

WORLD•WATCH

WORKING FOR A SUSTAINABLE FUTURE

Indonesia's Coral Reefs On the Line

by John C. Ryan
(with addendum by Lisa Mastny)

Excerpted from May/June 2001 WORLD WATCH

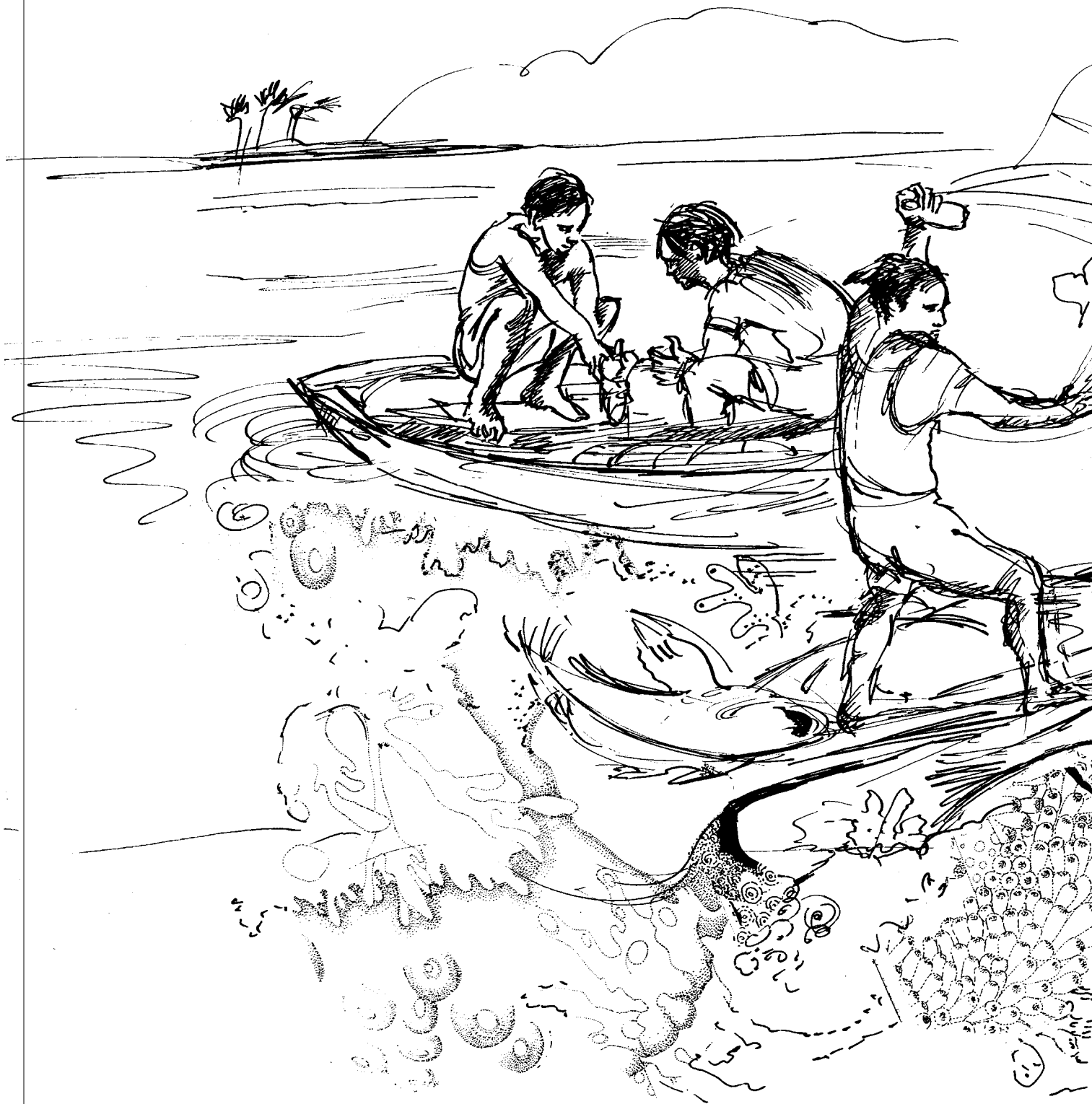
© 2001, Worldwatch Institute

For more information about Worldwatch Institute and its programs and publications,
please visit our website at www.worldwatch.org

 WORLDWATCH
INSTITUTE
1776 Massachusetts Ave., NW
Washington, DC 20036
www.worldwatch.org

From Wallace's Line to the Front Lines of the Explosive Struggle for the World's Richest Underwater Treasures

Indonesia's Coral Reefs



On the Line

by John C. Ryan

Illustrations by Narcissa Weatherbee

Nusa Dua, Bali, Indonesia Here on the eastern shore of Bali, as I look past the thin, white line of surf breaking over an offshore reef to the sparkling seas of the Lombok Strait, I'm not just looking toward another Indonesian island, I'm also looking past an invisible line to the edge of another world.

That invisible line running between the islands of Bali and Lombok—Wallace's Line—divides the living worlds of Asia and Australia, with elephants, pheasants, and towering Dipterocarp trees found on one side and marsupials, cockatoos, and Eucalyptus on the other. Named for the 19th century explorer-naturalist Alfred Wallace, Wallace's Line is at the heart of the sprawling Indonesian archipelago, one of the world's richest storehouses of biological diversity—both on land and under water.

Turning away from Wallace's Line, I see another dividing line. On the beach above me are the swimming pools, manicured grounds, and pampered guests of the Sheraton Nusa Indah, walled off from the real Indonesia of rice fields, crowded streets, and, well, Indonesians.

