

# CHANGES IN THE CHESAPEAKE

IN THE FACE OF CLIMATE CHANGE AND  
POLLUTION, BIOLOGISTS TAKE ACTION

By Dana Kobilinsky

Navigating the dark marshes of Saxis Wildlife Management Area in Virginia, it was hard for Bryan Watts to listen for the sound of black rails with mosquitoes buzzing in his ears.

► Wildlife biologists survey for black rails at dusk. The birds used to have a stronghold in the marshes of the Chesapeake Bay watershed, but their populations are now challenged by sea-level rise.

Credit: Bryan Watts

Guided by a GPS, Watts and his team boated between designated sites from midnight until 4 a.m.—when black rails are more likely to call—conducting 10-minute surveys for the secretive bird. Using playback surveys, they alternated between playing a breeding song and waiting to hear a response.

Watts was getting impatient when he finally heard what he had been waiting for.

“Kick-ee-kerr.”

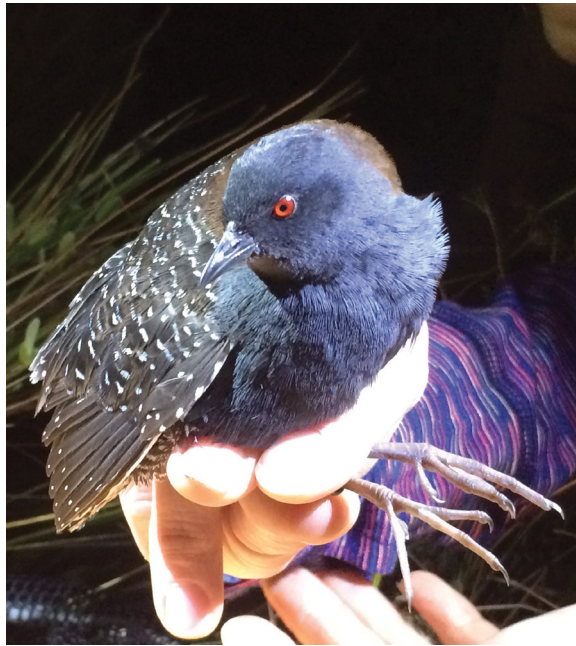
The sound came from a black rail standing at his feet. “It walked right up on my boot,” said Watts,

the director of the Center for Conservation Biology at the College of William and Mary and a TWS member, who was instrumental in getting the bird listed as threatened under the Endangered Species Act in 2020.

This sound isn’t heard as often in the marshes of the Chesapeake Bay watershed as it was 10 years ago. The black rail (*Laterallus jamaicensis*) has declined to just 1% of its historical population size. “They were a fairly widely distributed species with a few hot spots where there were really high densities of black rails,” Watts said. “You had annual forays from birders going to these places.”



► Wildlife biologists conduct callback surveys to detect black rails in the marshes of the Chesapeake Bay watershed.



Credit: Whitney Beisler

The bird once had a stronghold on Elliott Island on Virginia's eastern shore, used the extensive tidal marshes in the nearby Saxis Wildlife Management Area in Virginia and Blackwater National Wildlife Refuge in Maryland, and showed up north of Baltimore along Maryland's Western Shore. Everything seemed fine until a survey in the late 1990s suggested that in many of these areas, the birds had completely disappeared. "It was sort of a surprise to everybody and set off alarms," Watts said.

