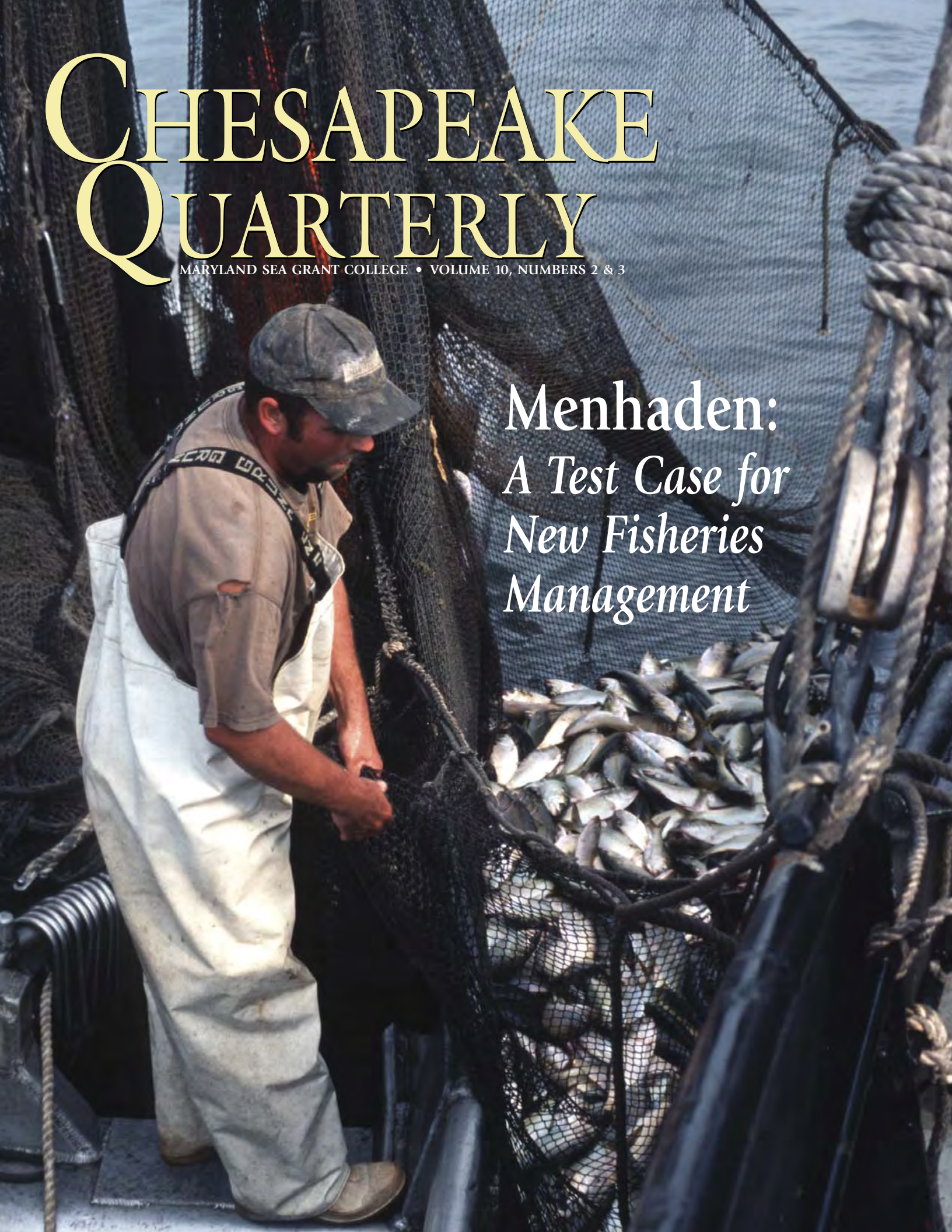

Chesapeake Quarterly

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Menhaden:
A Test Case for New Fisheries Management

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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Cover photo: *A crewman aboard a "snapper rig" fishing vessel out of Reedville, Virginia, gathers in a purse seine net full of menhaden that will be sold as bait.* PHOTOGRAPH BY HAROLD ANDERSON FOR THE SMITHSONIAN CENTER FOR FOLKLIFE & CULTURAL HERITAGE. ***Page 2:*** DRAWING OF MENHADEN BY DUANE RAVER. ***Opposite page:*** *Chesapeake Biological Lab researcher Ed Houde and his graduate assistant Carlos Lozano (upper left) found a lot of hogchokers on a sampling cruise in the Choptank River — but that's not the fish they were looking for.* PHOTOGRAPH BY MICHAEL W. FINCHAM.

WHERE HAVE ALL THE MENHADEN GONE?

A Tale of Two Rivers

Michael W. Fincham

From the dock down at the tail end of Solomons Island, I can watch the charter boats heading out through the early light for a day of fishing. Dozens of charter boat captains keep their boats down in this small Southern Maryland harbor near the mouth of the Patuxent River. From here they carry out clients who drive down from cities like Washington, D.C., and Baltimore, hoping to land some big fish from the Chesapeake Bay.

I'm waiting to board the *RV Rachel Carson*, an 81-foot, shallow-draft vessel that launched only two years ago. It is the primary research vessel for the Chesapeake Biological Laboratory, a marine science center that launched 86 years ago. Now part of the University of Maryland Center for Environmental Science (UMCES), the lab has long been known for housing a cadre of fishery scientists focused on figuring out what is happening to fish stocks in the Bay.

Seven charter boats, according to my count, are already motoring quietly past the research boat in a single-file parade. On the bridges, the shadowy figures of captains at the wheel, and down in the open cockpits, the silhouettes of men with coffee cups in hand outlined against the eastern light. Gliding out onto the broad mouth of the Patuxent River, the captains curve their boats to the east and open up their throttles. The sterns sink, the bows lift, and the boats race hard toward the open Chesapeake.

Most of those charter boats will be hunting for striped bass, the most popular target fish for recreational fishermen who pay big money and make the long drive down to this Solomons Island harbor. And the big stripers they're hunting will be hunting a small fish called menhaden.

Ed Houde will also be looking for menhaden today on this research vessel, but he's a fishery scientist who only wants to count the fish, not catch them or eat them. A compact, dark-haired man with a bushy, slightly graying moustache, he arrives at the *Rachel Carson* with a laptop and a search plan. It calls for a series of cruises that will seek out juvenile menhaden this summer in two Maryland rivers: the Choptank and the Patuxent. Both researchers and recreational fishermen are interested in this small, little-known fish, because they know it provides food for more famous species like striped bass, bluefish, and weakfish. Research samples from these summer cruises could help solve one of the major mysteries bothering both fishermen and scientists: Where have all the menhaden gone?

On the bridge of the *Rachel Carson*,

Houde spreads out a chartbook on a table to review today's plan with the ship's captain, Mike Hulme, and the lab's marine superintendent, Bruce Cornwall. Today's mission is finding out whether many (or even any) young menhaden have gone up the Choptank River, a long winding river on the other side of the Bay. "We'll do the trawl just below the Dover Bridge," he tells Hulme. "We know that is a good place." Hulme nods and soon has the *Rachel Carson* powering across the open Chesapeake toward the Eastern Shore at 24 knots an hour, its props kicking up four separate rooster tails behind us.

It's a Bay that's changed since Houde made his first boat ride across the mainstem of the estuary. The year was 1980, and he remembers that a new governor, Harry Hughes, had just declared the Bay "a national treasure." The Chesapeake Biological Laboratory, fortunately for him, was hiring new faculty to study the estuary. He still has vivid memories of those early boat trips. "If you were out here on the Bay in July and August, you would see schools of fish everywhere, all around you these little menhaden," he says. "In the 70s and 80s, the abundance of young menhaden was very high."

Houde began work on the Chesapeake just in time to see the tail end of that great abundance, episodes when the water could suddenly seethe with a white, splashy energy as bluefish and stripers, ospreys and pelicans all attacked, setting off feeding frenzies on schools of menhaden gliding near the surface. A sheen of fish oil would soon spread on the water, and any fishermen lucky enough to be nearby would hustle over, hoping to get in on the action.

Where all that energy went is a mystery. Menhaden stocks in the Chesapeake are now at their lowest point in the past 54 years. It's a mystery that matters to recreational fishermen who claim that low levels of menhaden are starving a lot of stripers. It's a mystery that matters to a lot of commercial fishermen also. In Maryland and Virginia, pound netters catch menhaden to sell as fish bait, as do five

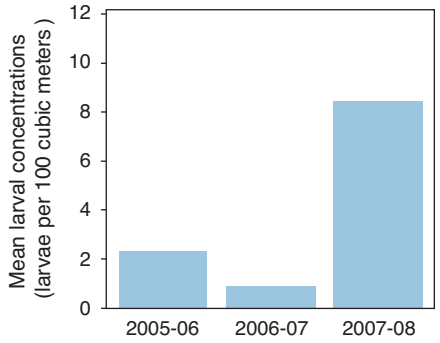
small "snapper rig" boats that fish the southern Bay, working out of Reedville, Virginia. The town is also a base for Omega Protein, a Houston-run corporation that operates the last "fish reduction" plant on the East Coast. Menhaden may be a small, oily fish that nobody eats, but it supplies the largest commercial seafood harvest in the Chesapeake Bay.

In the 30-plus years since he arrived at the lab, Houde has become a leading authority on the early life stages of species like alewives, anchovies, herring, and menhaden. They may be less sexy and less studied than striped bass and blue crabs and oysters, the Bay's iconic species, but anchovies and menhaden are the most numerous fish in the Bay. And as forage species for other fish, they seem to play essential roles in the energy flows of the whole ecosystem.