This exclusive and isolated resort (incredibly, it's more than half a mile's drive from the hotel's front door to the outside gate) is the setting for the Ninth International Coral Reef Symposium, the largest gathering ever of coral reef scientists. Some of the 1,500 experts gathered here grasp the irony of discussing community-based conservation at a conference far too expensive for anyone from an Indonesian coastal community to attend. Some apparently *don't* grasp it. But for better or worse, Nusa Dua is one of the only places in Indonesia where it is possible to hold such an enormous meeting.

If you're going to talk about coral, Indonesia is the place to be. With the world's richest and most extensive coral reefs, Indonesia probably harbors more underwater species than any other nation. This archipelago of 17,000 islands is also where the stakes are highest for ocean conservation: more people live closer to reefs here, in the fourth-most populous nation on Earth, than anywhere else. So the discussions at Nusa Dua—on the latest updates on reefs worldwide, the devastating implications of El Niño and climate change for corals, and ways to stop reef-killing fishing practices and the spread of coral disease—are tremendously important for this nation of coastal dwellers and fish eaters.

Yet, just a day into the conference, still jet-lagged, I'm already itching to cross the line to the other Indonesia: the Indonesia where putt-putting wooden fishing boats and outrigger canoes, not jet skis and "ocean adventure rafts," dot the waters. Where gravity-defying geckos, not hotel landscapers on a chemical quest for a pest-free paradise, hunt for insects. Where comfort comes from ocean breezes or wobbly fans, and discomfort means serious sweating in the equatorial heat.

But here at Nusa Dua, my discomfort—even my difficulty typing—comes from turbo-charged air-conditioners apparently set on "stun" (or perhaps "permafrost"), running so hard they rattle the furniture. The hotel tries so hard to be Western that it's almost colder than the U.S. Northwest in winter.

Every day while I sit here in the Bali Freezerdome taking notes and doing interviews, I know that bombs are going off in the real Indonesia.



Not in the war zones like Timor or Aceh, but in some of the quietest, most idyllic settings imaginable. From palm tree-dotted islands across the archipelago, millions of Indonesians head out each day in their wooden boats of all shapes and sizes. Most of them wield simple hand-made nets or hand-held lines to bring home food or to earn a few thousand rupiahs to support their families. But a fraction of these seafarers, mostly young men and teen-aged boys, carry explosives. Once out of earshot of the nearest village, each bomber looks into crystal-clear waters for the flash of a school of fish above the coral forest of branches, tables, domes, and fans. When he sees a good-sized school, he takes one of the day's stash of homemade bombs—a beer or water bottle filled with a mix of fertilizer and kerosene and a cheap underwater fuse—and hurls it into the water. A few seconds later, a white plume erupts 15 feet into the air and disappears just as quickly. Above the surface, the bomb has left no trace, but underwater, each bomb has killed or stunned hundreds of fish, easily scooped up by divers. It has also left perhaps a car-sized crater of coral rubble (see small photo, back cover) and, farther away, snapped and cracked coral branches and domes, the ruined products of decades or centuries of achingly slow growth.

This ragtag fleet of bombers collectively poses the greatest threat to the world's richest underwater habitats. Nationwide, blast fishing does about \$500,000 a day in damage, if you believe the economists who try to quantify such things; in some spots,

20 to 30 explosions can be heard daily. Bombs have at least moderately affected three-fourths of Indonesia's reefs. Much of the shallow Indonesian seafloor is now occupied by flattened dead zones, spreading as far as the snorkeler's eye can see. Damage from bombs and other disruptions, like sedimentation, cyanide fishing, and coral mining, has severely degraded 70 percent of the nation's reefs and left only six percent in excellent condition. Though corals and fish can recover from many of these stresses, coral almost never recovers from bombing. Young corals, which need a solid substrate to grow upon, cannot mature on fields of rubble that shift with the passing of every wave.

Incredibly, toward the end of the week-long conference, reports come in about a rash of new bombings in Komodo National Park, my next destination—partly *because* of the conference. Reef bombers in the park know that many of the environmental watchdogs, who often help authorities track down fish bombers and wildlife poachers, are out of town all week at this meeting. It's open season on coral reefs, even in one of the few places in Indonesia where the laws against reef bombing are actually enforced.

Marine ecologists, who study the interrelationships among living things in the sea, have recently proposed the existence of an underwater Wallace's Line, oddly enough, perpendicular to the original north-south line. Most sea creatures begin their lives as free-floating larvae, often carried great distances before they develop an adult's ability to propel themselves against a current. Researchers were surprised to discover that shrimp, and very likely other wide-ranging reef organisms, apparently don't cross this underwater line. Because they do not interbreed with other members of their species on the wrong side of the tracks, so to speak, the species are more vulnerable to local extinction than previously thought.

While it's possible to think of tropical ocean habitats in linear terms, it is perhaps more useful to picture them globally as a series of concentric circles. Each circle has more species—of fish, corals, sponges, mollusks, crustaceans—than those outside it. And the bull's eye of all these circles—the heart of the world's aquatic biodiversity—sits in the middle of Indonesia, in the biological wonderland known as Wallacea.

Spreading east from Wallace's Line, Wallacea is a sort of no-man's land between Asian and Australian realms, the exclusive home of many strange creatures like the dragons of Komodo, the dwarf buffalos of Sulawesi, and the megapode birds of the Moluccas. But underwater is where Wallacea really shines. Indonesia's best reefs are here, far from the silt-laden rivers of the big western islands like Java and Sumatra. With its strong currents, stable year-round water temperatures, absence of typhoons, and unmatched variety of reef habitats, eastern Indonesia has supported



an unmatched variety of underwater life forms, including 400 species of reef-building corals and close to one out of four of the world's fish species.

