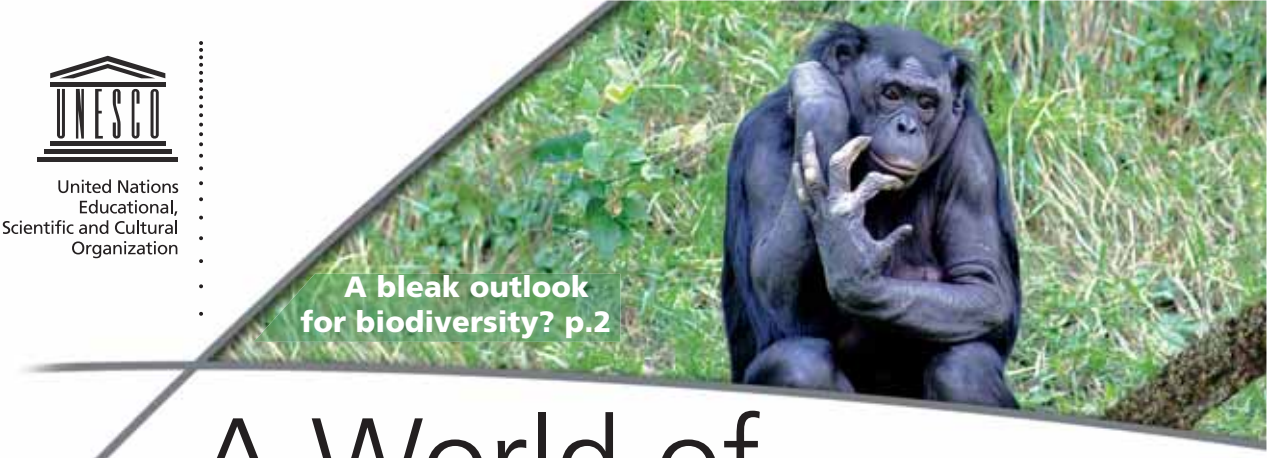
United Nations
Educational,
Scientific and Cultural
Organization



A World of SCIENCE

Natural Sciences
Quarterly Newsletter

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IN THIS ISSUE

EDITORIAL

A **biocultural** alliance

In the summary of the latest *Global Biodiversity Outlook* overleaf, one of the rare bright spots in an otherwise bleak tableau is the ingenuity of traditional and local approaches in protecting biodiversity. In one example, fish and rice have cohabited in China for at least 2000 years in an agricultural system that is sufficiently productive for there to be a lesser need for chemical fertilizers and pesticides. But for how much longer? The homogenizing forces of globalization are whittling away some of the world's most effective cultural strategies for protecting biodiversity.

To combat this worrying trend, UNESCO and the Secretariat of the Convention on Biological Diversity (CBD), author of the *Global Biodiversity Outlook*, have joined forces to study and tackle the threats hanging over cultural and biological diversity. This joint programme is the brainchild of the Conference on Biological and Cultural Diversity for Development, held in Montreal (Canada) on 8–10 June; it brought together scientists, representatives of indigenous and local communities, politicians, NGOs, intergovernmental bodies, development agencies and environmentalists. If the joint programme is adopted by the Conference of the Parties to the CBD in Nagoya in October, UNESCO and the CBD Secretariat will begin by elaborating a set of guiding principles for future research, management, practice and policy work at the interface between biological and cultural diversity.

The programme will also advance knowledge on the ways in which cultures have shaped and continue to shape biodiversity in a sustainable way. It will collect empirical case studies of the links between cultural and biological diversity in biosphere reserves, world heritage sites and elsewhere. In parallel, it will strengthen collaboration and coordination among relevant international agreements, including the Convention on Biological Diversity (1992) and UNESCO culture-related conventions, in particular the World Heritage Convention (1972) and those for the Safeguarding of Intangible Cultural Heritage (2003) and the Protection and Promotion of the Diversity of Cultural Expressions (2005).

One of my first decisions upon taking office was to launch *A World of Science* 'to keep UNESCO's concerns in the public eye and at the centre of public debate.' I believe the newsletter has fulfilled that promise. Above all, I would like to thank the editor, Susan Schneegans, for putting flesh on the bones of this idea and for maintaining a high standard over the past eight years. I would also like to thank our colleague Yvonne Mehl, to whom we owe the attractive lay-out.

Today, the newsletter fills a unique niche and the readership continues to grow. Feedback from readers is most positive. As I prepare to hand over the reins to my successor, Gretchen Kalonji, I can only encourage her to maintain this line of communication open with those who share UNESCO's ideals and a keen desire to understand – and influence – the changing world in which we live.

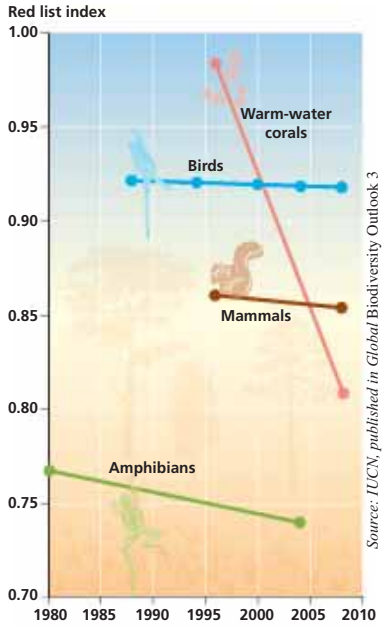
W. Erdelen
Assistant Director-General for Natural Sciences

A bleak outlook for **biodiversity?**

The latest *Global Diversity Outlook* makes for grim reading. 'Not a single government claims … that the 2010 Biodiversity Target has been completely met at the national level,' observes the report released by the Convention on Biological Diversity (CBD) on 10 May. Despite a stepping-up of conservation efforts, biodiversity continues to decline under the assault of escalating pressures, even if negative trends have been slowed or even reversed in some ecosystems.

There are signs that many countries now measure the enormity of the problem. Although the 2010 Biodiversity Target of achieving a significant drop in the rate of biodiversity loss has not been met, 167 countries now have national biodiversity strategies and action plans, protected areas have grown in number and size, and countries are applying environmental impact assessments more widely than before.

So what is the status of biodiversity today? This question takes on added acuity as 'Nagoya' approaches. From 19 to 30 October, governments will be meeting in the Japanese city to fix fresh targets for reducing the rate of biodiversity loss, at the next conference of the Parties to the CBD. Knowing the status of biodiversity today will be vital to fixing realistic targets for tomorrow.

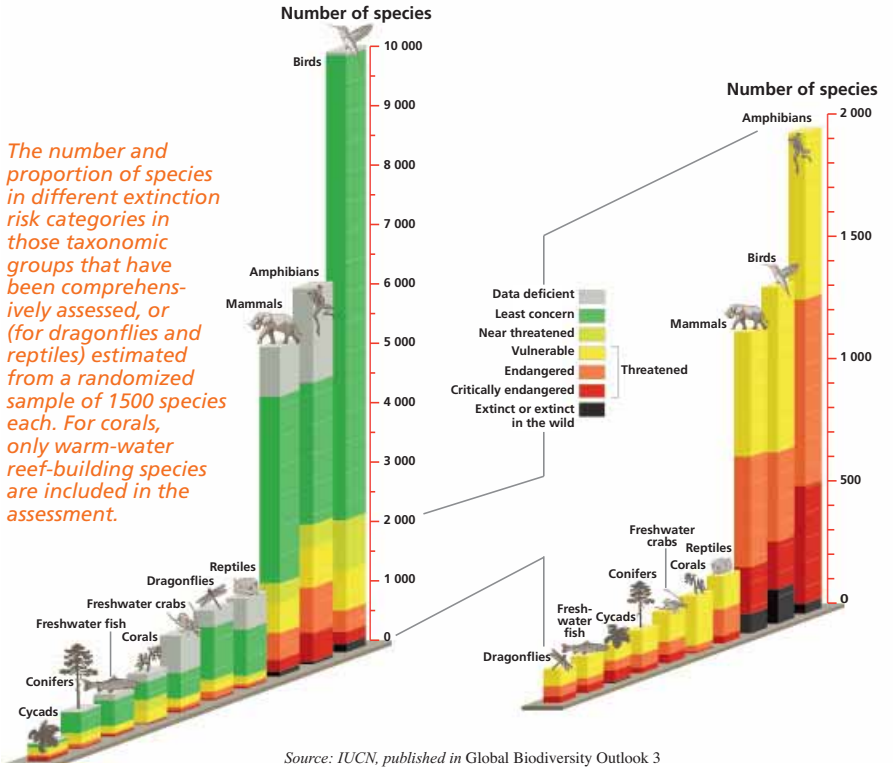


The Red List Index summarized here shows that all fully assessed species groups are declining.

All assessed species being driven closer to extinction

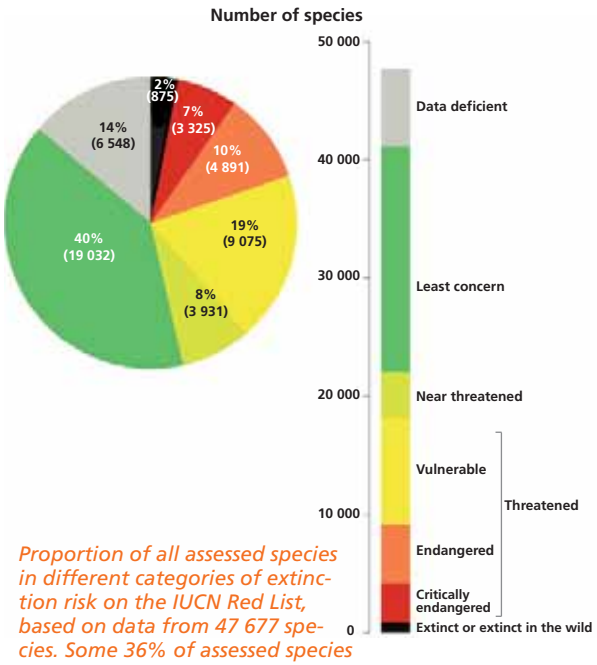
Conservation efforts have reduced the extinction risk for some species but these success stories are outnumbered by those species moving closer towards extinction. The Red List Index of the International Union for the Conservation of Nature (IUCN) shows that all groups that have been fully assessed for extinction risk are becoming more threatened (*see figure*).

Amphibians face the greatest risk and warm-water reef-building corals show the most rapid deterioration in status. In the case of coral species, this is probably due in large part to the widespread bleaching of tropical reef systems in 1998. Some 42% of amphibian species are declining through a combination of habitat modification, changes in climate and the fungal disease chytridiomycosis. The figure is also high for bird species: 20%. Among selected vertebrate, invertebrate and plant groups, between 12% and 55% of species

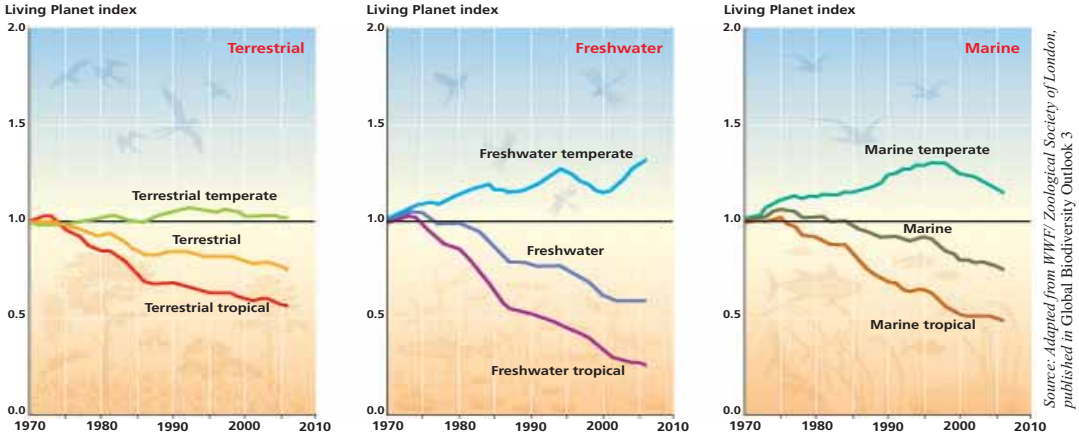


The number and proportion of species in different extinction risk categories in those taxonomic groups that have been comprehensively assessed, or (for dragonflies and reptiles) estimated from a randomized sample of 1500 species each. For corals, only warm-water reef-building species are included in the assessment.

Source: IUCN, published in Global Biodiversity Outlook 3



Proportion of all assessed species in different categories of extinction risk on the IUCN Red List, based on data from 47 677 species. Some 36% of assessed species are considered to be threatened.



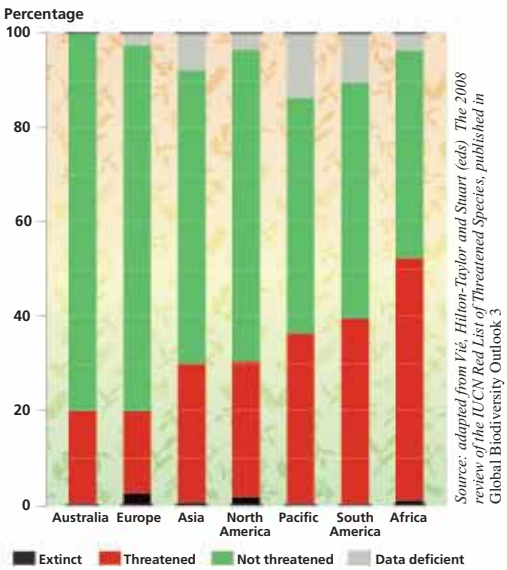
Source: Adapted from WWF/ Zoological Society of London, published in Global Biodiversity Outlook 3

The Living Planet Index has declined by more than 30% since 1970 , with especially steep losses for freshwater and tropical species.

are currently threatened with extinction. Preliminary assessments suggest that 23% of plant species are threatened.

The population of wild vertebrate species fell by an average 31% globally between 1970 and 2006, with the decline being especially severe in the tropics (59%) and in freshwater ecosystems (41%) [*see figure*]. Temperate species populations have actually increased on average since 1970, so the steady global decline since that date is accounted for entirely by a sharp fall in the tropics. This does not necessarily mean tropical biodiversity is in a worse state than in temperate regions: if the Living Planet Index used to measure this trend were to extend back centuries rather than decades, populations of temperate species may have declined by an equal or greater amount. Moreover, the increase in wild animal populations in temperate regions may be linked to widespread afforestation of former cropland and pasture, and does not necessarily reflect richer diversity of species.

Bird and mammal species used for food and medicines are, on average, facing a greater extinction risk than species as a whole, through a combination of over-exploitation, habitat loss and other factors. This emphasizes the threat posed by biodiversity loss to the health and well-being of millions of people directly dependent on the availability of wild species. For example, WHO estimates that 60% of children suffering from fever in Ghana, Mali, Nigeria and Zambia are treated at home with herbal medicines while, in one part of Nepal, 450 plant species are commonly used locally for medicinal purposes (*see figure*).



Source: adapted from Vié, Hilton-Taylor and Stuart (eds). The 2008 review of the IUCN Red List of Threatened Species, published in Global Biodiversity Outlook 3

Extinction risk for medicinal plants is greatest in those regions where they are most widely used.

