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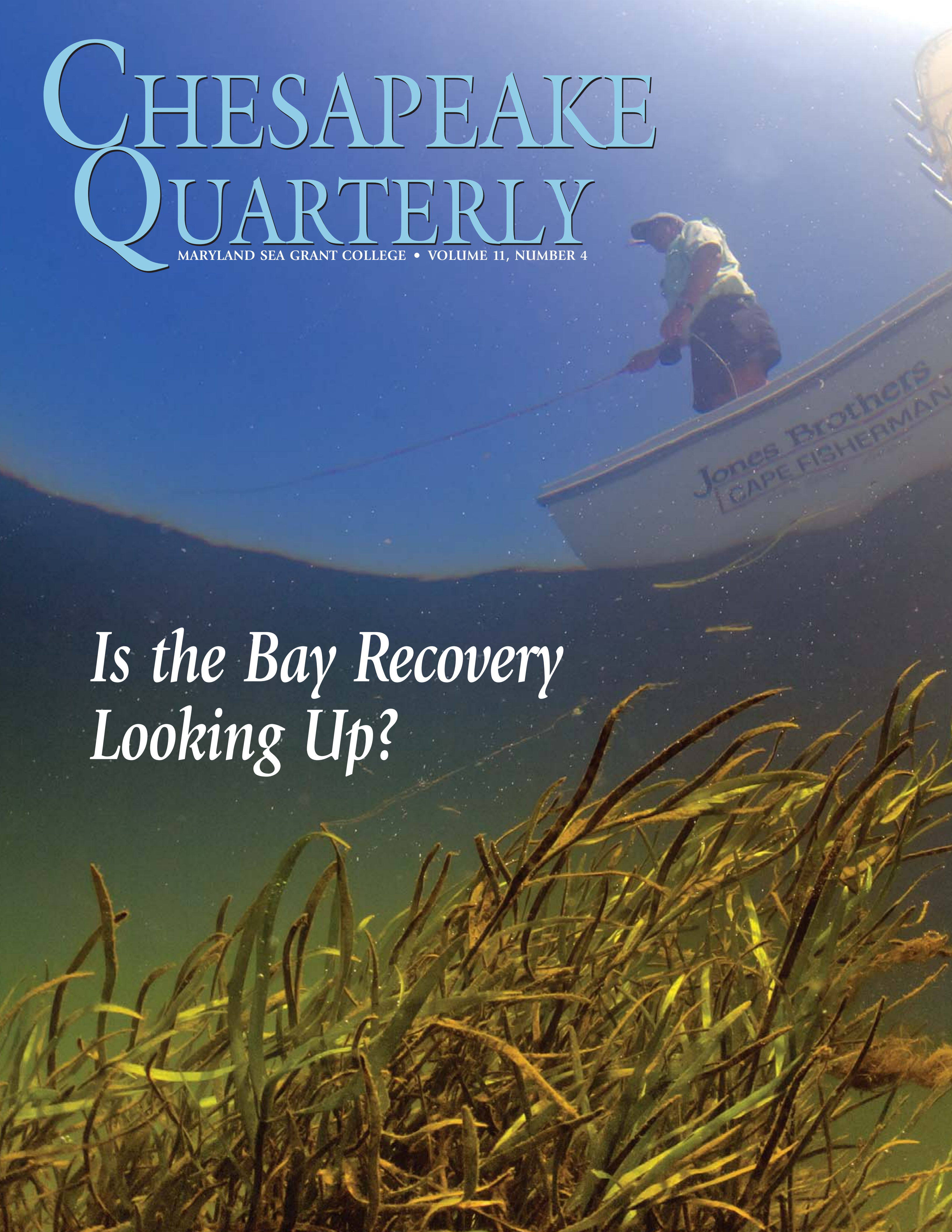

Is the Bay Recovery Looking Up?

contents

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Chesapeake Quarterly explores scientific, environmental, and cultural issues relevant to the Chesapeake Bay and its watershed.

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Maryland Sea Grant College
4321 Hartwick Road, Suite 300
University System of Maryland
College Park, Maryland 20740
301.405.7500, fax 301.314.5780
e-mail: mdsg@mdsg.umd.edu
www.mdsg.umd.edu
www.chesapeakequarterly.net

Cover & p. 2 photos: *An underwater fisheye-lens shot (cover) gives a dramatic view of bay grasses and a fisherman in the Susquehanna Flats. In recent years underwater grassbeds have suddenly expanded across the Flats, the broad, shoal-like shallows at the head of the Chesapeake Bay. Grass species returning to the Flats include redhead grass, coontail, watermilfoil, water stargrass, and this strand of wild celery (p. 2) found by Debbie Hinkle, a research technician with the University of Maryland Center for Environmental Science.* PHOTOGRAPHS: COVER, OCTAVIO ABURTO; P. 2, DALE BOOTH.

A Chesapeake Bay Recovery: Half Empty or Half Full?

Michael W. Fincham

Is the health of the Chesapeake Bay getting better or worse? Is the Bay cleanup campaign a success or a failure? Or something in between? Hard questions to answer, especially in light of good news about bay grasses and blue crabs and bad news about rising sea levels. Let's try a simpler question: is the Bay recovery picking up speed?

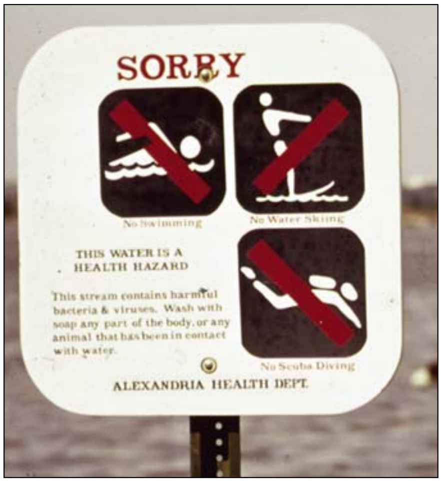
The Bay cleanup began in the 1980s because there was so much evidence during the 1970s that the health of the Chesapeake was declining. Bay grasses were disappearing, and so were striped bass and shad and oysters, and blue crab harvests were up-and-down affairs. The water was getting cloudier and the dead zones of low oxygen were growing larger every summer and lasting longer. Newspaper headlines were asking the question: "Is the Bay dying?" And the Chesapeake Bay Foundation was growing into a powerful nonprofit education and lobbying force by building on a slogan that was really a plea: "Save the Bay."

In 1983, nearly 30 years ago, the cleanup campaign was launched at a meeting that included environmental leaders; state and federal officials; and the governors of Maryland, Virginia, and Pennsylvania. One primary focus was pollution from excess nutrients like nitrogen and phosphorus, the force behind the dead zone, the darkening waters, the bay-grass dieoffs. In 1987, exactly 25 years ago, the states and the federal government first committed themselves to specific goals and deadlines: a 40 percent reduction in nutrient pollution by the year 2000. When that deadline was missed, another was set: 40 percent by 2010. And when that was missed, another goal was set: 40 percent by 2025. Maybe this time, it would be different: a voluntary approach was replaced by a mandatory regime with the Environmental Protection Agency enforcing a "pollution diet" for the Bay that carries penalties for insufficient progress.

Now 30 years out from that first pledge, the results seem mixed: nobody is running headlines asking whether the Bay is dying, but nobody's saying it's been cleaned up. With the public reading headlines about missed deadlines, some leaders in the environmental and scientific communities worry the campaign could start losing ground. "What worries me the most is political complacency," says Will Baker, president of the Chesapeake Bay Foundation. "I don't think we'll get another chance if we fail," writes Don Boesch, president of the University of Maryland Center for Environmental Science (UMCES).

This 2025 deadline may be the last chance for the Chesapeake Bay cleanup. It's hard, after all, to keep building a campaign on a slogan that sounds like an excuse. "It could have been worse" doesn't make an inspiring call to action — even if it's true.