Alfred Wallace himself, when exploring these far-flung islands, saw pristine reefs in water as clear as anywhere in the world and, like many others after him, was amazed. One day in 1869, he spent hours peering over the side of a small boat in Ambon Bay, in the Moluccas. Afterwards, he marveled:

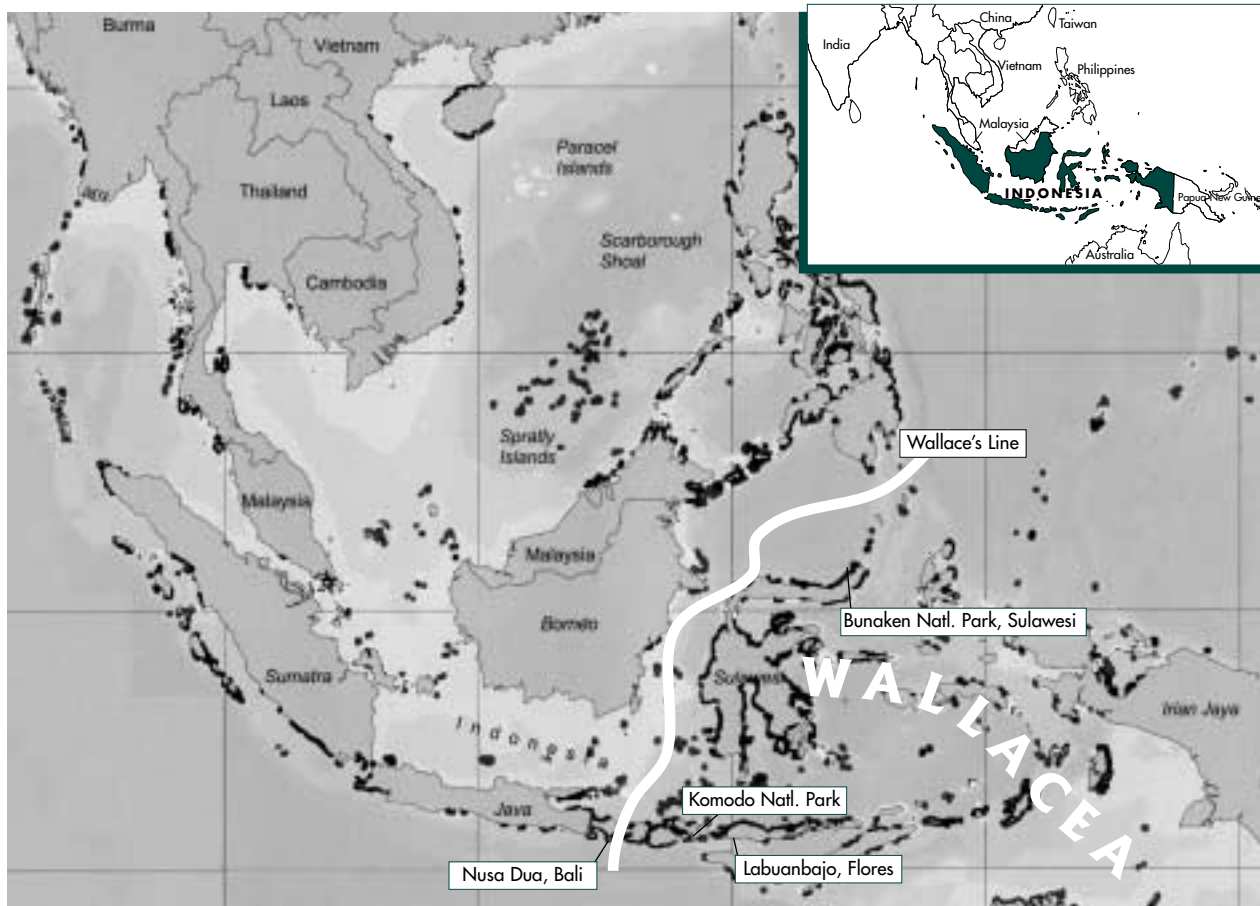
The clearness of the water afforded me one of the most astonishing and beautiful sights I have ever beheld. The bottom was absolutely hidden by a continuous series of corals, sponges, actiniae, and other marine productions, of magnificent dimensions, varied forms, and brilliant colors.... The bottom was very uneven, rocks and chasms, and little hills and valleys, offering a variety of stations for the growth of these animal forests. In and out among them moved numbers of blue and red and yellow fishes, spotted and banded and striped in the most striking manner, while great orange or rosy transparent medusae floated along near the surface. It was a sight to gaze at for hours, and no

description can do justice to its surpassing beauty and interest. For once, reality exceeded the most glowing accounts I had ever read of the wonders of a coral sea. There is perhaps no spot in the world richer in marine productions, corals, shells and fishes, than the harbour of Amboyna.

