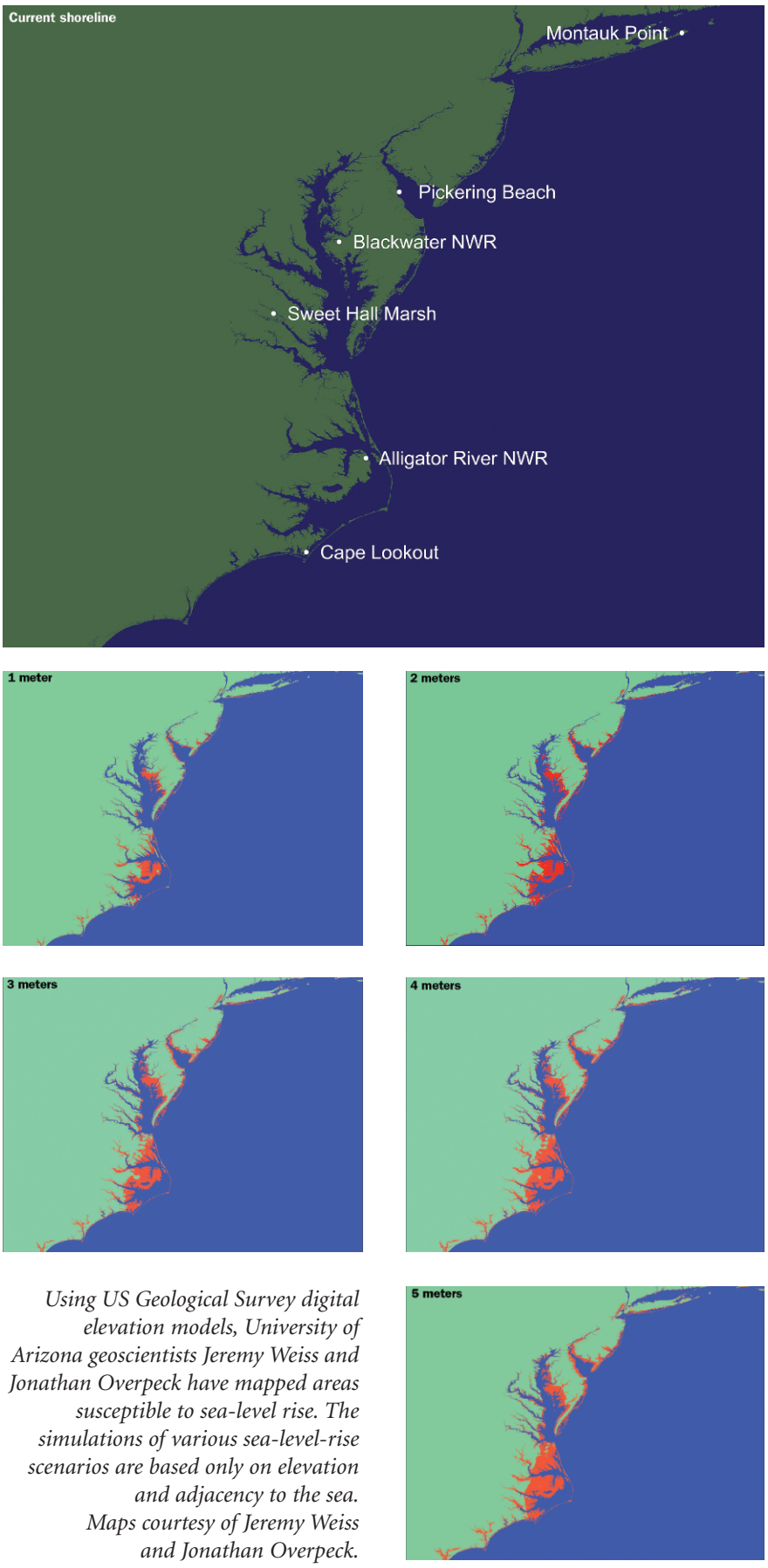
bring, even if they are not completely submerged.

Much of the shoreline's crucial habitat is public land. Alligator River and two adjacent national wildlife refuges in North Carolina are perhaps best known as the last remaining wild habitat for a reintroduced population of about a hundred red wolves. "The red wolf's primary population center is at risk due to sea level rise.... It is not likely to adapt to the marsh habitat in the short amount of time that these processes are already taking place," the USCCSP report notes, citing several studies.