Agricultural biodiversity shrinking

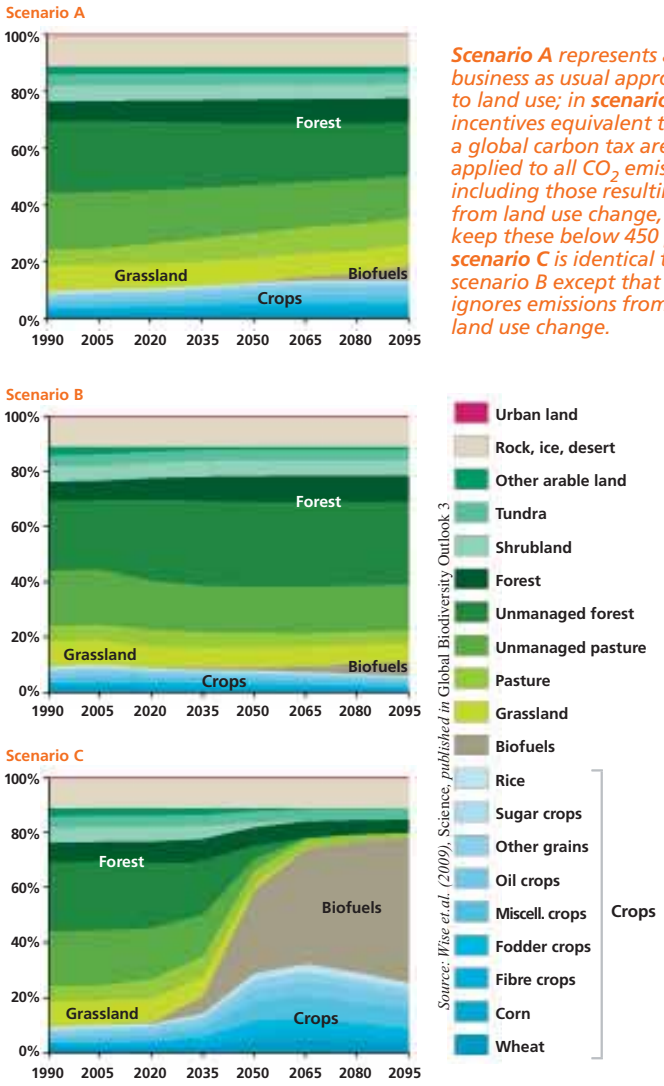
Genetic diversity is not only being lost in natural ecosystems but also in systems of crop and livestock production. Some 21% of the world's 7000 livestock breeds are classified as being at risk. The true figure is likely to be much higher, as a further 36% are of unknown risk status. More than 60 breeds reportedly became extinct during the first six years of this century alone.

Standardized and high-output systems of animal husbandry are responsible for this erosion of the genetic diversity of livestock. Government policies and development programmes can make matters worse, if poorly planned. A variety of direct and indirect subsidies tend to favour large-scale production at the expense of small-scale livestock-keeping and the promotion of 'superior' breeds will further reduce genetic diversity.

The reduction in the diversity of breeds has so far been greatest in developed countries, as widely used, high-output varieties like Holstein-Friesian cattle come to dominate. In many developing countries, changing market demands, urbanization and other factors are leading to rapid growth of more intensive animal production systems. This has favoured the use of non-local breeds 'imported' largely from developed countries, often at the expense of local genetic resources.

There is particular anxiety that a general homogenization of landscapes and agricultural varieties may make rural populations vulnerable to future changes, if genetic traits kept over thousands of years are allowed to disappear. In China, the number of local rice varieties being cultivated has declined from 46 000 in the 1950s to slightly more than 1000 in 2006. In some 60–70% of areas where wild relatives of rice used to grow, they have either disappeared or are being grown over a much smaller area.

Significant progress has been made in *ex situ* conservation of crops. For some 200–300 crops, it is estimated that over 70% of genetic diversity is already conserved in gene banks, meeting the target set under the



*Scenario A represents a business as usual approach to land use; in **scenario B**, incentives equivalent to a global carbon tax are applied to all CO_2 emissions, including those resulting from land use change, to keep these below 450 ppm; **scenario C** is identical to scenario B except that it ignores emissions from land use change.*

Global Strategy for Plant Conservation. The FAO has also recognized the leading role played by plant and animal breeders, as well as by the curators of *ex situ* collections, in conservation and sustainable use of genetic resources.

In many parts of the world, traditional techniques of managing land for agriculture are being lost, partly due to the intensification of production and partly to migration from rural to urban areas. In some cases, this trend may create opportunities for biodiversity through the re-establishment of natural ecosystems on abandoned farmland. However, the changes may also involve important losses of distinctive biodiversity among both domesticated and wild species.

One example of an agricultural landscape maintained by farmers is rice-fish agriculture, which has been practiced in China for at least 2000 years. In this system, fish are kept in wet rice fields. The fish provide fertilizer, soften soils and eat larvae and weeds, while the rice provides shade and food for the fish. The fish are highly nutritious, labour costs are lower and there is a lesser need for chemical fertilizers, herbicides and pesticides.

Habitat loss and degradation biggest threat

The FAO's Global Analysis of Land Degradation and Improvement estimates that 24% of the world's land area was undergoing degradation, as measured by a decline in primary productivity, over the period 1980–2003. Degrading areas include around 30% of all forests, 20% of cultivated areas and 10% of grasslands. Geographically, these are found mainly in Africa south of the Equator, Southeast Asia and southern China, north-central Australia, the Pampas grasslands in South America and parts of the Siberian and North American boreal forests. Around 16% of land is becoming more productive, the largest proportion (43%) being in rangelands.

The decline in fixation of carbon from the atmosphere associated with this degradation is estimated at nearly a billion tonnes from 1980 to 2003, almost the equivalent of annual carbon dioxide (CO_2) emissions from the European Union! Emissions from the loss of soil carbon are likely to have been many times greater.

The five principal pressures directly driving biodiversity loss are habitat change, overexploitation, climate change, pollution and invasive alien species. All five pressures are either constant or increasing in intensity. The overwhelming majority of governments reporting to the CBD cite these pressures as affecting biodiversity in their countries.

Taken together, habitat loss and degradation are the biggest single source of pressure on biodiversity worldwide. For terrestrial ecosystems, habitat loss is largely accounted for by conversion of wild lands to agriculture, which now accounts for some 30% of land globally. In some areas, it has recently been partly driven by the demand for biofuels.

The sharp decline of tropical species populations shown in the Living Planet Index mirrors widespread loss of habitat in those regions. For example, in one recent study, the conversion of forest to oil palm plantations was shown to lead to the loss of 73–83% of the bird and butterfly species of the ecosystem. Birds face an especially high risk of extinction in Southeast Asia, the region that has seen the most extensive development of oil palm plantations, driven in part by the growing demand for biofuel.

Forests: expanding in temperate zones, shrinking in the tropics

The best information on terrestrial habitats relates to forests, which currently occupy about 31% of the Earth's land surface. Forests are estimated to contain more than half of terrestrial animal and plant species, the great majority of them in the tropics, and account for more than two-thirds of net primary production on land: the conversion of solar energy into plant matter.

Tropical forests continue to be lost at a rapid rate, although deforestation has recently slowed in some countries. Net loss of forests has slowed substantially in the past decade, largely due to forest expansion in temperate regions.

Deforestation through the conversion of forests to agricultural land, for the most part, is showing signs of slowing down in several tropical countries but continues at an alarming rate. Just under 130 000 km^2 of forest were converted to other uses or lost through natural causes each year from 2000 to 2010, compared to nearly 160 000 km^2 per year in the 1990s. The net loss of forests has slowed substantially, from approximately 83 000 km^2 per year in the 1990s to just over 50 000 km^2 per year from 2000 to 2010. This is mainly due to large-scale planting of forests in temperate regions and to natural expansion of forests. Since newly planted forests often have low biodiversity value and may only include a single tree species, a slowing of net forest loss does not necessarily imply a slowing in the loss of global forest biodiversity. Between 2000 and 2010, the global extent of primary forest – that is, substantially undisturbed – declined by more than 400 000 km^2, an area larger than Zimbabwe.

South America and Africa continued to have the largest net loss of forests in 2000–2010. Oceania also reported a net loss of forests, while the area of forest in North and Central America, taken as a whole, was estimated to be almost the same in 2010 as in 2000. The forest area in Europe continued to expand, although at a slower rate than in the 1990s. Asia, which had a net loss in the 1990s, reported a net gain of forests in the period 2000–2010, primarily due to large-scale afforestation reported by China, despite continued high rates of net forest loss in many countries in South and Southeast Asia.

Forests and rivers have become highly fragmented

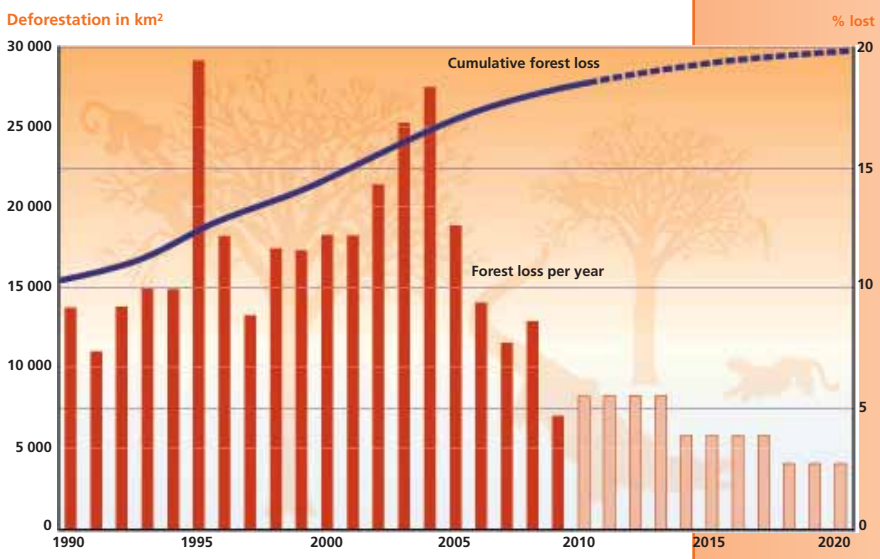
Ecosystems across the planet have become severely fragmented, threatening the viability of species and their ability to adapt to climate change. Global data are hard to obtain but some well-studied ecosystems provide eloquent illustrations. For example, the remaining South American Atlantic Forest, estimated to contain up to 8% of all terrestrial species, is largely composed of fragments less than 1 km^2 in size. More than 50% lies within 100 m of the forest edge. When ecosystems become fragmented, they may be too small for some animals to establish a breeding territory, or force plants and animals to breed with close relatives. The inbreeding of species can increase vulnerability to disease by reducing the genetic diversity of populations. A study in the central Amazon region of Brazil found that forest fragments of less than 1 km^2 lost half of their bird species in less than 15 years.

Of 292 large river systems, two-thirds have become moderately or highly fragmented by dams and reservoirs. The most fragmented rivers are in industrialized regions like much of the USA and Europe, and in heavily populated countries such as China and India. Rivers in arid regions also tend to be highly fragmented, as scarce water supplies have often been managed through the use of dams and reservoirs. Rivers flow most freely in the less-populated areas of Alaska, Canada and Russia, and in small coastal basins in Africa and Asia.

More than 40% of the global river discharge is now intercepted by large dams and one-third of sediment destined for the coastal zones no longer arrives. These large-scale disruptions have had a major impact on fish migration, freshwater biodiversity more generally and the services it provides. They also have a significant influence on biodiversity in terrestrial, coastal and marine ecosystems.

Brazilian Amazon not out of the woods yet

The most recent satellite data suggest that annual deforestation of the Brazilian portion of the Amazon has slowed significantly, from a peak of more than 27 000 km^2 in 2003–2004 to just over 7000 km^2 in 2008–2009, a decrease of over 74% (*see figure*).



However, the same satellite images indicate that a growing area of the Amazon forest is becoming degraded. The 2008–2009 deforestation figure, the lowest since satellite monitoring began in 1988, may have been influenced by the economic recession, as well as by actions taken by the government, private sector and civil society organizations to control deforestation.

Notwithstanding this, the average from 2006 to 2009 was more than 40% below the average for the previous decade. Cumulative deforestation of the Brazilian Amazon is nevertheless substantial, covering more than 17% of the original forest area. Even if the government achieves its target of reducing annual deforestation by 80% (from the 1996–2005 average), this would bring the cumulative loss of forest to nearly 20%.

Source: Brazilian National Space Research Institute and Ministry of Environment, published in Global Biodiversity Outlook 3

Inland water ecosystems are often poorly served by the terrestrial protected areas network, which rarely takes into account the impact upstream and downstream. Some 159 governments have ratified the Ramsar Convention, currently committed to conserving 1880 wetlands of international importance covering over 1.8 million km^2. However, the condition of these wetland protected areas continues to deteriorate, with the majority of governments reporting a greater need to address adverse ecological changes in 2005–2008, compared with the previous three-year period. The countries reporting the greatest concern about the condition of wetlands are in the Americas and Africa.

A severe decline in savannas, woodlands and grasslands

It is estimated that more than 95% of North American grasslands have been lost. Cropland and pasture have replaced nearly half of the Cerrado, the woodland–savanna biome of Central Brazil which has an exceptionally rich variety of endemic plant species. Between 2002 and 2008, the Cerrado is estimated to have lost more than 14 000 km^2 per year, or 0.7% of its original extent annually, well above the current rate of loss in the Amazon.

The Miombo woodlands of Southern Africa, another savanna region with significant plant diversity, are also experiencing continued deforestation. Stretching from Angola to Tanzania and covering an area of 2.4 million km^2 (the size of Algeria), the Miombo provide firewood, building materials and extensive supplies of wild food and medicinal plants to local communities. The woodlands are threatened by land-clearing for agriculture, extraction of wood to make charcoal and uncontrolled bush fires.

Coastal habitats shrinking

Coastal habitats such as mangroves, seagrass beds, salt marshes and shellfish reefs continue to shrink at a disturbing rate, even if the rate of mangrove loss has slowed somewhat in all but Asia – the region where most remaining mangroves are found. Threats include tourism and urban infrastructure, shrimp farming and port facilities, including dredging. This is compounded by sea-level rise, creating what might be termed a 'coastal squeeze'.

The FAO estimates that about one-fifth of the world's mangroves, covering 36 000 km^2, were lost between 1980 and 2005. During the 1980s, an average of 1850 km^2 was lost each year. In the 1990s, this dropped to an annual average of 1185 km^2, and from 2000 to 2005 to 1020 km^2.

Seagrass beds or meadows fringe coastlines throughout the world. They support commercial fisheries, serve as a food source for species such as manatees and dugongs, and stabilize sediments. Since 1980, the loss of seagrass beds has averaged approximately 110 km^2 per year, a rate of loss comparable to mangroves, coral reefs and tropical forests.

Salt marshes, important as natural storm barriers and as habitats for shorebirds, have lost some 25% of the area they originally covered globally and current rates of loss are estimated to be 1–2% per year.

Shellfish reefs are an even more threatened coastal habitat. They play an important role in filtering seawater and providing food and habitat

Shrinking Arctic sea ice affecting biodiversity

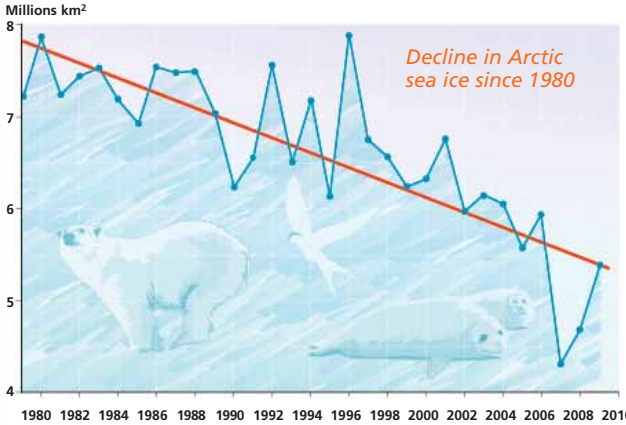
The annual thawing and refreezing of sea ice in the Arctic Ocean has seen a drastic change in pattern during the first years of the 21st century. At its lowest point in September 2007, ice covered a smaller area of the ocean than at any time since satellite measurements began in 1979, 34% less than the average summer minimum between 1979 and 2000. Sea ice extent in September 2008 was the second-lowest on record and, although the level rose in 2009, it remained below the long-term average.