When I got to Komodo, I went diving with a dozen American marine biologists, some of whom have a thousand dives under their belts, but most of whom had never seen a coral reef outside the United States or the Caribbean. After our first dive, everyone surfaced smiling from ear to ear. This first reef was somewhat degraded, yet it remained unlike anything most of us had ever seen: Komodo National Park has more fish species than the entire Caribbean Sea, which is a thousand times its size. "Every time I bring people from the Caribbean here, I see their mouths drop open," recalled trip leader Mark Erdmann, a reef biologist who works as an advisor to Bunaken National Park in North Sulawesi. "This is the center of marine biodiversity—it's absolutely stunning to dive on an Indonesian reef, even a partially degraded

The Amazon of the Oceanic World

Indonesia's 17,000 islands harbor the planet's richest store of marine biological diversity. The region's coral reefs (shown in black) were mapped by the World Resources Institute. *Map reprinted with permission from WRI, Reefs at Risk, 1998. White marks added.*



one, and see how many forms are out there, how many species of practically any group you can think of. And if you're lucky enough to see an Indonesian reef that has not been degraded, it's just an awe-inspiring sight."

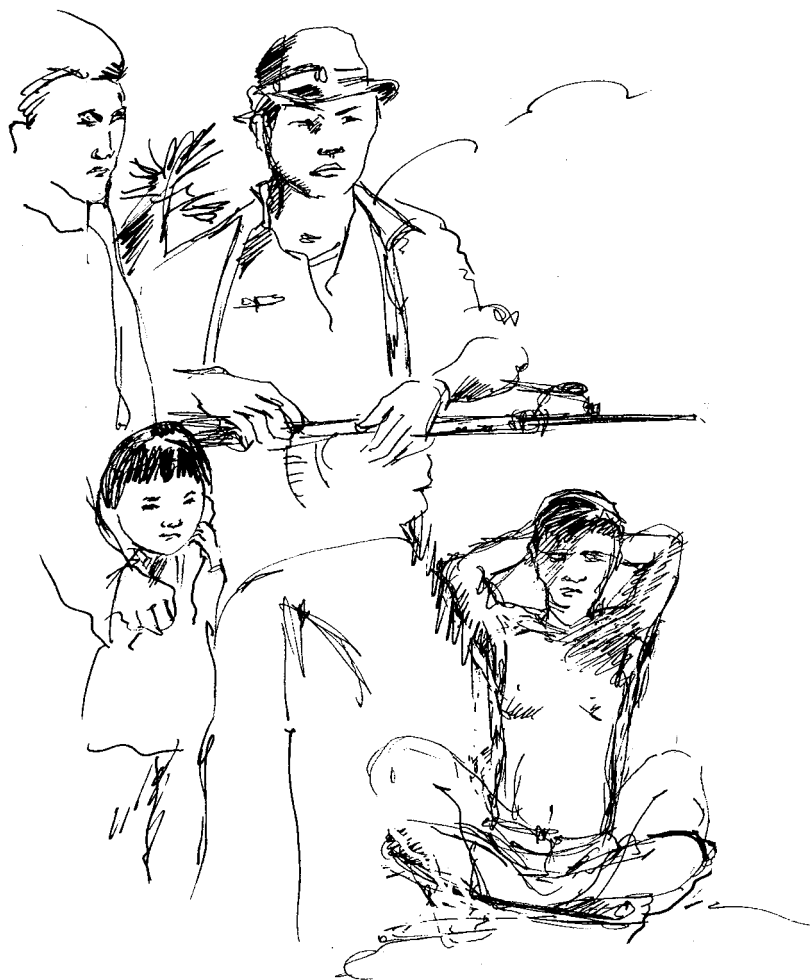
I had snorkeled and dived on a number of reefs in Indonesia, yet I, too, was mesmerized by the otherworldly, even psychedelic, wonders of Komodo. I saw things I'd only dreamed of seeing, like 15-foot-wide manta rays circling each other in slow banked turns: silent, living airplanes. Bumphead parrotfish—bigger than I—taking enormous, noisy chomps out of the reef and pooping out crunched-up coral (you call it sand). Bright orange soft corals waving gently in the current, their long-stemmed polyps slowly opening and closing like a baby's chubby-handed "bye-bye." I also saw many beautiful things I never knew existed: technicolor "sea apples" jamming their broccoli-like tentacles into and out of their red mouths; a red, white, and blue "fire urchin" scuttling across the seafloor with transparent, neon blue-spotted shrimp hitchhiking between its poisonous spines; a fuzzy, hot pink- and purple-striped "squat lobster" (a species not discovered until 1994, though it is common in Komodo). And the fish!—bannerfish, batfish, boxfish, butterflyfish, clownfish, lionfish, Picassofish, pufferfish, surgeonfish, triggerfish, trumpetfish, unicornfish.... Basically, put any noun before the word "fish," and Komodo probably has it.

While visiting snorkelers and scuba divers love to look at reef fish, Indonesians love to eat them: coral reefs provide 60 percent of the animal protein in the Indonesian diet. If it's not attached to the seafloor, odds are somebody eats it. Unlike Western attitudes toward seafood, the Indonesian view is that all this varied and bizarre sea life is just so much protein. Sea cucumbers, often seen drying in the sun on fishing boat decks and sidewalks, resemble nothing more than a cross between a water balloon and a human turd, and you couldn't pay me to eat one.

In eastern Indonesia's coastal communities, among the nation's poorest, fishing is both a way of life and a fallback when crops or other sources of food or cash fall short. Most of those who fish do so on a small scale, using simple, relatively harmless methods, but they have watched their incomes and food supplies diminish as the reefs they depend on get bombed and poisoned. Many of these people oppose the use of bombs and cyanide, which they understand are robbing them of their livelihood. But they have little ability or authority to stop the destruction, especially when government officials or powerful business interests are involved.

