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Eight predictions for 21<sup>st</sup> century conservation, p. 2

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### Tuna on the menu in Doha

All eyes are on Doha (Qatar) this month and the diplomatic talks over the proposed ban on bluefin tuna fishing in the Atlantic Ocean and Mediterranean Sea. Monaco's proposal to prohibit this lucrative trade in order to give depleted stocks time to recover has won the support of the USA and European Union but is opposed by Japan, which imports 80% of its tuna.

In Doha from 13 to 25 March, the 175 Parties to the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) are examining more than 40 proposals for the conservation and sustainable management of a range of mammal, reptile, fish, insect, coral and plant species. The United Republic of Tanzania and Zambia, for example, are requesting authorization to hold a one-off sale of government ivory stocks recovered from elephants which have died of natural causes. Seven other African countries led by Kenya are making a counter-proposal for a 20-year moratorium on any softening of the ban on ivory trade in place since 1989. The USA proposes prohibiting all hunting of the polar bear. Canada argues that climate change is a greater menace for the species than hunting. Egypt wishes to reduce the level of protection of the Nile crocodile, arguing that stocks have recovered sufficiently. Guatemala and Honduras are proposing the inscription of four iguana species in Appendix II – which would permit trade in these reptiles but with strict controls – to protect them from collectors. Brazil and Argentina are proposing a similar listing for the commerce of rosewood and Palo Santo, two trees which produce essential oils used extensively in perfumery and cosmetics.

The debates should be animated. But then, there is a lot at stake. The case of the bluefin tuna, which can grow to 3 m in length, is symptomatic of growing international concern over the destruction of the world's marine ecosystems through overfishing: 81.9 million tons of fish were harvested from the oceans in 2006. A single specimen of bluefin tuna was reportedly sold for US\$120,000 in January this year.

The oceans 'are in a terrible state,' observe the authors of our lead story in this issue. 'Destructive practices have continued in the oceans that would never have been tolerated on land.' One of their eight predictions is that the plight of the oceans will come to the fore of conservation efforts this century. There is no time to lose: an estimated 52% of marine fish stocks are fully exploited, 19% overexploited and 9% depleted or recovering from depletion. CITES observes that 'the maximum wild capture fishing potential from the world's oceans has probably been reached and a more closely controlled approach to fisheries is required.' The fate of the bluefish tuna in Doha will be a gauge of the international community's commitment to sustainable fisheries.

As this issue was going to press, the news broke that the proposed ban on blue tuna fishing had been rejected in Doha.

*W. Erdelen*  
Assistant Director-General for Natural Sciences

## Eight predictions for 21<sup>st</sup> century conservation

Conservation was among the most successful cultural movements of the 20<sup>th</sup> century. Perhaps its most remarkable achievement is the designation of vast areas of the globe for nature: some 12% of the Earth's land mass according to the UNEP World Conservation Monitoring Centre. Equally important has been the changing of people's attitudes. Once a novel minority idea, nature conservation has become a mainstream interest in many countries. But what does the future hold? Will conservation in 2020 or 2050 be broadly similar to today or will climate change, global politics and technological innovation radically change its direction and influence?



*The Napoleon Wrasse (Cheilinus undulatus) is found mainly in coral reefs in the Indo-Pacific Ocean. The Tubbataha Reefs Natural Park in the Philippines, a World Heritage site, is one of the few places in the world where it is actively protected.*

The Nobel Prize-winning physicist Nils Bohr famously quipped, 'Prediction is very difficult, especially if it is about the future.' We agree but would suggest that one prediction about conservation is a sure bet: conservation will change because society will change, forcing our conservation values, goals and ideals to evolve. Just as some of us might be horrified to know that our grandmothers lusted after a fur coat made from the skin of a rare cat, our grandchildren might find our use of disposable plastic cups equally abhorrent. Here, we outline our eight predictions for conservation in the 21<sup>st</sup> century. Some are based on the extrapolation of current trends in global conservation; others are pure speculation on our part! We hope all of them will inspire debate, reflection and hope.



### Conservation of the oceans comes to the fore

The emphasis of conservation during the 20<sup>th</sup> century was firmly on the conservation of terrestrial ecosystems.<sup>1</sup> Our first prediction is that conservation of the oceans will emerge as an exciting and compelling new cause.

The oceans are currently in a terrible state. In his excellent, if depressing, book *The Unnatural History of the Seas*, Callum Roberts describes the once-teeming life of

our oceans and the devastating impact of centuries of commercial fishing and hunting on its abundance. 'Fishing down the food chain' captures the true seriousness of the situation: commercial fleets with ever-bigger boats and ever-more powerful technology have driven several species to commercial extinction and some close to biological extinction. Fishermen have thus turned their attention to smaller and smaller species of upper ocean fish and, more worrying still, to deep-sea species, which reproduce and grow at much slower rates than species in shallower waters. A startling example is the orange roughy (*Hoplostethus*

*In winter, humpback whales swim off East Australian coasts to breed and give birth. The first whale sanctuary was established by the International Whaling Commission in the Antarctic in 1938. The Indian Ocean Sanctuary followed in 1979 then the Southern Ocean Sanctuary (1994). Two additional proposals for establishing whale sanctuaries in the South Atlantic and South Pacific have to date both failed to achieve the required three-quarter majority of votes.*



© IRD / BORSA Philippe – UNESCO partner in biodiversity exhibition 2010

*atlanticus*), a deep-sea fish found in cold waters from Iceland to New Zealand that can live for 150 years; it does not even reach sexual maturity until it is 20–30 years old. Overfishing has caused many populations of this incredible fish to crash and, due to its long life cycle, there are no prospects for a quick recovery.

Marine conservation's relatively low profile during the 20<sup>th</sup> century is partly explained by the political power of the commercial fishing lobby and partly by the fact that, beyond 200 miles from shore, the oceans are a commons beyond national or supranational control. However, the biggest problem is, arguably, that the changes in the marine environment have been largely invisible to all but a few. Most of us think of the oceans as a flat expanse, sometimes blue and sparkling, sometimes rough and cold. Seas teeming with fish, whales and turtles are a lost memory for contemporary society. Until very recently, it was only possible to get an occasional insight into the variety of life in the seas and the horrendous impact of commercial fishing, offshore development and waste disposal on marine ecosystems. Destructive practices have continued in the oceans that would never have been tolerated on land.

A forward-looking development in conservation is the Planet Ocean Initiative.<sup>2</sup> It represents two key insights of 19<sup>th</sup> century conservation: first, that transformational change tends to be initiated by informal and eclectic networks of individuals at the cutting edge of science, politics, business and technology; second, that where governance institutions are weak, simple conservation approaches work best. British government marine specialist Dan Laffoley and ocean explorer Sylvia Earl have linked up with Google to put the oceans on Google Earth.<sup>3</sup> The 2009 version of this ubiquitous free software includes a detailed bathy-metric map of the ocean floor; new Internet technologies allow users to 'dive' under the water and explore the seafloor in three dimensions. A range of partners, including National Geographic, the US Navy and the International Union for Conservation of Nature, have contributed information. The ocean bed is filled with 'pop-up' windows providing videos, pictures and text on species, sites and threats. It is an amazing development and far more than 'edutainment'; it is a state-of-the-art conservation advocacy tool with massive potential. Conservationists and researchers can use the information to analyse and pinpoint threats or as a base on which to overlay new information about endangered species and populations. Field workers can link video reports of local issues and activities through file-sharing websites like YouTube.

In February, Jacques Perrin's documentary *Oceans* opened to rave reviews in France, while in April Disney Nature will launch its latest blockbuster film, also called *Oceans*. National Geographic television will add to this fest of amazing marine imagery with an animal's-eye view of the seas, produced by new cameras mounted on the shoulders of sea creatures. Developments in camera and



Photo: US Federal Government; Text: Wikipedia.org

*This Laysan Albatross chick was accidentally fed plastic by its parents and died as a result. Floating debris in the ocean can kill wildlife directly by ingestion or indirectly by absorbing organic pollutants in seawater, including DDT. Toxin-containing plastic is eaten by jellyfish, which are in turn*

*eaten by larger fish – and turtles – and ultimately by humans. The biggest concentration of plastics and other debris in the sea is found in the central North Pacific Ocean, carried by marine currents. Known as the Great Garbage Patch, this area is thought to be twice the size of the US State of Texas.*

satellite tracking technology will create a new and exciting genre of wildlife film where the viewers' gaze will no longer be directed towards the animal; instead, we shall be looking over its shoulder and through its eyes. Taste and interest in wildlife programmes will move away from natural history towards animal ethology. This new genre will start in the oceans where animals are bigger, more mobile and where camera weight is less of an issue. Remarkably, it will be the animals themselves who reveal the destruction wrought by humans on their world. We predict this combination of technology, representation and revelation will bring the oceans into the public mind, inspiring a new phase of conservation.



## **REDD stalls but lays the foundation for better forest governance**

One of the positive outcomes of the talks in Copenhagen was the progress made towards implementing the mechanism for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD). This mechanism establishes a financial value for the carbon stored in forests to create incentives for developing countries to 'reduce emissions from deforestation and degradation'<sup>4</sup> and establish effective management of forested lands. Our (possibly unpopular) prediction is that progress on REDD will stall, in part because it is linked to a broader framework agreement on climate change. More specifically because there are major political and technical sticking points relating to the scope of the framework, reference levels, national or sub-national management, finance mechanisms and the means of monitoring and verification. REDD has created opportunities for a wide range of interest groups but one group poorly represented so far are forest managers and conservation practitioners, the people with the practical knowledge and insights into the feasibility of what is being proposed.

Although the dream of an internationally binding forest framework may remain elusive, we also predict that the



© Yann Arthus Bertrand

Burning in the Amazon forest to clear land for agriculture

legacy of REDD will be a new and more effective era of forest governance. REDD has put forests back near the top of the political agenda: significant budgets have been earmarked, conservationists and others have received a crash course on the challenges and complexities of forest management and the REDD process has transformed participation in forest governance to include entrepreneurs, investment banks and corporations. REDD pilot projects not only exemplify new partnerships but are also test beds for a variety of innovative and promising new governance approaches and techniques. These projects represent significant investments and have created expectations that need honouring; they will proliferate to produce models of resource governance that will inspire positive transformations in other sectors such as agriculture and water.



**China changes the rules of international conservation**

One outcome of the climate talks in Copenhagen last December is the realization that global geopolitics have changed: China and other large emerging economies like Brazil and India are now major international players. We predict that the influence of China will transform the nature of international conservation.

International conservation is arguably approaching the end of a golden age when it could ‘piggy-back’ on Western political and economic power overseas. Until recently, developing countries in need of investment had no choice but to approach Western donor countries, which typically attached various environmental ‘conditions’ to their low-cost loans and grant aid. Conservationists have been adept at using this reality to integrate conservation and sustainable resource management into development agendas, thereby enabling partnerships and building influence, welcome or otherwise, with governments in developing countries.

The phenomenal growth of the Chinese economy – and the need to find the raw materials to fuel it – means

that China’s influence in developing countries is increasing. China doesn’t do development ‘aid’ in the Western sense. Instead, its big state companies negotiate joint venture deals with state-owned companies in developing countries. These deals commonly involve the construction of infrastructure such as roads and railways in return for resources and/or a stake in resource extraction companies.

Such investment will undoubtedly benefit the poor of these countries but improved access to resources is also likely to hasten the demise

of wildlife and forests. For instance, Chinese companies are rebuilding the railways of the oil-rich Nigeria and Democratic Republic of the Congo, pumping US\$8 billion into road and rail infrastructure and bringing mines back into production. Consequently, the last relatively untouched forests of the Congo are likely to be utterly transformed in the next 30–40 years. Crucially, developing countries now have access to a new major source of development investment – and one that doesn’t come with the same environmental strings attached.

In our view, the economic rise of China poses a major future challenge for international conservation. This will require a new breed of conservation professional who can build the necessary cultural bridges and broker new deals: Chinese-speaking social entrepreneurs, perhaps? What seems certain is that, if conservation succeeds in maintaining its international influence and vibrancy, the profile of future conservationists will look very different to that of today.



**Conservation becomes increasingly industry-led**

Bizarrely, considering their past reputation for environmental destruction, the major resource industries – mining, oil and gas, timber and plantation companies – may become key future players in nature protection. Currently, it is governments, NGOs, wealthy individuals and sometimes traditional communities who own and manage protected areas. In future, conservationists might have to add transnational companies to the mix and accord them the access to policy and funding presently reserved for non-profit organizations.

Most leading companies now acknowledge the business argument for corporate social responsibility and an increasing number are incorporating conservation in their strategy and operations. Many resource companies own vast areas of natural habitat for mining, plantations and so on. The operations of some do not necessarily require them to clear all, or even much, of their land. Protecting this land for conservation

can enhance security, the company's image and brand, as well as access to investment, contracts and new markets.

