SECOND ACT

Forest ecologist Robin Chazdon is helping show that regenerating tropical forests aren't wastelands

By **Elizabeth Pennisi**

When ecologist Robin Chazdon began studying tropical forests in the 1990s, she took the road less traveled. Whereas many researchers were scrambling to study undisturbed forests before they disappeared, she focused on what grew back once the trees were burned or logged. Rather than working in the forest's shaded understory, an ecosystem celebrated in Hollywood films, she labored in scraggly deforested plots in the broiling sun, covered head to toe to keep prickly bushes and biting chiggers at bay.

For decades, Chazdon worked in relative obscurity, barely scraping together funding for long-term studies of these so-called secondary forests. Her findings challenged some prevailing views: that tropical forests wouldn't regenerate, and that second growth was a biological wasteland. And over time, Chazdon and like-minded colleagues began building a case that, although protecting intact tropical forest was essential, second growth couldn't be ignored in efforts to protect the environment and human livelihoods. Secondary forests are "very dynamic places where nature is reasserting itself," Chazdon says. "It's an elegant thing to behold."

The rest of the world is beginning to see her point. Chazdon has "done a huge amount to elevate the visibility of secondary forests," says tropical community ecologist Stephen Hubbell of Princeton University. Now that humanity has cleared or damaged at least three-quarters of the world's primary forests, governments and conserva-

PHOTO: JOANNA B. PINNEO

Robin Chazdon made a career of studying tropical secondary forests, but she feels just at home in this regenerating forest on her family ranch in Colorado.

tion organizations are increasingly turning their attention to the "junk" that regrows. Thanks in part to Chazdon's work, many now see secondary forests as key to restoring biodiversity and performing important ecosystems services, such as providing clean water and sequestering carbon. And last year, nations attending a United Nations climate conference set a goal of reforesting 350 million hectares of degraded land—an area larger than India—by 2030.

Reaching that goal, however, will require resolving some thorny issues. Some advocates insist "reforestation" should mean recreating, as closely as possible, the original forest. But others think planting rows of oil palms or timber trees should qualify. There are also disagreements over which areas should be targeted for reforestation, and whether people can and should accelerate the process with costly tree-planting programs. Some worry that efforts to promote second growth could undermine efforts to preserve intact forest.

For Chazdon, 58, the rising interest in secondary forests has prompted a second act of her own. After 27 years as an academic at the University of Connecticut (UConn), Storrs, she's taken a leave of absence, moved to Colorado, and shifted much of her attention from collecting and analyzing data to influencing policy—most notably in Brazil, which has made tropical reforestation a centerpiece of its efforts to combat climate change. "She has the drive, the personality to be a major player" in policy, says Peter Raven, president emeritus of the Missouri Botanical Garden in St. Louis.

But Chazdon is aware of the risks. She worries that policymakers might think she's been in the ivy tower too long, whereas scientists might look askance at her entanglement in policy. She'd like to make policy work her full-time job, but has no offers yet. "I'm facing a very uncertain next few years," she admits. "And that's weighing heavily."

STROLLING THROUGH A WOODED GLEN on the family ranch 2 hours southwest of Denver, Chazdon examines the new growth on a chest-high lodgepole pine. She impulsively gives the young tree a hug, telling it that despite the risk of drought and disease, it may one day be a giant. She identifies with a forest, she says: "When I just stand in there, I can feel the photosynthesis flowing."

That affinity developed early. Despite growing up in Chicago in the late 1960s, family camping trips and summer camps turned her into an environmentalist. She fell in love with the tropics after a field course in Costa Rica in 1976, her sophomore year of college. "I felt like it was a second home," she recalls. "That was very empowering."

As a graduate student at Cornell University, she returned to Costa Rica and did her dissertation research at La Selva, a field station run by the Organization for Tropical Studies. Trying to understand how understory palm trees could grow in the deep shade of a mature rainforest canopy, she spent days using a homemade sensor to measure the light that filtered through the leaves. She discovered that flecks of sunlight were the secret to palm success: Eighty percent of the plants' productivity was fueled by these temporary patches of light.

Her studies of photosynthesis continued for years, but each time she returned to Costa Rica, more forest had disappeared, cleared by loggers, farmers, and developers. So once she moved to UConn in 1989, she decided to shift gears. Chazdon and Julie Denslow, an ecologist who studied forest dynamics and is now with the U.S. Forest Service's Pacific Southwest Research Station in Hilo, Hawaii, began to track how shrubs and trees were returning to plots on abandoned pastures purchased by La Selva and on nearby farms. The work would ultimately lead to a landmark 25-year project.

At the time, many ecologists doubted a tropical rainforest would ever grow back—they thought the soils were too fragile and would erode away before new roots could take hold, or too nutrient-poor to sustain regrowth. In La Selva, however, Chazdon and her colleagues found that tropical forests can make a comeback. They documented that, gradually, biodiversity returns, with a mix of plants reestablishing the understory and canopy layers that support key ecosystem services. Even species with commercial potential can regain a foothold.