But now there are signs the ecosystem is beginning to respond — in fits



Often called the nation's river, *the Potomac was also called a "health hazard" back in the 1960s, when it was unsafe for swimming, water skiing, or diving (top left). In 1972, the year Congress passed the Clean Water Act, Tropical Storm Agnes sent massive loads of sediment flooding down the Potomac in June; in September the muddy water was still flowing past the Key Bridge in Georgetown (top right). Over the decades, the river began to recover water quality, grassbeds, and fish populations in many areas. In September 2012, the Potomac Riverkeeper and the Water Keeper Alliance (above) staged a river rally near Key Bridge to celebrate the 40th anniversary of the Clean Water Act.* *TOP PHOTOGRAPHS BY ERIK CALONIUS (LEFT) AND DICK SWANSON (RIGHT), FROM THE U.S. NATIONAL ARCHIVES COLLECTION; BOTTOM PHOTOGRAPH BY ALAN LEHMAN.*

and starts, with ups and downs, in some places and not others. Water quality has improved in some of the Bay's largest rivers; underwater grassbeds have expanded dramatically in several of those rivers; and in the mainstem, dead zones of low oxygen seem to be shrinking more than we knew, if less than we hoped. Stripers and yellow perch and blue crabs have been rebounding, with natural fluctuations, from historic low points for those species. Even oysters in certain areas have shown some signs of recovery.

A more upbeat slogan might be: "We may be halfway home." It seems accurate enough. The most thorough accountings to date show that nutrient pollution — first targeted for a 40 percent cutback — has now been reduced by slightly more than 20 percent. The cleanup campaign is clearly but slowly cutting into the nutrient inflow. Cities and towns are upgrading sewage plants and stormwater systems. Many farmers are adopting practices like manure pits, nutrient management plans, and winter cover crops. Nearly half the cutback on nitrogen pollution came from tough enforcement of the Clean Air Act, an approach that forced power plants, factories, auto companies, and states to work harder at controlling air pollution. (See What Goes Up Must Come Down, p. 9.)

As a campaign slogan, "halfway home" may be even more hopeful than you think. According to some ecologists, ecosystem recoveries, like ecosystem declines, can pick up speed pretty quickly once they're well started.

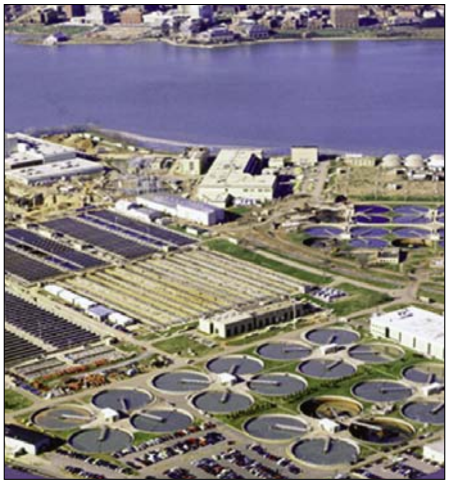
Underwater grasses, for example, recently expanded fourfold in only six years up on the Susquehanna Flats near the head of the Bay, a recovery scientists called "amazing." Behind that sudden rebound were factors like good weather and better water quality, the latter resulting from more controls on both land-based and airborne pollution.

But something else was also in play: the workings of a natural process that ecologists call "positive feedback." Feedback is a tricky idea that goes something like this: There are more grasses on the Flats now because the water clarity is better. And the water clarity is better, in part, because there are more grasses on the Flats. (See The Bay-Grass Surprise, p. 5.)

Positive feedback, however, is a sword that cuts two ways, according to Michael Kemp, an ecologist at the University of Maryland Center for Environmental Science Horn Point Lab. When things are going bad (when bay grasses are starting to disappear), the feedback will make them worse (they will disappear faster). But when things are going better (when bay grasses are starting to come back), then things will get better faster (more grasses will come back). When the glass is half empty, Kemp likes to say, it is more than half empty. And when it's half full, it is more than half full.

Feedback may also be at work at a slower pace along the Potomac, the Bay's second largest river, where grassbeds have been reappearing along coves and shorelines that went bare back in the 1970s. The campaign to clean up the Potomac, "the nation's river," dates all the way back to 1965 when President Lyndon Johnson called the Potomac "a national disgrace" during his State of the Union Address. Johnson helped set the country and the Congress on a course to eventually pass a Clean Water Act that would call for "fishable, swimmable waters" in all American rivers.

The key steps to cleaning up the tidewater reaches of the Potomac River included a series of expensive upgrades to the Blue Plains Advanced Wastewater Treatment Plant in Washington, D.C. In 1980, the upgrade was a new system to



Sewage from Washington D.C. *ran untreated into the Potomac and Anacostia rivers until 1938 when a rudimentary wastewater treatment plant was built at Blue Plains to provide primary settling treatment to remove solid wastes. Thanks to numerous and ongoing upgrades, the plant now removes much of the nutrient pollution that led to loss of grasses and caused poor water clarity. Now the world's largest advanced treatment center, the Blue Plains plant currently handles 330 million gallons a day on average, collecting sewage and stormwater from the capital city and nearby regions of Maryland and Virginia.* PHOTOGRAPH, AECOM, INC..

reduce nitrogen, in 1982 it was new filters to reduce phosphorus. By 1983 underwater grasses, led by an exotic species named hydrilla, began to appear in the river. By 1985 a dozen species were growing, most of them native species. Feedback seemed to be kicking in. Since 1996, through up years and down years, grassbed coverage has increased fourfold in the upper reaches of the tidal Potomac.

It's not easy, however, to draw systemwide lessons from local successes, says Bob Orth, the scientist at the Virginia Institute of Marine Science who's been running annual aerial surveys of the grassbeds since 1984. "Most of the effects are local," he says, "because all of the tribs have different watershed characteristics." Where local watersheds have reduced nutrient inputs — as they have in Gunston Cove and Lynnhaven Inlet in Virginia and in the Patuxent River in Maryland — bay grasses have often responded, helping "positive feedback" kick in. (See The Little Cove that Could, p. 12). So maybe those local successes add up to a useful lesson: systemwide recovery may be a piecemeal process, a river-by-river rebound.

The grassbeds of the Bay, however, hold another, more sobering lesson: natural forces like weather and climate can drive ecosystem declines so forcefully, they nearly overpower human campaigns for environmental restoration. From 1984 to 1993, underwater grasses were expanding in the southern Chesapeake Bay, ranging from the mouth of the Bay all the way up to the mouth of the Potomac. The key to their comeback, says Orth, was better water clarity, the result of a series of dry years when low river flow washed less sediment and nutrient pollution into the Bay. When the weather turned around in the mid 1990s, dousing the watershed with wet, high-flow years, the bay grass recovery turned around, at least in the lower Bay. And feedback probably kicked in to push grasses down. Sometimes the glass is more than half empty.

Climate forces, on the other hand, can sometimes speed up ecosystem recoveries. A change in climate-driven wind patterns, for example, may soon help shrink that dead zone of no-oxygen water that appears along the bottom of the mainstem Chesapeake every summer. (See The Rise & Fall of the Dead Zone, p. 10.)

Southerly winds are becoming more frequent in the new pattern, as frequent as they were before the 1980s. One result: as winds out of the south sweep up the long fetch of the mainstem Bay, they tend to cause vigorous mixing of Bay waters, and that mixing hauls those lower, oxygen-poor waters up for air. The dead zone could start to shrink.

Changes in long-term wind patterns are, of course, well beyond the reach of any Bay cleanup campaigns. Such patterns are tied to shifts in large-scale climate patterns such as the Bermuda-Azores High, which is part of the North Atlantic Oscillation. And those air pressure cycles are altered by changes in sea surface temperatures, including the long-term cycles of warmings and coolings known as the Atlantic Multi-decadal Oscillation. So the dead zone in the middle of the Chesapeake may be indirectly tied to water temperatures in the middle of the Atlantic Ocean.

That's a hard truth, but a hopeful one. "This cycle in my lifetime will probably shift back," says ecologist Michael Kemp. If there is less nutrient pollution flowing into the Bay when that shift occurs — and there's evidence the shift has already begun — then the dead zone with its hypoxic waters could start shrinking faster. "So the Bay all of a sudden is going to have less hypoxia per unit loading (of nitrogen) than what we expected," says Kemp.

Climate and weather clearly matter. But so do good science and smart management — and they are in our control. They mattered a lot in the rebound of striped bass and blue crabs, two iconic Bay species whose populations are driven in part by climate-forced wind patterns, in part by management decisions. The striped bass recovery grew out of a controversial, science-based moratorium on fishing, followed up by stocking of hatchery-spawned fish and a quota system imposed on both commercial and recreational fishermen. As a result: striped bass populations increased nearly eightfold over two decades. The recent blue crab recovery followed a science-based cutback on the harvesting of female blue crabs. Populations of blue crabs increased nearly threefold in just five years.