Illustrative of this change is the island of Sumatra in Indonesia. In 2007, the Royal Society for the Conservation of Birds, a UK charity, bought the rights to manage 100 000 ha of threatened lowland Sumatra rainforest, at a cost of several million pounds. A little further to the north, a major pulp company which owns massive areas of forest is planning to protect an area greater than this by implementing a mosaic planting scheme that will maintain high conservation values and carbon assets, in addition to producing the timber needed to supply the mill.

Intriguingly, some industries may be better at delivering conservation than either governments or NGOs. There are at least six areas in which business has an advantage over conservation NGOs (*see table*). If comparative benchmarking of corporate, government and NGO management of conservation reserves were undertaken, it could well be that corporations would come out on top. More likely, major resource extraction industries and conservation NGOs may form land or reserve management partnerships in which the company runs the reserve and the NGO takes care of the science, policy and marketing.

Whatever the precise outcome of various initiatives, we expect the development of a very different relationship between the international conservation establishment and industry. The 'people power' environmentalism of the 1970s brought about a relationship often of antagonism and suspicion but this attitude has softened in the past two decades, resulting in numerous partnerships between NGOs and business. In the near future, we expect that conservation NGOs will stop criticising corporations which clear forests and instead work with them to plan responsible deforestation and design multiple-use landscapes in which natural forest blocks and corridors fit with commercial production. This is not a perfect situation but would be a considerable improvement on the current default scenario of complete destruction.

**Prediction 5**

**The extinction debt will be paid**

Studies of oceanic islands tell us that, the bigger an island, the more species it can hold. They also tell us that, as the size of an island shrinks, some species are squeezed out. For oceanic islands, this reduction normally takes millions of years, as the island slowly erodes into the sea, but it happens much more quickly when newly-created 'islands' of forest find themselves surrounded by agricultural land. Additional species are lost as climatic conditions within the remaining habitat change beyond the ability of its organisms to cope. This reduction of diversity does not happen immediately; habitats all over the world now owe a significant 'extinction debt'. In other words, many nature reserves and remaining fragments of habitat contain species that have travelled a long way down the road to extinction.

We have been lucky. There have been very few high-profile species extinctions since the 1960s. But many species are barely hanging on and it can only be a matter



© UNESCO/Pierre Gaillard

Wikipedia

Poachers kill African elephants (seen here in Zimbabwe's Hwange National Park) for their ivory tusks. Tagua has been called 'vegetable ivory' because the hard tagua nut has a white endosperm similar to elephant ivory. Tagua can be dyed to make jewellery or sculpted (see insert). Prior to the invention of plastic, it was even used to make buttons. There are several species of tagua palm in South America but it is the kernels of the Ecuadorian palm, *Phytelephas aequatorialis*, which are harvested most.

**Six areas where business has an advantage over conservation NGOs**

Temporal scale	Resource-based companies plan and budget their operations on temporal scales of decades, whereas conservation NGOs are financed by short-term grants from donors who rarely fund beyond five years.
Land tenure	Industries are major land-owners or lease-holders in less developed countries, which brings more political power than grant-aided projects.
Resources	Few NGOs have the financial, logistic or human resources necessary to engage in long-term management of substantial areas of land in developing countries. By contrast, successful resource-extraction businesses have, by definition, had to develop the technical and operational expertise to manage land and incorporate this into their business structures, planning and ethos.
Human resource management	Strong social and environmental credentials help a business attract talented and creative employees. Since the core business of NGOs is conservation, this activity brings no competitive advantage in terms of human resources.
Accountability	Industries report publicly on their performance and a number of structures exist to hold them to account. No such pressure is exerted on governmental and non-governmental conservation groups.
Governance	Companies operating in remote areas are major employers and contributors to local economies, which means they can wield far more influence locally than can conservation groups.

of time before the world experiences extinctions on a par with those of the passenger pigeon in the USA, of which there were over 3.5 billion individuals less than two centuries ago, or the Great Auk (*Pinguinus impennis*), a flightless bird that was once a common sight on islands of the North Atlantic. One of the groups most at risk are the primates because many species are reliant on having good-quality rainforest to live in and are hunted as bushmeat. Currently, eighteen species of south-east Asian primate have populations of fewer than 250 individuals. A rash of high-profile extinctions could shake public trust in conservation and might be interpreted as evidence that conservation bodies and governments are not working effectively.

Perhaps the looming extinction of the mountain gorilla, orang-utan or Asian elephant in the wild might galvanise the next generation of conservationists and lead to the birth of new, more successful conservation organizations and movements. These large, charismatic species are unlikely to be allowed to become extinct in the wild: they are simply too important. When their situation becomes critical, huge resources will be thrown in their direction. It is most likely that the extinction debt will be paid by numerous, less well-known, species of invertebrates, amphibians and reptiles – species that most people know little about and, arguably, care about even less. Such extinctions will not go completely unrecorded or uncommented upon but are unlikely to force a change in global attitudes to conservation.



Photo: Vincent Raintung, 8 years old (Germany) / Airbus Photography Awards

*Baby orang-utan feeding with its mother in a park in Indonesia. Ongoing deforestation could lead to the extinction of orang-utans in the wild within a decade or so.*

had controlled the forest structure. The Dutch government allowed Vera and his colleagues to set up a public experiment of his ideas at the 6000-ha Oostvaardersplassen reserve. In the mid-1980s, Vera's group introduced red, fallow and roe deer, Konic ponies and Heck cattle to the reserve. Konics are a very old breed, thought to be very close to Europe's extinct horses, whereas Heck cattle are a breed developed in the 1920s by the Heck brothers of Germany, who cross-bred the oldest breeds of cattle they could find to create an animal that resembled the last known European species of wild cow, the auroch, which became extinct in 1627.

A visit to Oostvaardersplassen is a surreal and conceptually challenging experience. It is rather like looking across a cold Serengeti; herds of cattle, horses and deer are interspersed with flocks of geese and shorebirds that occasionally rise in vast clouds as an eagle drifts into view. After the initial spectacle has sunk in, a number of fascinating questions confront the conservationist. Should we view the cattle and horses as domestic species used as a management tool to deliver conservation targets or as conservation targets in their own right? Did the auroch and tarpan (the Eurasian wild horse) actually become extinct? Did humans transform aurochs and tarpan into cattle and horses and is the Oostvaardersplassen the crucible of their rebirth? Is the reintroduction of large herbivores even sensible? The experience of Oostvaardersplassen and other sites in the Netherlands where they are

introducing 'naturalistic grazing' suggests that, while the abundance of some species may increase, the overall diversity of species may decline. Is this good or bad? Could it suggest that rewilding is an approach for ex-agricultural land rather than for existing reserves?

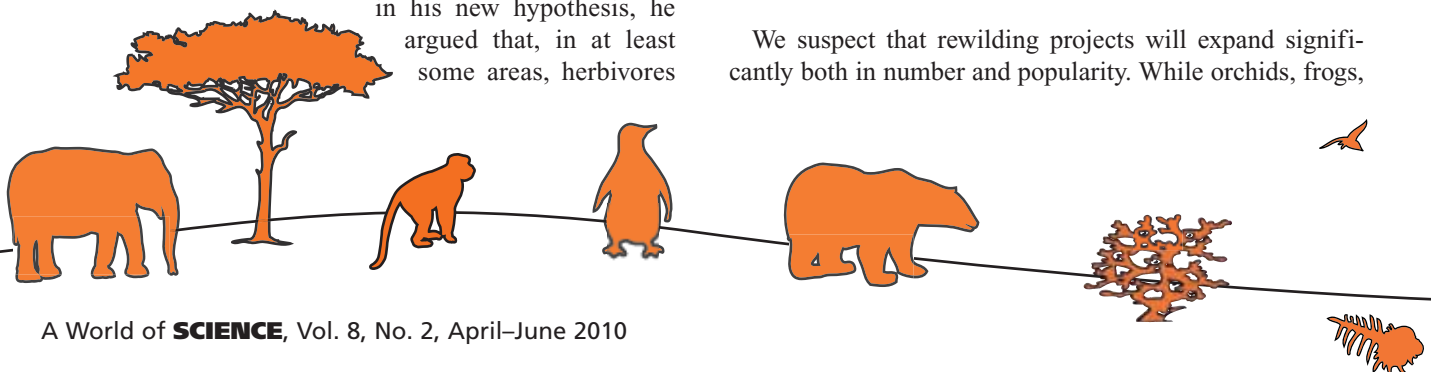
Reconstituting large mammal communities is not confined to the Netherlands. The 'Pleistocene Park' project in Russia aims to recreate the tundra steppes that were widespread up until the last ice age through the creation of grasslands and the introduction of bison, musk ox, Yakutian horse, hares and marmots which used to roam here, according to the fossil record. The reintroduction of predators is planned, once herbivore populations have become firmly established.

We suspect that rewilding projects will expand significantly both in number and popularity. While orchids, frogs,

**Prediction 6** **Return of the wild**

A number of new strands of conservation thinking and practice are starting to coalesce as 'rewilding': the reintroduction of relatives of extinct species, normally large herbivores and predators, into natural areas to restore their ecological function. The best example is probably the groundbreaking Dutch project to recreate a community of Europe's large herbivores. The architect of the project is Frans Vera, an ecologist with the Dutch nature conservation agency, Staatsbosbeheer. His observations of grazing animals led him to challenge the established view that Europe was once covered with forest;

in his new hypothesis, he argued that, in at least some areas, herbivores



bitterns and the like appeal to traditional nature lovers mainly drawn from the Western white middle classes, large mammals fascinate a broad cross-section of society across the world. The synchronised birth of Heck calves or the rutting of stags are natural spectacles with universal appeal. Rewilding projects can bring nature to the forefront of public debate. Letting the wild-acting cattle starve to death at Oostvaarderplassen outraged Dutch animal welfare organizations so much that they sued the Dutch Nature Conservation Agency. The debate focused on notions of cruelty; in particular, why it is considered cruel to allow natural winter starvation, yet not considered cruel to separate social animals from their mothers at an early age. If we are to renegotiate society's relationship with nature to meet the rapidly changing environmental and social circumstances of the 21<sup>st</sup> century, such debates are critical.



Photo courtesy of Alan D. Wilson – www.naturespeciesonline.com

*Wood Bison (Bison bison athabascae) in the state of British Columbia in Canada. Wood bison are a subspecies of the American Bison (Bison bison). The Wood Bison is being introduced into Pleistocene Park in Russia to replace the Steppe Bison (Bison priscus), which became extinct in the late Pleistocene at the end of the last ice age. The Steppe Bison was found throughout Europe, Central Asia and North America during the Quaternary.*

a sheep, so such ideas may not be as preposterous as they first appear. The Australian Natural History Museum in Sydney has attempted to clone the extinct Tasmanian tiger (*Thylacinus cynocephalus*). According to Nicholls, the woolly rhinoceros is a good candidate for resurrection. Like the mammoth, there are plenty of specimens of this animal preserved in permafrost and it has close living relatives. The dodo would be more difficult: pigeons could possibly take on the role of surrogate parents but only a few dodo bones and skin fragments exist,

and these have produced hopelessly poor-quality DNA. The giant ground sloth, which became extinct 8000 years ago, falls in the 'extremely unlikely' category. Several specimens have been found bearing hair, which is an excellent source of DNA. The difficulty would be finding a suitable surrogate for this six metre-long, four-tonne giant!

Scientifically, rewilding epitomises the 'functionalist' approach to conservation; giving priority to managing and restoring ecological processes. This contrasts with the 'compositionalist' approach, the dominant conservation paradigm of the 20<sup>th</sup> century, which emphasizes the conservation and management of species and species assemblies. Faced with the prospect of climate change transforming ecosystems, many conservation scientists argue that we have no choice but to focus on restoring and strengthening ecological process so that natural systems can adapt.

Some leading geneticists think such projects are a waste of time and that cloning a species from ancient DNA is, and always will be, impossible. Conservation bodies are also cool on the idea, arguing that the prospect of a 'technofix' will distract public attention from the more urgent need to save existing species and undermine the imperative for action that follows from the knowledge that extinction is forever. Nevertheless, public enthusiasm for bringing back extinct animals, coupled with advances in cloning techniques, suggests to us that more teams of bioscientists will be attracted by the technical challenges, the scope for publicity and funding, and the fact that it is such an intriguing idea.

