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Man and nature

Making the relationship last

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Man and nature
making the relationship last

Collection directed
by Lisa Garnier

Publication manager: Natarajan Ishwaran
Scientific Director: Robert Barbault
Editor-in-Chief: Lisa Garnier
Revision: Françoise Fridlansky
Graphic design: Kelig Boëdec
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1, rue Miollis
75732 Paris Cedex 15, France
Tel.: +33 (0) 1 45 68 40 67
Fax: +33 (0) 1 45 68 58 04
E-mail: mab@unesco.org
www.unesco.org/mab

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THIS collection was conceived several years ago – I hardly dare count them! – and I would like to welcome it to the world: long gestation, beautiful baby, born at the right time. Many participated in its growth. Could it be otherwise? – the field is so vast and the goal so innovative, at the interface of the sciences of nature conservation and biodiversity management policies: *Between Man and nature*. There is no lack of textbooks covering the wrongly named "conservation biology". "Conservation Biology" is the tidal wave of Ecological Sciences, which, since the 1980s, has been pushed on by the winds blowing around the global summit in Rio de Janeiro (1992) and the ratification of the Convention on Biological Diversity. Along with its spiritual (or strategic?) son, the concept of biodiversity, it has changed the face of ecology – the science of crisis, as so aptly put by Michael Soulé. Involved science evolves.

And that is just what is shown by this book, which was not intended to critically explore ecology and its mutations at the borders of other sciences and other major scientific fields. Thanks to the mobilization and generous collaboration of many specialists, thanks to the preparatory and exploratory work and the contacts established with the multifaceted world of land managers conducted by Katia Schmitzberger and Marie Winterton at the dawn of what was to be just a project of the French MAB Committee, the present volume breaks out of the "biological shell" (and the term formerly thought adequate conservation biology) which had become too narrow for conservation sciences. The cumbersome crab has become transformed, in a handsome book, into a handsome buck: watch him run in all directions, he opens with *the MAB approach – the optimistic view* as Catherine Cibien and Michel Étienne say in the opening to the first part! And numerous countries are encountered; ideas *at the crossroads of many domains* presented by Katia Schmitzberger and Marie Winterton who introduce the second part of the book: can we make it more clearly understood that we are now in the land of interdisciplinarity? The buck runs on and on from one patch of nature to another, between urban and rural areas, coming across naturalized species, invasive species, indigenous species. And here he listens to local knowledge, to the word of social sciences – a little cramped, I fear, in these green corridors we want to spare him – and ears to the wind, he waits for new public policies.

And off he shoots again our friendly bounding buck, in all the territories of biodiversity – the symbol of dynamic conservation covered in the third part of the book introduced by Frederic Bioret and Raphael Mathevet.

It was appropriate to finish on a note of optimism: an opening made by Michel Trommetter at the threshold of the last part, "Innovation at the service of biodiversity management".

Handsome buck, precious book: the MAB approach opens wide the way to optimism, between Man and Nature. A pledge for lasting relationships!

Dr. Robert Barbault

Director of the department
Ecologie et Gestion de la Biodiversité
of the Paris *Muséum national d'Histoire naturelle*
President of the MAB France Committee

TABLE OF CONTENT

Yildiz AUMEERUDDY-THOMAS is a member of the Centre d'Ecologie Fonctionnelle et Evolutive in Montpellier where her work is centred on research and teaching at the interface between biological sciences and social sciences. Her anthropological and ethnobiological approach focuses on local knowledge and know-how, the effects they have on nature and their current role in sustainable development. After having worked in the programme "People and Plants" (WWF-UNESCO) in the Himalayas, she has now turned to the study of the Mediterranean regions.
yildiz.thomas@cefe.cnrs.fr
www.cefe.cnrs.fr/coev/Y_Thomas.htm

Luc ABBADIE is head of the unit Biogéochimie et écologie des milieux continentaux (University Paris VI, ENS, CNRS, Inra, ENSCP, AgroParisTech) and vice scientific director of the CNRS department Environnement et développement durable. His research concerns the interaction between biodiversity and the biogeochemical cycles. He has published numerous works on the nitrogen cycle in tropical herbaceous ecosystems. His studies into the control of biogeochemical cycles by living organisms have led him towards ecological engineering.
abbadie@biologie.ens.fr
http://www.biologie.ens.fr/bioemco

Jean-Eudes BEURET is a teacher-researcher in socio-economics in the Ecole nationale supérieure agronomique in Rennes, in the laboratory for rural development. After having been cooperation programme leader, and consultant for the OCDE, he now focuses on the organisation of discussion processes for the management of resources and goods from the environment in Europe, Africa and Latin America. He works on the processes of arbitration and conflict prevention in several biosphere Reserves.
jeaneudesbeuret@yahoo.com

Laurence BÉRARD is a researcher in the Unité mixte de recherche éco-anthropologie et ethnobiologie (CNRS-MNHN). She is co-director of the group Ressources des terroirs – Cultures, usages, sociétés and of the reference and research centre devoted to this subject, both located in the Alimentec site, Bourg-en-Bresse. Her research concerns the anthropology of local agriculture and food products, including questions raised by geographic indications and their effect on biodiversity.
laurence.berard@ethno-terroirs.cnrs.fr
www.ethno-terroirs.cnrs.fr

Frédéric BIORET is a professor of environmental sciences at the University of West Brittany and is vice president of the MAB France Committee. He is a member of the board of the Natural Reserves of France, which he represents at the National Council for the Protection of Nature. His research interests focus on coastal flora and vegetation, issues connected with the management of sensitive natural areas and also the use of bioevaluation as a planning tool.
Frederic.Bioret@univ-brest.fr

Marie BONNIN, a researcher in international law of the environment, works on the question of ecological networks at the Institut de recherche pour le développement (UMR 063-C3ED) at the University of Versailles Saint-Quentin. In her role of consultant for the Council of Europe, she has written several chapters of the evaluation report of the pan-European ecological network, published in 2007.
marie.bonnin@ird.fr
www.c3ed.uvsq.fr/

Stephanie CARRIÈRE is an ecologist at the Institut de recherche pour le développement (IRD). Her work concerns the interrelationships between traditional agricultural practices and the ecological dynamics of forests in developing countries. She has especially worked on this issue in Madagascar in the forest corridor area of Fianarantsoa.
stephanie.carriere@ird.fr
www.mpl.ird.fr/ur168/equipe/carriere.htm

Johan CHEVALIER is currently working on a PhD in the definition of the objectives in the management of natural heritage in the Centre d'études et de recherches interdisciplinaires sur le développement durable in the technological University of Troyes. After having done studies in nature conservation, he went on to specialise in the ecology of vertebrates. He has worked, in particular, on the protection of turtles in Guyana and the French West Indies.
johan.chevalier@utt.fr

Catherine CIBIEN is the scientific secretary of the MAB France Committee. She has a PhD in ecology and, before she worked in consultancy offices for environmental issues, her research focused on Large Mammals. She is the coordinator of the French MAB Committee and of the national network of biosphere Reserves for which she is the Editor of La Lettre de la Biosphère. Her interests are environment management and the development of links between research and management.
catherine.cibien@mab-france.org

Isabelle DAJOZ is a professor at University Paris VII. She studies the role of interaction networks in the maintenance of biodiversity and ecosystem functioning (e.g., plants, below-ground symbioses with soil microbes, above-ground pollinator mutualisms). Her approach is largely experimental.
dajoz@biologie.ens.fr

Michel ÉTIENNE is an agronomist and an ecologist. He works on the support of management projects for renewable natural resources. He takes part in resolving conflict between users of natural areas applying the method of co-construction and multi-agent models. He is one of the leaders of the ComMod network bringing together researchers from the Cirad, Inra, Cemagref, CNRS and the IRD working on support modelling. He is vice-president of the MAB France Committee.
etienne@avignon.inra.fr

Doug EVANS is a graduate of Stirling and Aberdeen universities, where he studied plant ecology and has also worked for the UK Institute of Terrestrial Ecology and the French INRA. He joined Scottish Natural Heritage in 1993 and has been on secondment to the European Topic Centre on Biological Diversity (Paris) since 1999. He has been involved in implementing the EU Habitats Directive since 1994, at first in the Scottish Highlands and Islands and more recently at the EU level, giving scientific advice and assistance to DG Environment of the European Commission, particularly for issues relating to plants and habitats.
evans@mnhn.fr

Éric FOUCHER is a research manager at Ifremer. He is director of the laboratory halieutic Resources in Normandy. He is specialised in the biology,

exploitation and management of living resources from aquatic environments. For a number of years, he has participated in the scientific evaluation of commercially exploited stocks of molluscs, especially scallops in the English Channel. He is a member of various international work groups on scallop management.
Eric.Foucher@ifremer.fr

■ **Françoise FRIDLANSKY** is a member of the MAB France Committee. She is a specialist in biology and molecular physiology and has worked at the Cancer Research Institute in Villejuif and also in the INSERM Unit Hormones et Reproduction. She joined the Centre for Molecular Genetics in 1990. That is where she participated in setting up the national programme Dynamique de la biodiversité et environnement, which led to the creation of the Institut Français de la Biodiversité (IFB) in 2000.
francoise.fridlansky@gmail.com

■ **Éric DE GARINE** is an associate professor in the Department of Ethnology of University Paris X-Nanterre. As an ethnologist, he studies the interactions between farming communities on the African continent and biological diversity.
eric.garine@mae.u-paris10.fr

■ **Lisa GARNIER** is a scientific journalist specialised in plant ecology. With a PhD in Ecology, she has participated in the television series Ushuaïa Nature and is the author of several popular science articles and books. Having been a writer for the popular science magazines Science & Vie Hors Série and Science & Vie Junior, she now works free-lance, especially for Ushuaïa magazine. Owing to her interest in the relationships that landscapers have with biodiversity, she gives conferences at the École Nationale Supérieure de la Nature et du Paysage in Blois. She is Editor-in-Chief of the present collection.
lisa.garnier@wanadoo.fr

■ **Jean-Claude GÉNOT** is an ecological engineer. He is responsible for nature protection in the Biosphere reserve of Vosges du Nord-Pfälzerwald. He has written several naturalist books and one of his major interests is forest management in the respect of biodiversity.
jc.genot@parc-vosges-nord.fr
www.parc-vosges-nord.fr

■ **Sarah HERNANDEZ** is an environmental economist. For several years, she led a research programme named Economic valuation and policy in biodiversity at the research institute, Instituto Alexander von Humboldt (Colombia). Specialising in market-based mechanisms for the conservation of biological diversity, she is now working as policy advisor in biodiversity issues in the Department of economic studies and environmental assessment in the French Ministry for Ecology, Sustainable Development and Spatial Planning (Paris).
sarah.hernandez@ecologie.gouv.fr

■ **Joël HOUDET** is working towards a PhD on the dynamics of interactions between business and biodiversity at the Institut des sciences et industries du vivant et de l'environnement (AgroParisTech). An interdisciplinary approach to problem solving is very useful for his tasks as biodiversity advisor for the association "Orée", notably for the daily management of the working group "Integrating biodiversity into business strategies" which was created in 2006 in partnership with the Institut Français de la Biodiversité (IFB).
joel.houdet@u-psud.fr

■ **Mireille JARDIN** is a member of the MAB France Committee. As a specialist in international law of the environment, she has devoted a large part of her career with UNESCO to the implementation of the World Heritage Convention and then to the secretariat of the MAB programme.
mireillejardin@orange.fr

■ **Clive G. JONES** is a Senior Scientist at the Institute of Ecosystem Studies in Millbrook, New York, USA, and a visiting scientist at Biogéochimie et écologie des milieux continentaux, Ecole normale supérieure, Paris. His research addresses links between species and ecosystems, particularly ecosystem engineering by species, ecological complexity and ecological theory. His work has earned him several honours including election as a Fellow of the American Association for the Advancement of Science (AAAS) and a Chaire internationale de recherche Blaise Pascal.
jonesc@ecostudies.org
www.ecostudies.org/people_sci_jones.asp

■ **Romain JULLIARD** is an associate professor at the Muséum national d'Histoire naturelle in Paris. Specialised in Conservation Biology, he develops and runs Biodiversity Observatories (Vigie Nature project). His research concerns the functional homogenisation of biodiversity, its mechanisms (reorganisation of communities under the influence of global changes) and its applications (development of biodiversity indicators).
julliard@mnhn.fr

■ **Catherine LARRÈRE** is a professor at the University of Paris I-Panthéon-Sorbonne. She is the director of Nosophi (EA 3562), and is also a researcher associated to the Inra. As a specialist in moral and political philosophy, she is interested in the ethical and political issues related to the environmental crisis and to the new technologies (protection of nature, risk prevention, development of biotechnologies). She is the author of numerous books and articles in this field.
c.larrere@wanadoo.fr

■ **Harold LEVREL** is an environment economist. His research concerns the indicators of interactions allowing links to be established between conservation and development issues. As a consultant for UNESCO's MAB programme, he also works on biodiversity indicators in a forest environment for GIP-EcoFor. He is a researcher at the Ifremer.
harold.levrel@ifremer.fr

■ **Robert LIFRAN** is an economist and a researcher at Inra, Lameta research unit located in Montpellier. Over the last ten years, he has developed a research programme into the evaluation of public policies concerning the environment and natural resources. He is specialised in the design of instruments for public policies for biodiversity and landscapes conservation. He teaches at the SupAgro School in Montpellier and in the Universities of Montpellier and Sydney, Australia. lifran@supagro.inra.fr

■ **Nadia LOURY** is General Delegate for Orée, an association which helps in taking the environment into account and organising concrete applications in the field. Trained as a biogeographer and a geomorphologist, her experience of natural environments and of the landscape approach qualify her to work on conflict

issues related to land use. As director of the association, she heads operations and initiates multiple partnerships between public and private sectors. She has a particular interest in the economic approach to biodiversity.
loury@oree.org

Nathalie MACHON is a professor at the Muséum national d'Histoire naturelle in Paris. Her work is devoted to establishing restoration plans for endangered plants and the study of the impact of human activities on plant diversity (agriculture, urbanisation, transport, and so on). She works in the research unit CNRS-MNHN-UPMC Conservation des espèces, Restauration et Suivi des populations.
machon@mnhn.fr

Frédéric MAGNIN is a researcher for the CNRS in the Institut méditerranéen d'Ecologie et de Paléoécologie located in Aix-en-Provence. His work concerns the ecology and biogeography of quaternary and current terrestrial molluscs of the Mediterranean region.
frederic.magnin@univ-cezanne.fr

Philippe MARCHENAY is a researcher in the Unité mixte de recherche éco-anthropologie et ethnobiologie (CNRS-MNHN). He is co-director of the group Ressources des terroirs – Cultures, usages, sociétés and of the reference and research centre devoted to this subject, both located in the Alimentec site, Bourg-en-Bresse. His research concerns the anthropology of local agriculture and food products, including questions raised by geographic indications and their effect on biodiversity.
philippe.marchenay@ethno-terroirs.cnrs.fr
www.ethno-terroirs.cnrs.fr

Raphaël MATHEVET is an ecologist and geographer in the Centre d'Ecologie Fonctionnelle et Evolutive in Montpellier. He works on the conservation of biodiversity, integrated management and on the multiple uses of natural resources. Member of the ComMod network, he applies simulation tools and role-play in multidisciplinary approaches to resolving access to resources, especially in the context of the Mediterranean wetlands. He is also vice-president of the MAB France Committee.
raphael.mathevet@cefe.cnrs.fr

Nicole MATHIEU is a doctor of History. She is an Emeritus research director with the CNRS in the laboratory Dynamiques sociales et Recomposition des espaces at the University of Paris I-Panthéon-Sorbonne. She is Deputy Editor-in-Chief of the journal Natures Sciences Sociétés, she is coordinator for several interdisciplinary programmes concerning interactions between nature and society in rural and urban environments. She has published work on the evaluation of interdisciplinary practices and on the epistemology of interdisciplinarity. She is also a corresponding member of the Académie d'agriculture de France.
mathieu@univ-paris1.fr