As well as shrinking in extent, Arctic sea ice has become significantly thinner and newer: at its maximum extent in March 2009, only 10% of the Arctic Ocean was covered by ice older than two years, compared with an average of 30% during 1979–2000. This increases the likelihood of continued acceleration in the amount of ice-free water during summers to come.

The prospect of ice-free summers in the Arctic Ocean implies the loss of an entire biome. Whole species assemblages are adapted to life on top of or under ice – from the algae that grow on the underside of multi-year ice, forming up to 25% of the Arctic Ocean's primary production, to the invertebrates, birds, fish and marine mammals further up the food chain.

Many animals also rely on sea ice as a refuge from predators or as a platform for hunting. Ringed seals, for example, depend on specific ice conditions in the spring for reproduction and polar bears live most of their lives travelling and hunting on the ice, coming ashore only to den.

There are wider implications. Bright white ice reflects sunlight. When it is replaced by darker water, the ocean and the air heat much faster, a feedback that accelerates ice melt and heating of surface air inland, with resultant loss of tundra. Less sea ice leads to changes in seawater temperature and salinity, leading to changes in primary productivity and species composition of plankton and fish, as well as large-scale changes in ocean circulation, affecting biodiversity well beyond the Arctic.



Source: adapted from NSIDC (2009) Sea Ice Index. National Snow and Ice Data Center, USA; published in Global Biodiversity Outlook 3

for fish, crabs and seabirds. It is estimated that 85% of oyster reefs have been lost globally and that they are functionally extinct in 37% of estuaries and 28% of ecoregions.

The quantity of carbon buried each year by vegetated coastal habitats such as mangroves, salt marshes and seagrass beds has been estimated at between 120 and 329 million tonnes. The higher estimate is almost equal to the annual greenhouse gas emissions of Japan. In the USA, salt marshes may account for more than one-fifth of the carbon absorbed by all ecosystems, despite covering a relatively small area.

Growing concern over deep-water habitats

The condition of deep-water habitats such as sea mounts and cold-water corals has become a cause for concern as awareness grows of the impact of modern fishing technology on previously inaccessible ecosystems. Bottom-trawling and use of other mobile fishing gear can have an impact on seabed habitats equivalent to the clear-cutting of rainforests. Species from the deep ocean have become increasingly targeted as more accessible fish stocks become depleted and more strictly regulated. Data are still scarce but damage caused by reef trawling has been documented in the Faroe Islands, Denmark and Iceland. All three have now closed some coral areas to trawling.

Early signs of the impact of climate change

The impact of climate change on biodiversity will depend largely on the ability of species to migrate and cope with more extreme climatic conditions. Those ecosystems already at, or approaching, the extreme limits of tolerance for temperature and precipitation are particularly at risk (*see boxes*).

Already, changes to the timing of flowering and migration patterns as well as to the distribution of species have been observed worldwide. In Europe over the last 40 years, the beginning of the growing season has advanced by 10 days on average. These types of changes can alter food chains and create mismatches within ecosystems where different species have evolved synchronized interdependence, for example, between nesting and food availability, pollinators and fertilization. Climate change is also projected to shift the ranges of disease-carrying organisms, bringing them into contact with potential hosts that have not developed immunity. Freshwater habitats and wetlands, mangroves, coral reefs, Arctic and alpine ecosystems, dry and sub-humid lands and cloud forests are particularly vulnerable to the impact of climate change.

Poor prospects for Great Barrier Reef

Although it is among the healthiest and best-protected coral reef systems in the world, Australia's Great Barrier Reef – a World Heritage site – is showing strong signs of decline. The ecosystem continues to be exposed to rising levels of sediments, nutrients and pesticides, which are proving devastating inshore, where they cause die-backs of mangroves and increase the presence of algae on coral reefs.

Photo: Kimberly Onton, Western Australian Dept of Environment and Conservation

There are no records of extinctions but some species, such as dugongs, marine turtles, seabirds, black teatfish and some sharks, are barely hanging on. Disease in corals and pest outbreaks of crown-of-thorns starfish and cyanobacteria appear to be becoming more frequent and more serious. Coral reef habitats are gradually declining, especially inshore as a result of poor water quality and the compounding effects of climate change. Coral bleaching resulting from increasing sea temperature and lower rates of calcification in skeleton-building organisms like corals because of ocean acidification are already evident.

While the impact of fishing on the Great Barrier Reef has been reduced significantly by measures such as bycatch reduction devices and closures, important risks to the ecosystem remain from the targeting of predators, the death of incidentally caught species of conservation concern, illegal fishing and poaching.

Even with the recent management initiatives to improve resilience, the overall outlook for the Great Barrier Reef is poor and catastrophic damage to the ecosystem may not be averted.

The conifer-dominated boreal forests of high Northern latitudes have remained broadly stable in extent in recent years. However, there are signs in some regions that they have become degraded. In addition, both temperate and boreal forests have become more vulnerable to outbreaks of pests and disease, due in part to warmer winter temperatures. For example, an unprecedented outbreak of the mountain pine beetle has devastated more than 110 000 km^2 of forest in Canada and the Western USA since the late 1990s.

Some species will benefit from climate change. However, an assessment of 122 widespread species of European birds found that about three times as many were losing population as a result of climate change as those gaining numbers.

The oceans have absorbed approximately one-quarter of the CO_2 produced by human activities over the past 200 years. This has made the oceans more acidic. This in turn is depleting the carbonate ions (positively charged molecules in seawater) which many marine organisms use to build their outer skeletons, among them corals, shellfish and many planktonic organisms. The concentrations of carbonate ions are now lower than at any time during the past 800 000 years.

Managing fisheries better


Photo: Wikipedia

Various management options have emerged in recent years to create more secure and profitable livelihoods by focusing on the long-term sustainability of fisheries rather than maximizing short-term catches. An example is the use of systems that allocate to individual fishermen, communities or cooperatives a dedicated share of the total catch of a fishery. This is an alternative to the more conventional system of quota-setting, in which allocations are expressed in terms of tonnes of a particular stock.

This type of system, sometimes known as Individual Transferable Quotas (ITQ), gives fishing businesses a stake in the integrity and productivity of the ecosystem, since they will be entitled to catch and sell more fish if there are more fish to be found.

A study published in 2008 of 121 ITQ fisheries found that they were about half as likely to collapse as fisheries using other management methods. However, the system has also been criticized in some quarters for concentrating fishing quotas in the hands of just a few fishing enterprises. Recent studies of the requirements for fish stock recovery suggest that such approaches need to be combined with reductions in the capacity of fishing fleets, changes in fishing gear and the designation of closed areas.

A study of a programme in Kenya to reduce pressure on fisheries associated with coral reefs found that a combination of closing off areas to fishing and restrictions on the use of seine nets that capture concentrated schools of fish led to higher income for local fishermen.

Certification schemes like the Marine Stewardship Council provide incentives for sustainable fishing practices by signalling to the consumer that the end-product is derived from management systems that respect the long-term health of marine ecosystems. Seafood fulfilling the criteria for such certification can gain market advantages for the fishermen involved.

The 'empty forest' syndrome

Wild species are being over–exploited. For example, bush-meat hunting, which provides a significant proportion of protein for many rural households in forested regions like Central Africa, appears to be taking place at unsustainable levels. In some areas, this has contributed to the so-called 'empty forest syndrome', in which apparently healthy forests become virtually devoid of animal life. This has potentially serious repercussions for the resilience of forest ecosystems, as some 75% of tropical trees depend on animals to disperse their seeds.

Over-exploited oceans

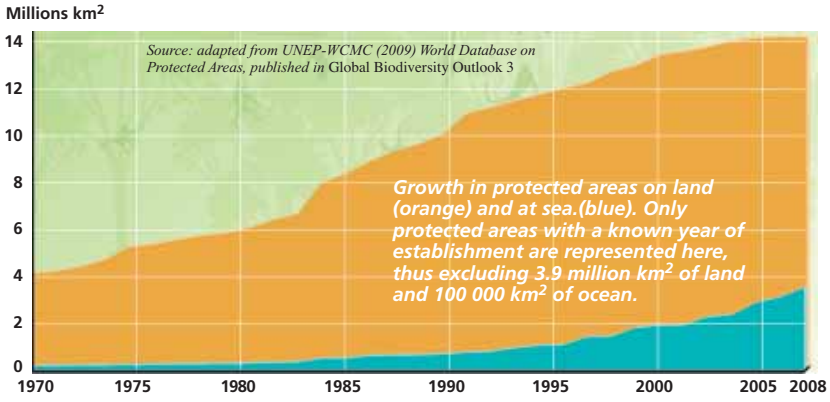
About 80% of the world marine fish stocks for which data are available are fully exploited or overexploited. Fish stocks assessed since 1977 have experienced an 11% decline in total biomass globally, with considerable regional variation. The average maximum size of fish caught has declined by 22% since 1959 globally for all assessed communities. There is also an increasing trend of stock collapses over time, with 14% of assessed stocks being collapsed in 2007.

In some ocean fisheries, larger predators have been caught preferentially in such numbers that their stocks do not recover and there has been a tendency for catches to become dominated by smaller fish and invertebrates, a phenomenon known as 'fishing down the food web'.

While the extent of marine protected areas has grown significantly in the past 30 years, less than one-fifth of marine ecoregions meet the target of having at least 10% of their area protected.

Nearly half of ecoregions on land lack protection

Today, 12.2% of land is covered by more than 120 000 protected areas. However, nearly half (44%) of terrestrial ecoregions fall below 10% protection and many of the most critical sites for biodiversity lie outside protected areas (*see figure and map*). Of those protected areas where management has been assessed, 13% were judged to be clearly inadequate, more than one-fifth demonstrated sound management and the remainder were classed as 'basic'.

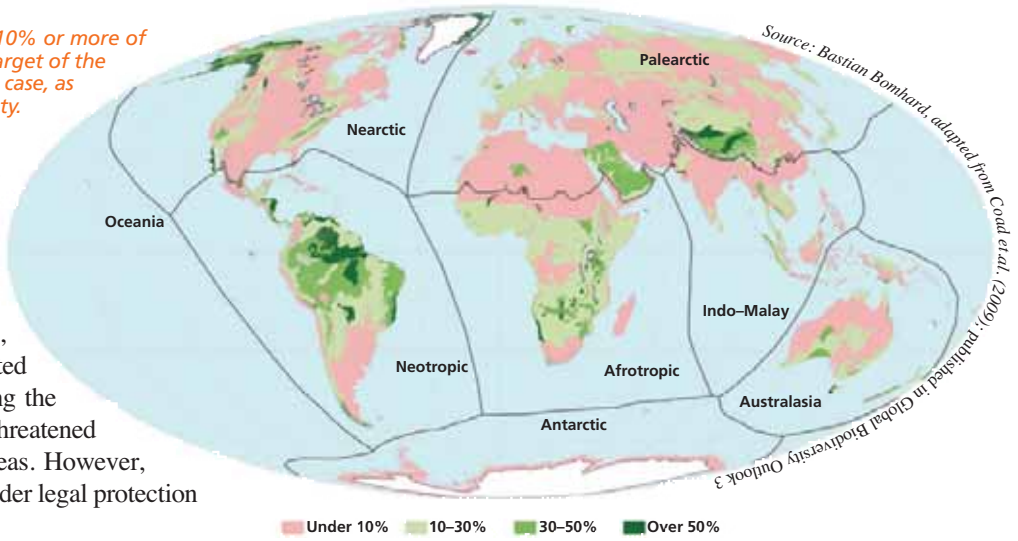


Locally managed marine areas in the South Pacific

In the past decade, more than 12 000 km² in the South Pacific have been brought under a community-based system of marine resource management known as Locally Managed Marine Areas. The initiative involves 500 communities in 15 Pacific Island states and is based on traditional knowledge, customary tenure, information-sharing and good governance.

Since 1997, in Fiji, the system has achieved a 20-fold increase in clam density in the *tabu* areas where fishing is banned; an average 200–300% increase in harvest in adjacent areas; a tripling of fish catches; and a 35–45% increase in household income.

Some 56% of 825 terrestrial ecoregions have 10% or more of their area included in protected areas, a sub-target of the 2010 Biodiversity Target. Antarctica is a special case, as it is entirely protected by an international treaty.



Source: Bastian Bomhard, adapted from Coad et al. (2009); published in Global Biodiversity Outlook 3

The existing protected area network also excludes many locations of special importance to biodiversity. For example, complete legal protection is given to only 26% of Important Bird Areas (IBAs). Of nearly 11 000 IBAs in 218 countries, on average, just 39% of their area is included in protected areas. Similarly, only 35% of sites holding the entire population of one or more highly threatened species are fully covered by protected areas. However, the proportion of both categories of site under legal protection has increased markedly in recent years.

Community conserved areas: biodiversity's ally

In addition to officially designated protected areas, there are many thousands of Community Conserved Areas across the globe, including sacred forests, wetlands and landscapes, village lakes, catchment forests, river and coastal stretches and marine areas. These natural and/or modified ecosystems are voluntarily conserved by indigenous and local communities through customary laws or other effective means and are not usually included in official protected area statistics (*see box*).

Globally, 4–8 million km^2 (the larger estimate is an area bigger than Australia) are owned or administered by communities. In 18 developing countries with the largest forest cover, over 22% of forests are owned by or reserved for communities. In some of these countries, the community forests cover 80% of the total, as in Mexico and Papua New Guinea. Some studies show that levels of protection are actually higher under community or indigenous management than under government management alone. The close association between biodiversity and culture is particularly apparent in sacred sites, thanks to the application of traditional knowledge and customs over time.

For example:

- ✓In central Tanzania, a greater diversity of woody plants exists in sacred groves than in managed forests.
- ✓In Khawa Karpo in the eastern Himalayas, trees found in sacred sites have a greater overall size than those found outside such areas.
- ✓Strict rituals, specific harvesting requirements and locally enshrined enforcement of permits regulate the amount of bark collected from *Rytigynia kigeziensis*, an endemic tree in the Albertine Rift of western Uganda which plays a central role in local medicine.
- ✓Coral reefs near Kakarotan and Muluk Village in Indonesia are periodically closed to fishing by village elders or chiefs. The average length and biomass of fish caught in both areas has been found to be greater than at control sites.

Pollution from nutrients a growing threat

Reactive nitrogen stimulates plant growth. Humans are now adding more reactive nitrogen[1] to the environment than all natural processes, such as nitrogen-fixing plants, fires and lightning. In terrestrial ecosystems, the largest impact is on nutrient-poor environments, where some plants that benefit from the added nutrients out-compete many other species and cause significant changes in plant composition. Typically, plants such as grasses and sedges will benefit at the expense of species such as dwarf shrubs, mosses and lichens.

Nitrogen deposition is already the major driver of species change in a range of temperate ecosystems, especially grasslands across Europe and North America. High levels of nitrogen have also been recorded in southern China and parts of South and Southeast Asia. Biodiversity loss from this source may be more serious than first thought in other ecosystems, including high-latitude boreal forests, Mediterranean systems, some tropical savannas and montane forests. Nitrogen is also building up to significant levels in biodiversity hotspots.

Large parts of Latin America and Africa, as well as Asia, are projected to experience elevated levels of nitrogen deposition in the next two decades. Although the impact has mainly been studied in plants, nitrogen deposition may also affect animal biodiversity by changing the composition of available food.