**Prediction 7 An end to extinction**

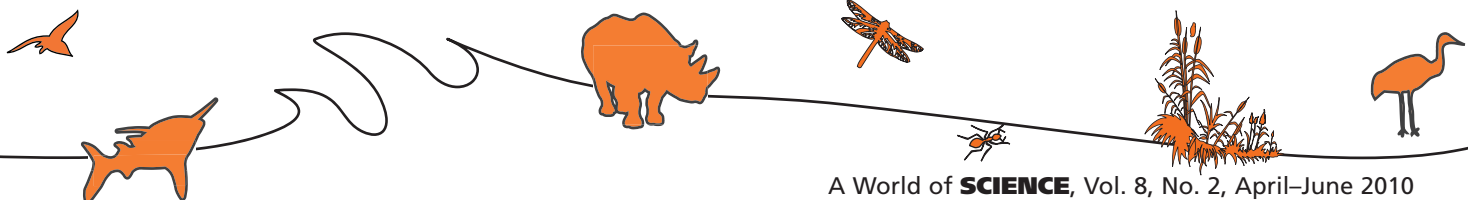
We suspect that public interest in rewilding projects and reintroducing species will grow during the first half of the 21<sup>st</sup> century. The reintroduction of species such as the beaver, lynx, Californian condor or wolf is an antidote to the doom-laden stories of destruction and extinction that seem to dominate the headlines. But will advances in genetic technology and conservation combine to bring species back from the dead?

The science journalist Henry Nicholls has prepared a revival recipe for extinct species; take the following ingredients: a well-preserved DNA, several billion DNA building blocks, a suitable surrogate mother and some highly advanced technology. In 1960, we could not have imagined being able to clone



Photo: Wikipedia

*A Heck bull among Konik ponies in Oostvaarderplassen. These species were introduced recently to graze the wetlands and thereby prevent this coastal bird habitat from turning into dense woodland.*



While it is impossible to know whether rewilding of extinct species will ever really happen, we'd be willing to place a (very) small wager that tourists of the late 21<sup>st</sup> century will be able to head off to the Russian steppes for photo safaris with the big five: the woolly rhinoceros (extinct), musk ox, auroch (extinct), Siberian tiger and bison. Rewilding, reintroductions and reversals of extinction will be an increasing source of hope, inspiration and controversy.

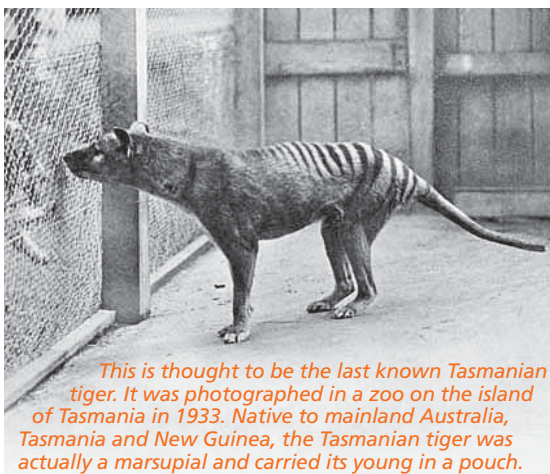
**Prediction 8**

**Aliens are accepted**

Ever since humans first migrated out of Africa, they have brought other species with them. Initially, these may have only been the parasites that lived in them or on them but, with the development of complex societies and transport systems, almost any species on Earth can find itself unexpectedly living in a new region or continent. One of the earliest examples is the tamarind tree (*Tamarindus indica*) that found its way into China along the ancient Shu-Yan trade route linking China to India 8000 years ago. The problem, from a conservation perspective, is that the number of non-natives establishing themselves has increased dramatically in the past 50 years, often to the detriment of local fauna and flora – not to mention human health and the economy.

Often, it is the same non-native species that is being introduced into multiple locations and, as a consequence, disparate locations are beginning to look more ecologically similar. Known as biotic homogenization, this process is the reason why you can see native European house sparrows (*Passer domesticus*) in almost any major city in the world, or go fishing for North American rainbow trout (*Oncorhynchus mykiss*) in Brazil, India or New Zealand.

One of the most interesting consequences of increased homogenization, along with forced migrations due to climate change, will be the creation of novel or non-analogue ecological communities. Clearly, in some respect, any area that has lost native species or gained non-native species



*This is thought to be the last known Tasmanian tiger. It was photographed in a zoo on the island of Tasmania in 1933. Native to mainland Australia, Tasmania and New Guinea, the Tasmanian tiger was actually a marsupial and carried its young in a pouch.*



Photo: R. K. Hemming : www.Jatropha.org

*Jatropha curcas originated in Central America but is now found around the world. The plant produces a fruit rich in oil which can be used for producing biofuels, soap and candles. It grows easily, even in wastelands and sandy, stony or saline soils. In a study published in PLOS ONE in April last year, researchers at the University of Hawaii found that some biofuel crops could be invasive and should thus not be planted in biodiverse areas. They cited the examples of jatropha, gorse and kudzu but considered other crops like macadamia and sugarcane to be non-invasive.*

is novel. The point is that many species assemblages will be transformed to such an extent that they will cease to resemble anything that we currently consider as natural. This is both worrying and exciting: worrying because we may see species that get squeezed out of these new assemblages but exciting because the ‘new’ nature that emerges may be a vehicle to reconnect urban societies to the natural world. We predict that, with the exception of oceanic islands, attitudes to non-native species will soften radically during the 21<sup>st</sup> century as innovative solutions are sought to the biodiversity crisis.

To an extent, this is already happening. In an innovative switch of direction, a conservation group on the Indonesian island of Bali decided against releasing captive bred Bali starlings back into the ‘natural habitats’ of the Bali Barat National Park where the final wild population had become extinct in 2006. Instead, they released them into plantations on the neighbouring island of Nusa Pencia outside the species’ known range. So far, the starlings appear to be flourishing. An even more radical idea from Germany is to build up feral populations of endangered parrots in urban centres. One thing is certain, non-native species are here to stay and conservation will need to change attitudes to non-native species or become paralysed by the enormity of the task.

**Four good reasons to expect change**

This short article has largely been about current trends in conservation and how these might extrapolate into the first half of the 21<sup>st</sup> century. The further one looks into the future, the harder it is to predict accurately what might happen. However, there are four very good reasons to think that the practice and focus of conservation at the end of this century will be radically different to the way it is today.



An African honey bee (left) and a European honey bee. African honey bees were accidentally released in Brazil in 1957 and have been moving north ever since. A 17-year study of bee populations in tropical rainforests of French Guiana, Panama and the Mexican Yucatan has found that natural disasters such as hurricanes and drought have a negative impact on native bee populations but that the sustained presence of African honey bees does not. The African honey bees live on a diet of pollen from more than 171 plant species, including all of the most important plants for the native bees, but the native bees have managed to switch their feeding habits to similar trees, shrubs and vines that flower at the same time as their preferred diet. In areas with less biodiversity, the native bees would not have the same range of options. The study was published last year by David Roubik from the Smithsonian Tropical Research Institute in Panama and Rogel Villanueva-Gutiérrez from the College of the Southern Border in Mexico.



- First, climate change will cause huge shifts in the composition and structure of ecosystems, necessitating a major rethink of conservation strategy and focus. Second, technology will continue to develop, dramatically increasing the kinds of interventions available to conservationists. Third, the world population will change – present predictions show it increasing until about 2060–2070 then declining. Conservation will be radically different at a time of population loss – an indication of just how different can be seen in northern and eastern Europe, where a decline in the human population has gone hand-in-hand with reforestation. Finally, social values will continue to change, not necessarily in a manner favourable to conservation.

- It is tempting to speculate that, combined with mass human migrations, the need to move countless species in response to climate change may change human attitudes to non-native species. Our grandchildren’s generation may be far more likely to ask what can live here rather than what did live here. Or perhaps, future societies will create complex mosaics of reserves, spanning everything from re-creations of pre-industrial habitats to fully functioning exotic ecosystems.

- Conservation is entering a critical, dynamic and exciting phase; it needs innovative ideas, original perspectives, fresh enthusiasms, new kinds of commitment and people able and willing to ask hard and insightful questions and to offer imaginative and inspiring visions. If, as most experts suggest, humanity is entering a period of accelerated social and environmental change, conservation and conservationists, as well as the species and habitats they seek to save, must change.

- In our view, the best way to adapt is to connect to, unite with and become part of the forces that are shaping the future. Since the middle of the 20<sup>th</sup> century, conservation has maintained a distinct identity which, in some ways, has kept it conservative and lacking in self-awareness. Relatively stable, if limited, funding from subscribers, foundations and governments has enabled ten or so organizations to dominate the market and create stable networks in which they operate in a steady, low-risk way. A shake-up may be needed to help conservation adapt. The pressure for such a change must come from people outside, as well as inside, conservation groups.

Paul Jepson<sup>5</sup> and Richard Ladle<sup>6</sup>

*This article is extracted and adapted from Conservation: a Beginner’s Guide by Paul Jepson and Richard Ladle, published by Oneworld Publications (UK) in February 2010 (£9.99). The book is available to readers of A World of Science at a 25% discount until 31 August 2010: <http://tinyurl.com/ykpz6d2>*



A polar bear cub in Alaska (USA). Shrinking sea ice from global warming led to polar bears being listed as threatened in 2008 under the US Endangered Species Act. In October 2009, the US Department of the Interior proposed designating key areas of polar bear habitat across Alaska: barrier island habitat, sea ice habitat and terrestrial denning habitat.

1. One notable exception is Frenchman Jacques Cousteau, whose hugely popular TV series first brought colour images of life in the oceans to mass audiences in the 1960s and 1970s via his beautifully filmed documentaries.
2. [www.protectplanetoocean.org](http://www.protectplanetoocean.org)
3. <http://earth.google.com>
4. The Copenhagen Accord of 18 December 2009 also states that ‘the collective commitment by developed countries is to provide new and additional resources, including forestry and investments through international institutions, approaching US\$30 billion for the period 2010–2012 with balanced allocation between adaptation and mitigation [...] developed countries commit to a goal of mobilizing jointly US\$100 billion a year by 2020 to address the needs of developing countries.’
5. Course Director, MSc Nature, Society & Environmental Policy, School of Geography and Environment, University of Oxford, UK
6. Senior Research Associate, School of Geography and the Environment, Oxford University, UK



## Women laureates battle parasites and disease

**On 4 March, five exceptional women each took home US\$100,000 in recognition of their contribution to the life sciences. As every year, the l'Oréal-UNESCO for Women in Science award ceremony took place at UNESCO headquarters in Paris. The ceremony was preceded a day earlier by the award of 15 fellowships to promising young women researchers from around the world.**

**Prof. Lourdes J. Cruz (1)** from the Marine Science Institute at the University of the Philippines is the Laureate for Asia–Pacific. She is rewarded for the discovery of conotoxins produced by certain marine snails that can serve as painkillers and pharmaceutical probes to study brain function. Cone snails are marine gastropod molluscs that live in the shallow waters of tropical oceans. In seven out of ten cases, the venom of certain species can be fatal. Yet, in medicine, these toxins serve as components for developing drugs to fight pain, epilepsy and other neurological disorders. Conantokin is being studied, for example, for its potential as an anti-convulsive for treating epilepsy. In the 1970s, Professor Cruz was one of the first to research the toxins of these marine snails, succeeding in elucidating the structure and function of conotoxins.

**Prof. Rashika El Ridi (2)** from the Faculty of Sciences at Cairo University (Egypt) is the Laureate for Africa and the Arab States. She is rewarded for paving the way towards the development of a vaccine against the tropical parasitic disease schistosomiasis, which affects over 200 million people. Schistosomiasis is the second-most devastating epidemic in the world after malaria, with 280 000 deaths a year. It is found mainly in sub-Saharan Africa (85% of cases), Asia and Latin America.

Prof. El Ridi has helped reveal how the schistosome parasite survives in the lungs and why it is so hard for the immune system to eliminate it. Most importantly, she has demonstrated how the immune system reacts strongly to several substances secreted by the parasite, which it uses to protect the body from new infections.

**Prof. Elaine Fuchs (3)** from the Laboratory of Cellular Biology at Rockefeller University in the USA is the Laureate for North America. She is rewarded for the discovery of stem cells and key processes involved in skin development, maintenance and repair.

The skin is remarkable in many respects: not only is it the largest organ of the human body, measuring around 2 m<sup>2</sup> and 5 kg; it also acts as a vast immune system. The same stem cells produce two very distinct structures: our skin surface (the epidermis) and hair. Scientists are thus faced with the question of what biological process determines whether a cell becomes epidermis or hair.

Prof. Fuchs was the first to describe precisely keratins, skin cells' principal protein structures, and to identify a certain number of skin disorders resulting from them. She pioneered a new method of determining the genetic basis of human diseases. Her first application was in elucidating the genetic basis of a blistering skin disease, epidermolysis bullosa simplex (EBS), which count about 40 000 sufferers worldwide. Her research on EBS

has helped identify more than 20 hereditary diseases and their proteins, all from the same family as keratins. Prof. Fuch's considerable body of work has revolutionized the scientific approach to skin stem cells, which makes it possible to reverse hair loss or regenerate the cells of the epidermis.

