

# Vanishing Biodiversity

## IS SPECIES LOSS APPROACHING A “TIPPING POINT”?

**E**arth's biodiversity — the profusion of plants and animals that work together to support life — continues to shrink. Species are going extinct at a rate most scientists find alarming — possibly as many as 150 a day — while the populations of many surviving species are declining rapidly. Endangered species range from plants and large animals such as tigers and rhinoceroses to smaller creatures such as insects and honeybees. All play key roles in sustaining healthy ecosystems, which provide a variety of costly environmental services for free, such as filtering water and scrubbing carbon from the air. Some researchers believe the Earth could be approaching a so-called tipping point, in which biodiversity loss causes global ecosystems to change rapidly and dramatically, but other scientists doubt the theory. Meanwhile, there is widespread concern about humanity's ability to sustain itself in a world of diminishing biodiversity if the global population reaches 9.5 billion by 2050, as is projected. While many more areas are being protected today than in the past — including the bio-rich Amazon rainforest — conservation efforts are not keeping up with the loss of biodiversity.

A keeper at the Singapore Zoo examines a majestic rare African white rhino on July 17, 2012. The huge creatures are on the verge of being threatened with extinction due to poaching. Their horns are used for medicinal purposes in Asia and for ornamental dagger handles in the Middle East.



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# Vanishing Biodiversity

BY REED KARAIM

## THE ISSUES

As scientists study the web of life that makes up Earth's shrinking biodiversity, they continue to find unexpected connections. Consider the sea otter and climate change.

A small marine mammal that lives in the frigid northern Pacific coastal waters, the sea otter has the densest fur in the animal kingdom, with up to a million hairs per square inch.<sup>1</sup> Sea otter fur was so prized they were hunted to the brink of extinction in the early 1900s, when only about 2,000 remained.<sup>2</sup> Thanks to changing fashions and conservation efforts, the sea otter population has recovered to number in the tens of thousands, although it's still far below what it once was.

Once their fur was no longer cherished, sea otters were seen merely as cute, playful creatures — until recently.

A new study indicates that the sea otter plays a measurable role in fighting global warming. Researchers at the University of California, Santa Cruz, found that the otters helped to protect Pacific seaweed forests by eating kelp-loving sea urchins.<sup>3</sup> Kelp consumes carbon dioxide (CO<sub>2</sub>), a principal contributor to global warming. By eating the sea urchins, the otters enable kelp forests to process up to an additional 9.6 million tons of carbon dioxide a year, the researchers found.<sup>4</sup>

“From the perspective of trying to mitigate climate change, all the focus has been on [CO<sub>2</sub>-consuming] plants — managing forests, that sort of thing



Commuters use a boat bridge in Dhaka, the capital of Bangladesh, where the Buriganga River is clogged by invasive water hyacinths. The dense foliage of the rapidly growing plant covers the river's surface, blocking light, killing native species and destroying the fragile food web. Non-native species like the hyacinth are disrupting ecosystems and threatening plants and animals around the world.

AFP/Getty Images/Munir uz Zaman

— but this indicates that animals might have a strong impact on the carbon cycle. There might be win-win conservation-climate change scenarios,” says assistant professor of environmental studies Chris Wilmers, the study's lead author.

The sea otter study is one of several recent reports that are deepening scientific understanding of the importance of biodiversity and how humans affect it. For years, conservation biologists and other scientists have reported that the Earth is losing plant and animal species at an alarming rate. One new study, published in *Nature*,

raises the possibility the planet is nearing a “state shift,” or tipping point, in which the global ecosystem changes dramatically.<sup>5</sup>

Other recent research has taken a closer look at humanity's dependence on healthy ecosystems for everything from the food we eat to the water we drink and the clean air we breathe.<sup>6</sup>

“When we look at the bigger picture, we discover we depend on a whole lot of species,” says Michel Loreau, director of the Centre for Biodiversity Theory and Modelling in Moulis, France.

Conservationists have made progress in some areas, including the Amazon, where forest clearing has slowed. “There's a lot more good news than people think,” says Stuart Pimm, a conservation biologist with Duke University in Durham, N.C., and the University of Pretoria in South Africa. “Globally, for example, we've reduced the rate of bird extinctions to about a quarter of what it would have been if we hadn't bothered.”

Yet, overall, the Earth is still losing species. From large animals such as tigers and rhinoceroses to insects and plant varieties, populations are declining, and many species are believed to be going extinct. Estimates have ranged as high as 150 to 200 species a day, although some researchers believe the number could be significantly lower.<sup>7</sup> Part of the problem: No one knows how many species exist on Earth; estimates range from 2 million to 100 million.<sup>8</sup>

Scientists, however, can use the fossil record to compare the normal “background” rate of extinctions with the rate of recorded extinctions in

## Most Threatened Species Are in Asia, Western Hemisphere

More than 900 species have gone extinct worldwide in the last 500 years, and more than 10,000 are in danger of extinction, according to the International Union for the Conservation of Nature. Ecuador, which is rapidly losing its biodiversity-rich rainforests to oil exploration, logging and road building, has the world's largest number of species threatened by extinction. Indonesia, India and Mexico have the most endangered mammals.

### Countries with the Most Threatened Species



Source: "Threatened species in each country," "Red List," International Union for the Conservation of Nature, 2012, [www.iucnredlist.org/documents/summarystatistics/2012\\_2\\_RL\\_Stats\\_Table\\_5.pdf](http://www.iucnredlist.org/documents/summarystatistics/2012_2_RL_Stats_Table_5.pdf). Map by Lewis Agrell

more recent times. "We know the current extinction rates in the last four centuries are about 100 to 1,000 times higher than the background rates," says Loreau. Some projections, he says, show the Earth soon reaching extinction levels that are "10,000 times the background rates."

A few analysts are skeptical of such claims and even doubt a biodiversity crisis exists. Others believe the key to healthy ecosystems isn't the diversity of species but the health of key plants

and animals. However, the level of biodiversity loss most experts see is alarming enough that many believe the planet is experiencing the "sixth great extinction" in Earth's history. But unlike previous mass extinctions, which were caused by natural disasters, this one largely is the work of humans, they say.

Researchers say there are five principal causes of biodiversity loss:

- Shrinking or fragmented natural habitat, largely caused by humanity's growing footprint;

- Overuse, such as commercial fishing that has depleted bluefin tuna and other key marine species;

- Poisoning through pollution or agri-chemical runoff;

- Invasive species, often carried by humans into areas where they overwhelm native populations;

- Human-caused climate change.<sup>9</sup>

All the causes are tied to the rapid growth of population, expected to reach 9.5 billion by 2050. "Ultimately, it all comes back to how many people

there are on Earth, and how much of the resources each of those people uses,” says Anthony Barnosky, a professor of integrative biology at the University of California, Berkeley, who was lead author on the “state shift” study published in *Nature*.

The World Wildlife Fund (WWF), an international conservation group, has taken a leading role in tracking the state of biodiversity through its annual “Living Planet” report. The group’s 2012 edition found that biodiversity has declined globally by around 30 percent between 1970 (the year the WWF began keeping track) and 2008.<sup>10</sup> The loss has been worst in the tropics, the richest storehouse of life on the planet, where it has fallen 60 percent.<sup>11</sup> (For more details, see “Current Situation,” p. 512.)

Perhaps most alarmingly, the WWF estimates, every year humans use one-and-a-half years’ worth of natural resources — in other words, 50 percent more resources than the Earth can replenish in a year. “In essence, the Earth has built up a bank account of natural resources, and what we’re doing is eating into our principal,” says Colby Loucks, WWF senior director for conservation science. By 2030, the fund projects, humans will need the equivalent of two planets worth of resources to meet their annual demands.

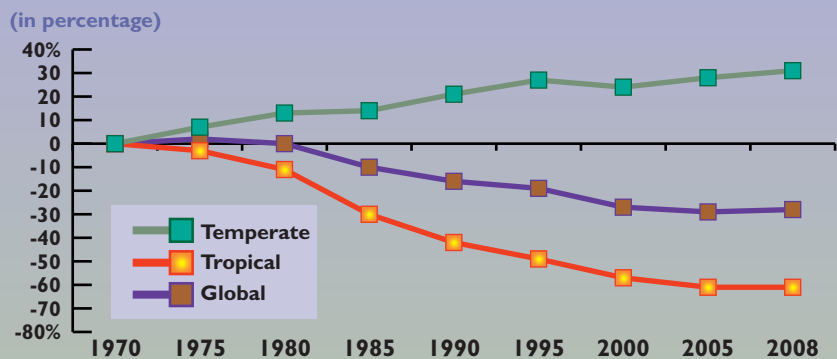
Efforts are under way to reverse those trends. The Convention on Biodiversity, adopted by the United Nations in 1992 and eventually signed by 193 nations, commits participating countries to conserve biodiversity and promote sustainable development.<sup>12</sup> In 2002, the convention set a goal of achieving by 2010 “a significant reduction of the current rate of biodiversity loss at the global, regional and national level . . . to the benefit of all life” on Earth.<sup>13</sup>

But the convention’s latest summary report bluntly concluded that this goal “has not been met.”<sup>14</sup> In fact, none of the 110 nations that submit-

## Tropical Species Are Declining

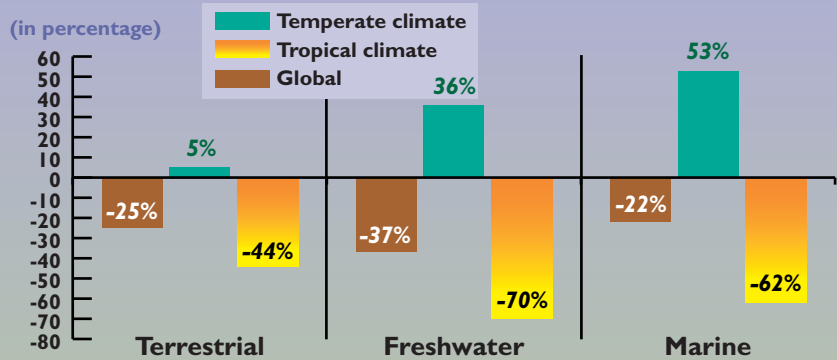
The populations of wild species in tropical climates have declined by more than 60 percent since 1970, while those in temperate climates have seen moderate growth (top graph). Freshwater and marine vertebrates in temperate climates have made gains, while those in tropical climates have declined 70 percent and 62 percent, respectively (bottom). The World Wildlife Fund’s “Living Planet Index” has tracked population trends of more than 2,500 vertebrate species since 1970.