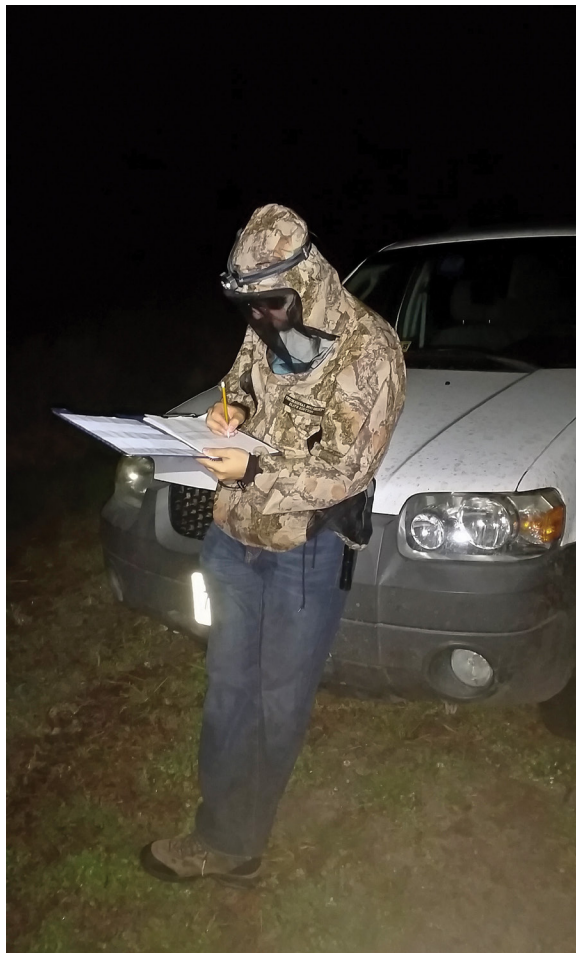
Researchers didn't know much about the black rail—it's hard to study a species that's hiding in dense vegetation. But they do know the bird prefers to nest in a couple centimeters of water—they're small and don't like water going up to their bellies. That's a problem for the rail as rising sea levels due to climate change are becoming higher than the birds prefer, drowning the marshes and converting them to open water in some spots. "The species is in desperate need of management," Watts said. "We're playing catch-up as quickly as we can to design a management plan."

Sea-level rise is one of the main challenges wildlife faces in the Chesapeake Bay watershed, a productive system of water bodies that flow into the largest estuary in the U.S. Wildlife professionals are working hard to help numerous species persist among these changes while also dealing with factors like urban development, agriculture, invasive species and fishing pressures.

"It's kind of a dire situation, to be perfectly honest," said Matt Whitbeck, supervisory wildlife biologist for the Chesapeake Marshlands National Wildlife Refuge Complex and TWS member. "We're looking at the local extirpation of some very important species like black rail and saltmarsh sparrow. But I think what's encouraging is that there are a lot of people really working hard on helping these species exist in the landscape."

### A complex system

The Chesapeake Bay is a vast estuary where freshwater streams meet the saltwater of the Atlantic Ocean. It covers nearly 4,500 square miles between Havre de Grace, Maryland, and Virginia Beach, Virginia. The watershed of rivers and streams that feed it is even more massive, reaching across New York, Pennsylvania, West



Credit: Rob Colquoun

► Wildlife biologist Eric Sibbald surveys for black rails at night.



Credit: Bill Portlock courtesy of Chesapeake Bay Foundation

Virginia, Maryland, Delaware, Virginia and the District of Columbia. “The drainage is absolutely huge,” Whitbeck said. “A lot of people think of the Chesapeake Bay as the bay itself, but the watershed is absolutely enormous.”

The mountainous regions of the watershed have cool, crystal-clear waters filled with trout and freshwater mussels. These waterways flow to the productive tidal wetlands that surround the bay. They’re often referred to as the “kidneys of the bay” because they absorb contaminants from runoff the streams pick up as they pass cities, towns and farmland along the way.

The bay itself is fairly shallow. Historically, sunlight had hit the bottom, supporting abundant plant life. “You get underwater grasses or submerged aquatic vegetation,” said Rob Schnabel, a restoration scientist with

the Chesapeake Bay Foundation. These plants provide resources for fish and migratory birds.

### Excess nutrients

But things have changed a lot. Now, excess nutrients cause increased growth in algae blooms, which ultimately result in bay eutrophication—microorganisms eat the algae, which deplete the oxygen in the water. Algae blocks sunlight to the bay’s bottom, killing the underwater grasses that provide oxygen and critical habitat for migratory birds and juvenile fish. The result has been a so-called “dead zone” where algae blooms choke out the oxygen that marine life needs to survive.

“The Chesapeake Bay water is not as clear as it used to be,” said Lorie Staver, an assistant research professor at the University of Maryland Center for Environmental Science. There’s less submerged aquatic vegetation—or SAV—which

▲ The Chesapeake Bay covers nearly 4,500 square miles from Havre de Grace, Maryland, to Virginia Beach, Virginia. But its watersheds reach across New York, Pennsylvania, West Virginia, Maryland, Delaware, Virginia and the District of Columbia.