As I stand on the crowded concrete dock, looking in disbelief at the two fresh corpses laid out on bloody stretchers beneath traditional, oddly beautiful ikat blankets, the thought hits me: I am definitely not in Bali anymore. I am the only foreigner, and the only journalist, in the hushed crowd of a hundred people standing in the hot mid-morning sun. Here in the port town of Labuanbajo, on the island of Flores, just east of Komodo National Park, I am on the far side of both Wallace's Line and the line between happy tourist Indonesia and the decidedly more difficult nation most Indonesians inhabit.

I came down to the docks to meet a staffer from the Nature Conservancy's local office and head out in their speedboat to Komodo village, where I planned to interview some of the local people. But with the commotion on the waterfront, all plans are off. The word among the onlookers is that the two victims were deer poachers killed in a pre-dawn bomb and gun fight with authorities in the waters of the national park. I decide to play police-beat reporter to get the facts, just as I did a week earlier when authorities brought ashore two boatloads of reef bombers arrested in the park. Arrests under Indonesia's environmental laws are almost unheard of, but I happen to have landed in town just in time for two of the park's biggest busts on record. A new "floating ranger station" patrol boat, purchased and operated with funds



provided by the Nature Conservancy, a U.S.-based nongovernmental organization (NGO), and by local scuba dive tour operators, has quickly gotten results.

I try to interview various uniformed officials on the dock, but they all refuse to answer my questions. I try to take photos but am ordered not to by a soldier in an East Timor T-shirt. I decide it's a good idea not to make him angry.

Eleven other suspects, three of them wounded, are brought ashore, as well as their 24 hunting dogs and a number of dead deer, the main prey of the Komodo dragon. The uninjured suspects are stripped to the waist to mark them as prisoners. Police pose them for official photos around a severed deer carcass and make them crawl on their bellies or squat-walk, in front of the crowd, to the interrogation room. Last week's reef bombers had to walk around, hands behind their heads, while repeating, "*saya melakukan bom*"—"I use bombs." I get the impression that the credo of the local justice system is "humiliated until proven guilty." I wonder if this is what conservation is supposed to look like.

I slip unannounced into the interrogation room and observe unobtrusively—watching the suspects get slapped and threatened—until I am physically yanked out of the building. I spend the next two days trying to get someone from any of the agencies—the park, police, army, water police, forestry police—that operate the "floating ranger station" patrol boat to confirm the rumors I have been hearing about the case. (Indonesia is a nation of rumors, the result of

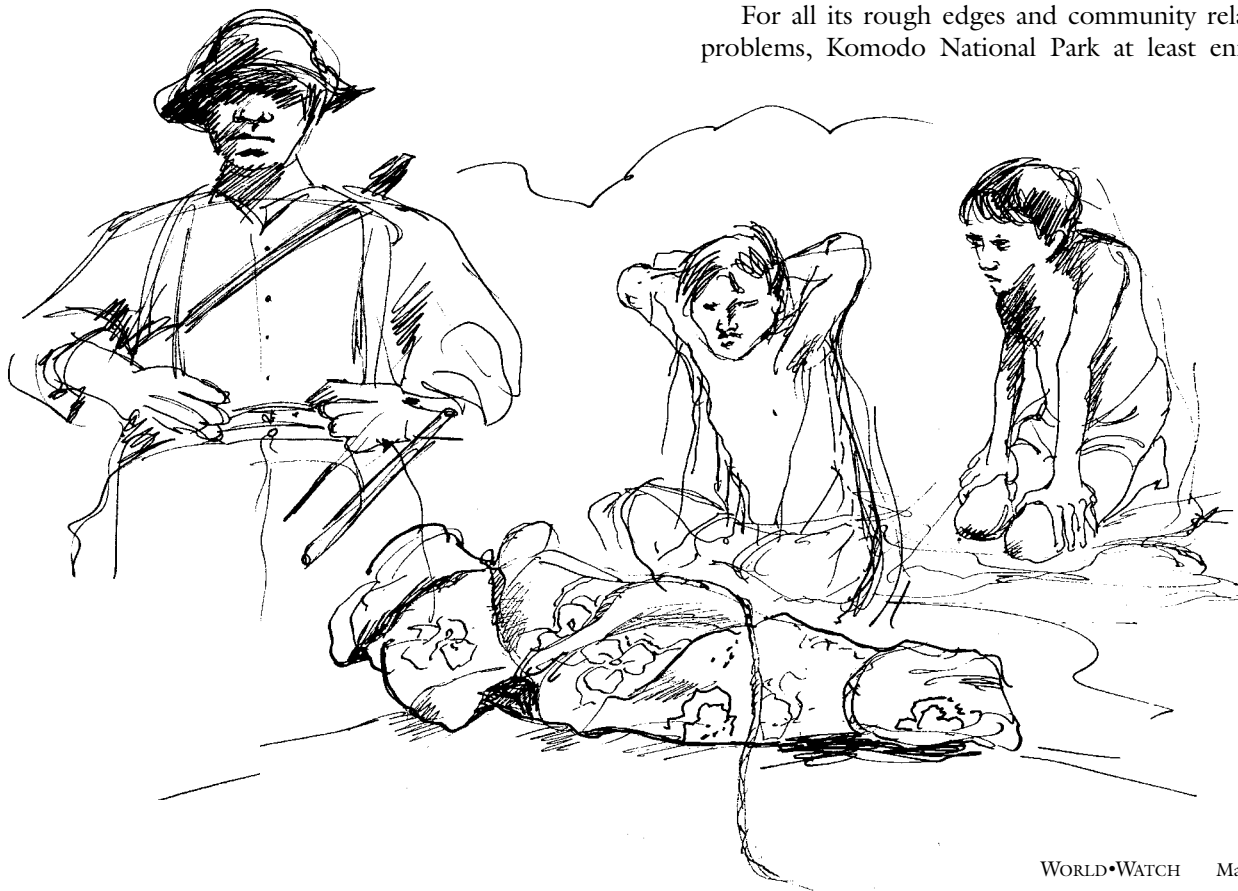
half a century's suppression of real news.) Whether they are hiding something or just being paranoid that a journalist might try to make them look bad in a sensitive case, I can't decide.