Bay grasses, blue crabs, the dead zone — scattered successes like these may be adding up to something more than the sum of their parts. "The Bay is starting to do better, modestly, modestly, on the increments," said Will Baker, addressing a meeting of Maryland environmentalists earlier this year. "It is going in the right direction."

Direction matters. Because there seems to be another kind of feedback at work, a feedback between climate forces and cleanup campaigns. When climate forces start giving us boom years for bay grasses and blue crabs and stripers, then smart, science-based management can magnify the booms. And speed up the Chesapeake Bay recovery. When the glass is half full, it may be more than half full.

— *fincham@mdsg.umd.edu*

THE BAY-GRASS SURPRISE

Michael W. Fincham

Bay grasses in the Susquehanna Flats, *mainly wild celery* (Vallisneria americana), *with some water stargrass* (Heteranthera dubia).

Why would the Susquehanna Flats suddenly be full of bay grasses? Two years ago Michael Kemp was motoring across the northern end of Chesapeake Bay with a boatful of scientists and students, checking out reports that underwater grassbeds might be expanding along the famous shoals that sit at the mouth of the Susquehanna River. An ecologist with the UMCES Horn Point Lab, Kemp has spent 35 years studying bay grasses and for most of those years those grasses have been declining throughout the Chesapeake.

Lanky and lightly bearded, he scanned the passing water as the 26-foot cruiser crossed the deepwater shipping channel along the eastern side of the Bay and then headed northwest towards the mouth of the Susquehanna. Moving up onto the Flats, Kemp began spotting bay grasses — a lot of bay grasses. Water stargrass and wild celery were there as well as redhead grass and coontail, and plenty of watermilfoil and hydrilla, two nonnatives that also live here now.

Kemp was motoring right into the middle of a mystery. These grasses weren't expected to be here, at least not this many. They began declining nearly 50 years ago, and then 40 years ago most of the grasses abruptly disappeared when Tropical Storm Agnes unleashed heavy and historic rains across the Chesapeake's huge watershed and sent floods of brown, silt-bearing water surging down all the Bay's great rivers.

The first victim of Agnes was the bay grassbed that Kemp was now motoring through. The Susquehanna Flats are the shallow-water delta at the mouth of the largest and longest river on the East Coast, a river that drains a watershed of 27,000 square miles, including parts of upstate New York and nearly half of Pennsylvania. Carrying runoff from so much rich farmland, the Susquehanna empties as much water and sediment into the Bay as all the other rivers in the estuary combined. In just one week in the summer of 1972, the floods of Agnes washed 20 years of sediment into the Chesapeake, much of it sediment long trapped upstream behind the big dam at Conowingo. Unleashed through roaring floodgates, all that sediment began burying bay grassbeds and oyster bars, altering the ecology of the estuary for decades.

Before the flood, the biological abundance on the Flats was legendary — especially among fishermen, hunters, and birdwatchers. The grassbeds were a gathering ground for shad and stripers, catfish and largemouth bass; they were a feeding ground for millions of ducks and geese. In one survey, biologists in the 1940s counted more than 1.2 million ducks in the Flats, including canvasbacks, redheads, and widgeon.

After the flood, the Flats went mostly bare for 25 years or more, with some grasses scattered around the edges, but only sparse patches of bay grasses dotting the shoals. The disappearance of these grasses on the Flats became an early signal of systemwide decline. When the grasses failed to come back after Agnes, when they kept dwindling throughout the estuary, they came to symbolize the

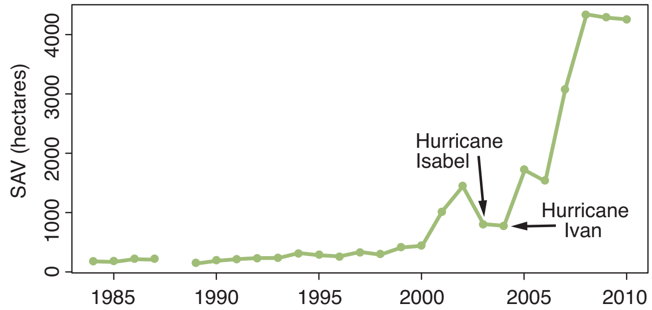
PHOTOGRAPH BY DEBBIE HINKLE.

plight of the Bay and the failure of Bay restoration efforts.

Gliding across the Flats in 2010, Kemp found himself cutting through bay grasses tall enough to reach up to the surface through six feet of water and thick enough to clog his propeller at low tide. In the late 1990s, the scattered patches of bay grass that survived Agnes began to slowly expand. Starting in 2005, the grass coverage suddenly quadrupled in only six years. As an ecologist, Kemp thought this expansion was explosive — and unexplained.

With the boat at anchor, Kemp clambered up on the roof of the cabin. The view from the top: bay grasses stretched in all directions as far as he could see. According to his maps and his quick math, he was looking at 25 square miles of healthy grassbed. He was, he admits, amazed. It was a once-upon-a-time vision: the Flats as they used to be.

He saw fishermen working the Flats for stripers, and ducks and geese working the beds for food. Perhaps it was time for ecologists to start working the big questions: why were the grasses coming back so fast? “This was an abrupt change,” Kemp says now. “It was an incredible response to something — but we didn’t know what.”



***The bay-grass explosion** on the Susquehanna Flats followed an eight-year window that brought no major storms or extreme river flows from 1995 to 2002. As a result, grassbeds were spreading rapidly across the Flats by 2001 and 2002. When Hurricane Isabel arrived in 2003, followed by Hurricane Ivan in 2004, the grassbeds were strong enough to take a one-two punch and get off the floor. Between 2005 and 2010, grassbed coverage expanded fourfold.*

FIGURE BY CASSIE GURBISZ.

Kemp had been surprised by bay grasses before. Like many ecologists he had studied examples of abrupt ecosystem change, but most of those changes were abrupt declines — not recoveries. Some 35 years ago he launched his career by teaming up with Walter Boynton at UMCES Chesapeake Biological Lab and other scientists to organize a major study investigating the decline of bay grasses in the Chesapeake. The result was a set of unexpected findings about the causes of decline, findings that radically altered the scientific understanding of the Bay’s ecology.

The major culprits, according to Kemp and Boynton and their colleagues, were not the usual suspects like toxics from industries or herbicides and pesticides from farm fields. Faced with a systemwide bay-grass decline, they focused on systemwide causes. Kemp and Boynton came to the Chesapeake as protégés of H.T. Odum, a founding pioneer of systems ecology and a proponent of a big-picture approach that focuses on how energy moves through biological communities, how communities organize into ecosystems, how ecosystems function, how they change. According to these newly minted systems ecologists, the key culprit in the bay-grass decline was the oversupply of nutrients that was flowing into and altering the Bay ecosystem. Washed into the Chesapeake, nitrogen and phosphorus were overfertilizing the growth of phytoplankton and other algae, creating enormous blooms that clouded the water, blocked sunlight from reaching bay grasses, and in their decay created dead zones along the bottom of the Bay.

Worse yet, nitrogen and phosphorus were coming into the ecosystem from everywhere: from the sewage plants of cities, suburbs, and towns; from the soil, manure, and fertilizer running off farmlands; they even came in from the atmosphere that carried the exhaust of hundreds of power plants and millions of automobiles. Cutting back on that inflow of nutrients became the central focus of a multistate campaign to restore the Chesapeake Bay.

Bay grasses had always played important roles in the ecology of the Chesapeake — and now they began to play a key role in the public’s perception of ecosystem health. When people ask whether the Bay is getting better or worse, they want to know whether the summer dead zones are going away and whether the bay grassbeds are coming back.

Bay grasses had another surprise in store for Kemp. In 2010 the ecologist began investigating the bay-grass comeback by putting a graduate student to work. With funding from Maryland Sea Grant, he had Cassie Gurbisz start pulling together all the long-range data sets she could find on rainfall, river flow, temperature, salinity, water clarity, and 25 years of bay-grass surveys.

It’s the kind of grunt work graduate students often get stuck with, but Gurbisz welcomed the opportunity. “We hear a lot of bad news about the environment, but this is a real example of good news,” says Gurbisz, who once spent several years running field trips for the Chesapeake Bay Foundation trying to educate people about the problems facing the estuary. “It’s cool,” she says, “to be studying really good news and trying to figure out why it’s happening and maybe help it happen in other places.”