In inland water and coastal ecosystems, the build-up of nutrients (nitrogen and phosphorous), mainly through run-off from cropland and sewage pollution, stimulates the growth of algae and some forms of bacteria, threatening valuable ecosystem services in systems such as lakes and coral reefs, and affecting water quality. It also creates 'dead zones' in oceans, generally where major rivers reach the sea. In these zones, decomposing algae use up oxygen in the water and leave large areas virtually devoid of marine life. The number of reported dead zones has been roughly doubling every ten years since the 1960s and by 2010 had reached more than 500 (*see figure overleaf*). Among the most comprehensive measures to combat nutrient pollution is the European Union's Nitrates Directive (*see box overleaf*).

What is at stake?

Some estimated values of terrestrial biodiversity

- The Southern Africa tourism industry, based to a large extent on wildlife viewing, was estimated to be worth US$3.6 billion in 2000.
- It has been estimated that the real income of poor people in India rises from US$60 to US$95 when the value of ecosystem services such as water availability, soil fertility and wild foods is taken into account – and that it would cost US$120 per capita to replace lost livelihood if these services were denied.
- Insects that carry pollen between crops, especially fruit and vegetables, are estimated to be worth more than US$200 billion per year to the global food economy.
- Water catchment services provided to New Zealand's Otago region by tussock grass habitats in the 22 000 ha Te Papanui conservation park are valued at more than US$95 million, based on the cost of providing water by other means.

... inland water biodiversity

- The Muthurajawela Marsh, a coastal wetland located in a densely populated area of Northern Sri Lanka, is estimated to be worth US$150 per ha for its services related to agriculture, fishing and firewood; US$1 907 per ha for preventing flood damage and US$654 per ha for industrial and domestic wastewater treatment.
- The Okavango Delta in Southern Africa is estimated to generate US$32 million per year to local households in Botswana through use of its natural resources, sales and income from the tourism industry. The total economic output of activities associated with the delta is estimated at more than US$145 million, or 2.6% of Botswana's GNP.

... and marine and coastal biodiversity

- The world's fisheries employ approximately 200 million people and provide about 16% of the protein consumed worldwide, for an estimated value of US$82 billion.
- The value of the ecosystem services provided by coral reefs ranges from more than US$18 million per km^2 per year for natural hazard management to up to US$100 million for tourism, more than US$5 million for genetic material and bioprospecting and up to US$331 800 for fisheries.
- The annual economic median value of fisheries supported by mangrove habitats in the Gulf of California has been estimated at US$37 500 per ha of mangrove fringe. The value of mangroves as coastal protection may be as much as US$300 000 per km of coastline.
- In the *ejido* (communally owned land) of Mexcaltitan, Nayarit, Mexico, the direct and indirect value of mangroves contribute to 56% of the *ejido's* annual increase in wealth.

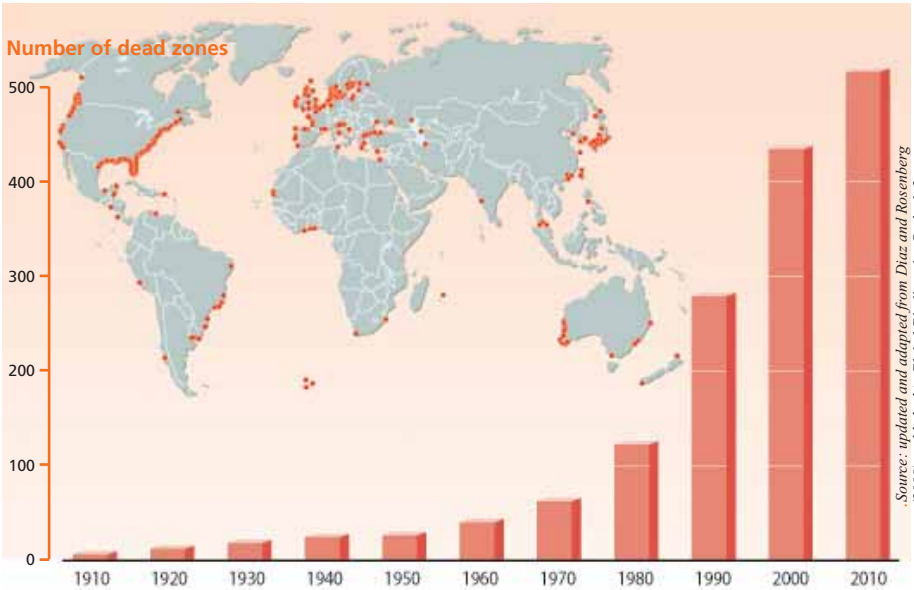
Question marks hang over invasive aliens

In a sample of 57 countries, more than 542 alien species were found, with an average of over 50 such species per country. This is most certainly an underestimate, as it excludes many alien species whose impact has not yet been examined and includes countries known to lack data on alien species.

It is difficult to get an accurate picture of whether damage from this source is increasing, as, in many areas, attention has only recently been focused on the problem; hence, a rise in the impact of known invasive species may partly reflect greater knowledge and awareness. However, in Europe, the cumulative number continues to increase and has done so at least since the beginning of the 20th century. Although these are not necessarily invasive, more alien species present in a country means that, in time, more may become invasive. Trade patterns worldwide suggest that the European picture is similar elsewhere and that the size of the invasive alien species problem is thus increasing globally.

Eleven bird species (since 1988), five mammal species (since 1996) and one amphibian (since 1980) owe their much lower extinction risk today primarily to the successful control or eradication of alien invasive species. Without this, it is estimated that the average survival chances would have been more than 10% worse for bird species and almost 5% worse for mammals. Take the example of the Black vented Shearwater (*Puffinus opisthomelas*), which breeds on six islands off the Pacific coast of Mexico, one of which is Natividad. Predation from approximately 20 feral cats was thinning the population by more than 1000 birds per month, while introduced herbivores such as donkeys, goats, sheep and rabbits damaged habitat of importance to the bird. With the assistance of a local fishing community, goats and sheep were removed from the island in 1997–1998, while cats were controlled in 1998 and eventually eradicated in 2006. As a result, the species was reclassified from Vulnerable to Near Threatened in the Red List of 2004.

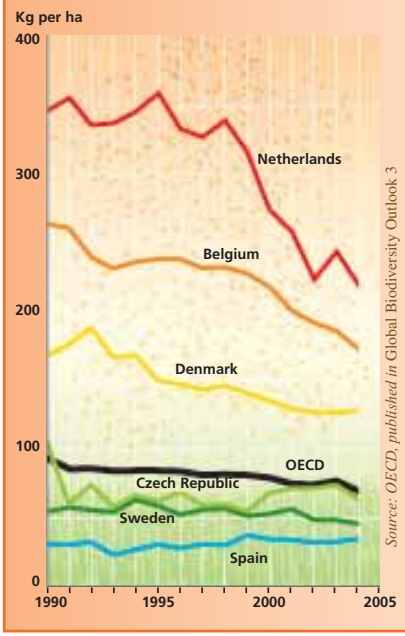
Despite this success story, the Red List Index also shows that, overall, bird, mammal and amphibian species have become more threatened due to invasive alien species. While other groups have not been fully assessed, invasive species are known to be the second-leading cause of extinction for freshwater mussels and more generally among endemic species.



Source: updated and adapted from Diaz and Rosenberg (2008), published in Global Biodiversity Outlook 3

Growth in the number of dead zones worldwide. Dead zones are coastal areas where water oxygen levels have dropped too low to support most marine life. Many are concentrated near estuaries of major rivers and result from a build-up of nutrients.

The European Union's Nitrates Directive



Source: OECD, published in Global Biodiversity Outlook 3

The European Union has attempted to address the problem of nitrogen build-up in ecosystems by tackling diffuse sources of pollution, largely from agriculture, which can be much more difficult to control than point-source pollution from industrial sites. The Nitrates Directive of 1991 promotes a range of measures to limit the amount of nitrogen leaching from land into watercourses. These include:

- Use of crop rotation, soil winter cover and catch crops: fast-growing crops grown between successive planting of other crops in order to prevent flushing of nutrients from the soil. These techniques limit nitrogen leaching during wet seasons;
- Limiting the application of fertilizers and manures to what is required by the crop, based on regular soil analysis;
- Proper storage facilities for manure so that it is made available only when the crops need nutrients;
- The use of the 'buffer' effect of maintaining non-fertilized grass strips and hedges along watercourses and ditches;
- Good management and restricted cultivation on steeply sloping soils and limited use of irrigation.

Recent monitoring of inland water bodies within the European Union suggests that nitrate and phosphate levels are declining, albeit slowly (*see figure*). While nutrient levels are still considered too high, the improvement in quality, partly as a result of the directive, has helped in the ecological recovery of some rivers.

The amount of nitrogen added to land as fertilizer, as compared with the amount taken up by crops and pasture, in selected European countries

Hard choices ahead

This *Outlook* presents some stark choices for human societies. It warns that the pressures driving the loss of biodiversity show few signs of letting up and are even escalating in some cases. The consequences of current trends are much worse than previously thought and cast doubt as to whether biodiversity will be able to continue providing us with vital ecosystem services. It is the poor who stand to suffer disproportionately from potentially catastrophic changes to ecosystems in coming decades but, ultimately, all societies stand to lose.

But the *Outlook* also offers a message of hope. The options for addressing the crisis are wider than was apparent in earlier studies. Determined action to conserve biodiversity and use it sustainably will reap rich rewards. It will bring people better health, greater food security and less poverty. It will safeguard the variety of nature, an objective justified in its own right. It will help to slow climate change by enabling ecosystems to absorb and store more carbon and it will help reduce our vulnerability to climate change by making ecosystems more resilient. Moreover, ensuring the maintenance and restoration of well-functioning ecosystems can provide economic gains worth trillions of dollars a year.

Certainly, efforts to date have not been sufficient to reduce significantly the rate of biodiversity loss for the reasons analysed above. Moreover, more than 80% of Parties concede in their latest national reports to the CBD that fragmented decision-making and/or limited communication among government ministries or sectors remains a challenge for meeting the CBD goals.

The ecological footprint of humanity now exceeds the biological capacity of the Earth by a wider margin than at the time the 2010 target was agreed upon in 2002. The choices we make over the next two decades will determine whether the relatively stable environmental conditions on which human civilization has depended for the past 10 000 years continue beyond this century. If we fail to seize this opportunity, we shall enter the unknown. Many ecosystems on the planet will move into new, unprecedented states, taking humanity into uncharted territory.

Read the report: http://gbo3.cbd.int/; www.cbd.int/GBO3

Extracted and adapted from Global Biodiversity Outlook 3*, with special thanks to David Ainsworth and Kieran Noonan-Mooney from the Secretariat of the CBD*

An early warning system for Europe's alien species

The Delivering Alien Invasive Species Inventories for Europe (DAISIE) project is creating an inventory of invasive species. The inventory can be used to prevent and control biological invasions, assess the ecological and socio-economic risks associated with the most widespread invasive species and to distribute information and data to member states as a form of early warning system.

Currently, about 11 000 alien species have been documented by DAISIE. Examples include Canada geese, zebra mussels, brook trout and the Bermuda buttercup. A recent study based on information provided by DAISIE indicated that, of the 11 000 alien species in Europe, 1094 have a documented ecological impact and 1347 an economic impact. Terrestrial invertebrates and terrestrial plants are the two taxonomic groups making the greatest impact.

1. *via widespread crop cultivation, combustion of fossil fuels – which converts both atmospheric N_2 and fossil N to reactive NOx – and via fertilizer use*

'IPCC for nature' gets green light

Meeting in the coastal city of Busan (Republic of Korea), delegates from 90 countries approved the proposal for an Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) on 11 June.

The independent panel has been largely modelled on the Intergovernmental Panel on Climate Change (IPCC). It will bridge the gulf between the wealth of scientific assessments accumulating on the decline of biodiversity worldwide and the decisive government action required to reverse this trend. A growing number of periodic national assessments are interspersed with occasional or regular international assessments involving UN agencies and others that include the *Millennium Ecosystem Assessment* (2005), the *International Assessment of Agricultural Science* and *Technology for Development* (2008), *The Economics of Ecosystems and Biodiversity* (2009) and the *Global Biodiversity Outlook* (2001, 2006, 2010, *see page 2*).

Many of the findings of these assessments are failing to translate into meaningful and decisive government action, however, due in part to varying methodologies and standards. The IPBES will bring consistency to assessments, conduct scientific assessments of its own to fill gaps in knowledge and carry out peer reviews of the wealth of science on biodiversity and ecosystem services emerging from research institutes around the globe, UN bodies, NGOs and the private sector, in order to provide 'gold standard' reports to governments.

It will also act as an early warning system, alerting governments to fresh topics identified by science and indicating where greater research is needed. For example, some scientists claim that evidence of deoxygenated dead zones in the world's oceans took too long time to migrate from scientific circles into the in-trays of policy-makers. A similar argument is made about the pros and cons of biofuels.

One key function of the IPBES will be to support capacity-building in developing countries and catalyse funding to assist scientists in these countries in preparing national assessments.

In Busan, participants welcomed the offer by UNEP and UNESCO to sponsor the IPBES. Moreover, Brazil and a number of European countries offered to host the permanent secretariat or a technical support unit in a structure that would mirror the IPCC. The next step will be for the United Nations General Assembly to establish the independent panel formally at its next session in New York on 22 September.

For details: www.ipbes.net; s.arico@unesco.org

13 new biosphere reserves

On 2 June, the International Coordinating Council (ICC) of UNESCO's Man and the Biosphere (MAB) programme added 13 new sites from 10 countries to the World Network of Biosphere Reserves, during its Paris meeting. This brings the number of sites belonging to the network to 564 in 109 countries.

Reserves were inscribed in Ethiopia and Zimbabwe for the first time this year. For their part, Sweden and the United Kingdom decided to withdraw two sites from the global network, Lake Torne and Taynish respectively, because they do not meet the criteria set out in the Seville Strategy of 1995.

The ICC also approved extensions to five existing biosphere reserves: Araucarias Biosphere Reserve (Chile), Cordillera Volcanica Central Biosphere Reserve (Costa Rica), Archipelago Sea Area Biosphere Reserve (Finland), Berchtesgadener Land Biosphere Reserve (Germany) and the Val Müstair–Parc Naziunal Biosphere Reserve (Switzerland).

Two days later, the ICC announced this year's 10 laureates for the MAB Young Scientist awards worth up to US$5 000 each (*see table*). In addition, the Austrian MAB Committee has awarded two exceptional grants: to Philista Malaki (Kenya), for her socio-economic analysis of the utilization of mangrove-dominated wetlands in the Malindi–Watamu Biosphere Reserve; and to Sri Astutik (Indonesia) for his study of the carbon stock linkage to plant diversity in Mount Gede Pangrango National Park, the core area of Cibodas Biosphere Reserve.

The Michel Batisse award of US$6 000 for biosphere reserve management goes to Fabio Kalesnik (Argentina) this year for training he organized in the Delta del Paraná Biosphere Reserve.

For details: www.unesco.org/mab; mab@unesco.org

The MAB Young Scientists and their projects

Maria Jose Lopez (Argentina)	Attitudes of the population towards environmental conservation in the Parque Atlantico Mar Chiquito Biosphere Reserve
G. Fifanou Vodouhe (Benin)	Relations between tourism and biodiversity conservation in the Pendjari Biosphere Reserve
HaiQian Li (China)	A model of sustainable economic development involving different stakeholders: a comparative study of the Lake Heilongjiang Xingkai Biosphere Reserve and the Miyun water resource reserve in Beijing
Fiby Adib (Egypt)	A comparative economic assessment of two Ramsar sites and the Omayed Biosphere Reserve
Amélie Le Ster (France/Argentina)	Participatory management, a pilot study in the Yungas Biosphere Reserve
Alex Asase (Ghana)	Impact of land-use change on plant diversity and carbon storage in the Bia Biosphere Reserve
Ari Kurnia (Indonesia/ Malaysia)	Contribution of the Tasik Chini Biosphere Reserve to the development of the local economy
Joachim Makori (Kenya)	Impact of climate change on the Malindi–Watamu Biosphere Reserve
Salama El Fatehi (Morocco)	Evaluation of the genetic resources of a threatened legume species, *Vicia ervilia (L.)*, in the Mediterranean Intercontinental Biosphere Reserve (Morocco/Spain)
Llewellyn Foxcroft (South Africa)	Non-native species as a driver of global change: unravelling the dynamics and risks of plant invasions using molecular techniques.