**Prof. Anne Dejean–Assemat (4)** from the Pasteur Institute in France is the Laureate for Europe. She is rewarded for elucidating the molecular and cellular mechanisms at the origin of certain cancers in humans. She was the first to demonstrate that, in some cases, the hepatitis B virus, by inserting its genome into that of the hepatic cell, can disrupt neighbouring human genes and directly trigger the development of liver cancer. In one case of liver cancer, she observed that viral insertion was carried out in a nearby new human gene that provides coding for a retinoic acid receptor, the active form of vitamin A. Later, Anne Dejean–Assémat and her colleagues discovered that an alteration of this same gene was responsible for certain types of leukaemia, a cancer of the blood and bone marrow.

**Prof. Alejandra Bravo (5)** from the Institute of Biotechnology at the Universidad Nacional Autonoma de Mexico is the Laureate for Latin America. She is rewarded for her understanding of the mechanism of a bacterial toxin that acts as an environmentally friendly insecticide. Due to the widespread use of *Bacillus thuringiensis* (Bt) toxins, certain insect species have developed resistance to them. This adaptation looms as the biggest threat to the fight against parasites in the cultivation of cotton, corn and rice. Prof. Bravo and her team have been able to develop Bt toxins capable of thwarting insects' resistance.

For details: [www.forwomeninscience.com](http://www.forwomeninscience.com); [rclair@unesco.org](mailto:rclair@unesco.org)

## UNESCO comes to Haiti's aid

**UNESCO Director-General Irina Bokova visited Haiti on 9 March to examine with Port-au-Prince authorities the implementation of UNESCO's assistance in education, science and culture. Approximately 220 000 people were killed by the earthquake of 7.0 magnitude which struck on 12 January, leaving more than 1 million homeless and much of the capital in ruins.**

One of the first priorities after the earthquake was to establish a safe water supply. On 29 January, the coordinators of the International Hydrological Programme in Latin America and the Caribbean (IHP-LAC) met with UNESCO water-related centres and staff from UNESCO's field offices in the region to put together an action plan for backstopping projects identified by the National IHP Committee in Haiti. UNESCO's Groundwater for Emergency Situations programme also liaised with other competent UN bodies to identify groundwater resources which could provide a safe water supply. In March, IHP-LAC began compiling hydrological information from Haiti, in order to rebuild the severely damaged databases.

In education, UNESCO has been assisting the Haitian authorities in assessing damage to secondary and tertiary facilities and in drawing up a master plan for the speedy resumption of classes. Of some 1500 schools visited in the worst-hit areas of Haiti by

early February, only 85 had escaped severe damage. Brazil has donated US\$400,000 in response to UNESCO's public appeal for donations to rebuild Haiti's devastated education system. The donation will fund a project for teacher training in psycho-social support and disaster awareness for the benefit of 110 000 secondary and tertiary students. UNESCO is also developing technical and vocational education and training for young people to help them find employment and participate in the reconstruction effort.

Prior to the earthquake, there were plans to create the first biosphere reserve in southeast Haiti as a continuation of the Dominican Jaragua–Bahoruco–Enriquillo Biosphere Reserve. Transborder co-operation holds great potential, as the Dominican Republic would be able to help Haiti increase agricultural productivity along the border. Since the earthquake, Haiti's National Committee for UNESCO's Man and the Biosphere Programme (MAB) has been organizing participatory fora with Rezo-Ekolo, a network of environmental NGOs, to promote the exchange of information on environmental protection and foster responsible reconstruction. This network will support the development of short-term strategies to avert the potential rise in forest conversion as a result of the earthquake. The Spanish Autonomous Authority for National Parks (OAPN) has donated 100,000€ towards this project. MAB is also contributing to the Haitian government's Post Disaster Needs Assessment.

Experts from UNESCO's Intergovernmental Oceanographic Commission (IOC) finalized a full performance assessment of the Caribbean Tsunami Warning System in mid-February. It shows that the earthquake generated a tsunami which caused a runup<sup>7</sup> of 3 m at both Jacmel and Petit Paradis (Haiti) and one of 1 m in Pedernales (Dominican Republic). The tsunami was recorded with an amplitude of 12 cm (peak to trough) at the Santo Domingo sea-level station in the Dominican Republic. It arrived just 47 minutes after the earthquake struck. The assessment revealed that timely tsunami bulletins were received by most of the countries that answered the survey. Sea level was scarcely monitored during the event, though, and some national tsunami warning centres did not know how to access sea level data via WMO's Global Telecommunication System or via the website of the UNESCO-IOC Sea Level Observation Facility. The IOC will now focus on helping to iron out these weaknesses in the warning system.

UNESCO has obtained satellite images for the elaboration of detailed risk assessment cartography for cultural heritage in

Haiti, within the joint European Space Agency–UNESCO Open Initiative on the Use of Space Technologies to support World Heritage. Haiti's only World Heritage site, the National History Park – Citadel, Sans Souci, Ramiers, an early 19th century complex in the north of the country which includes the ruins of a royal palace appears to have been largely spared by the 'quake but its full impact on the property is yet to be fully analysed.

On 27 January, the Director General wrote to UN Secretary-General Ban Ki-moon calling for a temporary international ban on trade in Haitian artefacts. UNESCO also asked the UN Stabilization Mission in Haiti to provide round-the-clock protection for key landmarks and museums.

In Paris on 16 February, UNESCO laid the foundations for an International Coordination Committee (ICC) for Haitian culture. If approved by the Executive Board in April, the committee will inventory, safeguard and rehabilitate all the assets and remains linked to Haitian heritage. The committee involves Interpol, the World Customs Organization and the International Council of Museums, among others.

For details: tsunami assessment: <http://ioc-unesco.org/>; UNESCO Flash Appeal for Haiti: <http://donate.unesco.org/>; [zmay@unesco.org.uy](mailto:zmay@unesco.org.uy)

## Biodiversity target will not be met in 2010

**On 21 January, participants in the launch of the International Year of Biodiversity at UNESCO headquarters in Paris learned that no country in the world would meet the goal of reducing the rate of biodiversity loss by 2010, the target set in 2002 at the World Summit on Sustainable Development.**

To drive the point home, the Director-General of the International Union for Conservation of Nature (IUCN), Julia Marton-Lefevre, recalled some sobering statistics: 22% of all known mammals are threatened, 30% of amphibians, 12% of birds, 28% of reptiles, 37% of freshwater fish species, 70% of plants and 35% of invertebrates.

This said, it will be several years before we have a clear picture of the current situation, owing to the fact that scientific data are not yet available for the most recent years and the natural time lag between changes to ecosystems and their impact on biodiversity.

Ms Marton-Lefevre regretted that just 12% of the world's land surface and 1% of the oceans were protected areas. She was optimistic, however, as to the chances of increasing this proportion to 15% by 2015 for land areas and by 2020 for marine areas.

Given the worrying rate at which biodiversity is disappearing, the Year will not be a classic celebration like other international years, even if it will be celebrating biodiversity in all its splendour. Rather, as Ahmed Djoghlaif, Executive Secretary of the Convention on Biological Diversity (CBD) explained, the Year will be a rallying cry that could be summed up as 'Stop the carnage!' For him, the Year will be an opportunity to learn from past mistakes, such as that of fixing international targets in 2002 without simultaneously fixing national objectives and identifying the financial and material means of achieving these.



© UNESCO/Alberto Hernandez Salinas

Young people recovering iron from the ruins in early March to sell on the street

The Year is being coordinated by the CBD, which is part of UNEP, with UNESCO being a key partner. Angela Cropper, UNEP Deputy Executive Director, listed the Year's main themes: strengthening the ties between biodiversity science and policy; awareness-building and education; economics; combating invasive species, responsible for annual losses worth an estimated US\$1.4 trillion; improving access and benefit-sharing; and better international governance via international conventions that include the CBD, CITES, the Convention on Migratory Species, the World Heritage Convention and the Ramsar Convention for wetlands.

One of the main rendez-vous of the Year will be the Conference of the Parties to the CBD in Nagoya (Japan) on 18–29 October, at which it is hoped that an intergovernmental platform on biodiversity and ecosystem services will see the light of day. This platform is being modelled on the Intergovernmental Panel on Climate Change (IPCC) sponsored by UNEP and WMO. The IPCC is considered as having succeeded not only in building public awareness of human-induced climate change but also in galvanizing the world's governments to act. Nagoya will also see the adoption of a protocol on access and benefit-sharing.

The level of awareness of climate change is still sorely missing from the biodiversity debate: in a recent national survey in France, 66% of respondents said they were unsure of the meaning of 'biodiversity', observed State Secretary for Ecology Chantal Jouanno. It is significant that, if the CBD dates back to 1992, the theme of biodiversity is being debated for the first time at the UN General Assembly in New York in September this year.

A representative of each of the environmental conventions took the floor on the second day of the launch to outline 'the road to Nagoya'. It is expected that fresh targets will be fixed in the Japanese city but that, this time, they will be accompanied by national action plans. As if to illustrate this trend, Ahmed Djoghlaif observed that the latest report of the CBD on the state of biodiversity, *Global Biodiversity Outlook 3*, due for release in May, is the fruit of more than 110 national reports, the first time that individual countries have contributed to the report. Its findings are thus expected to be more detailed than in the past.

## Post-2010 targets must recognize key biodiversity areas

**'The post-2010 CBD targets should recognize the need to conserve the most important sites for biodiversity, not just a percentage area of land and sea.'** So say the 250 experts who attended a scientific conference on biodiversity hosted by UNESCO in Paris on 25–29 January.

One of the questions the conference asked was 'Where are the most important sites for conservation?' Observing that 'studies show that most protected area networks have serious gaps,' the conference proposed that 'one effective way to halt further extinctions



*The common mealworm beetle, **Tenebrio molitor**, quickly fights microbial infection then for several days produces an antimicrobial agent. It could inspire research into medical treatments which reduce the development of multiresistance to antibiotics.*

and conserve important centres of endemism is to protect sites that hold the only populations of highly threatened species. These should be a top priority for conservation attention. The participants recommended that national, sub-national and regional protected area planning exercises incorporate the most important biodiversity sites – such as key biodiversity areas (KBAs) – as fundamental building blocks.' KBAs are identified using internationally consistent criteria based on vulnerability and irreplaceability but through a nationally led process involving a range of stakeholders and drawing extensively on local knowledge. Sites holding the only populations of highly threatened species form an important subset of KBAs.

Other recommendations focused on managing biodiversity at the landscape scale. The conference called for the role of indigenous and local communities in conserving biodiversity to be recognized, for instance, and for ways to be found to record and transfer their knowledge so that it can be used by newcomers who can also bring knowledge, skills and investment to adaptive management. Participants also suggested that the biodiversity of the urban environment, where more than 50% of humans now live, should be inventoried, conserved and enhanced.

In the area of biodiversity and development, the conference observed that, 'while the rich can often afford to replace ecosystem services, the poor cannot. Economic models, appropriate evaluation metrics and transparent accounting methods for tangible and intangible biodiversity benefits, can contribute to redressing this imbalance.' It called for explicit economic accounting of non-market value goods and services to be incorporated when developing plans for a sustainable future. Participants also advocated promoting and applying, where appropriate, methodological tools like those outlined in *The Economics of Ecosystems and Biodiversity Report* that can facilitate full economic accounting of alternative scenarios for biodiversity use. Participants also called for biodiversity to be mainstreamed into all development, agriculture, fisheries, industry, business and policy decisions.

These and other recommendations will be presented in October to the next Conference of the Parties to the CBD in Nagoya (Japan) and to UNESCO's Executive Board.

*Read the conference's recommendations:*

[www.unesco.org/mab/doc/iyb/recommendations.pdf](http://www.unesco.org/mab/doc/iyb/recommendations.pdf)

## Afghanistan launches plan for higher education

**Five research universities are to be set up in Afghanistan by 2014. This and other targets are outlined in the National Higher Education Strategic Plan (NHESP) launched by the Afghan Ministry of Higher Education (MoHE) in December.**

The plan builds on a series of consultation workshops organized by the MoHE with Afghan universities in 2009, with sup-

port from UNESCO and the World Bank. It also builds on the previous strategic plan for higher education<sup>8</sup> developed by the MoHE with the support of the UNESCO International Institute for Educational Planning (IIEP) in 2004. Higher education is one of the eight pillars of the Afghan National Development Strategy (2008–2013).

While Afghanistan has begun the process of re-opening and reconstructing its universities since the fall of the Taliban in 2001, the overall capacities of these institutions are limited and do not meet the overwhelming demand for access from the increasing number of high-school graduates.

Two broad programmes are outlined in the NHESP. Programme I seeks to educate and train skilled graduates, enhance teaching, research and learning and encourage service to the community and the nation. It includes various sub-programmes for building human capacity in the higher education sector and developing infrastructure, including curriculum development and the involvement of graduates in regional and international research partnerships. The plan states that research policy and practice should focus on science and technology (S&T) as a cornerstone of development. UNESCO plans to continue supporting the MoHE in developing an S&T policy.