Menhaden populations, however, have been low for 25 years, according to Houde, who says, "Overall, we don't know what has driven that." We're down in the long, narrow shipboard lab, where Houde is checking his data sheets for the day and trying to explain why menhaden populations are such a puzzle.

Pieces of the puzzle can be found hundreds of miles from here. "Menhaden spawn out on the continental shelf," explains Houde, "and later come into estuaries." It takes the right combination of ocean currents and winds, of course, to deliver menhaden into estuaries along the coast. When they deliver an especially large mass of larvae, the payoff can be a lot of new menhaden, a "year class" large enough to sustain population levels for several years. That right combination of forces, however, is almost impossible to predict, and according to some researchers, it seems to include slugs of water from warm-core rings and onshore streamers that break off from the Gulf Stream and push larvae toward the Chesapeake. One potent force recently identified is the Bermuda-Azores High, a weather pattern that correlates strongly with high recruitments of menhaden.

The menhaden puzzle clearly has a lot of parts, and it's the last part — what happens to larvae as they come into the Chesapeake — that Houde has focused on. To get a rough estimate of the numbers and ages of larvae entering the Bay, Houde and his graduate student, Carlos Lozano, ran cruises down near the mouth of the Bay over three winter seasons. They hit the same sites, trip after trip, month after month, dragging trawl nets through the chilly waters in hopes of catching and counting menhaden larvae at their entry point into the system. It was cold, slippery work with ice forming on the decks and rails and 400-pound nets swinging alongside the boat.



The number of menhaden larvae *arriving at the mouth of the Chesapeake Bay can vary widely from year to year. The data above come from 18 winter cruises that sampled 5 sites from November to April at the mouth of the Chesapeake. Most of the larvae reached the Bay 30 to 60 days after they hatched. Their dominant prey at that stage of development are tiny crustaceans called copepods.* SOURCE: CARLOS LOZANO.

One payoff from his winter cruises has been evidence that the number of larvae coming into the Bay can vary hugely from year to year. "We found that larval ingress varied ninefold during the three years that we were out there," says Houde. The winter of 2007-08, for example, had nine times more larvae than the year before.

That payoff only raised some new puzzles. The jump in incoming larvae never showed up in later surveys of menhaden young-of-the-year. When Houde compared his record of incoming larvae with a survey of juvenile menhaden run by the Maryland Department of Natural Resources, he found no connection. Big years for menhaden larvae did not bring big years for juveniles in the department's surveys. One explanation could be a difference in survey gear. Another, more disturbing possibility: Something unhealthy was happening to all those new larvae once they got into the Bay.

By 8:24 a.m. the *Rachel Carson* has crossed the Bay mainstem and is cruising into the wide mouth of the Choptank River. It slides past the housetops and church towers of Cambridge, slips under the Route 50 Bridge, and begins winding upriver past marshes and woods that give glimpses of farms beyond. When the Dover Road Bridge finally blocks further passage, Hulme wheels the boat in a tight turnaround and the crew gets the net ready for the first mid-water trawl. Houde peers over the side. The river here is turbid.

How many of the winter arrivals made it up here into the Choptank? To count them, you have to catch them first, and that leads to a guessing game of sorts. "We don't know how to catch them when they are at this size," says Houde. "They are transforming into little juvenile fish. We don't know exactly where they are."

To come up with a search plan, scientists have to try thinking like a menhaden. Houde's thought is to start the trawl near the bottom, then raise it to a different depth and pull it through the water for a timed interval. Then repeat several times at several depths. If there are any juvenile menhaden in the river today, the net should find them.

Running a trawl takes teamwork as well as strategy. On the back of the deck, Houde has a crew of graduate students and lab technicians standing ready, holding the end of a long, green net. Working at the back-deck control console, Bruce Cornwall in a wide-brimmed hat talks with Hulme who's up front on the bridge lining the boat up for a downriver run.

Cornwall gives a signal of sorts, a sudden right jab in the air, and then he pushes the throttle that unwinds the net cable. Two crew members throw over the end of the net, the boat surges downriver, the net pulls away and sinks. Houde walks

to the stern, steadying the net cable with his hand. Two metal slabs, the doors that hold open the net, clank across the deck and disappear into the dark water.

The haul is underway and everybody relaxes for the 20-minute run, taking in the sun on deck or grabbing a snack down below — everybody except Houde and Cornwall and the captain up on the front bridge. Houde stands by the console, clipboard in hand, making notes on the net timing, and checking his watch constantly. "The usual: two minutes at a step," he tells Cornwall. They raise the net higher in the water column, time an interval, then raise it again. If you were a menhaden, where would you be swimming?

Houde gives the signal, Cornwall reverses the throttle, the cable drum starts groaning and the net line starts winding in. Students and technicians reappear and start muscling the net up onto the deck, laying it down in layers. Houde eyeballs the clean net and realizes his sampling didn't get all the way to the bottom of the river.

The payload is at the end of the net and it's a big haul, perhaps a historic haul. Crew members pick out 17 small fish, all white perch, and then empty the rest of the catch into a green plastic tub. To the untrained eye, it looks like a sticky clump of gray-brown pasta. To Houde's eye, it's a mass of fish larvae. "All these are larval white perch and larval striped bass," he says as he and Lozano bend close and start picking through the pasta. "There must be 100,000 or more in here. It's probably the biggest catch I've ever seen."

But this biggest catch holds no juvenile menhaden, none of the menhaden that came into the Bay as larvae last winter. "The menhaden would be bigger," Houde says, "and look like juvenile fish already." They would be easy to pick out in this mass of mixed-together larvae.

The second sampling run brings a bluegill and another mass of larval white perch and striped bass. But no juvenile menhaden. The third sampling brings two adult menhaden as well as nine bay anchovies. But no juvenile menhaden. As the *Rachel Carson* moves downriver into saltier water, the Choptank yields plenty of perch and hogchokers, as well as several eels and toadfish — even one big, ugly (and invasive) blue catfish. But no juvenile menhaden, not at the fourth, fifth, or sixth station.

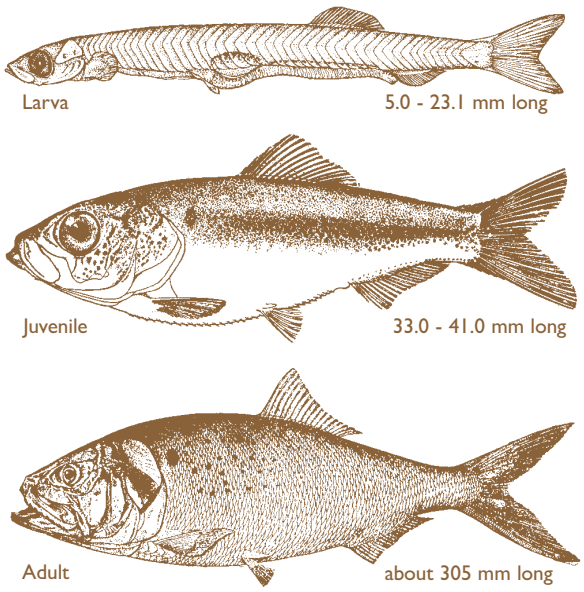
Where have all his winter menhaden gone? They may not be here yet, says Houde, sitting at the galley table, punching his laptop in search of a wireless connection. Or they may have already come in, schooled up and left the river looking for more food. If they left any stragglers behind, the mid-water trawl missed them. The guessing game goes on.

Some of those missing menhaden, it turns out, went up the Patuxent River, back on the western side of the Bay. The next day Dave Secor, a co-investigator with Houde, led a similar crew to collect samples at six stations along the Patuxent, the river that runs right by the Chesapeake Biological Lab. They found juvenile menhaden, 45 in all, most of them where you would expect them: at the three upriver, low-salinity sites. More juvenile menhaden were in the Patuxent, suggests Secor, because more menhaden food was there. On aerial surveys he had seen a major phytoplankton bloom hovering right at the mouth of the Patuxent, but he found no blooms near the Choptank.

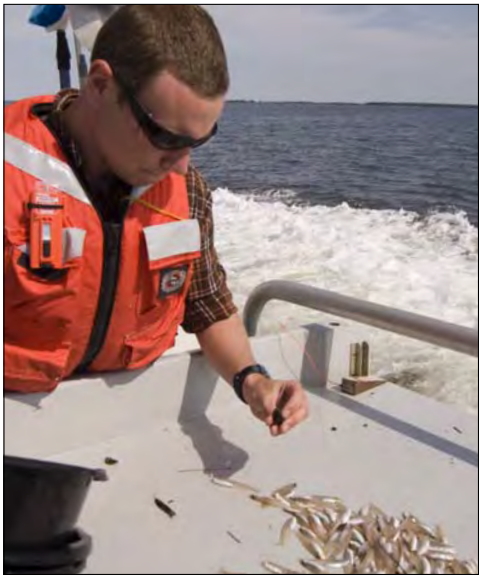
The two rivers, at the least, highlight in crude form one clear lesson emerging from Houde's research. To find juvenile menhaden, first find the phytoplankton blooms. Strong evidence for that lesson came from a recent study by Houde and UMCES Horn Point Lab researcher Larry Harding. They compared historical data from aerial surveys with historical records showing the recruitment of juvenile menhaden into the fish population. The records revealed strong correlations between the frequency of large blooms of phytoplankton and high recruitments of juvenile menhaden. Like scientists, menhaden seem to have search strategies for finding phytoplankton blooms: They are able to sense and track down density gradients in the water created by blooms of phytoplankton and algae. With no bloom in process, the Choptank turned up

Atlantic Menhaden (*Brevoortia tyrannus*)

Atlantic menhaden range from Nova Scotia to Florida and are found in nearly all sections of the Chesapeake Bay. These silvery fish have a distinct black shoulder spot behind their gill opening, with a variable number of smaller spots on their sides. They spawn in the ocean and return to the Bay and its tributaries as juveniles. They grow up to 15 inches long and travel in large schools. Atlantic menhaden are an important prey species for many predatory fish, a favorite food for herons, egrets, ospreys, and eagles, and a valuable fish commercially. The fish, along with blue crabs, has dominated the Bay's commercial fisheries for the past 60 years. More pounds of menhaden are landed each year than any other fish in the Chesapeake. A related species, Gulf menhaden (*Brevoortia patronus*), is found in the Gulf of Mexico, where the commercial menhaden reduction fishery is one of the largest fisheries, by volume, in the United States.



