CHESAPEAKE
BAY JOURNAL
November 2019 Volume 29 Number 8

Welcome to your new home

A Chesapeake logperch is gently lowered into Chiques Creek, a Susquehanna River tributary in Lancaster County, PA. Ichthyologists raised 1,500 fingerlings from 28 caught in the spring as part of a reintroduction effort to keep the fish off the endangered species list. (Dave Harp) *See article on page 15.*

Striped bass decline spurs new look at mycobacteria

≈ Chronic wasting disease infects most of the striped bass in the Chesapeake

By Karl Blankenship

When Wolfgang Vogelbein peered at striped bass sores through a microscope 22 years ago, he knew he was looking at something very different than what was grabbing headlines at the time.

Pfiesteria piscicida — the so-called "cell from hell" — was being blamed for fish kills in Maryland and making people sick.

But what Vogelbein saw through his lens wasn't the result of a harmful algae toxin. It was a nasty bacterial infection, creating ugly sores on the outside of fish and lesions on the inside.

The infections were caused by mycobacteria, a type of bacteria that are widespread in the environment, but not typically associated with problems in wild fish. Suddenly, though, it was turning up in large numbers of the Chesapeake Bay's most prized finfish.

"I thought I would be spending the rest of my career working on myco," recalled

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Fox Island and its 'magical' classroom on stilts near their final act

≈ Education center inspired waves of future Bay advocates, but can no longer stem tide of rising water

By Jeremy Cox

This is the way the Fox Island Environmental Education Center ends: not with a gale or wrecking ball, but with the slow inevitability of wind and waves.

After four decades of hosting students and teachers, the spartan, barracks-style building that stands on stilts in the middle of the Chesapeake Bay is closing its doors at the end of this season, likely in early December.

The Chesapeake Bay Foundation, which purchased the low-lying Virginia archipelago and its lone structure in 1975, is bidding a reluctant farewell to the facility. The cause, according to the conservation and advocacy group, is rising water that has swallowed about 70% of Fox's land mass over the last half-century.

"It's a really hard thing for us," said Tom Ackerman, the foundation's vice president of education. "Fox Island is the heart of our program. In some ways, it's the heart of the organization. So, losing it is pretty tough."

According to William Cronin's book, *The Disappearing Islands of the Chesapeake*, the island group totaled 357 acres in 1895. By the book's publication in 2005, it was down to 67 acres. A GIS survey conducted this year by the foundation showed a mere 34 acres remaining.

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Water laps at the Chesapeake Bay Foundation's education center on Fox Island. Rising sea level has led to a decision to close the facility. (Jeremy Cox)

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Vogelbein, a fish pathologist at the Virginia Institute of Marine Science.

It didn't turn out that way. Mycobacteria never snagged the attention — nor large-scale research funding — as did Pfiesteria. Nor was it associated with high-profile fish kills or considered a human health threat.

Decades later, Pfiesteria has largely vanished from discussion, and some scientists now question whether it was responsible for fish kills at all.

But the mycobacteria problem never went away — and has only gotten worse. The majority of the Bay's striped bass are infected and, by the time they are 5 years old, nearly all carry the disease. An unknown number are thought to die. "We think it is substantial," Vogelbein said.

Now, with the striped bass population in trouble, the Bay's mycobacteria problem may get another look. Striped bass numbers have been declining along the East Coast for a decade and a half, and a recent stock assessment for the Atlantic States Marine Fisheries Commission concluded that the population was being overfished.

The commission, made up of East Coast fishery managers, was poised at the end of October to impose new fishing restrictions in response.

But the assessment also raised questions about whether mycobacteria infections may be playing a bigger role in the decline than currently thought, citing studies that suggest even higher rates of mortality among striped bass from the Bay than assumed in the assessment. The study called for a better understanding of the impact the disease might be having in the Bay and coastwide, and flagged it as one of the highest research priorities.

If the disease is having a greater impact than previously thought, it could also mean any new fishing regulations would be less effective than hoped.

"There is likely an impact somewhere," said Mark Matsche, a fish health scientist with the Maryland Department of Natural Resources. "My question is, what is the severity of the impact to the population?"

An apparently healthy stripped bass, left, and a suspiciously unhealthy one will have their spleens removed and tested for mycobacteria. (Dave Harp)

A mysterious disease

Mycobacteriosis — and what it means for the Bay's most valuable recreational species — has perplexed scientists and fishery managers since it was first observed in 1997. It is a chronic wasting disease which, in aquaculture, usually results in death, but severe infections typically are not seen in wild fish populations.

