





ECOLOGY

Let the Fish Breathe

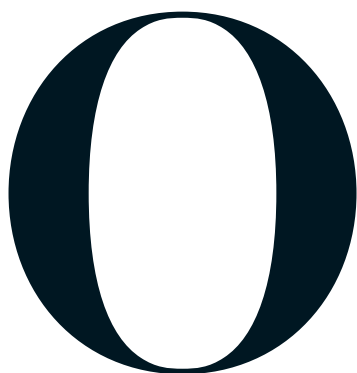
In Indonesia's Raja Ampat islands, local people are leading the effort to protect the world's most diverse coral reefs—and their own livelihoods—from the ravages of overfishing

By Brendan Borrell

OUTSTANDING:

Fishers in wood boats prowl Raja Ampat's teeming waters as baitfish circle a tiny island.

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ON A BRISK AUGUST NIGHT DORTHEUS MENTANSAN SLIPPED INTO THE CALM ocean in a wood outrigger canoe with a lantern tied to the bow. A slight, solemn man with the precise paddle stroke that comes from 30 years of practice, Dorteus counts himself as a descendant of the original clan that settled here in the Mayalibit Bay region of Indonesia's remote Raja Ampat islands. Clouds blocked the moon, but Dorteus had no trouble navigating.

Soon several grayish forms—mackerel—took shape in the lamp-lit water: darting, disappearing and reemerging. Dorteus herded the quarry to a cut in the limestone bluffs, where reddish-brown rocks formed a shallow corral. The water's surface roiled as two dozen glistening fish splashed about. Dorteus stepped into the ankle-high water with a triangular net and scooped their bodies into the canoe, where they thumped against its walls for several minutes, robotically opening and closing their mouths.

It was a ruthless method and one that few outsiders—five by Dorteus's count—had ever witnessed. The lamp seems to throw off the mackerel's sense of direction. Some villagers use the technique to catch excessive numbers of fish, but Dorteus takes only what he needs. "I'm trying to set an example," he explains. Overfishing has been "depleting the spawning zone."

In the past two years his village has prohibited fishing in a zone to the north, and the local church has ordered villagers not to fish on Saturday so that some mackerel—locally called *lema*—can breed. The actions are part of a larger effort by residents to manage natural resources and protect biodiversity. Conservationists have learned the hard way that if locals do not support top-down measures imposed on them, they may flout or overturn the regulations. In Raja Ampat's hundreds of islands, coral reefs and mangroves, conservationists have taken this idea to the extreme, helping individuals such as Dorteus take on leadership roles, design conservation programs, monitor resource use and enforce rules.

The goal of enlisting Dorteus and others is to ensure that preserving the extremely diverse Coral Triangle, which stretches from Bali to the Solomon Islands and the Philippines, does not end up harming the people who depend on its resources for food

and jobs. For years conservationists set up protected areas without thinking much about how such actions would affect the human communities around them. The establishment of large, new marine protected areas, or MPAs, in Raja Ampat and the surrounding Bird's Head peninsula constitutes a crucial test case. Because community people are more involved, they are upholding the MPA rules. Yet the arrangement has also created friction among citizens who live within protected zones and others outside them who once exploited the zones for profit.

The experiment is important because under the 1992 United Nations Convention on Biological Diversity, countries have vowed to protect 10 percent of the world's marine areas by 2020, which will affect many fishing communities. The World Wildlife Fund has partnered with the State University of Papua in Indonesia to monitor villages in the Bird's Head MPAs until 2014 and possibly longer, examining how the areas influence the local people's health, economic well-being, education and cultural preservation. "Do MPAs value fish over the fishermen who depend on them?" asks Michael B. Mascia, director of social science at the World Wildlife Fund. "This is the source of conflict around the world, and there hasn't been a lot of rigorous research."

In scientific literature and publicity materials for conservation organizations, the positive social benefits of MPAs are assumed as foregone conclusions. Yet if the effects on people turn out to be negative or if people just ignore the MPA rules, then better strategies to preserve ocean health and food supplies will have to be developed immediately. The data from Bird's Head are just beginning to come in, but anecdotes are revealing some instructive insights. And the launch of this grand test is already marking a new era of accountability for marine conservation.