### Change in Population for Species in “Living Planet Index,” 1970-2008



### Percent Change in “Living Planet Index” for Vertebrates, 1970-2008

(by type of climate and environment)



Sources: “Living Planet Report 2012,” World Wildlife Fund for Nature, 2012, p. 130, [awsassets.panda.org/downloads/l1\\_lpr\\_2012\\_online\\_full\\_size\\_single\\_pages\\_final\\_120516.pdf](http://awsassets.panda.org/downloads/l1_lpr_2012_online_full_size_single_pages_final_120516.pdf); “Living Planet Index Interactive Graph,” World Wildlife Fund for Nature, 2012, [wwf.panda.org/about\\_our\\_earth/all\\_publications/living\\_planet\\_report/living\\_planet\\_report\\_graphics/lpi\\_interactive/](http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/living_planet_report_graphics/lpi_interactive/)

ted individual reports had completely met their deadline, the report said. The study also found that nearly one-quarter of the planet’s land surface

has been degraded and lost biological productivity since 1980. Of 292 large river systems, two-thirds have

*Continued on p. 503*



## Inside the ‘Doomsday Vault,’ Hope for Survival

*But some conservationists ask: Is it enough?*

High above the Arctic Circle, on the remote Norwegian island of Svalbard, a huge vault has been carved into the side of a mountain. If its isolated location, concrete walls and steel doors aren't security enough, the so-called “doomsday vault” is also surrounded by tall fences and motion detectors ready to sense any intruders.

The facility holds a treasure so common it can be found blowing in the wind on every continent, and yet it could hold the key to humanity's survival in the event of a global disaster.

The “doomsday vault” was built to hold seeds from wheat, corn, rice and other crop varieties from all around the world, a storehouse of genetic diversity intended to provide a final safeguard against the consequences of biodiversity loss. The collection is part of a system of some 1,400 other seed banks around the world.<sup>1</sup>

But some conservationists are asking whether even the doomsday vault and its sister vaults around the world are sufficient.

More than 740,000 seed samples are being kept in the chilled chambers of Svalbard, according to a recent estimate.<sup>2</sup> The project, a collaborative effort among the Norwegian government and several private organizations, reflects awareness of the precariousness of the genetic underpinnings of the world's food supply.

Selective breeding to boost crop productivity and other desirable features, such as early maturity, has led to a dramatic loss in plant diversity, about 75 percent, by most estimates. (See p. 505.)

Moreover, the genetic uniformity of major crops leaves them more vulnerable to diseases and environmental shifts like climate change. By including many different strains of various plants, the seed banks are meant to provide genetic ammunition to protect against such problems, or even to restore a species should it be wiped out by a calamity.

However, some experts say, the seed banks represent only a tiny portion of the genetic richness that once existed in the wild. Even more problematic, the seeds in storage represent nature frozen at a particular point in time, unable to evolve to meet changing conditions.

“Conservation is about keeping diversity in a dynamic state. . . . The Svalbard gene bank, and many others, focus only on collecting and preserving. . . . You can capture only so much, and in 100 years it will be useless because the planet will have changed,” said Melaku Worede, an Ethiopian agronomist who has been in the forefront of efforts to keep different strains of important crops and their wild relatives alive in nature.<sup>3</sup>

Pat Mooney — executive director of ETC, an international organization based in Ottawa, Canada, that tracks the impact of biodiversity loss in the developing world — also questions the ability of the seed banks to respond to a major crisis, such as a new disease sweeping through one of the major food grains.

“They have preserved quite a bit of diversity,” Mooney says, “but their ability to crank up and produce enough seed is very low. They really can't do that quickly. The quality of the storage is also very variable. A lot of the collections are kind of poorly maintained, even in some of the major centers.”



Getty Images/Oli Scarff

The 24,200th seed sample — from a pink, wild banana native to China — is added to the 3.5 billion seeds stored in the sub-freezing vault at the Millennium Seed Bank in Sussex, England, on Oct. 15, 2009. Some 1,400 seed banks across the globe preserve thousands of plants to be used in the event of a global environmental disaster.

Mooney and Worede are among the experts who say it's important that the seed banks, while necessary as an emergency safeguard, not be seen as a sufficient substitute for maintaining genetic diversity on working farms around the world. “Farmers have been the custodians of biodiversity, and they need support,” said Worede. “We lose everything if we lose diversity in the field.”<sup>4</sup>

— Reed Karaim

<sup>1</sup> Charles Siebert, “Food Ark,” *National Geographic*, July, 2011, <http://ngm.nationalgeographic.com/2011/07/food-ark/siebert-text>.

<sup>2</sup> Scott Stump, “‘Doomsday Vault’ holds seeds that could save the world,” *Today.com*, March 2, 2012, [http://today.msnbc.msn.com/id/46602078/ns/today.today\\_news/t/doomsday-vault-holds-seeds-could-save-world/#.UGx6r14rzww](http://today.msnbc.msn.com/id/46602078/ns/today.today_news/t/doomsday-vault-holds-seeds-could-save-world/#.UGx6r14rzww).

<sup>3</sup> Melaku Worede, interview with *GRAIN*, April 22, 2009, [www.grain.org/article/entries/709-melaku-worede-interview-in-english](http://www.grain.org/article/entries/709-melaku-worede-interview-in-english).

<sup>4</sup> *Ibid.*

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Continued from p. 501

become moderately or highly fragmented by dams and reservoirs, making it difficult for many species to survive. And more than 19,300 square miles of forests — crucial biodiverse habitats — are cleared every year by loggers, farmers, ranchers and developers. One bright spot: The species-rich Amazon rainforest is more protected now than in the past.

The news is grim for many wild animal populations. Various wild vertebrate species dwindled by an average of 31 percent between 1970 and 2006.<sup>15</sup> And many of those are teetering close to extinction. Even some domesticated creatures are at risk. One-fifth of all livestock breeds, such as cattle and sheep, could face extinction due to over-reliance on fewer and fewer breeds, leading to less genetic diversity and leaving them vulnerable to disease.<sup>16</sup>

“Our mathematical models and our observations and our experiments show that we’re not necessarily doomed,” said Paul Leadley, director of the Laboratoire d’Ecologie at the University of Paris at Orsay and one of the study’s authors. “But they do show that if we don’t do something now, we will be in big trouble.”<sup>17</sup>

As conservationists and scientists assess the impact of biodiversity loss, here are some key questions being debated:

### ***Is Earth at a global biodiversity-loss tipping point?***

As they examine the degree to which human activity has changed the planet, some researchers believe the Earth could be nearing a “state shift,” or a “tipping” point, in which the planet will see a dramatic change in its biodiversity. In an article in *Nature*, the researchers predicted it would likely include mass extinctions, drastic changes in species abundance, distribution and diversity and even new evolutionary trajectories for some forms of life.<sup>18</sup>

“Things will be different in a very noticeable way,” says Barnosky, of UC-Berkley. “The last time one of these global state shifts happened — about 11,000 years ago, when the Earth moved from an ice age to the interglacial period (that we’re still in) — we lost about 50 percent of the big-body animals and saw dramatic changes in what species lived where. That’s the sort of changes we’re talking about.”

The last global state shift took about 1,600 years, but Barnosky says things could happen much more quickly this time because of the impact of the two principal drivers of change — climate change and an expanding human population. “What’s happening now is much more intense than what happened then,” he says.

It may seem hard to believe man’s impact on the planet could be more significant than the retreat of the ice age, but at that time 30 percent of Earth’s surface went from being covered by glaciers to being ice-free. Humans already have converted 43 percent of the globe’s land for agricultural or urban use, with much of the remaining land cross-hatched with roads.<sup>19</sup>

The scientific consensus is that human activities also have increased the concentration of carbon dioxide and other gases that cause global warming. Higher CO<sub>2</sub> levels have increased ocean acidity, while polluted runoff from cities and chemically fertilized fields has damaged rivers and coastal areas.<sup>20</sup>

The cumulative impact of these changes is growing as the human population swells. By 2050, when the population is expected to reach 9.5 billion, “we’ll have changed well over 50 percent of the planet’s land surface,” says Barnosky. “At that point, I’d say we would very likely see dramatic changes in the remaining places that aren’t affected directly.”

But some experts doubt a shift is at hand. “The concept of a tipping point drives me crazy,” says Patrick Moore, a former Greenpeace member

and co-founder who is now a frequent critic of current conservation claims.<sup>21</sup> “In a sense, every microsecond is a tipping point because everything is always changing.

“Change is the only constant. Stasis would mean the end of time,” continues Moore, who now operates Greenspirit, a consulting firm in Vancouver, Canada, that advises and represents corporations on sustainable environmental policies. “It is inevitable there will be change, and the judgment as to whether or not that change is negative or positive is a value judgment.”

Moore believes life on Earth is now more profuse than during most of the planet’s history, part of an explosion of biodiversity that began many millions of years ago. He acknowledges that humans have been responsible for the extinction of many species but believes that trend, too, is overstated. “It’s only been since 1930 that we cared whether a species went extinct or not, and since then I believe we have done a fairly good job,” Moore says. “It’s very likely that the rate of extinction has slowed.”