Blackwater National Wildlife Refuge, on the eastern shore of the Chesapeake Bay near Cambridge, Maryland, consists of about 11,000 hectares of freshwater ponds, brackish tidal wetlands, fields, and mixed forests. A new study by the National Wildlife Federation (NWF) predicts that 32 to 45 percent of the refuge's dry land and 66 to 98 percent of its marshes will be submerged by a 60- to 90-cm SLR, though adroit management might forestall some of the damage.

When the sea moves landward, new wetlands can be created. That process is governed by the slope of the shorelines and the amount of soil added by sedimentation over time. This potential is small, however, compared with the extent of the wetlands at risk, according to the USCCSP report and the NWF study, both of which model SLR along the Atlantic. The nearshore dry land that is low enough for conversion to wetlands is less than one-sixth as large as what may be lost to SLR.

Another major factor in the creation of new wetlands is how humans will adapt. As shorelines flood, political pressure mounts to allow home and business owners to install more riprap, bulkheads, dikes, seawalls, revetments, groins, jetties, and other barriers to try to hold back the sea. In varying degrees, these structures wall off the potential for new beaches, wetlands, and other habitats and guarantee obliteration for existing ones as the waters rise. A recent survey found that 26 percent of Maryland's 6600 kilometers of shoreline is already hardened (the figure does not include tidal creeks).



Using US Geological Survey digital elevation models, University of Arizona geoscientists Jeremy Weiss and Jonathan Overpeck have mapped areas susceptible to sea-level rise. The simulations of various sea-level-rise scenarios are based only on elevation and adjacency to the sea. Maps courtesy of Jeremy Weiss and Jonathan Overpeck.

Carl Hershner, of the Virginia Institute of Marine Science, describes vegetation and sea-level changes at Sweet Hall Marsh. Photograph: Steve Nash.

Rapid construction of new waterfront homes and businesses raises the stakes. The NWF study says "the opportunity for inland migration in parts of the Chesapeake Bay region is becoming increasingly limited.... Essentially, habitats become squeezed out." New building and coastal armoring also speed beach erosion, and when dredged materials are used to "renourish" beaches, it's "a process that is not only costly but can be harmful to native fish and wildlife."

Delaware is less likely to permit new shoreline hardening, according to its Department of Natural Resources and Environmental Control, but many other jurisdictions still favor it. According to a tally by the Virginia Institute of Marine Science (VIMS), local and state agencies there approved 240 kilometers of bulkheads and revetments along tidal shores from 2000 through 2007. The USCCSP report holds out hope that more well-informed state and local planning—a "key opportunity"—might remove some existing hardscape, forestall more development, and allow the remaining natural coastline to adapt to SLR, at least to some extent.

In an aside, the study's authors reflect that "institutional inertia is a key barrier to change." The warming climate, however, forces new choices about "whether and how particular areas will be protected with structures, elevated above the tides, relocated landward, or left alone and potentially given up to the rising sea."

"Functioning cynics"

A line of planks nailed atop pilings leads out into Sweet Hall Marsh, a pristine, 353-hectare freshwater tidal wetland, one of the largest in the United States. Privately owned for generations and kept as a hunting preserve, this is also a research lab of sorts for SLR. The marsh straddles a big oxbow bend of Virginia's lethargic Pamunkey River, about 80 kilometers upstream from the Chesapeake Bay and just above the point where brackish water yields to fresh.

"When we started working out here 30 years ago, you would have been in the midst of a stand of *Spartina cynosuroides* [big cordgrass], because the marsh was dominated by that," says Carl Hershner, director of the VIMS Center for Coastal Resources Management. Duck hunters would use the walls of spartina along the river as blinds. These days, it grows only in a few patches in the higher elevations, replaced mostly by lush, low-growing, more water-tolerant arrow arum. "In that period of time, sea level has risen probably 5 inches [12 cm] in this area," Hershner says.

As SLR accelerates, sediment input is no longer able to keep pace, and the waters deepen. This marsh will eventually become a tidal mudflat without vegetation and then a shallow pond. "These are some of the most rapidly changing marshes; this is a hotspot for SLR," Hershner says. "We're seeing some of those changes now, but they're going to be slow. It's not like tomorrow we're going to wake up and find there are no marshes here. It's just that these marshes over the next hundred years or so are likely to change dramatically in character."