Programme II aims to lead and manage a coordinated system of higher education comprising universities, institutes and community colleges. It focuses on governance and developing capacity both in the MoHE and in universities. It also tackles issues of access to university and the expansion and structure of the higher education system. A specific committee has been established to redesign the national admissions examination: the system will be computerized to make it efficient and user-friendly and configured to ensure that applicants with optimum potential are admitted to university, taking into account the different disciplines and national needs.

Programme II will also provide accreditation and quality assurance by establishing a self-assessment process for universities and founding a quality assurance and accreditation agency in Afghanistan. The development and institutionalization of a Higher Education Management Information System (HEMIS) will be another challenge for the MoHE to ensure proper planning and monitoring of the NHESP over the next five years.

Specific targets of the NHESP to 2014 include:

- increasing the number of faculty members with Master's degrees by 60% and faculty members with PhDs<sup>9</sup> to at least 20%;
- reaching a target of at least 30% female university students;
- increasing the number of students enrolled in universities from 62 000 at present to 110 000;
- establishing five community colleges with a total enrollment of at least 5000 students, giving a total of 115 000 students and 800 additional staff.

A national research and education network will also be established linking all universities and institutes in Afghanistan to the MoHE and the Internet, in tandem with collecting data and providing access to a digital library.

Another important aspect of the NHESP is the funding strategy for universities. The MoHE will continue to decentralize financial control to universities and other institutes, and to push for legislation allowing universities to raise and spend funds from non-government sources. The ministry will also facilitate fundraising

from non-government sources for higher education and work to establish scholarships for poor students.

For details: [http://planipolis.iiep.unesco.org/upload/Afghanistan/Afghanistan\\_HESP\\_2010-2014.pdf](http://planipolis.iiep.unesco.org/upload/Afghanistan/Afghanistan_HESP_2010-2014.pdf); in Kabul: [m.patrier@unesco.org](mailto:m.patrier@unesco.org)

## First karez restored in Iraq

**Water has returned to the village of Shekh Mamudian in northern Iraq, three years after it stopped flowing. In January, UNESCO completed the refurbishment of a traditional aqueduct (*karez*, or *qanat*) supplying 900 people with water. Funded by the European Union to the tune of US\$1.6 million, the UNESCO project has also been designed to provide on-site training for Iraqi karez practitioners, who will go on to refurbish up to 20 additional *karez* in the coming year within the project.**

The refurbishment was celebrated with a ribbon-cutting ceremony in the village of Sheikh Mamudian on 29 January presided over by Christine McNab, Deputy Special Representative of the UN Secretary-General. Also present were Mohamed Amin Faris, Director-General for Irrigation within the Kurdish Regional Government, UNESCO project manager Casey Walther and local community members.

The 800 m-long karez collects water from the Harir Valley aquifer which it conveys to the community mosque. Fifty families and their livestock share the water, which also irrigates 6 ha of cropland downhill from the village.

Water flowing from the karez began to diminish in 2004 at the onset of drought. The karez had dried up completely by 2007 after the villagers discontinued regular maintenance. Without the karez, the villagers were no longer able to grow figs, cucumber, tomatoes, eggplant and okra. The community was forced to resort to cultivating wheat during the seasonal rains and importing water and food from beyond the village.

A feasibility study by the UNESCO International Centre for Qanats and Historical Hydraulic Structures in Iran in July last year concluded that drought had caused the water table to recede to a depth of just 1.5 m below the karez tunnel. Work focused on deepening the tunnel and extending the exit by 300 m using traditional methods. An Iranian engineer and a veteran Iranian qanat master supervised the work and the village was provided with equipment and materials. Twelve villagers trained by the Iranian supervisors provided the physical labour. A local construction company was also hired to resize the pool at the mosque to allow locals to use the karez water for their ablutions and to lay an underground pipe from the mosque to the fields to irrigate crops.

By mid-March, the karez was producing 10 litres per second, enough to allow the village to cultivate Spring crops and raise sheep. The karez should provide water to the villagers all year round, even during the drier months. Currently, UNESCO is refurbishing a second karez in the mountain village of Kuna Flusa, whose inhabitants are on the brink of leaving for lack of water.

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## Iraq joins Avicenna Virtual Campus

**On 11–15 April, Iraqi technical staff and professors from the Universities of Baghdad, Basra and Salahaddin are participating in a second training workshop in online course development in Amman (Jordan). The three universities joined the Avicenna Virtual Campus for Science and Technology in November when their staff participated in a first workshop in Amman.**

UNESCO has extended the Avicenna network to Iraq in collaboration with the Iraqi Ministry of Higher Education and Scientific Research. In Iraq, the virtual campus is building on ongoing endeavours by UNESCO and its partners to promote ties between Iraqi universities and universities abroad, in order to expand access to education and improve the quality of teacher training.

Over the past four months, Avicenna Knowledge Centres have been established at the Universities of Baghdad, Basra and Salahaddin. These centres have then been linked up with those belonging to the Avicenna Virtual Campus in Algeria, Cyprus, Egypt, France, Italy, Jordan, Lebanon, Malta, Morocco, the Palestinian Territories, Spain, Syria, Tunisia, Turkey and the UK.

The three Avicenna centres in Iraq are already able to use the modules developed by the Avicenna network over the past five years. Ultimately, each Iraqi university will produce modules of its own which will then be pooled among the institutions participating in both the Avicenna Campus and the recently established African Virtual Campus.

Two technical experts from the Avicenna Knowledge Centre at the Middle East Technical University in Ankara (Turkey) will be attending the April workshop to strengthen regional ties and share best practices for course development with their Iraqi counterparts. In November, the Iraqi team met experts from UNESCO and the Avicenna Knowledge Centres at Philadelphia University (Jordan) and the Universidad Politecnica de Valencia (Spain).

*For details: [www.unesco.org/science/psd/thm\\_innov/avicenna.shtml](http://www.unesco.org/science/psd/thm_innov/avicenna.shtml);  
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## The Scarlet Knight arrives in Spain

**After battling treacherous currents, the Scarlet Knight arrived at its rendez-vous site off the coast of Baiona on schedule on 9 December to joyous celebrations.**

Upon departing the USA on 27 April, the robotic underwater glider had travelled more than 4000 nautical miles (7408 km) to Spain under the guidance of students and faculty from Rutgers's Institute of Marine and Coastal Sciences in New Jersey (USA) and with help from other students at partner universities in Europe.



*Rutgers marine technician Chip Haldeman approaches the Scarlet Knight midway through its Atlantic journey for an unscheduled cleaning at sea.*

‘In just ten years, the first generation of Argo autonomous floats, which profile the ocean’s structure while simply drifting with the currents, has transformed our ability to observe and understand ocean currents and heat distribution,’ observes Tom Gross, Programme Specialist for the Global Ocean Observing System (GOOS) at the UNESCO-IOC. ‘The successful transiting of the Atlantic Ocean by the Scarlet Knight launches the next generation of controlled remote observations. Over the next ten years, we expect the glider technology to become a large part of the future GOOS.’ Profiles of the water column made using instruments like the Scarlet Knight provide oceanographers with a three-dimensional view of the ocean’s interior.

‘The opportunity to participate in this project was a true scientific adventure that allowed us to learn new interpretations of our satellite products,’ says Alex Redondo Arolas, a doctoral student in marine sciences at the University of Las Palmas de Gran Canaria who is specializing in satellite data processing and the use of remote sensing to study the environment. Once the glider entered Spanish waters in mid-November, it was Redondo Arolas who took over maintaining the daily conversion of five geophysical variables into transferable images for Rutgers to interpret: sea surface temperature, chlorophyll, thermal fronts, the anomaly of sea surface height and the direction of the surface currents.

During the crossing, the glider team overcame several hazards, including biofouling from gooseneck barnacles that required a mid-Atlantic cleaning mission (see photo). The team also had to navigate through warm and cold-core eddies (circular or contrary currents), sometimes sailing the Scarlet Knight perpendicular to the current to escape.

‘Crossing the Atlantic Ocean is just the beginning,’ enthuses Alex Redondo Arolas. ‘A new round of sampling gear is taking its first steps. The new gliders under development now will have more comprehensive knowledge of the ocean environment, more power, more sensors to sample more biogeochemical variables and more autonomy.’

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7. *Runup is the height of the tsunami wave from mean sea level on the shore.*

8. *See A World of Science, October 2004*

9. *In 2008, 5.5% of the 2526 faculty members at universities held PhDs, 30.1% an MA or MSc and 63.8% a BA.*



David Hills

## 'Nature is a library from which industry can learn'

What do Velcro, a full-body swimsuit and the world's largest passenger aircraft have in common? The answer rests in a growing field of scientific study through which engineers, scientists and architects are looking not at what we can *extract* from the natural world but what we can *learn* from it: biomimicry.

David Hills is Senior Manager of Flight Physics Research with Airbus, one of the world's leading aircraft manufacturers with 52 000 employees. The company builds aircraft ranging from the A320 family, which starts with planes that seat about 100, to the world's first double-deck aircraft, the A380, which has over 500 seats! Based in the UK, David works with engineering colleagues around the world to design new aircraft and improve existing ones so that they burn less fuel, create less noise and fewer emissions, and have less impact on the environment. For many of these engineers, nature is a great source of inspiration.

**A representative of Airbus spoke at the UNESCO launch of the International Year of Biodiversity on 21 January. Why should an aircraft manufacturer be interested in biodiversity?**

Over 30% of known species worldwide are currently under threat. For Airbus, the potential loss for our planet and future generations is already disastrous but, what's more, it also means the loss of vital sources of inspiration and innovation. In the past 40 years, technological innovation has reduced aircraft fuel burn and emissions by 70% and noise by 75%. Today, the aviation industry contributes 2% of all anthropogenic CO<sub>2</sub> emissions. It is continuing to seek technological solutions to help reduce that impact even further – and nature might just provide the answers.

The natural world has of course always been a source of inspiration for the aviation industry, ever since Italian inventor Leonardo da Vinci first started drawing planes and helicopters some 500 years ago. His intriguing designs were based on continual observations of the world around him.

**What exactly is biomimicry?**

Biomimicry is biologically inspired engineering. Simply put, it's the study and imitation of nature's best ideas to help solve human challenges: science inspired by nature, if you like. It's why that famous swimsuit worn by American swimmer Michael Phelps at the Olympic Games in Beijing in 2008 was able to replicate a shark's ability to reduce friction and stay clean, properties that not only made Phelps even slicker in the water but also protect bacteria-sensitive surfaces in hospitals.

Look deep into nature and you will understand everything.  
Albert Einstein

**How do aircraft mimic nature?**

A growing number of aeronautical innovations are inspired by a vast range of natural structures, organs and materials; the tried and tested patterns in the natural world. Let me give you a couple of examples.

The surface structure of lotus leaves is designed to keep the surface clean and dry in damp conditions.

Rainwater is unable to penetrate but rather runs off, taking any dirt with it. This is known as superhydrophobicity or 'the lotus effect'. These properties have inspired coatings for aircraft cabins. The coatings reduce the amount of cleaning fluid required to wash cabin interiors, removing fingerprints and spillages left by hundreds of passengers.

The coatings are particularly useful for the lavatories because substances don't stick to the surfaces and can simply be rinsed away, using less water than would otherwise be needed. This improves hygiene and reduces the amount of water the aircraft has to carry, which in turn reduces the weight of the aircraft and, therefore, the amount of fuel burnt and emissions generated by the flight.

To take another example, in the same way that sea birds sense gust loads in the air with their beak and adjust the shape of their wing feathers to suppress lift, probes on the new Airbus A350 XWB detect gusts ahead of the wing and deploy moveable surfaces for more efficient flight.

**Which species inspired the new A380?**

Our engineers learned a lot from birds like the Steppe Eagle. The eagle's wings cannot be too long or its turning circle will take it outside the thermal: a rising column of warm air about 20 m wide on which it relies to soar high in the sky.

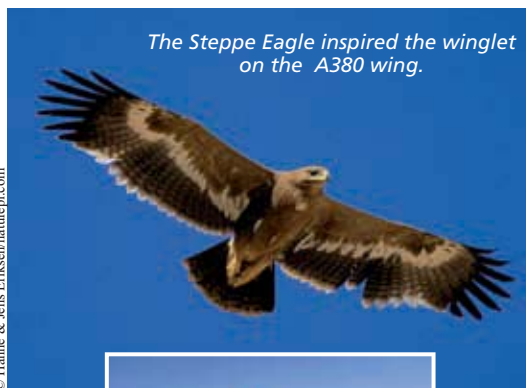
The eagle's wings perfectly balance maximum lift with minimum length. It can manipulate the feathers at the tips, curling them upwards until they are almost vertical to create a 'winglet', a natural adaptation that acts as a barrier against the vortex for highly efficient flight.