A site's "ecological memory" helps shape what returns. Residual seeds that survive in the soil, waiting for a chance to sprout, are part of this biological memory bank, as are trees that remain standing nearby. Visits by bats, birds, and other seed dispersers also play a role in determining which plants reemerge, as does the site's history of use.

After a forest is cleared, a few remaining trees, such as those in this Costa Rican pasture (left), can help promote the return of a relatively diverse forest (right) once the pasture is abandoned.

At the time, few paid much mind to these findings: Tropical plant succession wasn't a sexy topic. So attracting funding was a challenge. "We don't do secondary forests," one funder told Chazdon as she scrambled to find money after a grant from an early backer, the Andrew W. Mellon Foundation, expired. They were "too messy," said another. "That was the low point," Chazdon recalls. Still, she persevered, often with her husband, the recently retired ecologist Rob Colwell, and their two children in tow.

In 2007, just when she thought she had finally exhausted her funding opportunities, she enlisted Brazilian and Mexican researchers in a successful bid for a National Science Foundation (NSF) grant. In part, it aimed to use what had been learned over decades in La Selva to examine the validity of a common, less time-consuming approach to studying forest regrowth, known as "chronosequence" studies. Unlike long-term projects that track changes at a single site for

PHOTOS: (LEFT TO RIGHT) BRYAN FINEGAN; ROBIN CHAZDON

decades, chronosequence studies—which have become a backbone of regeneration science—take a simultaneous snapshot of a set of plots in the same area, each at a different stage of regrowth. The goal is to get a quick read on how local forests might regenerate—without waiting years for the answer. "The assumption is that what's happening in the younger forest [plots] is what happened in the older forest [plots]," says forest ecologist Jess Zimmerman of the University of Puerto Rico, Río Piedras, another pioneer of studying tropical secondary forests. The long-term studies indicated that young forest plots did not necessarily reflect what older forest plots were like in their past. So researchers need to be careful about the conclusions they draw from chronosequence studies, the researchers concluded in June in a paper published online in the *Proceedings of the National Academy of Sciences*.

Chazdon says the work underscores perhaps the most important message to emerge from La Selva and related studies: that each regenerating site "tends to have its own path," even when they share similar soils and climate. That's because chance plays a big role in what regenerates in the forests both short- and long-term. The research shows "you can reforest," says Stefan Schnitzer, an ecologist at Marquette University in Milwaukee, Wisconsin, "but you still don't know what you will get."

As policymakers come to grips with that ecological uncertainty, they are finding Chazdon's recent book, *Second Growth: The Promise of Tropical Forest Regeneration in an Age of Deforestation* (University of Chicago Press), all the more valuable. Five years in the writing and published last year, the tome is a kind of guide to restoration, synthesizing decades of research and explaining how tropical forests can come back on their own—and what to do if they don't. "It's an opus; it covers all you would want to know and could imagine you want to know about secondary forests," says Thomas Rudel, a rural sociologist at Rutgers University, New Brunswick, in New Jersey. "There's nothing quite like [it]."

THE BOOK, *SECOND GROWTH*, ARRIVED at a timely moment, just as large-scale forest restoration was gaining momentum. In 2010, nations that had signed the United Nations' Convention on Biological Diversity set a goal of restoring 15% of the world's ecosystems by 2020. The following year, ministers from many countries issued the Bonn Challenge, which called for widespread reforestation. Then at last year's U.N. meeting, they upped the ante in a statement known as the New York Declaration on Forests, setting the 350-million-hectare goal. "I was

For decades, researchers have periodically measured the trees in this regenerating Costa Rican forest to learn how forests grow back. The data could now prove useful for global reforestation efforts.

PHOTO: ROBIN CHAZDON

thrilled—the international dialogue is not just about deforestation anymore," Chazdon says. "It changes the vision."

But the new vision is still blurry—and Chazdon thinks she can help achieve clarity. The Food and Agriculture Organization of the United Nations' official definition of reforestation is "very imprecise," she notes. By its criteria, replacing a natural forest with plantations of introduced trees to make fuel and wood, or soak up carbon, could qualify as reforestation.

Not surprisingly, many conservationists oppose that idea, arguing that monocultures provide fewer of the ecological benefits of less homogenized forests. "Such projects have a long history of failure and they do nothing to restore 'health' to forests," Hubbell argues. Some advocates say projects should count in official tallies only if they aim to restore a forest to some original state—typically a long and difficult task.

Chazdon isn't a big fan of monoculture plantations, but believes that to reforest "is not just to create a forest like before." There are now too many people in need on the planet to allow for the return of unmanaged forests in very many places, she says. And she notes that the discovery of ancient pottery shards and earthworks in tropical forests once considered pristine shows that people have long played a role in shaping landscapes. "I used to be a little bit more idealistic," she says. "But it's not realistic to have it all natural forest."

Reforesters face another pressing question: to plant or not to plant. There's a long history of planting trees to speed the process along, Chazdon notes. But her work has shown that, if left alone, some forests come back on their own—with less effort and cost. And although active managers often replace mixed forests with a single species, or introduce exotic species, she notes that more passive strategies can restore something closer to the original species mix.

