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Tracking the Imperiled Bluefin From Ocean to Sushi Platter

By [ANDREW C. REVKIN](#)

For sushi aficionados, the essence of the Atlantic bluefin tuna is its fat-laced, butter-soft belly meat, called toro. For the long-liners, purse seiners, harpooners, trappers and fish farmers who seek the bluefin from Cape Hatteras to the frigid waters south of Iceland to the balmy Mediterranean, the fish are a potential bonanza, with choice specimens fetching \$50,000 or more in Tokyo.

But the intensifying trade in bluefin may soon empty the waters of this master of the sea.

In just the last 35 years, exploding markets for sushi-grade tuna, combined with intensifying industrial-scale hunts aided by satellites and spotters in airplanes, have devastated not only the fish but also many fisheries.

Dozens of Mediterranean towns that maintained coastal net traps for half a millennium or more are turning away from now-barren waters. Anglers off New England, who once watched great parading schools of bluefin migrate north at the end of each summer now scour the seas for scattered fish. Most vulnerable, by far, marine biologists say, is the apparently distinct population of bluefin tuna that breeds in the Gulf of Mexico.

The threat to the bluefin was underscored last week by researchers who have tracked hundreds of the fish on their ocean-spanning journeys using electronic tags. They found that the tuna that spawn in the west, which are most severely depleted, are further threatened by an ever-broadening gantlet of hooks, seines, harpoons, traps and now farm-style pens, in which netted fish are raised and fattened - all to supply the Japanese sushi trade.

Dr. Barbara A. Block, a marine biologist at Stanford and the lead author of a study, published in the April 28 issue of *Nature*, said she found it hard to believe that "a fish of this size and beauty, an animal that had captured the hearts of fishermen and scientists alike for millennia, is slipping off Earth."

The bluefin, known to biologists as *Thunnus thynnus*, is a wonder of metabolic and evolutionary perfection, a Ferrari-like mix of refinement and brute power.

Adult bluefins, some topping half a ton and living 40 years, slice through icy or tropical waters while maintaining their body temperature around 80 degrees.

Their physiology allows their ruby-red muscles to generate a split-second tail flick, rocketing the fish to on-ramp speeds in pursuit of prey. But having an oceanic range may also be their undoing, exposing them to harvests at every turn.

Dr. Block has been studying the physiology and behavior of tunas for 25 years. Lately, she has spent much of her time at sea, surgically implanting tags in thrashing giants hauled briefly onto the decks of sport and commercial fishing boats assisting in her research.

From her base next to the Monterey Bay Aquarium, which helps support her work, she leads a research team that focuses on every facet of the bluefin, from its evolution, genetics and unique muscle physiology to its diet and migrations.

"We're trying to see the planet through their lens," Dr. Block said. But increasingly, she added, the bluefin are seeing the end of a fishing line, the inside of a net and the hold of a fishing boat.

The new study is based on the research team's grueling, decade-long effort to implant hundreds of increasingly sophisticated electronic tags in the giant fish, an enterprise that is beginning to reveal in new detail their ocean paths, from feeding grounds along the East Coast and in frigid waters south of Iceland to spawning areas in the balmy Gulf of Mexico and Mediterranean.

Most tagging studies provide only two data points - the place and time of release and the place and time of capture. In this

study, 772 fish were tagged with sophisticated devices that continually record body and water temperature, depth and daylight. Some tags stayed in the fish until they were caught, often for years. Others were intended to break a tether, pop to the surface and relay stored data to satellites after a programmed number of weeks.

In all, 330 tags provided unparalleled records of fish as they repeatedly dove thousands of feet, traversed the ocean in a few weeks, and routinely crossed imaginary lines drawn nearly 25 years ago by tuna-fishing nations to divvy up what were thought to be separate eastern and western populations.

In the study, Dr. Block's team showed that there indeed appear to be distinct populations of bluefin that spawn either in the gulf to the west or the Mediterranean to the east.

But when the fish disperse across the Atlantic to feed, they mingle, rendering the management boundary, which runs along the 45th meridian, relatively meaningless.

That means that big quotas, granted for two decades to countries fishing east of the line, probably added pressure to the ailing western bluefin population, said Dr. John J. Magnuson, an emeritus professor of zoology at the University of Wisconsin. He was chairman of a National Academy of Sciences panel that included Dr. Block and that assessed the tuna's problems in 1994.

"Fishing the mixed fishery as though it is a strong stock depletes and can eliminate the weak stock," he said.

The tuna spawning in the gulf are even more endangered, Dr. Block and her team said, because spawning "hot spots" overlap with areas where boats, using long lines of baited hooks, pursue another tuna species, the yellowfin.