Frédéric MÉDAIL is a university professor in ecology and plant biogeography in the Institut méditerranéen d'Ecologie et de Paléoécologie in Aix-Marseille University. A specialist in biogeography and conservation biology in the Mediterranean area, he coordinates numerous research programmes and is an active member of 15 scientific committees of international, national, and regional importance.
f.medail@univ-cezanne.fr

Philippe MÉRAL is a researcher at the Institut de recherche pour le développement (IRD). He has a PhD in economic sciences and specialises in the economy of the environment and of natural resources. He spent 4 years in Madagascar analysing the environmental policies and local management of natural resources.
philippe.meral@ird.fr

Agnès MICHELOT is an associate professor at the Faculté de droit et de sciences politiques et de gestion in la Rochelle. As a member of the Laboratory Sociologie de l'Action publique, her research into international environmental law especially concerns the protection of biological diversity. She teaches in several universities and institutes abroad (notably French-speaking Africa, Europe and Canada). She is a member and consultant for several commissions, she is special associate for the environment-law training programme run by the UN for teaching and research (Unitar in Geneva, Switzerland).
agnes.michelot@univ-lr.fr

Jean-Claude MOUNOLOU is an honorary professor at Paris-Sud University where he was responsible for the chair in general biology until 2000. Member of the Académie d'agriculture de France, has a close interest in genetic resources and the interrelationships that become established between human societies and nature.
mounoloujcm@wanadoo.fr

Serge MORAND is a specialist in the evolutionary ecology of host-parasite interactions at the Institut des Sciences de l'évolution in University Montpellier II and in the Cirad Research Unit gestion de la faune sauvage. He participates in and runs several research programmes in Africa and Asia. He is a member of the Scientific Councils of the IFB and the programmes of the GICC (Gestion des Impacts du Changement Climatique – Management of the Impacts of Climate Change) and EcoFor (Forest Ecosystems) where he was Chairman for the report on the national research strategy for biodiversity serving sustainable development.
morand@isem.univ-montp2.fr

Nicolas MOUQUET is a CNRS researcher at the Institut des Sciences de l'évolution in University Montpellier II. He develops theoretical and experimental approaches in relation to the dynamics of diversity in metacommunities. He also works on the mechanisms that explain the emergence and the maintenance of biological diversity.
nmouquet@univ-montp2.fr

Audrey MURATET is temporarily associated to teaching and research at University Paris VI. Her PhD, carried out with the Conservatoire botanique national du Bassin parisien concerned plant diversity in an urban environment. Affiliated to the laboratory Conservation des espèces, Restauration et Suivi des Populations of the Muséum national d'Histoire naturelle de Paris, she is continuing her research into urban ecology.
muratet@mnhn.fr

Anne-Marie PLANTY-TABACCHI is an associate professor at Paul Sabatier University in Toulouse. She is a researcher in the laboratory of functional Ecology and has a particular interest for invasions by introduced species of plants occurring in the strips of land on either side

About the authors

of watercourses. She is responsible for chairing INVasions BIOlogiques programmes and publicising the findings.
am.tabacchi@cict.fr

Brigitte POULIN is a researcher in community ecology in Tour-du-Valat. Specializing in the concepts of niche segregation with emphasis on trophic relationships, she participated in the multidisciplinary research programme on the Mediterranean reed beds of Tour-du-Valat by defining the ecological requirements of the vulnerable birds that live there.
poulin@tourduvalat.org

Anne-Caroline PREVOT-JULLIARD is an associate professor with the IUFM of Versailles and affiliated to University Paris-Sud. A specialist in the dynamics of animal populations and conservation biology, she has currently turned to urban ecology, especially on socio-ecological systems within cities. She coordinates an interdisciplinary group working on the place of nature in the city using the urban pigeon (rock dove) as study model.
anne-caroline.julliard@u-psud.fr

Katia SCHMITZBERGER is a forestry engineer and has a PhD in ecology, specialising in population dynamics and conservation biology. After having worked in the management of aquatic environments for a number of NGOs, she is currently contributing to the application of the Framework Water Directive for the Rhin-Meuse water board.
schmitzberger@eau-rhin-meuse.fr

Annick SCHNITZLER is a professor at Paul Verlaine University in Metz. Her work concerns the dynamics of plant populations in forests – from ancient forests to intensively exploited forests. Her studies have led to reflections on the notions of naturalness and biodiversity and to the association of these reflections with those of nature managers and scientists in other domains, especially the social sciences.
schnitz@univ-metz.fr

Véronique SERVAIS is a professor of Communication theories and communication anthropology in Liège University. She works on the relationships between humans and animals. She has, in particular, carried out research into the therapeutic role of dolphins and other animals and into the interactions between primates and zoo visitors as well as on the systems of communication established between dolphins and their trainers.
v.servais@ulg.ac.be

Éric TABACCHI is a researcher with the CNRS in the laboratory of functional Ecology, Paul Sabatier University in Toulouse. He works on biodiversity dynamics and on environmental disturbances along the strips of land paralleling watercourses. He is responsible for chairing INVasions BIOlogiques programmes and publicising the findings.
eric.tabacchi@cict.fr

John THOMPSON is a research director for the CNRS and director of the department Dynamique des systèmes écologiques in the Centre d'Ecologie Fonctionnelle et Evolutive (UMR 5175) in Montpellier. His research concerns the dynamics and the ecology of plant populations in a heterogeneous environment with a particular emphasis on the evolution of diversity and the issues of conservation, particularly in the Mediterranean region.
john.thompson@cefe.cnrs.fr

Michel TROMMETTER is an economist and a research director for INRA, (GAEL IUPMF) in Grenoble and a researcher associated to the Econometry Laboratory of the Ecole Polytechnique in Paris. He is an active member of various scientific councils: Institut Français de la Biodiversité, Bureau des Ressources Génétiques, Muséum national d'Histoire Naturelle de Paris. His research mainly concerns the economic analysis of intellectual property rights in biotechnology, innovation and biodiversity.
michel@grenoble.inra.fr

Jacques WEBER is an economist and an anthropologist. He is currently the director of the Institut Français de la Biodiversité (IFB). He is vice-president of the MAB France Committee. His main field of interest concerns the interactions between social dynamics and natural dynamics in the context of biodiversity and renewable resources.
weber@gis-ifb.org

Marie WINTERTON is project leader for the consultancy ECOTONE Recherche et Environnement, which she founded in 1998. She is an ecological engineer and has a PhD in ethology.
marie.winterton@ecotone.fr

Peter WINTERTON is an associate professor at the UFR de Langues vivantes of Paul Sabatier University in Toulouse. After doing a PhD in polymer chemistry, he specialised in teaching English to scientific students and in the translation of scientific documents. He translated the present collection.
peter.winterton@univ-tlse3.fr

This collection would not have been possible without the participation of: Donato BERGANDI, Peggy BOUCHY, Thierry BOULINIER, Frédérique CHLOUS DUCHARME, Philippe CLERGEAU, Aurélie COULON, Franck COURCHAMP, Denis COUVET, Sergio DALLA BERNARDINA, Henri DÉCAMPS, Agnès FORTIER, Nina GIOTTO, George GONZALEZ, Françoise GOURMELON, Nicolas KIDJO, Emma LEBELLE, Iwan LE BERRE, Jane LECOMTE, Michel LOREAU, Colette MÉCHIN, Betty QUEFFELEC, Olivier RENAULT, François SARRAZIN, Elisa THÉBAULT, Gabrielle THIEBAULT, Nicolas VILLERETTE, Maurice WINTZ.

CHAPTER 1

The MAB approach: the optimistic view

- Which biodiversity?
- A different system of values
- An original legal framework

The MAB approach: the optimistic view

By Catherine Cibien and Michel Étienne

"Management must recognize that change is inevitable". This is the ninth principle of the ecosystemic approach which is the framework for action of the Convention on Biological Diversity. Fifteen years after its signature in Rio de Janeiro, global changes – pollution, reduction of fresh water reserves, temperature increases – have become the signature that humanity has left on the whole of our planet. But despite this, the countries that signed the convention undertook to maintain the services ensured by the ecosystems by conserving their structure and their dynamics (principle 5). The aim of UNESCO's Man and the Biosphere (MAB) programme is to establish a relationship – where both partners are the winners – between man and nature, a relationship that is intended to last. Is this not the aim of the whole of humanity?

Since the beginning of the 1970s, MAB research and MAB programmes in general have favoured actions that bring out the tight links existing between biodiversity conservation and human development. It is only by using biological resources – agriculture, fishing, stock rearing, hunting or industry, and even resources coming from past biological activity such as coal or oil – that humanity can be fed, clothed, housed, etc. and that it has been able to occupy the majority of the planet. Each area that has been colonised, then populated, has been transformed. The nature that we can see today is simply the result of a long history of multiple and complex interactions between man and his environment, during which species and whole ecosystems have vanished. Meanwhile others have appeared – for natural reasons but also because of man.

By preventing the practice of burning the land carried out since time immemorial by the now expelled Bushmen, the Cape region in South Africa has lost part of its plant diversity.

The first political measures taken for the conservation of nature led to the exclusion of human activities, the extermination of domestic animals and sometimes, the eradication of species considered invasive. Shortly after the creation of the state of Israel, one of the biodiversity hotspots of the Mediterranean basin, a network of natural reserves and protected areas was set up to halt the degradation of the semi-arid, arid and desert ecosystems. Each type of ecosystem was attributed a "type sample" which was "put under glass". No human population, whether local or nomadic had right of access – the locals having been expelled. The result? Astounding! In the space of 20 years, the flora and fauna had flourished. Soon, however, the picture became less rosy as forest vegetation became established. Pines and oaks replaced the herbaceous plants and the incredible biodiversity of the areas grazed by the Bedouin herds gave way to the much less diverse Mediterranean forest.

In another place, we have another example: the extraordinarily floristically rich Cape region of South Africa. With the main pretext of wanting to control the spread of fires, a policy similar to that of Israel was set up in a network of natural reserves. Here again the results diverged from the official aim. By preventing the practice of burning the land carried out since time immemorial by the now expelled Bushmen, the innumerable species of shrub that have led to the Cape's reputation for a rich and endemic flora went into decline. At the time, the authorities had not understood their adaptation to different frequencies and intensities of fire. The irony of it is that now, burns have to be organised on a regular basis to mimic the traditional Bushman practices.

These examples illustrate how much the presence of humans has, over the eons, fashioned a biodiversity that is resistant to fire, grazing, and periodic ploughing up to grow crops. Of course, this is one form of biodiversity and exists at the expense of other forms. Today, the sections of the Mediterranean that have been intensively used for the last 7000 years for grazing, burning and firewood collection host several hotspots of global biodiversity.

Work undertaken by monasteries in the Middle Ages transformed marshy areas into the vast stretches of water still found in Brenne, Dombes and Sologne – they became a source of fish but also encouraged diverse species of bird including the black-necked grebe and the red-crested pochard. In the region of Trebon in the Czech Republic, the great projects of the 15th and 16th centuries created 460 lakes, whose ecological importance far outreaches the 70 000 hectares of wetland they cover. Listed in the Ramsar wetland convention, this Biosphere reserve is also a region with a well-developed fishing industry.

When Man and nature are both winners.

Landscapes in Movement

Human societies have always modified their habitat: to make it easier to live in, to produce more, or to make it more like their vision of the world as it should be. The consequence of these alterations of the landscape is sweeping modifications of the biodiversity, whatever the scale considered. Very locally, man-made structures can eradicate endemic species or species present only in small numbers. Recently, the construction of a rest home near Montpellier almost wiped out the only French population of the yellow autumn dafodil *Sternbergia lutea*. On the other hand, man-made structures can also become the habitat of endangered species. When a biodiversity inventory was performed in the Biosphere reserve of Mont Ventoux, in France, it was in the ponds used by the ochre quarries that a population of the Western Spadefoot toad (*Pelobates cultripes*) was discovered. This species is usually restricted to dry regions of the Iberian Peninsula and a few patches on the French coast. This very discreet animal is listed as vulnerable in the red book of endangered species. Today its protection has led to the preservation of man-made microhabitats. Actually, the way man alters landscapes and biodiversity acts like an open gate. An example is the Causse Méjean in France. At the end of the 18th century, tree-felling had left the Causse almost bare. The people had turned to growing cereals and herding. The Little Owl, which nests in hollow trunks, should have logically disappeared from the area. But instead, the bird took to nesting in the dry-stone walls and piles of rocks regularly removed from the fields. The Little Owl managed to find a way in and nest. Two hundred years later, man invented the rock crusher, and agricultural policies changed, resulting in the spontaneous expansion of pine forest. How will the owl populations react? Crushing the rocks decreased the raptor's "secondary" habitat and reforesting brought back its classic habitat.

Linking human activities to biodiversity conservation does not simply imply that the direct links between man and other species must be known, it also requires action on the more indirect, global links such as the flow of matter and energy which acts way beyond their place of occurrence. An illustration is the mangrove in the Guadeloupe Biosphere Reserve, around the edges of the Grand Cul-de-Sac Marin, and the numerous species that it is home to – it is a nursery for crustaceans and fish. It is extremely sensitive to the quality of the water in the rivers flowing into it. Excessive agricultural input from all around the watershed is a source of pollution by nitrates and pesticides, industrial residues is another. It is therefore at this level that management must intervene.

Global changes, especially climatic, will lead to upheavals in biodiversity. Efforts made on the local level (every little helps – even very little) to limit the changes act indirectly on the erosion of biodiversity. In the last ten years, the automobile traffic in the Wiernerwald Biosphere Reserve, right next to the Austrian capital, has increased dramatically. A programme to control automobile traffic has been in

operation since 2004: in an exemplary move, the local authorities ran a programme to make people more aware of the impact of CO_2 emissions, the main greenhouse gas. They also promoted low-impact travel, hoping to show that it is possible to reduce automobile traffic without high costs through the use of flexible measures that are negotiated and where nothing is actually forbidden. This approach contrasts with a more typical response where technical measures are sought to address the problem.

In conclusion, as soon as man understands the strength and the diversity of his links with nature, and actually acknowledges their existence, he can act and learn to handle the situation better. This is the whole philosophy behind MAB.

The MAB approach in practice

With knowledge as it is today, having the information required to judge the state of a socio-ecological system, understanding the dynamics involved and discussion of the possible outcomes are the elements necessary for flexible management. To reach this goal, a combination of three points of view is necessary: the first is that of ecological processes on all scales of space and time; the second comes from the analysis of the social and cultural processes required to identify the cultural trends of society; the third involves the economic processes – their analysis enables us to understand the points that are relevant to guarantee the survival of society. Implementing this type of approach comes up against three difficulties.

Strengthening the link between research and management

Following a sharp fall in the numbers of cormorants, the species became protected in France in the 70s. Simultaneously benefiting from the development of fish farming, the bird began proliferating, causing certain damage to the industry. Today, a black and white attitude to cormorant conservation calls some to fight to avoid its removal from the protected lists while others have reached the point where they poison ponds, destroying the whole fabric of biodiversity, the effects far overreaching just the simple cormorant. In this example, the scientific data concerning a threatened species were removed from the context of fisheries management. It was forgotten that a cormorant is a predator and that it interacts directly and negatively with an economic activity. This example also illustrates how necessary it is to develop decision-making procedures that involve more dialogue, allowing for a balanced evaluation of their probable effects and enabling adjustment, if necessary.