IN BRIEF

Marine protected areas (MPAs), which limit such activities as fishing, are increasingly popular and seem to protect fisheries and biodiversity, but little research exists on whether they help communities.

Extensive work to answer that question is now

under way in Raja Ampat, a large region of hundreds of islands, coral reefs and mangroves in Indonesia.

Two lessons already seem clear: smaller reserves are more likely to benefit the local fishers because small areas are easiest to defend and are therefore

more likely to flourish and to be managed sustainably. Second, the community must end up devising rules and policing compliance if MPAs are to succeed. Otherwise inhabitants may flout MPAs, and tensions can rise between locals and outsiders.

FISHING HOLES BECOME BATTLEFIELDS

IN THE LATE 1990S, when Mascia was a graduate student at Duke University, the state of land conservation was light-years ahead of what was going on at sea. For example, Costa Rica had set aside 26 percent of its land in protected areas but less than 1 percent of its territorial waters. Mascia, who has degrees in biology and environmental policy, believed that more marine space needed to be protected worldwide to preserve biodiversity and to reverse the collapse of fisheries that a billion people depend on for protein. He also did not want to see conservationists and governments make the mistakes they had made on land: evicting local people from protected areas or restricting access to their resources. These top-down approaches too often harmed the world's poorest communities. The alternative—communities managing their own resources—was being heralded as a novel approach and was leading to successes involving timber production in India and water rights in South America. Sustainable practices were starting to put people first.

Translating success from land to sea requires more than getting wet. Forests can be readily marked and monitored, but economically important fish such as tuna and mackerel swim across vast distances. And isolated fishers in dugout canoes often lack the resources to prevent outsiders from zipping in with more powerful vessels and fishing technologies.

MPAs vary in tactics but generally restrict access and are zoned for different types of activities, often including no-take zones and even no-go zones. As Mascia puts it, they are about who may do what, when, where and how. But MPAs also vary in who sets the rules, who enforces them and who benefits. That variability is what led Mascia to realize that the effects on communities needed to be examined more closely, and he homed in on Raja Ampat as the place to hunt for answers.

Back in the late 1990s, Mascia surveyed 42 MPAs in the Caribbean and found that just one third of them allowed subsistence fishing and that local people rarely played a role in an MPA's management. In a recent worldwide study, he concluded that after marine reserves were established, food security remained stable or increased most of the time, which seemed like a good sign. On closer inspection, however, he realized that within a single community, some groups of fishers might be losing control of their resources as others were gaining control. The reported increases in food

security were actually an illusion produced by restricting fishing rights to a subset of dominant fishers and then asking them how they were doing.

As Mascia examined such disheartening results, he started to hear more about complications at Raja Ampat, a biodiversity hotspot with a whopping 1,320 fish species and 540 coral species—about 70 percent of the global coral tally. No MPAs were in place. The region was located in the resource-rich province of West Papua, a political tinderbox that hosted indigenous tribes and a simmering separatist movement closely watched by the Indonesian military.

At about the same time, Mark Erdmann of Conservation International had noticed serious threats to the archipelago's fisheries from outsiders. Raja Ampat's original coastal inhabitants—4,000 to 5,000 people known as the Ma'ya—were once feared as headhunters but were now struggling to support their modest way of life. They had previously respected one another's traditional claims to land and fishing grounds, and they conducted seasonal closures, known as *sasi*, to manage them. Yet population pressure caused by a migration of land-based tribes to the coast and the arrival of better-equipped newcomers had turned fishing into a game of winner-takes-all.

Fishers from Sulawesi, in particular, had become notorious for the most destructive harvesting practices. Sometimes they hired locals to do the dangerous dirty work. Other times they did it themselves with the backing of the police and military. They poisoned reefs with cyanide to stun slow-growing grouper and Napoleon wrasse for the live reef-fish food trade in Hong Kong. To catch speedy fusilier fish, they flung dynamite or fertilizer bombs into the water with impunity. Then there were the trawlers. "In the old days we could catch Jack fish that were as wide as your body," says Trofinus Dailom, a 57-year-old church leader from the village of Kalitoko, who has taken part in enforcement missions around the bay. "They have been rare since the trawlers came through in the 1990s."

Raja Ampat's waters had become a battleground, and local leaders held no sway over the invaders.