The new biosphere reserves

Kafa (Ethiopia)	Stretches over more than 700 000 ha. Contains more than 50% of Ethiopia's remaining Afromontane evergreen forest. The place of origin of the rare, critically endangered *Coffea arabica*. Characterized by numerous fertile valleys and lowlands linking the mountains and ridges, as well as majestic waterfalls. Successful public–private partnerships have been implemented that can serve as models for sustainable coffee production and marketing.
Yayu (Ethiopia)	In the southwestern Illubabor Zone of the Oromiya Regional State, part of the Eastern Afromontane Biodiversity Hotspot, one of 34 in the world. Comprises undisturbed natural forests and semi-forest systems managed for the production of coffee, spices, honey and wood while providing watershed protection in the Nile Basin. The Yayu forest has the greatest abundance of wild *Coffea arabica* anywhere.
Dena (Iran)	Stretches across the Central Zagros Mountains, consists primarily of semi-arid steppe forest. Oak species predominate in the highlands, with pistachio and almond at lower elevations. Large rivers, including the Karun, Dez and Kharkeh, originate from the Central Zagros, draining into the Persian Gulf and the Caspian Sea. Waterfalls, pools and lakes abound. Includes a nomadic community of about 20 000. Development priorities include sustainable range management and ecotourism.
Naha–Metzabok (Mexico)	Covers the northern part of the Lacandona forest, the country's biggest tropical forest. An integral part of the Mayan Forest biological corridor, is home to more than 6500 indigenous people, including the most ancient Maya–Lacandon as well as Tzeltales and Choles communities. Sustainable agriculture is practiced by indigenous communities in the buffer and transition zones.
Los Volcanes (Mexico)	Includes Popocatépetl, one of the most impressive active volcanoes on the planet, and a variety of endemic species like the volcano rabbit. Provides a water catchment for Mexico City. Projects for reforestation, soil rehabilitation and groundwater infiltration are being developed to protect the water supply.
Maria's Island (Mexico)	A reservoir of endemic species that developed over eight million years of insularity. Contains a dry tropical forest, mangroves, swamps and coral reefs. A federal penitentiary is established there. The National Institute of Ecology, the National Commission of Natural Protected Areas and the Secretariat of Public Security have introduced sustainable management projects, such as reforestation and agriculture, to rehabilitate the prisoners on the island.
Ometepe Island (Nicaragua)	An island biosphere reserve in the country's biggest freshwater reservoir, Cocibolca Lake or Lake Nicaragua, home to the freshwater sawfish and Nicaraguan freshwater shark. The site's name in the local Nahuatl language is 'island of two hills', referring to its two volcanoes. Home to 30 000 inhabitants with rich pre-Columbian vestiges (petroglyphs, statues, ceramics). Activities include community-based ecotourism.
Oxapampa–Ashaninka–Yanesha (Peru)	Part of the country's Amazonian high forest region. Although classified as a conservation hotspot, the region is under intense pressure from deforestation, causing loss of biodiversity. Participatory management processes involve regional authorities, NGOs and the local population. Indigenous cultures, such as the Yánesha and Asháninka, help preserve ancestral knowledge in managing natural resources. Progressive adoption of agroforestry, ecotourism and handicrafts.
Tuchola Forest (Poland)	One of the country's biggest forest complexes, in the northwestern Pomerania region, 50 km southwest of Gdansk on the Baltic coast. About 17 000 people live in the buffer zone and 102 500 in the biosphere reserve. They depend mainly on tourism and forestry, logging, hunting and mushroom- and berry-picking. In recent years, agrotourism combining tourism, recreation and craft development have taken off in the transition area.
Gwangneung Forest (Republic of Korea)	In the central part of the Korean peninsula where the extreme continental climate of northeast Asia meets the oceanic climate of the Pacific. Contains well-preserved deciduous hardwood forests over 500 years old, farmlands and private forests. Home to the Royal Tombs of the Joseon Dynasty, a World Heritage property, and the Korea National Arboretum. Planned activities include eco-labelling of local goods, renewable energy and organic agriculture.
Kozjansko and Obsotelje (Slovenia)	Nestled between the Sava, Savinja and Sotla Rivers. Includes alpine landscapes. Part of the ancient Roman province of Panonia. To the east, it borders Croatia, separated by the Sotla River. Forests cover over 55% of the site. The Kozjansko Regional Park makes up much of the core area. A well-preserved natural landscape. The 11 communities are all involved in ecological farming, ecotourism and production of traditional foodstuffs and crafts.
Lake Vänern Archipelago (Sweden)	Includes the largest lake in Sweden and third-largest in Europe, 350 km-long Lake Vänern. Some 60 000 people live within the site. The transition area incorporates Mariestad and other cities. Fishing, agriculture, forestry and tourism are of great economic importance. Projects include sustainable travel, ecotourism and product development.
Middle Zambezi (Zimbabwe)	Stretches over 40 000 km^2 in the Zambezi valley. Includes one of the subcontinent's largest artificial reservoirs, Lake Kariba. The Mana Pools National Park in the core area is a World Heritage property. Controlled safari sport hunting in the buffer zone employs hundreds of people. The town of Kariba depends largely on fishing in Lake Kariba, which rivals major lake fisheries in the region, with an annual output of 40 000 tonnes of the pelagic fish, *Limnothrissa miodon*, worth an estimated US$40 million.

Source: Nabu/S. Bender

Collecting coffee beans in the new Kafa Biosphere Reserve in Ethiopia

A 4D system to improve conservation of Calakmul

A four-dimensional (4D) geographical information system (GIS) was delivered to the Mexican authorities on 25 May to allow the managers of the Calakmul Biosphere Reserve and World Heritage site to store, share and visualize the data they use for conservation, management, planning, monitoring and research. The online system was funded by the Belgian Science Policy Office to the tune of 1 250 000 euros within a collaboration agreement with UNESCO.

Created in 1989, the 723 000 ha biosphere reserve is the largest tropical forest reserve in Mexico. This biodiversity hotspot shelters rare species of flora and fauna, and is considered to be an important part of the Mesoamerican Biological Corridor. A Mayan site, it is also an outstanding testimony to the changing political and cultural influences over this vast area during the twelve centuries to the 8th century AD. The archaeological zone covers 3000 ha and was registered as a cultural World Heritage site in 2002.

In recent years, settlements, farming, extraction of commercial timber, tourism and other pressures have threatened this unique site. Earth observation data from Formosat 2 and SPOT satellites have already been used to analyse the evolution of land use and land cover in the area. They have also been used to investigate the potential of remote sensing for documenting Mayan ruins and to detect evidence of the presence of archaeological remains hidden from view in the tropical forest.

The second stage of the project will consist of training courses and other forms of capacity-building for the conservationists working in the biosphere reserve and the cultural site managers at the Archaeological Urban Centre of Calakmul, to enable them to use the 4D information management system developed during the first phase.

For details: m.hernandez@unesco.org; www.unesco.org/mab

50 years of ocean studies

The Intergovernmental Oceanographic Commission of UNESCO (IOC) inaugurated its 50th anniversary celebrations on 8 June, World Ocean Day, at a ceremony and exhibition held at UNESCO in Paris.

The celebrations offered a chance to showcase the IOC's achievements over the past 50 years and consider its future role. 'The IOC is a standard-bearer for UNESCO', said Irina Bokova, Director-General of UNESCO. 'Indeed, it is integral to my vision of our Organization's role in the 21st century: providing essential continuity while responding to the changing needs of today's and tomorrow's world. [The IOC's] contribution to climate science is a good example,' she observed in the company of Assistant Director-General and Executive Secretary of the IOC Wendy Watson-Wright, French Secretary of State for Sustainable Development Valérie Létard and French navigator and IOC spokeswoman Maud Fontenoy. 'The challenge posed by climate change is a main focus of my mandate and I recognize the vital role the IOC must and will play in that regard,' Bokova said. She highlighted the role of the Global Ocean Observing System (GOOS), the ocean component of the Global Climate Observing System which supports the UN Framework Convention on Climate Change.

The role of GOOS is continually evolving but keeping the system mantained is critical to ensuring that data are available on demand, such as when a disaster strikes. Since the explosion and sinking of an offshore drilling rig in the Gulf of Mexico on 20 April, flow-rate modellers from the Woods Hole Oceanographic Institution have estimated that 20 000–40 000 barrels of oil – and possibly 50 000 barrels – have been leaking into the Gulf every day. US scientists used models developed with GOOS data to produce a study released on 3 June which indicates that, within weeks, oil from the massive spill might extend thousands of kilometres along the Atlantic coast and into the open ocean. The spill has demonstrated how useful regular ocean observations are to disaster response – and how inadequate ocean observing systems are, even in a rich country like the USA. Vital equipment for oil spill response, such as coastal radar which could provide real-time data on surface currents and thus the oil spill movements, has either not been deployed or been inadequately maintained in the Gulf of Mexico.

During the anniversary ceremony, Geoff Holland, former chair and architect of the IOC's *Ocean Charter* in 1998, presented an *Ocean Call* appealing for greater priority to be given to programmes in coastal and ocean management, ocean sciences and ocean technologies.

Representatives of a youth delegation also presented a call for action from policy-makers and a list of their own commitments. 'Deeply troubled by the rapid degradation of the oceans and seas, and in support of the recognition of the ocean as a public good for all humanity, we ask for the establishment of a global ethics board, which we propose to name the United Oceans,' they said. Since 1998, close to 800 young people have taken part in national, regional and international youth delegations and parliaments organized with the help of the World Ocean Network. The next youth delegations in 2011 and 2012 will take place in the Caribbean and South Africa.

From 40 nations when it first came into being into 1960, the UNESCO-IOC has grown to 138 Member States today, including a number of landlocked countries.

For details: www.unesco.org/en/ioc-50anniversary; c.reed@unesco.org;

on the oil spill: www.ioc-goos.org/content/view/265/48/

Cambridge University Press retraces the past 50 years in Troubled Waters *(see page 24)*

Photo: Paul Mauricio/Scripps Institution of Oceanography

A research and training vessel from the Scripps Institution of Oceanography (USA) cruises past an iceberg in the Antarctic. As part of anniversary celebrations, a number of countries[1] have announced research and training cruises for 2010 and 2011: Argentina, Belgium, Brazil, China, Ecuador, India, Indonesia, Iran, Mexico, Russia, Sweden, Thailand, Tunisia, Ukraine, the UK, USA and Venezuela.

Vineet Soni

Saving the guggul

The resurgence of public interest in plant-based medicine, coupled with the rapid expansion of pharmaceutical industries, has fuelled demand for medicinal plants, causing many of them to be overexploited. Such has been the fate of the guggul plant (*Commiphora wightii*), a thorny bush found in the States of Rajasthan and Gujarat in India but also in arid and semi-arid zones of Pakistan. The guggul plant produces a sap, or resin, that has been central to Ayurvedic medicine in India for nearly 3000 years. It is mentioned in classic Ayurvedic literature as being an efficacious treatment for bone fractures, arthritis, inflammation, obesity, cardiovascular disease and lipid disorders like high cholesterol levels. It is still widely used today to treat these ailments.

Thirty-one year old Vineet Soni is Associate Professor within the School of Life Sciences at Jaipur National University. Dismayed to see the guggul plant slipping towards extinction in an apparent climate of indifference, he founded the Save Guggul Movement in November 2007. Less than three years later, the fortunes of the guggul plant are looking up. Vineet Soni is living proof that, with a little determination and some help from your friends, one person can make a difference.

Why is the guggul plant so vulnerable?

The biggest threat comes from overexploitation by pharmaceutical companies but its habitat is also being converted for agriculture and engulfed by urbanization. Adding to its vulnerability is the fact that it is found only in the wild, grows slowly and has a poor seed germination rate. A guggul plant generally takes about 10 years to reach tapping maturity in an arid or semi-arid climate.

The guggul plant features on the IUCN's Red List. It is calalogued there as data-deficient because we know numbers are declining but not to what extent. However, as early as March 1994, the Government of India banned the export of guggul plants as a result of increasing exploitation.

In 2008, The Red List catalogued 45 tree species from India as being critically endangered and 246 plant species as being threatened but this went largely unnoticed in India. Unfortunately, more then 90% of the raw plant material used in herbal industries in India is drawn from natural habitats.

What motivated you to found the Save Guggul Movement and how did your project get off the ground?

I had studied various biochemical and phytochemical aspects of the guggul plant towards my PhD in botany, so was familiar with the plant's remarkable qualities. Upon returning home in November 2007 after completing postdoctoral research at the University of Geneva in Switzerland, I was struck by the fact that the plant was becoming scarce, yet nobody seemed to care. That is when I decided to found the Save Guggul Movement, or *Guggal Bachao Abhiyan* in Hindi.

Conservation cannot work without the involvement of the people who depend on biodiversity. That is why the first thing I did was to organize a series of awareness-building programmes in 23 villages in Rajasthan in 2008, with the help of friends. Local villagers and tribes responded enthu-siastically. After participating in a series of meetings, talks and discussions, these communities are now more aware of what they stand to lose if the guggul plant disappears from the landscape. They now also know how to protect the plant.

What do they use the plant for?

In addition to herbal remedies, the guggul plant is used for fuel by some rural communities. Women and children especially go into the forest daily to collect guggul wood for cooking purposes. There is an abundance of alternative plants they could use, so I advise people to collect these instead.

Guggul-gum can also be purchased in a loosely packaged form under the trademark of Dhoop, an incense which is burned over hot coals. The burning coals produce a fragrant dense smoke. People then carry the burning coals through the home, lingering in every corner for a few seconds, as this is said to drive away mosquitoes. Some believe it also drives away evil spirits. I advise people to replace Dhoop with electronic mosquito repellents, which are sold locally at a low price.

Who collects the guggul-gum?

The oleogum resin is mainly collected by local unskilled tribal and rural people who make several deep incisions on the stem to extract a maximum amount of guggul-gum. The thick branches are incised during the winter to extract the oleogum resin. Collected crude oleogum resin is then sold at market or directly to pharmaceutical companies.

I explain to people that these crude tapping methods are now thought to kill the plant. After making an incision, the 'tappers' apply a paste around it consisting of a mixture of horse or wild ass urine, oleogum resin and copper sulphate. This method increases the amount of guggul-gum yielded by the plant to three to four times that obtained using normal tapping procedures. However, after a couple of years, the shrub becomes unfit for tapping and ultimately dies of copper sulphate poisoning.

Elders told us that, during the 1960s and 1970s, pharmaceutical company representatives had come to see them and employed villagers to collect oleogum resin from the guggul plant. The companies provided them with a special knife known as a *mitchie golledge* and with ethephon, an ethylene-releasing synthetic chemical known as 2-chloroethyl phosphoric acid. It has now been proven that the application of ethephon on the cuts enhances guggul-gum production several times over but that, in the long run, this technique exhausts and kills the plant.


Photo: Vineet Soni

Vineet with villagers participating in the guggul awareness-raising programme. Vineet is holding a guggul plant propagated from stem cuttings.