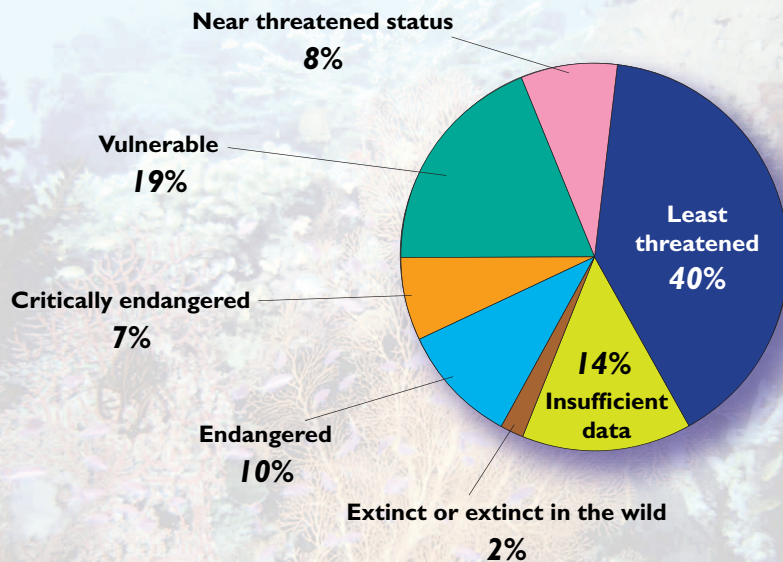
However, Mikael Fortelius, a professor of evolutionary paleontology at the Institute of Biotechnology, University of Helsinki, Finland, and co-author of the *Nature* study, says the current rate of extinctions is cause for alarm. “If species were going extinct at the rate they’ve always done, we wouldn’t have to worry, but they’re going extinct at a thousand times that, so, yeah, we should be worried,” he says. “It’s not a difference in kind, but it’s a huge difference in degree.”

Fortelius’ ongoing research supports the idea that state shifts can happen quickly. While cautioning that his results are preliminary, Fortelius says fossil records show that in the past, ecosystems, or “ecological packages,” have remained stable for long periods — sometimes millions of years — before changing. “Then that state shift

## One-Third of Species Are Threatened

Thirty-six percent of 47,677 plant and animal species being tracked by scientists were endangered, critically endangered or vulnerable to becoming endangered as of 2009,\* according to the International Union for Conservation of Nature (IUCN), which reports on the status each year of select species of, among others, mammals, birds, amphibians, corals and conifers. Two percent of those species already had become extinct in 2009.

**Threat Status of World Species, 2009**



\* Most up-to-date figures available.

Source: Global Biodiversity Outlook 3, *Convention on Biological Diversity*, 2010, p. 27, [www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf](http://www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf). Information is drawn from the IUCN's "Red List of Threatened Species."

happens very quickly, comparatively, and the old system completely disappears and is replaced."

Looking at planetary changes occurring today, he agrees "we are getting into the range in several different areas where we are close to that 50 to 60 percent mark that is often associated with state shifts."

Many cases already exist of local ecosystems tipping into new states. J. Emmett Duffy, a professor at the Virginia Institute of Marine Science at the College of William and Mary, in Williamsburg, Va., points to the collapse of the cod fishery off the coast of Eastern Canada in the 1980s. "A moratorium was imposed. It was too

late. The fish just wouldn't come back, and it wasn't clear why," he says.

Researchers finally realized cod had been predators of smaller fish that fed, among other things, on cod eggs. With the cod population decimated the number of these small fish boomed and by devouring the eggs of their former predators, they kept the cod population depleted. "The system had flipped past the tipping point," he says. "You ended up with a stable system that prevented cod from coming back."

At that point, Duffy says, it takes another significant shift to move the system. In the North Atlantic, the cod appear to be returning after decades.

Evidence indicates the small fish that had been devouring cod eggs eventually grew too numerous and cleaned out their own food supply, so their populations collapsed.<sup>22</sup>

But even some scientists who are worried about the degree of biodiversity loss doubt that the planet is on the verge of a global state shift. Charles Perrings, a professor of environmental economics at Arizona State University, Tempe, isn't sure there is a threshold at which biodiversity change takes place on a planetary scale. He believes shifts are likely to be confined to specific ecosystems.

"Are we at a global tipping point? I don't see that. I think, case by case, you can see these shifts, and in some instances, there may be a change of regime, or the system might just lose functionality," he says. "But I don't see the evidence for that globally."

### ***Does monoculture agriculture threaten biodiversity?***

Modern agriculture relies heavily on "monocrops" — or monoculture — in which large swaths of land are covered with one crop. It was a major component of the "Green Revolution" of the 1950s and '60s, which introduced higher-yielding crop varieties and modern farming methods to the developing world.

The worldwide spread of monoculture has been hailed for saving hundreds of millions of people from famine and with feeding a global human population that has more than doubled in less than 50 years.

The recent biotech revolution, which uses genetic engineering to create new plant varieties with very specific traits — such as tolerance of certain herbicides — also has pushed farmers toward monoculture. Genetically modified (GM) breeds are designed to be raised on fields planted in a single crop. The use of GM crops has exploded since they were introduced in the mid-1990s. Between 1996 and



2000, the number of acres planted worldwide in biotech crops jumped from 4.2 million acres to 109.2 million acres.<sup>23</sup>

Yet, the expansion of monoculture has significantly reduced the genetic variety of food plants around the world, according to the U.N. Food and Agriculture Organization (FAO), which estimates that 75 percent of crop diversity was lost between 1900 and 2000.<sup>24</sup> A handful of breeds also now dominate among domesticated livestock, although the loss of livestock diversity has gotten less attention than dwindling plant diversity. Livestock loss has been “probably about 80 to 90 percent,” says Pat Mooney, executive director of ETC, an international organization in Ottawa, Canada, that examines the impact of new technologies on traditional societies. “The loss there has been massive.”

The genetic uniformity of crops and animals makes them susceptible to new diseases and pests, which can spread quickly through a monoculture field or herd without encountering much natural resistance. “In terms of biodiversity, there’s not that much difference between paving something over for a city and clearing or replacing it with a monoculture of corn and soy. Those are equivalent, and to some extent if you add in all the pesticides that are going to go on that [crop], it may be even worse,” says Kierán Suckling, executive director of the Center for Biological Diversity in Tucson, Ariz.

But Clive James, an agricultural scientist who worked with Norman Borlaug\* at CIMMYT, a Mexican agricultural research center, believes bio-engineered crops can take the Green Revolution one step further while helping to preserve biodiversity. Only genetic manipulation will enable the

\* Borlaug was a Nobel-Prize winning plant scientist hailed as the father of the Green Revolution.



Indonesian fishermen load tuna in Denpasar, Bali, on July 9, 2012. Many marine species and ecosystems, especially the bluefin tuna and coral reefs — have been decimated at an alarming rate in recent years by overfishing, coastal development, pollution and climate change.

development of crops that can thrive on less water and nutrients and resist specific pests while yielding enough to feed the world’s growing population, he says.

“We have 1.5 billion hectares [3.7 billion acres] of land in crops today, and if you want to protect the Amazon or other endangered habitats or areas that are biodiversity sanctuaries, the key is to increase productivity per

hectare,” James says. “What you have in biotechnology is a land-saving technology, allowing you to increase the production of food and fiber on existing land.”

Twenty years ago, James founded the International Service for the Acquisition of Agri-biotech Applications (ISAAA), to share the benefits of crop biotechnology with farmers in developing countries. In the 15 years since

AFP/Getty Images/Sonny Tumbelaka

bioengineered crops began to be used widely, farmers have boosted production by 276 million tons, he says. “Without those 276 million tons, you would have had to put another 91 million hectares [225 million acres] into production,” he contends.

Some conservationists, however, such as Vandana Shiva, an international environmental activist who founded Navdanya, an Indian organization that promotes biodiversity conservation and organic farming, believe the benefits of bioengineering and monoculture have been vastly overstated. “Our work in Navdanya shows that biodiverse organic farming produces more food and nutrition per acre than chemical monocultures,” she says. “Intensifying biodiversity is the solution to hunger.”

Supporters of biotech crops include billionaire philanthropist Bill Gates, whose Bill and Melinda Gates Foundation has invested significantly in the development of genetically modified rice and cassava (a food staple for 250 million Africans) that provide enhanced nutrients. The foundation also has supported research into drought-resistant GM varieties of corn.

While acknowledging that widespread concerns persist about genetically modified crops, Gates believes the necessity of finding new ways to help developing nations feed themselves means seeking innovative approaches to boosting production. Speaking at the 2010 World Economic Forum in Davos, Switzerland, Gates said for some valuable crop characteristics, such as drought resistance, the GM approach “can probably do better than any other approach.” He sees genetic engineering as “a tool, particularly for disease resistance” that could be “a real help” to developing world farmers.<sup>25</sup>

But Mooney notes that most bioengineered crops have been designed primarily to allow more chemical use. Prominent examples are Monsanto’s

Roundup Ready crops, which allow heavier applications of the company’s Roundup herbicide.

“Seventy-seven percent of the land area is in herbicide tolerant crops,” he says. “It doesn’t improve the yield. It’s simply there to encourage the priority use of the herbicides the company sells.” He notes that the increased use of herbicides and other pesticides can be devastating on other plants and creatures. “There’s an indirect loss, which is quite substantial,” Mooney says. “We’ve had a huge loss in pollinators — bees, which are absolutely essential. Two-thirds of our crops depend on wild pollinators.” (See sidebar, p. 508.)