RAJA AMPAT ("four kings") includes hundreds of islands around the tip of the Bird's Head peninsula at the northwestern corner of West Papua. Three protected areas already exist there (*light red*). An unusual test case is under way on the archipelago to see if community leaders can oversee four other marine protected areas (*bold*) in ways that benefit local people.



HOTSPOT: Raja Ampat, home to 70 percent of the world's coral species, could become a hub for diving instead of illegal fishing.

TESTING THE WATERS

IN 2004 ERDMANN, an American who had been living in Indonesia off and on for 20 years, met with communities in Mayalibit Bay, the fjordlike region where Dortheus lives, to discuss how they could regain control of their resources. He could provide them with advice, training and funding to establish an MPA, but they would have to take charge. In December 2006 the traditional leaders of Raja Ampat declared their intent to create four MPAs with the help of conservation groups, and a passionate resident named Bram Goram rose to take charge of the Mayalibit MPA. Bram harnessed his knowledge of the area to expand the *sasi* system. For example, his people designate ancient cemeteries or natural features off-limits out of respect for their ancestors and believe that entering those areas, called *mon*, can lead to illness or bad luck. Bram created the hybrid concept of *sasimon* to introduce no-take zones to his neighbors. And he set up a team to patrol the waters and thus discourage infractions.

Two years later, however, residents still lacked the legal authority to prevent outsiders from exploiting their fishing grounds. That changed on March 15, 2009, when locals showed their willingness to fight for their resources. A commercial fishing boat anchored just outside the bay, along with a fleet of smaller boats, swept through the area. When Bram's patrol team confronted them, the outsiders flashed a permit from the regional fisheries office. Bram was furious and demanded that the government revoke the permit. Remarkably, the government complied and also put in place a moratorium on all outside fishing permits in Mayalibit Bay. "The community finally had the power they needed to protect their fisheries," Bram says proudly. Today 29 percent of the bay is

a no-take zone, including about 40 percent of its mangroves and reefs. The other MPAs in the Bird's Head seascape developed their own protections and are in various stages of implementation.

For Mascia, these rapid changes in Raja Ampat offered a prime opportunity to examine the human impact of MPAs. An ongoing experiment in conservation could also become a test case for the social sciences. Some social scientists had conducted small-scale studies of fishing communities, but Mascia wanted to follow in the footsteps of an ambitious effort conducted on land. Arun Agrawal, a social scientist at the University of Michigan, had studied a network of 9,000 forest plots in 16 countries and found, for instance, that putting local people in charge of protecting their own forests increased forest regeneration. That finding suggested that Bram's patrols could help fish populations recover. In 2009 Mascia and his collaborator Helen Fox, also at the World Wildlife Fund, met with Agrawal to launch a monitoring program in the Coral Triangle.

In late 2010 Mascia's team began baseline surveys of 2,433 households in 102 villages inside and outside Mayalibit, Cenderawasih Bay and four other MPAs in the region. They would ask individuals, for instance, how often they went fishing or—in an effort to understand who was better off—whether they had a DVD player or a generator. The first year's data indicate that only 12 percent of households in Mayalibit face recurrent hunger, compared with 21 percent in Cenderawasih, where residents get more of their protein from sources other than seafood. Differences in how much each community relies on marine resources will impact the success of the MPA, yet it is hard to predict how. For example, locals who depend more heavily on marine resources

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may be more inclined to defend them from outsiders, but they may also be prone to overexploit them. Mascia's team has finished stacks of follow-up surveys at Mayalibit and Cenderawasih and is now waiting for the data to be assessed to see if and how the areas have changed after two more years under MPA rules.

Because each protected area has its own mix of marine resources, cultural histories and levels of involvement from international conservation groups, the most important survey findings will be about the types of benefits MPAs are providing, such as food security or improved economic status. Comparing the 2010 and 2012 surveys will also elucidate contentious questions such as whether coastal farmers receive trickle-down benefits from marine protection. The team needs to study all the MPAs before drawing generalizations. For example, Mayalibit Bay is surrounded by land, which makes protecting it from outsiders somewhat straightforward. Other reserves have open water with only scattered islands, which may be more difficult to police and may mean they offer fewer benefits to the people living there.