A search for causes often begins with a search for correlations. When Kemp and Gurbisz started digging through the data, river flow emerged as the one factor constantly connected to changes in bay grasses (either recoveries or declines). Gurbisz calls it “the master variable.” The remnant bay grasses left on the Flats after Agnes did poorly during wet years with high river flows, but they did much worse during years that brought big storms like Agnes (1972) or Eloise (1975), Isabel (2003) or Ivan (2004), or the huge, unnamed nor’easters of ’93 and ’96. During years of average river flow, on the other hand, these left-

Ecologists Michael Kemp and Jeremy Testa *gather bay-grass samples on the Susquehanna Flats (above). Graduate student Cassie Gurbisz hammers away at the support pipes that will hold a water sampling station, while research technician Debbie Hinkle lends a steadying hand (left). The station will suck up water every two hours and discharge it into 30 sampling bottles. Back at the Horn Point Lab, Gurbisz and Hinkle will analyze the samples for nutrients, chlorophyll, suspended sediments, and other water quality indicators. One platform will sit in the middle of a grassbed, another will sit outside the bed, giving researchers data on how water quality affects grasses and how grasses affect water quality.* PHOTOGRAPHS BY DEBBIE HINKLE (ABOVE) AND DALE BOOTH (LEFT).

over grasses usually maintained themselves. They did better during dry years with low flow, and they did best of all during dry years with no major storms. Drought years may be bad for the farm economy, but they are usually good for the Bay's ecology.

If you want to write a formula for bringing back bay grasses, then delete storms from the equation. And delete them for several years in a row. Here's what Kemp and Gurbisz found in the data: the abrupt, fourfold expansion of grassbeds across the Susquehanna Flats followed an eight-year stretch that ran from 1995 to 2002 with no extreme flow events. That low-flow window, Kemp says, may have been enough to get a full-scale recovery started.

That's an important finding and something of a surprise. Since the floods of Agnes, other low-flow windows have come and gone without unveiling any major bay-grass recovery. Even in low flow years, after all, the Susquehanna was still draining sediment and nutrients off a huge watershed.

Yet water clarity, according to Kemp and Gurbisz, was improving on the Flats, suspended sediments and phosphorus were decreasing in the water column, and all these changes were clearly correlated with increases in bay grasses. Were all those sewage plant upgrades, all those new controls on farm runoff finally working? According to estimates, the flow of nutrients into the Chesapeake has been cut 20 percent in recent years. That's only about half the 40 percent nutrient reduction called for in the Chesapeake Bay cleanup plan, but it's now apparent that half a loaf can feed a recovery.

Half a cutback and a low-flow window let the grassbeds achieve liftoff, breaking out of a long-term equilibrium that featured low-density patches of plants scattered across the broad shoals of the Susquehanna Flats. According to Kemp's scenario, the clear water and calm weather helped grass patches spread quickly and link up into wider, denser beds. By the summer of 2011, the grassbeds on the Flats seemed to have reached a new, healthy, high-density equilibrium. But it was an equilibrium untested by big storms and high river flows.

In August of 2011, Tropical Storm Irene arrived. In September, Tropical Storm Lee also arrived, dumping even heavier rainfall across the Bay watershed. Lee unleashed the highest river flow in 15 years.

By early May of 2012, Kemp and his crew were back in their boat. Motoring across the Flats, they began seeing a lot of water that looked like chocolate milk. What they were not seeing was a lot of bay grass. The Flats held only some scattered stands of watermilfoil, but not much in the way of wild celery or water stargrass or redhead grass.

Scanning the water for a spot to take samples, Kemp decided the storm had destroyed the big grassbed and it was not coming back. Even though Lee had not been as huge as Agnes, history seemed to be repeating itself on the Susquehanna Flats.

When he came back in June, Kemp was able to find some grass along the eastern side of the flats, perhaps a remnant population, and his team started doing some biomass sampling. Better some data than no data. With some more hard data, Kemp could do some more theory building. Over several trips, he worked with Cassie Gurbisz and research technician Debbie Hinkle to set up water sampling stations inside and outside several grassbed patches. One of his research goals was a more detailed theory for how water quality could affect bay grasses — and how bay grasses could affect water quality.

As she worked, Gurbisz noticed a weird effect: there was more chocolate water in the middle of the grassbeds than outside. One of the ecological benefits of grassbeds is their ability to trap sediments and clear up cloudy water, but in the spring and early summer it was clear that sediments left over from Lee were being easily resuspended by wind and tidal action. As the summer progressed, however, more grasses began showing up and many of them were growing taller. As they began stretching to the surface, Gurbisz saw the water start to clear. And as the water got clearer, more grasses grew taller.

Were the grasses growing because the water was clearer? According to one of Kemp's theories, the causality was running in two directions: the grasses were growing on the Flats because the water was clearer — and the water was clearer because the grasses were growing there. The plants themselves were reshaping their environment, making the Flats a better place for plants to grow. Kemp calls this process a "positive feedback effect," and he says it can be a strong force for recovery. "There is nothing subtle about the impact this bed has on the movement of water, the transport of sediments, the removal of nutrients, and a variety of other characteristics," he now says. "It is a dominant factor in that region." How dominant? At full strength, according to Kemp's calculations, the big grassbed in the Flats could absorb 5 percent of the total nitrogen entering the Upper Bay.

Here's where the going gets tricky. "Positive feedback" can sometimes have negative effects. "A simple fact about positive feedbacks: when things are bad," says Kemp, "the positive feedback makes them worse." When only a few bay grass plants are there, says Kemp, they can't help clear the water. Without clear water, new plants will not get started, and existing plants will disappear.

***"When things start getting better,** then 'positive feedback' will make them get better faster," says Michael Kemp.*
PHOTOGRAPH BY ANNE GAUZENS.

So why did bay grasses begin to return to the Flats? Part of the answer is a low-flow window with no large storms. Another part is clearer water, the result of environmental policies that are cutting down both land-based and airborne pollution. But an unnoticed piece of the answer is feedback, a natural ecosystem response unleashed by climate and clear water. There were now more bay grasses on the Flats to help clear up the water, that meant more clear water to help more bay grasses to grow, that meant more clear water, then more bay grasses, then more clear water, and on and on. "When things start getting better," says Kemp, "then positive feedback mechanisms will make them get better faster."

Systems ecologists talking about bay grasses can sometimes sound like physicists talking about the wave-particle paradoxes of quantum mechanics. "Positive feedbacks" that can also have negative effects is just one of the concepts in the intellectual toolbox of contemporary ecologists. As Kemp studies the rise and fall of bay grasses on the Flats, he also works with concepts like thresholds, equilibria, ecosystem regime shifts, and resilience, the ability of a biological system to withstand and recover from a major disturbance.

If bay grasses can survive on the Flats, they may yet provide a new narrative for understanding the plight and potential of Chesapeake Bay restoration efforts. Forty years ago, bad water and a big storm knocked down the famous grassbed, kicking off a feedback cycle that helped Bay ecology get worse faster. The disappearance of bay grasses on the Flats became an early warning signal that a Baywide decline was coming. Now bay grasses had reappeared, kicking off a new feedback cycle that could help the Bay's ecology get better faster. Perhaps an early alert that systemwide recoveries could be coming sooner than we expect?

Were the bay grasses back to stay? By the time his team wrapped up their 2012 field work on the Flats, Kemp had a better sense of the damage done by the barrage of big storms in 2011. There was deep scouring along the western side of the bed where the current was strongest, pushed there by the Coriolis effect created by the planet's rotation. "The storms really did have an impact," says Kemp.

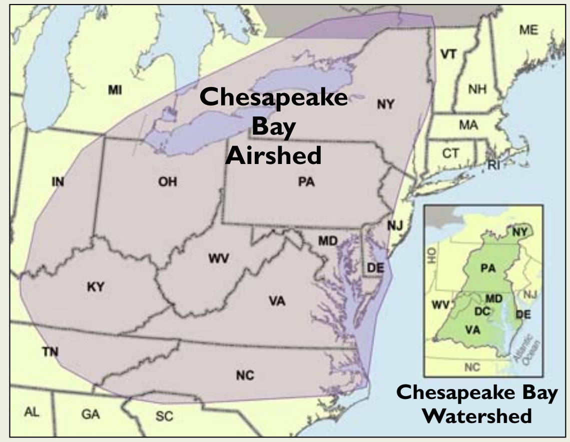
But the bay grasses, at least those along the Susquehanna Flats, had one last surprise for Kemp: they passed the big storm test. He estimates that 60 percent of the grassbed survived the floods from tropical storms Irene and Lee, achieving lush green growth despite a cool spring and a short growing season. Good evidence for "resilience," one of his favorite concepts. "I would say that it's an amazing recovery," says Kemp. "If it weathered that storm, it is going to hang around for a while."