Diseases affecting finfish are usually short-lived events, which sometimes result in dramatic fish kills and then disappear. In contrast, the mycobacteria infections in the Bay show no sign of relenting and are likely to take years to kill fish.

"We are not used to seeing this persistent, long-term epizootic which doesn't seem to go anywhere," Matsche said. "It is very, very different."

Further, the two types of mycobacteria causing problems in the Bay — *Mycobacterium shottsii* and *M. psuedoshottsii* — were previously unknown. They were only discovered when a researcher at VIMS accidentally left slides with tissue samples from striped bass in an incubator, and colonies of the bacteria began to grow.

No one knows why they seemed to have suddenly appeared and become a problem. In early years after the discovery, only 10–20% of striped bass in the Bay seemed to carry the infection. Today, the majority are infected, and surveys in Maryland and Virginia show that 80–90% of striped bass carry the disease by the time they are 5 years old.

Also unclear is why striped bass are so susceptible. Although the same two mycobacteria species sometimes turn up in other fish, they don't seem to have the same impact, even in closely related species like white perch.

Nor does the disease seem to be a problem outside the Bay. While there is some anecdotal evidence that infections are seen in other areas, they do not seem as widespread or severe as in the Bay, and it's unclear whether they are even the same mycobacteria species.

There is also some evidence that the disease may progress more slowly in adult fish after they leave the Chesapeake. That makes scientists suspect there may be some type of stress in the Bay that makes the condition worse — but it's unclear what that might be.

Efforts to answer such questions have lagged in recent years. Aside from some support after the initial discovery, research funding largely dried up. The striped bass population, after bottoming out in the 1980s, was thriving by the time mycobacteria infections were discovered.

"Things were so good with striped bass — management was in a great place, anglers were happy and the pressure wasn't there to deal with a crisis mode," said Robert Latour, a VIMS fisheries scientist. "It was, 'How do we enjoy this recovered fishery?' And there were many other fires for fisheries managers to put out."

Slow killer with uncertain impacts

The biggest unanswered question is the extent to which the infections are actually killing fish and impacting the striped bass population.

The disease progresses slowly, with the condition of the fish deteriorating over time. Scientists believe many of the infected fish die, but how many and how quickly are difficult to determine.

"We are not seeing thousands of fish washing up on the shoreline," said David Gauthier of Old Dominion University. "They are probably dropping out of the population a few at a time and getting eaten by crabs, so it is not highly visible. So trying to measure how much mortality there is on a population basis is really difficult."

An intensive study years ago on the Rappahannock River, in which striped bass were tagged, recaptured and examined over a period of years, concluded the mortality rate of infected fish was double that of uninfected fish.

Still, that's not the full story. It's unclear whether the disease shaves a few months, or many years, off the lifespan of an infected striped bass. If it survives long enough to reproduce, the impact of the disease on the overall population might be minimal.

On the other hand, a number of sublethal impacts could also be important. For instance, studies show that infected females tend to mature earlier and are smaller than uninfected fish. Because smaller fish produce fewer eggs than larger ones, the reproductive capacity of the population might be reduced.

Trying to figure out what that means for the overall striped bass population is further complicated because most do not spend their entire lives in the Chesapeake. They are spawned in the Bay, and the young live there for several years. Eventually, most move to the ocean until returning to spawn, though some males never leave the Bay at all.

And while the Chesapeake is thought to be the largest component of the overall coastal population — and the focal point of the disease — it's unknown just how much of the coastal stock they constitute. It's also unknown how many males stay in the Bay and how many leave.

"We feel like it is a problem within the Bay for the time that the resident population is here, but sort of casting that into the broader, full coastwide population is a little more murky because of these missing pieces of information," said VIMS' Latour.

Modeling the population

The model used in the Atlantic States Marine Fisheries Commission assessment to estimate the size of the striped bass stock lumps the entire population together. If striped bass from the Chesapeake Bay are dying at a faster rate than fish elsewhere, it has no way to precisely account for the difference.

As a result, increased mortality caused by mycobacteria is not directly factored into the stock assessment. Estimates of "natural mortality" — fish that die because of all non-fishing activities — have been adjusted over time for the entire coast, but it's not known whether they fully capture the

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impact of the disease.

Complicating the problem is that those estimates are based partly on tagging studies. Each year, biologists along the coast place tags on striped bass, asking that they be returned when those fish are caught, often years later. That helps biologists estimate the ultimate fate of fish.

But return rates for tagged fish have declined since the striped bass population crisis ended decades ago. It's not totally clear how much of that decline is caused by the loss of fish to disease and how much is from public apathy.