ILLUSTRATIONS BY ALICE JANE LIPPSON.



Puzzled by the decline of menhaden *in the Chesapeake, Ed Houde (upper left) organized searches for juvenile menhaden in two Maryland rivers, the Choptank and the Patuxent. On the first Choptank cruise, he found no juvenile menhaden but turned up plenty of bay anchovies for Jim Seuberling (lower left) to count, as well as an occasional blue crab for Jen Humphrey (lower right), and one big blue catfish for Carlos Lozano. This blue catfish is one of the first found in the river. An invasive species native to the Mississippi drainage, blue cats are widespread in the James River and have been caught in the Potomac. Sportfishermen like catching them, but scientists worry these voracious feeders (they can top 80 pounds) will disrupt food webs supporting traditional Bay species. Ed Houde (opposite page) measures one of the 9 adult menhaden found on the Choptank cruise. The Patuxent River cruise netted 45 juvenile and 280 adult menhaden.* PHOTOGRAPHS BY MICHAEL W. FINCHAM.

empty of juvenile menhaden while the Patuxent proved well endowed with both blooms and juvenile menhaden.

If these two rivers have a tale to tell, it's part of a larger story about how timing and food may be driving menhaden recruitment in the Chesapeake Bay — or derailing it. This fish story is still being written by Houde and Secor and other scientists, and it may take more winter and summer cruises to complete the final chapter. But the plotlines that are emerging suggest that offshore winter weather patterns and onshore springtime runoff events are two of the lead players in a menhaden drama that may not have many happy endings.

When winter larvae first arrive at the mouth of the Chesapeake, they are entering a critical and highly vulnerable stage in their life cycle. Those menhaden larvae are not only transitioning into a new environment, moving out of the ocean into an estuary, but they are also transitioning to a new life stage. They will soon become juveniles and switch their food preference from zooplankton to phytoplankton, thanks to new comb-like gill rakers that allow them to begin filtering food out of the water. "It's a complex life cycle," says Houde. "When you have to filter feed, you would like to be in the Bay at a time when there is sufficient food."

The timing of their arrival can be key to their finding food. Menhaden larvae tend to enter the Bay between November and mid-April, according to Houde and Lozano, but for many of those months they will not find much food available. The time for rich phytoplankton food stocks is not November, not December, not January, not even February. Any early arrivals will have to survive a winter when the water is cold and the food is scarce — and most will not make it.

The late-comers, on the other hand, will soon find plenty of food. Larvae entering in March and April encounter a Bay that is warming up and a springtime runoff that is firing up plankton blooms. Blooms in April, May, and June, according to Houde and Harding, bring big jumps in menhaden recruitment

because they create a lot of phytoplankton just when menhaden larvae are transitioning into filter-feeding juvenile fish.

What brings in a lot of late-arriving menhaden? A warm, dry, late-winter weather pattern, the gift of a high-pressure system that moves back and forth between Bermuda and the Azores. When a large Bermuda-Azores High shifts to the west, it creates clockwise winds that pull warm air up from the south and help drive menhaden larvae toward Atlantic Coast estuaries. It also discourages storminess that can disrupt larval migrations. When the high pressure is small or shifted toward the east, however, those winds have less effect on larval transport. That has frequently been the case during recent decades of low menhaden recruitments. The shifts and sizes of Bermuda-Azores Highs are, in turn, affected by larger, longer-lasting shifts in sea-surface temperatures called the Atlantic Multidecadal Oscillation.

The Bermuda-Azores High affects more than menhaden recruitments, according to Bob Wood, a scientist with the National Oceanic and Atmospheric Administration who first identified this effect. A former Houde student, he found that frequent favorable Bermuda-Azores Highs also help raise recruitment levels for spot and summer flounder, two other Bay species that spawn in coastal shelf waters during winter months.

Which brings us to a paradox in the menhaden puzzle: A good year for menhaden arrivals may be a bad year for menhaden survivals. Warm, dry winter patterns created by Bermuda-Azores Highs bring more menhaden into the Bay, but cold, wet winters with high springtime runoff seem to supply the most food.

There's a second paradox. Good years for new menhaden are usually bad years for new stripers. And vice versa. Cold winters and wet springs often lead to a lot of new stripers, but they usually disrupt the influx of new menhaden. With this see-saw pattern at work, high populations of stripers will never match up for long with high populations of menhaden, their favorite food fish.

Surprisingly, this negative see-saw pattern that Wood discovered also holds true for other species: A year of high influx for shelf-spawning fish like spot and summer flounder is usually a year of low influx for other Bay-spawning fish like white perch, alewives, and blueback herrings.

So where *have* all the menhaden gone? There's no simple answer, but there are some emerging hypotheses, none of them very hopeful. Long-lasting trends in the Atlantic Multidecadal Oscillation have led to fewer Bermuda-Azores Highs, to fewer warm, dry, late winters, and to fewer large influxes of menhaden larvae into the Chesapeake. Those trends may be changing, but they shift slowly. Over decades.

An even less-hopeful hypothesis, according to Houde, suggests that the large-scale climate pattern called global warming may have encouraged menhaden to spawn in waters farther north from the Bay, making it less likely large numbers of larvae will make the trip down to the Chesapeake. Recent surveys show higher numbers of new menhaden arriving in estuaries north of the Bay.

For Chesapeake Bay larvae, offshore winter weather patterns seem to control their arrivals, and springtime runoff events seem to control their survivals. Global warming, offshore winter patterns, springtime runoff events — none of these forces can be controlled by changes in fishery management. But they can be mitigated or magnified.

There's no easy advice in Houde's work on how to improve menhaden recruitments into the Chesapeake. The only thing that can be controlled in the meantime is the commercial harvest, and that harvest probably does have an effect, according to Houde. "If not enough eggs are being produced now to get high recruitments," he says, "that could be a reason for the low recruitments we are seeing. It may play a role."

A cutback on commercial harvests could lead to more spawners setting more eggs and larvae adrift in the coastal ocean. Increasing spawning far out in the ocean seems a small step to take in the face of events as powerful as climate, weather, and freshwater flow. But Houde still stresses, "You want more eggs to ensure more recruits." In a boom year these extra eggs and larvae could magnify the size of a large year class. In low years, cutting back on harvest could help sustain a spawning stock until all those larger environmental forces line up.

These small steps become even more important, says Houde, just when all those large-scale forces are so out of sync. That may be the final paradox in the menhaden puzzle.

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Food Fish Fight

Ecosystem-Based Fisheries Management & the Menhaden Wars

Michael W. Fincham

It was a day like this when the osprey got robbed.

Today the menhaden were running and the *FV Hush Puppy* was running after them. The guy up in the spotter plane was reporting fish, and Fred Rogers, down on the fishing boat, started working his binoculars, looking for osprey.

Like spotter pilots, ospreys are skilled at spying fish in the water — so skilled they're called fish hawks. An adult osprey, with its pale body and dark, hawklike wing spread, is a master fish killer: It can slap the water like a skipping stone as it swipes a small fish off the surface or splash down and sink its talons into a bigger fish gliding lower in the water.

Menhaden are not big fish, but they travel in large schools, making them easy to spot from the air. To a pilot, a crowd of menhaden, tightly bunched, can look like a clump of dark green broccoli bobbing just below the surface. Or a school, numbering tens of thousands, can stretch out and bend and curve like a strand of wet spinach waving in the water. To birds wheeling above, to rockfish and weakfish and bluefish swimming up from below, these masses of menhaden look like a moveable feast.

To Fred Rogers on board the *Hush Puppy*, they are a losable feast. Rogers could lose his menhaden to birds and to fish but most often to other fishermen. His *Hush Puppy*, 80 feet long with a steel bottom, is competing with four other boats, all known locally as "snapper rigs," that also hunt menhaden in the mid-Bay region of the Chesapeake. His big competition, however, comes from a nearby fleet of ten larger, industrial fishing boats, most of them twice the size of the *Hush Puppy*, all of them carrying two net boats. This fleet of big boats comes out of Reedville, a fishing village down at the end of the Northern Neck of Virginia, where Omega Protein, a Houston-based company, runs the last large-scale menhaden processing plant left along the Atlantic Coast.

As soon as he sighted osprey off to the north, Fred Rogers ordered four of his crew off the *Hush Puppy* and down into the small net boat they were towing. Then he jumped in and quickly gave chase.