Bringing together common knowledge and scientific data

It is no longer questioned that the world-wide spread of cultivated species such as wheat, rice, maize or sorghum, but also manioc, have enabled a large part of humanity to stay alive and then to prosper. But, for twenty or so years the adversaries of modernisation and intensification of agricultural systems have denounced their inevitable effects on the impoverishment of biodiversity. And yet, studies carried out in the north of Cameroon have shown that the correlation between modernisation of agriculture and erosion of biological diversity is not systematic. In spite of the expansion of the cultivation of cotton, the family field remains a lifeline for the household. Through selective weeding, agricultural practices maintain numerous species that really are just "weeds" for the agronomists, but excellent vegetables for the local people. The farmers thus conserve a mosaic of plots in which, alongside the cotton, they grow secondary crops indispensable for the continued well-being of local society. Moreover, in some farming communities, over 40 visibly different types of sorghum are conserved through mixed sowings and the habit of swapping seed between villagers. Domestic biodiversity is here the fruit of a fine mixture between the need for basic feeding of the population and the will to maintain close social links between farmers allowing access to traditional seedstock for all farmers. To conserve this biodiversity, it is therefore necessary to understand both the common lore that is attached to it and also the social rules that underlie its perpetuation. Then, scientific means must be found to ensure that the agricultural techniques in practice guarantee the continuation and possibly the enhancement of that biodiversity.

Sharing the uncertainty of knowledge in decision making

In the 1950s, scientific data on the levels of stock removal from the shoals of cod around Newfoundland were already available. They indicated that in the middle of the last century, technological improvements considerably increased the tonnage fished, then the catches levelled off. Eventually, the day came when the catches started to diminish. Scientists sounded the alarm. But in vain. Only when cod fishing started to become unprofitable was it decided to apply quotas. Even then, the nets remained empty. It was thought that a 5-year interruption would bring the cod back – a ban that was repeated without success – so finally it was decided to put a permanent halt to fishing for cod. What is the lesson to be learned from this? It is that managers failed to correctly interpret scientific signals. There is a large gap between what the researchers report – obviously anticipatory – and the practices of the trawler men – their daily routine. In addition, the uncertainty of the data appears to be inadequately communicated to the resource managers.

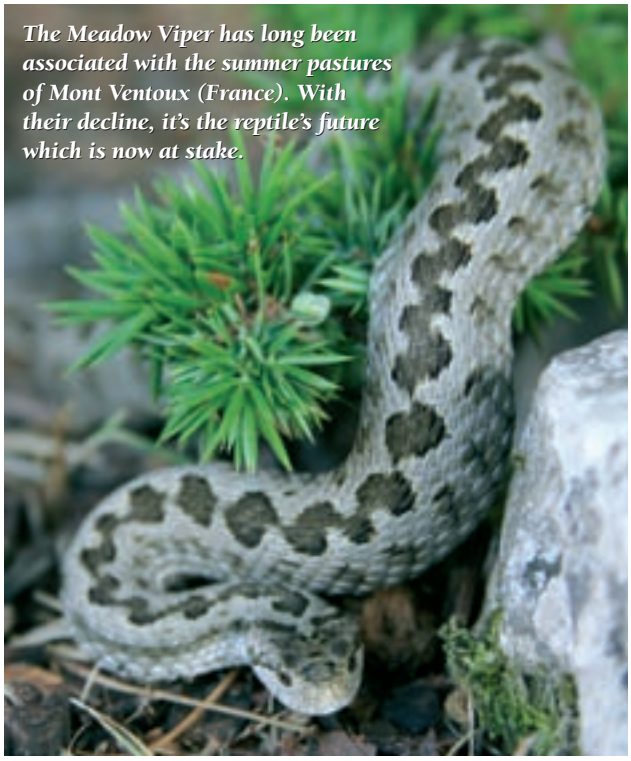
Michel Étienne, Catherine Cibien and Éric de Garine

Society's choices

Let us take a look at the Ventoux Biosphere Reserve in France. At subalpine altitudes on land used for many years for summer grazing, an open landscape dominated by dry grassland and a few juniper bushes was long considered to be the reference natural habitat. The occurrence of an isolated population of Meadow Viper (*Vipera ursinii)* established in this habitat revealed a beneficial association between sheep farming and the conservation of this reptile. The socio-economic changes of the last 30 years have led to the decline of herding. Then, the recolonisation potential of the original fir forest with its associated range of forest species – deciduous understorey, Hazel grouse, etc. – made itself felt. What can be done? Keeping both ecosystems side by side caused insuperable management problems so we must now decide which it is to be: dry grassland or fir forest. Based on purely scientific criteria, it is the level of susceptibility of the viper and the grouse, the expansion potential of the fir and the probable effects of global warming on the viability of these new populations that will have the greatest weight. On the other hand, using political criteria, it will be the legitimate representatives of the local community who should agree on the landscape that they wish to have in the future. If it is social criteria that are given precedence, the representatives of associations and local personalities will work together. Finally, from a purely economic point of view, an evaluation will be made of the stakeholders to find the most active and a forecast will be made of the dynamics resulting from the development of their activities. The problem can therefore be summed up as: Which biodiversity should be kept? Who is the legitimate decision maker? What resources are available to reach the chosen goal?

From a historic perspective, the relationship between man and nature has never been linear as some periods have been affected by human expansion, colonisation, land clearance, etc. more than others.

From a geographic perspective each local society is modified by and in turn modifies the surrounding biodiversity in several ways.



The Meadow Viper has long been associated with the summer pastures of Mont Ventoux (France). With their decline, it's the reptile's future which is now at stake.

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It is therefore through these multiple interactions between ecological and social processes that our actions have an effect. The first principle in the ecosystemic approach laid down by the Convention on Biological Diversity clearly states that "The objectives of management of land, water and living resources are a matter of societal choice" The question that remains is: what level of society should make the decisions – local? national? international? – and using what criteria? ■

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ZOOM

When reed-beds benefit from exchanges between Science and Society

By Brigitte Poulin and Raphaël Mathevet

Ten years. That is the time it took for the Biological Station of Tour du Valat located in the Camargue (Rhone delta, southern France) to successfully conclude its programme of research into the management and sustainable exploitation of the reed-beds. The multidisciplinary project benefited from the varied skills of ecologists, geographers, economists, hydrologists, local stakeholders and more. Thanks to these fruitful exchanges, the reed beds and their emblematic bird, the bittern, are now considered differently by the local people. Fishermen, ramblers, farmers, and hunters from the whole region now know their environment better and the role they themselves can play in its protection.

Thousands of reeds

The beds of common reed occupy numerous shallow marshes and cover about 8000 ha of the Camargue. In spite of their simple plant structure, they are the exclusive habitat of several species of bird such as the moustached warbler, the great reed warbler, the Eurasian bittern and the purple heron. All these species are today considered to be vulnerable and are protected throughout France. In order to estimate their abundance and their needs – especially their requirements for water, vegetation and food resources – the Biological Station of Tour du Valat has undertaken several studies on the basis of various European conservation programmes. The bittern, a vulnerable species given high conservation priority in Europe, had a whole LIFE-Nature programme devoted to it. It is interesting to note that the range of micro-habitats used by the birds of the reed beds of Mediterranean France is significantly different from that reported in the specialised literature, which rather tends to concern northern Europe. In the search for sustainable management of the environment, this result emphasises the utility of studies carried out on a regional scale.

The Camargue marshes (France) provide reeds.

Another interesting point highlighted by the studies is that local culture is also well rooted in the reed beds. The reeds, or "sagne" as they are called in the area, are for instance, harvested for roof thatching. Hunters appreciate the waterfowl, stock breeders graze their herds of bulls, fishermen find fish and tourists enjoy a unique landscape with its marsh fauna. These different socio-economic activities do however have different water level requirements. Chronic conflict between users has often resulted in plots of marshland being dyked off resulting in the fragmentation of the environment. To find the best possible compromise between the requirements of the vulnerable fauna and the needs of the people using the reed beds, the Biological Station of Tour de Valat experimentally tested management

These bundles of Camargue reed will be used for thatching in the north of Europe.

Many species of bird live in the Camargue. This is the night heron hunting.

approaches and ways of using the marshes with the support of the stakeholders. The aim was to maintain the socio-economic activities in the long-term while preserving the heritage value of the reed beds.

Compromise as a policy

To reach these goals, actual land use was mapped at the same time as an extensive campaign of surveys was run. It gave a clear picture of the practices and strategies used by the stakeholders in the management of the natural environment. It also explained the logic and the way of thinking of those acting on the marshland. Following this phase, the scientific data were confronted with the empirical knowledge of the users in a system set up for dialogue in order to reach optimal compromise. The various compromises were then integrated into a water and environmental management plan (under the responsibility of the *Syndicat Mixte pour la Gestion et la Protection de la Camargue Gardoise*: Local Authority for the Management and Protection of the Camargue in the *département* of Gard) and into various agri-environmental measures and Natura 2000 contracts for use of the reed beds in cooperation with the Chamber of Agriculture of the Gard.

To ensure the awareness of the stakeholders as to the utility of collective management of the resources, two multi-agent models were developed. The first, ReedSim, integrated a maximum amount of data: abiotic (meteorology, water level), ecological (the plant structure, the abundance and the diversity of species of birds) and socio-economic (the practices, loans, costs). It simulated the impact of various hypothetical management plans on the health, the use value and the heritage value of the reed beds over time. The second, ButorStar, a simplified version of ReedSim, was applied in the form of a computer-assisted role-playing game. It was a good opportunity to get all categories of stakeholders together around a table, in a relaxed atmosphere, who could then benefit from exchanges of knowledge about the way the reed beds function, with a collective debate about the consequences of the actions of each on the natural and cultural heritage.

While the next step must focus on management and on the institutionalisation of the relationships established between the different partners to perpetuate the knowledge gained by the study, one fact is well established: the advantage for the sustainable development of the environment of combining understanding obtained from research on biodiversity, engineering, social sciences and public action. In brief, exchange between science and society. ■

Specificities hard to define

By Lisa Garnier

Many would argue that the term biodiversity covers a fuzzy concept and everyone sees what they want in it, but at least it has the merit of encouraging people to rally around the same cause: the loss of all forms of diversity. Diversity of living organisms, naturally, but also human and linguistic diversity. The diversity of peoples and their languages closely parallels the distribution of biodiversity. And all three types of diversity can be threatened with extinction, which appears to be increasingly frequent.

Diversities in the plural

Since the Convention on Biological Diversity of the Rio Conference, the concept of biodiversity alone expresses the crisis of society with respect to its environment. Scientists, politicians, sociologists and economists all have something to say about a term which starts to annoy by its omnipresence. The reason is simple: for the man who coined the word, Edward O. Wilson, biodiversity represents the diversity of all forms of living organism, it covers three different biological scales where man has a direct interest: ecosystems, species and genes. Genetic diversity is the diversity of the genes within the individuals of one species, species diversity is representative of the number of species and ecological diversity refers to the different ecosystems – habitats – in a landscape. Each of these scales is dependent on the two others and all are in perpetual evolution. As it is the fruit of a long history, of about 4 billion years, today's biodiversity represents past and present life as it does future life. It is a vast network of links between molecules, complex organisms, viruses and bacteria, biomes, etc. right up to the whole biosphere.

If the specificities of biodiversity are so difficult to define, it is because humans are included: biological beings, resulting from a long line of evolutionary events. Their survival depends on other living beings – and in particular on photosynthetic organisms able to transform carbon dioxide into oxygen making earth's atmosphere breathable. Humanity is also largely dependent today on past life

Measuring biodiversity

With its three main nested entities, there is no simple yardstick to quantify biodiversity. As there is no universal system of measurement, those used depend on the aim in question. The most frequent method is to calculate the species richness of a given habitat. There is then a greater chance of including a large genetic, phylogenetic, morphological, biological and ecological diversity. Another approach is to identify the diversity of the habitats in an ecosystem or the ecosystems in a landscape. But, here again, the method is not unanimously accepted because it reduces diversity to a non-exhaustive list of habitats. The development of suitable indicators is today an active field of research. L.G.

Just like counting the florets in this asteracae, listing all living species is a meticulous task.

In Practice

The continent of Europe is formed by a wide diversity of habitats which reflect the diversity of altitude (0 - > 4 000m), latitude, geology and landuse. The map of potential natural vegetation published recently includes approximately 700 units while the European Environment Agency'classification, EUNIS, has 323 units in its first three hierarchical levels (see opposite).

– extraction of sedimentary rock, coal and oil – upon which it has built its societies.

By integrating humanity into the concept, there is a logical increase in the number of interactions linking ecosystems and human populations; but also in the number of points of view on the question. The key to unifying opinion could be in accepting the scientific definition of the term, the main cause of its enormous appeal. ■

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In figures

■ Man has 20 000 to 25 000 genes. A poplar tree has 45 500 and the fruit fly over 16 548.

■ 2 million species have been described (excluding bacteria and viruses).

■ It is estimated that 3 to 6 million species actually live on earth (excluding bacteria and viruses).

■ In four years, 530 species have been added to the red list of the IUCN: i.e. 132.5 per year.

■ 1 single biosphere exists: Earth.

Habitats at a European Scale

The term 'habitat' has come to be used in many European languages recently and its use in languages other than English owes much to the 1992 European Habitats Directive. In the fields of nature conservation and biodiversity its most common meaning is a group of animals and plants in association with their environment. It is very close to the concept of 'biotope' and the two are often used as synonyms.

With the progressive implementation of environmental programmes and laws during the 1990s the European Commission became aware of the need for a classification system covering terrestrial, coastal and marine habitats in the European Union. The CORINE biotopes classification was developed as part of the CORINE (Co-ordinated Environmental Information) project and is a hierarchical classification covering all habitats within the then 12 countries of the European Union. Later, the Council of Europe produced the Palaearctic classification, which covers the whole of Europe. Although these classifications were useable, they suffered from some inconsistencies, and particularly from the lack of clear criteria to define the habitats. When the European Environment Agency was established in 1994 a new classification was developed by a group of experts from the two previous classifications. This was the EUNIS habitats classification, a part of the EUNIS information system (European Nature Information System). EUNIS redefined the first three levels of the hierarchy for terrestrial habitats and the first four levels for marine habitats with all criteria used in the definitions clearly explained. The lower levels of the hierarchy correspond to those of CORINE-biotopes and the Palaearctic classifications.

Contrary to a widely held notion, the list of habitats of community interest, more commonly known as the habitats of Annex I of the Habitats Directive, is not a habitat classification. It is a selection of habitats considered by experts to require particular attention at a European scale. With the addition of new member states in 1995, 2004 and 2007 the list has been amended. The majority of habitats are defined using the Palaearctic classification.

Doug Evans

A recipe based on ecosystems

By Lisa Garnier

Take a plant community, add animals and microorganisms, mix through gently with the ambient habitat, water, air and rocks. Let it act dynamically so that interactions proliferate at all scales. The ecosystem is ready.

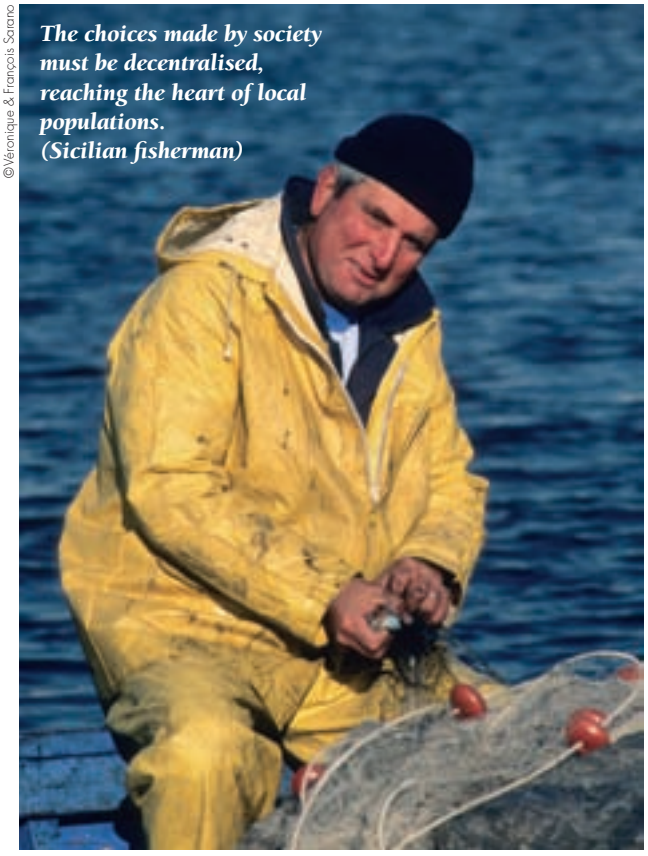
This recipe, poorly known to the general public, includes a vital function of life on earth: interaction – or interrelationship, or even reciprocal relationship. Whatever the expression used, it is now known that the relationships between man and nature are the fruit of multiple interactions, which should be a subject of concern if each entity is to be sustainably maintained (see the article by I. Dajoz on p. 22). It was from this idea that the ecosystem approach was born.