— *fincham@mdsg.umd.edu*

What Goes Up Must Come Down…Somewhere

The water in the Bay may be getting cleaner, largely because the air is getting cleaner. That's an unexpected and somewhat ironic success story that is emerging from recent research on the upper reaches of some of the Bay's tributaries.

In 1997, the U.S. Environmental Protection Agency began enforcing the Clean Air Act more aggressively, trying to clamp down harder on the release of airborne nitrous oxides. And shortly thereafter, hydrologist Keith Eshleman began seeing drops in the amount of nitrogen washing into the rivers of Western Maryland and southern Pennsylvania, rivers that run into the Bay.



Nearly one-third of the nitrogen *entering the Chesapeake Bay arrives through the air, and half of that loading originated as nitrous oxides rising from sources like coal-burning power plants and factories along the Ohio River valley (left) and other urban and industrial sites located far from the Bay. While the Bay's watershed covers 64,000 square miles, the Bay's airshed covers nine times as much territory, stretching over 570,000 square miles and extending into 12 states. According to the U.S. Environmental Protection Agency, the Clean Air Act in 2010 saved 165,000 lives and prevented 130,000 heart attacks and 1.7 million asthma attacks. Cutbacks in air pollution are also helping clean the waters of the Chesapeake Bay.* *PHOTOGRAPH BY ALFRED T. PALMER (1944), LIBRARY OF CONGRESS COLLECTION; AIRSHED AND WATERSHED MAPS, CHESAPEAKE BAY PROGRAM.*

Nitrogen inflow into the Bay is one of the primary causes of many of the Bay's contemporary ills. It overfertilizes phytoplankton and algae blooms, causing cloudy waters, dieoffs in bay grasses, dead zones of no oxygen, and frequent fish kills. And nearly a quarter of the nitrogen that ends up in the Bay begins as nitrous oxides pouring into the air from the exhaust stacks of factories and power plants that burn coal and oil and from the exhaust pipes of cars and trucks and buses that burn gas.

A lot of those power plants and factories and cars are located hundreds of miles away, well outside the Bay watershed. When those nitrous oxides land in the watershed, they can be washed into rivers that lead down to the Bay. And their arrivals have been measured by Eshleman, a professor at the UMCES Appalachian Laboratory in Frostburg, Maryland. His data come from river systems with stream gauges that have been recording nitrogen inputs for 25 years. His findings are unambiguous. "On average, we are seeing about a 50 percent reduction in nitrates," says Eshleman, who is getting ready to publish his results. "It's a really clear-cut effect."

More evidence of the effect comes from the scientists running the watershed model for the Environmental Protection Agency's Chesapeake Bay Program. According to estimates by Gary Shenk, a modeler for the program, total nitrogen loads to the Chesapeake have been cut by 20 percent since 1985, thanks in part to controls on farm runoff, urban runoff, and wastewater discharges. But nearly half that reduction in nitrogen, 46 percent, has come from cutbacks in atmospheric deposition of nitrous oxides.

These reductions, according to Eshleman, can be traced in part to changes in the much-amended Clean Air Act. Originally launched in 1963, the Act was first given teeth in 1970, with strong amendments added in 1977 and 1990. Under President Clinton, the EPA in 1997 added tougher rules on nitrous oxide emissions, a decision that was controversial and historic and expensive because the new rules required many older factories and power plants in the Midwest to switch to cleaner-burning fuels or install advanced scrubbers similar to those already in use in the Northeast states. In addition, many states had to move more aggressively to reduce automobile emissions and encourage mass transit options. Within a few years the stream gauges in Mid-Atlantic rivers were showing declines in nitrates. "From watersheds with thousands of acres down to small watersheds, we are seeing robust reductions," says Eshleman. "This is a huge success story."

It's also an unexpected success story. Protecting human health was always the primary goal of the Clean Air Act, but protecting the ecological health of the Chesapeake Bay has, ironically enough, been a surprising payoff. According to ecologist Michael Kemp, an expert on nutrients in the Chesapeake, these nitrogen cutbacks are helping both to revive bay grasses along some shallow areas and to slowly reduce the dead zone along the deep mainstem of the Bay. These "secondary" benefits from clean air legislation, in his opinion, outweigh the benefits from clean water legislation or any other effort to improve the water quality of the Chesapeake Bay. "The Clean Air Act," Kemp says, "has provided us with a gift."

— *Michael W. Fincham*

THE RISE & FALL OF THE DEAD ZONE

Daniel Strain

The Chesapeake Bay's dead zone may have finally begun to heal, but progress could depend on the weather.

Few people will ever see a crab jubilee in Maryland. During these events, whose comings and goings are hard to predict, blue crabs, by the dozens or hundreds, scuttle out from the deep and up the banks of the Chesapeake Bay. They sit there in the shallows, right on top of each other and often for hours. For those who are lucky enough to be walking by and like seafood, they're easy pickings.

But, scientists say, such jubilees are no party. In fact, they're a sign that something's rotten down below. Namely, the crabs are escaping the Bay's dead zone, a wide region of water lying along the estuary's deeper channels that each year becomes stripped of most of its oxygen — or, as scientists would say, the water turns hypoxic. This happens because excess nutrients such as nitrogen and phosphorus spill off the land and into the estuary, kicking off biological and chemical processes that form the dead zone. Winds will sometimes push those bottom waters up and into the Bay's shallower regions, forcing crabs to get moving in search of water with enough oxygen for them to survive. And so the crab jubilee begins.

But one recent report has some good news for those crabs and for people, too. The size of the Bay dead zone has shown signs of shrinking, at least in the late summer, researchers say. It may not be the end of crab parties, but it's a start. At the same time, scientists are also struggling to understand why that zone hasn't shrunk more, especially as humans have cut the nutrients they've sent down to the estuary since the mid-1980s.

The changes seen in the late summer dead zone represent "a slow decline," says Michael Kemp, an ecologist at the University of Maryland Center for Environmental Science's Horn Point Lab. "But it's enough that we can statistically measure the changes."

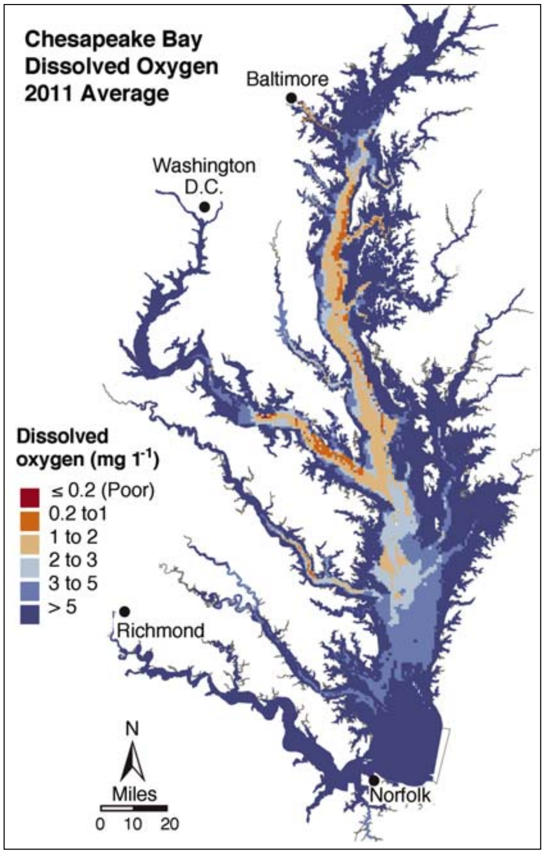
A Dead Zone World

From his office in Gloucester Point, Virginia, Robert Diaz can see a lot of dead zones — but few that are shrinking. Diaz, a marine scientist at the Virginia Institute of Marine Science, is part of a project that tracks the formation of oxygen-poor, or hypoxic, zones in the Chesapeake Bay and worldwide. Generally, water is considered hypoxic if it carries less than two milligrams of dissolved oxygen per liter (most fish need about three milligrams per liter just to survive). So far, he and his colleagues have listed around 500 sites that fit that criterion. The team gives each one their own dot on a map in Google Ocean.

The Chesapeake Bay's own dot was first reported in 1938. Then, scientists taking early dissolved oxygen measurements recorded the first hints of low oxygen in some of the Bay's waters. The phenomenon was later called an "oxygen desert." This desert, eventually renamed a "dead zone," had been expanding across the Chesapeake for decades. But, beginning in the 1980s, its growth tapered off. In recent years, "the Bay has just about kept even with the population growth and the other pressures on it," Diaz says. While that's a victory of sorts, he notes, the estuary should have made bigger gains.