Why are so many boats competing for menhaden — a small, oily fish that most

An osprey who spotted *a school of menhaden heads back to the nest. Fred Rogers (opposite page), captain of a "snapper rig" called the* FV Hush Puppy, *surveys a school of menhaden caught in his net. Rogers and his crew (above) haul in a net full of menhaden. With purse seine nets they circle around and underneath a school of menhaden. After running the two ends of the net through a power block, they are able to close up the "purse," preventing any escape below the net. The purse boat then drags the full net to its mother ship where menhaden are vacuumed up into a refrigerated hold.* PHOTOGRAPH OF OSPREY BY JOHN GRESHAM. PHOTOGRAPHS OF FRED ROGERS AND PURSE SEINE BOAT BY HAROLD ANDERSON FOR THE SMITHSONIAN CENTER FOR FOLKLIFE & CULTURAL HERITAGE.

people have never heard of? You won't, after all, see menhaden in supermarkets or seafood stores or on restaurant menus. If the fish are caught by snapper rigs or pound netters, they usually end up as bait for crabbers and chum for charter boat crews trying to catch striped bass. If they are caught by Omega's fleet, on the other hand, menhaden will be compressed or "reduced" into fertilizer, fish meal, or fish oil. If you eat farm-raised fish or chicken, you may be sneaking menhaden into your diet. If you pop a daily fish oil pill with omega-3 fatty acids, you may be using menhaden to keep your heart healthy. If you give your house a new coat of paint, menhaden oils could be part of the paint mix. Products for agriculture, aquaculture, industry, and health foods — and bait for fishermen. It's no wonder the little menhaden is a big money fish.

With fish stocks at a 54-year low, it should be no surprise that all this commercial harvesting of a depressed fish stock is stirring a growing controversy. Many scientists are calling for a new way of managing fisheries and dozens of sportfishing and environmental groups are calling for cutbacks in a way of fishing that has thrived in the Chesapeake for more than a century.

Gliding up to his school of menhaden, Fred Rogers and his crew dropped a sea anchor, an underwater parachute that holds one end of a purse seine net. Motoring in an arc, the crew began spooling out net behind them, carving a circle around the fish. Several osprey and pelicans soon came wheeling lower to feed, and some of the target fish began slipping out of the closing corral. Snapper rigs like this work more slowly than the big Omega ships that can each launch two net boats at the same time. Two boats, each carrying one end of the net, can encircle a school of fish twice as fast.

Closing the loop back to the anchor end of the net, Rogers hooked the two net ends together. With the purse seine now surrounding their target fish, the crew began drawing the net together from underneath the school, cutting off any deep escape routes. Running the two net ends through a mechanized pulley, called a power block, Rogers and his men began to zip the purse, winching up the net and forcing the fish catch toward the surface. The water in the loop began to fleck and bubble, the surface dimpling as though raindrops were splattering it from below. More birds descended.

The* FV Hush Puppy *heads out *of Reedville, Virginia, for a day of menhaden fishing. Owned and operated by Fred Rogers, the* Hush Puppy *is an 80-foot, steel-bottomed fishing boat towing a 40-foot seining skiff. Most of its catch will be sold to Bevans Oyster Company in Port Kinsale, Virginia, then resold to bait shops and resold again to crabbers and charter boat captains.* PHOTOGRAPH BY HAROLD ANDERSON FOR THE SMITHSONIAN CENTER FOR FOLKLIFE & CULTURAL HERITAGE.

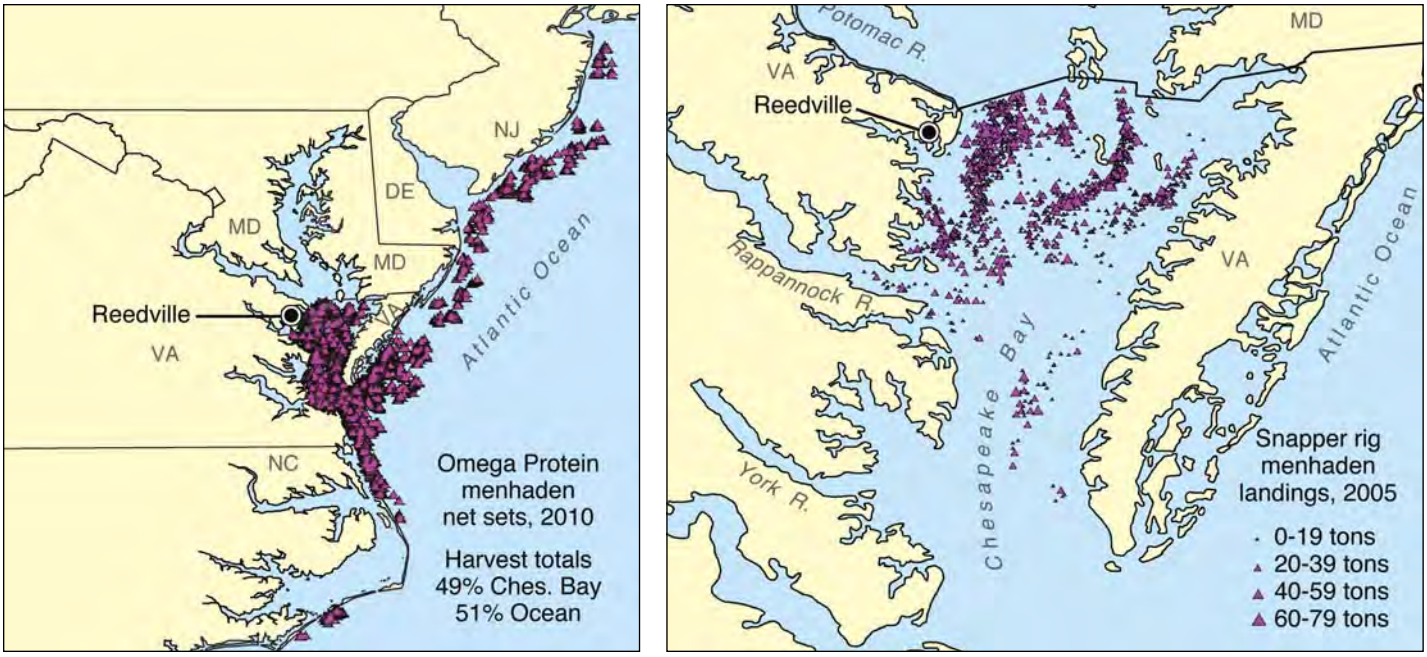
Back on the high bridge of the *Hush Puppy* where he worked the wheel, veteran deckhand Phil Shahan pointed out a familiar sight: Many of the menhaden down in the net were banding together for a jail break. "They always break toward the sun," said Shahan as the massed fish surged toward one end of the corral. A line of foam began to form along the net line as masses of fish butted up against the tightening mesh.

Up on the bridge with Shahan was Fred's father, Ray Rogers, a retired net maker who still enjoyed watching his son work a net set. He could see ospreys dipping lower to pluck at the trapped fish and several pelicans simply plopping down in the middle of the loop like they were settling in for dinner.

When Shahan talked of seeing a pelican chase down an osprey for its fish, Ray Rogers, then in his 70s, talked about the day he watched the osprey get robbed. He saw a fast-moving eagle swooping after a fish-carrying osprey. The eagle made multiple runs, swiping and swiping at the osprey and its prey. "He just kept fooling with him and fooling with him," said Rogers, until the exasperated osprey finally dropped the fish and darted away. Whirling on an unseen dime, the eagle dove toward the water, said Rogers, then swung under the falling fish and, like an acrobat, flipped on its back and caught the fish in its claws — all before it could hit the water.

Eagles and osprey aren't the only ones willing to go to war over menhaden these days. Clearly angered by the spectacle of industrial-scale fishing, sportfishermen have organized to push hard for restrictions on the commercial menhaden harvest, a tradition that dates back 140 years in Virginia waters.

In their view every net that lifts menhaden out of the Bay robs food from the mouths of fish and birds. It's not exactly an altruistic argument: Sportfishermen, of course, want more menhaden as food for rockfish, weakfish, and bluefish, the fish



Most of the commercial harvest of Atlantic menhaden *occurs in Virginia waters, either along the ocean side or in the southern half of the Chesapeake. In 2010, Omega Protein, based in Reedville, Virginia, operated a fleet of ten commercial fishing vessels that set purse seine nets from New Jersey to North Carolina. Only Virginia and North Carolina, however, allow netting inside the three-mile, state-managed zone. Since 1995, the snapper rig fleet has varied between three and five vessels. In 2005, four vessels made the vast majority of their net sets south of the Potomac and north of the Rappahannock. The snapper rigs and the Omega boats together turned this mid-Bay area into the menhaden breadbasket of the Chesapeake.* SOURCE: JOSEPH SMITH, NATIONAL MARINE FISHERIES SERVICE.

they like to catch. Groups such as the Coastal Conservation Association and the Maryland Saltwater Sportfishing Association have created the Menhaden Coalition, an alliance that includes 33 sportfishing and environmental organizations with total memberships topping 400,000 and a common goal of saving menhaden as a food fish. In the last two decades their combined communication campaigns have focused the policy debate on one key question: Who gets first call on the menhaden bounty of the Chesapeake Bay?

Should it be the ten big boats of Omega Protein? The five smaller snapper rigs? The pound netters who work along Maryland and Virginia shorelines? What about the striped bass and bluefish? What about the eagles and ospreys?