The wilder relatives of cultivated crops, known as “land races,” which often grow along the edges of fields, also can be damaged by the chemicals used to protect monocrop agriculture. These land races mix genetically with their cultivated relatives, helping to provide natural, hardier hybrids, Shiva points out.

Genetically modified crops also reportedly have cross-pollinated with wild, non-GM species, breeding herbicide-resistant weeds. This creates a vicious cycle in which such “super weeds” require even more chemical use, increasing the damage to other “ecologically useful plant species,” Shiva notes.

Nevertheless, even some scientists who are concerned about biodiversity loss in monocrop agriculture believe it’s needed in order to balance environmental needs with those of a swelling human population.

“When you look at agriculture, you have two ways of growing: either extensively or intensively. Extensively means using more fields, more land. Intensively, you have more high-yielding plants, more fertilizer and so on,” says Arizona State University’s Perrings. “If you ask which is the biggest threat to biodiversity, it is the extensive growth of agriculture. Intensification is a much better solution to dealing with the challenge.”

## ***Does biodiversity loss threaten human civilization?***

The extinctions of wild animals and plants sometimes are dismissed as having little practical impact on the well-being of the human race. Yet civilization is built on exploiting the planet’s biological richness.

People rely on biological diversity for — among other things — food, medicines, shelter and clothing. More than 70,000 plant species are used in modern and traditional medicines alone, according to the International Union for the Conservation of Nature (IUCN), the world’s oldest environmental organization.<sup>26</sup> Healthy, biodiverse ecosystems also provide goods and services, ranging from filtering fresh water to removing carbon dioxide from the air. The IUCN puts the value of those services, which humanity currently receives for free, at \$16 trillion to \$64 trillion.<sup>27</sup>

The possibility that the planet could be reaching an environmental tipping point because of the accelerated rate of extinctions raises the question of whether biodiversity loss threatens the human race. While scientists are not suggesting that humans themselves face extinction, some worry that biodiversity loss could have severe consequences for humankind. “Do I think there’s a high likelihood of world catastrophe? I think it’s a real possibility. No one knows the future, but if we don’t change the way we’re doing things today and just go blindly forward, we’re setting ourselves up for disaster,” says UC-Berkeley’s Barnosky.

The point is approaching, he says, at which biodiversity loss could result in a fairly rapid reduction in the natural resources available. Agricultural production also could be significantly affected as growing patterns are changed by a shifting of global ecosystems. All of this would be occurring as human population growth puts added pressure on the planet’s productive capacity.

*Continued on p. 508*

# Chronology

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## 1900-1940s

**Concern about extinctions leads to first major efforts to protect endangered species.**

### 1901

President Theodore Roosevelt greatly expands wilderness preservation in the United States, eventually protecting 230 million acres.

### 1914

“Martha,” the last passenger pigeon on Earth, dies at Cincinnati Zoo.

### 1934

Geneva Convention for the Regulation of Whaling is one of first international treaties to protect a species.

### 1936

The last Tasmanian tiger and the world's largest carnivorous marsupial go extinct.

### 1948

The world's first global environmental group, the International Union for the Protection of Nature (later the International Union for Conservation of Nature) is founded.

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## 1960s-1980s

**Modern environmental movement is born; biodiversity loss becomes global concern.**

### 1962

Government biologist Rachel Carson's best-selling book *Silent Spring* ties pesticides to declines of several wild species, helping to spur the environmental movement.

### 1970

World Wildlife Fund (WWF) launches Living Planet Index to track biodiversity.

### 1973

President Richard M. Nixon signs landmark Endangered Species Act to protect both species and their ecosystems. . . . Convention on International Trade in Endangered Species of Wild Fauna and Flora is first negotiated by a group of concerned nations and later signed by 176 countries.

### 1980

American biologist Thomas E. Lovejoy III coins the term “biological diversity.”

### 1988

British ecologist Norman Myers, identifies 10 endangered global “hot spots” with exceptional biodiversity; list is later expanded to 34.

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## 1990s International community organizes to protect endangered species.

### 1992

Convention on Biodiversity, intended to protect biodiversity and promote sustainable development, is signed by 150 nations at Earth Summit in Rio de Janeiro, Brazil. President Bill Clinton signs it in 1993, but Senate fails to ratify it.

### 1995

International Coral Reef Initiative is launched to protect endangered reefs through collaborative, multinational efforts.

### 1997

More than 150 nations agree on Kyoto Protocol to reduce emissions causing global warming, considered a key cause of biodiversity loss; United States refuses to ratify it.

### 1998

U.N. declares 1998 the “Year of the Ocean” to promote awareness of threats to marine habitats.

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## 2000-Present

**Researchers forecast accelerating extinction rates as world population continues to rise.**

### 2002

Members of Convention on Biodiversity set targets for reducing biodiversity loss by 2010; heads of state later endorse the goals at World Summit on Sustainable Development.

### 2005

U.N.'s “Millennium Ecosystem Assessment” finds human activity has seriously degraded the services provided by 24 vital ecosystems.

### 2008

Norway becomes first country to support a Brazilian fund to preserve the rainforests, offering \$1 billion for conservation efforts.

### 2010

Convention on Biodiversity acknowledges that the world has fallen short of 2010 targets for reducing biodiversity loss.

### 2012

Brazilian government says about 150 million acres of Amazon rainforest have been conserved, although deforestation continues, but at a slower pace. . . . WWF's “Living Planet Report” says biodiversity declined 30 percent from 1970 to 2008, mainly in bio-rich tropical regions. . . . Study in *Nature* says Earth may be reaching a “state shift,” or tipping point, in which biodiversity loss significantly changes global ecosystems.



## Mystery of the Disappearing Bees

*New studies point to widely used pesticide for worldwide decline.*

In the mid-2000s, beekeepers and others noticed that honey-bee colonies — whose role as pollinators makes them critical to plant life and, thus, the entire food chain — were disappearing throughout the developed world at an alarming rate.

Since bees exist both in commercial hives and the wild, an exact tally of the losses are impossible, but millions of colonies and billions of bees have died. Everything from African viruses to global warming were suggested as possible causes for the disappearance. But now researchers believe they may have the solved the mystery. Three new studies, including two published in the respected journal *Science* earlier this year, blame a class of widely used pesticides known as “neonicotinoids.”<sup>1</sup>

At least 142 million acres of corn, wheat and cottonseeds in North America were treated in 2010 with the chemicals, which also are common in home gardening products.<sup>2</sup> Neonicotinoids, also known as “neonics,” were developed in the 1980s and became common in the following decade. Bayer, the German chemical manufacturer, sold the first commercial version of neonics and still dominates the business.

Trace elements of the insecticide are absorbed by plants and are present in the nectar on which bees feed and the

pollen they gather. Studies confirm that the neonicotinoids — long suspected as a cause of the bee disappearance — can be deadly to bees in two ways. Research by scientists primarily affiliated with the University of Stirling in Scotland found that bee colonies that encountered the neonicotinoids had significantly reduced growth rates and an 85 percent reduction in the production of bee queens, critical for future survival.

“Given the scale of use of neonicotinoids, we suggest that they may be having a considerable negative effect on wild bumble bee populations across the developed world,” the authors wrote.<sup>3</sup>

Another study by French researchers indicates that even non-lethal doses of the pesticide can impair bees’ homing instincts that allow them to find their way back to their colonies. The scientists used tiny, radio transmitting chips to track bees exposed to neonicotinoids and found the damage was sufficient to lead to the collapse of colonies.<sup>4</sup> The study also provides an answer to another mystery that had puzzled researchers: Why they didn’t find more dead bees when bee colonies died out.

A third study by Italian scientists found that dust containing the pesticide released during planting can also be lethal to bees.<sup>5</sup>

*Continued from p. 506*

“There will be more people, less clean water, less of all kinds of things,” Barnosky says. “It’s going to be harder to feed people. Where our agricultural lands are now — they’re not going to be there, which leads to economic and political instability.”

To avoid major disruptions, governments must address biodiversity loss in the next couple of decades, he says. “Here’s the reality: By 2050, we’ve got 9 billion people we have to feed and provide for. We have to start now, because when we get to 2040, it’s too late.”

But some skeptics say the threat is seriously overstated. “It’s part of the ‘end is nigh’ rhetoric, which has been with us since the beginning of humans,” says Moore, of Greenspirit. “If they think the sky is falling, fine. I don’t think it is. Certainly, there are places where species are endangered and some areas where we’re seeing a loss of diversity,

but I totally reject the idea that we’re in a sixth mass extinction.”

Moore believes the argument that extinction rates are 100 or 1,000 times the normal background rate is based on faulty science and mostly questionable estimates of how many species exist overall. He also thinks scientists who see the possibility of a catastrophe ahead are underestimating the ability of plants and animals to adapt to an environment altered by humans and of humans to extract the resources they need without seriously impacting biodiversity.

Environmentally responsible logging, for example, he says “is not responsible for much [biodiversity loss] at all.” Biodiversity can flourish even where landscapes have been severely depleted through human interaction, he says. “With reclamation, it is often possible to return the land to a higher state of ecosystem biodiversity than was present initially, by contouring the land

differently,” he says. “We are actually capable of increasing biodiversity.”

Other scientists believe losing biodiversity isn’t critical if key species are preserved. “Just counting the number of species you’ve got is very misleading,” says J. Philip Grime, a plant ecologist at the University of Sheffield in England. “The big questions are what kind of organisms are they, what do they do in the landscape and how are they going to respond to what we’re doing to the planet. That’s why [focusing on] biodiversity is not very helpful.”