Humans, after all, have reduced the excess nutrients flowing into the Bay — and, as a result, the size of the dead zone should have shrunk. The reasoning is this: Every year, nutrients like the nitrogen in farm fertilizers and factory gas emissions dribble down to the Bay during the rainy season. There, they kick off a chain reaction. Algae consume the nutrients come spring, and, when those algae die in the summer, bacteria binge on their remains, consuming huge quantities of dissolved oxygen in the process. Voilà, you've got your dead zone. So if you reduce the nutrients, you should reduce its size. In recent years, those sorts of cuts have come from a number of different sources, including sewage treatment plants, farms, and factories (see What Goes Up Must Come Down, p. 9).

But the dead zone didn't go away. In fact, things actually got worse. Over the decades, scientists have noticed, something has been altered about the way that hypoxia builds up in the Bay. The end result is that in recent years, the same amount of nitrogen has given rise to twice the volume of dead zone than in the past. Scientists have pinpointed that tipping point to around 1986. According to Diaz, who's seen similar trends in other dead zones around the world, it's possible that these ecosystems have been fundamentally changed by decades of pollution. "These large systems have been hypoxic now for such a long time that something has changed about them… [so] that it takes less new nitrogen coming in nowadays to create the same-size dead zone," he says.



The red zone is the dead zone, *where the water is anoxic, empty of oxygen. The orange and yellow zones are hypoxic regions, holding a little more oxygen but still not enough for a healthy, life-supporting ecosystem. When the wind shifts, low-oxygen water can slosh out of the deeps, creep up into the shallows, and send blue crabs scuttling up onto shore, creating a spectacle known as a "crab jubilee" like the one in this photo taken in Delaware (opposite page).* PHOTOGRAPH OF CRAB JUBILEE (P. 10) BY KEVIN FLEMING; MAP, COURTESY OF ECOCHECK, DATA PROVIDED BY THE CHESAPEAKE BAY PROGRAM.

But new research suggests that the Bay might not be so broken after all.

That comes from a research team at Johns Hopkins University who worked with Kemp to test a new idea: could the dead zone be growing or shrinking during only one part of the summer but not another? In other words, was the dead zone holding as steady in June as it was in July? The team was onto something, it turns out.

The researchers reported in 2011 that today's dead zone seems to be as big and nasty, on average, as it was in the mid-to-late 1980s — and maybe a bit bigger. But that bad news story described only the early summer months. In the late summer, or from mid-July on, the news was better. The dead zone seemed to have begun to mellow. To be precise, the late summer dead zone measured, on average, about nine cubic kilometers in the 1980s. By the 2000s, that number had shrunk down to about seven cubic kilometers, the researchers reported in the journal *Estuaries and Coasts*. In even more good news, the dead zone also seemed to be sticking around for less time, too, lasting for 110 days, on average, in the summer as opposed to 130.

The bottom line is that the Bay might not be as stubborn to change as some scientists thought. To be sure, the reduction in size of the late-summer dead zone was relatively small. Even so, "if we hadn't controlled the nutrients, things would be even worse," says William Ball, an environmental engineer at Johns Hopkins whose graduate student, Rebecca Murphy, spearheaded the study.

But some big questions remain: despite these hopeful signs, why has the dead zone been relatively resistant to change? What happened in 1986 so that fewer nutrients could create the same-sized dead zone, and why was the dead zone shrinking in late July but not June?

Stormy Weather

Malcolm Scully thinks the answer to these dilemmas largely comes down to those windy days out on the Chesapeake. "[For] anyone who's looked at a lot of data or even probably spent time in a boat out there, the wind is hugely important," says Scully, a physical oceanographer at Old Dominion University.

Important because winds are like a silver bullet to the heart of the dead zone. A good, strong wind can mix up the Bay, pushing surface waters around and drawing bottom waters up. Those hypoxic waters can then refill their depleted oxygen levels by absorbing the gas from the atmosphere. So while some winds may be bad for crabs — sending them scrambling on a jubilee — they're beneficial for the Bay as a whole.

Scully got a good look at that phenomenon in 2011. He left an array of sensors for monitoring levels of dissolved oxygen out on the Chesapeake during Tropical Storm Irene. While the storm swept over the Bay in August of that year, the scientist watched as the entire dead zone, which had been sizable, disappeared. Oxygen levels leapt up, beginning along Maryland's Western Shore and moving east.

Not all winds are created equal when it comes to their effect on the Bay, Scully says. Southerly winds, or those that blow up from Norfolk toward Annapolis, tend to act a lot more like Irene did. They mix up the Bay. A lot. But around 1980, southerly winds became less common on the Bay, while westerly winds became more so, and they didn't stir the water quite as much. That comes down to how wind direction, in combination with the rotation of the Earth, sloshes water around inside the Bay. Luckily, southerly winds seem to have increased again in recent years, reaching the normal levels seen before 1980. Those changes were driven by a shift in atmospheric pressure around Bermuda, Scully reported in a 2010 paper in the *Journal of Physical Oceanography*.

Such climatic shifts would likely have the biggest effect on the Bay in the early summer, too. During that season, the estuary is usually more stratified than at other times — its bottom waters, which tend to be cold and salty, stay separate from the waters above, which tend to be warmer and fresher. It's somewhat like how oil and water don't mix in a jar. For reasons that remain unclear, too, that June stratification has grown even stronger over the past several decades, slowing the natural mixing of the Bay's waters at that time. Winds blowing from the south would help to mix those waters up, but they came less often beginning in 1980. That means that the dead zone would likely have been bigger, or more stubborn, in the early summer than scientists expected — just what the Johns Hopkins team and Kemp had found.

And the decrease in southerly winds in 1980 would help to explain why, several years later, it began taking fewer nutrients to build up the same-sized dead zone. During the early summer, "it would appear that things are not getting better even though the nitrogen loads have come down," Scully says. But "if you account for winds, as well, you explain a lot of that."

The science isn't settled, however, and there are other explanations for the dead zone's resistance to recovery. Rising sea levels could explain why the Bay's waters have become even more stratified, especially in June. Higher sea levels send a bigger flux of salt water into the estuary, helping to keep the salty bottom and fresher surface waters more separate than otherwise.

And, as Diaz suggested, there's a chance that the biology and chemistry of the Bay have been altered, too. Specifically, the consistently low oxygen levels around the estuary may have made it more difficult for bacteria, plus chemical processes, to remove nitrogen and phosphorus from the water column and the sediments below. That, in turn, leaves more nutrients free for algae to consume, leading, ultimately, to less oxygen in the water. In other words, when excess nutrients are added to the Bay, they may make the estuary even more susceptible to nutrient pollution — something scientists call a "positive feedback." Such a feedback could help explain the sudden shift seen around 1986. "This positive feedback couldn't have caused this doubling of hypoxia," on its own, says Jeremy Testa, a graduate student who studies, among other things, nutrient recycling in the Bay with Michael Kemp. "But it could certainly support it once the wheels are set in motion."

Diaz, for his part, buys all of these explanations. "I think it's a mix of all of these things," he says. But regardless of how stubborn the dead zone is, restoration is possible, Diaz adds. "I don't think the dead zone will ever go away. But I do think it can be reduced in size."

Now, that may be a reason to party. Don't forget to invite the crabs.

— *strain@mdsg.umd.edu*

THE LITTLE THAT

Rob Hartwell's childhood was, in a way, vintage Mark Twain. He grew up on Mason Neck, a small peninsula on the Potomac River in Virginia. Located about 20 miles south of Washington, D.C., the neck forms the southern border of a narrow bay called Gunston Cove. "My idea of an ideal day was to walk a mile or two down the river bank at low tide and see how many snakes I could find," says Hartwell, who still lives near the banks of that cove today.

But it was Mark Twain with a twist. Many days, he'd have to play on the opposite side of the neck because dead fish had piled up along Gunston Cove — likely the victims of poor water quality.

Then there was the home movie he watched over and over again. Shot by his mother on an eight-millimeter camera, the film showed one of their neighbors climbing out of the water off Mason Neck after a swim. He was covered in green slime. "He looked like the creature from the black lagoon," says Hartwell, who today is a Virginia commissioner for the Interstate Commission on the Potomac River Basin, a government group that advocates for the Potomac.