I advise villagers not to collect oleogum from natural habitats, as access is restricted by the government, which has passed various acts to save the plant from extinction. To ease the pressure on wild populations, I myself am working on the creation of a network of protected areas.

How else can rural populations help to save the plant?

With the help of villagers and rural tribes, we have embarked on large-scale cultivation of seedlings from stem-cuttings. We then plant these seedlings in the guggul's natural habitat in different parts of Rajasthan. The sites have not been chosen at random. Rather, we have selected those locations which are the most suitable for producing guggulsterone, the medicinal agent found in the plant's resin. Recent research has shown that it is the E-guggulsterones and Z-guggulsterones in the guggul resin that are responsible for reducing cholesterol levels.

Over the past couple of years, I have collected resin from different locations in Rajasthan to identify genetic types of guggul plant which yield high levels of guggulsterone and thus those habitats where the guggul plant ought to be conserved in the wild.

Why use stem-cuttings rather than seeds to cultivate guggul plants?

We use stem-cuttings because this is the best method for propagating guggul on a large scale. Stem-cutting offers several advantages over seeds; it saves time and labour, and produces plants from superior parent stocks which are both genetically superior and uniform. Stem-cuttings are also inexpensive and easier to perform than other propagation methods which clone cells like tissue culture. Stem-cuttings offer another advantage; they can continuously supply stocks throughout the year for the purposes of reforestation.


Photo: Vineet Soni

Oleogum resin seeping from incisions in the trunk of a guggul plant

Has there been a noticeable increase yet in the numbers of guggul plants growing in the wild?

Yes, definitely. We have observed a distinct increase in some regions thanks to the involvement of local rural populations. Villagers take care of the seedlings until they are ready to be planted in their natural habitat. But there is still a lot of work to be done, owing to the vast geographical area covered by Rajasthan.

What can developing countries do to conserve medicinal plant species better?

In my opinion, poverty is the root cause of biodiversity loss in developing countries. The overexploitation of wild medicinal plants can only be reversed if conservation programmes are combined with greater food and energy security for the world's large and growing low-income populations.

Rural populations should be mobilized to contribute to any effort to conserve areas of high biodiversity. In order for local people to adhere to any long-term conservation strategy, they need to understand how to protect their natural environment, so that it can continue to provide them with food, shelter, medicines, household implements and other services. To maintain their support, you then need to make sure that their access to these benefits is respected.

Interview by Susan Schneegans

Tracking plant diversity in a changing world

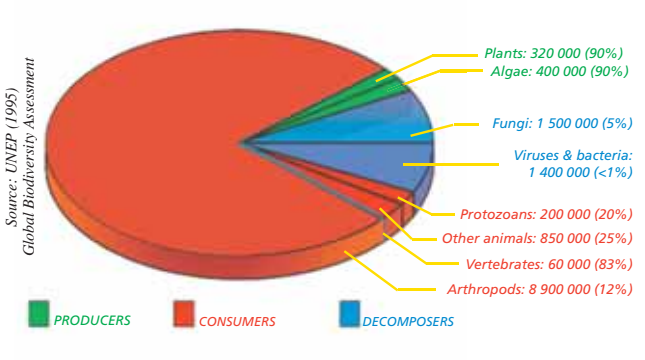
If ambitious programmes have been launched in recent years to monitor the environment in general and climate in particular, biodiversity monitoring has been relegated to the back seat. As a result, we are still far from having a complete inventory of the species on Earth, despite the importance of this baseline information for monitoring progress towards the 2010 Biodiversity Target and future targets.

The BIOTA Africa Network of biodiversity observatories is one of only a handful of monitoring schemes operating on regional, continental and global scales. Launched a decade ago by the German Federal Ministry for Education and Research, which funds and operates the network together with African partners, BIOTA Africa has brought together several hundred African and central European researchers to document and analyse the state of African biodiversity and its importance for local communities. These studies are part of a broader effort to monitor diversity on Earth. An overview of this global inventory as concerns plant diversity was presented in January to a UNESCO conference on the interface between biodiversity science and policy.

Photo: Jens Mutke

Well-known botanist Prof. Laurent Ake Assi from Côte d'Ivoire explaining plant life of the Comoe National Park to African and European colleagues and students on a joint BIOTA Africa field trip

Many of the well-documented species groups, such as higher plants or terrestrial vertebrates, tend to be located in the humid tropics and sub-tropics, especially in mountain areas with high geodiversity. Generally speaking, biodiversity decreases as you move from the equator towards the poles. An area the size of a football stadium in the lowland rainforest of equatorial Ecuador harbours 1000 different species of trees, shrubs, herbs, lianas and epiphytes – as many plant species as you would find in all of Ireland or in the Yukon Territory in Canada! It is no coincidence that the United Nations Convention on Biological Diversity was adopted in Rio de Janeiro in 1992, in one of the top five global centres of plant diversity,[2] Atlantic Brazil.



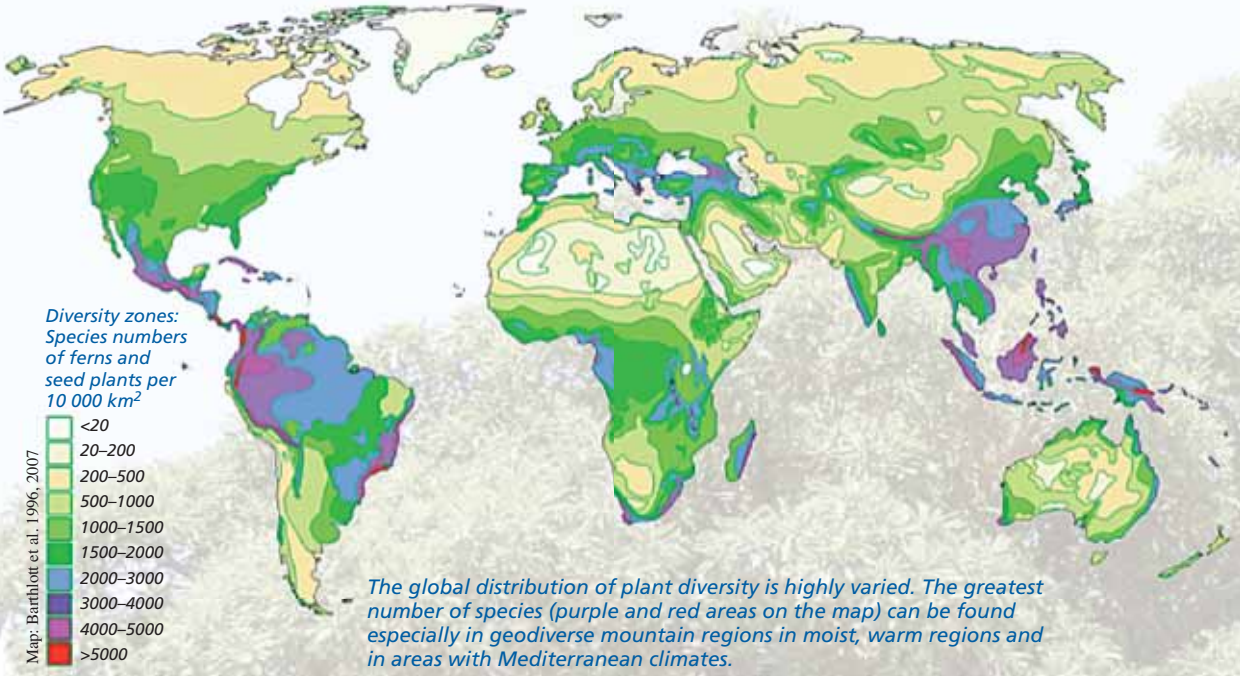
Global diversity of producers, consumers and decomposers of biomass. In brackets is the percentage of species already scientifically described and housed in natural history collections per group. About 90% of the higher plant species (ferns and seed plants) are already known to science. Compare this figure with the state of knowledge of some other ecologically important groups, such as arthropods (insects, spiders, crustaceans, etc), bacteria or fungi.

This said, there are also extra-tropical centres of diversity. The European Alps sport floral diversity comparable to that of the central Congo Basin. In temperate South Africa, the Cape Floral Region is one of only six floral kingdoms in the world.

Even areas with comparable environmental conditions may show great disparities in the number of plant species. Namaqualand in west South Africa is hot and arid yet harbours an estimated 3500 plant species. The central Sahara is almost 100 times larger but hosts far fewer than 1000 native plant species.

Quantity versus quality

Biodiversity is more than simply a matter of the sheer number of species. One key qualitative aspect considered in biogeography is the size of the species' range. Rare species or species that can only thrive in certain conditions are considered of greater concern for conservation than other species. The floras[3] of many islands in particular have high proportions of species with a restricted range. More than 85% of Hawaii's 1140 native plant species are endemic and thus occur nowhere else. The German federal state of Thuringia is a similar size to Hawaii with a comparable overall species richness but does not have a single endemic species! Around 70 000 plant species, or one-fifth of global flora, are endemic to oceanic islands, which account for just 3.6% of land on Earth. Due to their restricted distribution area, many of these endemic species are highly threatened. If their habitats are destroyed or replaced by the introduction



The global distribution of plant diversity is highly varied. The greatest number of species (purple and red areas on the map) can be found especially in geodiverse mountain regions in moist, warm regions and in areas with Mediterranean climates.

of non-native invasive species, the endemic species are irreversibly lost. Islands may thus warrant a high priority in global biodiversity conservation this century.

Consulting the archives of biodiversity

When we began mapping plant biodiversity worldwide in the 1990s, we were able to consult a variety of sources of information and data, such as flora treatments, species checklists or ecological studies. There are still large gaps in places like the Amazon Basin, parts of the Congo Basin or New Guinea where we know very little about the flora and fauna. However, the scientific collections assembled over the past 250 years in our natural history museums, herbaria, seed banks and botanical gardens can still provide us with a good overall picture of global plant diversity.

Tillandsia multicaulis *growing on a tree in Costa Rica.* Tillandsia *is an epiphyte, or 'air plant', so-named because it does not grow in soil. Epiphytes cling to other plants for support but are not parasitic. In the tropics, epiphytes include ferns, cacti and orchids. In temperate zones, some algae, lichens and mosses are epiphytes but no higher plants.*

Add to this the recent advances in information technology, geographical information systems (GIS) and digitally available natural history data and our team of biogeographers had all the tools it needed to study the causes and consequences of shifting biodiversity patterns around the world. We also interacted with the major environmental NGOs, all of which have their own science programmes for mapping biodiversity and identifying priority areas for conservation, such as Conservation International or the World Wildlife Fund (WWF). For sub-Saharan Africa, we were particularly reliant on the collections in natural history museums. These 'archives of biodiversity' are all the more precious in that they contain information on where and when each sample was collected.

Mapping plant diversity in Africa

The research institutions participating in the BIOTA network are sub-divided into four regional research networks: BIOTA West Africa, BIOTA East Africa, BIOTA Southern Africa and BIOTA Morocco. Over the past decade, the results of monitoring projects at each of the biodiversity observatories in Africa have not only been published in scientific journals but also shared with stakeholders to support decision-making related to conservation and sustainable development. Relevant information is accessible to all partners in the form of data nodes, Internet databases and checklists of flora and fauna. Field work in the context of BIOTA West Africa, for example, has helped to increase the number of known plant species in Burkina Faso by 30% in the past 15 years. Scientists and decision-makers can also consult an environmental atlas for the West African region.

The BIOTA Africa project has made it possible to install GIS and infrastructure like the Gusõn medicinal botanic

Photo: courtesy of Georg Zizka, www.westafricanplants.senckenberg.de

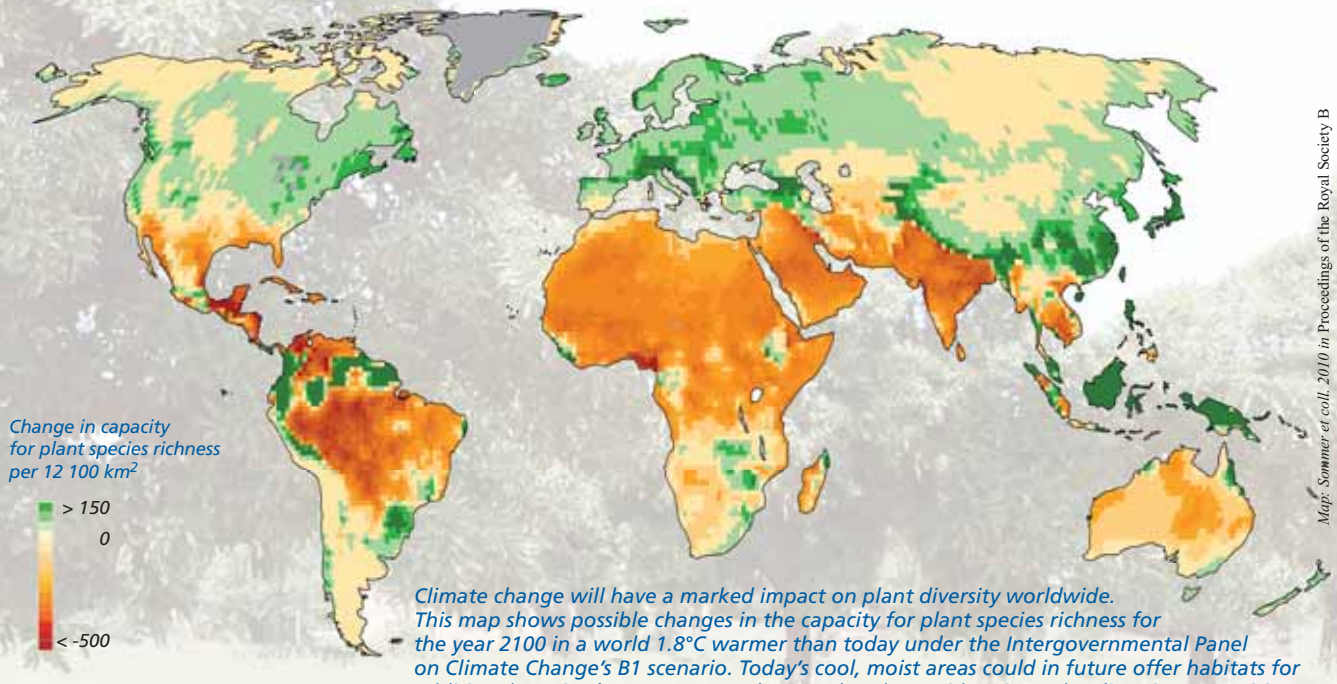
*Shea butter tree (*Vitellaria paradoxa*) in Burkina Faso. The seeds of this tree are an important source of vegetable oil in West African countries, both for the rural population and increasingly for the cosmetics industry. The trees are protected by farmers when clearing fields for cultivation because of their value and slow growth.*

garden in Benin or the Information Centre on Biodiversity at the University of Ouagadougou in Burkina Faso, inaugurated in January this year. The project has also trained African students, conservation officials and para-ecologists. The latter are ecologists who replace formal academic credentials with on-the-job training. For instance, BIOTA Southern Africa hired and trained para-ecologists in South Africa and Namibia to help with field studies and work as field rangers on nature conservation projects. The para-ecologists were appointed to facilitate exchanges between researchers and local land-users. BIOTA trained each para-ecologist in biodiversity assessment, vegetation monitoring and the use of technical equipment like global positioning systems.

Large international collaborative projects like BIOTA Africa that incorporate experts from both the northern and southern hemispheres are essential for developing balanced cooperation that transfers knowledge and generates other benefits for all parties. Political initiatives to ensure access to biological diversity and to guarantee the fair and equitable sharing of the benefits arising from their utilization are important preconditions for such cooperation. These regulations should not impede non-profit biodiversity research and scientific cooperation, however. They are an indispensable prerequisite for deepening our understanding of ecological systems and the way they function, in order to develop effective strategies for conservation and sustainable use of ecosystem services. One way of building mutual trust are participatory initiatives like the International Plant Exchange Network established in 2002 by a number of botanical gardens.