Chazdon concedes that natural regeneration can be a long process. It "isn't just a Band-Aid for a photo shoot after 2 years," she says. And she notes that it may make sense in some places to plant some native species, particularly commercially valuable ones, to kick-start regeneration—in part to give local people a greater financial incentive to protect nascent forests. "We must meet the needs of the people or we are not going to be able to protect the landscape," she argues.

Chazdon's approach has attracted particular attention in Brazil, where Environment Ministry officials have pledged to reforest some 12 million hectares of land as part of the nation's climate commitments. With official support, she'll be spending at least 3 months a year in Brazil, helping researchers and policymakers figure out how best to harness passive reforestation approaches. "Before we spend a lot of money on active restoration, let's first take advantage of the free help of nature," says ecologist Pedro Brancalion of the University of São Paulo, who is involved in the effort.

DECIDING EXACTLY WHERE to grow new forests is another source of friction. Since 2009, the World Resources Institute (WRI), an influential think tank based in Washington, D.C., together with researchers at the International Union for Conservation of Nature and the University of Maryland, have been developing global and regional maps that highlight more than 2 billion hectares of land that could be reforested. When Chazdon borrowed the maps and displayed them at a workshop last year, however, some researchers were stunned—and infuriated. That's because the maps identify some endangered grassland ecosystems, including portions of Africa's savannas, as having "high reforestation potential." (That's because they, too, have climates suitable for trees.)

The maps "provided a clear illustration of the fact that grassy biomes are undervalued and misunderstood as 'degraded' ecosystems," says one critic of the effort, ecologist Joseph Veldman of Iowa State University in Ames. Earlier this year, he, University of Cape Town vegetation ecologist William Bond, and others criticized the map in a letter to *Science* (30 January, p. 484), and they have another critique in press at *BioScience*.

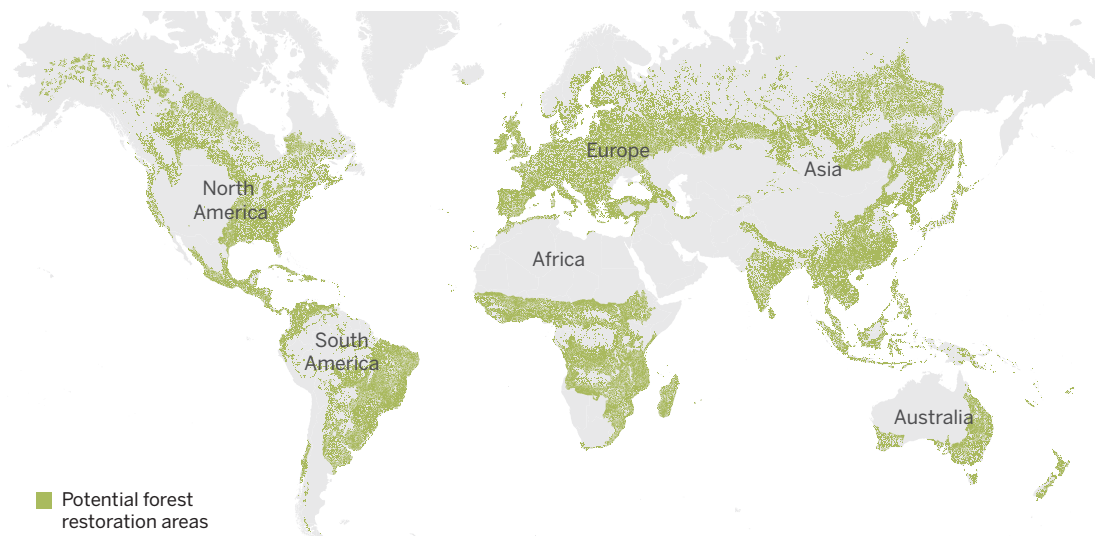
Chazdon would like to see the maps reworked and has been corresponding with both sides toward that goal. In the meantime, she's busy trying to catalyze discussion and consensus elsewhere. She and two colleagues have founded People and Reforestation in the Tropics, an NSF-funded networking effort aimed at getting policymakers, landowners, and scientists talking about what reforestation means, how to implement it on a large scale, and how to monitor the impact on local people.

It's a potentially contentious conversation, but colleagues believe she's got the people skills to hold her own—and produce results. "She has the rare ability to bring disparate communities together around a common cause," says Toby Gardner of the Stockholm Environment Institute. "She's standing with two feet in science, but she communicates it in a way that policy people like me can use," says Lars Laestadius, a senior associate at WRI.

For Chazdon, the dive into policy is a chance to put decades of science to practical use—and to try to make sure that reforestation is done right. And it is rooted in her belief that once-ignored secondary forests can play a phoenixlike role in restoring global forest health. "Things are dying and things are coming back to life at the same time," she says. "It fills me with a lot of hope." ■

Where new forests can grow—but should they?

More than 2 billion hectares of land have potential for reforestation, according to a map compiled by the World Resources Institute and other groups. But some scientists worry the map could promote the replacement of grasslands and other ecosystems with trees.



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