But Bradley J. Cardinale, principal author of the *Nature* paper assessing the cost of biodiversity loss, says it’s critical to maintain complex ecosystems. “Losing biodiversity is going to reduce how productive and how sustainable most ecological processes are,” he says, “and almost everything we care about, everything a biosystem gives to humanity, depends on those

The three studies are likely to add to pressure on the U.S. Environmental Protection Agency to ban neonicotinoids. Several European nations have already instituted partial bans on the pesticides.<sup>6</sup>

Bee researchers and environmental activists say they still believe other environmental causes may also be playing a role in the disappearance of bees.<sup>7</sup> But the three studies indicate at least a large share of the mystery seems to have been solved.

— **Reed Karaim**

<sup>1</sup> Richard Schiffman, "Mystery of the disappearing bees: Solved!" Reuters, April 9, 2012, <http://blogs.reuters.com/great-debate/2012/04/09/mystery-of-the-disappearing-bees-solved/>.

<sup>2</sup> Tom Philpott, "3 New Studies Link Bee Decline to Bayer Pesticide," *Mother Jones*, March 29, 2012, [www.motherjones.com/tom-philpott/2012/03/bayer-pesticide-bees-studies](http://www.motherjones.com/tom-philpott/2012/03/bayer-pesticide-bees-studies).

<sup>3</sup> Penelope P. Whithorn, *et al.*, "Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production," *Science*, April 20, 2012, [www.sciencemag.org/content/336/6079/351.abstract#aff-1](http://www.sciencemag.org/content/336/6079/351.abstract#aff-1).

<sup>4</sup> Mickaël Henry, *et al.*, "A Common Pesticide Decreases Foraging Success and Survival in Honey Bees," *Science*, April 20, 2012, [www.sciencemag.org/content/336/6079/348.abstract](http://www.sciencemag.org/content/336/6079/348.abstract).

<sup>5</sup> Andrea Tapparo, "Assessment of the environmental exposure of honeybees to particulate matter containing neonicotinoid insecticides coming from



AFP/Getty Images/Remy Gabalda

A beekeeper tends a hive in southwestern France on June 1, 2012. Three new studies indicate that in the past decade widely used pesticides known as neonicotinoids may have caused the deaths of millions of colonies of bees — whose role as pollinators makes them critical to the entire food chain.

corn coated seeds," *Environmental Science and Technology*, March 6, 2012, [www.ncbi.nlm.nih.gov/pubmed/22292570](http://www.ncbi.nlm.nih.gov/pubmed/22292570).

<sup>6</sup> "Colony Collapse Disorder: European Bans on Neonicotinoid Pesticides," Environmental Protection Agency, May 9, 2012, [www.epa.gov/opp00001/about/intheworks/ccd-european-ban.html](http://www.epa.gov/opp00001/about/intheworks/ccd-european-ban.html).

<sup>7</sup> Philpott, *op. cit.*

processes. It's the variety of life in nature that provides us with all the goods and services we count on."

Cardinale, a professor at the School of Natural Resources and Environment at the University of Michigan, Ann Arbor, says researchers continue to discover new connections that indicate how extinction or even a shrinking population of one species can have unexpected ramifications. One study, he says, found that the incidence of Lyme disease in humans is tied to the number of different species of mammals in forests. With more species, the ticks that carry the disease are spread thinner and the disease is diluted. "We have almost no idea how the well-being of our own species might be linked to the great variety of life that is the most striking feature of life on our planet," Cardinale says.

Without a better understanding of what's at stake, Cardinale believes,

humans could be courting disaster. "We're maybe two centuries away from the situation being equivalent to a mass extinction where 75 percent of everything is gone. Can we survive that? That's the question everyone in the discipline is trying to answer," he says. "I don't think we have to act like it's doomsday. But I do think global loss of biodiversity ranks among the most important and dramatic problems in modern history." ■

## BACKGROUND

### Extinction Epochs

To the nonscientist, life can still seem so bountiful on Earth it's hard to

imagine most of it disappearing. But five great extinction events have occurred during the planet's 4.5 billion-year history.<sup>28</sup> In each case, 75 percent or more of all species disappeared.<sup>29</sup>

Perhaps most well-known — and most recent — was the great extinction that occurred 65 million years ago, when many researchers believe the impact from a large asteroid kicked enough particulate matter into the air to change the climate and wipe out nearly all of the dinosaurs. Today's birds are generally thought to be the descendants of dinosaurs that managed to survive.<sup>30</sup>

But the most dramatic extinction, known as the Great Dying, occurred about 250 million years ago and resulted in the elimination of up to 96 percent of all species, including plants, insects and larger creatures. All of life on the planet today descended from the 4 percent of species that survived.<sup>31</sup>





Getty Images/Mario Tama



Getty Images/Ted Aljibe

## Threats to Biodiversity

Construction of the world's third-largest hydroelectric project — the Belo Monte dam near Altamira, Brazil — will destroy up to 230 square miles of Amazon rainforest (top). Although nearly three-quarters of the 270,000 square miles of biodiverse forest habitats protected worldwide since 2003 have been in Brazil's biologically rich Amazon, deforestation continues in the region. The illegal trade in threatened species — such as these endangered sea turtles (bottom) that have been stuffed to sell to wildlife traffickers — is another threat to the planet's biodiversity. A worker from the Philippine Protected Areas and Wildlife Bureau in Manila displays one of the hundreds of turtles seized from Vietnamese fishermen last April off the southeast coast of the Philippines.

Scientists aren't sure exactly what caused the Great Dying, but massive volcanic eruptions in Siberia, setting coalfields aflame and filling the air with both volcanic and coal ash, are thought to be a possible cause.<sup>32</sup> One or more asteroid strikes also may have played a role.

The other great extinctions occurred 440 million, 359 million and 200 million years ago. Causes vary, but a unifying element seems to be climate change caused by dust and dirt being hurled into the atmosphere after an asteroid collision, volcanic eruption or some other event.<sup>33</sup> "The evidence would support that each of the big five occurred at the same time that major shifts in the overall 'normal' for global climate occurred, and also to a large extent changes in ocean chemistry," says U.C. Berkeley's Barnosky. "This may be highly relevant to interpreting the present state of events, given that we are witnessing unusually fast changes in climate and ocean chemistry [acidification], this time of course caused by humans."

In more recent times, geologically speaking, large numbers of species disappeared during certain periods. About 73,000 years ago, some scientists believe the eruption of a mammoth volcano in Indonesia may have thrown so much ash into the air that it reduced the human population around the world to as few as 10,000 people.<sup>34</sup>

The advance and retreat of glaciers around the world during the last 100,000 years also caused periods of significant extinctions.<sup>35</sup> The current epoch — known as the Holocene — began about 11,700 years ago with the retreat of ice-age glaciers. The Holocene has been marked by the spread of what the University of Helsinki's Fortelius calls "the ultimate invasive species" — human beings.



## Humans and Extinction

Giant mammals once roamed the Earth. The giant sloth, the woolly mammoth, the short-faced bear (which stood 13 feet tall on its hind legs and weighed nearly a ton), the giant condor and, in Australia, a giant kangaroo were just some examples of these “megafauna,” as scientists call them.

These massive creatures had all disappeared by about 8000 B.C., probably due to human hunting, according to some scientists. Most megafauna in Australia disappeared relatively soon after the arrival of humans. “It was because these large, slow moving mammals had never had to run away from people with spears before,” says Moore, of Greenspirit.

Humans also began selecting and breeding strains of plants for agriculture in pre-historic times. The earliest varieties of wheat were cultivated in the Middle East as long as 11,000 years ago.<sup>36</sup> Corn has similarly ancient origins. “We would never have maize (corn) today if farmers in Mexico hadn’t selected the best grain over a long period of time, thousands of years ago,” says James, of the International Service for the Acquisition of Agri-biotech Applications.

By hunting some mammals to extinction and domesticating certain plants and animals, humans were altering the ecosystems in which they lived and impacting biodiversity long before recorded human civilization. “Part of the change we’ve witnessed in the last 10,000 years is directed change,” notes Perrings, of Arizona State University. “It’s the result of deliberate actions taken by people to promote certain species and get rid of others.”

Humans continued to press species into — or to the edge of — extinction without much thought until relatively recently. The population of North American bison on the Great Plains was estimated at 60 million be-

fore being decimated by European-American hunters. By 1889 the population had fallen as low as 1,100, before conservation efforts began to rebuild numbers.<sup>37</sup>

Other creatures disappeared forever. “The dodo bird and the passenger pigeons were victims of overhunting for food; the Carolina parakeet, the only parrot that was native to North America, was eradicated by farmers because it ate their crops,” wrote Moore

Great Plains, for example, were once largely native grasslands, with a variety of species. Many animals that existed in this ecosystem were either forced to move to new territory or declined steeply in population.

In the last century, concern that commercial fishing was hunting whales to the brink of extinction led to one of the first international efforts to protect a species. The Geneva Convention for the Regulation of Whaling became ef-



Yemeni and foreign tourists admire a dragon blood tree, unique to the virtually untouched Yemeni island of Socotra, a site of global importance to biodiversity conservation. Located in the northwestern Indian Ocean, Socotra is sometimes referred to as “the Galapagos of the Indian Ocean” because of its unique and spectacular vegetation. The island’s flora are among the world 10 most endangered island flora systems.

AFP/Getty Images/Khaled Fazaa

in *Confessions of a Greenpeace Dropout: The Making of a Sensible Environmentalist*.<sup>38</sup>

Humans also have caused extinctions — either intentionally or accidentally — by introducing foreign species, particularly on islands or other contained ecosystems, that overwhelmed native creatures.<sup>39</sup> Finally, humans have pervasively changed their environment through the spread of agriculture. The grain fields that now cover thousands of square miles across the American

continent in 1935, although it was ignored by some nations.<sup>40</sup> Other treaties and laws would follow as the conservation and environmental movements gained strength. The organized effort to protect some plants and animals marked a sea change in humanity’s long relationship with its fellow inhabitants.