Who gets the biggest share in this food fight? And who gets robbed?

Questions like these usually get answered by the Atlantic States Marine Fisheries Commission, the multi-state body charged with regulating coastal fisheries. In its August meeting, the commission voted to consider new restrictions on commercial harvesting. The problem was clear: Coastal menhaden stocks dropped from an estimated 160 billion fish in 1985 to 40 billion in 2008. And the solution was hopeful: Harvest cutbacks might let more menhaden reach spawning stage.

Before making a final decision on harvest cutbacks, however, the commission will hear three months of public comments. When the commission meets for a final vote in November, its options will be: Move forward with the harvest cutbacks. Or cancel them. Or ask for more study.

The debate over who gets how many menhaden is clearly heating up again, but this time with a new twist. According to environmental advocates, cutting back on commercial harvesting could be a historic step toward adopting a new paradigm about the best way to manage this country's fisheries.

The new approach goes by the name "ecosystem-based fisheries management." A philosophy as much as a method, it has yet to be applied in fishery cases, especially cases like the menhaden management wars. By placing primary focus on the health and structure of the ecosystem, this approach reverses traditional priorities featured under "single-species management." That system focused first on a target species and then went to work figuring out how to achieve a "maximum sustainable yield" within current ecosystem conditions. Under the new paradigm, however, fishery managers would look first at the "ecosystem services" that menhaden might provide and then balance those benefits against any economic payoff from the commercial harvest.

Menhaden, for example, play a crucial role in the energy flows of the ecosystem. As heavy plankton eaters, they convert plankton energy to fish flesh (their own) which then becomes forage food for fish-eating species at the top of the food chain. "Menhaden have a unique role in that mid-trophic position," says Dave Secor, a fishery biologist with the Chesapeake Bay Laboratory. "There are not many fish that perform that role in the Chesapeake."

This food issue, the forage fish concept, has also become the central argu-

ment for sportfishing advocates and environmentalists who want to build their case for harvest cutbacks — and they're expecting that scientists will back up their claim.

The new approach, however, has its advocates, its doubters, and its disbelievers, and its new influence on policy has put scientists back in the middle of the menhaden wars. (They've been there before.) Doubters would seem to include the snapper rig operations and Omega Protein, the large corporation that sells fish oil products around the world. Their spokesmen say the current fishery is sustainable under traditional management approaches.

At the heart of the conflict is a core concept out of ecosystem theory: Menhaden might prove more valuable swimming in the water than floundering in a commercial net. If menhaden are important to the fish and fowl that feed on this species, is that reason enough to force cutbacks on a historic fishery? It's become the central question in the debate over the commercial harvesting of menhaden.

This time the rockfish, eagles, and osprey might get a bigger share of the menhaden bounty, and the commercial fishermen might feel they're the ones getting robbed.

The outcome of this new menhaden policy, if it passes final muster, could prove a decisive test case for the value of this new paradigm in fisheries management. Would ecosystem-based fisheries management do a better job with this species than single-species management?

The low level of menhaden stocks worries sportfisherman because it threatens the hard-earned recovery of striped bass stocks that began under a single-species approach back in the early 1980s. It was a recovery that came with some pain: A moratorium on fishing was followed by a carefully monitored quota system imposed on both commercial and recreational fishermen. But the pain paid off: Striped bass populations increased from less than 9 million in 1982 to more than 70 million by 2004.

As a charter boat captain *and owner of the Ingram Bay Marina, Billy Pipkin has survived recessions in the economy and slumps in the stocks of popular fish like striped bass and bluefish. He's now worried about whether the rebound of striped bass, his bread-and-butter fish, will survive a localized depletion of menhaden, a striper's bread-and-butter food. "If the menhaden industry has to cut back, hopefully they will be willing to do it," he says. Living just south of Reedville, he's seen firsthand the importance of the industry to the local economy. "At the same time, you've got to see past your hand," he says. "There's a great future ahead as long as the science is right and the management is right."*
PHOTOGRAPH BY MICHAEL W. FINCHAM.

Menhaden were important in the recovery because the species is the favorite prey for striped bass. Young stripers switch into their fish-eating stage by feeding first on small prey like bay anchovies and then graduating to juvenile menhaden, according to Jim Uphoff, a researcher with the Maryland Department of Natural Resources. Striped bass chase menhaden for the same reason Omega's boats chase them. Their high lipid content creates an energy source for stripers as well as an oil source for Omega. As they grow older and larger, stripers keep eating menhaden, moving up to larger, older menhaden. "These older striped bass are capable of eating all sizes of menhaden," says Uphoff. "And they do."

The recovery of striped bass stocks seemed to stand as the best evidence that smart management — in this case single-species management — can save a fishery. "None of us are big fans of government regulation," says Billy Pipkin, a charter boat captain located south of Reedville who well remembers the pain of the moratorium. "But if it wasn't for government intervention in the striped bass industry, we would be without striped bass now," he says. "I'm thankful the fishery is back. That's a large part of my income."

The recovery strategy, it now appears, may have been flawed. In a number of studies, the recovery of striped bass is now being implicated in the decline of menhaden. Rebuilding striped bass populations was the same as dropping another fleet of harvesters into the Bay, says Uphoff, a field researcher who models the bioenergetic needs of fish populations. Since 1997, according to his calculations, that fleet of stripers may have been harvesting more menhaden than the fleet of Omega boats.

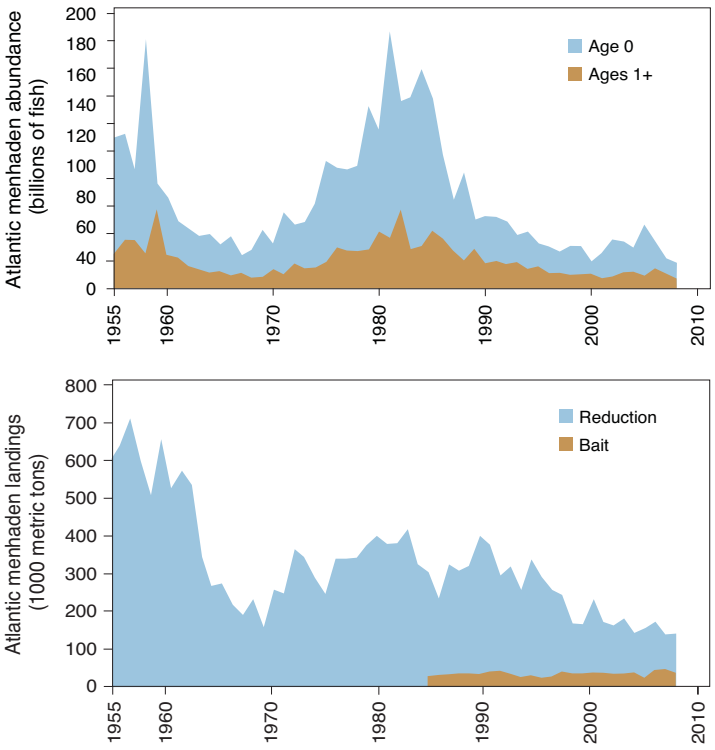
"The striped bass recovery was a great success story that was also a failure," says Bill Goldsborough, senior fishery scientist with the Chesapeake Bay Foundation and a member of the Atlantic States Marine Fisheries Commission. "If you are going to maintain a high level of a predator, you have to preserve its primary food base," says Goldsborough. Single-species management succeeded in bringing back stripers, as he suggests, but it failed to figure out how all those new stripers would change the ecosystem.

Could an ecosystem-based approach have done a better job? Could it have explained what striped bass would do for food without a lot of menhaden to feed on? Stripers are expanding their diet to other species, including blue crabs. In some cases big stripers, unable to find large menhaden, are now going after anchovies and smaller menhaden. "The anchovy is like the starter fish for these piscivores, for small weakfish, bluefish, and striped bass," says Uphoff. "If a big striped bass is eating anchovies, then he's competing with all these smaller fish." Their new foraging strategies could cascade through the food webs with unpredictable effects.

Could ecosystem-based management figure out all these interconnections before they happen? Its critics suggest this approach could prove too complex to apply to real-world situations. Can fishery science identify, describe, quantify, model, and connect all the interactions that can affect the fate and ecological role of a fish species like menhaden in an ecosystem like the Chesapeake? "It becomes very complex," says Uphoff. "A lot of the things that are going to happen are hidden."

Under an ecosystem approach, however, some things previously hidden could now become clearer. When striped bass populations dropped off after 2006, for example, and more fish began showing signs of malnutrition and disease, fisheries managers began considering a cutback on commercial and recreational fishing. The short term goal: Increase the spawning stock. The long-term goal: Increase the number of striped bass along the East Coast of the United States. If the strategy works, however, the result could be a bigger fleet of stripers chasing menhaden. This time, at least, fishery managers would see the surge coming.

And this time they could try to get ready. A cutback on the commercial menhaden harvest might — with luck and a large year for new menhaden — rebuild populations of the oily food fish that stripers like to chase. Or it might not. At the very least, the cutback on striper harvest would require some sacrifice from



Populations of menhaden have risen and fallen *dramatically over the past 55 years and — to a lesser degree — so have commercial harvests. Menhaden fish stocks (top graph) hit their high points in the mid 1950s and again in the late 1970s and early 1980s. Commercial harvests (lower graph) also peaked in the 1950s — but never reached that level again. When fish stocks slumped during the 1960s and again during the 1980s, many factories north of the Chesapeake closed, never to reopen again. Since the 1950s, the fishing fleet has dwindled from 150 vessels to 9 this year, and the number of factories has gone from 25 to 1, Omega Protein of Reedville, Virginia.* SOURCE: ASMFC STOCK ASSESSMENT OVERVIEW — MENHADEN, MAY 2010, ATLANTIC STATES MARINE FISHERIES COMMISSION.

recreational fishermen who share a passion for stripers, letting them share some of the pain now proposed for menhaden fishermen.