The next day, I finally get the police chief, and even the visiting Indonesian Minister of Forestry, to fill in the blanks and confirm that one of the victims, Musasini, was the reputed ringleader of a gang of both illegal hunters and coral reef bombers, long sought by police. In an account corroborated by a Nature Conservancy crewmember on board the patrol boat, officers chased the poachers for hours and only opened fire after the fleeing poachers threw homemade bombs at them. The Minister of Forestry, Nurmahmudi Ismail, who has authority over all national parks, defends the patrol's actions: "Because the hunters ignored warnings and even attacked the police, yesterday's actions had to be taken. If you want to call that a human rights violation, go ahead."

Though I remain troubled by the police practices I witnessed on the dock, in the end, I agree with the Minister's assessment.

But in Labuanbajo, though many local people support the park, gossip and innuendo fly about after these big arrests. Some fishermen claim that police fabricated the story of the bomb fight. A legislator from Sape, home of the reef bombers, threatens violence if their confiscated air compressors are not returned. A mob, reportedly instigated by a local cyanide fishing kingpin, prepares to attack the office of the Nature Conservancy for its role in helping authorities shut down illegal fishing.

For all its rough edges and community relations problems, Komodo National Park at least enforces



environmental laws, a rarity in a nation with very limited budgets and seemingly unlimited corruption. Just months before the Komodo busts, reef patrols in North Sulawesi's Bunaken National Park, funded by a voluntary tax of \$5 per scuba diver, made the nation's first big busts for bomb fishing. "Now people in villages all throughout North Sulawesi are demanding better enforcement," according to Mark Erdmann. Komodo's boat patrols, paid for by the Nature Conservancy's Indonesia Program, have reduced fish bombing in the park by roughly 80 percent.

Villagers in the Komodo area, like most rural Indonesians, are very poor. Malaria and diarrhea are rampant. Most children do not finish elementary school. Though many tourists pay great sums to visit the park and to stay on deluxe live-aboard dive boats, little of their money trickles down to the village level. Most of what did trickle down has dried up: tourism in Komodo has fallen by more than half in the wake of political unrest in other Indonesian provinces since 1997.

Given the economic chasm between their world and that of a wealthy American NGO, it's hardly surprising that locals might resent the Nature Conser-

vancy with its high-powered speedboat that blows by everything else in the water and its array of almost impossibly high-tech equipment—like satellite-linked electronic tags for studying manta rays. And the group has a long record of doing science and reserve management with greater ease than working with local communities.

Yet its work helping protect the park's reefs is absolutely vital for the region's economic future. A healthy reef provides ten times as much fish as a degraded one; experience around the world has shown that protecting part of a reef from fishing (not to mention bombing) is the surest way to let fish populations, and fishing economies, bounce back. Absent the bomb-stopping patrols, fishing communities around Komodo face a bleak future. Throughout eastern Indonesia, many fisheries have already collapsed. Reef bombers and other fishers often travel hundreds of miles, even to Australian waters, on month-long trips, in search of healthy fishing grounds.

But for the time being, the wages in destructive fishing, and the incentives to break little-enforced laws, remain tremendous. "Destructive fishers here make a lot of money," Mark Erdmann explains. "They are not poor fishermen who've been forced into doing bombing and cyaniding because they have no alternatives. They're typically younger men, 15 to 25, going out and doing something which is inherently dangerous—you can easily kill yourself with homemade bombs, or squirting cyanide, or doing a lot of deep diving." It makes providing economic alternatives next to impossible, according to Erdmann. "What are you going to give a sixteen-year-old kid who makes four times as much as a high-ranking government official?"

For now, coral reef conservation in eastern Indonesia is mostly focused on protecting reefs inside the region's few marine protected areas. Thanks largely to the intensive and top-down park management funded by outsiders, Komodo National Park is an oasis of life in what is rapidly becoming an underwater wasteland of rubble fields and reefs emptied of the once-ubiquitous clouds of fish hovering above them. Indonesia would benefit greatly from additional marine parks, yet reef conservation has to move beyond national parks to be effective. Without attention to the reefs and people outside parks, the pressure for fishers from all around to abandon their emptied fishing grounds and pounce on protected reefs may be inescapable, according to Imran Amin, a marine specialist with TELAPAK, an Indonesian NGO. "Our concern is that coral reef conservation is not a local problem but a regional problem. It's not limited by any national park boundary, but by the region wherever people who interact with the reef live," he says.

The threats confronting Indonesia's coral reefs—bombs, poisons, overfishing, and climate change, to name a few—are as great as ever. But the climate for



conservation may be better than ever, too. Even as late as the mid-1990s, few outside conservationists or funders paid any attention to the archipelago's underwater wealth; they focused instead on its rapidly disappearing rain forests. But by decade's end, many governments and NGOs had recognized that what the Amazon is to land habitats, Southeast Asia is to the sea, and had started to work toward protecting this global treasure.