The 1973 U.S. Endangered Species Act, which extended federal protection to species identified as at risk, is considered a landmark step in the process.<sup>41</sup> The Center for Biological

Diversity studied how many species have become extinct since the act became law. “We found that the vast majority of species that were listed (as endangered) in the act were saved from extinction,” Suckling says. “The good news is we have a tool that works. Unfortunately, there are not that many Endangered Species Acts around the world.”

Indeed, events around the world reveal very different situations regarding biodiversity loss and the range of government responses. ■

## CURRENT SITUATION

### Threats and Progress

Although the sheer profusion of life on Earth prevents researchers from developing an accurate estimate of how many species have gone extinct in recent years, reports by the World Wildlife Fund, the Convention on Biological Diversity and the International Union for the Conservation of Nature (IUCN) show a continuing and precipitous decline in many plant and animal species. The studies show that many of the species are headed for extinction if current trends are not reversed.

One of the most widely cited measures of plant and animal populations is the IUCN “Red List,” which determines the likelihood a species may become extinct if current conditions persist. The list is based on information gathered by species scientists around the world. As of this year, 31 percent of the 63,837 species that had been evaluated were threatened with extinction.<sup>42</sup>

But while biodiversity loss continues, there have been advances on the political front. “Some 170 countries now

have national biodiversity strategies and action plans. At the international level, financial resources have been mobilized and progress has been made in developing mechanisms for research, monitoring and scientific assessment of biodiversity,” notes *Global Biodiversity Outlook 3*.<sup>43</sup>

Gains have been made in protecting some of the most critical and endangered habitats, including tropical forests and animal habitat. “Nations as a whole are now protecting 13 percent of their land surface in national parks, which is great news. The national parks aren’t always in the places we’d like them to be, but nonetheless countries are coming together to protect more of the planet,” says Pimm, of Duke University and the University of Pretoria.

Here is a look at important efforts in key parts of the globe:

**Oceans** — Oceans cover 70 percent of the planet’s surface and hold some of the most critically endangered habitat and species.

Increased acidification and warmer water temperatures caused by climate change have made reef-forming corals among Earth’s most endangered creatures. In less than 25 years, the number of ocean reefs with living coral on at least half of their surfaces has fallen from more than 60 percent to only 4 percent.<sup>44</sup>

“These are the rainforests of the sea. There’s a huge diversity of species that live in coral reefs and nowhere else,” says Duffy, of the Virginia Institute of Marine Science. Should the reefs die out, the *Global Biodiversity Outlook 3* concluded the repercussions on the ocean food chain could threaten the livelihoods and food security of hundreds of millions of people.<sup>45</sup>

Losing these ecosystems would also be tragic, Duffy adds, because “reefs are a major source of interesting chemical compounds that have led to new drugs and have been used in pharmaceuticals.”

Overfishing also threatens ocean fisheries, a critical source of the world’s food. In Africa and South Asia alone, about 400 million people depend on fish for most of their animal protein.<sup>46</sup> The amount of fish taken out of the oceans has increased nearly five-fold since 1950.<sup>47</sup> Eighty percent of the fish populations assessed by researchers are either “exploited or fully exploited,” according to *Biodiversity Outlook 3*.<sup>48</sup>

Some of the larger, slower-growing fish hunted by humans are the most vulnerable. “The poster child, in some ways, is the bluefin tuna. If this were a land vertebrate it would have been declared an endangered species long ago,” says Duffy, “and yet it’s [still] fished commercially.”

The oceans remain largely wide open to exploitation. The nations attending the 2010 meeting of the Convention on Biodiversity in Nagoya, Japan, agreed to a plan that includes establishing marine protected areas covering 10 percent of the oceans by 2020. Currently, however, less than 1 percent of the oceans are in marine reserves.<sup>49</sup>

**Amazon and Latin America** — Species conservation efforts in recent years have been concentrated in Brazil’s vast portion of the biologically rich Amazon rainforests. “The little-known secret is that the Amazon has gone from almost no protection to 57 percent protected, and while that’s not enough it shows you can actually make a big difference,” said Tom Lovejoy, head of the H. John Heinz III Center’s biodiversity effort, based in Washington, D.C.<sup>50</sup>

In fact, of the 270,000 square miles worldwide that have been put in protected areas since 2003, nearly three-quarters have been in Brazil, largely through collaborative efforts between Brazil and a several other nations and international groups.<sup>51</sup> Norway, for example, is contributing \$1 billion to a Brazilian fund to reduce deforestation.<sup>52</sup>

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## *Is biodiversity loss reaching a critical stage?*



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WRITTEN FOR *CQ GLOBAL RESEARCHER*,  
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**W**ithout a doubt, biodiversity loss is reaching a critical stage. The ever-growing human demand for natural resources continues to place tremendous pressures on Earth's biodiversity, threatening the very ecosystems and benefits that we rely on for security, health and well-being.

This trend is evident in the World Wildlife Fund's 2012 "Living Planet Report," a biennial assessment of the state of global biodiversity produced in collaboration with the Zoological Society of London and the Global Footprint Network. Overall, the report shows global biodiversity has declined nearly 30 percent since 1970, with tropical and freshwater species experiencing the most precipitous declines.

Meanwhile, humanity's ecological footprint — which compares our consumption against Earth's regenerative capacity — is rising. Currently, humans are consuming 50 percent more resources than the Earth can provide annually. We are living as if we have an extra planet at our disposal. In essence, we are overdrawing Earth's bank account — consuming the "principal" — which is clearly not sustainable.

By 2050, Earth must sustain a projected human population of 9-plus billion people while supporting healthy ecosystems and the invaluable free services they provide, such as purifying water, pollinating crops and absorbing the carbon dioxide emissions that contribute to global warming. While technology can replace some of nature's benefits — and buffer against their degradation — many are irreplaceable.

And therein lies the dilemma: How do we reduce the pressure on Earth's ability to regenerate itself while creating a prosperous future that provides food, water and energy for all?

The good news is we can reverse this decline in biodiversity and fragile ecosystems if we act now. The longer we wait, the more likely we'll reach a point of no return. Many ideas and actions can be taken now to head this off, including halting the loss of natural areas and preserving those that remain, increasing the efficiency of food supply chains and minimizing carbon emissions.

But that's just the start. We also must manage resources sustainably, scale up renewable energy production, consider environmental and social costs in national and corporate undertakings and foster equitable access to food, water and energy.

But first and foremost, humanity must recognize that we have a serious problem: We're running up a major ecological debt that is putting the health of our planet (and eventually us) in jeopardy. Let's deal with it now before the debt gets worse.



**PATRICK MOORE**  
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WRITTEN FOR *CQ GLOBAL RESEARCHER*,  
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**T**he idea that humans are driving a "sixth mass extinction" and that the planet's biodiversity is in peril is a myth. Biodiversity is higher in our era than it was 550 million years ago.

This trend toward increased biodiversity has continued throughout the millennia despite five major extinction events — two of which severely reduced the number of species on Earth. During the Permian-Triassic extinction 250 million years ago, 90 percent of all species were exterminated, the nearest life ever came to being wiped off the planet. Then 65 million years ago the Cretaceous-Tertiary extinction caused the loss of dinosaurs and about 50 percent of all species. Both events likely were caused by large meteor impacts, which threw millions of tons of debris into the atmosphere and blocked the sun, reducing plant growth and causing mass starvation. After both events, however, biodiversity recovered and rose to a greater number of species than before.

Humans have caused species extinction ever since they migrated from Africa to new environments where indigenous species could not cope with human predation. When humans reached Australia 60,000 years ago, they hunted most of the large, slow-moving mammals — such as mammoths, mastodons and saber-toothed tigers — to extinction, as they did when they arrived in the New World about 15,000 years ago. When Micronesians discovered New Zealand around A.D. 1200 they hunted the giant flightless Moas to extinction. And most recently, when Europeans colonized Australia, New Zealand and the Pacific islands, many local species were exterminated by non-native species brought in by the settlers — such as rats, cats, foxes and snakes.

The scale of these human-caused extinctions is not remotely close to the mass extinctions caused by natural disasters. Until recently, human-caused extinction was considered a natural event. But serious efforts are now being made to prevent further extinctions, perhaps triggered by the human-induced extinction of the passenger pigeon in the 1920s. The imposition of large protected areas, control of non-indigenous species and establishment of captive breeding programs all have helped to reduce extinctions.

Species will always go extinct, and new species will continue to come into being. Chances are, in the long run, the historical trend toward ever increasing biodiversity will continue through the coming millennia.



Continued from p. 512

The conservationist group SavingSpecies, which Pimm chairs, has worked to connect and protect fragmented habitats in the coastal forests of northeastern Brazil, in an effort to save the endangered golden lion tamarin, a primate that went extinct in the wild before being reintroduced in its habitat, beginning in the mid-1980s.

Pimm says the project, which purchased 31 square miles of largely unproductive grazing land, illustrates how relatively small investments (in this case, about \$300,000) can provide big returns. The group bought — and allowed to return to their natural state — parcels of land that bridged the gaps between surviving areas of habitat, providing a much larger range for

Despite these efforts, however, deforestation in the Amazon Basin continues, albeit more slowly, and has reached more than 17 percent of the original forest. Even if current conservation efforts are successful, it is expected to hit 20 percent by 2020.<sup>53</sup>

Other ecosystems in South and Central America also continue to suffer losses. Populations of tropical freshwater fish, both in Latin American and other equatorial regions, have declined by 74 percent since 1970, primarily due to habitat loss and fragmentation.<sup>54</sup> Amphibian species also are down in numbers worldwide but are at the greatest risk of extinction in Latin America and the Caribbean, according to *Global Biodiversity Outlook 3*.<sup>55</sup>

habitat for many large mammals, while illegal hunting remains a problem across much of the region.<sup>56</sup>

Tigers, for example, have lost 93 percent of their natural range. Their population has fallen to between 3,200 and 3,500 in the wild.<sup>57</sup> Despite conservation efforts, poachers continue to kill tigers for their bones, which are made into “tiger bone wine” used in traditional Chinese medicine. Rhinoceroses are killed for their horns, believed to have medicinal value.

