ECOLOGY

'No-Take' Zones Spark Fisheries Debate

An unusual experiment is getting under way this month on a 30-kilometer-square patch of coral reefs, sea grass meadows, and mangrove swamps off the Florida Keys. Federal officials are banning all fishing from this part of the Florida Keys National Marine Sanctuary—in order to help replenish fisheries elsewhere. The hope is that the Western Sambos Ecological Reserve, as it's called, will serve as a source of fish, larvae, and eggs that will spill over into surrounding waters to help restock populations suffering from overfishing, pollution, and heavy tourism.

The reserve is the first no-fishing zone set up for this purpose in U.S. waters, but many ecologists and fisheries scientists hope it will fuel a trend. They argue that no-take reserves are crucial for preserving marine biodiversity and healthy ecosystems, and for restoring the ocean's dwindling fisheries. "[No-take marine reserves] are being seen as the last great hope for fisheries management in many parts of the world," says Kim Holland, a fish physiologist at the Hawaii Institute of Marine Biology in Kaneohe.

But although the Florida Keys reserve is finally a reality after six tumultuous years of back and forth between scientists, fishers, divers, aquarium fish collectors, local business leaders, and county, state, and federal officials, the idea that it and others like it will help enhance fish stocks is still very much a theory. "We have no idea, really, if the Western Sambos Ecological Reserve will have an effect on replenishment," says John Ogden, director of the Florida Institute of Oceanography in St. Petersburg and an ardent advocate of the reserve.

No-take marine reserves are "showing signs of being a fad, and fads don't necessarily promote good science," says Nicholas Polunin, a marine ecologist at the University of Newcastle in the United Kingdom. "How can we justify them to people for whom fishing is their livelihood [when] we cannot predict what the benefits will be?" Even those who support the strategy acknowledge that, in most instances, researchers don't know where many fish species spawn and how they disperse, making it difficult to pick out the best areas for protection.

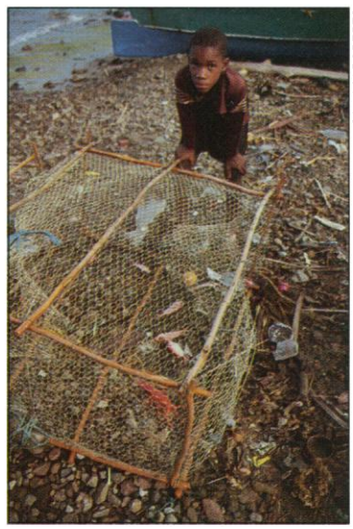
Few and far between. Historically, proposals to shut down fishing grounds have sparked fierce opposition, and that's why few no-take zones of any substantial size have been established so far. Most marine sanctuaries around the world place restrictions on fishing but don't ban it altogether. For instance, various kinds of fishing are allowed in more than 99% of the Florida Keys National Marine Sanctuary. And among the few reserves that do ban fishing, many are just "paper parks" where the ban is not effectively enforced, says Jane Lubchenco, a marine biologist at Oregon State University in Corvallis.

Saving fisheries requires tougher action, says Tony Pitcher, director of the Fisheries Centre at the University of British Columbia in Vancouver, pointing to the dismal record of fisheries management. In the last decade, at least 20 major fisheries have collapsed around the world, he says. As he points out, some were quite closely monitored, including the North Atlantic cod fishery. "We've obviously screwed up. The idea of closing off areas as a hedge against this imperfect science is a powerful one," he says.

CALLUM ROBERTS

Dramatic comeback. A school of grunts in Belize's Hol Chan Marine Reserve.

Fish species also are losing their natural refuges as improved fishing technologies give fishers access to ever more remote corners of the sea, says Callum Roberts, a marine ecologist at the University of York in the United Kingdom: "As we erode away their natural refuges, [reserves] are the only way to protect [vulnerable species]." Although reserves could not entirely replace current restrictions on fishing gears—such as mesh sizes of nets, he asserts—a "no fishing here" rule should be easier to enforce and produce more ecologically sound results than catch quotas.



CALLUM ROBERTS

Fished out. Typical trap catch in Santa Lucia, which has recently established a system of marine reserves.