The troubles facing Gunston Cove, which stretches about two-and-a-half miles long and reaches widths of more than three-quarters of a mile, came down to how the region dealt with sewage. A few miles upstream from this cozy cove on a tributary called Pohick Creek sat a wastewater treatment plant — now called the Noman M. Cole Jr. Pollution Control Plant. And every day, this facility, which was built in 1970, pumped tons upon tons of treated wastewater right toward Hartwell's old stomping grounds. That

COVE COULD

Daniel Strain

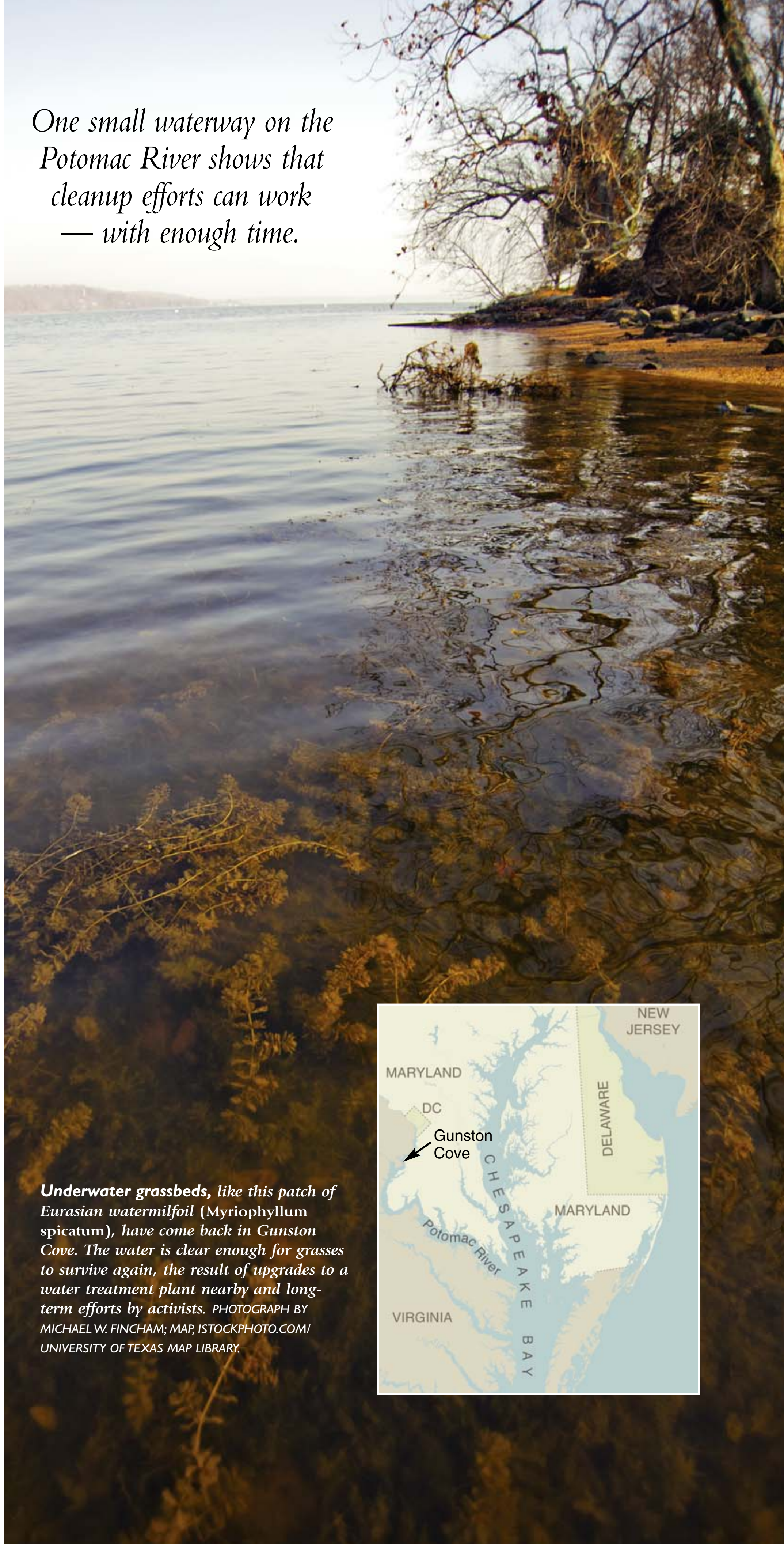
One small waterway on the Potomac River shows that cleanup efforts can work — with enough time.

wastewater, in turn, was loaded with phosphorus.

And that was a problem. Microbes need phosphorus to survive, but in freshwater ecosystems like this one, this nutrient tends to be harder to find than others, such as nitrogen. The sewage plant's discharges fed the algae's craving for phosphorus, and the microorganisms — particularly, a class of microbe called cyanobacteria or blue-green algae — feasted, growing out of control. In the deeper waters of the Potomac, such "blooms" even led to decreases in the oxygen dissolved in the water column, suffocating schools of fish. The region became known for its fish kills and for generally bad water quality. "It was notorious," Hartwell says.

In many senses, Gunston Cove's story mirrored the stories of tributaries up and down the Chesapeake Bay watershed: never-ending algae blooms and chronically poor water quality. But that notoriety also inspired change. By the early 1980s, a multistate and federal effort to clean up the Bay was beginning to organize, and its target was excess nutrients.

On Gunston Cove, change began early on in that drive. Responding to citizen concerns, Virginia's Fairfax County, which oversaw the plant, opted to upgrade its treatment technology. The work was finished by 1980. The plant's operators built new settling tanks and filters to dispose of phosphorus waste. Elsewhere, treatment plant operators around the Bay completed similar overhauls. The Fairfax County plant managed to winnow out around 85 percent of the phosphorus it was sending downstream toward Gunston Cove. But, by the next summer, the cove was no less green with



***Underwater grassbeds,** like this patch of Eurasian watermilfoil* (Myriophyllum spicatum), *have come back in Gunston Cove. The water is clear enough for grasses to survive again, the result of upgrades to a water treatment plant nearby and long-term efforts by activists.* PHOTOGRAPH BY MICHAEL W. FINCHAM; MAP, ISTOCKPHOTO.COM/UNIVERSITY OF TEXAS MAP LIBRARY.

Holding up a clump of healthy bay grass, *Rob Hartwell can smile about the Gunston Cove recovery. He remembers when Gunston was empty of grasses and covered with green slime. As a long-time advocate, he's worked to keep this cove healthy. He currently serves on the Interstate Commission on the Potomac River Basin.* PHOTOGRAPH BY MICHAEL W. FINCHAM.

algae. Nor was it the following year. Or the year after that.

"They made a strong management action. They invested a lot of public money, and they did what they thought was right. And the response was zero," says Walter Boynton, an ecologist at the Chesapeake Biological Laboratory of the University of Maryland Center for Environmental Science. "They had to wait."

A Lucky Find

Years later on Gunston Cove, Christian Jones pulls a clawlike tool called a Ponar grab up out of the water and onto his small sport-fishing boat. He dumps its contents into a bucket — globs of dark grey mud. He also finds a single sprig of bay grass. Jones, an ecologist at George Mason University, holds the plant in the palm of his hand. It's thin, leafy, and still wet. Hydrilla, he calls it, talking to a half dozen college students crammed in around him.

The scene is quiet this morning. The water is smooth, and what few waves there are barely jostle our boat. The students are here with Jones to learn how scientists like him gauge the health of freshwater rivers and bays. And that's where the hydrilla comes in.

The small plant says a lot about the health of Gunston Cove. Hydrilla, or *Hydrilla verticillata*, isn't native to the region, but it has been able to colonize rivers up and down the estuary since its introduction from Florida in the 1980s, providing habitat for native fish and other animals. That's important because underwater vegetation like this has been disappearing all over the Chesapeake Bay — plagued by deteriorating water quality. But here, bay grasses, even native ones, are flourishing. Much of the river bottom stretching out around us is covered in the stuff, Jones says in his casual, southern accent: "They're just below the surface right now." In other words, the cove today is not the same algae-choked waterway that Hartwell remembers from his youth — then, only a thin fringe of plants grew along the Mason Neck shoreline.

Other waterways, including the Potomac itself, have shown similar improvements in water quality, going from unswimmable to swimmable — or, at least, slightly less prone to fish kills. But few, if any, waterways the size of Gunston Cove have made such a stark turnaround. Still, the cove's story comes with a caveat: every river and Bay may take different times to recover.