The greatest opportunity may be the birth of the world's third-largest democracy and the new Indonesian government's commitment to decentralization. A new regional autonomy law, which went into effect in January of this year, has begun to transfer much of the authority of the Jakarta government to the 27 provinces and the 340 sub-provincial regencies. The push to decentralize provides hope that local people, who are in the best position to manage their local waters, may gain a greater say in the management of the reefs they depend on. Along these lines, Blongko, a fishing village in North Sulawesi, created the nation's first community-run marine reserve in late 1998, with technical assistance from the Indonesian and U.S. governments. Two other North Sulawesi villages followed suit in 2000, and many others in the province want to do the same. "We started the sanctuary to bring the fishing back to how it was in the past," explains Blongko's new village head, Dolvi Janis. "Now, for the first time in years, we can even cast a line from the beach near the sanctuary and catch a pelagic [open-ocean] fish."

There is no guarantee that decentralization will benefit Indonesians or their ecosystems. One concern is that provincial and local governments generally have less coastal management capacity than does the national government. Some observers fear *Reformasi* will do nothing to break abusive powerholders' grips on local economies. According to Celia Lowe, a University of Washington anthropologist who works with fishing communities in Sulawesi's Togean Islands, "we've gone from Soeharto to 27 different provincial Soehartos. I don't see any major changes in the thinking behind the Indonesian government's activities."

But it's clear that empowerment of local people must be part of the answer. There's no going back to the discredited top-down approach of the Soeharto era, effective at one thing only: enriching a few hundred officials and tycoons at the expense of current and future generations of Indonesians. Or as biologist Anugerah Nontji of the Indonesian Institute of Sciences puts it, "in a country like Indonesia it is not practical, cost effective, or appropriate to have a top-down approach in which the government provides and implements all the management."

Throughout Wallacea, there is no shortage of local people with the desire, and much of the expertise, necessary to manage and conserve coral reefs. I've been



fortunate to meet a number of them over the years. One is Pak Ely of Saparua Island in the Moluccas, a tribal leader whose family has been administering his village's *sasi* system—regulating fisheries, protecting sacred streams, keeping destructive fishers away from local reefs—for seven generations. Another is Pak Ahmat, a fisherman from the Togean Islands, who patrols local reefs against bombers and shows off his catch and his choice of gear for me: small hooks with bits of colored string attached: so simple. "We don't use bombs, just these hooks, and we don't hurt the coral," he explains with pride. And, of course, there are the rangers of Komodo National Park, their boats riddled with bullet holes.

Mark Erdmann recalls his recent experience setting up no-fishing zones in Bunaken National Park: "The last six months of working with villagers in Bunaken has made me an optimist. Indonesians are very close to the land, close to the sea. They understand that a small young fish doesn't produce many eggs, and they're willing to give it two or three years to see results. They're much more patient than Americans."

Activist Nina Dwisasanti of WWF-Wallacea is also optimistic, though she acknowledges *Reformasi* cuts both ways. "We in the NGO community have to race with the many investors who see decentralization as an opportunity to exploit the country's natural resources faster than ever. But there are so many recent examples of local communities, often with NGO help, organizing to protect their reefs from outside threats. With the brand-new flowering of NGOs operating now under our new more democratic system, I am optimistic for the future of our coral reefs."

Environmental journalist and former Worldwatch Institute researcher John C. Ryan is the author of several books, including *Seven Wonders: Everyday Things for a Healthier Planet*. He lives in Seattle.

A Worldwatch Addendum

On a global scale, add climate change, coral mining, toxic dumping, and overfishing to the phalanx of forces destroying coral reefs.

by Lisa Mastny

AS OF LATE 2000, AN ESTIMATED 27 percent of the world's coral reefs were severely damaged, according to the Global Coral Reef Monitoring Network. In 1992, the figure was only 10 percent, so the health of reefs is deteriorating quickly. The greatest losses have occurred in the Indian Ocean, in the Arabian Sea and Persian Gulf, and in Southeast Asia. (See table, opposite.)

More than 100 countries—many of them small islands—rely on coral reefs for essential goods and services valued at some \$375 billion a year. Reefs shelter coastlines from storm damage, erosion, and flooding, providing protection and other benefits for an estimated half-billion people. They are important feeding and breeding grounds for commercial fisheries, producing roughly a tenth of the global fish catch and a quarter of the catch in the developing world. Reefs also generate significant tourism revenue, with Caribbean reefs alone bringing in some \$140 billion annually.

Coral reefs cover less than 0.2 percent of ocean area, but are among Earth's most complex and productive ecosystems. The unique assemblages of tiny coral animals and symbiotic plants provide habitat for as many as 1 million species—including more than a quarter of known marine fish species. Reef-derived molecules have been used to develop medicines from antibiotics to HIV drugs.

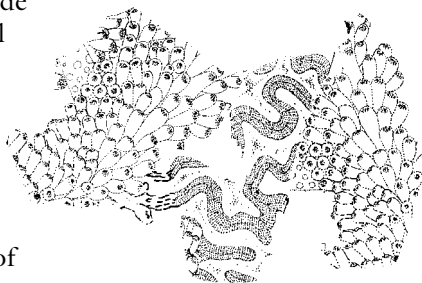
An estimated 11 percent of the world's coral reefs have been lost as a result of direct human pressures. These include fishing and coral mining, coastal development, waste dumping, vessel collisions, and inland deforestation and farming, which can cause runoff of harmful nutrients and sediments. Such activities now threaten nearly 60 percent of all reefs.