Will fisheries managers also get ready for the return of ospreys? After the outlawing of the pesticide DDT in the 1970s, these master fish killers increased their numbers tenfold in the Chesapeake region. And so did eagles and brown pelicans and great blue herons and other birds — all of which love to feast on menhaden. According to a recent review of the research literature, however, most ecosystem models have largely ignored the looming impact of all these flying fish eaters on menhaden populations.

Are they eating many menhaden? Only one published report examines the diets of osprey in the Chesapeake region, and it dates back to research done in 1985. Two scientists from the College of William and Mary spent two months observing osprey nests and estimated that menhaden made up 75 percent of an osprey's diet. They saw their osprey bring home to the nest an average of 5.4 fish per day, a haul that included white perch, croaker, toadfish, and American eel, but was mostly made up of menhaden. And on two vivid days they saw something else: An osprey flying home not with one, but with two menhaden, one clutched in each set of talons.

Will a new paradigm that surveys an entire ecosystem of competing species ever prove as successful as a single species approach once did? The evidence is not in, but expectations are still high. For managing a collection of fisheries that interconnect in unexpected ways, ecosystem-based fisheries management begins with this great advantage. "It is a more cautious way of doing business. You are attempting to make these linkages," says Uphoff, "rather than managing as though they don't exist."

Descriptions of fishing aboard the FV Hush Puppy *were drawn from field notes, photos, videos, and interviews gathered by Harold Anderson for the Smithsonian Center for Folklife & Cultural Heritage in 2002.*

The Case for Fishing Menhaden

Could cutting back on commercial harvests help restore menhaden stocks to a healthy level? Probably not, according to Monty Deihl, the new general manager of the Omega Protein plant in Reedville, Virginia. "We catch a very small percentage of the stock each year, very small," says Deihl, whose father, grandfather and great-grandfather once worked the menhaden boats. "We've done this for 130 years, and now there is less fishing pressure on this stock than ever before."

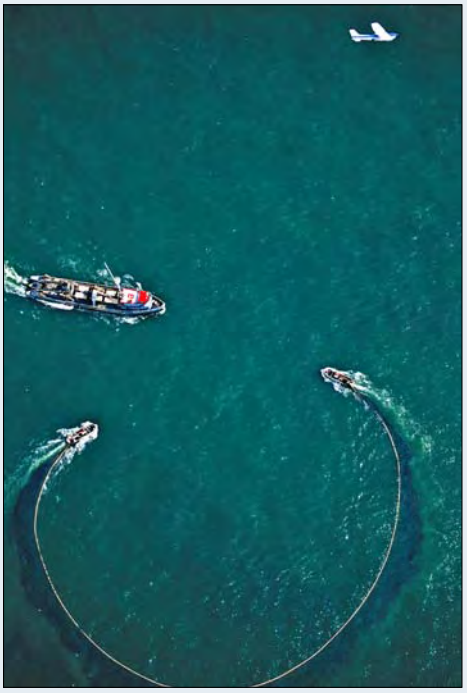
A tall man, with wide shoulders, a broad face, and a confident style, Deihl is a Reedville native, but he took over as manager only two years ago after a long career with the Air Force and a short career with a defense contractor. He came back to an industry that has shrunk from 20 menhaden reduction plants located along the Atlantic Coast in the 1950s to one: the Omega Protein plant he now manages. Since 1997, the menhaden fleet has dropped from 20 vessels fishing the Chesapeake and the mid-Atlantic Coast to 9 this year. And its harvests are running 30 percent below the previous decade.

He quickly found that part of his new job was building a better public case for commercial fishing, a case he based, in part, on claims about the small impact of commercial fishing and the large impact of environmental forces. "If this species is threatened, it certainly is not from us," says Deihl, sitting in his office at the Reedville plant. "It is from the same environmental factors that are threatening most other fisheries."

Turning to fishery science for support, he dug up some findings that helped his cause — and some that didn't. Scientists who track the menhaden fishery have documented a series of booms and busts in menhaden populations that seem to occur in cycles and play out over a decade or more. Populations surged in the 1950s, only to decline in the 1960s. They began rising again during the late 1970s and early 1980s, only to decline anew in the 1990s. (See graph, page 13.) Those cycles, recent research suggests, depend on the sudden appearance of large year classes that swell population counts.

Those large year classes, however, remain hard to predict. Since menhaden spawn in the ocean zone between the Gulf Stream and the nearshore, it's a combination of currents and weather and wind that delivers — or fails to deliver — menhaden eggs and larvae into nursery areas like the Chesapeake. Driving those year-class explosions are complicated, large-scale environmental factors like changes in water temperatures caused by the Atlantic Multi-decadal Oscillation and changes in air pressure caused by the Bermuda Azores High. All of which remain poorly understood — and largely beyond the control of fisheries managers. (See "Where Have All the Menhaden Gone?" page 2.)

"It is the environmental conditions that make or break the fishery," says Deihl, "not the stock, not the fishing." And not a cutback in commercial har-



The hunt for menhaden *starts with a spotter plane (above, lower left) and a pilot who can fly on a tilt, scout out schools of fish, and guide a large fishing vessel to its prey. Each vessel launches two skiffs to encircle the school with a purse seine net, draw the net together, and steer the fish load back to the big ship. There the fish are vacuumed into refrigerated holds. Many of the ships in the menhaden fleet are oft-converted vessels that began their lives as military transports. The* FV Earl J. Conrad Jr. *(above top) served in the Pacific during World War II and Korea. Various ship historians believe the vessel also had a brief career under another name as a pirate radio ship broadcasting rock and roll music during the 1960s to fans in England and Europe. Monty Deihl (opposite page), general manager for the Omega Protein plant in Reedville, Virginia, is the fourth generation Deihl to work in the menhaden industry.* PHOTOGRAPHS: OPPOSITE PAGE, MICHAEL W. FINCHAM; ABOVE TOP, AND MIDDLE AND BOTTOM RIGHT, WWW.OCEANSART.US; BOTTOM LEFT, OMEGA PROTEIN.

vests. "If the environmental conditions are not right," he says, "then [the cutback] did not matter anyway." Then the decline continues, the cutbacks are wasted, and profits are lost.

If the environmental forces do create a boom cycle? Then the cutbacks would still not be necessary, according to Deihl. "What was there in the first place was plenty to sustain the stock," he says. After all, those forces were apparently able to drive boom years for menhaden in decades past when fishing pressure was much heavier.

It's a forceful argument as he delivers it, but one that slights some other findings from fishery research. More spawners would mean more eggs and larvae in coastal waters that could be moved shoreward when and if all the right forces finally line up. "Schooling fish can respond very rapidly to favorable conditions," says Dave Secor, a fishery researcher with the Chesapeake Biological Laboratory who has been studying the dynamics of juvenile recruitment. "They can suddenly break out into new foraging

conditions or break out of predation (pressures) and have a big spatial expansion. This is a common pattern for schooling fish like menhaden, herring, and anchovies." More spawners might magnify a boom year.

That is the bet behind the harvest cutbacks proposed by the Atlantic States Marine Fisheries Commission. Although current fishing pressure has declined, as Deihl says, it's only allowing 8 percent of menhaden to make it to year three, the year when menhaden become effective spawners. The proposed harvest cutback could raise that spawning potential to 15 percent of the stock — still well below the spawning level that many scientists and most environmentalists would like to see.

Deihl's economic argument is simpler. A cutback on harvest would be a bet on unpredictable environmental forces — an uncertain bet that would put at risk the profits of a company that employs 300 people, provides work to thousands of contractors, and has a $45-million-dollar economic impact in Virginia.

Omega is still able to squeeze good profits out of declining harvests because of its success in finding new uses for fish oil — especially in health supplements containing omega-3 fatty acids. To earn those profits, the company was operating nine large vessels and eight spotter planes during 2011. Those boats and planes work in the Chesapeake Bay and along the offshore waters of New Jersey, Delaware, and Maryland, states that prohibit commercial netting inside the three-mile, state-managed fishery zone. Virginia and North Carolina are now the only East Coast states that still allow menhaden fishing in their coastal waters.

The largest chunk of Omega's catch, however, is coming from Virginia's ocean waters and from its portion of the Chesapeake Bay. And that's where the loudest complaints are now coming from as recreational fishermen in the state are campaigning hard to reserve menhaden as the primary food for striped bass, weakfish, and bluefish, their target species.

— M.W.F.

The Case against Fishing Menhaden

Who gets first call then on the menhaden bounty of the Chesapeake Bay? Omega Protein? The snapper rigs? The striped bass that fishermen like to catch? The ospreys and eagles that sometimes fight over the fish?

Ed Liccone would leave most of the menhaden as food for striped bass and other predators. He's chairman of the Maryland chapter of a sportfishing group called the Coastal Conservation Association (CCA), and he's showing me a photo of a striper that was well fed enough to win him a third place in the organization's spring tournament. Liccone is showing a photo, not a fish, because he let his fish go. The CCA spring tournaments are catch and release. "We are sportsmen who are trying to protect the resource," he says, summarizing what seems to be the official stance of many sportfishing groups.