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## What's good for the bay

When thinking about conserving the bay, most people wouldn't consider the importance of maintaining forests.

But protection of forested wetlands and the forests along the edges of streams are also important for nutrient control, said Cherry Keller, an endangered species biologist with the Chesapeake Bay Ecological Services Field Office and TWS member. "All wetlands—ponds, emergent wetlands, forested wetlands—hold water on the landscape, slow down that runoff, and just improve things for the Chesapeake Bay," she said.

Not only have forest protections helped the whole system, they have also helped one species come off the federal endangered species list.

The Delmarva fox squirrel (*Sciurus niger cinereus*) was on the first version of the endangered species list in 1968. The squirrel—slightly larger than a gray squirrel and with a white underbelly—is a unique subspecies only found on the Delmarva Peninsula. With only 10% of its historic range remaining by the time it was listed, the squirrel had suffered from overhunting and habitat loss. By 2015, hunting had long been stopped, and scientists were conducting translocations to bring the species back.

At the same time, under the Environmental Protection Act, conservationists worked on maintaining and [restoring](#) the forests that lined the rivers feeding the bay. "Those riparian forest buffers reduce runoff from farm fields and take up nitrogen from the runoff water. They also end up being great travel corridors for Delmarva fox squirrels." These corridors are made up of some of the most mature forests in the area, since regulations hinder people from cutting down trees up to the water's edge. The fox squirrel uses the cavities in mature trees to raise their young, Keller said.

The subspecies was delisted in 2015, and Keller and her colleagues considered whether sea-level rise would put a damper on the squirrels' success. She and her team ran models to determine if flooding would affect the squirrels, and their findings were promising.

"Because it's a mobile terrestrial animal, it can move inland, and it will," she said.

is important habitat supporting a variety of fish, shellfish and invertebrates.

This underwater vegetation began to decline in the first half of the 20<sup>th</sup> century. When Hurricane Agnes struck the region in 1972, it declined even further. Rivers swelled with stormwater that carried nutrients and sediment into the bay. The vegetation losses continue to affect the ecosystem, Staver said. Ospreys (*Pandion haliaetus*) and bald eagles (*Haliaeetus leucocephalus*) feed on fish that rely on SAV. "It's not like everything disappears when SAV is gone," she said, "but it does have a ripple effect up the food chain."

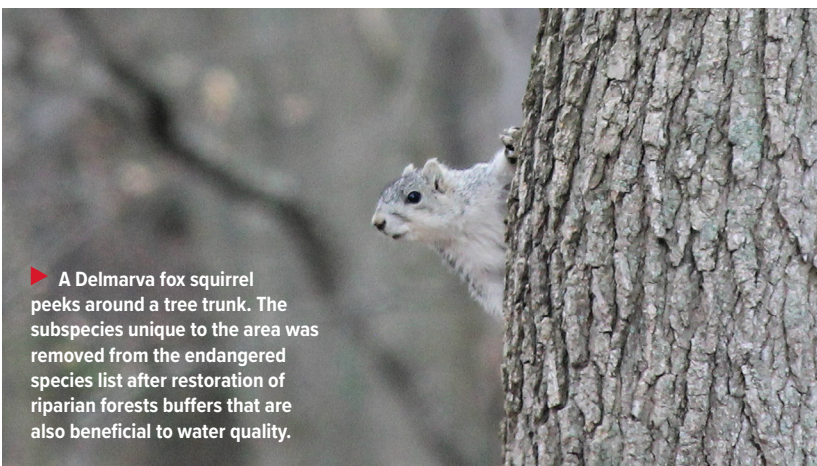
Oysters naturally filter water in the Chesapeake Bay, but they have been declining for decades due to pollution and overharvest. In 2011, oyster populations in the upper Chesapeake Bay were only [0.3% of their historic levels](#), according to the University of Maryland Center for Environmental Science.