On land and at sea

Its application is only at its beginnings. Adopted at the conference of the Parties to the Convention on Biological Diversity in May 2000, it is now the driving force behind the Biosphere reserves. In 2003 the FAO instigated responsible fishing practices by publishing a document on the ecosystem approach to fisheries. In 2007, the French Research Institute for Exploitation of the Sea (Ifremer) followed suit. Even the Health Service is taking an interest (see box on p. 21). In industry, industrial ecology has seen the light, considering its activities as particular ecosystems, characterised by flows of matter, energy and information. In places all over the world, the Ecosystem Approach has found followers. But this does not mean that it is always applied correctly.

By acknowledging that human beings and their cultural diversity are an integral part of ecosystems, the method suggests that the management of land, water and living resources obviously depends on society's decisions and must therefore be decentralised and brought as close to the base as possible: a solution difficult to accept for some. Its great advantage is that it is completely independent of the scale,

Responsible fishing, showing greater respect for the seabed in the 21st century?



The choices made by society must be decentralised, reaching the heart of local populations. (Sicilian fisherman)

the ecosystem being, by definition, exempt of any notion of scale. A leaf, a flowerpot, a factory or a mountain for instance can all be dealt with as an ecosystem.

A glimmer of hope

In a world where the exhaustion of resources, the erosion of the land and global changes all affect human populations, the ecosystem approach could give a glimmer of hope. In particular, we can mention the fusion of two formerly opposing notions: preservation of nature and socio-economic interest. But, note that the elegance of the words must not mask all the work that lies behind them. Firstly, it should be clear that each decision must be taken bearing in mind the local biological diversity, which is a source of goods and services on an economic and social level. Agriculture, fisheries and forestry should therefore maintain close communication – to satisfy the principle of interrelationships – in order to pool experiences and thus progress by each taking the objectives of the others into consideration. And if the approach assumes that the services given by the ecosystems must be equitably redistributed among the populations, it is also because we now know that the links between poverty, underdevelopment, the environment and natural resource management are all closely interwoven.

Maintaining or improving ecosystems and productivity so that the production of their goods and services is maintained and even improved for present and future generations: that is the challenge taken up by the ecosystem approach. Will the recipe be a good one? All depends on the last ingredient: humanity's willingness to be reconciled with nature. ■

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Development through health

The EcoHealth approach of the International Development Research Centre (IDRC), whose head office is in Canada, is based on an ecosystem approach. It recognises that the inextricable interrelationship between humans and their biophysical, social and economic environments has direct repercussions on human health. With over 6.6 billion people on earth, the approach accepts that it is difficult to ignore humans as stakeholders of ecosystems. Moreover, in spite of the progress that has been made, environmental factors still dramatically affect the health of numerous populations, According to the WHO, the environment has a significant effect on over 80% of the main diseases. The IDRC supports positive actions on the environment to increase well-being and improve the health of the communities. One of the basic assumptions of the EcoHealth approach is that the programmes it instigates will be less expensive than health care. L.G.

The importance of interactions

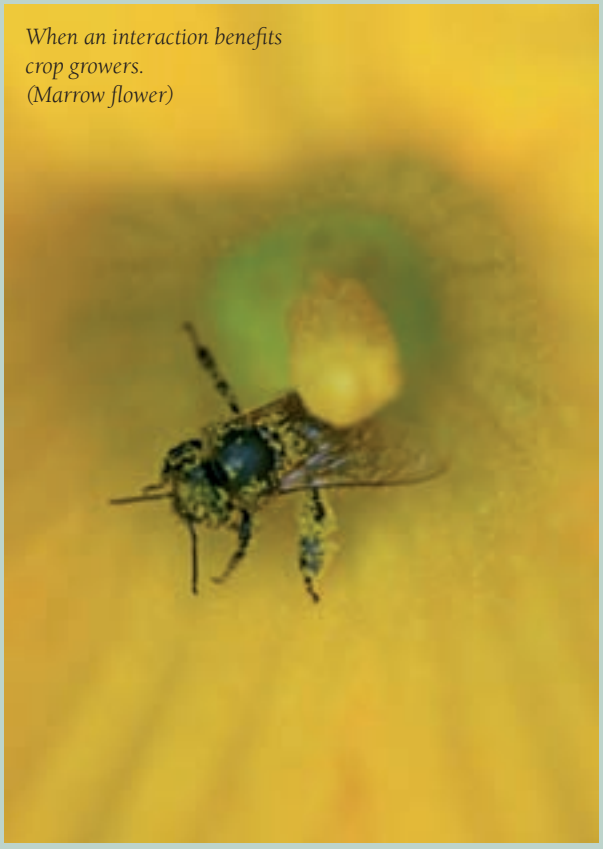
There is increasing evidence for the importance of species diversity in ecosystem processes. Although many studies tend to remain rather theoretical, an increasing number of experimental approaches are coming closer to the way real ecosystems operate. Interaction webs, which can be trophic – predation, parasitism – or not – symbiosis, mutualism – are no longer linked to a single trophic level but to several.

Higher plants are very suitable models to illustrate these ideas; as sessile organisms, they grow both above and below ground. They therefore participate in a multitude of symbiotic and mutualist interactions with varied organisms – from microorganisms: bacteria and fungi – which live in symbiosis with the roots, to the animals that pollinate the flowers. These symbiotic interactions with soil microorganisms are very relevant to agriculture (in particular to leguminous plants) and forestry (trees with mycorrhiza, that also enable wild mushroom harvesting). Each species of plant has one or sometimes several strains of fungus, with which it establishes an efficient symbiotic relationship – usually leading to an enhanced mineral supply. It has been recently demonstrated that the more different strains of fungi there are associated with roots, the greater the number of higher plant species in the community. This suggests that a highly diverse soil fungus microflora is necessary for each species of plant to survive in a plant community.

Intermixed networks

Also, the biodiversity of the web of interactions between plants and pollinators seems to play a determinant role in the long-term survival of a plant community. A high density of pollinators is not enough to ensure the reproduction of all plant species, what is essential is the diversity of pollinators present. So, the greater the number of plant species in a plant community, the more sensitive it is – in terms of extinction probability for each of its species – to a simplification of the web of interactions with its pollinators. In summary, plants are extremely sensitive to a loss of biodiversity in their pollinating fauna. The importance of biodiversity, in the way interaction webs operate, also acts indirectly by linking different compartments of an ecosystem, joining non-adjacent trophic levels and even joining different ecosystems. A study showed how a link existed between the biodiversity of pond fish and the reproductive success of plants in

When adult, the dragonfly is a fearsome predator for pollinating insects.



When an interaction benefits crop growers. (Marrow flower)

© Stéphane Durand

the surrounding meadows. When the ponds contain species of fish preying on dragonfly larvae, the density of adult dragonflies decreases. Adult dragonflies feed on airborne insects, and in particular on pollinators. If the density of adult dragonflies is lowered, there will be more pollinating activity on the flowers and the plants will reproduce better.

Humans, foxes and guano

But, finally, how do human activities affect the biodiversity of interaction webs. At the start of the 20th century, in several islands of the Aleutian archipelago, man introduced the fox for the fur trade. Foxes feed on the colonies of seabirds that nest on the islands. The birds feed on fish and fertilise the soil with guano rich in minerals coming from the ocean ecosystem. In the islands where foxes were introduced, the density and the biodiversity of the populations of seabirds rapidly declined, reducing the input of minerals from the guano. In the space of a few decades, the primary production of these islands became negligible. On islands where foxes have not been introduced and thus the interaction web not disturbed, plants continue to show strong growth. The high primary production in turn sustains very diversified primary and secondary consumers. The introduction of foxes therefore led to drastic modifications of the landscape and the species diversity on the islands.

Another example is the generalisation of intensive agriculture, which has led, *inter alia*, to a decrease in pollinating insects. In nine species of cultivated plant – including the tomato, coffee and sunflower – it has been proven that crop yields decrease with increased fragmentation and degradation of surrounding habitats, which are then home to fewer species of pollinator.

According to ecologists David Hooper and Peter Vitousek, the degradation of ecosystem processes resulting from a loss of biodiversity is mainly due to a reduction in symbiotic and mutualistic interaction webs. In any case, the disappearance of species leads to a simplification of the webs. In the future, it will no longer be possible to ignore these interrelationships between living entities, which are now recognised as playing an active role in the stability and the durability of ecosystems.

Isabelle Dajoz

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Nature and its resources

By Lisa Garnier

In his conquest of earth, man has learned how to tame and control many of the natural elements. Stone, fire, plants, animals, iron, coal, oil. Each time, these resources acquire a certain value, implying exchanges or trade. Since the end of the 20th century, man has entered into a new era: that of taming genes. While knowledge is progressing rapidly, revealing the astounding diversity of species and wild populations, only a few plants – 15 out of the 100 or so currently domesticated – are used to feed the great majority of mankind.

Man is tempted to take "old" to make "new".

High-yield agriculture, in conjunction with increasing demand and strong economic constraints, has led to many local varieties being abandoned. This trend has accelerated over the last decades. At the same time, more economically profitable varieties have been developed through man's understanding of the laws of genetics. But, these species are generally rather fragile. Selected on the basis of their high yield, they have proved to be less resistant to the vagaries of climate, bacterial and viral diseases and attack from predators. Requiring ever-increasing inputs in the form of pesticides, fertilisers and antibiotics, they are now being criticized for the many types of pollution they cause. To reply to these problems, genetics is again at the forefront. In particular with the creation of genetically modified

Rural populations have long used peat bogs to provide game, fruit, animal fodder and peat for fuel. (Vosges du Nord-Pfälzerwald Biosphere Reserve)

What does 'genetic resources' mean?

A genetic resource is a good that is both material and immaterial. It is the combination of what we now call "genetic information" and the physical sample in which this information is contained (in the form of seed, fragments of plants, living animal tissue, sperm, cultures or microbial suspensions). It can result from human intervention and/or adaptation to environmental constraints.

organisms, which represent the ideal solution. Producing plants that resist their predators will indeed reduce the use of pesticides. But, in terms of human health and impact on the genetic diversity of wild species, genetically modified plants have yet to prove their worth. Another solution would be to return to the gene stock of domestic species and even to the wild species that were the ancestors of current varieties. Unfortunately, many of those that remain are disappearing.

A potential for the future

Man is therefore tempted to take "old" to make "new". He must use genetic sequences laid down in the genome of domestic varieties a long time ago in an attempt to respond to current needs in terms of crops and livestock. Just like nature, man must adapt. His selections are, of course, for his own benefit but he uses all the resources available, all the possible genetic potential. This is why each species, whether domesticated or not, has a definite future potential.

So, although genetic resources have a real or potential economic value, they also represent an immaterial value. They are the guardians of genetic information, which ensures their potential. This particular situation, which is quite unique, was recognised as humanity's heritage by the FAO in 1983. It is a paradoxical situation however, as the management of the genetic resources was made the responsibility of each state. The Convention on Biological Diversity (1992) therefore encouraged these resources to become a marketable entity. Genes have become a resource almost equivalent to coal or water. The laws protecting intellectual property are one of the ways to survey the conditions in which these resources are used. But, the debate is wide open: firstly concerning the use of genetic resources and more generally of biotechnology.

Beyond the debate, actions to preserve genetic biodiversity, included in the overall notion of biological diversity, have not led to convincing results, as both domestic and wild species still exist in alarmingly low numbers. But, we may have forgotten the origin of genetic resources: the evolution of living things which, for domestic species, reflects cultural and territorial diversity. Many follow man's social and cultural values: traditional uses, techniques and craftsmanship that have to be encouraged. ■

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The management of genetic resources

Two management strategies are used: *in situ* conservation in the natural habitat (gene banks in fields, conservation on farmland) and *ex situ* conservation in orchards, seed banks or collections of vitroplants (plants conserved *in vitro*). In France, the Bureau for Genetic Resources – bringing together 6 ministries and 7 research organisations – has adopted a national charter for the management of genetic resources in France. It also participates in European cooperation programmes. Seed producers too have a part to play. During their selection activities, they maintain and enrich their working collection without which the creation of new varieties would not be possible.

L.G.

The main currents in environmental ethics

By Catherine Larrère

"*Is there a need for a new, an environmental ethic?*" In 1973, the article by the Australian philosopher Richard Routley – who later changed his name to Richard Sylvan – marked the start of moral and philosophical debate on the environment and the relationships between man and nature. Especially in English-speaking countries (Britain, North America, Australia), this went on to develop into a current of environmental ethics, with its different schools of thought, its peer-reviewed scientific journals, its associations and its congresses. In his pioneering article, the author describes an imaginary case: that of the last survivor on earth after a global catastrophe "Mr Last Man". Before he in turn disappears, he devotes his efforts to eliminating every living thing, animal or plant, that is around him. How should his acts be judged?

©Stéphane Durand

How do you see nature? (Torpa Stenhus, Sweden)

Limiting our opinion to that of the ethics that dominate in the western world – where the only rights and duties are those between man and man – he has done nothing wrong because he has wronged no one. But, if we consider that there are values in nature and that we have a duty towards them, his act becomes morally reprehensible.

Nature as a whole entity

The environmental ethics that evolved in the wake of this article developed around the central notion of intrinsic value - that of natural entities or of nature as a whole. The expression "intrinsic value" was used by Kant: for him, every being whose existence in itself is an end in itself – that is humanity and more generally, rational beings – have intrinsic value. All the rest is considered as a means, as an instrumental value. Environmental ethics will refer to this position as "anthropocentric". It only recognises the moral dignity of humans excluding the rest, i.e. nature, which is considered simply as a set of resources. What environmental ethics aim to reach is the opposite i.e. to show that natural entities also have moral dignity and "intrinsic values".

The idea is that where there are means, there are necessarily ends. All living things, from the simplest to the most complex, whether they are animals (even lacking sensitivity), plants or monocellular organisms, all maintain themselves within existence and reproduce. They do this by using complex adaptive strategies, which are all means to reach an end. There are therefore ends in nature. All living beings can be considered as the functional equivalent of a set of intentional acts, like something that is "an end in itself". The opposition between humans and things, characteristic of anthropocentrism, becomes substituted by a whole range of teleonomic individualities which can all lay claim to being ends in themselves and therefore to having an intrinsic value. Any

living individual is, being equal to any other, worthy of moral consideration: this is what is called biocentrism, its standard-bearers are Paul Taylor and Holmes Rolston.

Biocentric environmental ethics thus recognise an infinite number of individual wills-to-live at work in the whole of nature. These ethics transfer to life, and to all that is living, the moral dignity that the ethics of Kant confer to free beings. This justifies an attention to living things that has rapidly gained supporters. The 'intrinsic value' has become the war cry of numerous nature protection activists. The preamble to The Rio Convention on Biological Diversity (1992) stressed the "intrinsic value of biological diversity" underlining the importance given to the intrinsic value.

It's in our own interests to preserve the resources that we find in nature.

From bio to eco-centrism

However, this biocentric ethic can be criticised in that it does not satisfy the requirements of the protection of nature. It only grants value to individual entities while the general aim involves protecting populations. It only takes account of living entities whereas ecosystems, the focus of nature protection, also contain abiotic components. Some environmentalists, such as Baird Callicott, consider that value should be attributed not to separate elements but to the whole that they form; the "biotic community". This approach, known as "ecocentric", is attributed to an American forester in the first half of the 20th century, Aldo Leopold, whose book A Sand County Almanac presents environmental ethics that Leopold names "Land Ethic" which can be summed up in his maxim that "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community; it is wrong when it tends otherwise."