A380 engineers faced almost the same problem – only this time the issue wasn't turning inside thermals, it was turning inside airports! How could they create enough lift for the world's largest passenger aircraft while still fitting inside airports, where the width of the wingspan is limited to 80 m? If built to a conventional design, the wingspan of the A380 would have had to be about 3 m longer to create the lift needed to get the fuselage into the air. That's because of little pockets of air called 'wing-tip' vortices, which are created by high-pressure air leaks from under the wing, around the ends. These mean the tips don't provide any lift, so the wing has to be longer. But thanks to small devices known as "winglets", which mimic the upward movement of the eagle's feathers, the A380's wings are just 79.8 m wide – keeping them 20 cm inside that all-important airport limit.

In fact, the technique is so effective that Airbus applies the same theory to all its aircraft, even though they are much smaller: the wing of an A320 aircraft, for example, is the same length as just the vertical tail fin of the A380!

**How important will biodiversity be to aircraft manufacturers in the future?**

Nature remains a source of innovation for us but it is about so much more than mimicking birds or flying animals. It is about building on the diversity of the natural patterns available. In the face of environmental changes, nature banks on its capital of biodiversity to adapt and the aviation industry relies on this capital to renew itself.



© Hamme & Jens Eriksen/naturepl.com



© H. Gouesse / Airbus

What all this shows is that nature is a library from which industry can learn. Look at all the important examples in industries such as biomedicine, nanotechnology and materials science. You have to wonder how many industries can afford *not* to protect the resources that may hold the key to the future innovation of competitive products, less environmental impact and sustainable growth?

Many people know that biodiversity loss could act as a catalyst for issues such as water scarcity, soil and coastal erosion, population displacement, disease and uncertain food security. But more people need to understand that losing biodiversity also means losing the potential to find innovative solutions to challenges faced by humankind.

**So what is Airbus doing to help protect biodiversity?**

Airbus is working with the UN Secretariat of the Convention on Biological Diversity to support the Green Wave programme. The Green Wave encourages young people to plant a tree or celebrate the nature around them at 10 am on 22 May each year, which is International Day of Biodiversity.

As the ten o'clock celebration passes through the world's time zones, it creates a 'green wave' of awareness and activity from east to west bringing together young people from around the world as they upload photos, videos and stories about their Green Wave activity.

It will be a particularly big celebration this year because 2010 is the International Year of Biodiversity, so acknowledging the role of nature in designing the A380, we have put the logo on the side of the aircraft to tell as many people as possible in the hope that they too will act.

Interview by Frederic Picard<sup>10</sup>

For details of the green wave: <http://greenwave.cbd.int/en/home>; [www.facebook.com/pages/Green-Wave/12681286515](http://www.facebook.com/pages/Green-Wave/12681286515)

To find out more about biomimicry, visit: <http://brainz.org/15-coolest-cases-biomimicry/>

On the A380 and Airbus: visit: [www.airbus.com](http://www.airbus.com)

Photos provided by Airbus, UNESCO partner in the International Year of Biodiversity



10. Head of the Physical Design Process, Methods and Tools Programme at Airbus



© GaryFack/A lamy

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## Fisheries in a cod climate

There has been continuous settlement along the northeast coast of Norway for 11 000 years. Over the generations, the local people in the fjords and along the coast have developed knowledge that has allowed them to adapt to changing environmental conditions, in part by using a range of fish species. They are thus confident that they will be able to adapt to climate change. The greater challenge for them will be to reconcile their subsistence livelihoods with their growing dependence on global markets, for in integrating the national economy, the Saami have been confronted with the centralized management of marine resources and inflexible regulations for fisheries. The Norwegian economy is threatened by climate change, as it relies heavily on a single fish species, the Barents Sea cod (*Gadus morhua*), which will migrate out of the Norwegian economic zone if the waters become too warm.

This case study is taken from a compilation of papers presented by prominent Chukchi, Even, Inuit and Saami leaders from across the circumpolar North to a meeting in Monaco organized by UNESCO in March 2009. The book spawned by that meeting, *Climate Change and Arctic Sustainable Development*, was launched by UNESCO in December during the climate talks in Copenhagen.



The author posing with a Barents Sea cod in Varangerfjord

Unjárga–Nesseby is a municipality in the innermost part of the Varangerfjord in Finnmark County in northeast Norway. The Saami culture and identity is still very central to Unjárga today. The Saami language is spoken by most of the inhabitants and quite a number of people are still occupied with subsistence livelihoods. Archaeological investigations prove that the historic site of Ceavccageadgi–Mortensnes has been continuously settled for the past 11 000 years. The Varanger Peninsula became ice-free 13 000 years ago and the land has been rising ever since the downward pressure of the ice was removed, in a process known as ‘post-glacial rebound’. Today, this phenomenon can be seen with the naked eye in the form of natural terraces in the landscape. People traditionally settled on the terraces along the sea shore. Today, we can ‘read’ the history of these settlements simply by walking from the highest hill down towards sea level, one step being the equivalent of 100 years of history!

The Ceavccageadgi site offers a walk through the history of climate adaptation and resilience. Archaeologists are able to tell the story of how house construction and lifestyles have evolved with changing climatic conditions. Conversely, it may also be possible to learn how the climate has changed from studying how people lived at the time. During warmer periods around 9 000–5 500 years ago, communities were more stable with only one settlement for the summer and another with solid constructions of pine wood for the winter. During colder periods up to around 2000 years ago, their constructions were simpler and people became more mobile. The aim was always to find a place with living resources they could utilise and which offered shelter and firewood for the colder months. Various kinds of settlement can be spotted at the site in Ceavccageadgi and, the closer they get to the present sea level, the more recent they are.

Photo: Gunn-Britt Retter

Each step you take represents 100 years of history on these terraces at Ceavccageadgi cultural heritage site in the municipality of Unjárga–Nesseby.

### Historic eating habits

Archaeologists can tell a lot about diet at a given time in history from domestic waste. Remains of fish, sea mammals and birds tell us what kind of species our ancestors depended upon as the climate changed over time. Their diet consisted mainly of cod, seal and whale, as well as mostly migratory birds, such as kittiwake (*Rissa tridactyla*), red knot (*Calidris canutus*), common redshank (*Tringa totanus*) and European widgeon (*Mareca penelope*). Studies of domestic waste from settlements dating from a warmer period than today also reveal fish species normally found in warmer waters which are thus no longer found in the fjord. These include whiting (*Merlangius merlangus*) and moonfish or cusk (*Brosme brosme*). Of course, people would use what was available to them at the time. As with the contemporary fjord fisheries, the past has taught us to rely not simply on one species for survival but rather to depend on the diversity of species available throughout the year. In Varangerfjord today, that means cod in the winter, salmon (*Salmo salar*) in the spring, pollock (*Pollachius virens*) and haddock (*Melanogrammus aeglefinus*) in the summer and flatfish (*Pleuronectiformes spp.*) and halibut (*Pleuronectidae spp.*) in the autumn. All are equally essential to our culture.

After 1600 AD, the coastal Saami, or Sea Saami, culture developed into a combination of small-scale farming and fishing combined with hunting and gathering. The seasonal migration and combination of subsistence livelihoods continued until the Second World War in 1939–1945.

### A rash of regulations

From the 19<sup>th</sup> century onwards, various acts regulating fisheries were established, followed by a number of guidelines, all of them different for each region of Norway. These acts concerned mainly ocean fisheries rather than the fjords, which traditionally have been understood as being reserved for local people. However, an act regulating fisheries in salt

water in 1955 revised all the existing regulations into one single act for salt-water fisheries for the whole of Norway, including the fjords that had so far, in practice, been reserved for local people. As I see it, from this time on, the main objective of the fisheries regulations was increasingly to strengthen the big fisheries and weaken the small-scale fjord fisheries. In 1951, there were 1512 inhabitants in the Unjárga–Nesseby municipality. In January 2009, there were 878. The population has almost halved in the past 60 years, perhaps largely due to the fisheries regulations reducing options for people's livelihoods.

The fisheries in Finnmark totally collapsed in the late 1980s, due to overfishing and bottom-trawling which damaged spawning grounds and capelin (*Mallotus villosus*) stocks. In January 2009, the Marine Resource Act came into force, thereby changing the approach from single fish stock management to ecosystem-based management. However, this is what was being practiced in the fjords in the first place by traditional fishermen, albeit with equipment that was perhaps not as efficient as that available today.

### If the waters warm, what will happen to the cod and the capelin?

In January 2009, the research director of Norway's Institute of Marine Research, Einar Svendsen, gave a presentation to the Arctic Frontiers Conference in Tromsø, Norway.<sup>11</sup> The Institute of Marine Research conducts research and provides policy-makers in Norway with advice on managing fisheries. In his presentation, he pointed out that the Barents Sea cod was very vulnerable to water temperature: when it got warmer, the cod spawned farther north and, when water temperatures dropped, the spawning area moved southwards. Svendsen showed that, so far in Norway's northern waters, there has been an increase in fish stocks. Climate change has been positive for cod. This is in line with what the local fishermen in Varangerfjord have experienced since 2007, with cod fishing during the winter months proving exceptional.



Photo: Gunn-Britt Røtter

*In recent years, we have seen fish hanging on the scaffolding again. The catch has been better than in a long time.*

However, if climate change exceeds previous experience and the waters become even warmer than at present, science cannot predict what will happen. There is thus a need to improve our current models. For example, the capelin, the main source of food for the Barents Sea cod, migrates between the coast of Norway and the ice edge. In summer, the capelin graze on dense swarms of plankton at the edge of the ice shelf. This plankton is extremely rich in the fat known as omega 3. Thus, fish are a major source of this much-needed fat and this is a main reason why people today make sure they include fish in their diet. If the ice edge is disappearing, what will happen to the capelin? No-one knows.

It is thus difficult to predict what to expect if the waters continue to warm. It is likely that the cod will move even farther northwards or even eastwards in search of colder waters. That might put the cod outside the Norwegian economic zone. In 2009, Norway was the world's second-largest exporter of fish. If the important cod fish moves out of the Norwegian economic zone, this will have a huge impact on the country's economy.

The Norwegian economy is thus vulnerable to climate change. Conversely, the traditional Saami fishing economy is not, as local people depend on the entire ecosystem and the diversity of fish stocks, giving them the flexibility to adapt to changing conditions. The Saami culture is more vulnerable to mismanagement and the centralization of power and research than to climate change, as these factors may limit the Saami's freedom to act. For example, inflexible quotas on catches of certain species may limit avenues for adapting to shifting fish populations. So too might regulation of the start and end dates for the fishing season and limitation of the hours during which we are allowed to fish, something that is already in place for salmon fishing in salt water. Strict hunting regulations on seal, which prey heavily on fish, also interfere with the Saami's ability to adapt to changing ecosystems.

### Fish farming may not be the answer to climate change

Svendson has suggested that fish farming might be a solution, as 'there is a lot of "farmland" out there.' However, fish farming may not be a suitable solution for adapting to climate change. Farmed fish may bring diseases to the wild fish populations. Furthermore, farmed fish may not be as

healthy as wild fish, as they will not have access to the natural wildlife in the ocean like the fatty plankton they consume via capelin, thus reducing their levels of omega 3. However, worryingly, Norway's policy seems rooted solely in concern for the national economy.

If we manage to keep the waters clean, our past has shown that food is also available when the climate warms but that the type of food may differ from what we see now. Is the aim of good management to keep ecosystems the same as they were 60 years ago? Is that why we put money into monitoring and seed banks on Svalbard, an archipelago north of the Norwegian mainland? Or is it more appropriate to attempt to adapt to changes as they arrive?

### Why a regional approach would be best

The main future challenge will be to adapt to rapid change but I believe a more regionalized approach to managing fisheries in Finnmark would be of benefit, as proposed by the Smith committee.<sup>12</sup> This issue is controversial, however. The huge, influential industrialized fishing companies based mainly on the southwest coast of Norway are worried that, with regionalized management, they might lose their quotas and access. In addition, local Norwegian fishermen are wary of the proposal because it is based on Saami rights, even though the rights to fjord fisheries are not based on ethnic background or 'belongingness'. Some coastal Norwegian fishermen do see the benefits, however. Undoubtedly, strong political leadership is needed to manage fisheries through the changes that are predicted to result from climate change. I would suggest that it is also crucial to involve the local people who depend on the ecosystems in question in managing them today.