"We don't know how many of the fish that disappear are dying naturally, and how much is because they are caught and people are seeing them again, but just aren't telling us," said Katie Drew, the stock assessment team leader with the ASFMC.

She said the assessment's overall estimates of total striped bass mortality are probably correct because it matches what is observed in the overall population trend. But it's possible that the population model underestimates natural mortality and overestimates fishing mortality.

In either case, she said, the remedy is the same — reduce fishing pressure — because managers have no control over the disease. But if disease is responsible for a larger portion of overall mortality than assumed, and fishing causes a smaller portion, efforts to reduce the catch may have less of an impact than hoped.

"You will see some benefit in reducing fishing mortality for sure," Drew said. "But if natural mortality is a much bigger component of total mortality than we think, it won't be as big of an effect."

The commission might get better estimates in the future. It wants to move away from a stock assessment model that lumps the entire striped bass population together and toward one that separates the population by regions —allowing them to better estimate disease-related impacts on fish spawned in the Bay.

A rockfish awaits a necropsy. Its spleen will tell whether it has been infested with mycobacteria. (Dave Harp)

Models to do that have yet to pass scientific peer review. But scientists are optimistic they will be ready for the next striped bass assessment in several years.

Trying to answer questions

In the wake of the recent stock assessment, scientists are working to fine-tune what they think they can say about the disease's impact on striped bass.

"I think people are really eager to get to the bottom of this and to try to better understand what might be causing this particular epizootic in the Bay," said Genevieve Nesslage a fisheries scientist with the University of Maryland Center for Environmental Science.

Nesslage is working with a graduate student to use disease data that the state collects each year, along with environmental and other information, to build a computer model that examines potential population-level impacts of disease-related mortality in the Bay. They also want to try to identify environmental triggers that may worsen its impact on infected fish.

An enlarged spleen is a sign of a mycobacteria infestation in striped bass. By the time they are 5 years old, 80-90% of the Bay's striped bass carry the disease. (Dave Harp)

Likewise, Vogelbein, Gauthier and Latour are working to analyze many hundreds of samples from striped bass collected over the last decade that have been preserved but never examined because of a lack of funding. The hope is that a larger, richer set of data will help paint a clearer picture of what's happening — at least in the Chesapeake.

Because most "deaths" are seen in computer models rather than the real world, that improved understanding will help modelers better predict disease impacts, and mortality, on the population and gain confidence in their results.

"Models are only as good as the data that go into them," Vogelbein noted.

Scientists generally believe that some stress factors are playing a significant role in making the disease impact worse.

Variables such as increased temperatures, large oxygen-starved dead zones — even increased particulates in the water — have been suggested as factors that speed the decline of infected fish. Some think changes in striped bass diet, related to changes in menhaden abundance, might have reduced their health and made them less resistant to disease.

The renewed focus might shed light on those issues.

While the disease progresses over time, that progression isn't always steady. Matsche said that some recaptured fish show relatively little change after several years, but some are considerably worse after a single season. "There are a lot of variables at play here that we don't fully understand," he said.

If those factors could be understood — and alleviated — it might open another door for management to help the fish.

Does a dead zone equal dead fish?

One prime suspect is the Bay's poor water quality. During the hot summer, striped bass seek refuge in deeper, cooler water. But if the Bay's oxygen-starved dead zone makes those areas off limits, it pushes the fish into warmer water that is more stressful — and may make them more vulnerable to disease progression.

A laboratory study several years ago by scientists at VIMS showed that when infected fish were exposed to both low dissolved oxygen and higher temperatures, they appeared fatigued and were likely less able to elude predators or pursue prey fish to eat.

Jim Gartland, an assistant research scientist at VIMS, has observed this in the wild as well. Gartland, who helps conduct a fish survey along the entire length of the Bay each year, said striped bass in midsummer heat appear especially stressed near areas of low oxygen water.

"When you are in the dead zone area, you will see them just easing along the surface sometimes," Gartland said. "And striped bass usually don't do that."

If such a correlation between environmental conditions and disease exists, it could offer both hope — and peril — for striped bass.

While there may be little that can be done about the disease itself, such work could suggest that some actions — such as accelerating nutrient reduction efforts aimed at eliminating the dead zone — might reduce disease impact on striped bass.

On the other hand, Bay water temperatures are already warming, and if that trend continues, it could stress striped bass even more and make oxygen conditions worse.

"This level of a significant pathogen in a population is kind of ominous," Gauthier said. "It is possible they are holding their own against it right now, but what is going to happen? They are already sort of at the edge of their thermal limit down here. What is going to happen in the future if the environment keeps changing?"

After two decades of wondering, scientists hope a resurgence in interest will help shed light on those questions.