Whether they are biocentric or ecocenrtic, it is reasonable to expect that these moral positions, which confer an intrinsic value to non-human entities, will not be found generally acceptable by all. Certain philosophers, such as Bryan Norton, have noted that in spite of any philosophical divergences, environmentalists generally agree as to the practical approaches towards the protection of nature. They apply a more pragmatic approach which considers that convergence of the results requires finding a common ground for agreement. This "extended anthropocentrism", also known as "weak anthropocentrism" questions the distinction made between intrinsic value and instrumental value by showing that the criticisms of anthropocentrism are based upon much too narrow a conception of what is instrumental. We do not see that nature cannot simply be reduced to a set of resources ready to be consumed or destroyed. It is in our own interests to preserve the resources that we find in nature. This is true for the services that it provides (e.g. pollination of plants, recycling of waste), for its scientific interest (naturalists should try to preserve the object of their work), but also for its aesthetic interest or religious interest. We wish to preserve the nature that we admire, that we love, that makes us feel better people. This attitude, which is philosophically less demanding, and easier to understand, also presents the advantage of taking into account the dimension of time – it is for future generations that we are doing this – and hence aligns more easily with the demands of sustainable development. ■

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Scientific models for the protection of nature

By Catherine Larrère

It was in the second half of the 19th century that the industrialised nations, on both sides of the Atlantic became aware that nature needed protecting. Until then, the subject had received no deliberate attention; there had been no coherent programme. In Europe, and particularly in France, the primary concern was to preserve landscapes – the "artistic series" of Fontainebleau were protected by measures taken in 1853, 1861, 1892 and 1902 – as being of exceptional patrimonial, cultural and artistic value. In the United States, attention was more directly focused on the protection of nature in the wild state, nature which the westward expansion of the pioneers was tending to shrink. In 1864 Lincoln took the decision to protect the Yosemite Valley in California, which was followed by the creation, on March 1st 1872, of the Yellowstone National Park. This was to become the major element of a vast network of 36 national parks covering 1% of the surface of the territory of the USA. In Europe, it was only after the Second World War that similar concern was paid to the protection of natural spaces.

On one side, the wise-use advocates, on the other the untouched wilderness defenders.

But, although North America played a pioneering role, this never led to a unified philosophy of the protection of nature. In fact its history was marked by the split of two of its founders: John Muir and Gifford Pinchot.

An idyllic relationship becomes a schism

All started well in the beginning. When they met in 1896, during a National Forestry Commission survey, Muir and Pinchot shared the same love for nature and this led them on long treks through the forests together. But their friendship was not to last. The two men had different backgrounds and although they shared the same desire to save the forests from being clearcut, they did not have the same approach. Pinchot was a forester who had received his training in Germany and in France. He had learned the methods that the Europeans used to regenerate and maintain forest cover, which had strongly diminished since the Middle Ages, jeopardising the ability to satisfy the ever-growing need for wood in Europe since technical development, fuelled by military and economic growth, was accelerating. On his return to the USA, where he would later found Yale University's School of Forestry, Pinchot attempted to ensure the renewal of the resources available for national development by applying rational management techniques to forestry based on scientific knowledge. He was not against the use of the forest for man's needs but was against its abuse. He denounced the egotism of those who had trees removed for their personal profit, and called for the "wise use" of the forest resources for the good of the whole nation and not for a minority of private interests. In Pinchot's view, the end was economic, and his reasoning was utilitarian.

Considering a forest as a reserve of resources at the disposal of economic development was, for John Muir, like transforming a Gothic cathedral into a warehouse. His thoughts are reminiscent of the transcendentalist principles of Henry David Thoreau and Ralph Waldo Emerson, of whom he was a disciple, praising the spiritual, aesthetic and religious value of nature. But, his dispute with Pinchot made him take one step further and led him to clearly state that nature had an intrinsic value which he wanted to preserve. It was because of love of nature itself, nature preserved in its original purity – the wilderness – that its destruction or modification had to be forbidden. He opposed Pinchot who was in favour of letting sheep graze in the forest, he was violently against the idea that access to the forest be granted to what he called "hoofed locusts".

This was how the movement for the defence of nature became divided. Under the "Conservation" flag were those who, along side Pinchot, defended "wise use" – the use of forests

in such a way as to manage the resources sustainably. Under the "Preservation" flag were the supporters of Muir, the defenders of the wilderness untouched, to be totally preserved. On one side then, there was a concern for rational efficiency, both technical and economic, with an explicit reference to utilitarianism, i.e. the moral philosophy which transposes the quest for individual well-being to society as a whole. On the other side, was the concern for nature, sentimental and religious, which gained impetus from the American version of the romantic movement, be it in the form of Emerson's or Thoreau's transcendentalism, the American artists painting the sublime, such as Thomas Cole, or the poetry of Walt Whitman.

The birth of moral philosophy

This duality was not restricted to the USA. It also split Victorian Britain, opposing the romantic vision of John Ruskin, a critic of industrialism and defender of an idyllic vision of nature, with the position of John Stuart Mill who defended a moral utilitarian philosophy. But also, as an economist, Mill was a partisan of the stationary state: a state which is opposed to growth, being at the same time concerned with the protection of nature to which however he refused to grant any moral value whatsoever. More generally, the question arises as to whether this duality is not a basic component of ecological sensitivity. Donald Worster traced out the genealogy when he distinguished, at the very origins of ecology in the 18th century, two opposing perspectives: the vision of Arcadia of Gilbert White, a country vicar and the rational management programme of Linnaeus, that of an "economy of nature".

Subsequently these two currents, preservation and conservation, went through various ups and downs. John Muir was not only the founder of the Sierra Club, one of he most powerful organisations for the defence of nature in the USA, he also became the inspiration for contemporary environmental ethics. These ethics developed in the USA and more generally in the former British colonies in the late 1970's and focused on two questions raised by Muir: that of the intrinsic value of nature – as opposed to its purely instrumental value at the service of human needs – and that of the "wilderness" as a model of nature to protect. What came out of this was an original moral philosophy, known as either biocentrism or ecocentrism, attacking what it called "anthropocentrism" (see the article by C. Larrère on p. 26).

The heritage of preservation is not only theoretical. The Wilderness Act of 1964 – a public law fixing the rules for the protection of nature

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Nature preserved in its natural purity, that's the notion of untouched wilderness. (Mercantour national park, France)

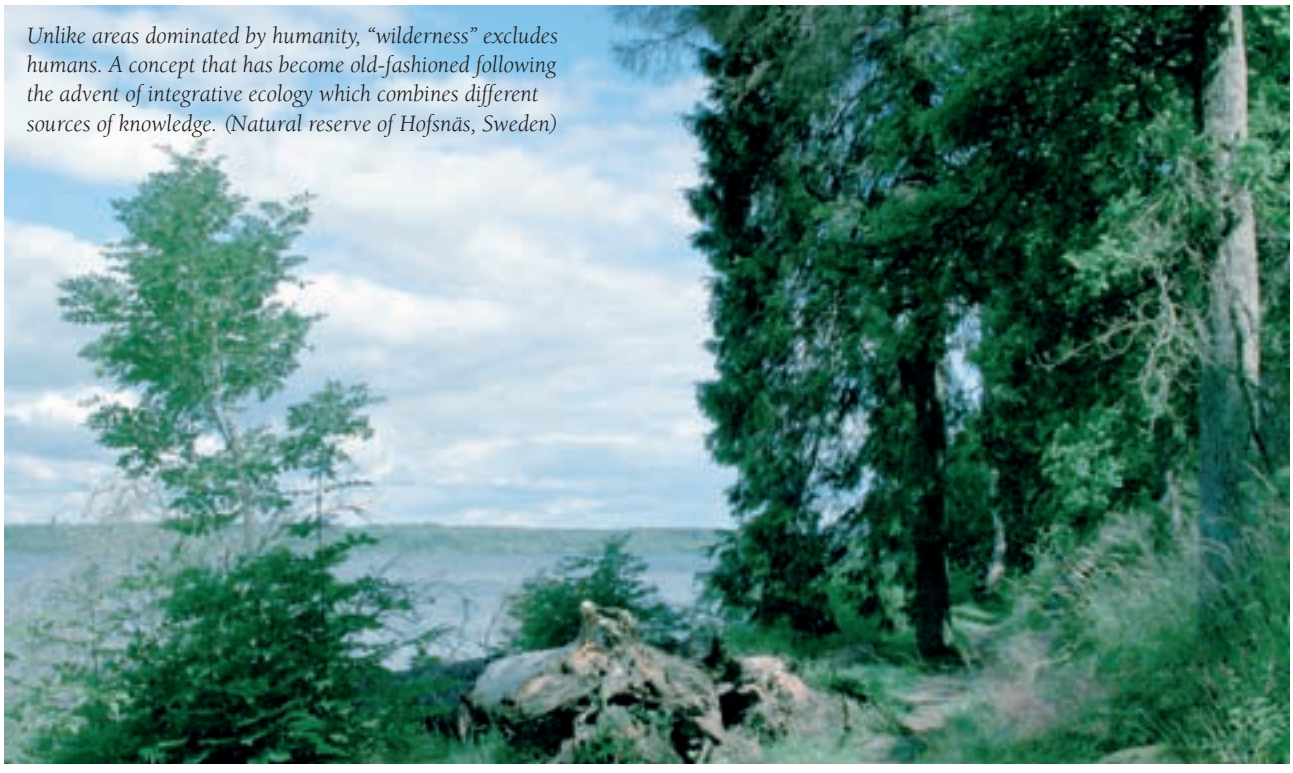
– embodies the victory of the supporters of preservation, involved in drawing up the law, over the supporters of conservation. The act gives the following definition "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

The document continues, stating that the "wilderness" as it is defined, must retain "its primeval character" and that it is protected and managed in such a way that it "generally appears to have been affected primarily by the forces of nature". Nature then appears like a radical otherness, which must be preserved form being trampled by humans, who can only be harmful.

Preservation versus conservation

But, although they have been overcome in the US nature protection movement by preservationists, conservationists have succeeded outside the US, their position now being dominant worldwide. From the fifties, one of the largest international NGOs for the protection of nature, currently known as IUCN (International Union for the Conservation of Nature) has in fact adopted C (for conservation) to replace the original P (for preservation). Gifford Pinchot who, unlike John Stuart Mill was not a supporter of the stationary state but upheld the principle that "the first great fact about conservation is that it stands for development", could possibly be considered as the instigator of the sustainable development ethic. He was without doubt one of the first to clearly express concern about future generations when he adapted the classical dictum of utilitarianism "the greatest happiness of the greatest number" to include the notion of duration "the greatest good, for the greatest number, for the longest time". The definitions of sustainable development (both those of Brundtland's 1987 report, which made the expression "official", and those of the Rio Declaration) did not use the term Nature and only spoke of the environment as of a need. These definitions are clearly anthropocentric and just consider the instrumental value of nature, absolutely not the intrinsic value. Must it necessarily be concluded therefore that the victory of the principle of sustainable development parallels the abandonment of the more radical objectives of nature protection which in turn would be finally sacrificed to human egotism?

However, the opposition between conservation and preservation may be neither irremediable nor unalterable. The opposition is especially



Unlike areas dominated by humanity, "wilderness" excludes humans. A concept that has become old-fashioned following the advent of integrative ecology which combines different sources of knowledge. (Natural reserve of Hofsnäs, Sweden)

clear when keeping to a static vision of nature: a vision with balances to preserve, to which the ecological notion of "climax" can give body. Here, man is excluded from nature, leaving nature to find its equilibrium state. It is this concept of the protection of nature that was dominant as long as the reference used was the systematic ecology introduced by Arthur G. Tansley and generalised by Eugene and Henry Odum in Fundamentals of ecology (1962). The vision of nature in equilibrium with the great regulating mechanisms of circulation of the fluxes of energy guided a protection of nature regulated by a principle of "naturalness": the reference is nature in a spontaneous state kept isolated from man. The idea is therefore to protect existing equilibria (the climax being taken as the ideal ecosystem), to preserve the integrity of ecosystems by setting them aside from human disturbances, and to let the dynamics of secondary successions lead back to the climax after abandoning exploitation.

The opposition between conservation and preservation may be not irremediable.

Ecology becomes dynamic

But, conservationists were not always wrong to reproach preservation supporters for locking up or freezing the natural spaces that they intended to protect. A more dynamic vision of nature became predominant from the 90s on. Distancing themselves from the Odum-type ecology that focussed on the "balances of nature", scientists tended to adopt a dynamic concept of ecology, integrating disturbances as factors acting to structure the biotic communities. It became acceptable to consider that our surroundings are the product of history – that of the disturbances they, or the environments with which they interact, have undergone. The varying degrees of species richness, just like the mosaic structure of ecosystems therefore result from a historic process where disturbances of natural origin act in conjunction with disturbances of human origin. This transforms the way in which human activities are perceived since disturbance caused by man is not necessarily more disastrous than natural disturbances. If nature has a history and co-evolves with human society, man can no longer be considered as the great disturber of natural balance. Human activities and human productions can now be integrated into the global picture of ecology. In parallel, various specialist fields are developing such as landscape ecology and conservation biology which together lead to the discipline of ecological engineering. This discipline enables the restoration of environments, the orientation of biotic community dynamics, the reinforcement of certain populations or the reintroduction of species that have disappeared from a particular region. The aim of ecology has now become to assist nature in managing itself. The aim is no longer necessarily to let specific environments dwindle while forest claims more space for itself: open areas can be maintained and biodiversity kept richer.

The concept of "the wilderness" has played an important role in the history of the protection of nature. It certainly still has its supporters although the point of view is difficult to uphold. It is strongly criticized in North America where it led to the protection of natural spaces after the expulsion of the Indians who lived there. It cannot be applied in most non-western countries where the creation of natural parks based on the wilderness model would in fact consist of creating leisure space for western tourists from which the local populations would be excluded. It does not make much sense in Europe where the last primary forests disappeared long ago and where the driving force for creating natural parks has never been wilderness protection. The objectives of biodiversity management do have the merit of ending the opposition between man and nature, an opposition that the wilderness ethic tended to dramatise. They also seek to identify the possible different ways of reaching a happy coexistence of man and natural spaces. This objective is not only grounded in current scientific knowledge but also allows local knowledge to play its role. Integrative ecology practices can be in phase with the aims of sustainable development without sacrificing the protection of natural spaces. ■

Nature conservation over the years

By Marie Bonnin

The protection of Nature is not a modern phenomenon. The first measures taken can be seen in the beliefs and ideologies of antiquity. Felling, pruning or even transplanting a sacred olive tree was, for instance, strictly forbidden in Greece. However, it was only in the 19th century that the first treaties on the protection of species saw the light.

It was during this period that the international community started to ask questions about the dwindling stocks of sea mammals. The main question in fact concerned the economic future of those exploiting them. The first international agreement covered the seals of the Bering Sea and was therefore the first measure signed to protect an economic resource. Then came the treaty on the preservation and protection of fur seals (Washington, 1911) and the first whale convention (Geneva, 1931). However, these wild species were only protected by international law when they were outside territorial waters.

At the beginning of the 20th century, the protection of species useful to man had made its appearance on the international scene. Some conventions, such as the Convention for the Protection of Birds Useful to Agriculture (Paris, 1902), or the Convention on the Preservation of Wild Animals, Birds and Fish in Africa (London 1900) presented the particularity of classifying species according to whether they were useful or considered as pests. Pests could be destroyed.

The protection of nature for itself without taking into account the immediate benefit for man was first heard of in the 20th century. The International Convention for the Protection of Birds (Paris 1950), laid down the general principles of the protection of birds. Any utilitarian references, like there were in the Convention

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The first convention for the preservation of wild animals, birds and fish in Africa dates from 1900.
(Elephants in Etosha national park Namibia)

for the Protection of Birds Useful to Agriculture (Paris 1902), disappeared completely.

After the first steps, more were to be taken, and in these pre-war years, international law concerning the environment turned to protecting remarkable landscapes. The convention concerning the protection of nature in Africa (London 1933) was the first of its kind. It obliged the signatories to establish strictly protected national parks and natural reserves.

