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Flight of the Freshwater Fish

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How rising water temperatures are changing marine life in fresh waterways across North America.

Everyday, tugboats and barges inch though the choppy waves of the Hudson River; river taxis ferry passengers between Manhattan and New Jersey; tour boats with awe-struck passengers drink in the skyline views. Below this daily bustle is a marine ecosystem in massive flux, as numerous fish species struggle to adapt to changes wrought by a warming climate.

Under the river's turbulent waters, entire species of fish, like the Atlantic Tomcod, have been retreating from this long familiar habitat toward northern waters and colder temperatures. In the midst of this retreat, less commonly found fish species, like the Smallmouth Bass, have burst onto the scene, according to researchers from New York State's Department of Environmental Conservation (DEC). These changes are presenting unique challenges for DEC biologists, who are reluctant to intervene as these transitions play out.

"Changes in fish distribution affect fish communities, of course," said Lisa Holst, Rare Fish Unit Leader at the DEC's Bureau of Fisheries. "Invasion of waters by non-native species, for example, can be beneficial or detrimental. There are often no absolute good or bad outcomes of these shifts."

Researchers at the DEC and across the country see consistent trends of seismic change for populations of fish in many of the waterways. This evolution of ecosystems in the Lower Hudson River and across North America appears to be linked directly to a warming climate. In fact, whole populations of fish are losing their natural habitats, in part, due to average water temperature increases of 2° Fahrenheit since the 1940s.

Warming Waters and Shifting Marine Life

The warming water paved the way for fish better equipped to thrive in those conditions to beat out native fish such as Brook Trout and the Atlantic Tomcod for food. When the ideal conditions no longer exist and a more durable, faster fish moves in, the original fish population start looking for cooler pastures, according to Stuart Findley, an aquatic ecologist at the Cary Institute of Ecosystem Studies.

In the Hudson, the Rainbow Smelt's withdrawal is a key example of these warming changes. It was once found in abundant numbers swimming up the Hudson River to

spawn. Now, it has disappeared from the river to the point that researchers no longer believe it reproduces in the river at all. A recent report, called the "Atlas of Inland Fishes of New York", says that the Rainbow Smelt was “at the southern edge of its range in the Hudson River and temperatures there may no longer be suitable.”

Another clear signal of climate changes' effects on the Hudson can be seen in the Atlantic Tomcod, a small codfish that prefers the brackish waters of the lower Hudson. It was once plentiful throughout the lower river until the early 2000s. In the last 15 years the number of Tomcods experienced “catastrophic decline” due to “higher water temperatures” according to the DEC's Fish Atlas report.

“The Hudson is the southern limit of its range, so if it’s was borderline to warm for them 20 years ago, its really borderline to warm for them now,” said Findley.

Other species, like the American Shad and the Atlantic Sturgeon, have endured similar retreat from the Lower Hudson due, in part, to warming waters. Climate change has clearly contributed to these fish populations’ retreat from the river, according to Findley.

Paired with those disappearing populations is the growing evidence of new species showing up in the river in expanding numbers. The Smallmouth Bass, for one, has greatly expanded it's range, since it was first reported as appearing in just 20 percent of fish surveys in 1936. It is now thriving not only in the Lower Hudson, but also throughout most of the river and its tributaries, or feeder creeks and streams, according to the DEC's Fish Atlas report.

The Blue Crab, most commonly associated with the Chesapeake Bay in Maryland, has become abundant in the Hudson in recent years. The Lower Hudson is now more adapted to the species preferred environment. So much so, in fact, that the fisheries research team from Maryland Department of Natural Resources has joined the DEC’s fisheries team in monitoring the expansion of the Blue Crab in the Hudson River.

Changes similar to those in the Hudson River are being seen across North America, from the Great Lakes to streams in the Rocky Mountains and it has become the central focus and concern for biologists from the local parks to the United States Geological Survey (USGS), which recently released a series of special reports on climate change’s impact of fresh water fish.

Catching the Right Data and the Right Fish

The DEC’s researchers are still working to unravel the full scope of these trends in the Hudson River. The task has proven to be difficult and tedious, as hands-on fish counting remains one of the best tools for collecting that data.

For six months each year the New York State's fisheries research team surveys fish populations along the Hudson River, from Poughkeepsie to Albany. They gather the data needed to understand the river's ecosystem and how the fish species are changing over time.

In late October, despite the unseasonably warm air and the smooth churning of the tide along the boats bow, Robert Adams' face appeared frozen in a stoic gaze toward the shore several hundred yards down the Hudson River, just south of Newburgh, New York.

