of the Technical University of Munich in Germany. If the sum of all oscillations doesn't add up to 100%, then the data would point to a fourth flavor (*Science*, 21 October 2011, p. 304)—a possibility that could topple the standard model of particle physics and help explain a host of astronomical puzzles.

Another mission for JUNO is to observe geoneutrinos emitted during radioactive decay in Earth's deep interior, which generates heat that helps drive plate tectonics and power our planet's magnetic field. Detecting geoneutrinos "is the only way to get a glimpse of Earth's internal heat budget and distribution," McDonough says. The three facilities now detecting geoneutrinos, including the revamped Sudbury detector, record about 45 a year in total. JUNO should spot about 500 a year, enough to test various models of Earth's composition and heat flow, McDonough says. And that would score China another triumph in neutrino physics.

–JANE QIU

Jane Qiu is a writer in Beijing.

MARINE ECOLOGY

As Lionfish Invade, Divers Defend Threatened Ecosystems

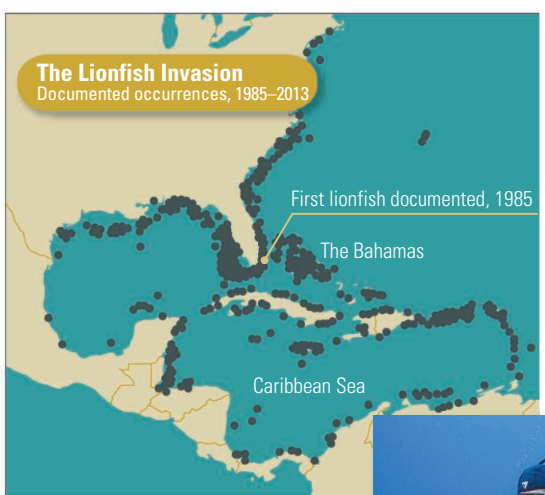
NASSAU—The red lionfish, with its striking stripes and huge outrigger fins, wasn't hard to spot. Nor to spear: It simply studied me, utterly fearless until I killed it. Within a half-hour, my group of divers had caught four of the gorgeous fish along a coral reef here; they made excellent eating that night.

For ecosystems in the southwestern Atlantic Ocean, however, the lionfish is a curse. Marine scientists say that the voracious predator, a Pacific native believed to have been released into the Atlantic by aquarium lovers in the mid-1980s, is spreading rapidly and wiping out native fish, especially on vulnerable Caribbean coral reefs. "They'll eat just about anything they can swallow and almost nothing eats them," says ecologist Stephanie Green of Oregon State University, Corvallis.

In the Bahamas, where *Pterois volitans* was first spotted in 1985, "they're everywhere," says Pericles Maillis, a Bahamian conservationist who has led local efforts to battle the invader. "It's a doomsday scenario."

Late last year, however, Maillis and other lionfish opponents got some good news. Using ecological models to plan a surgical 18-month offensive, divers killed enough lionfish for native fish populations to rebound at 24 coral reefs near the Bahamian island of Eleuthera, researchers reported online on 2 December in *Ecological Applications*. Removing 75% to 95% of lionfish at the sites allowed prey populations to increase by 50% to 70%—with up to one-third less effort than it would have taken to totally exterminate the invaders. The study shows that "we don't have to catch every lionfish" to allow native species to recover, says Green, the lead author, although the culling must be repeated regularly.

Such targeted tactics could help beat back an invasion that has spread to some 3.3 million square kilometers of the Atlantic, ranging from Rhode Island to the Panama Canal, according to Pam Schofield of the U.S. Geological Survey in Gainesville, Florida. Population densities are often many times greater than in the lionfish's native Pacific range, but the fish's phenomenal success is a mystery. Mark Hixon of the University of Hawaii, Manoa, guesses that a predator that keeps Pacific populations in check by eating baby lionfish is "absent in the Atlantic … but we have no idea what it is."



Gotcha. A diver bags a lionfish in the British West Indies as part of an effort to protect native fish from the invader, which has spread rapidly since it was first spotted off Florida in 1985 (map).

Lionfish invaders can snap up one-half of resident fish within just a year after arriving on a reef, recent research shows. So far, they have taken their most visible toll on small reef fish. But researchers say they also eliminate the young of large predators such as snappers and groupers, an absence that might not be noticed for years.

Recent studies have found clues as to why the invader is so lethal. For example, some common Pacific reef fish inexplicably don't recognize lionfish as a threat, although they dart for cover when other predators appear, an Australian research team reported in *PLOS ONE* this past October. That's a worrying sign that Caribbean fish aren't likely to learn to avoid lionfish either. "That scares me even more," says lionfish specialist Isabelle Côté of Simon Fraser University, Burnaby, in Canada.

To reduce lionfish numbers, policymakers in the Bahamas and elsewhere have tried to promote commercial fishing of the tasty species. You need to "eat it to beat it," says Frederick Arnett II of the Bahamas' Department of Marine Resources. One problem facing any fishery, however, is that handling lionfish requires special care: Their venomous spines can make the slightest puncture extremely painful. And their unusual appearance can make consumers skittish.

Still, in Florida, the commercial catch quintupled from 1.1 tons in 2011 to 6.1 tons in 2012, according to the U.S. National Marine Fisheries Service. "But we don't know yet if it's putting a dent in the population," says Lad Akins, founder of the Reef Environmental Education Foundation in Key Largo, Florida.

In the recent Eleuthera island study, researchers examined the effectiveness of a more targeted approach by killing virtually all lionfish on one set of reefs, fewer at two other sets, and none in a fourth control group. The surprises were how fast the lionfish decimated the local fish in the control, and that the native species quickly rebounded on other reefs even when 25% of the lionfish remained. That suggests focused lionfish culls aimed at protecting juvenile fish could be useful. "If we can get divers to take the lionfish out of the shallow reefs and the mangroves where the juveniles are," Green says, "we may be able to keep some reefs relatively intact."

–CHRISTOPHER PALA

CREDITS (TOP TO BOTTOM): U.S. GEOLOGICAL SURVEY; OREGON STATE UNIVERSITY

Published by AAAS