When big adult bluefin get caught on the lines, the researchers said, the warm water and their high-revving metabolism can push them beyond their physiological limits. Many die before they can be released. The toll is significant because it includes fish at the peak of their reproductive potential, the researchers said.

In the paper, Dr. Block and her colleagues recommended seasonal bans on long-line fishing in spawning hot spots in the gulf. They also urged tighter controls on fishing in the Central Atlantic, where a feeding area straddles the existing boundary line and fish from both coasts congregate. Right now, that area is intensively fished by a host of countries with almost no monitoring.

Without action, Dr. Block said, the western population has little hope. "If such megafauna can disappear, imagine what else is occurring?" she said. "And it's all because we do not have a system that manages the oceans properly."

American boat owners say that existing restrictions on long-line fishing in the Gulf are sufficient, and add that the spawning zones identified by Dr. Block are likely to shift each year, making specific "time-area closures" impossible. Long-liners in the area also use lightweight hooks that hold smaller yellowfin but are designed to uncoil under the powerful tug of a bluefin, they say.

Dr. Block said that when she worked on long-line vessels in the region, the same smaller hooks caught and killed a substantial number of bluefin. She added that only a few percent of longliners in the area carry observers who independently tally bluefin deaths.

Perhaps the biggest unresolved question is whether the new information can change an international regulatory regime that almost everyone, from anglers and commercial fishers to biologists and tuna diplomats, agrees is broken.

There are signs that the accumulated scientific evidence is starting to sway some members of the International Commission for the Conservation of Atlantic Tunas, the body created under a treaty in 1969 to oversee the fishery.

For two decades, many marine biologists have criticized the organization for setting quotas too high and for favoring data and analyses provided by the industry.

In an interview last week, Masanori Miyahara, the chairman of the commission and a senior fisheries official from Japan, acknowledged that the existing system had failed.

"We've spent too much time under the wrong assumption - two-stock management," he said. "After 25 years of those measures we don't see any improvement in western spawners. We believe something is definitely wrong."

He said that eastern catch limits needed to be better enforced, and he noted that a particular problem was the greatly increased penning of Mediterranean tuna, which disrupts spawning.

A meeting of scientific advisers to the commission will take place next month to consider new ways to manage the fish stocks. Mr. Miyahara added that Japan was particularly committed to restoring the bluefin.

"We feel some responsibility for this mess," he said. "Japanese buyers are running all around the world and buying as many fish as possible, particularly bluefin.

"We're seriously working with our buyers now to contain their eagerness," Mr. Miyahara said.

Even with such statements, and the new research, many scientists and scholars who study tuna and tuna fishing said they doubted much would change.

Glenn Delaney, an American who formerly served on the international commission and represents American fishing companies at meetings of the group, said Dr. Block's findings, while possibly correct, were at best preliminary and spotty - and thus unlikely to move the commission to act.

Mr. Delaney is one of many people in the tuna debate, including a host of biologists and environmental campaigners, who view Europe as a bigger impediment to better protections than Japan or the United States. Under the longstanding division of the Atlantic bluefin population, Europe has long had the advantage, with recent quotas of more than 30,000 metric tons of bluefin a year; less than a tenth that is allocated for western waters.

In an e-mail message, John Spencer, the chief European negotiator in international commission meetings, said that Europe had an "open mind" about management options after 2006. But, he added, "If we are going to change the current system, which has brought stability to the management, then we need to be demonstrated the added value of any new system."

William T. Hogarth, the assistant administrator for fisheries of the National Oceanic and Atmospheric Administration, said that trade sanctions or other economic measures may be required to push some countries to end routine violations of size and catch limits by their fleets.

As long as the issue is hashed out only in the invisible realm of fisheries bureaucracies, there will be little progress, environmental experts and industry representative agreed.

They also agreed that while the international commission has been a problem, the organization and the underlying treaty are the only source of a solution, as well.

For the moment, however, there are few signs of change. Last month, a group of fisheries experts from the international commission met in Fukuoka, Japan, to ponder alternative systems for managing the shared resource. The main camps - the United States, Europe and Japan - staked out starkly different positions.

Several tuna experts who were not involved with the new study said that Dr. Block's pointillist maps, showing the movements of some tuna for more than four years, were sufficiently concrete that they could force an end to the prolonged stalemate.

"Without her, we'd be in exactly the same place we were 15 years ago: a bunch of theoreticians waving their hands and a bunch of European fisheries politicians arguing the case based on no data," said Dr. E. Don Stevens, an emeritus professor of zoology at the University of Guelph in Ontario and an author of the 1994 National Academy of Sciences tuna study.

"If the managers do not accept this evidence," Dr. Stevens said, "then it seems to me that they will never accept any evidence and that their argument is not based on logic but rather is based on shortsighted political grounds."