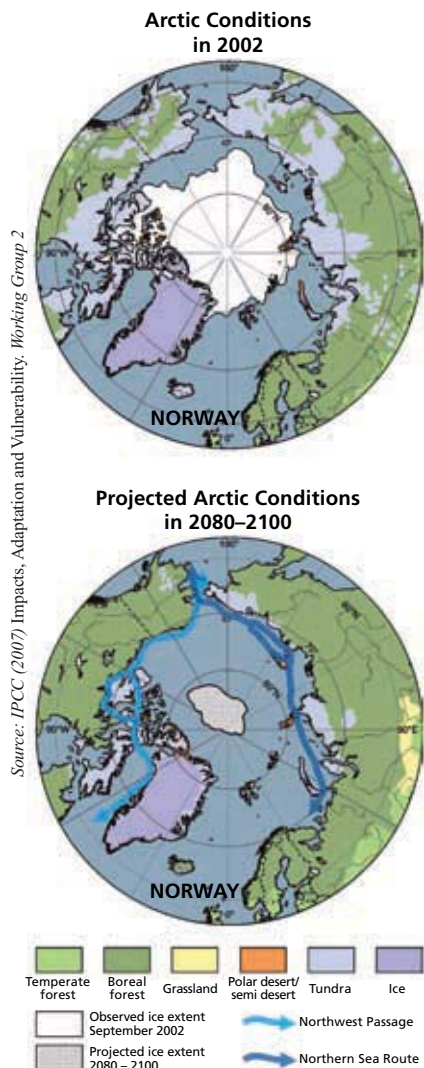
Gunn-Britt Retter<sup>13</sup>

To order a copy of *Climate Change and Arctic Sustainable Development: Scientific, Social, Cultural and Educational Challenges*, go to [www.unesco.org/publishing](http://www.unesco.org/publishing) (22 €), ISBN 978-92-3-104139-6; for details, contact [links@unesco.org](mailto:links@unesco.org)

11. see <http://arcticfrontiers.com/>

12. White Paper delivered to the Ministry of Fisheries and Coastal Affairs in February 2008, entitled *The right to fish in the sea outside Finnmark*.

13. Head of the Arctic and Environmental Unit, Saami Council, Norway



Predicted impact of climate change on the circumpolar North

Source: IPCC (2007) Impacts, Adaptation and Vulnerability. Working Group 2

# All you ever wanted to know about biodiversity...

During the International Year of Biodiversity, anyone can download an exhibition from the Internet which answers some of the most frequently asked questions about biodiversity. Entitled 'Biodiversity is life. Biodiversity is our life', the exhibition has been prepared by UNESCO and its partners. These include the Convention on Biological Diversity, the Global Environment Facility (GEF), UNEP and three French bodies, the Centre Sciences, the Centre national de recherche scientifique and the Institut de recherche pour le développement. Here are some extracts.

## What is biodiversity?

Biodiversity is the variety of life on Earth. It comprises all living things and ranges from microscopic viruses to the largest animals on the planet like the blue whale. Humans are an integral part of biodiversity.

Biodiversity is made up of all the genes, species, ecosystems and landscapes that comprise our world. These elements constantly interact at all levels. Each living thing has a unique genetic make-up. Even within species, no two individuals are the same. Humans have used this genetic variation to breed thousands of varieties of food crops and domesticated animals.

Biodiversity is about communities and relationships. All living things are components of dynamic ecosystems (e.g. forests, farmland, lakes) which themselves form part of a landscape. In this shared environment, their lives are interwoven in a web of relationships characterized by cooperation, competition, predation, symbiosis or parasitism. This delicately balanced interconnected system provides food and shelter, cycling of energy and reproduction. Every member of this community plays an essential role in keeping this web in balance.

## Where is biodiversity?

Biodiversity can be found everywhere on Earth, from extreme environments such as the North and South Poles to deep rocks beneath the Earth's surface, the deepest oceans and the highest clouds. Distinctive patterns of biodiversity exist around the world, made up of recognized biogeographical realms with a shared evolutionary and climatic history.



*This hermit crab in Thailand has adopted the neck of a broken glass bottle as its shell.*



© CNRS Photothèque/ IRBI / BEZIER Annie – UNESCO partner in biodiversity exhibition 2010

*This parasitic wasp lays its eggs in caterpillars and simultaneously injects viral particles to delude the host's immune defence system. A genetic study shows that this wasp 'domesticated' the virus.*

There are an estimated 13 million species on Earth (estimates vary from 2 to 100 million species!) but scientists have only identified around 1.75 million species so far. Just 16 000 new species are described each year. Only some groups of species are well-documented, among them mammals, birds, amphibians and conifers. We lack knowledge about many others, including deep sea species, fungi or micro-organisms.

Some geographical regions are centres of both high species diversity (megadiversity) and endemism (species unique to a particular geographical location). These 34 'hotspots' represent just 2.3% of the Earth's surface yet concentrate 50% of the world's plants and 42 % of all terrestrial vertebrates. They are frequently concentrated in isolated or topographically variable regions (islands, mountains, peninsulas) and are particularly vulnerable.

## How does biodiversity serve us?

Ecosystems provide us with the following services:

- ❑ *Provisioning services* provide us with the basic elements for life, including food, fresh water, wood, fibre, genetic resources, medicines, ornamental and cultural products;
- ❑ *Regulating services* help maintain air quality, purify water, treat waste and protect us from natural hazards, erosion, pests and disease. For example, the unique biodiversity of wetland ecosystems assists in the natural purification of water, trees in cities reduce air pollution and mangrove forests and coral reefs protect coastal populations from erosion and the full force of tsunamis and storm surges.

- ❑ *Supporting services* are fundamental but often invisible processes on which all the other ecosystem services depend. For example, food production depends on soil formation, which itself greatly depends on climatic conditions as well as chemical and biological processes.
- ❑ *Cultural services* are the non-material benefits people obtain from ecosystems through spiritual enrichment, reflection, recreation and so on. Biodiversity has shaped our legends and inspired our cultures, history and arts.

### Why do scientists speak of a sixth major extinction?

From the fossil record, we know of five major extinctions affecting biodiversity in the Earth's history.<sup>14</sup> Unfortunately, over the past 50 years, human activity has sharply increased the natural extinction rate, calculated at 100–1000 times that of the geological record. This is much greater than the rate at which new species arise, resulting in a net loss of biodiversity.

### Why are we losing biodiversity?

We are losing species at an alarming rate. The International Union for Conservation of Nature (IUCN) notes that one bird species out of eight, one mammal out of four, one conifer out of three, one amphibian out of three and six marine turtles out of seven are threatened with extinction. In addition, 75% of the genetic diversity of agricultural crops has been lost and 75% of the world's fisheries are fully exploited or overexploited. Indirect causes of biodiversity loss include population growth and economic development.

Direct causes of biodiversity loss are:

#### Habitat loss

Habitat loss can occur naturally through drought, disease, fire, volcanoes, earthquakes and slight changes in seasonal temperature or rainfall but it is the changes in land use through human activities which are the main drivers of habitat fragmentation, deterioration and loss. Agriculture is mostly to blame but also the construction of infrastructure, logging, mining and rapid urbanization. Croplands account for more than 25% of land surface, excluding Antarctica.

In recent times, the Earth's forest surface has been reduced by 40%, wetlands by 50%, coral reefs by 20% and mangroves by 35%. Deep-sea fishing is causing considerable damage to sea beds and seamounts with the potential loss of millions of species.

*Native to South America, water hyacinth was probably introduced into Lake Victoria by humans in the 1980s. It is extremely difficult to eradicate and has spread phenomenally thanks to the lack of natural enemies. Although it contains a lot of nitrogen, making it a good candidate for biogas production, water hyacinth also smothers aquatic life by deoxygenating the*



### Climate change

The distribution of wild and domesticated animal and plant species is sensitive to temperature and humidity. For example, warming seas and changes in water chemistry due to natural carbon sequestration could cause Australia's Great Barrier Reef to lose up to 95% of its living coral by 2050. In Africa, elephants have become highly vulnerable to longer dry periods. In Asia, projected rises in sea level could result in the disappearance of mangrove forests, threatening livelihoods. Temperature fluctuations affect the life cycles of crops and domesticated animals.

### Invasive alien species

The introduction, whether accidental or intended, of alien invasive species of plants like water hyacinth in Lake Victoria in Africa (*see photo*), or animals like the grey squirrel in Europe, can have a devastating impact on natural and cultivated species and ecosystems, as well as on the economy. After habitat loss, invasive alien species are the second-most important driver of species extinction. Invasive species interfere with the web of relationships and distort the services provided by the ecosystem, particularly in isolated ecosystems such as rivers and islands. The rate of introduction of alien species and the risk associated with them have mushroomed in recent years due to human population growth and expanding travel, trade and tourism.

### Overexploitation and pollution

Unsustainable hunting, fishing and the extraction of raw material are increasing the ecological footprint, a measure of human demand on the Earth's ecosystems. Pollution occurs when humans emit more waste than the absorption capacity of the ecosystem. Greenhouse gases, fertilizers, agricultural and toxic waste all disturb interactions impacting on biodiversity. For example, agricultural waste pours excess nutrients into rivers, stimulating excessive plant growth in a process known



*Bissap (Hibiscus sabdariffa) is very popular in Africa. The bitter-tasting leaves and fragrant flowers are used as a food, condiment and beverage. Rich in vitamin C, the infusion is known to facilitate digestion and to lower blood pressure.*

*water and reduces nutrients for young fish; it is also a breeding ground for mosquitoes and other insects. The Nile perch (Lates niloticus) was probably introduced into Lake Victoria in the 1950s. This freshwater fish has since caused the extinction of 200 native fish species. The Nile perch is native to the Congo, Nile, Senegal and Niger river basins and Lakes Chad, Volta and Turkana.*

as eutrophication which consumes too much oxygen, causing the widespread death of fish species.

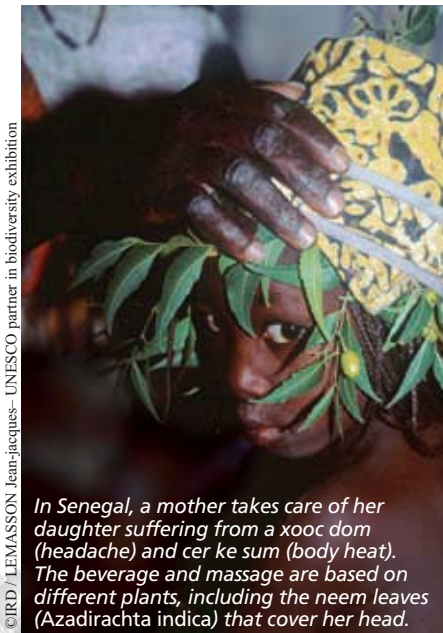
**Why is biodiversity conservation important for the economy and development?**

It is difficult to estimate the full value of biodiversity. We can estimate the economic value of services such as food, wood and pharmaceutical products by taking into account their market value. But how can we calculate the economic value of the ecosystem services to which biodiversity contributes, such as the provision of food, the regulation of climate and soil formation? *The Economics of Ecosystems and Biodiversity* (2009) report estimates the total value of biodiversity and its services at US\$33 000 billion per year, twice the value of the world economy.

The ‘green economy’ includes industries such as solar panel and windmill manufacturing, green forms of transport like vehicles powered by hydrogen which emit only water vapour, carbon capture underground, green building practices, organic agriculture and ecotourism.

Biomimicry is a growing scientific field of study where engineers, scientists and architects are turning to biodiversity not to extract products from nature, but for inspirational, innovative and sustainable solutions to technically challenging problems (*see photos below*).

Most of the world’s poorest people, particularly in rural areas, depend directly on biodiversity for as much as 90% of their needs, including food, fuel, medicine, shelter and transportation. Plant and animal products are traded to obtain such basic items as soap, clothing and school equipment. Biodiversity is also the basis on which to build local industries like the perfume industry in Madagascar, which



© IRD / LEMASSON Jean-Jacques - UNESCO partner in biodiversity exhibition

*In Senegal, a mother takes care of her daughter suffering from a xooc dom (headache) and cer ke sum (body heat). The beverage and massage are based on different plants, including the neem leaves (Azadirachta indica) that cover her head.*

uses *ylang ylang*, *vetiver*, vanilla and a local forest orchid, *Angraecum*.

The Millennium Development Goals were established by the United Nations in 2000 to promote development by 2015 in eight specific areas of human well-being. Ensuring environmental sustainability is Goal 7 and includes a specific biodiversity target that aims to achieve a significant reduction in the rate of biodiversity loss by 2010 – the 2010 Biodiversity Target. Biodiversity conservation is also an important factor in achieving the other development goals, such as the eradication of extreme poverty and hunger, and gender equality.

**How is biodiversity linked to cultural diversity?**

Since their first appearance on Earth, humans have shaped and managed biodiversity and the natural world, contributing to the diversity of its species, ecosystems and landscapes. Cultures have in turn been shaped by their natural environments. Today, indigenous and local communities frequently play a key role in biodiversity conservation, maintaining complex systems of knowledge and practice. Their territories, often in protected areas, are among the most biologically diverse on the planet; they cover up to 24% of the world’s land surface and contain 80% of the Earth’s remaining healthy ecosystems. The peoples of the South American Andes, for example, are guardians of thousands of varieties of potato, oca, mashua, olluco and quinoa.