Yet ongoing efforts to clean up the bay are showing results. Last summer, the Chesapeake had its [smallest dead zone](#) since monitoring began in 1985. Biologists say the promising results are due to work throughout the watershed to reduce runoff, along with some help from lower-than-usual rainfall. "This may finally be clear evidence that our nutrient reduction strategies are improving water quality and fish and shellfish habitats," said Marjy Friedrichs, research professor at the Virginia Institute of Marine Science, in a statement.

## 'Polar bear of the Chesapeake'

But contamination is only one challenge to wildlife in the bay, and despite management successes in controlling it, additional factors are threatening some species. One species is particularly vulnerable to being hit from many different directions. The northern diamondback terrapin (*Malaclemys terrapin terrapin*) spends most of its time in salty marshes in the Chesapeake Bay. "Climate change and sea-level rise are becoming quite an issue for the terrapins," said Chris Rowe, an associate professor with the University of Maryland's Center for Environmental Science.

The terrapin's vulnerability to climate change has led to its nickname, "the polar bear of the Chesapeake." On the one hand, climate change is affecting the species' sex ratios. Like many turtles, terrapin sex is temperature-determined, and warming sands are leading to more females than males. But the turtles are also losing habitat. Female terrapins tend



► A Delmarva fox squirrel peeks around a tree trunk. The subspecies unique to the area was removed from the endangered species list after restoration of riparian forests buffers that are also beneficial to water quality.

Credit: Cherry Keller

to nest in sandy areas behind beaches. These areas allow them to hide from predators, and they're high enough so that when the tide comes in, their eggs won't be submerged. This leaves terrapins pinned by climate change. As sea levels rise, marshes should migrate inland, providing additional habitat for the terrapins. But the region's steep topography halts that migration. Meanwhile, the sandy areas where terrapins nest are highly susceptible to storm surges. Without marshes to buffer the effects, their eggs are increasingly at risk.

"One of the problems is the area's topography goes up fairly steeply, and marshes can't migrate really far," Rowe said.

People have responded to the rising waters by hardening shorelines with bulkheads—large stone piles to prevent water from eroding away the soil—but the terrapins struggle to cross these barriers to nest. "It's a double whammy," Rowe said. "Sea-level rise is taking away their habitat, and we're responding to that by hardening the shorelines."

It's not only sea-level rise that's upsetting the populations. They also face pressure from animals like red foxes (*Vulpes vulpes*) and raccoons (*Procyon lotor*) that prey on their nests. "One of the really tough aspects of being a turtle is that practically



Credit: Chris Rowe

everything out there wants to find your eggs and eat them," Rowe said. "Unless a nest is protected, 80 to 90% of them are destroyed, usually by foxes or raccoons." The threat from these predators is "an insidious human connection," he said. These opportunists thrive around humans. "When we move into areas, we're taking with us these predators."