As the water rises everywhere along the coast, governments will make more frequent, critical, and expensive decisions about what to protect. Adaptive management will be essential for natural areas, Hershner says: cautious decisions, continuous monitoring, revisiting deci-

sions, and informing and motivating policymakers.

Sometimes they just aren't listening, of course. "That's why we describe ourselves, after decades of fighting this, as functioning cynics," Hershner says. "We've been beaten down and beaten back enough to know what's coming, but we're still able to get up and continue to fight the fight, because we've got to do it.... We now have enough insight to see how things are changing, and the public's motivation to deal with them will probably never be greater. It is really within our capacity as a society to say, 'Yup, now's the time.'"

Ice dice

The fates of Sweet Hall Marsh and Pickering Beach are linked with Ilulissat Harbor, Greenland, though it is more than 3200 kilometers distant. There, tourists arrive in increasing numbers to see bergs from the icefjord emerge and float past, and to witness a warming planet. The front of the glacier upstream has retreated more than 8 kilometers in eight years.

The significance of that for the future rate of SLR is a vexed question for climate scientists. Several glaciologists have documented accelerated melting in both Greenland and the West Antarctic ice sheets during the past three years, but it's not known whether this will continue, nor how quickly it may advance, nor whether humankind will rein in greenhouse gas emissions.

Climatologist James E. Hansen, of the NASA Goddard Institute for Space Studies, warned colleagues in a recent paper against indulging their "scientific reticence" despite the risk of disastrous SLR. By Hansen's calculation, "business as usual" greenhouse gas emissions could lift sea levels by as much as 5 meters this century. He has called for a scientific commission to study ice-sheet melting rates immediately.

Climatologist James Hansen is shown during his presentation at the AIBS annual meeting in May. Photograph: Carroll Photography.

University of Colorado glaciologist Waleed Abdalati travels to Greenland to do field work. Photograph courtesy of the University of Colorado at Boulder.

Glaciologist Waleed Abdalati's fieldwork has taken him all over Greenland, including the Ilulissat glacier. He says that Hansen's calculations are unproven (Hansen agrees), that the research is still developing, and that the current "loose consensus" of climate scientists is that SLR could be as high as 1 meter by 2100—which should easily be enough of a risk to rivet public attention. Abdalati, director of the University of Colorado's Center for the Study of Earth from Space, is ambivalent about the possibility that he may be too "reticent" when he communicates with the public about SLR: Sometimes, after he gives a public talk, "they tell me I'm not scary enough. But other times they say I'm too scary."

Governments may react to change on different schedules than those of coast-dwelling organisms, including people. Rob Thieler, for example, lives on the Massachusetts shore. He is 43, his children are 4 and 7, and his driveway is 5 meters above sea level. A USGS research geologist whose name appears more than three dozen times in the USCCSP report as a chapter author or cited researcher, Thieler has reason to be aware of SLR.

"I'm probably fine for the rest of my lifetime in the house," he says. "At some point it might become a storm-surge issue, should the right one come up Buzzard's Bay. But it's in that time frame that our uncertainty about what's really happening in Greenland and in Antarctica begins to clarify.

"When I'm in my 70s and hopefully 80s, that'll be right in the heart of my kids' economically productive lifetime. I can't help but look at them and their peers and think, okay, where are we going to be then? How fast will the earth be changing? Will we know by then? Will we know what we ought to be doing? I hope so."

For more information, visit these sites:

www.iop.org/EJ/article/1748-9326/2/2/024002/erl7_2_024002.html
www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/sea_level_rise/sea_level_rise.htm
http://climatescience.gov/Library/sap/sap4-1/public-review-draft/
http://epa.gov/climatechange/effects/downloads/background_report.pdf
http://ccrm.vims.edu/coastal_zone/climate_change/index.html
www.nwf.org/sealevelrise/chesapeake.cfm

Steve Nash (e-mail: snash@richmond.edu) teaches journalism and environmental studies at the University of Richmond. He is the author of Millipedes and Moon Tigers *(University of Virginia Press, 2007) and* Blue Ridge 2020 *(University of North Carolina Press, 1999).*

doi:10.1641/B581004
Include this information when citing this material.