Mascia also hopes to establish a broad repository of traditional knowledge and fishing practices throughout Raja Ampat and the Bird's Head seascape. That will help him understand the degree to which the MPA legal framework will work in concert with, or in opposition to, local leadership. The insights will help communities and policy makers improve how they are managing resources and will also help Mascia draw conclusions about who is actually benefitting from a given MPA. Conservation groups seem eager for his results; in 2011 the Society for Conservation Biology gave Mascia an Early Career Conservationist Award for the "development, mobilization and application of social scientific knowledge."

LOCAL SUCCESS IS GLOBAL SUCCESS

UNDERSTANDING THE SOCIAL IMPACTS of marine protected areas is critical as they multiply. Nearly 6,000 now exist worldwide. Ever since former president George W. Bush designated the world's largest MPA in the northwestern Hawaiian Islands in 2006, a succession of ever larger reserves have wowed conservationists but have left Mascia feeling uneasy. In April 2010, for example, the U.K. broke Bush's record with a 545,000-square-kilometer no-take reserve in the Chagos Archipelago in the Indian Ocean. The original residents of Chagos, who were evicted from the islands in 1967 and have been fighting for their return, were never consulted. To Mascia, the process of designating an MPA should not even begin until such a serious social conflict has been resolved.

Large, remote MPAs may offer countries a flashy way to meet their obligations under the Convention on Biological Diversity, but their success is tenuous. Smaller reserves are more likely to benefit subsistence fishers, who can defend the rights to their resources, giving the protected area a greater chance of long-term sustainability. Off the shore of Massachusetts or Alaska, however, industrial-scale fishing poses a very different set of challenges. Yet one lesson that can already be gleaned from Raja Ampat is that a healthy dialogue among fishers, conservationists and regulators can streamline the creation of a protected area, which is a boon for biodiversity.

Will that biodiversity be a boon for people, too? Early indications suggest that conservation in Mayalibit Bay improves the lives of the fishing community. For instance, locals used to fish intensively next to their villages, creating an ever expanding void

of depleted waters. Maintaining a small conservation zone directly in front of villages has changed that. "In only two years we now see many big fish under our jetty," MPA leader Bram says. Fish allowed to take refuge in front of the village multiplied and spilled out into adjacent fishing grounds. The decision succeeded because leaders took a proactive role in managing their resources and educating their own people.

On a misty morning, I watched one gaunt villager with a canoe full of bananas pull Bram aside and tell him that he had spotted a suspicious group of outsiders in a hidden cove. The man went further, suggesting a new no-catch zone there and adding that he would like to see a monitoring outpost nearby.

"That is one of the things we want to push," Bram agreed. "Thank you," the man replied. "Some people always want to destroy our situation."

More generally, the designation of three of the four Raja Ampat MPAs—Kofiau, Misool and Dampier—has modestly reduced the harvest by outside fishers from about 99 to 90 percent, according to Crissy Huffard of Conservation International. In Mayalibit Bay, local fishers can claim nearly 60 percent of the catch, compared with 14 percent just outside the boundaries, and their patrol team has nabbed more unauthorized fishers than any other MPA.

Although conservationists dearly hope that research will show that preservation efforts are restoring marine life and enhancing local communities, they do not yet have strong proof, and they cannot say whether new forces, such as a shift in the political climate, could undermine progress. Certainly in Raja Ampat, nonnatives are not happy with the increased scrutiny, and traditional villages that fall outside of MPA boundaries complain of being left out. One worrisome development is that during my visit the local police had stopped assisting patrol teams after an officer accidentally shot and killed a fisher who was using dynamite late last year.

Funding is also a worry. Raja Ampat receives, and currently needs, substantial support from philanthropic organizations. The goal is for the MPAs to be self-sustaining via a fund collected from recreational divers who use the waters. It is too early to say whether the relationship between the local people and government will survive without international conservation groups acting as watchdogs and mediators.

And what happens if Mascia's study finds that MPAs do not help the region's fishers? "Our goal is that they are fully educated and aware of the trade-offs so that they can make their own informed decisions," Erdmann says. "That is the best we can do. In the end it is their land and natural resources, not ours." ■

MORE TO EXPLORE

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SCIENTIFIC AMERICAN ONLINE

Photographs and brief profiles of local Raja Ampat fishers can be found at ScientificAmerican.com/apr2013/borrell