“The increasing wealth of China and Vietnam is driving demand for more tiger bone,” says WWF’s Loucks. “Rhino horn, per kilo, is more expensive than gold and cocaine, so it’s attracting organized crime into the field (in both Asia and Africa). The situation is pretty bad.”

Krithi Karanth, a conservation biologist with the Centre for Wildlife Studies in Bangalore, India, has studied wild animal populations and their interactions with rural Indians. She says the fragmentation of habitat is causing difficulties for a variety of large mammals in the region. Although India has set aside about 5 percent of its land as nature parks, many are too small and isolated from other habitat, Karanth has found.

Still, she sees attitudes on the subcontinent evolving. “For the first time in history there’s a large Indian middle class,” Karanth says, and with that more affluent population, has come increasing attention to conservation. “There’s a lot of public support in India for animals like tigers and elephants. At least in the southern part of the country, you’ve seen a recovery of the tiger population.”

She believes Indian culture provides hope. “Despite having a billion people, we still have a lot of wildlife left, and part of this is because in India there is a large amount of what we call cultural tolerance,” she says. “I’ve talked to thousands of villagers and asked them why, if they have an agricultural loss (because of wild animals)



AFP/Getty Images/Pornchai Kittiwongsakul

Endangered tigers are protected at a Buddhist temple in Kanchanaburi province in Thailand, one of 13 countries hosting fragile tiger populations. The animals are highly prized by international wildlife smugglers. Wild tiger populations have been decimated in recent decades, in part because their bones are sought by practitioners of traditional Chinese medicine. The world tiger population is estimated to have fallen to only 3,200 from about 100,000 a century ago.

the animals to live in. “The simplest things you can do is buy small fragments of land and then reconnect them,” Pimm says. “By reconnecting the land, we can have a disproportionate impact on biodiversity.”

**Asia and India** — Tigers, Asian elephants, Indian rhinoceroses — some of the most well-known threatened species on the planet — live in Asia and India. Rapidly growing human populations have reduced the natural

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they haven't reported it, and the answers are, 'It's their land, too,' or 'It's part of the natural process.' ”

Iraq provides a surprising bright spot for habitat recovery in Asia. Under the regime of Saddam Hussein, 90 percent of the country's Mesopotamian marshes were drained. Since 2003, however, much of the drainage has been dismantled and by 2006 nearly 60 percent of the marshes had been flooded again, enabling the natural vegetation to recover.<sup>58</sup>

**Africa** — A coalition of conservation groups and scientists conducting the first continent-wide survey of habitat for the great African apes recently found that in the past two decades habitat has shrunk by more than 50 percent for the Cross River and eastern gorillas and 31 percent for western gorillas. Chimpanzee habitat also is disappearing across Africa.<sup>59</sup> Deforestation and overhunting threatens the apes. The meat of gorillas and chimpanzees, called bush meat, is a primary source of protein for many rural Africans and is considered a delicacy in some African cities.

“The situation is very dramatic. Many of the ape populations we still find today will disappear in the near future,” said Hjalmar Kuehl, a primatologist with the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, who helped organize the research.<sup>60</sup>

As in Asia, the African human population is growing rapidly, leading to extensive clearing of land for urban growth, agriculture and industry. Forests are losing their trees and biodiversity in waves emanating from major cities, according to the World Wildlife Fund. In Tanzania, for example, logging has advanced 75 miles from the city of Dar es Salaam in just 14 years, depleting all high-value timber within 124 miles.

“This first wave of degradation was followed by a second that removed medium-value timber, and a third that consumed the remaining woody biomass for charcoal production,” according to the “Living Planet Report 2012.”<sup>61</sup> Without alternatives for con-

struction materials and fuel, this stripping of the forests is likely to continue around Africa's major cities.

**North America and Europe** — With established wildlife reserves, conservation laws and active environmental movements, the industrialized countries have not faced the same degree of biodiversity loss in recent years as those in the less developed world.

The WWF's “Living Planet Report 2012” found that the populations of some birds and land and marine mammals have increased in the temperate climate zones, which include North America and Europe, and that there has been an overall increase of biodiversity since 1970 in those regions.

But the industrialized countries cannot pat themselves too firmly on the back, says the WWF's Loucks, because they did their damage in earlier decades. “Prior to 1970, they were much more impacted,” he says. Also, he adds, “There's naturally much more biodiversity in the tropics, so there's more to lose.”

Despite overall positive trends, areas of concern still exist in the North. Since 1980, farmland bird populations have declined in Europe by an average of 50 percent, according to the Convention on Biological Diversity.<sup>62</sup> Wildflowers, including marigolds, cornflowers and poppies, also are disappearing from much of the English countryside, according to conservationists, who believe the increased use of agricultural herbicides may be responsible.<sup>63</sup>

The United States witnessed a conservation success story with the recent recovery of most of the nation's offshore fisheries, which had been badly depleted, through a federal program that set quotas for total catch based on scientific assessments.<sup>64</sup> Regional councils then apportion that quota among commercial fishermen.

Despite the program's success and its support by commercial fisherman, however, it is controversial with recreational fishermen, who feel the program

benefits large commercial fishermen at the expense of sports fishing. The U.S. House of Representatives voted last May to deny federal funds to expand the program. The two Republican lawmakers behind the bill, Florida's Rep. Steve Southerland and Rep. Michael Grimm of New York, declared the system was part of federal efforts “to destroy every aspect of American freedom under the guise of conservation.”<sup>65</sup>

The bill has not advanced in the Senate. ■

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## OUTLOOK

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### Coming Changes

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If the world is indeed nearing a global biodiversity state shift, as some scientists believe, then the natural environment could start to look very different in as little as 20 years or so. No one can predict the shape of that new world, except that many of the plants and animals we know now would not be around.

But even some scientists who believe a so-called tipping point is approaching say it could still be a century or more away. Conservation biologists and other researchers point out, however, that current rates of biodiversity loss will still result in significant changes in life on the planet, whether or not the ecosystem reaches a tipping point.

If the declines in population of tropical freshwater fish and many important ocean species are not reversed, much of the world's population could face a shortfall in one of its important food sources. If agricultural plant and livestock biodiversity continues to be lost, the prospect for a devastating disease sweeping through crops, such as the strain of wheat rust now hurting

farmers in Asia and Africa, grows more likely.

“Unfortunately, I’m not very optimistic regarding the long-term future, unless we take drastic measures,” says Loreau, of the Centre for Biodiversity Theory and Modelling in France. “We live in a civilization that is based on the idea that humans are very different from everything else and should really dominate nature, and it leads us to completely downplay natural processes and the importance of ecosystems. To address the problem we have to recognize that humans are part of nature. We have to change our relationship with nature and how much we consume.”

Karanth, of the Centre for Wildlife Studies in Bangalore, fears a confluence of environmental changes. “On the global level, it looks pretty grim,” she says, “with climate change being the big factor. With huge areas becoming warmer, it’s going to be hard to save much of what’s here.”

But others focus on the progress that has already been made. “Here in the U.S., where we have strong laws, lots of money for recovery and a democratic system that allows citizens to hold the government’s feet to the fire, we can and do save species. So it is possible for us to turn this around,” says Suckling, of the Center for Biological Diversity in Tucson.

“It’s going to require a lot of effort and a lot of money and, in many countries, political reform,” he says. “But we’ve done it in a lot of places.”

Barnosky, of UC-Berkeley and the primary author of the state shift study, believes the future depends on bringing down the rate of world population growth. “It’s all too easy to turn this into a ‘gloom-and-doom, we’re screwed’ story. For me, the key point is, if we want to make a future for our kids as good as the one we live in now, there are things we have to recognize are happening and take steps to manage. We’ve got a window of time here.

“We’re poised right on the cusp,” he continues. “If we do the right thing, it’s all going to turn out okay. If we don’t, all hell can break loose.” ■

## Notes

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<sup>14</sup> *Ibid.*

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<sup>16</sup> *Ibid.*, p. 53.

<sup>17</sup> *Global Biodiversity Outlook 3* video presentation, Secretariat of the Convention on Biological Diversity, 2012, [www.cbd.int/gbo3/](http://www.cbd.int/gbo3/).

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<sup>19</sup> *Ibid.*, p. 54.

<sup>20</sup> *Ibid.*

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## FOR MORE INFORMATION

**Center for Biological Diversity**, P.O. Box 710, Tucson, AZ 85702; 520-623-5252; [center@biologicaldiversity.org](mailto:center@biologicaldiversity.org). A leading advocacy organization for protecting biodiversity in the United States.

**Conservation International**, 2011 Crystal Dr., Suite 500, Arlington, VA 22202; 703-341-2400; [www.conservation.org](http://www.conservation.org). Promotes biological research and works with national governments and businesses to protect 34 biodiversity hot spots worldwide.

**Defenders of Wildlife**, 1130 17th St., N.W., Washington, DC 20036; 202-682-9400; [www.defenders.org](http://www.defenders.org). An advocacy group dedicated to the preservation of all wild animals and native plants in their natural communities.

**The International Union for Conservation of Nature**, IUCN Conservation Centre, Rue Mauverny 28, 1196 Gland, Switzerland; +41 22 999-0000; [www.iucn.org](http://www.iucn.org). The world's oldest and largest global environmental organization; maintains the "Red List," which identifies species at risk of extinction.