The diversity of indigenous languages can help identify trends in traditional knowledge relevant to biodiversity conservation. There is an overlap between areas of biological megadiversity and areas of high cultural and linguistic diversity. For example, nine countries together account for 60% of human languages: six of these are



Photos: Wikipedia commons

*Built in 1996, the Eastgate Centre in Zimbabwe is modelled on termite mounds, which use vents to maintain a stable inner temperature even when outside temperatures fluctuate between 3°C and 42°C. Like the termite mounds, the shopping centre practices passive cooling: heat accumulated during the day is ventilated at night via massive chimneys which also draw in cool air at the bottom of the building. The shopping centre uses only 10% of the energy consumed in a conventional air-conditioned building, thus reducing energy costs and CO<sub>2</sub> emissions.*

also biologically megadiverse. Meaningful knowledge of biodiversity will be lost when a language dies. Since 2002, the number of speakers of indigenous languages and trends in linguistic diversity have been designated a 2010 Biodiversity Target Indicator within the Convention on Biological Diversity.

### What can the international community do to halt biodiversity loss?

#### Develop international instruments

At the 1992 Earth Summit in Rio de Janeiro (Brazil), world leaders agreed on a comprehensive strategy and legal instruments to achieve sustainable development. One of these instruments was the Convention on Biological Diversity (CBD), which has three main objectives: the conservation of biological diversity; the sustainable use of its components; the fair and equitable sharing of the benefits from the use of genetic resources.

Today, over 190 countries have ratified the CBD. In 2000, the CBD adopted the Cartagena Protocol on Biosafety to protect biodiversity from the risks posed by living modified organisms. In October 2010, governments will agree on the new strategic plan for the CBD at the Conference of the Parties to be held in Nagoya (Japan).

Inspired by the success of the Intergovernmental Panel on Climate Change in raising awareness about climate change, governments are now considering the idea of creating an intergovernmental platform on biodiversity and ecosystem services (IPBES) to evaluate biodiversity loss and its impact on ecosystem services and human well-being, as well as to support related decision making.

#### Finance biodiversity

Estimates of the current funding gap for reaching the three CBD global objectives and the 2010 Biodiversity Target range from US\$10 billion to US\$50 billion per year.

#### Expand the coverage of protected areas

Protected areas are safe havens for biodiversity. These are tracts of forest, mountains, wetlands, grasslands, deserts, lakes, rivers, coral reefs and oceans that are managed to maintain the Earth's biodiversity. Most protected areas are managed for multiple, yet compatible uses including biodiversity conservation, outdoor recreation, tourism, watershed protection, sustainable forestry, hunting or fishing, scientific research and environmental education. Today, nearly 1.1 billion people depend on protected forest areas for their livelihoods. There are over 108 000 protected areas in the world, 12% on land and 1% in the sea. The IUCN hopes to expand this coverage for both to 15%.

#### Promote sustainable use of biodiversity

The FAO estimates that at least 40% of our global economy is based on the use of biological resources. The sustainable use of renewable biological resources is the best way to ensure the continued conservation of biological diversity. In addition, conserving biological capital can generate income.

For example, Georgia has over 350 local species of grain crops, more than 100 species of fruit trees, nuts and wild berries, and 500 local varieties of grapes. During the past century, introduction of modern agricultural practices replaced diversified agricultural production. As a result, the cultivation of many valuable local plant varieties has been abandoned, with the

loss of important native cultivars. With the support of the GEF, local farmer cooperatives have been formed to distribute seeds of local varieties which are more pest-resistant and nutritious, adding to their market and consumer appeal. Diversified crop production will also ensure that crops are better adapted to climate change.

#### Ensure fair and equitable sharing of benefits

Taken from plants, animals, fungi or microorganisms, the genetic resources of the Earth can be used to generate tremendous benefits, such as new medicines and cosmetics. Monetary benefits include royalty payments, access fees or joint ownership of intellectual property rights. Non-monetary benefits include training and education, research findings and the transfer of technology.

The third objective of the CBD, the Bonn Guidelines and the proposed international regime on access and benefit-sharing due to be adopted later this year<sup>15</sup> all encourage users and providers of genetic resources to share access to, and benefits from, their use in an equitable, fair way. This includes seeking prior informed consent from, and negotiating terms and conditions with the provider.

Edited by Anne Candau<sup>16</sup>



Both Green Sea turtles and hawksbill turtles use the Tubbataha Reefs Natural Park, a World Heritage site in the Philippines, as their nesting ground.

©UNESCO/Yvette Lee

Read the panels of the travelling exhibition or download them for your own use: [www.unesco.org/en/biodiversity](http://www.unesco.org/en/biodiversity)

14. See *The Rise of Animals*, A World of Science, October 2007 and January 2008

15. For background, see *The Bushbuckridge healers' path to justice*, A World of Science, January 2010

16. UNESCO coordinator of the travelling exhibition on biodiversity: [exhibition.iyb2010@unesco.org](mailto:exhibition.iyb2010@unesco.org)



2010 International Year of Biodiversity

## Diary

### 9–15 April

#### Geoparks

4<sup>th</sup> intl UNESCO conf. More than 300 participants: researchers from geotourism, conservation, environment and sustainable development, policy-makers, economists and local community administrators, NGOs, business operators and individuals with keen interest in geoheritage development. Langkawi Global Geopark (Malaysia): [www.geoparks2010.com/](http://www.geoparks2010.com/)

### 13–14 April

#### Qatar sustainability

Conf. Doha (Qatar): [m.sutcliffe@unesco.org](mailto:m.sutcliffe@unesco.org)

### 14–17 April

#### Biosphere reserves, ecosystem services and sustainability indicators

Intl seminar. Ouro Preto (Brazil): [c.karez@unesco.org](mailto:c.karez@unesco.org)  
<http://rbse-unesco.blogspot.com>

### 19–23 April

#### Vulnerability of energy systems to climate change and extreme events

Joint ICTP-IAEA workshop. Trieste (Italy):  
<http://agenda.ictp.it/smr.php?2138>

### 20–21 April

#### Water – science, policy and capacity development

Workshop of Global Network for Arid Lands (G-Wadi) to make scientific data and knowledge about arid and semi-arid regions of Africa more accessible and see how scientific solutions could be better taken

up or promoted. UNESCO-IHP and UN-Water Decade Programme on Capacity Development. Dakar (Senegal): [a.mishra@unesco.org](mailto:a.mishra@unesco.org)

### 3–7 May

#### Oceans, coasts and islands

Ensuring survival, preserving life and improving governance. 5th global conf. UNESCO Paris:  
[www.globaloceans.org/](http://www.globaloceans.org/)

### 6–8 May

#### Bureau of IHP Council

Netherlands: [a.tejada-guibert@unesco.org](mailto:a.tejada-guibert@unesco.org)

### 10–14 May

#### Human variome project

3<sup>rd</sup> meeting to determine how to prepare the systems to gather routinely and systematically the deluge of variations in genes causing disease (mutations) now being discovered. Participants include bioinformaticians, clinical geneticists, etc. Topics include clinical and genetic data collection, ethics of databasing and funding. UNESCO Paris: [j.hasler@unesco.org](mailto:j.hasler@unesco.org) ;  
[www.humanvariomeproject.org/meetings/paris/](http://www.humanvariomeproject.org/meetings/paris/)

### 25–28 May

#### Seismicity and earthquake engineering in South Asia

Intl workshop. The optimal use of national data for regional earthquake monitoring is a major challenge requiring the exchange of data, software and expertise among interested nations. Tehran (Iran):  
[b.rouhban@unesco.org](mailto:b.rouhban@unesco.org)

### 30–31 May

#### Water Days

Doha (Qatar): [b.boer@unesco.org](mailto:b.boer@unesco.org)

### 31 May – 4 June

#### MAB Intl Coordinating Council

Will designate new biosphere reserves and select MAB Young Scientists. UNESCO Paris:  
[n.ishwaran@unesco.org](mailto:n.ishwaran@unesco.org)

### 8–10 June

#### Biological and cultural diversity

Intl conf. to exchange knowledge and practices linking biological and cultural diversity and to elaborate joint programme of work between UNESCO and CBD Secretariat. Montreal (Canada): [a.persic@unesco.org](mailto:a.persic@unesco.org)

### 21–25 June

#### Seismicity and earthquake engineering in extended Mediterranean region

Intl workshop. Ankara (Turkey): [b.rouhban@unesco.org](mailto:b.rouhban@unesco.org)

### 21–27 June

#### Benthic harmful algal blooms

GEOHAB open science meeting and training workshop. Joint IOC-UNESCO/SCOR event to develop intl. research plan. University of Hawaii (USA): [www.geohab.info](http://www.geohab.info)

### 20–23 June

#### Marine and coastal engineering

Middle East Summit, Doha (Qatar):  
[b.boer@unesco.org](mailto:b.boer@unesco.org)

## New Releases

### Conocimientos del Pueblo Mayangna sobre la Convivencia del Hombre y la Naturaleza : Peces y Tortugas

By Paule Gros and Nacilio Miguel Frithz. Produced by UNESCO's Local and Indigenous Knowledge Systems (LINKS) programme. Exists in Spanish and Mayangna. Two volumes. ISBN: Volume 1 (284pp) ISBN 9789233041493; Volume 2 (168pp) ISBN 9789233041509.

Launched on 29 January at UNESCO Biodiversity Science – Policy conference. For background, see *A World of Science*, October 2008, or contact: [d.nakashima@unesco.org](mailto:d.nakashima@unesco.org);  
[www.unesco.org/links](http://www.unesco.org/links)

### Sistemas Nacionales de Ciencia, Tecnología e Innovación en América Latina y el Caribe

Edited by Guillermo Lemarchand. Published by Regional Bureau for Science in Latin America and the Caribbean (Montevideo) to mark 60<sup>th</sup> anniversary of bureau, Spanish only, 324 pp.

Traces the major developments in the STI systems of Latin America since 1945. A general overview of the past 60 years is followed by country profiles and an analysis of the extent to which each has implemented the recommendations of the World Conference on Science organized by UNESCO and International Council for Science in 1999. Download: [www.unesco.org/uy/](http://www.unesco.org/uy/); for details: [glemarchand@unesco.org.uy](mailto:glemarchand@unesco.org.uy)

### Structural map of North Atlantic Ocean

By Peter Miles, Jacques Ségoufin. Scale: 1:20 000 000. Size: 119 x 84 cm. 10.00 €. Produced by Commission for a Geological Map of the World (CGMW) with UNESCO support.

Part of CGMW mapping programme of the world's oceans. The structural map includes the main features of the North Atlantic Ocean: age of the oceanic crust, seafloor spreading axes, fracture zones, distribution of earthquakes, deep drilling sites, sediment thickness contours, etc. A physiographic inset includes the bathymetry, multi-beam imagery and continental relief plus recent or currently active volcanoes and meteoritic impact craters. This is shown alongside a corresponding geodynamic sketch describing the juxtaposition of the tectonic plates.

To order: [www.cgmw.org](http://www.cgmw.org) or [cgmw@club-internet.fr](mailto:cgmw@club-internet.fr)



### Five Years after the Tsunami in the Indian Ocean

#### From Strategy to Implementation

Brochure produced by UNESCO-IOC. Exists in English, French and Spanish, 28 pp. Describes progress over the past five years in putting in place a global early warning system for tsunamis, including both operational and financial aspects:  
<http://unesdoc.unesco.org/images/0018/001858/185825e.pdf>

### International Year of Biodiversity 2010

#### Biodiversity is life. Biodiversity is our life.

Brochure produced by Natural Sciences Sector. Exists in English, French and Spanish, 4 pp.

Outlines the global biodiversity challenge and UNESCO's contribution to the Year. Download: [www.unesco.org/mab/doc/iyb/UNESCOandIYB.pdf](http://www.unesco.org/mab/doc/iyb/UNESCOandIYB.pdf)

### Animales Invasores en las Reservas de Biosfera en América Latina y el Caribe

Map of invasive animal species in biosphere reserves. Produced by UNESCO's Regional Bureau for Science in Latin America and the Caribbean (Montevideo) within the UNESCO-MAB programme, Spanish only.

Download: [www.unesco.org/uy/mab/documentospdf/MapaEEL-web-2009.pdf](http://www.unesco.org/uy/mab/documentospdf/MapaEEL-web-2009.pdf)

### Structural map of Eastern Eurasia

By Manuel Pubellier. Evolution of Crustal Blocks and Orogenic Belts through Time. Scale: 1:12,500,000. Size: 118 x 84 cm. 15.00 €. Produced by Commission for a Geological Map of the World (CGMW), with UNESCO support.

Results from a synthesis of the tectonic events throughout Asia and part of eastern Europe. It differs from geological, tectonic and terranes maps by emphasizing the continuity of the large mountain belts of Eurasia, like the Alpine belt crossing from Europe to Indonesia. Offers global legibility of the tectonic belts that contributed to the continental growth of Eastern Eurasia. To order: [www.cgmw.org](http://www.cgmw.org) or [cgmw@club-internet.fr](mailto:cgmw@club-internet.fr)