At the annual meeting of the Society for Conservation Biology held in June in Victoria, British Columbia, Lubchenco and others called for a bold step to halt these trends: boosting no-take marine areas from today's one-quarter of 1% of the ocean's surface area to 20% by 2020. Doing so could help replenish fisheries in two ways, say some proponents. First, reserves would allow fish inside them to live longer, grow larger, and produce a bounty of eggs. Over time as the population density increased, adult fish would leave each reserve, adding to catches in neighboring areas. Currents also would transport eggs and larvae from the reserve to surrounding fishing grounds, reseeding them. "The country that has the courage to set up no-take reserves now is the country that will have a thriving fishing industry in 20 to 30 years," says Pitcher.

Bigger fish. It is still not clear, however, how much of this will stand up to scientific scrutiny. There is good evidence from around the world that fish are, in fact, larger (presumably because they are older) and more abundant inside marine no-take reserves. For instance, in tropical Kenya the red lion triggerfish, which has been nearly wiped out from other coral reef areas, has rebounded inside no-take zones, says Tim McClanahan, an ecologist who works for the New York City–based Wildlife Conservation Society. Rockfish living in two no-take reserves off the coast of northern California grow up to 48 centimeters long, compared to just 36 centimeters outside the reserves, says Michelle Paddack, who surveyed the fish populations for a master's degree at the University of California, Santa Cruz, and pre-

sented her findings at the Victoria meeting.

A study of a tiny, 400-meter-square coral reef reserve in the Philippines called Apo Island also supports the idea that adult fish migrate from reserves into surrounding fishing areas. Surveys of large, predatory fish, such as groupers and tropical snappers, over 10 years in areas 200 to 300 meters outside the reserve revealed an increase in fish density over time, with significantly more fish after 9 years, says Garry Russ, a marine biologist at James Cook University in Queensland, Australia. McClanahan has also reported that adult fish from a 6-kilometer-square reserve in Kenya can venture into neighboring waters.

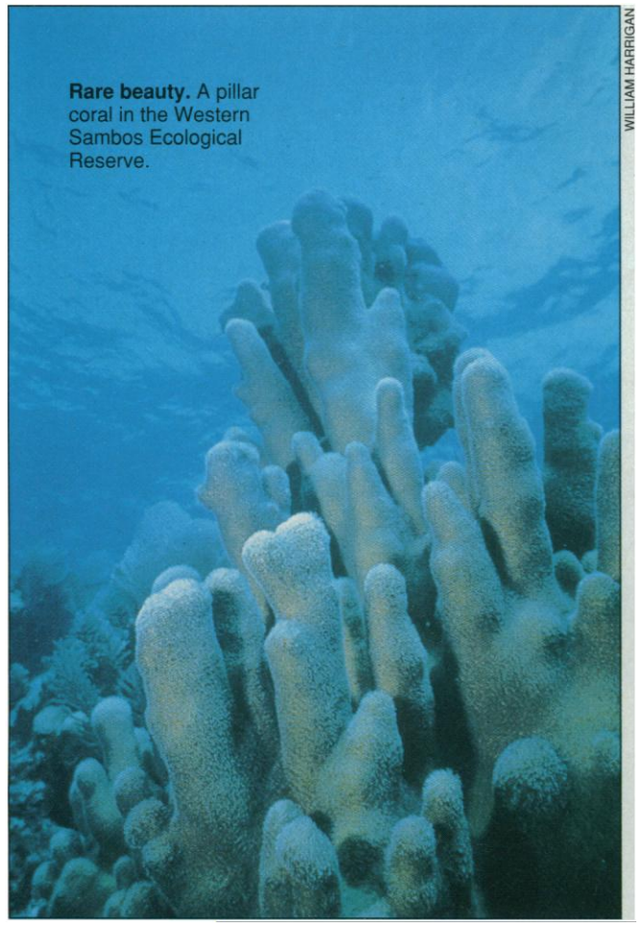
But so far there's little evidence that this spillover of adults is swelling catches. McClanahan found that in one study area where a reserve was set up, total catches dropped by 35% by the third year. He says he's now skeptical that closing more areas to fishing will increase catches overall: "I don't think marine no-take areas are the golden goose. A lot of the claims are too hopeful and are made because there's almost no data to show the opposite."

Even those researchers who argue that reserves will up catches in the long run say they don't expect the spillover of adult fish to do the job. Many fish species may not move around much as adults, particularly if they live on reefs. For reserves to really enhance fisheries, say researchers, most adults need to stay inside the protected area, producing massive quantities of juveniles and larvae to be transported by ocean currents into fished areas. While there's no evidence yet that replenishment by this mechanism has occurred at any reserve, it is known that fish larvae disperse widely. In the Caribbean, for instance, larvae have been found to ride on ocean currents for 50 days on average and can settle throughout an area 1900 kilometers by 800 kilometers, says the Florida Institute of Oceanography's Ogden.