**The Nature Conservancy**, 4245 North Fairfax Dr., Suite 100, Arlington, VA 22203-1606; 703-841-5300; [www.nature.org](http://www.nature.org). Supports land conservation to protect wildlife habitat in the U.S. and more than 30 nations.

**Secretariat of the Convention on Biological Diversity**, 413, Saint Jacques St., Suite 800, Montreal QC, H2Y 1N9, Canada; +1 514 288-2220; [www.cbd.int](http://www.cbd.int). U.N. agency charged with supporting the goals of the Convention on Biological Diversity.

**World Resources Institute**, 10 G St., N.E., Suite 800, Washington, DC 20002; 202-729-7600; [www.wri.org](http://www.wri.org). Conducts research on ecosystem threats and works with indigenous communities to balance human and wildlife needs.

**World Wildlife Fund International**, Av. du Mont-Blanc 1196, Gland, Switzerland; +41 22 364 91 11; [wwf.panda.org](http://wwf.panda.org). Works to protect endangered species around the world and publishes the omnibus "Living Planet" reports.

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In a seminal work on biodiversity loss, a leading critic of monoculture agriculture and biotechnology examines their impacts on biodiversity and indigenous farmers in the developing world.

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A U.S. conservation group finds that the Endangered Species Act has been largely successful.

# The Next Step:

## *Additional Articles from Current Periodicals*

### ***Disappearing Bees***

Richards, Linda, "Going Organic Affects Bees and Butterflies," *Redlands (Calif.) Daily Facts*, Aug. 27, 2012, [www.redlandsdailyfacts.com/news/ci\\_21410046/going-organic-affects-bees-and-butterflies](http://www.redlandsdailyfacts.com/news/ci_21410046/going-organic-affects-bees-and-butterflies).

Organic farming benefits the preservation of bees because it requires less pesticide spraying, according to The Soil Association in England.

Walters, Tiara, "Be Nice or They Buzz Off," *Sunday Times (South Africa)*, May 20, 2012, [www.timeslive.co.za/sundaytimes/2012/05/19/be-nice-or-they-buzz-off](http://www.timeslive.co.za/sundaytimes/2012/05/19/be-nice-or-they-buzz-off).

Experts say efforts should be made to stem the disappearance of bees because they are arguably the most crucial ecological driver on Earth because of the billions of flowers they pollinate.

### ***Monoculture and Invasive Species***

Gray, Lisa, "The War Against the Plants," *The Houston Chronicle*, Oct. 23, 2011, p. 1, [www.chron.com/life/gray/article/Gray-The-war-against-the-plants-2228834.php](http://www.chron.com/life/gray/article/Gray-The-war-against-the-plants-2228834.php).

Chinese tallow trees — an invasive species in southeast Houston — are growing so fast they leave little space for other plants and animals.

Griffin, Mary, "Mission to Save Brownfield Sites So Precious to Our Wildlife," *Coventry (England) Telegraph*, Oct. 16, 2012, p. 12.

Critics of modern agriculture say agricultural monocultures threaten biodiversity.

### ***Seed Banks***

"SAARC Seed Bank Finalized: Mijarul," *Bangladesh Government News*, Nov. 9, 2011.

The foreign secretaries of eight South Asian nations have agreed to develop a common seed bank to boost agricultural production in the region.

Foderaro, Lisa W., "Local Seeds: Not for Food, But for Future," *The New York Times*, Oct. 23, 2011, p. MB1, [www.nytimes.com/2011/10/23/nyregion/new-york-city-native-plant-centers-seed-is-for-the-future.html?\\_r=0](http://www.nytimes.com/2011/10/23/nyregion/new-york-city-native-plant-centers-seed-is-for-the-future.html?_r=0).

England's Millennium Seed Bank is saving seeds collected from 10 percent of the world's plant species for posterity.

Thompson, Sylvia, "From Gathering Apple Seeds to Protecting Global Biodiversity," *Irish Times*, Aug. 10, 2012, p. 14, [www.irishtimes.com/newspaper/features/2012/0810/1224321880112.html](http://www.irishtimes.com/newspaper/features/2012/0810/1224321880112.html).

Ireland's president opened the country's new seed bank, in which seeds will be stored in a climate-controlled envi-

ronment until they might be needed in the event of a massive loss of agricultural biodiversity.

### ***Threats***

"41% of Country's Forest Cover Has Suffered Degradation," *Economic Times (India)*, Feb. 11, 2012, [articles.timesofindia.indiatimes.com/2012-02-10/the-good-earth/31045785\\_1\\_biodiversity-loss-biological-diversity-act-species](http://articles.timesofindia.indiatimes.com/2012-02-10/the-good-earth/31045785_1_biodiversity-loss-biological-diversity-act-species).

More than 40 percent of India's forest cover has been degraded to some degree, says the former head of the Indian Space Research organization.

Connor, Steve, "Amphibians Face Raised Extinction Threat," *The Independent (England)*, Nov. 17, 2011, p. 24, [www.independent.co.uk/environment/nature/amphibians-face-raised-extinction-threat-6263377.html](http://www.independent.co.uk/environment/nature/amphibians-face-raised-extinction-threat-6263377.html).

Many of the world's amphibians could die out faster than expected, according to a study from Copenhagen University.

Esong, Liengu Etaka, "Biodiversity Conservation Plan Under Review," *Cameroon Tribune*, Aug. 26, 2012, [allfrica.com/stories/201208271069.html](http://allfrica.com/stories/201208271069.html).

Cameroon's government is addressing new and emerging challenges to biodiversity in its new National Biodiversity Strategy and Action Plan.

Jacobs, Clemencia, "Region Most Affected by Climate Change," *Namibia Economist*, April 2012, [allafrica.com/stories/201204290073.html](http://allafrica.com/stories/201204290073.html).

Sub-Saharan Africa is not the biggest culprit when it comes to pollution, but it is the most affected by climate change, partly because of the loss of biodiversity, says South Africa's deputy minister of science and technology.

### ***CITING CQ GLOBAL RESEARCHER***

Sample formats for citing these reports in a bibliography include the ones listed below. Preferred styles and formats vary, so please check with your instructor or professor.

#### **MLA STYLE**

Flamini, Roland. "Nuclear Proliferation." *CQ Global Researcher* 1 Apr. 2007: 1-24.

#### **APA STYLE**

Flamini, R. (2007, April 1). Nuclear proliferation. *CQ Global Researcher*, 1, 1-24.

#### **CHICAGO STYLE**

Flamini, Roland. "Nuclear Proliferation." *CQ Global Researcher*, April 1, 2007, 1-24.



# Voices From Abroad:

## ERACH BHARUCHA

Director, Bharati  
Vidyapeeth Institute of  
Environment Education  
and Research  
India

### *A multi-pronged strategy*

“Planning a strategy for biodiversity conservation must also include breeding of endangered species. . . . Preserving corridors between protected areas to facilitate movement of animals is crucial to maintain wildlife population. Identifying ecologically sensitive areas around parks and sanctuaries to form buffers is necessary to protect animals inside the protected areas and reduce conflict with local people’s needs.”

*Economic Times (India)*  
April 2012

## SALIHU DAHIRU

Head, United Nations  
Initiative on Reducing  
Emissions from  
Deforestation and  
Forest Degradation  
Nigeria

### *Sharing the costs*

“The cost of such additional investments [in biodiversity] must be fairly shared between those countries that demand forest-related emission reductions and those that supply them.”

*Daily Trust (Nigeria)*  
December 2011

## DIANE KLAIMI

Program Officer  
U.N. Environment Pro-  
gramme, Regional Office  
West Asia, Bahrain

### *Accelerated loss*

“The Gulf region is under pressure from urban growth and development, and they are drivers of biodiversity loss. Biodiversity loss has reached 1,000 times more than it used to be 50 years ago; we are trying to bring these figures to policymakers and the business sector and see how they can implement biodiversity conservation.”

*Gulf Daily News (Bahrain)*  
May 2011

## NAOKI ADACHI

President, Response  
Ability (an environmental  
consulting firm), Japan

### *A wise business decision*

“Until recently, most companies considered their businesses and biodiversity separate issues. But now they realize that without healthy biodiversity, they cannot maintain their businesses.”

*Japan Times, October 2010*

## TRACY REES

Deputy Director, Business  
in the Community,\* Wales

### *Superficial reporting*

“Biodiversity and ecosystem services are usually treated superficially in company reports and are rarely seen as

financially material or relevant to annual financial reporting.”

*Western Mail (Wales)*  
January 2012

## ABSALOM SHIGWEDHA

Environmental journalist  
Namibia

### *More than just wildlife*

“Biodiversity is not just about wildlife or wild places. It includes the crops that we eat, the insects that pollinate them and the bacteria that create soil that sustains farming.”

*New Era (Namibia)*  
December 2011

## IAN SPELLERBERG

Professor of Nature Con-  
servation, Lincoln University  
New Zealand

### *More to do*

“New Zealand is seen as a world leader in nature conservation — but let’s not forget that nature conservation is not a luxury. It is the most fundamental of all the pillars of sustainability. We have

achieved a lot in nature conservation, but it’s more than just about saving iconic species. . . . A lot more has to be done to conserve and ensure sustainable, equitable use of nature’s goods and services. Diversity in nature is the key, whether it is diversity of biota in the soils, genetic diversity or diversity within ecosystems.”

*New Zealand Herald*  
November 2010

## CATHERINE NAMUGALA

Minister of Tourism  
Environment and  
Natural Resources  
Zambia

### *Tourism depends on it*

“Without natural resources, it would be very difficult to attract tourists. We also need to balance the ecological, economical, ethical and scientific roles in the country. In short, we all depend on biological diversity.”

*Times of Zambia, October 2010*

\* A charity that promotes corporate social responsibility.