Several regional conventions of the same type followed. They adopted the same objectives. The world heritage convention (Paris 1972), however, stood out owing to its "world" aspect. It brought together both cultural and natural heritage. However, granting the areas concerned "outstanding universal value" status, from an aesthetic or a scientific point of view, only had a limited effect on nature conservation.

A new turn in the law

The 1970s marked a real turning point in the ideas underlying nature protection. Habitats were to become protected to maintain the quality of the environment in which species lived. The convention concerning Wetlands of International Importance (Ramsar, 1971) is a well-known example. It was from this moment onwards that international nature protection conventions sought to protect the habitats of endangered species while conserving natural habitats for their functions. Protection started to become more universal. The Agreement on the Conservation of Nature and Natural Resources (Kuala Lumpur, 1985) notably imposed on the contracting parties that they maintain maximal genetic diversity everywhere possible. The protocol concerning protected areas (Nairobi 1985) to The Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region also stipulates "Contracting Parties shall take all appropriate measures to maintain essential ecological processes and life support systems, to preserve genetic diversity, and to ensure the sustainable utilization of harvested natural resources under their jurisdiction." And, in addition to being universal, the protection also tends towards greater territorial coherence. Preserving a fragment of nature within a strictly closed area is not satisfactory if, in the surrounding area, uncontrolled activities take place that threaten to damage ecological processes. So, numerous conventions attempt to encourage the contracting parties to improve the protection afforded by protected areas: it is recommended to set up a transition or buffer area, around the area to be protected. This is for instance the case of the Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. As the end of the 19th century approached, the isolation of habitats was increasingly recognised as being a major obsta-

The main international conventions for the conservation of nature

1902 - Paris
Convention for the protection of birds useful to agriculture

1950 - Paris
International convention for the protection of birds

1971 - Ramsar
Convention on Wetlands of International Importance especially as Waterfowl Habitat

1972 - Paris
The UNESCO convention concerning the protection of the world cultural and natural heritage

1973 - Washington
Convention on International Trade in Endangered Species of Wild Fauna and Flora

1979 - Bonn
Convention on the Conservation of Migratory Species of Wild Animals

1992 - Nairobi
Convention on Biological Diversity

1994 - Paris
Convention to combat desertification

©Véronique & François Sarano

Pinipeds were the first to benefit from international protection like these fur seals in the southern hemisphere.

cle for the conservation of wildlife populations, especially because it reduces genetic exchange. This process is particularly evident in the intensively farmed areas of north-west Europe but also occurs in other landscapes. The forest, for instance, where the management strategies employed to satisfy the demands for wood production lead to increasing fragmentation. This leads to the isolation of habitats and poorer biodiversity. The concept of ecological network has then become the preferred approach in nature conservation. The ecological network is defined as the set of natural areas enabling the long-term conservation of the wild species in a territory. It implies maintaining a coherent network of natural and semi-natural ecosystems. Ecological networks are generally considered to be composed of three types of zone: core areas, buffer zones and ecological corridors. The core areas ensure the environmental conditions required to maintain extensive ecosystems, habitats and animal or plant populations. They generally correspond to areas already protected by international, community or national law, where the measures taken can provide efficient protection or not. The role of the buffer zones is to protect the core areas from negative processes brought about by the activities going on outside the network. Finally, the main function of the ecological corridors is to link up the core areas in order to allow species to disperse and migrate. The integrated nature conservation approach therefore has the advantage over the simple protection of a given area of land governed by rules that are tend to be coercive. The advantage is heightened by the choice of new tools and the possibility to act at different decisional levels enabling all the stakeholders of the territory to participate. Protecting, maintaining or reinforcing biological diversity by setting up protected zones does, however remain a fundamental tool in nature conservation. However, the species, populations and habitats that were traditionally the sole goal of protection, are now considered to only be components of open, dynamic and heterogeneous ecological systems. In this period of

Preserving a fragment of nature within a strictly closed area is not satisfactory.

Diversity in European vocabulary

The expression "ecological network" is not used systematically in all the countries of Europe. Belgium calls it the Principal green structure, in Estonia it is the network of compensating areas, Lithuania refers to a system of ecological compensation areas and finaly Slovakia and the Czech republic talk about a territorial system of ecological stability.

For the different reserve areas, Estonia uses the terms core area, buffer area and ecological corridors, Lithuania uses the Geo-System terms buffer territories and ecological corridors, for Poland there are core areas and eco-corridors. The Slovakian and Czech networks are made up of bio-centres, bio-corridors and interactive elements.Finally, the Benelux countries distinguish core areas, areas of reconstitution and ecological corridors.

globalisation and taking universal phenomena into account, nature is entering a new era: that of universality. The laws will have to change accordingly. ■

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In spite of international conventions being signed to protect them in the 1930s, whales are only protected in international waters. (Fin whale)

The particular case of biosphere reserves

By Mireille Jardin

At an international level, the World Network of Biosphere Reserves is administered on the basis of two texts adopted in 1995 by a resolution of the UNESCO General Conference: *The Seville Strategy* and the *Statutory Framework*. Before that date, biosphere reserves were simply a project, more precisely the eighth, in the larger programme on Man and the Biosphere (MAB) initiated at the end of the 1970s.

Unlike a convention, neither of these two texts is legally binding. However, it can be considered that as they were established by consensus and adopted by the UNESCO General Conference, so UNESCO Member States are bound to honour them.

The Seville Strategy describes the goals to be reached in the fields of conservation, development, research and education, i.e. the three functions of Biosphere reserves. The strategy makes recommendations to achieve the objectives and defines implementation indicators. As its title suggests, it is a strategic document and its role is to guide.

The Statutory Framework, on the other hand, fixes the rules of the game. These rules have been debated, through sometimes-difficult negotiations, and established over a good number of meetings. They are also the fruit of a broad consultation by correspondence, allowing numerous amendments to be made. During the Seville Conference (1995) the text was reviewed and discussed before being submitted to the International Coordinating Council of the MAB where it was again amended.

All these stages showed that the Member States – and at that time even non-member states, because the USA participated actively in the discussions – were favourable to applying the provisions of the agreed text, including compulsory periodic review. None of the States involved have ever disputed this point.

Biosphere reserves are much more than just protected areas.

The official designation of a Biosphere reserve, by the MAB Council, after examination of the proposition by the Advisory Committee, represents both recognition of the correct implementation of the concept and admission of the site into the world network. It is interesting to note how the Seville Strategy and the Statutory Framework are complementary. The explanations and recommendations of the Strategy can often be used to enlighten and illustrate the provisions of the Statutory Framework. This is particularly the case for the provisions that concern the definition of Biosphere reserves: the three functions (article 3) and the criteria (article 4). If these criteria often appear to be vague, this is in fact due to the great variety of situations that must be covered and the Member States' needs for flexibility.

As stressed in the Statutory Framework and in "The Vision From Seville", " Biosphere reserves are much more than just protected areas." In other words, they have progressively become actual sites for the demonstration of the principles of sustainable development. This is what has led to the difficulties in incorporating the Biosphere reserve concept into national legislations for protected areas. The same is true for classifying Biosphere reserves in the categories of protected areas established by the IUCN.

Elements of the Statutory Framework

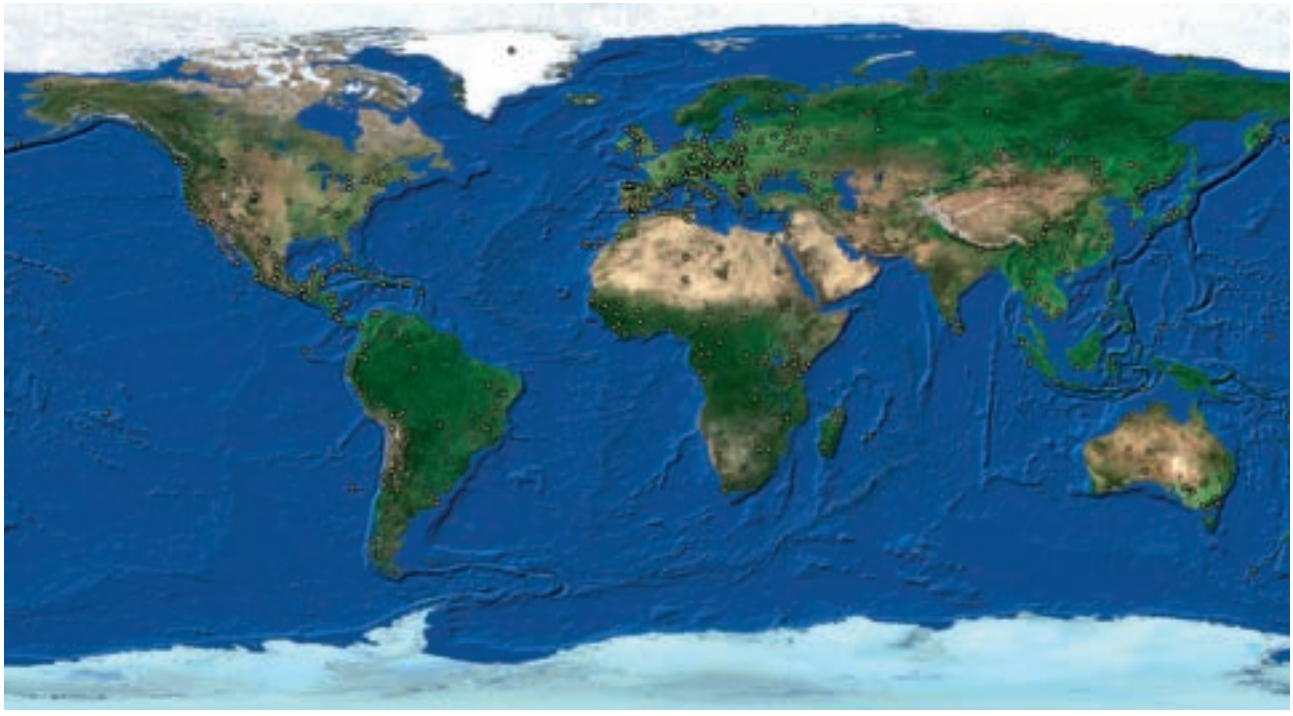
Definitions and criteria (articles 1 to 4)

Designation procedure (article 5)

Obligations of the individual states to promote their biosphere reserves (article 6), to participate in the World Network (article 7) and to participate in the regional and thematic subnetworks (8)

Submission to periodic review, every ten years (9)

Secretariat functions (10)



There were 502 biosphere reserves in 2007. Spread over the whole globe, they reflect the diversity of ecosystems.

The founding principles

■ The three functions (conservation, development and logistic support) and their complementarity. The key element here is that the three functions must be combined (article 3) implying that they provide each other mutual support. Also, the three functions are accorded equal importance: no function predominates over any other. The integrated approach is encouraged.

■ Zonation is related to the three functions without overlaying them. A single zone must be covered by legal protection: it is the core area (or areas), which are usually composed of a protected area of the "full reserve" or "national park" type. The buffer zones are mainly defined by their contribution to the conservation objectives. Finally the transition area is more directly devoted to development and sustainable resource management. The way the zonation is applied varies with the context: many biosphere reserves are composed of a mosaic of protected areas, with various degrees of coercive status, and of areas without protected area status, which make up the transition area.

■ Participative management, as allowed for in the statutory framework and explained in the Seville Strategy, deals in particular with (Objective II.1: Secure the support and involvement of local people): the resolution of conflict, provision of local benefits, respect of traditional life styles and knowledge, maintaining cultural diversity, local uses of biodiversity, alternative sources of revenue and profit sharing.

■ From an institutional viewpoint, the Statutory Framework recalls that each Biosphere reserve must have an effective management policy or plan and an appropriate authority or mechanism to implement it. This is laid out in Objective II.2 of the Seville Strategy, which recommends setting up institutional mechanisms to manage, coordinate and integrate the Biosphere reserve's programmes and activities and to establish a local consultative framework: i.e. to allow participative management.

■ Programmes of research, monitoring, education and training must be set up. This is the so-called logistic support function. Objective III of the Seville Strategy describes the types of activity to be carried out in this respect. Biosphere reserves are designed to be sites for the demonstration of sustainable development approaches.

■ Finally, the Statutory Framework states in article 9 that each Biosphere reserve should be subject to a periodic review, every ten years, with the aim of inciting the authorities concerned to evaluate the general condition and the state of operation of their Biosphere reserve. The report, forwarded to the Secretariat, is submitted to the MAB Council which can recommend improvements, and, in certain cases, consider that the site no longer satisfies the criteria.

M.J.

And yet this broader vision of protection, the will to escape the mould of protected areas *sensu stricto* is becoming increasingly widespread. Now, means must be found to introduce the principles of biosphere reserves into the various legislations so that they become included in the policies of resource management and land-use planning. The main focus is the complementarity between conservation and sustainable use of the resources, the presence of people in the protected areas, access to the resources, participative management, profit sharing, etc.

Should biosphere reserves have their own legal status? From an administrative point of view, setting up a management authority would be easier for the whole of the territory concerned, even if certain areas have a "protected" status. Moreover, the Biosphere reserve could be granted its own budget and would be better equipped to receive international backing. Countries including Argentina, Brazil, China, Mexico, India, Madagascar, Mali, the Ukraine and recently Germany, have opted for this solution. Legally recognising biosphere reserves also comes up against some serious difficulties. The first is that these reserves are not simply protected areas. Their legal status should explicitly refer to a multifunctional area with human presence and with utilisation and land planning objectives. It should also foresee that a Biosphere reserve can be superimposed on existing or planned protected areas. A Biosphere reserve is both the application of a concept and an international designation. Inevitably, some biosphere reserves already established in national legislation are not included in the World Network as their country did not forward any nomination to UNESCO. This is the case, for instance, in India, China and Mexico, where national networks are active. However, remaining outside the world network is not a major issue in as far as the MAB concept is actually being implemented and disseminated. These reserves must be considered as national biosphere reserves.

To conclude, the legal recognition of Biosphere reserves in national law occurs in response to a more general evolution. The trend is towards a broadened concept of biodiversity conservation which should be encouraged whenever possible. It also corresponds to a tendency to draw up new biodiversity management policies that favour contractual tools rather than regulations. ■

The Mediterranean coast is particularly desirable for tourism and development. Legislation has been set up to limit and orient urban development in the area.

Law's first steps in nature protection

By Agnès Michelot

France has a broad range of tools to help in the protection of natural areas. They can be used to support the protection procedure, to enhance the powers granted to a particular territory, or to emphasise the objectives pursued on a particular site: areas that are, for instance, wooded, fragile or just rare. Each time, the legal structure can vary. For instance, conservation of rare and fragile natural areas has taken the shape of protection of sites representing a general interest from an artistic, historic, scientific, legendary, or picturesque point of view. The main procedures in France are not mutually exclusive: all can be combined in policies of land planning, development, and economic and social cohesion.

Legislative tools

These tools aim to preserve fragile areas that are under particular pressure: for example, mountains and the coastline. The idea behind French law N°85-30 of 9th January 1985 relative to the development and the protection of mountains was to protect the characteristic areas, landscapes and habitats of the natural and cultural heritage in eight designated mountain regions: Northern Alps, Southern Alps, Corsica, Massif Central, Jura, Vosges, Pyrenees, Reunion Island. The protection measures accorded by this law can be modified by local directives established in each mountain range, depending on particular local conditions. Law N°86-2 of 3rd January 1986 relative to planning, protection and valorisation of coastal areas also acts as a town planning law. It enables selected urbanisation, limited near the coast, and protects remarkable areas and the habitats required for the maintenance of ecological balance.

Legal protection

Legal protection offers a series of instruments that can be useful in certain territories with several levels of management. In this framework, the territorial planning directive fixes the choices made by the state concerning planning and achieving balance between the development objectives, protection priorities and the recognised value of the territories. Approved by Decree of the Council of State, the Territorial Directive then associates the relevant regions, *départements*, and possibly communes and groups of communes.

And around the world?