Species don't stop at the border, neither should monitoring

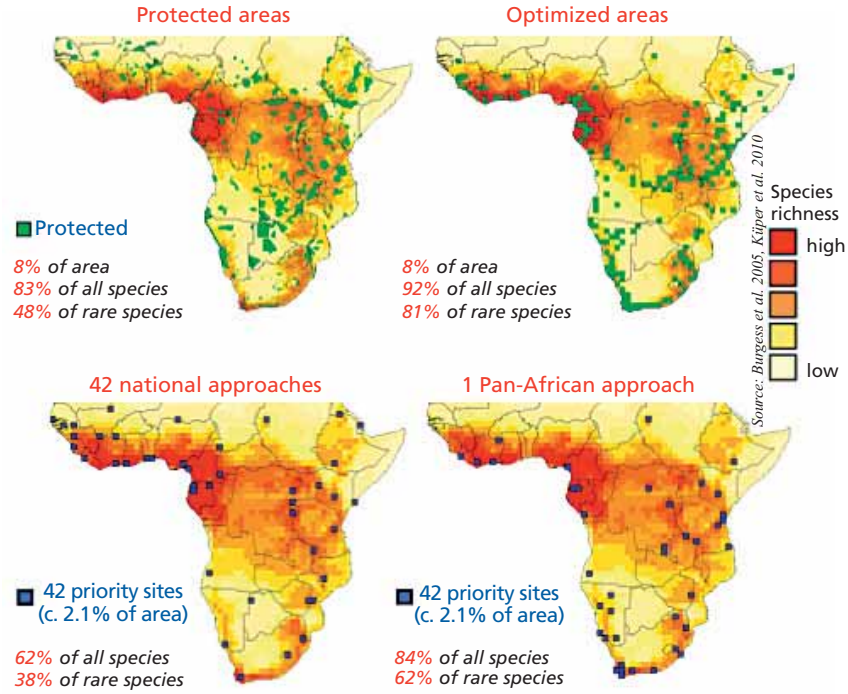
The overarching benefit for biodiversity conservation could be spectacular if only the value and endangered status of species and ecosystems were to be considered on a multilateral level rather than on a country-by-country basis. Species and ecosystems cross political borders, so collaboration should do the same. The conservation of a particular species might be very difficult or expensive in one country, for example, because its range overlaps with a highly populated area.



Map: Sommer et coll. 2010 in Proceedings of the Royal Society B

*Climate change will have a marked impact on plant diversity worldwide. This map shows possible changes in the capacity for plant species richness for the year 2100 in a world 1.8°C warmer than today under the Intergovernmental Panel on Climate Change's B1 scenario. Today's cool, moist areas could in future offer habitats for additional species (*green areas on the maps*). In hot, arid regions, the climatic prerequisites for high-species richness will deteriorate (*orange–red areas on the map*).*

The same species might be more easily protected in another country harbouring a larger wilderness. A collaborative approach to biodiversity conservation would also offer opportunities for incorporating the principle of floristic complementarity when selecting areas for conservation.



Protected areas in Africa (top left) *and three hypothetical approaches to conservation. Based on detailed distribution data for about 15% of African plant species, it is estimated that current protected areas protect about 83% of the species investigated but only 48% of rare plant species. If every one of the 42 countries in this region were to protect its priority site (circa 10 000 km² each, or 2.1% of sub-Saharan Africa in total) characterized by the highest plant species richness (unilateral approach), 38% of rare species might be protected; if, instead, the same number of 42 priority sites covering about 2.1% of Sub-Saharan Africa were optimized via a hypothetical Pan-African approach, 62% of rare species might be covered. A pan-African approach covering 8% of the continent's surface area* (top right) *might even protect 81% of rare plant species.*

Photo: Wilhelm Barthlott

An example of the threat to biodiversity on islands: a fossil egg of the elephant bird, or Aepynornis, *which was indigenous to Madagascar until it was exterminated by humans a few hundred years ago. The elephant bird could be up to 3 m in size and 400 kg in weight. It resembled the extant species of cassowary and emu. Like them and the diminutive kiwi native to New Zealand, it was a ratite, a diverse group of flightless birds of Gondwanan origin.*

In this regard, the launch of the GEO Global Biodiversity Observation Network (GEO BON) by Diversitas[4] and other partners in 2008 has been a leap in the right direction.

It is time to shoulder our responsibilities

Although prioritizing areas for biodiversity conservation is a complex process, today there is a far-reaching consensus among scientists on a global minimum set of irreplaceable key biodiversity areas where conservation would be most effective. However, despite the existence of solid empirical evidence for nearly a decade, environmental degradation continues and is even accelerating at many of these sites.

We know that most of the effects of climate change on biological systems will only be detectable on medium- to long-term time scales. Yet, the funding policy of many science foundations tends to focus on research projects of 3–5 years duration. This is a terrible impediment to long-term monitoring of global environmental change and especially the impact on natural ecosystems.

Biodiversity has no lobby to defend its interests. Nor do ecosystem services appear on the balance sheets of traditional economic thinking. The mission of science is to raise awareness constantly of the dangers facing biodiversity and sustainable development. But policy-makers also have a duty to translate scientific findings into laws and initiatives and to put adequate prices on the services provided by nature. Even more importantly, policy-makers, the media and scientists themeselves have a duty to educate the public better about the value and vulnerability of biodiversity.

Jens Mutke[5,7], Jan Henning Sommer[5],
Sié Sylvestre Da[5,6], Wolfgang Küper[5],
Adjima Thiombiano[6] and Wilhelm Barthlott[5]

For details: barthlott@uni-bonn.de, www.nees.uni-bonn.de

See also: www.biota-africa.org; www.bgci.org/resources/ipen

For photos of West African plants: www.westafricanplants.senckenberg.de

2. *Costa Rica-Chocó, Atlantic Brazil, the Tropical Eastern Andes, Northern Borneo and New Guinea cover only 0.2 % of the terrestrial surface, yet 6.2% of all vascular plant species are restricted to these regions.*
3. *In botany, flora (plural floras or florae) refers to the plant life occurring in a particular region.*
4. *Diversitas is a programme sponsored by the International Council for Science, International Union of Biological Sciences and UNESCO: www.diversitas-international.org*
5. *Nees Institute for Biodiversity of Plants, University of Bonn, Germany*
6. *Laboratory of Plant Biology and Ecology, University of Ouagadougou, Burkina Faso*
7. *Diversitas Germany: www.biodiversity.de*

Mapping the oceans
to save the seas

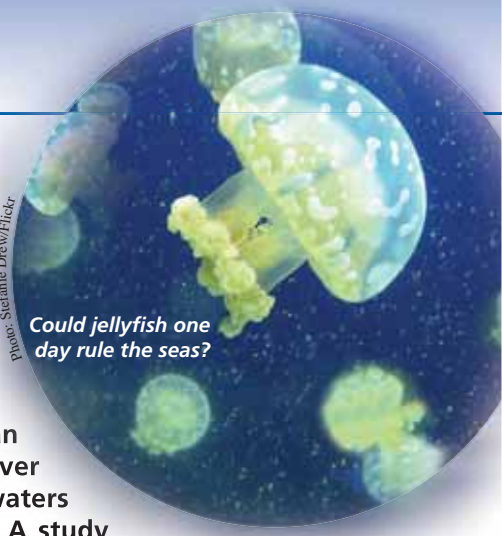


Photo: Stefanie Drew/Flickr

Could jellyfish one day rule the seas?

Marine ecosystems provide us with a minimum of US$20.9 trillion in goods and services every year. Yet, we treat the sea like a sewer, a dump and an inexhaustible supply of fish. The ecological responses tell it all: a loss of over 90% of top predators, collapsing fisheries and a shift from vertebrate-rich waters to seas dominated by jellyfish, with an increasing number of dead zones. A study published in *Science* in 2008 estimated that almost every square kilometre of the oceans was under threat (*see map overleaf*).

Without a doubt, more must be done to protect the marine realm. But where do we start? Which approach is the most effective? And what contribution can marine biogeography make? Here we take a look at some of the global initiatives being undertaken to improve marine conservation, based on a presentation to the UNESCO conference in January this year on the interface between biodiversity science and policy.

Four of the most common approaches to systematic conservation planning are: hotspots, representation, ecoregions and key areas. Each of these approaches reflects a different biogeographical concept and data.

Photo courtesy of John Randall

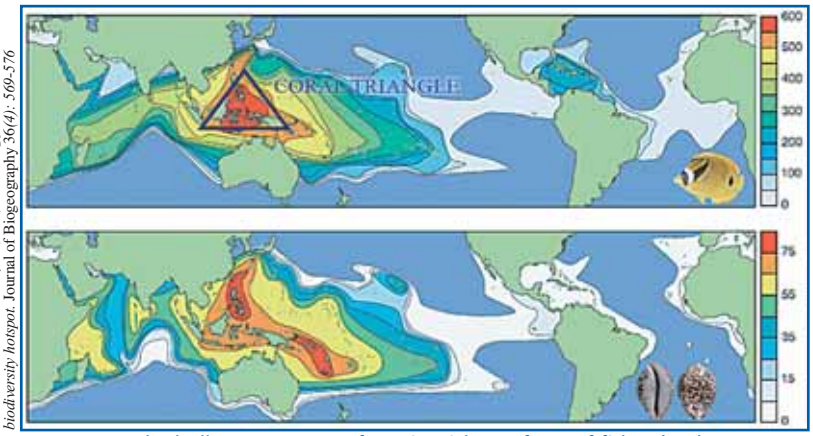
Bengal sergeant major swimming off One Tree Island in Australia

Hotspots

The simplest conceptual approach is to prioritize 'hotspots', those areas where there is most of something. With nearly 100 000 km^2 of coral reefs – 34% of the world's total – and over 2000 species of reef fish, Southeast Asia is unquestionably a hotspot of species richness. It is estimated that the relatively small area between the Philippines, Indonesia and Papua New Guinea (the 'Coral Triangle') harbours 83% of the world's coral species and 58% of reef fishes (*see map*). However, this species richness is primarily due to a concentration of overlapping distributions of wide-ranging species like the Bengal sergeant major (*Abudefduf bengalensis*), rather than an abundance of species with restricted ranges (endemics) like the spike-fin goby (*Discordipinna griessingeri*).

From an ecological perspective, however, it may be that biodiversity 'coldspots', or species-poor regions, are more vulnerable. For one thing, low diversity implies a greater likelihood that the extinction of one or more species will mean the loss of a critical ecosystem function. Coldspots also contain disproportionately large numbers of endemic species. In 2002, scientists mapped the distributions of 3235 species of fish, corals, lobsters and snails and showed that, as on land, restricted-range species in the sea were concentrated in centres of endemism.

While the hotspot approach is relatively simple, politically appealing and analytically transparent, assuming high-quality data, there is a risk that such an approach may disenfranchise communities in 'non-hotspot areas' who also need to be engaged in the conservation effort.



Source: Bellwood and Meyer (2009) *Searching for heat in a marine biodiversity hotspot.* Journal of Biogeography 36(4): 569-576

The bull's eye pattern of species richness for reef fishes (top) and cowries, a type of seashell (bottom)

Representation

A second approach to conservation priority-setting is to ensure adequate and comprehensive representation of each habitat type or biogeographical zone. Devising appropriate classifications of the marine environment, however, in order to assess representation at a range of spatial scales is no easy task. Marine classifications are based on a variety of data that include direction, the velocity and persistence of currents; temperature and ice-cover; geomorphology; satellite images; sonar soundings; faunal records; biotic associations and percentage of endemism. 'Rooted' ecosystems in the sea, such as coral reefs, seagrass, hydrothermal vent faunas, oyster beds and soft-coral gardens are easier to map than ecosystems in the open sea (pelagic zones), notwithstanding the challenges involved in locating them.

Ecoregions

Recently, there has been a shift towards an 'ecosystem approach' in marine conservation, with scientists going beyond patterns and numbers to consider the ecological functioning of areas. In this way, linked ecosystems such as coral reefs, mangroves and seagrass beds are considered together in an ecoregional management plan.

Key areas

The 'key areas' approach does not depend on a prior classification step but simply focuses on specific locations where significant ecological processes take place. For example, key areas include breeding grounds for whales, turtle-nesting beaches, upwelling areas, migration corridors, or sites where particular threatened species exist.

Juggling different approaches

In practice, international NGOs use a combination of approaches to help them determine their conservation priorities. Conservation International's marine programme was initially driven by a hotspots approach, combining hotspots of endemism with hotspots of threat from a map-based analysis similar to the one shown above. Currently Conservation International is focusing on three broader 'seascapes' using additional biological and socio-economic criteria.

In 1995, the IUCN assessed the degree to which existing marine protected areas contributed to a representative system but this initial assessment was hampered by a lack of an agreed-upon global biogeographical framework. Recent reviews using the Marine Ecoregions of the World classification[8] show that only 16 of the world's ecoregions have more than 1% of their area designated as no-take zones. This classification is now being used in global and regional conservation planning by the World Wildlife Fund (WWF), the Nature Conservancy and other international NGOs, and has been adopted as a support tool by the Convention on Biological Diversity to help increase representation on a global scale. On smaller scales, the representation principle has been used successfully, for example, in underpinnng priority-setting and zoning for Australia's Great Barrier Reef.

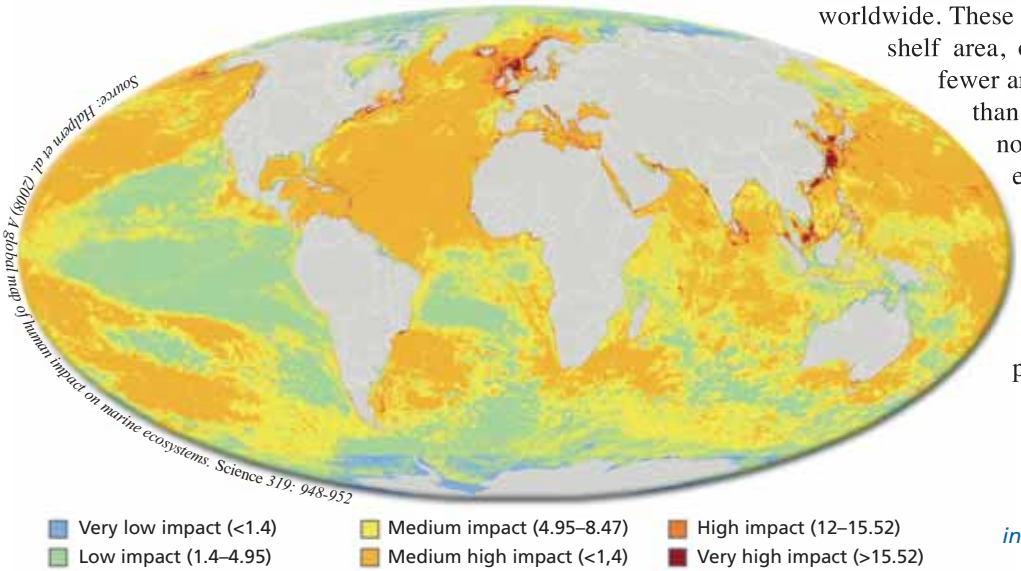
In 2002, the WWF used an ecoregions approach for their Global 200 analysis. In the marine realm, ecoregions were defined, mapped, and assessed for different biodiversity criteria, such as species richness, endemism, higher taxonomic uniqueness, unusual ecological or evolutionary phenomena, and global rarity of habitat type. Ecoregions were then ranked as globally outstanding, regionally or bioregionally outstanding, or locally important. Lastly, they were assessed for the level of threat in order to come up with a final list of 43 priority marine ecoregions. Of these, the WWF is currently working in 20 of them.