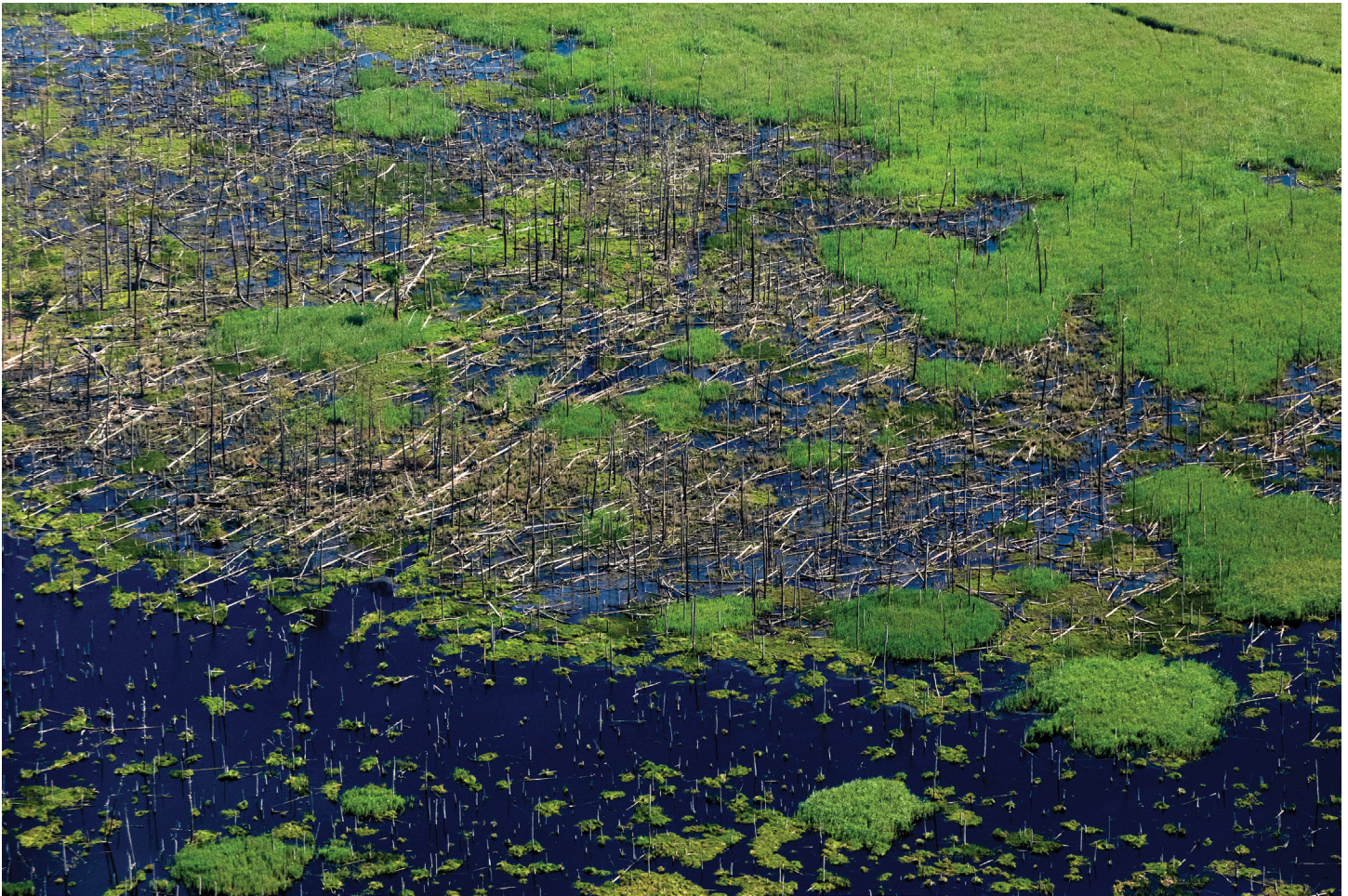
The terrapins also face the threat of becoming bycatch in crab pots. In Maryland, legislators

▲ **The northern diamondback terrapin faces threats of sea-level rise, nest predators and climate change skewing sex ratios, since the terrapins' sex is determined by temperature.**



Credit: Dave Gelenter/CBF Staff

◀ **The Chesapeake Bay is losing submerged aquatic vegetation that fish feed on. That can have a ripple effect up the food chain for wildlife like ospreys.**



Credit: Will Parson/Chesapeake Bay Program

▲ In Blackwater National Wildlife Refuge, rising water has overrun forests. These so-called ghost trees stick up from the water in the marsh.

passed a law in 1999 requiring recreational crab trappers to put excluders on their pots to keep out bycatch, but the law didn't apply to commercial crabbers. Requiring excluders across all fisheries would reduce this threat, Rowe said, but it could face steep opposition. "In Maryland, we have a real traditional respect for and love for the waterman's community, which make their living on the water, so they tend to be above the law."

Rowe isn't optimistic about the fate of the northern diamondback terrapin. "There's an awful lot of things going against them," he said. But wildlife biologists aren't giving up. In an area where the Patuxent River meets the Chesapeake Bay, the Naval Air Station Patuxent River created a [living shoreline](#) in 2021 and 2022. Made up of sand, stones, seagrass and other plants, it is an alternative to bulkheads to manage sea-level rise. Rather than being blocked from nesting, terrapins can use it as habitat.

## Migrating marshes

Blackwater National Wildlife Refuge on Maryland's Eastern Shore is working on other methods to improve conditions for wildlife that specializes in these areas.