"I think it's a good lesson that we're dealing with a complicated ecosystem," Jones says. "While we understand the basics of how it works, we don't know it well enough to know exactly when our management efforts are going to kick in or pay off."

The Big Wait

Jones spent a lot of time waiting for that payoff. He's monitored the health of Gunston Cove with funding from Fairfax County since 1984 and has long been fascinated by freshwater communities, especially their microscopic members. Even today, the Arkansas native brings home a jar filled with water every time he travels to the cove — which is often. He puts the sample under his microscope and looks for the tiny animals, bigger than algae but too small to see well with the naked eye, swimming or just floating around. "I always find a wonderful thrill looking at microorganisms," he says.

Many of those animals and many larger ones (fish) do best when there are thick beds of bay grass around. But when Jones first began his studies, Gunston Cove was still very much the domain of the creature from the black lagoon. The situation got so bad that in 1983, the Metropolitan Washington Council of Governments invited a team of international experts on water quality to the region to discuss one topic — why wasn't the cove getting better?

Here's what they concluded: the faucet supplying Gunston Cove with large amounts of phosphorus had been effectively cut off, but algae there were still thriving off a huge reserve — and it lay just below the surface. Phosphorus molecules, by virtue of their chemistry, tend to bind to grains of dirt and silt. Those grains also sink, meaning that the mud at the cove's bottom was likely chock-full of the nutrient. And bit by bit, all that phosphorus was trickling back up into the water column. The theory was supported by observations taken later by Jones and his colleagues.

But there was good news, too. With enough time, all that phosphorus would likely be used up, washed away, or trapped under another layer of sediment. In other words, there'd be no more available for the algae. All Jones needed to do was wait.

The water quality in Gunston Cove never improved in one big leap. No single moment arrived when the scientists

"It's that magic little story that says if you do the right things, [a waterway] will heal itself."

***Christian Jones looks at a water sample** filled with small crustaceans called copepods, taken from the water near the mouth of Gunston Cove. An ecologist at George Mason University, he collects small organisms for fun and uses a microscope to photograph them, often posting the pictures on his team's website.* PHOTOGRAPH BY DANIEL STRAIN.

clinked champagne glasses, Jones says. Things just got better — slowly but surely. "By 1995, we weren't seeing the big algal blooms anymore," he says. "By 2000, it was obvious that not only were the blooms not occurring, but the average amount of algae was going down." Those changes built on top of each other, eventually clearing the way for bay grasses. Today, underwater plants, like watermilfoil and the hydrilla Jones found, cover about 40 percent or more of the cove bottom.

The net result is that Gunston Cove is now usually a lot less green with algae than the Potomac. It's a role reversal for the two bodies of water. "A lot of times, the cove is clearer than the river channel," Jones says. "And that would have never occurred before." Part of the difference lies in the fact that the Potomac, like much of the Bay watershed, also picks up a lot of nutrients from the fertilizers used on nearby farms. Gunston Cove, however, is relatively isolated from agricultural land. Still, for many, the inlet shows that, with enough time and effort, ecosystems like this one can regain some of their lost health and diversity.

"I love Gunston Cove because it's that magic little story that says if you do the right things, [a waterway] will heal itself," says Stella Koch, who works to conserve streams for the Audubon Naturalist Society.

Estuary in Recovery

That's a relatively new way of looking at river restoration. For years, scientists assumed that it might take generations to clean up waterways like Gunston Cove. But while it's clear today that you'll have to wait, you won't have to wait forever, says Walter Boynton who's studied ecosystems like these for decades. When he was a young student, "the view of estuary recovery followed the theme: we have been enriching these estuaries for…hundreds of years, and therefore it will take a similar time for restoration," Boynton says. Now, he can say, "that just doesn't seem to be true."

Gunston Cove isn't the only proof of that, either. The Potomac also cleared up in the 1980s after the nutrients spilling into it from a wastewater treatment plant in Washington, D.C. were cut. The Back River, which runs through northern Baltimore, offers an even newer example. In 1998, the operators of a sewage plant on this famously polluted waterway reduced the nitrogen discharged by the facility. Within three years, measures of algae in the river had been halved.

By comparing ecosystems like these, Boynton's seen that separate bays and rivers may recover at different speeds. The pace of change, he says, likely comes down to a number of factors, such as how efficient ecosystems are at storing nutrients. But for a scientist who's spent much of his career studying the Bay's decline, such recoveries are a welcome sign.

"It is kind of delightful at this stage of life to study issues of restoration, which are significantly more positive," he says.

Still, both Boynton and Jones say that restoration can't bring back the past. Both scientists doubt that Gunston Cove will ever return to how it was during the dawn of the United States — when, according to reports, one local landowner used to string a 350-foot-long seine net across the Potomac not far from the cove, catching tens of thousands of shad each year. Even when natural resource managers and scientists succeed in restoring waterways like Gunston Cove, "very seldom do they go back to the same system because so many things are off in so many ways," Jones says.

Rob Hartwell, however, is happy all the same. Algae or no, he's gone swimming around Mason Neck every year, much like his neighbor covered in slime. But these days, he can open his eyes underwater — a benefit of having fewer microbes around. There's still a lot work to be done, he says, but today, the region is an "oasis close to Washington." It's one where that old sea monster captured on an eight-millimeter camera won't be visiting anytime soon.

— *strain@mdsg.umd.edu*

Bay Grass Guide & More Info

Want to identify underwater bay grasses? Buy a copy of our field guide, or give it as a gift to a Bay lover. Go to the link below for information about the guide and for more information about all the topics covered in this magazine.

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Fredrika Moser Named Maryland Sea Grant Director

Fredrika Moser has been named director of the Maryland Sea Grant College following more than a decade of service to the program as its assistant director for research and, since 2011, its interim director.

Her selection, following a nationwide search, was announced by Donald Boesch, president of the University of Maryland Center for Environmental Science, of which Maryland Sea Grant is a part. Maryland Sea Grant is one of 34 university-based programs in coastal and Great Lakes states that support research, education, and public outreach on marine and coastal issues. These programs, administered by the National Oceanic and Atmospheric Administration (NOAA), work to promote environmentally sustainable and economically viable uses of natural resources.


Michael W. Fincham

"Dr. Moser stood out because of her deep experience in Sea Grant, her excellent understanding of Maryland's marine resource issues, and the administrative leadership she has demonstrated as interim director," Dr. Boesch said.

As Maryland Sea Grant's research leader from 2001 to 2011, Moser helped to develop several of the program's signature efforts to assist policy makers and natural resource officials in making management decisions in the Chesapeake Bay and Mid-Atlantic regions. One such multistate project convened scientific workshops to improve understanding and management of aquatic invasive species, including zebra mussels, Chinese mitten crabs, and unwanted "hitchhiker species" spread by the live bait trade.

Moser also played a key role in Maryland Sea Grant's education initiatives, leading a summer research program for college undergraduates. The Research Experiences for Undergraduates (REU) program, which is supported by the National Science Foundation, offers college students the opportunity to work on research projects under the guidance of the university's marine and coastal researchers. Moser has worked to increase the number of marine science students who come from groups that are underrepresented in the marine science community, including women and members of minority groups. Most recently, she has worked with the Universidad Metropolitana (UMET) in Puerto Rico to develop a new REU project and undergraduate research program there. Moser has also overseen Maryland Sea Grant's graduate research fellowship programs, which support student researchers and help them to translate their work for audiences outside of academia.

Going forward at Maryland Sea Grant, Moser plans to create new partnerships with other organizations working to preserve the Chesapeake Bay. She wants to expand support for "transformative" science — which tackles some of the most challenging interdisciplinary research problems — to help Maryland better face critical challenges. Such issues include climate change adaptation and mitigation, water quality, watershed restoration, sustainable fisheries, and the social and economic constraints that hinder policy and management responses to changing environmental conditions.

In addition, Moser wants to expand Maryland Sea Grant's collaborations with the state's universities and schools to enhance marine science education and research opportunities.

"I am excited and honored to accept this new position," Moser said. "I look forward to working with our many partners as we find science-based solutions to keep the Chesapeake Bay region healthy for future generations to enjoy."

She earned her doctoral degree at the Institute for Coastal and Marine Science at Rutgers University.

Moser succeeds Jonathan Kramer, who resigned as director in 2011 to join a new research center at the University of Maryland, the National Socio-Environmental Synthesis Center headquartered in Annapolis, Maryland.