The key areas approach has been less used in the sea than on land. However, Large Marine Ecosystems, of which 16 currently receive Global Environment Facility funding, focus on key areas of productivity. On smaller scales, the key areas approach has been incorporated within WWF's ecoregional planning.

Paper parks?

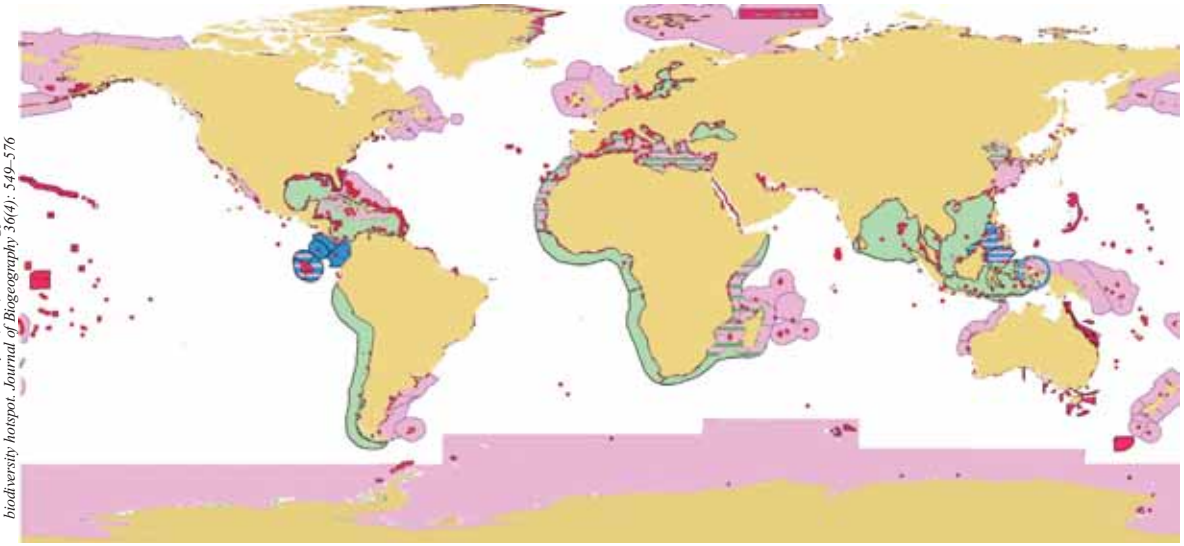
The implicit assumption of global priority-setting is that local site-based conservation within high global priority areas is an appropriate allocation of resources. Funding and resources for local site-based conservation are thus filtered by the global framework and may not necessarily take into account the social realities that govern the success of designated marine protected areas. Areas defined as priorities by different organizations commonly overlap (*see map*). Conversely, significant areas of the ocean attract no large-scale priority attention, nor the funding associated with it.

In fact, designated Marine Protected Areas (MPAs) occur in both priority areas and elsewhere. There are currently around 5045 designated marine protected areas worldwide. These cover about 4% of the total continental shelf area, or 0.7% of the ocean's surface. Even fewer are 'no-take' zones – these represent less than 0.1% of the world's ocean surface and none are on the high seas. Even worse, estimates of the effective management of MPAs suggest that most are no more than 'paper parks'. As of 2006, for example, less than 0.01% of the world's coral reefs were within MPAs estimated as no-take zones, with no poaching and at low risk.



Source: Halpern et al. (2008) A global map of human impact on marine ecosystems. Science 319: 948-952

Cumulative impact of fishing, pollution, invasive species, ocean acidificaton and other threats on marine ecosystems



Source: Bellwood and Meyer (2009) Searching for heat in a marine biodiversity hotspot. Journal of Biogeography 36(4): 549–576

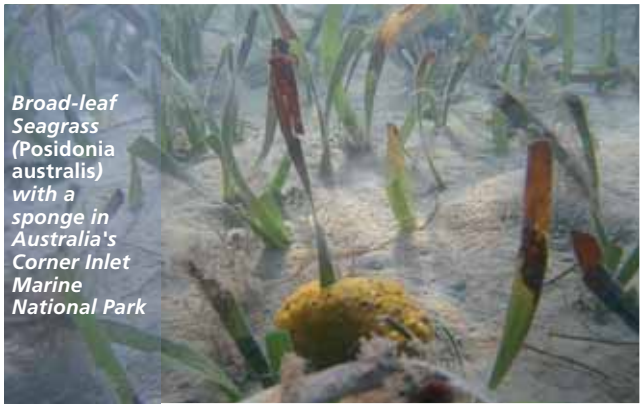
The currently funded priorities for global marine conservation and the distribution of marine protected areas. Note that the coloured areas represent entire ecoregions in which NGOs have some presence.

- *Conservation International's seascapes*
- *WWF's priority marine ecoregions*
- *Large Marine Ecosystems*
- *Designated Marine Protected Areas from the World Database of Protected Areas*

Tailoring schemes to the oceans

Most marine conservation still appears to be rooted in the idea of designating place-based protected areas, undoubtedly because most conservation planning theory stems from terrestrial work. While place-based approaches can contribute, the very nature of the sea means that some of the conservation approaches developed on land may not transfer effectively to a marine setting.

This is because the sea differs from the land in physical, biological and socio-political ways. For example, the sea is dominated by the high density of water. This allows organisms to be buoyant in a fully three-dimensional seascape without expending much energy. Indeed, some spend their entire lives in the open sea. Unlike rooted trees and grass on land, most marine plants are microscopic phytoplankton. These are at the mercy of water movements generated by variations in temperature, salinity and ocean chemistry and are thus very dynamic and hard to map. Even animals that spend their adult lives attached to a substratum (sessile species) or on the seabed (benthics) generally produce drifting larvae. The fluidity and relative lack of physical barriers means that much of the sea is interconnected physically, ecologically and genetically. Its huge size also enables individuals to move over enormous distances and allows species to have potentially vast ranges. The sea is also always downstream from the land.



Broad-leaf Seagrass (Posidonia australis) with a sponge in Australia's Corner Inlet Marine National Park

Photo: NASA

These characteristics of the sea, largely beyond our control, have important implications for biogeography, for the way threats to biodiversity can spread and for the efficacy of conservation approaches. For example, biogeographical regions in the sea are three-dimensional and their shifting boundaries are difficult to map. On land, in comparison, rooted plants grow in two-dimensional regions where transitions are generally more abrupt and comparatively stable over space and time.

Socio-political factors are more within our control. These include the demand for marine resources, the open access nature of much of the sea, perverse subsidies in the fishing industry, human-induced climate change, poor ocean governance and conflict resolution, combined with generally poor knowledge of marine issues.

An effective approach to marine conservation needs to consider the linkages within and among ecosystems rather than simply a group of isolated protected areas. Biogeography can make a significant contribution to conservation by providing data on the distribution of species and by answering the question 'why are things where they are?' Our understanding of marine species and their biogeography lags behind similar work on land. However, biogeographical science has the potential to further our understanding of ecological and evolutionary processes, strengthen the conservation voice in political discourse and educate and inspire the public to care about marine biodiversity and the need for a conservation ethic.

Sara A. Lourie[9]

For details: sara.lourie@mail.mcgill.ca
On marine protected areas: www.wdpa.org

8. *This classification divides the marine world above the continental shelf into 232 ecoregions. It was published in* Bioscience **57***(7): 573-583 in 2007 by Spalding et al.*
9. *Marine biogeographer, Redpath Museum, McGill University, Quebec, Canada*

2010 International Year of Biodiversity

Diary

2–3 July
Hydrocomplexity: new tools for solving wicked water problems
10th Kovacs Colloquium. UNESCO Paris: *s.demuth@unesco.org*

2–7 July
European Science Open Forum
UNESCO Venice office providing 28 young researchers from 12 countries of Southeast Europe with travel grants to attend. UNESCO stand and launch of report published with Observa on *Women in Science: Italy in the International Context*. Torino (Italy): *www.esof2010.org/; r.santesso@unesco.org*

5–9 July
IHP Council
19th session. UNESCO Paris: *www.unesco.org/ihp*

6–9 July
Reducing earthquake disasters
Post-earthquake workshop of UNESCO International Platform for Reducing Earthquake Disasters (Indonesia): *t.imamura@unesco.org*

13–17 July
Land surface observing, modelling and data assimilation
2nd summer school followed by Asian G-Wadi meeting (17 July). Beijing (China): *r.jayakumar@unesco.org*

25–27 July
Global climate change and ecosystem response
Intl symposium, part of 1st Eco-China Forum. Inner Mongolia Agricultural University, National Afforestation Environment Commission, State Forestry Administration, UNESCO Beijing (China): *r.jayakumar@unesco.org*

25 July – 3 August
World Heritage Committee
34th session to select new sites. Brasilia (Brazil): *a.lemaistre@unesco.org; www.unesco.org/culture*

18–20 September
Hands-on training for generating STI indicators
according to the Frascati Manual. Subregional workshop. UNESCO, ISESCO. Government officials from Iraq, Jordan, Lebanon, Syria, etc. participating. Damascus (Syria): *n.hassan@unesco.org*

20–22 September
Arab STI Strategy and Plan of Action
Arab regional parliamentarian meeting to discuss institutional framework for facilitating documents' adoption in region. UNESCO Cairo, ISESCO. Damascus (Syria): *n.hassan@unesco.org*

21–24 September
Earthquake risk reduction in Northeast Asia
Ulaanbaatar (Mongolia): *b.rouhban@unesco.org*

22 September
Biodiversity
First special session devoted to biodiversity at UN General Assembly. May see formal creation of IPBES (*see page 12*). New York City (USA): *s.arico@unesco.org*

New **Releases**

Troubled Waters

Geoff Holland and David Pugh (eds). Cambridge University Press, ISBN: 9780521765817. £30.00, English only, 320 pp.
Thirty international experts look at how governments use science to establish ocean policies, with chapters ranging from the history of ocean management to current advances in marine science, observation and management applications, and the international agencies that coordinate this work. With a focus on key topical issues such as marine pollution, exploitation and hazards, reflects on past successes and failures in ocean management and emphasizes the need for knowledge and effective government action to ensure a sustainable future for this precious resource.
For details and to order: *frobinson@cambridge.org; www.cambridge.org;*
see also: *http://tinyurl.com/TroubledWaters; www.unesco.org/en/ioc-50anniversary*

Celebrating 50 Years of the Intergovernmental Oceanographic Commission

Special issue of Oceanography *(Vol. 23, No. 3, September 2010), edited by US National Committee for the UNESCO-IOC.*
Traces 50 years of UNESCO-IOC efforts to drive ocean research forward and tackle issues in marine pollution. The IOC has had a major impact on the field of oceanography, especially in research on ocean and climate, biodiversity, integrated coastal dynamics and in facilitating observations to monitor change. Presents ideas about the future needs of the IOC in continuing to nurture, facilitate and foster international ocean science research.
Read the issue: *www.tos.org/oceanography/*; for details: *k.tedesco@unesco.org*

Ocean Teacher Video Gallery

Since 2006, the UNESCO-IOC programme for International Oceanograhic Data Exchange (IODE) has been video-recording courses taught at the Project Office for IODE in Oostende (Belgium). In March 2010, all videos were made available online through a dedicated video library. in order to preserve the expertise of the national experts around the world who collaborate with IODE. Go to the video library: *www.vimeo.com/iode*

The International Classification for Seasonal Snow on the Ground

Prepared by ICSI–UCCS–IACS–UNESCO-IHP Working Group on Snow Classification. Technical Documents in Hydrology, no. 83. English only, 88 pp.
Since 1990, our collective knowledge of snow and the techniques used to observe its characteristics have evolved. By 2003, the current classification needed updating. Here, the classification deals primarily with seasonal snow, even though many concepts in the present snow classification can also be applied to firn, the first stage in the formation of glacier ice. This publication does not attempt to classify snow covers from a climatic point of view. Download: *http://unesdoc.unesco.org/images/0018/001864/186462e.pdf*

Integrated Urban Water Management: Humid Tropics

Jonathan N. Parkinson, Joel A. Goldenfum and Carlos E.M.Tucc (eds). Urban Water series, UNESCO Publishing / Taylor & Francis. ISBN: 978-92-3-104065-8, €35.00. The output of a UNESCO-IHP project on the same topic. English only, 182 pp.
Focuses on engineering aspects related to water supply, wastewater and stormwater management in the humid tropics. Flood control is dealt with within a focus on reducing vulnerability to flood disasters in urban areas. Also addresses environmental health concerns and proposes strategies for their control. Draws upon case studies predominantly from South America.

Science and Education Policies in Central and Eastern Europe, Balkans, Caucasus and Baltic Countries

UNESCO Science Policy Series 7. Published by UNESCO Regional Bureau for Science and Culture in Europe (Venice) English only, 161 pp.
Provides insights into the linkages between higher education and research and their importance for the development of a knowledge society. Topics include: strengthening the international impact of national research and education programmes and best practices for stemming and reversing 'brain drain'. Download: *http://unesdoc.unesco.org/images/0018/001878/187823e.pdf*; for details: *i.nechifor@unesco.org*

Education for Sustainable Development

By A.A. Azizov, N.G. Akinshina. Edited by A.K Ergashev. Produced by UNESCO's Tashkent office with support of National Commission of Uzbekistan. Textbook in two volumes: Teacher's Guide (1142 pp); Exercises (256 pp). Published within a programme for developing a network of UNESCO-associated schools in Uzbekistan. Exists in Russian and Uzbek. Download*: www.tashkent.unesco.org/index.html;*
for details: *a.osipov@unesco.org*

Building an Ecologically Harmonious Civilization

Produced by Wuyishan Biosphere Reserve, UNESCO Beijing Office, Chinese National MAB Committee and East Asian Biosphere Reserve Network. Bilingual edition in English and Chinese, 34 pp.
Describes a GEF project implemented with guidance and financial support from UNESCO to turn Wuyishan Biosphere Reserve in China into a learning site for sustainable development. In 1994, the biosphere reserve set up a Joint Protection Committee to involve local communities in conservation efforts. By supporting alternative livelihoods such as bamboo-planting and black tea, and by introducing advanced techniques, the biosphere reserve has extended the benefits of conservation to local communities. This pilot project was presented to the China Biosphere Reserves Convention on 20 May at the UN Pavilion of the Shanghai World Expo Park. For details: *r.jayakumar@unesco.org;*
Download: *http://unesdoc.unesco.org/images/0018/001880/188020M.pdf*

Climate Change and Adaptation for Water Resources in the Yellow River Basin, China

Produced by UNESCO's Beijing Office with support from the Yellow River Conservancy Commission. UNESCO-IHP Technical Reports in Hydrology Series. English only, 124 pp.
Compiles research papers on the impact of climate change and adaptation for water resources in the Yellow River Basin, within the UN China Initiative of the Climate Change Partnership Framework supported by the MDG Achievement Fund.
Download: *http://unesdoc.unesco.org/images/0018/001879/187933E.pdf;*
for details: *r.jayakumar@unesco.org*

Implementation of MAB's Seville Strategy and Madrid Action Plan in Biosphere Reserves

Produced by UNESCO's Beijing Office, with Chinese National MAB Committee and East Asian Biosphere Reserve Network. English only, 144 pp.
Final report of meeting of East Asian Biosphere Reserve Network on 10–15 November 2009. Comprises summaries, papers, and country reports for China, DPR Korea, Japan, Rep. Korea, Mongolia and the Russian Federation.
Download: *http://unesdoc.unesco.org/images/0018/001881/188143E.pdf*

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