On a world scale, the protection of natural spaces is organised around various international conventions. The conventions lead the states to protect areas, sites, ecosystems or habitats that present particular ecological characteristics. Good examples are the Ramsar Convention on Wetlands of International Importance, the Convention concerning the Protection of the World Cultural and Natural Heritage, the Convention on the Conservation of Migratory Species, the Convention on Biological Diversity. One of the most successful of all programmes on an international level is UNESCO's MAB, which, although it does not have the force of a convention has led to the constitution of a large international network of national and cross-border reserves.

Regional initiatives support this global network of natural spaces, which is currently based on an ecosystem approach to conservation. In Europe, we can mention directive 92/43/CEE concerning the conservation of natural habitats and in Africa, the Convention on the Conservation of Nature and Natural Resources adopted in Maputo in 2003, in which the member states of the African union pledged to create or enlarge their conservation areas.

The World Conservation Union – IUCN – established an internationally recognised system for the classification of protected areas in which the states rank their protected natural areas depending on their management objectives. Community Conserved

Areas linked to local communities and native populations are encouraged. In addition, increasing numbers of natural spaces are run privately, or run as joint projects with public organisations or local communities. The terms of biological corridors, cross-border protected areas or ecological networks stress the variety of protection regimes that exist for the natural areas that have been established in relation with the development of international cooperation.

A.M.

Among the instruments, some were designed to provide more specific protection. Examples are the decrees for the protection of biotopes, biological reserves, game and wildlife reserves, fishing reserves, regional natural reserves, national natural reserves, national parks, listed sites and classified sites.

The aim of the decrees for the protection of biotopes is to prevent the disappearance of protected species in natural areas not heavily exploited by man. Here, 'protected species' are necessarily non-domesticated animals or plants. The decrees are made on the initiative of the state, which chooses the most suitable instrument for the protection objectives of the species concerned and for local conditions. They are under the responsibility of the Prefect.

Biological reserves instituted by joint decree of the ministries of the Environment and of Agriculture concern the areas under the control of the Forestry Commission (Office National des Forêts). The aim of these reserves is to ensure the conservation management of natural habitats that are particularly interesting or rare, of rare or endangered species and also other resources of the environment. This includes maximum protection reserves, which preserve habitat dynamics.

The game and wildlife reserves are decreed by the prefecture following a request by the party holding the hunting rights or on the prefect's initiative. Their aim is to protect populations of migratory birds, to ensure the protection of natural areas and to contribute to the sustainable development of hunting in rural territories.

National and regional natural reserves are created at the instigation of the administration or of associations for the protection of nature. They preserve endangered animal and plant species by removing any harmful activity. They contribute to the protection of ZNIEFFs (Natural Zones of Animal and Plant Ecological Interest), which were launched in 1982 to establish a national inventory of the ecological heritage of France.

The creation of the national parks satisfies a will to conserve habitats in their natural state. A reform was engaged by law N°2006-436 of 14 April 2006 relative to national parks,

The Mont Ventoux (France) is home to some rare species such as this alpine poppy.


©M. Rauch

The aim of the legislation covering the protection of the biotope is to prevent the disappearance of protected species such as the lynx.

marine natural parks and regional parks. The generalisation of charters, associating the local stakeholders, for the management of the protected areas illustrates how the legal context of national parks is approaching that of the regional parks.

Regional natural parks also involve a conventional approach. The charter project approved by the Regional Council is in fact the fruit of discussions between all the partners concerned. The parks participate in the policies of protection of the environment, town and country planning, economic and social development and are instituted for a maximum period of 12 years.

The conventional way

The conventional way proposes other legal tools for the protection of areas. They include Major Site Operations, country charters, Natura 2000 sites, which come from the 1992 EC Habitats Directive, conventions for the management of sites belonging to the state and also protection by contract.

Protection by contract is a voluntary approach by anyone having rights on a piece of land and who wishes to entrust the management and the preservation of the species that live there to another person.

Protection through planning permission

Protection through land ownership offers a series of possibilities by means of various techniques: acquisition, donation, legacy, exchange, etc. Regional conservatories of natural spaces, the Coastal protection agency, and various foundations and departments enable the sustainable management of selected areas in a perspective of preserving nature, the species, the habitats and the landscapes. Land purchases by the local authorities are frequent: by amiable agreement, by pre-emption and by expropriation. Natural areas can also be acquired by private organisations devoted to the conservation of nature. ■

Biodiversity law

Law is established by human societies. It controls the relationships between people and its purpose is not to preserve natural balance. But, in the 1992 Convention on Biological Diversity, biodiversity is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." Owing to the challenge put forward by the convention, the legal systems in place had to evolve. Historically, nature protection law only took into consideration the preservation and the protection of species and of their habitats and not genetic diversity or the diversity of ecosystems. In contrast, the Cartagena Protocol on Biosafety of 29th January 2000 illustrates one of the novel aspects of biodiversity law. What it attempts to do is to limit the potential risks posed by modern biotechnology and the spread of living modified organisms.

Biodiversity law now covers all the usual notions of nature protection with all the measures related to the identification and the management of activities and processes harmful to biodiversity. It includes rules covering various human activities involving taking and using species such as hunting, fishing, gathering and trade, but also the creation of protected areas, the protection of certain categories of animals and plants, the preservation of certain habitats and the integration of conservation objectives into, for instance, town and country planning objectives.

Biodiversity law also implies an inter-sector or even trans-sector approach. In practice, it must no longer simply be related to environmental services but must reach all the fields of public action including agriculture, business, tourism and education. All these fields are covered by the Convention on Biological Diversity with direct implications on the evolution of national legislation and planning. A.M.

CHAPTER 2

The benefits of interdisciplinarity, at the crossroads of many domains

- Biodiversity as the way in
- Society and what caused it

The benefits of interdisciplinarity, at the crossroads of many domains

By Katia Schmitzberger and Marie Winterton

Developing a new science to serve action and research.

© Stéphane Durand

Putting a halt to the erosion of biodiversity. That is the task facing modern society. But, without conciliating quality research and efficient management, improving interactions between man and nature will be difficult. We are becoming increasingly aware that interactions between living systems are essential for those systems to function adequately. Is it not remarkable then that the people the most deeply involved in this awareness do not interact much more? The reciprocal transfer of knowledge between researchers and managers is becoming increasingly urgent. Conservation research should be anchored in the reality of society, and likewise, managers should work towards gaining a multidisciplinary scientific culture to enable them to correctly orientate reflection upstream of any action or decision-making.

Researchers in ecology should therefore become familiar with the precepts of management and social sciences, and managers should become aware of the fundamentals of research. Conservation biology is the discipline directly involved in the maintenance of biodiversity and would like to be thought of as a multidisciplinary science. However, this is not, as yet, fully the case. Conservation biology was first developed by a group of researchers in population biology and was based on the so-called "virgin land" notion of large areas of the USA. This origin has weighed heavily on its theoretical foundations. But, the management of land, whether protected or not, must also take into account the omnipresence of man in the ecosystems. In spite of the principles laid down by conservation biology (see box on p. 44) the social sciences are poorly represented, the major issues being biodiversity rather than man-nature interactions. So, is the term "biology" really appropriate? This is why the expression "conservation sciences" appears to

correspond better to the notion of bringing the various disciplines together.

Conservation sciences are the meeting point of disciplines as varied as population biology, population genetics, functional ecology, animal behaviour sciences, geography, law, political sciences, economics, sociology, ethnology, anthropology, philosophy, and many more. In addition to their multidisciplinarity, the conservation sciences must foster reciprocal mutual interactions with the local stakeholders' activities such as agriculture, fishing, forestry or hunting, and must act as an ambassador encouraging links between researchers and managers. From the stage of recording various phenomena as they occur, conservation sciences must now pass on to the stages of action and anticipation. The added value of conservation sciences will be their theoretical approach, which will allow not only specific recommendations resulting from case studies but also the definition of global concepts that should give rise to general management principles.

The basic principles of conservation biology

The aims of conservation biology are to understand the impact of human activities on species, communities and ecosystems and to develop concepts to prevent the extinction of species, and even to reintegrate them into functional ecosystems.

Principle I. Maintenance of healthy populations of wild living resources in perpetuity is inconsistent with unlimited growth of human consumption of and demand for those resources.

Principle II. The goal of conservation should be to secure present and future options by maintaining biological diversity at genetic, species, population, and ecosystem levels.

Principle III. Assessment of the possible ecological and sociological effects of resource use should precede both proposed use and proposed restriction or expansion of ongoing use of a resource.

Principle IV. Regulation of the use of living resources must be based on understanding the structure and dynamics of the ecosystem of which the resource is a part and must take into account the ecological and sociological influences that directly and indirectly affect resource use.

Principle V. The full range of knowledge and skills from the natural and social sciences must be brought to bear on conservation problems.

Principle VI. Effective conservation requires understanding and taking account of the motives, interests, and values of all users and stakeholders.

Principle VII. Effective conservation requires communication that is interactive, reciprocal, and continuous.

The right form of communication

This interactive mode of operation stresses the necessity for the transfer of knowledge between researchers and managers. In the direction manager to researcher, dialogue can be set up on the condition that the researchers fully accept the absolute necessity to satisfy social demands and understand the objectives and constraints of management. In the other direction, it is not as simple.

It is difficult to achieve dissemination of knowledge to all those involved: organisations, private people, the media, local populations, etc. Access to scientific publications, basically in English, is difficult and most organisations have neither the will nor the means to subscribe to them. Even when they are available, they require time to read and to understand, and a busy manager's priorities are elsewhere. Different forms of dissemination of information should be encouraged such as meetings, where the data are presented orally, or more comprehensible documents where all parties can explain their work.

Researchers and managers have different objectives. Researchers attempt to understand a phenomenon and so put forward a number of working hypotheses that they then seek to validate or invalidate. Managers must resolve a problem, make decisions and act in order to put an end to or improve a situation. Usually, they look for rapid solutions to problems that in fact have multiple facets e.g. ecological, political, scientific, social or economic. For managers, it is the results that count: their work is evaluated by assessing the technical success-to-cost ratio for the actions planned and carried out. Researchers on the other hand seek answers to questions that can be highly specific, and they do not have the same tight time schedule to

Interdisciplinarity as seen by a natural heritage manager

INTERVIEW of Johan Chevalier

specialized in natural heritage management

After having been a natural heritage manager, you are currently preparing a thesis on the definition of objectives in natural heritage management – a subject that lends itself to interdisciplinarity. How do you explain your change of activity?

Johan Chevalier: Anyone who is responsible for the management of natural heritage must ask themselves certain difficult questions. For instance: How can the objectives of our activity be defined? What is decision-making based on and how can the choices made be justified? These questions are not just related to biological sciences, there are others such as anthropology, economy, political science, sociology and cognitive sciences that clearly give better grasp of how natural heritage managers operate and the questions that may arise.

But do you think that it is important to improve the contribution that interdisciplinary research makes towards the management of natural heritage?

JC: I see three lines of debate that need to be developed: firstly, the position of the manager. It is striking to note that during congresses and symposiums on biodiversity conservation, managers are accorded such little importance, especially when the aim is to determine the general lines of research for the future. This observation raises the question of which interdisciplinary approach we want to develop. Do we want theoretical interdisciplinarity, constructing bridges between laboratories – which is already a positive move – or do we want applicable interdisciplinarity? The fact that interdisciplinarity is often referred to as being at the crossroads of various domains llustrates current trends. Replacing the term domains, which refers to scientific disciplines, by Practices or Activities, which are also at the crossroads of disciplines, would appear to me to be more judicious. Such a change would indicate a more applied approach for interdisciplinary research – likely to give applicable results. Research involving various disciplines and targeting practical objects does appear to be the most fruitful.

What about the second subject for debate.

JC: It concerns the current role of anthropologists and sociologists in the development of interdisciplinarity. The Rio Convention points out that our motivations with respect to biodiversity conservation are partly cultural, social and aesthetic. It would appear logical then that locally, natural heritage management practices are inseparable from the representation that society has of the cultural, social or aesthetic object in question. In this context, sociology and anthropology will clearly make a useful contribution. This is regularly pointed out in meetings and discussions concerning biodiversity conservation. However, in practice, numerous environment managers have had regrettable experiences with some French scientists from these disciplines. The general impression is that, for some of these researchers the desire to tackle the "environmentalists" takes precedence over describing, then explaining their practices. These confrontations, which are becoming increasingly frequent, are making environmental managers, and also numerous ecologists, weary of anthropologists and sociologists in general. However, we should be cautious that the rejection of certain researchers does not become a rejection of whole disciplines, which are particularly important for the development of natural heritage management.

Previously, you spoke about the role of political sciences, is this the third subject for debate?

JC: Yes, and curiously they are all but absent. Today, the objectives of natural heritage management are generally considered as resulting from a choice made by society. This position is the first principle of the ecosystem approach of the Rio Convention on Biological Diversity. This novel vision has, logically led to a change in the modes of decision making towards taking more account of the desires of the people. In reality, natural heritage managers are faced with a practical problem, best dealt with through the political sciences: choosing and managing participative democracy procedures. In spite of this, researchers in political sciences are poorly represented in the current development of interdisciplinarity in biodiversity management.

So your point of view is not really negative.

JC: In fact, it's quite positive. However, now we absolutely must define the goals of interdisciplinary research in natural heritage management. To my mind, the aim should be to allow more efficient and more legitimate management policies to emerge. Although interdisciplinary research enlightens decision making, in no way can it replace the choices of society and hence democratic procedures. So, the current development of interdisciplinarity stresses the necessity to clarify the role of the different sciences in defining the objectives of natural heritage management. ■

Johan Chevalier was interviewed by Lisa Garnier

The interdisciplinary approach to biodiversity management

As conservation sciences can be defined as occurring at the interface between very varied disciplines in interaction with the local stakeholders, the use of interdisciplinary scientific approaches becomes a necessity. The emergence of new needs for knowledge at the junction between science and society appeared with the problem of biodiversity erosion and then again with the growing awareness of the increasingly rapid and radical interactions between the evolution of knowledge and social dynamics. In this context, it is difficult for managers, alone, to establish a programme of sustainable management. Also, the notion of sustainable development implies a difficult conciliation between the often-contradictory conservation objectives and the sustainable use of resources, economic development and social equity. At the origin of the need for interdisciplinary research is therefore the complexity of the research objectives and of the decisions that must be made.

But, what interdisciplinarity are we talking of? The term is often used for multiple notions and so must be defined for each scientific field. Interdisciplinarity can be defined as a research approach, methodically building up a collection of knowledge, opinions, concepts and working techniques coming from various disciplines. In the case of biodiversity management, however, this collection is not simply based on proximity, i.e. is not limited simply to obvious complementarity totally accepting the division of labour and the paradigms of the different disciplines. The interdisciplinarity we are dealing with here must, from the very start, take into account the structural and intrinsic duality of the issues that are to be dealt with. It must also be seen as a methodological construction, or even as the trajectory taken by the method. Step by step, it requires the evaluation of the compatibility of the space and time scales of the various disciplines and also the evaluation of any shifts in the meaning of vocabulary and even false similarities. Finally, it must be considered in the way it relates to the action. It is around the complex question posed to the researchers by the managers and their requirement for action that the interactions between the natural and social dimensions of the issue can be clarified.

Some examples of the interdisciplinary approach, although they do not concern the management of biodiversity in Biosphere reserves, illustrate the situation well. Research into urban cockroaches and asthma in rural life, gave a concrete illustration of the way in which the approach and the encounter of two disciplines can occur: life sciences met social sciences and ecology met geography. Here are some of the lessons learned.

Practicing the interdisciplinary approach is a choice, that of embracing complexity and social utility. It is defined around a problem that is finalised by the partners wanting to pool theoretical knowledge to solve a complex problem by constructing a pragmatic and adaptable methodology. It is in contradiction with a hierarchical vision of sciences but this does not exclude the practice of "ancillary" tasks, i.e. when necessary, it is important to be able to accept to "serve" a discipline that is more central to the study and which tends to "dominate" the research in question.