Adams, a fisheries biologist at the DEC, and his crew of two were charged with the task of collecting the data to understand which fish species are leaving the ecosystem, and which fish species are thriving.

Reaching the first location, Adams pulled the 17-foot Boston Whaler up along the shore of the river. He dropped off one of his team members, Chris Standley, who jumped from the boat deck into two feet of jerky Hudson water wearing waterproof neoprene waders and holding a seining net.

The seining net, a five-by-100-foot net with bookend wooden posts, is the primary tool for the fisheries team to catch fish and collect their targeted data. The team worked together, Adams from the boat and Standley from the shore, to make a "U" shape with the net, both ends touching the shore. Creating this shape allowed the team to sweep all of the water within 100-feet of the shore, catching any unsuspecting fish in the net's path.

At other sites throughout the day the net came up empty besides leaves and trash. More than once the wind and rough waters interrupted the process. Each variation in the fish count can affect the end result for the day. It is lab research without the luxury of climate control.

This research is being conducted all over the continent and is turning up similar findings. The fish species that once dominated their waters are being replaced by species that used to be rare in those same waters. At the national level researchers are seeing a trend toward a surge in warm-water loving fish with some striking examples and potential warning signs for a seemingly ever-warming future.

"Most of the examples of documented impacts of climate change are on cold-water fish species, such as salmon and trout," said Abigail Lynch, a USGS biologist, based in Virginia. "It is often easier to highlight these cold-water environments because the direct impacts of climate are very clear."

The Challenge of Protecting Evolving Ecosystems

Large-scale collection of data helps scientists with understanding the scope and range of fish migration from the Hudson. But, local research teams cannot compile all of the necessary information and that data wouldn't benefit watershed managers without the expanded context provided by other's experiences. Researchers frequently share that data with other fishery research teams across the region and even along the entire Atlantic Coast.

"We think of those as being Hudson River fish, but they're not," said Steven Stanne, Estuary Education Coordinator for the Hudson River Estuary Program. "They're born in the Hudson, but they are going to spend a good part of their lives out in the ocean swimming down to Virginia or up to Maine. So they have to be managed cooperatively, and just protecting them on the Hudson and understanding what they do on the Hudson is not going to be enough."

The DEC partners with its counterparts in Maryland to monitor the Blue Crab population, for example. They also participate in electronic tagging networks to report specific species that other teams are tracking along the coast. These collaborations help strengthen the research into fish populations and ultimately lead researchers to track the movement of fish like the Tomcod and Rainbow Smelt.

While researchers are providing data on major population changes for those fish, conservationists are faced with another dilemma: Should they intercede to help preserve existing populations or allow the potential loss of native species to happen naturally?

In 2014, a team of conservationists in Glacier National Park chose to intercede when bull trout numbers fell to levels of near local extinction. The plan was bold and counterintuitive. The team, lead by Clint Muhlfeld, a USGS aquatic ecologist, collected 111 bull trout from a small creek in northern Montana, and loaded them into backpacks outfitted for both hiking and keeping fish alive.

The team then hiked several miles up the mountain trail to a previously unreachable lake for this bull trout population, known as Grace Lake, and released all of the fish into their new home, a process known as translocation.

"Some might consider that an extreme measure to save one population," Muhlfeld said. "But the decisions [we make] now are going to have an enormous impact and probably the most critical ever in the world of conservation."

In 2015, the team went back to the same location and caught just one bull trout for translocation. This year Muhlfeld said the team could not find a single bull trout in the original stream.

Decisions to intervene like this have unknown long-term ramifications, but conservationists like Muhlfeld are more frequently being left with stark choices as water temperatures rise and species are threatened. Other plans to protect native

species have included blocking waterways to potential invading species and even building large shades to block direct sunlight on the water.

These interventional conservation efforts are far from perfect, but the stakes for fleeing fish populations are high and water temperatures are unlikely to fall in the near future. This leaves watershed managers with few other options.

While not every fishery is taking this hands-on approach many are closely monitoring their watersheds for a day when drastic measures might be the last option to preserving certain populations. The DEC fisheries team in the Lower Hudson has a much larger ecosystem to monitor than most, and is tasked with managing dozens of unique and challenged populations. It would present an even more unique challenge, if that day comes for fish like the Tomcod or American Shad.

Climate change is contributing to rapid shifts in freshwater ways. What those changes mean for the future are any biologist's guess, but the hard truth is that more change is coming. The hard answer is what will conservationists be able to do about it.

“What it’s prompting managers to do is develop more proactive conservation measures to increase [species] resiliency across broader landscapes and longer time horizons,” Muhlfeld said.