The refuge, established in 1933, is one of the oldest refuges in the Atlantic Flyway. "It was really put here in recognition of the phenomenal waterbird resources that we have here, particularly during migration during the winter," Whitbeck said. But those resources have changed in the face of climate change and sea-level rise.

Whitbeck, who has been at the refuge for 15 years, has watched the changes take place before his eyes. What used to be a healthy marshland has already lost over 5,000 acres to open water. "This is a place where people can come to see the impacts of sea-level rise with their own eyes," Whitbeck said. "I think a lot of people read these papers

about sea-level rise and think this is one of these coming issues that we're going to have to deal with, but it's very much something we're dealing with right now every day."

In Blackwater, king rails (*Rallus elegans*) serenade visitors, and muskrats (*Ondatra zibethicus*) torpedo through the water, indicative of the healthy biodiversity in the area. But in some spots, dead trees stick out from the water—so-called “ghost forests,” where water has overrun the trees. In others, tan waves of the invasive reed grass phragmites (*Phragmites australis*) bristle through the marsh, replacing diverse native plant communities.

Those changes are unlikely to stop anytime soon. Sam Krebs, a recent master's graduate from the State University of New York College of Environmental Science and Forestry in Syracuse, looked at three different sea-level rise scenarios (Krebs et al. 2023) and found each would result in significant habitat loss by the end of the century. Even in the best-case scenario, he found, “Blackwater alone is going to lose 81% of its current saltwater marsh habitat.”

The refuge is sandwiched between sea-level rise on one side and the natural geological processes of subsidence—or gradual sinking of the earth's surface—on the other, both of which are putting marshland under water. That has land managers trying to intervene by predicting where marshlands are likely to move on the landscape, encouraging native vegetation for species like the black rail and saltmarsh sparrow (*Ammospiza caudacuta*), and depositing dredged material—dug out elsewhere by the U.S. Army Corps of Engineers to allow for ship traffic—to raise the marsh platform.

“It's really a remarkable process, and it's also kind of the key to the future for us,” Whitbeck said.

Landowners should also be included in that planning, said Steve Kline, the president and CEO of the Eastern Shore Land Conservancy. As marshes migrate, they may end up on private land. Sometimes, Kline said, easements can facilitate some of that marsh migration. “There are ways to protect certain buffer areas and to relieve those areas from development pressure, such as they might exist, because there is tremendous pressure to build waterfront houses,” he said. “What easements allow for is marsh to migrate inland.”



Credit: David Frey

Easements are particularly important for a project TWS member Dan Murphy is working on to create a new national wildlife refuge in southern Maryland to protect native species in the watershed, like native shorebirds that migrate through the area. Murphy, the chief of the division of habitat restoration and conservation at the U.S. Fish and Wildlife's Chesapeake Bay Ecological Services Field

▲ Matt Whitbeck has worked at Blackwater National Wildlife Refuge for 15 years. Over that time, he watched the marshland lose over 5,000 acres to open water.



Credit: jared\_satchell

◀ Land managers are predicting where marshland is likely to migrate in order to protect species like saltmarsh sparrows. Increased flooding from rising waters is drowning out the sparrows' nests in high marsh habitat.



▶ Northern diamondback terrapins do better on Poplar Island, where there are no predators like raccoons or foxes. One year, Roosenburg and his colleagues captured over 1,500 hatchlings on the island.

▼ Willem Roosenburg and his students boat from Lowes Wharf to Poplar Island, an island on Maryland's Eastern Shore restored with dredged material. Once there, they monitor the northern diamondback terrapin population.



Credit: Willem Roosenburg

Office, said the project will rely on private landowners who are willing to sell their land to become part of the refuge or sell conservation easements on their land where they give up development rights but retain ownership. The proposal consists of four watershed units, making up 577,420 acres. But the USFWS plans to protect 40,000 acres within it. The goal of the refuge is to provide resilience to the effects of habitat loss and climate change on species, including nine species listed under the Endangered Species Act.

In some places, managers need to restore wetlands, Whitbeck said. In others, they need to be helping them migrate upslope. "We need to use every tool in the toolbox."