Joshua Sladek Nowlis, an ecological modeler at the University of the Virgin Islands on St. Thomas, created a computer model that tested the effects a no-take reserve could have on fisheries if adult fish stayed put and larvae traveled far and wide. He found "a huge fisheries enhancement," he says. The reserve also appeared to save some species that otherwise would have gone extinct. Concludes Nowlis, "What we need to do is design reserves in a way that larvae get distributed well and adults are maintained inside."

Researchers are still debating how big reserves should be to accomplish these goals. If a reserve is very small, too many adults and eggs may leak out and the population inside may not be self-sustaining (although many tiny reserves studied so far don't appear to suffer from this problem). Conversely, with an enormous reserve, the lost catch would be so great that replenishment may not be enough to compensate for it and catches overall could decline, says Nowlis.

Even more important than size, however, is location. Says James Cook's Russ, "The key to whether marine reserves will have any positive effect on fisheries is if they protect critical spawning sites." Those that do, he says, could help conserve even those species that migrate vast distances, such as the beleaguered bluefin tuna. No single reserve could ever protect adult bluefins, but a reserve placed where they spawn, such as in the Gulf of Mexico, could increase their numbers by aiding the survival of juveniles. Reserve designers could also focus on other "source" areas such as certain coral reefs, where myriad fish larvae of many species are produced before dispersing on ocean currents. Reserves may be most effective when placed where overfishing is most severe, says Nowlis. One of his computer models turned up the surprising result that heavily fished populations show a faster turnaround than lightly fished populations when reserves are set up.



Rare beauty. A pillar coral in the Western Sambos Ecological Reserve.

WILLIAM HARRIGAN

Strategic planning. Such factors have typically been given short shrift in the design of existing reserves, most of which have been placed where public resistance is lowest, says Lubchenco. But designers have also been hampered by a dearth of information—on the basic biology of species, including ranges and locations of spawning grounds, as well as on ocean currents and patterns of larval dispersal. To reduce the risk of selecting a site that's too small or in a less than optimal location, most proponents of no-take reserves say it's best to set aside a network of reserves, rather than one big area of ocean. By spreading reserves over a larger area, networks allow designers to sidestep the all-the-eggs-in-one-basket problem, which looms particularly large when the precise locations of spawning sites and larval sources are unknown. Networks also help get around the size question by including more types of habitat that are likely to meet the needs of more species, says Bill Ballantine, a marine ecologist at the University of Auckland in New Zealand, a country that has established 13 marine reserves over the past 20 years and continues to work toward building a linked network.

Still, even strategically placed networks of no-take marine reserves cannot fully conserve all species and ecosystems. Reserves can best protect species that dwell at well-defined sites, such as coral reefs, says Julia Parrish, a conservation biologist at the University of Washington, Seattle. By contrast, it would be nearly impossible to design a reserve to protect the Pacific salmon because the fish spawn in coastal river beds and migrate through the open ocean, swimming different routes each year depending on prevailing ocean current temperatures. In addition, marine reserves can't protect species and ecosystems from oil spills, pollution from coastal runoff, or climate change. Says Parrish, "Marine reserves are one tool and a good one. We should be serious about using them. But we would not be able to go to sleep at night thinking that everything is taken care of."

Ultimately, the success of no-take marine reserves is likely to depend as much on build-

ing and maintaining political support as on improving the science, proponents say. Take the Florida Keys case: Planners considered the best available science in coming up with their original proposal for a network of four reserves, says Rod Fujita, a marine ecologist at the Environmental Defense Fund in Oakland, California, who was involved in the planning. Although little was known about where important species—snappers, lobsters, and groupers—spawn and how their larvae disperse, the planners tried to infer crucial locations from the known water circulation patterns.

But in the final hour, some commercial fishing and "wise use" groups fought the proposal, and a nonbinding referendum last November in Monroe County, Florida, revealed that 55% of the voters opposed the entire marine zoning proposal for the sanctuary. As a result, the final plan included just one no-take reserve—the Western Sambos. "We shed a lot of blood to come up with the original network of four ecological reserves ... [and] we just barely got a scrap of what's needed," contends Fujita.