"We think the marine predators have first call on this resource," agrees Jerry Benson, vice president of the Virginia chapter of the Coastal Conservation Association. "Is that unreasonable? They depend on that for life itself. It's not a profit deal for them." A stocky man with graying hair and beard, and a ruddy, friendly face, Benson speaks calmly, even quietly, but his organization is one of the loudest voices pushing for cutbacks on commercial harvesting by Omega Protein in Reedville.

"To have a healthy ecosystem," he says, "you need more menhaden in the water." It's a concept straight out of ecosystem-based fisheries management, and in their campaigns for cutbacks, sportfishing groups like Benson's have been consistent advocates for this kind of science-based approach. Findings from fishery science, however, have not always helped their cause.

In their 20-year push to rein in commercial fishing for menhaden, sportfishing groups built a case based on three claims: That the accidental bycatch in menhaden nets was probably killing a lot of other fish. That the filtering power of huge schools of menhaden could help clean up water quality in the Chesapeake. That the forage value of menhaden as food fish for other species, both fish and fowl, made it a keystone species in the Bay's ecosystem. As rallying cries against commercial harvesting, the claims carried emotional power that was obvious and considerable.

Of all these issues, accidental bycatch sparked the most emotional response from recreational fishermen. Anyone who came upon the spectacle of spotter planes, big ships, and seine boats all working together to circle and trap a huge school of struggling, splashing menhaden could angrily assume — and many did — that those nets were also swallowing up a lot of striped bass and bluefish and sea trout.

It's an assumption that doesn't die easily or quietly. When three scientists from the Virginia Institute of Marine Science (VIMS) mounted a major study in 1992, however, they found little evidence of

With this striped bass, *caught near the mouth of the Choptank River, Ed Liccone won 3rd place in the fly-fish division of the annual spring catch-and-release tournament sponsored by the Maryland chapter of the Coastal Conservation Association. Now chairman for the association, Liccone says he probably catches 2,000 striped bass a year. And keeps two.* PHOTOGRAPHS: OPPOSITE PAGE, JAY FLEMING; ABOVE, MICHAEL W. FINCHAM.

large bycatch. The number of other fish in menhaden nets averaged less than 0.21 percent — or one fish in five hundred. That meant more than 99.7 percent of the fish in commercial nets were menhaden.

It was a finding based on 43 net sets observed and sampled by a science team led by Herb Austin, Jim Kirkley, and Jon Lucy. They rode the big menhaden ships and the smaller net boats and worked the unloading docks of Zapata Haynie, the company that later became Omega Protein. While all those net hauls on Zapata boats brought in over 2.5 million menhaden, they trapped only 5,337 non-menhaden fish. Spanish mackerel was the most numerous bycatch, followed by bluefish, croaker, hogchoker, and sea trout.

That research finding raised immediate outrage from many in the sportfishing community. "They said we were hoodwinked," says Jon Lucy, a retired Virginia Sea Grant extension agent with a long history of working with recreational fishermen. The criticism quickly got personal, says Lucy. "It was like I had slapped a hornet's nest." According to Kirkley, complaints flooded his email and his phone line, many of them cussing him out. "They said we were on the take. They accused me of being on the [Zapata] payroll, of forging the results," said Kirkley. "That went on for a good long time."

Concern about bycatch already had a good long history. Surprisingly, the results by the VIMS team nearly matched a finding from 100 years earlier. In 1894, the U.S. Fish Commission organized a similar, though much larger, study of menhaden bycatch, placing federal agents aboard menhaden boats for two to three months. They collected samples from 1,078 net hauls that totaled more than 28 million fish. Their finding was the same as the 1992 study: 99.7 percent of the fish in the nets were menhaden.

Also taking a hit from recent research is a second, perhaps more popular claim: that menhaden are helping clean up water quality in the Chesapeake. It was an idea based on biology and hope. Menhaden are filter feeders: They catch phytoplankton as they pass through their gills. That was the biology. Perhaps, like oysters, they could help cut down the overabundance of phytoplankton, reduce nitrogen levels, and shrink the size and frequency of dead zones during summer months. That was the hope. Menhaden swimming in the water, oysters sitting along the bottom — rebuilding stocks of these natural filters could deliver a one-two punch against nitrogen pollution in the Chesapeake Bay.

What if all the menhaden now fished out of the Bay were left in the water? What effect would that have on water quality? The question was interesting enough to draw research funding from three environmental organizations: the Chesapeake Bay Foundation, the Nature Conservancy, and the Keith Campbell Foundation for the Environment. When they funded studies by Patrick Lynch, Mark Brush, and Rob Latour, however, the scientists came up with answers last year that the sponsors never expected.

Working at VIMS, the researchers collected menhaden from cast nets and pound nets and released the fish into six large, circular tanks filled with water from the York River. Then they watched what happened. With plenty of plankton in the river water, the scientists were able to monitor any changes in phytoplankton and nitrogen resulting from menhaden feeding. They also estimated the feeding rates of menhaden at different ages and sizes and then calculated the impact that leaving 109,000 tons of menhaden (the maximum allowable catch) would have on water quality in the Bay. That led to a lot of math and a lot of modeling based on different assumptions.

The result: The menhaden in their tanks did not have a measurable impact on the phytoplankton concentrations and nitrogen levels. Under certain conditions, menhaden could *add* nitrogen through their own fecal waste. If all the menhaden taken out of the Bay by fishermen were left in the Bay, the effect on water quality would probably be "more or less negligible." That was "our best educated guess," said Rob Latour, one of the lead scientists for the VIMS study.

The "negligible impact" finding was surprising, admits Bill Goldsborough, senior fishery scientist with the Chesapeake Bay Foundation, one of the major funders of the research. For both Goldsborough and Latour, there was another, unexpected lesson coming out of this research on menhaden feeding patterns: The negative impact of nitrogen pollution on the Chesapeake was even greater than previously thought.

Here's the ecology: Estuaries that have been degraded by nitrogen over-

loads could see the evolution of phytoplankton species that are smaller in size. "One working hypothesis," says Latour, "is that we have altered the phytoplankton community." And here's the biology: Smaller-sized phytoplankton may pass right through the gills of adult menhaden. Some of those tiny phytoplankton will be caught by smaller, juvenile menhaden, creating a small but real filtering effect. But when menhaden grow larger, the space between their fingerlike gill rakers grows wider, most small phytoplankton pass straight through — and the filtering effect goes away.

The result, according to Goldsborough, is "a triple whammy" delivered by nitrogen pollution. Nitrogen overloads the system with plankton, leading to dead zones. It creates smaller plankton species. And it negates menhaden as a natural filter. In a healthier estuary featuring less nitrogen and larger phytoplankton, schools of menhaden could play a dominant role in controlling phytoplankton abundance. In a degraded estuary, they play a diminished role.

The negative findings about the filtering power of menhaden have stirred up some dissent. "I doubt that is totally true," said Benson of CCA. "If there were ten times as many menhaden, I think they would suck up a lot of stuff." But there has been none of the outrage (at least not yet) that followed the earlier bycatch studies. "We don't use that [filtering] argument any more," said Benson. "We used to, but there is no point in putting forth an argument that someone has accounted for."

One argument left standing, one argument that sportfishermen and scientists can agree on, is the role menhaden play as an essential link in the Bay's food webs. "They convert plankton energy to higher trophic energy," says Dave Secor, a fishery researcher with the Chesapeake Biological Laboratory. When they are abundant, they convert zooplankton and phytoplankton to a food form that dozens of fish and waterfowl species can feast on. "They are," he says, "incredibly efficient and important."

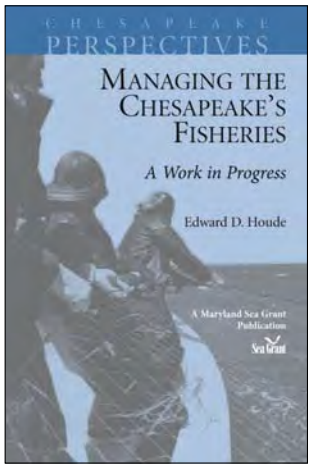
— *M.W.F.*

New Publications from Maryland Sea Grant

Scientist Assesses the Bay's Fisheries

There are a number of popular books about the Chesapeake Bay by excellent writers, but few by excellent scientists. Ed Houde, perhaps the preeminent fishery scientist of his time and region, is one of the few Bay scientists of note who's tried to leave a nontechnical explanation of findings in their field, complete with hard-earned opinions about the fate and future of the fish species the Chesapeake is famous for.

You can read about those findings and opinions in a new book, *Managing Chesapeake Fisheries: A Work in Progress*, published by the Maryland Sea Grant College as part of its *Chesapeake Perspectives* series. His goal in writing the book, Houde says, was to help nonscientists understand the forces that cause fish stocks to rise and fall. Those forces make fisheries management complicated and controversial work, but not, according to Houde, hopeless work.



In his 30 years of work with the Chesapeake Biological Laboratory, Houde has done pioneering work on well-studied species like striped bass and on less-studied species like alewives, anchovies, blueback herring, and menhaden. Much of his work on these species focused on the critical life stage when microscopic larvae become small, juvenile fish. In his research he was able to show that small changes in food supply, water quality, and habitat during those early transitional stages can have huge effects on the number of adult fish that eventually make up the population for these species. And the fate of these little-known forage fish in turn have large effects on the survival of more popular species like striped bass, bluefish, weakfish, white perch, croaker, and spot.