### Resurrecting an island

Projects that have literally reshaped the bay have already shown success. Long before human-caused climate change was visibly affecting the Chesapeake, the bay was already subject to natural forces creating and eroding landforms.

The 1,100-acre Paul S. Sarbanes Ecosystem Restoration Project at Poplar (also known as just Poplar Island) used to be home to about 100 people, but erosion whittled the island away. In the 1920s, residents abandoned the island. By the mid-1990s, approximately four acres remained.

An interagency team from the U.S. Army Corps of Engineers, Maryland Port Administration and many other federal and state environmental agencies decided that restoring remote island habitat lost in the Chesapeake Bay was of great environmental value to provide resources for species like ground-nesting birds that had lost their habitats to sea-level rise and farming. Using dredged material from Baltimore Harbor shipping channels, the U.S. Army Corps of Engineers and the



Credit: Willem Roosenburg

Maryland Port Administration worked to recreate the island. Today, it hosts approximately 372 acres of restored marshland.

“The wildlife has essentially flocked to the island,” Staver said. Scientists have documented over 200 bird species on the island. And those aren’t the only species finding refuge. In 2002, workers noticed northern diamondback terrapins nesting on the island and invited Willem Roosenburg, a professor of biological sciences at Ohio University, to come out and take a look. In less than an hour, he discovered eight nests. Over the next two years, Roosenburg worked to prevent turtles from going into construction areas. In 2004, he began conducting detailed surveys of the terrapins using the island.

Boating from Lowes Wharf, across Poplar Harbor to the eastern side of Poplar Island, Roosenburg has historically taken undergraduate and graduate students each summer to monitor the terrapins’ success. On neighboring, privately owned Coaches Island, the cacophony of a great blue heron (*Ardea Herodias*) rookery welcomes them as they conduct terrapin nest surveys on Poplar Island adjacent to the rookery, separated by Coaches Channel. “It’s what I would envision the Jurassic to sound like with all of these herons in this rookery making all of this noise and communicating,” he said. At the same time, he hears the roar of excavators on occasion as he enters his study area, since Poplar Island is still in the midst of construction, with approximately 485 acres of marshes remaining to be developed, in addition to upland habitat. The smell of a fishy double-crested cormorant (*Phalacrocorax auritus*) colony nearby and the not-so-pleasant scent of dredged material mix in his nose.

Roosenburg said the terrapin populations, likely native to the remnants of the previous Poplar Island archipelago, are doing immensely well. That’s in part due to a lack of nest predators. “On the mainland on the Patuxent River, we were documenting nest predation rates of 70 to 100% per year,” he said. “On Poplar Island, there are no raccoons or foxes. And as a consequence, during the initial 15 years or so, there were very low predation rates on terrapin nests. One year, we had over 85% nest survival and captured over 1,500 hatchlings on the island.”

But sea-level rise is still a concern. A robust monitoring program led by Staver’s team keeps



Credit: Bryan Watts

track of elevation changes in Poplar Island’s marshes. So far, the terrapins have been faring well, Roosenburg said. “But as the rate of sea-level rise increases in the future, that ability to keep up is likely to diminish.”

### An interconnected system

Projects like Poplar Island’s restoration are an example of how human interference can yield success.

“Even if we build these marshes and in 50 years they’re gone, in the meantime, they provide habitat to all kinds of species,” Staver said. “Wetland restoration projects like these are all important parts of the package to preserve habitats and help conserve the species that use them.”

While the effects of climate change are visible, they’re not immediate. That gives managers time to prepare for the changes they know are coming. Those preparations can benefit wildlife, but they also benefit people, Murphy said. The same wetlands that host rails and terrapins also protect communities from the ravages of hurricanes. Abundant marshes benefit people who make a living from commercial fishing, crabbing and oyster harvesting.

“A lot of people don’t realize how interconnected it is,” he said. “When we destroy habitat, we are really destroying a piece of our future.” ■

▲ **Wildlife biologist** Laura Duval uses a level to measure black rail habitat. The bird is declining along the Atlantic Coast due to sea-level rise drowning out their salt marsh habitat.



**TWS MEMBER** Dana Kobilinsky is the managing editor for The Wildlife Society.