The booming demand for reef species for food and for aquariums has depopulated many coral ecosystems. In Southeast Asia, live reef fish exports jumped nearly 13-fold between 1989 and 1995, then dropped 22 percent in 1996—a crash attributed to overfishing. Worldwide, a survey of reefs in some 40 countries in 1998 found that many high-value species, such as lobster, grouper, and giant clams, were missing from areas where they were once abundant.

Fishers often use methods that are highly destructive to reefs. In Southeast Asia, “blast” fishers set off as many as 10 separate explosions to obtain 1 ton of fish, shattering up to 20 square meters of reef per blast. This practice has degraded an estimated 75 percent of Indonesia's reefs. And in the Philippines, more than a million kilograms of cyanide have been injected into reefs since the 1960s—a procedure that stuns or kills many nontarget species as well. Powerful trawlers can also devastate reefs, removing up to a quarter of seabed life in a single pass.

But the greatest threat to coral reefs today is global warming. Reefs live at the upper edge of their temperature tolerance, making them good indicators of climate change. Warming of a little as 1 degree Celsius above normal can stress the microscopic plants that inhabit the tissue of corals and provide them with food and color. If the stress endures, the corals expel the plants and turn white, often eventually dying.

Such “coral bleaching” events have increased in frequency and intensity since the early 1980s. In 1997–98, a combination of El Niño/La Niña-related climatic changes and record-high tropical sea surface temperatures caused the worst episode on record, affecting some 16 percent of the world's reefs, in at least 60 countries. Indian Ocean reefs alone suffered damages



estimated as high as \$8.2 billion. In some areas, 1,000-year-old corals died and losses neared 90 percent, at depths nearing 40 meters.

About a third of the bleached reefs show early signs of recovery, having retained or recruited enough live coral to survive. Roughly half could rebound in the next 20–50 years—if ocean temperatures remain steady and human pressures are low. But if the warming continues, scientists predict that as many as 60 percent of all reefs could be lost by 2030. Mass bleaching events could begin to occur annually by then, offsetting any real reef recovery. Moreover, some corals may already have exceeded their capacity to adapt to warmer waters, and rising ocean carbon dioxide levels could further impede coral growth.

As reef loss worsens, partnerships like the International Coral Reef Initiative, the International Coral Reef Action Network, and the Coral Reef Alliance are working to raise awareness, promote conservation, and assess threats. Another global project, Reef

Check, enlists sport divers and locals to conduct annual reef surveys.

Innovative strategies are also emerging in developing countries, which typically lack the resources for effective reef protection. In Bonaire, a \$10 dive tax brings in \$170,000 annually, helping to pay for rangers and educational materials. And in one Indonesian park, a new reef patrol has helped reduce blast fishing by 80 percent since 1996.

Another key solution is creating marine reserves where activities like fishing and anchoring are banned. The United States plans to protect a fifth of its reefs in such reserves by 2010. But such actions may prove futile without parallel efforts to reduce emissions of climate-altering greenhouse gases.

Reprinted from the Worldwatch Institute annual *Vital Signs 2001* (New York: W.W. Norton & Company, 2001) available late May, 2001.

Status of Coral Reefs Around the World

Location	Share Destroyed (percent)	Condition of Reefs
Southeast and East Asia (30 percent of total reef area)	34	Reefs in southern Japan, Taiwan, Vietnam, and parts of the Philippines and Indonesia hit hard by the 1998 bleaching, with losses of 30–90 percent in areas. Remote reefs have a fair chance for slow recovery. Others face serious human pressures: Indonesia, home to 14 percent of the world's reefs, has lost roughly half its reefs, mainly to blast and cyanide fishing.
Pacific Ocean (25 percent)	4 in Australia and Papua New Guinea; 9 in rest of Pacific	Reefs generally in good condition. Palau and inshore areas of the Great Barrier Reef saw extensive bleaching in 1998, though recovery is reported in both areas. Central and Southeast Pacific reefs largely escaped this event. In early 2000, bleaching in the Solomon Islands and Fiji affected some 65 percent of Fiji's reefs, killing at least 15 percent. Other threats include development, sediment and nutrient runoff, overfishing, and predation by crown-of-thorns starfish.
Indian Ocean (24 percent)	59	The 1998 bleaching caused widespread damage, particularly in the Maldives, Sri Lanka, and parts of western India. Reefs off Kenya, the Seychelles, Tanzania, and Comoros saw live coral losses of 80–90 percent. Also serious damage from pollution, coral mining, and overfishing. Reefs not affected by human pressures have a fair chance for recovery—with some early evidence of this in East Africa, the Seychelles, the Maldives, and the Lakshadweep Islands.
Caribbean Sea and Atlantic Ocean (15 percent)	22	Caribbean reefs experienced extensive bleaching in 1998, but many have shown near full recovery. Greatest threats are from overfishing, sedimentation, pollution, and coral disease. In the Florida Keys, live coral now covers only 5 percent of the surface area of the largest reef, down from over 50 percent in 1975. Reefs off Central America suffered mass bleaching in 1995 and 1998, as well as damage from Hurricane Mitch in 1998.
Middle East (6 percent)	35	Nearshore reefs in the Arabian Sea and Persian Gulf virtually wiped out by bleaching in 1996 and 1998. Low chance of short-term recovery. Northern Gulf affected by bleaching in late 2000. Red Sea reefs remain healthy, but are threatened by tourism, oil development, and shipping.

Source: *Conservation Biology* (October 5, 2000); *Environmental News Network* (April 26, 2000); *Environmental News Service* (October 27, 2000); *Nature* (May 4, 2000); *Reef Relief* (www.reefrelief.org, December 12, 2000); *Science* (May 12, 2000); and other sources compiled by Worldwatch.