Researchers are now preparing to monitor fish density, diversity, and size, and look for signs of spillover into waters outside the Western Sambos. But because the site is quite small, may not include any spawning grounds, and is located in the path of runoff full of silt, excess nutrients, and algal blooms from Florida Bay, some researchers fear that studies of the reserve may yield little useful data. "What worries me is that if we do not get a big response, we won't know if it's because reserves don't work, or because the pollution from Florida Bay is killing everything," says Fujita.

Even with the uncertainties, most ecologists and fisheries scientists remain steadfast in their support of no-take marine reserves. "Despite the controversy over the fisheries enhancement benefit, there's little controversy over the other benefits: protecting ecological integrity and biodiversity from the direct effects of fishing," says Fujita. "Reserves placed almost anywhere are going to be better than no reserves at all," says York's Roberts. "Let's just get on and do it."

In fact, some argue that the whole debate should be turned on its head. No-take marine reserves should not be viewed as an experiment at all, contends James Bohnsack, a research fisheries biologist at the National Marine Fisheries Service in Miami: "The reserves are the controls, and everything else is the experiment." By allowing fishing throughout the ocean, he says, "we've been conducting a giant, uncontrolled experiment over the entire ocean for years."

–Karen F. Schmidt

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Brighter Prospects for the World's Coral Reefs?

Just a few years ago, scientists sounded the alarm that coral reefs around the world were seriously ailing. Some were bleaching a ghostly white as warmer than usual sea temperatures caused corals to expel their symbiotic algae. Others were being buried in silt, overrun by seaweed, or devastated by violent storms and disease. Scientists convened meetings, launched new research initiatives, and declared 1997 the International Year of the Reef to promote a greater awareness of the plight of these rich marine ecosystems.

But now, midway through that year, some coral reef scientists are beginning to suspect that reefs may not be quite as widely imperiled as they once thought. Increasingly, researchers are wondering whether the decline may be local or regional rather than global in scope. "I don't think reefs remote from centers of population are as bad as the horror stories [we've heard]," says marine geologist Robert Ginsburg of the University of Miami in Florida. Although reefs in the Philippines are dying, for instance, those of Palau, French Polynesia, the Marshall Islands, Micronesia, Fiji, and the Cook Islands seem, for the most part, to be thriving. Likewise, although corals throughout the Caribbean are crumbling, those in the Gulf of Mexico seem to be stable.

CALLUM ROBERTS

Substitutes. Intensive fishing has changed the structure of Caribbean coral communities, which now often are dominated by goatfish *(above)* and other smaller prey fish.

No one is suggesting that the major threats facing reefs have diminished or disappeared. In many fast-growing regions of the globe, such as the Caribbean and Southeast Asia, ship groundings, oil spills, and fishing with dynamite or cyanide are damaging reef communities, possibly beyond recovery. But new research indicates that some of the more tractable problems, such as simple overfishing, may be playing a larger role in reef decline than was once believed. Further, there's growing evidence that reefs do recover when given a chance. When communities or nations tighten restrictions on reef fishing or clean up pollution, reefs have rebounded.

"If we can begin to curb these [stressors], I think the oceans would be much healthier, [and] I think you would see reefs respond," says coral ecologist Phillip Dustan of the University of Charleston in South Carolina. Says Barbara Brown, an ecophysiologist at the University of Newcastle in the United Kingdom, "Some reefs will certainly deteriorate, and they are certainly going to change. But I don't think coral reefs are going to disappear."

Globalized anxiety. Concerns about a global decline began to gel 10 years ago, when a severe wave of coral bleaching in the Caribbean coincided with rising concern in the United States about global climate change. At congressional hearings in 1990, scientists and environmentalists portrayed reefs as fragile sentinels warning of the dire consequences of global warming. A handful of studies showed that corals were sensitive to even small temperature changes, which, to many marine biologists, suggested that ocean warming ultimately would lead to the loss of many reef communities.

The focus—although not the level—of concern shifted in 1991, when scientists gathered in Miami to discuss the implications of global climate change for reefs. They concluded that the gradual warming expected in coming years was the least of their worries. "Most coral reef scientists [were] concerned that by the time reefs had to cope with global warming, they would be dead anyway" from pollution, destructive fishing, and other more immediate threats, says Judy Lang, a coral reef scientist at the University of Texas, Austin. The assembled scientists realized that "the