It was a set of findings, documented rigorously in dozens of papers and projects, that had a huge influence on the way scientists understand the life history and life changes for these fish and on the way fisheries managers try to regulate fishing pressure on these species.

His new book appears at a critical time when several important species are declining, several seem to be recovering, and a new philosophy is beginning to alter our traditional approaches to managing the Bay's fisheries. The new approach, "ecosystem-based fisheries management," represents a shift from single-species management, which focused narrowly on figuring out how fishermen could land the maximum harvest possible while still allowing the target species to replenish itself. As its name suggests, the fresh approach focuses first on preserving the structure and function of the ecosystem that surrounds and sustains each fish species under management.

It has been a slow slog toward acceptance for an approach that traces its roots back half a century or more to the writings of Aldo Leopold, the father of modern ecosystem-based wildlife management, and to the rise of systems ecology, with its focus on energy flows through entire ecosystems. "Ten years ago, except for some ecologists and a few fishery scientists, people basically dismissed ecosystem-based fisheries management," says Houde. "I think now everybody recognizes that this is the direction we are heading."

Among Bay fisheries currently in decline, the menhaden fishery could become "the poster child for ecosystem-based fisheries management," according to Houde. Fisheries

managers are currently considering cutbacks in commercial harvesting in hopes of preserving menhaden for their "ecosystem services." The cutbacks could aid their recovery by increasing the number of spawners in coastal waters, but the real drivers for new recruitments are climate conditions in those offshore waters.

The experiment with menhaden cutbacks could prove a tough test for the ecosystem approach. "If menhaden spawn at the wrong time and in the wrong place," says Houde, "then physics, weather, and the climate are going to have a major effect on how many get into the Bay."

Another declining fishery, the historic oyster fishery of the Chesapeake Bay, may be lost, says Houde, despite all the current and long-standing efforts at restoration. According to Houde's take, oyster aquaculture may prove workable, but the recovery of the stock of native oysters is unlikely. "It is hard to think we are going to see a miraculous recovery of the oyster stock," says Houde.

He is a pessimist about the oyster, but not about the future of Bay fisheries in general. "I think management can play a big role in stabilizing fisheries and helping them to rebuild and recover," says Houde. As evidence that smart management can work, he cites the recovery of striped bass and, more recently, of blue crabs, two iconic Bay species that were rebuilt through tough, controversial management after decades of overfishing.

Is ecosystem-based fisheries management too complex — and too incomplete — to apply to a real-world fishery where jobs and profits are at stake? Not according to Houde. "We might not know all the connections and all the rate functions that describe predator-prey relations between all the fishes in a complex food web," he admits, "but we know enough that we can begin to take action." The key actions, he says, are four: Take a precautionary approach, don't allow fishing methods that destroy habitat, minimize bycatch, and take care not to catch threatened and endangered species.

Houde's forerunners in this narrow field of Bay scientists willing to write about their work in layman's language include W.K. Brooks from Johns Hopkins University, who wrote *The Oyster: A Popular Summary of a Scientific Study* back in 1891; R.V. Truitt, who wrote popular reports and books as founder of the Chesapeake Biological Laboratory; and Jerry R. Schubel, formerly with Johns Hopkins, who wrote *The Living Chesapeake* in 1981. It seems scientists willing to explain themselves and their work to the rest of us are still an endangered species.

— *M.W.F.*

Managing the Chesapeake's Fisheries: A Work in Progress. 2011. Edward D. Houde. 122 pp. *Chesapeake Perspectives* series from Maryland Sea Grant, College Park, Maryland. Soft cover, $12.95 (www.mdsg.umd.edu/store/books/cp); Kindle edition, $6.95 (www.amazon.com).

Book Series on Kindle

Maryland Sea Grant's *Chesapeake Perspectives* series encourages researchers, scholars, and other thinkers to share their insights into the unique culture and ecology of the Chesapeake Bay. All four books in the series have recently been released as ebooks for Kindle. To order, visit www.amazon.com.

Chesapeake Environmentalism: Rethinking Culture to Strengthen Restoration and Resource Management, Michael Paolisso (Kindle, $4.95; soft cover, $9.95)

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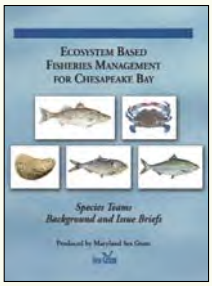
Managing the Chesapeake's Fisheries: A Work in Progress, Edward D. Houde (Kindle, $6.95; soft cover, $12.95)

Ecosystem-Based Fisheries Management: *Tools For Progress*



To develop ecosystem-based fisheries management plans for Chesapeake Bay species, managers need access to research-based information about topics as technical and diverse as recruitment patterns, food webs, predator-prey interactions, water quality, habitat, climate effects, and socioeconomic factors.

In 2008, a five-year Ecosystem-Based Fisheries Management Project was launched in hopes of developing the latest research information and the tools that could sustain an ecosystem approach to managing the Bay's fisheries. The effort was coordinated by Maryland Sea Grant, working in collaboration with the scientific community and the region's state and federal agencies, including the Maryland Department of Natural Resources, the Virginia Marine Resources Commission, the Potomac River Fisheries Commission, the Atlantic States Marine Fisheries Commission, the District of Columbia Department of the Environment, NOAA, and EPA. In all, more than 85 scientists, managers, and stakeholders collaborated on the project.

Teams of experts from within and beyond the Chesapeake region participated in a series of meetings facilitated by Maryland Sea Grant to explore how each of four key species (blue crabs, striped bass, menhaden, and the alosines group) function and interact in an ecosystem context. Maryland Sea Grant published the resulting papers as a set of in-depth Background and Issue Briefs for each of the four species. In addition, highlights of the findings were published in four eight-page Summary Briefs. Work on oysters will take place in the future.

All eight publications are now available in pdf format on the Maryland Sea Grant web site and the EBFM website:
www.mdsg.umd.edu/EBFM/products
www.mdsg.umd.edu/store/reports/ebfm.

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Burreson Receives Mathias Medal


Michael W. Findham

Eugene M. Burreson, a Virginia biologist who pioneered studies of parasites that decimated oysters in the Chesapeake Bay, is the latest recipient of a rare honor, the Mathias Medal.

The medal, sponsored by Maryland Sea Grant, Virginia Sea Grant, and the Chesapeake Research Consortium, has been presented every five years or so to a retired scientist who has made significant contributions to science and policy in the Chesapeake Bay. The medal is named for former U.S. Senator Charles "Mac" Mathias of Maryland, who launched the first federal-state partnership in the 1970s to restore the Bay.

Burreson retired in 2010 from the Virginia Institute of Marine Science (VIMS) as a professor after 34 years there. His unique contribution to shellfish pathology, monitoring oyster diseases, and providing information critical for developing oyster-management strategies has had an enormous impact on the Chesapeake Bay.

In 2000, he and a colleague published a landmark work of scientific sleuthing that pinpointed for the first time the source of the protozoan parasite that causes MSX, a disease that helped reduce oyster stocks in the Chesapeake to one percent of historic levels. Burreson used genetic fingerprinting to show that the DNA of the MSX microbe found here matched that in parasites found in Japanese, or Pacific, oysters (*Crassostrea gigas*), which apparently were imported to East Coast waters starting in the 1930s.

Burreson also developed molecular tests that are used worldwide to detect shellfish pathogens and trained scientists to use them.

"Gene's contributions clearly rank with the very best in shellfish biology over the past century," said Roger L. Mann, director of research and advisory service at VIMS.

Since the Mathias Medal was established in 1990, only five have been awarded, the most recent to Grace Brush, in 2004. Burreson was to receive the award at a ceremony in Richmond in October.

Brainard Heads Sea Grant Communications

Maryland Sea Grant has a new head for its communications activities, Jeffrey Brainard, who succeeds long-time leader Jack Greer, who retired in 2010.

Brainard is a career journalist whose resume straddles the worlds of academia and environmental science. That breadth should come in handy as he works to expand Sea Grant's coverage of Bay science in online forums and in Sea Grant's *Chesapeake Quarterly*.


Ken Cedeno

He comes to Sea Grant after 12 years at *The Chronicle of Higher Education*, the leading trade journal about colleges and universities. For much of that time, he wrote about the intersection of academic research and federal policy, including grant-making at the National Science Foundation and other agencies. He also crunched data and statistics for articles on trends in higher education.

Brainard grew up in New Jersey and as a child frequented the Jersey Shore. After graduating from Williams College, in Massachusetts, he worked as a reporter for several newspapers on the East Coast. Thanks to a long-standing interest in the outdoors and biology, he wrote for *The St. Petersburg Times*, in Florida, about coastal environmental education and groundwater overpumping.

Those stories led him to decide to switch to science reporting full time, a goal he pursued by completing the master's program in science journalism at Boston University. He went on to an internship at *Science News* magazine and the job at *The Chronicle*, both based in Washington, D.C.

"I like to write about science because it asks the big questions of enduring importance, especially, how our environment and economy can be sustained," Brainard says. "I'm also convinced that science is full of fascinating stories that are anything but dry. That's why I'm thrilled to have an opportunity through Sea Grant to offer the public informed perspectives about how science and policy can be harnessed to preserve the Chesapeake Bay."

To see photo galleries and videos and to send us your comments, visit www.chesapeakequarterly.net
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