To overcome the mechanism of using technical or legal solutions to introduce sustainable development into land management, action must be taken to stimulate awareness in all those involved at all levels and to convince them of the efficacy of their actions on the environment. This is what was revealed by studies based on the social concept of the "nature culture": within any given person, there is a certain degree of incoherence between their desire to live in an environment and the destructive practices that enable them to live there. Finally, the analysis of what people say and the evaluation of environmental policies can only be effective if they are adjusted to the knowledge of the ecologists who make up the "objective" aspect of the research. The "objective part" has to be considered and confronted with the representations and the observed practices of the inhabitants.

The practice of interdisciplinarity, as we have presented it, is in fact heuristic for each of the disciplines involved, since it always leads to new results. It is the indispensable basis without which the negotiated resolution of neighbourhood conflict and the sharing of resources and common goods would be unrealistic or impossible.

Nicole Mathieu

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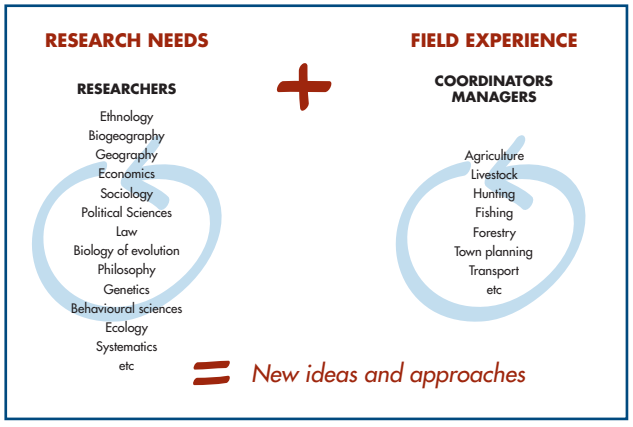

find the answers. For researchers, finding the right method to deal with the question is more important than the result itself. Their work is evaluated by the number of articles that they manage to get published in high-level international journals.

When researchers and managers are not aware of these basic differences in aims, misunderstandings can be numerous. A good example is the frequent confusion between research work and consultancy work. The studies that managers require from researchers are often technical and thus consultancy work rather than research. In the field of conservation sciences, this trend is accentuated by the fact that most work is urgent. But, if researchers do not show much interest in this sort of challenge, it is partly because they are asked to do the work of a consultancy office during their research time. If this incoherence is not identified early on, the managers risk seeing the researchers drifting away from the goals initially fixed. The results obtained will be considered unsatisfactory. Situations such as this can be avoided by referring to consultancies qualified to regularly follow-up scientific progress. However, when this solution is not feasible, recruiting a researcher to define the methodology for a technical study can prove useful. But, here again, the same pitfalls must be avoided, such as working in parallel without ever comparing the logic with the questions. The work must be done together.

Very schematically: managers decide and researchers understand. But, in a context of Conservation Sciences, the researchers must also conclude. At the end of the study, they must be able to say: "if you act on this particular factor, these are the possible consequences and their probabilities". Their indications must be sufficiently clear for managers to be able to make a decision, even if not all the criteria required for total objectivity are simultaneously present. But, the managers must not expect the researchers to do the decision making for them.

On the research side, basing the work on technical aspects and using the practical knowledge provided by the managers will definitely save time in selecting the most relevant theoretical issues to be developed. On the side of the Biosphere reserve coordinators and managers, the definition of appropriate management strategies is a good way to control spending. It would be good to take these advantages into account to reach the natural superimposition of management issues and scientific questions. All that remains to be done is merely to find a common language and establish a new

For one, two or several species, the advantage of conservation sciences is to bring different disciplines together. (Alpine Poppy)

The story of an owl and an orchard

By Jean-Claude Génot

In the French part of the Biosphere Reserve Vosges du Nord-Pfälzerwald, for the last 20 years and more we have been closely following the populations of a favourite night raptor: the Little Owl. As a result of this close collaboration between the coordination of the Biosphere reserve and the researchers involved in the project, this owl, also called the Little Owl of Athene – *Athene noctua* – has become the symbol of the renewal of traditional orchards.

The *Orchard Festival*

Since 2002, the French part of the Biosphere Reserve Vosges du Nord-Pfälzerwald, has organised an Orchard Festival, in the aim of promoting the use of full sized trees, i.e. with a trunk about six feet tall (1.8 m). These traditional orchards are the traditional habitat of the Little Owl whose population started declining in the region in the mid 1980s. At that time, knowledge of the biology of the species was totally insufficient to take suitable protection measures. Studies were carried out on the habitat, the reproduction biology, the home range, the diet and the population dynamics of the owl, but unfortunately, no clear answer was found to account for their decline. The Biosphere reserve coordinator then decided to invite researchers to collaborate in resolving the problem.

After various analyses, particularly in demography and population genetics, it was found that the Little Owl population acts like a metapopulation, depending strongly on the input of immigrants coming in from outside the region studied. Rather than attempting to restock the population, the researchers rec-

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Full-sized fruit trees are the preferred habitat of Athene's little owl.


The little owl has become the symbol of a renewed local culture.

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ommended acting on its main habitat, the orchards of the French part of the Biosphere reserve. In parallel to this study, another study, oriented more sociologically, analysed what the local people thought of the orchards. It revealed that in fact the people had lost interest in this type of farmland, even though it helped to diversify the landscape.

When consuming rhymes with diversity

Following these results, the French part of the Biosphere reserve launched a programme to encourage the orchards. The programme was ecological but also social and economic at the same time. The reserve continued to coordiante the monitoring of the population of Little Owls in the framework of a national observatory.

Over nine days every two years, the *Orchard Festival* brings together numerous local and regional partners, proposes multiple activities centred around the upkeep and expansion of the orchards: arboriculture, learning about the different varieties of apple, cooking demonstraitons based on fruit and done by local Grand Chefs, taste workshops to learn about friut tasting and to have fun at the same time, exhibitions and conferences, shows, educational activities, fruit markets, etc. The French part of the Biosphere reserve also helps groupings of communes to prepare action programmes called *Vergers Solidaires d'Alsace* [Solidarity in Alsace Orchards] funded by the Region. It has set in motion a project with the Food Bank of *Bas-Rhin* to pick fruit left unharvested by the owners. In 2004, almost 15 tonnes of fruit were picked. Finally, to cope with the success of the programme of actions in support of full-height trees in the orchards and the dynamics created by the Orchard Festivals, *Vergers Solidaires d'Alsace* recruited a person to look after the marketing side of the orchard products. They are running an awareness campaign directed at various publics to increase the demand for apple juice and other products.

The double effort made by researchers and Biosphere reserve stakeholders required a quantity of thought, fed both by manpower and financial power, and the involvement of numeroius partners. Today, although the right approach seems to have been found, what will happen next is still unknown. The future of the little owl depends upon the goodwill of the inhabitants, linking a landscape to a consumer choice. ■

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The conservation programme of traditional fruit trees has also favoured the diversity of processed products.

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Fragments of nature: elements of a heterogeneous landscape fashioned by man

By John Thompson

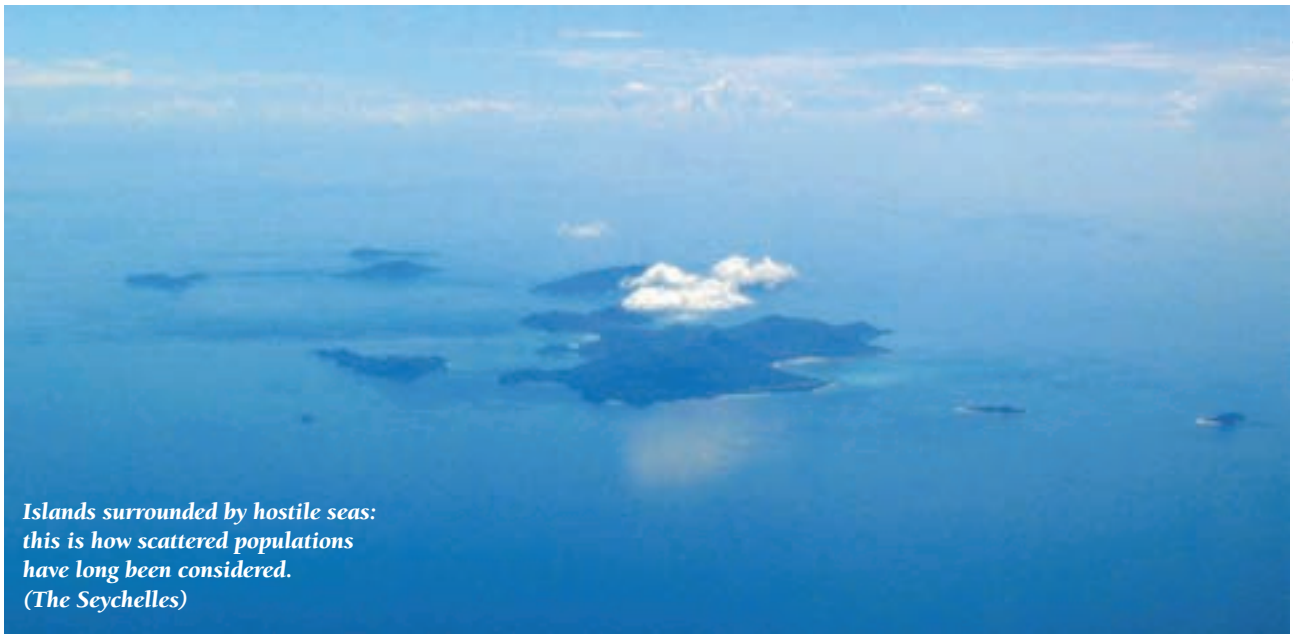
Four-fifths of the terrestrial ecosystems on earth are under the direct influence of human activities. It is through the rapid changes in land use due to urbanisation, road building, deforestation, changes in agricultural practices, etc., that man is remodelling ecosystems. As fragmentation has become a major cause of the rarefaction of species and the modification of the dynamics and function of ecological systems, it has become a priority in conservation biology research. For the last 30 years, studies have focused on the positive or negative effects of landscape fragmentation. Now, the subject should be broadened and the underlying socio-economic mechanisms and the direction in which species are evolving must be identified.

By definition, fragmentation is the action of separating into fragments. It is thus a process in which a habitat is divided into fragments of various sizes, more or less isolated from one another and which have a total surface area smaller than that of the original habitat. The consequences of such fragmentation for the spatial configuration of the habitat are also highly variable.

The notion of threshold population size takes on its full importance.

Today, no one refutes the negative impact of patchy habitats on the species richness of communities. One reason for this is that, at the scale of individual populations, small populations suffer more from random events – climatic events for instance. Such processes erode the number of individuals and hence the genetic diversity of the populations. In addition, a small number of individuals will decrease the possibilities for reproduction, again reducing the chances of survival of the population. In plants, for instance, a low abundance of pollinating insects will limit pollination. Likewise, a reduction in the diversity of the genes involved in the compatibility of pollen between plants can decrease fecundity and the chances that offspring will be produced.

How low can the number of individuals get in a population without jeopardising its near future? Here, the notion of threshold population size takes on its full importance. In contrast, populations that are isolated at the limits of the distribution of a given species may experience hardly any exchange of individuals or genes through reproduction with other populations; and in



Islands surrounded by hostile seas: this is how scattered populations have long been considered. (The Seychelles)

this way show marked genetic differentiation from other populations. This potential for evolution should not be neglected. The same is true for the evolution trajectories of species having to cope with the fragmentation of their habitat. In cities, where habitats suitable for wild plants are extremely patchy, the populations of a little yellow-flowered Asteraceae appear to be reducing their investment in means of dispersal: the size of the winglets on the seed has decreased. The study of the adaptation of such species to a fragmented habitat is therefore a particularly relevant path to follow.

The landscape as a mosaic

Owing to the isolation of populations that have become separated, they have often been compared to islands surrounded by a hostile sea. It appears, however, that this image is erroneous. In reality, the ecological dynamics of these populations is dependent on the effects of the environment that surrounds them – these effects can be exerted through various external influences such as pollution or the introduction of species. Also, it should be noted that the surrounding habitat is itself not uniform – it can also occur in the form of patches of landscape. In fact, the "ensemble" of heterogeneous fragments produces a mosaic-type landscape. Fragmentation should thus be considered and defined in relation to landscape structure if it is to be correctly integrated into conservation management strategies.

Spatial singularities? Variable scales? Here we recognise terms used in geography. Indeed, the science of ecology must learn to live and work with the tools and the principles of geographers. This is all the more important in that questions relevant to conservation, such as those concerning fragmentation, can no longer be dissociated from economic and social issues such as those of the rural economy and cultural values. Awareness of the impact of man on the erosion of biodiversity can be an extraordinary tool to encourage interdisciplinary cooperation: a major goal in the coming years.

Interdisciplinarity, however, is not as simple as that. It is first necessary to analyse the vulnerability of each type of species to fragmentation of a single type of habitat paying particular attention to the ecological mechanisms involved (modifications of the reproductive processes, offspring dispersal, interactions within communities, etc.). This should be done in the context of the socio-economics of the landscape dynamics (the costs entailed by conservation, the evolution of human pressure on natural habitats, etc.). One should remember here that the effects of fragmentation also depend on the regional context. The uncontrolled urbanisation of the Mediterranean coast and the fragmentation of the tropical forests do not pose the same ecological problems and their solutions cannot be found in the same socio-economic mechanisms. In addition, we must not forget that the importance of fragments in a

From populations to metapopulations

As landscapes are becoming increasingly fragmented, a key question involves the relationships between individuals and the space they live in. A fragment is in fact often considered to represent an area covered by a population or an area suitable for a population to become installed. It should be recalled that a population is defined as a set of individuals of the same species living in the same space. However, populations rarely live as sealed units, with some individuals moving out and some moving in. In plants, seed and pollen enables exchanges of genes via reproduction. The existence and the dynamics of populations are therefore dependent on interactions of varying strengths and frequency: these collections of interactive fragmented populations are called metapopulations. And, just like a string of fairy lights: one population can be seen to die out while another comes to life elsewhere, others remain "alight" for long periods, and finally new populations can be seen to kindle dead sites.

Some species function naturally in metapopulations. This is the case of the Rock Hyrax (*Heterohyrax brucei*), a small African antilope called the Klipspringer (*Oreotragus oreotragus*), marmots, the American pica (*Ochotona princeps*) and other species living in relictual mountain habitats or on islands.

Most, however, make the change from a continuous population to a metapopulation following fragmentation of their habitat by human activities.

Lisa Garnier and Katia Schmitzberger

landscape can become exacerbated when they become sources of recolonisation for the disturbed areas. A pertinent example of this can be seen in the fragments of forest left intact by the lava flows on the flanks of the Piton de la Fournaise volcano on Reunion Island. These fragments represent the source populations for dissemination and recolonisation of the slopes by forest species.

New challenges

In order to arrive at a constructive level of interdisciplinarity, ecologists must firstly clarify their aims. As today the processes of loss of area, isolation, and increased fragmentation – including the multiplication of forest edges – are so closely mixed that certain authors have suggested that the notion of fragmentation has no real meaning. Such confusion weakens the recommendations that scientific ecology can make to environmental managers. If this confusion is to be overcome, a threefold challenge requires attention. The first is to provide a more exact definition of the conceptual basis behind the ecological and socio-economic processes involved in fragmentation. The second is to describe the specificity of the biological level of organisation that could be affected (rare species, communities, taxonomic groups, etc.) and the third is to clarify the spatial scale and the landscape model considered. The spatial layout of habitats differs between ecological gradients and natural landscape mosaics where fragmentation is a natural component of the distribution in space.

Globally, the simultaneous analysis of ecological processes and social mechanisms should enable new recommendations to be made for the preparation of conservation strategies. However, in parallel, the evaluation of the ecological efficiency and the socio-economic durability of management measures should become the norm. The type of recommendations that scientists will be able to provide managers will depend on the precise identification of the processes that determine the nature of the fragmentation process. It will be necessary here to identify the point to which the development of

From metapopulations to metacommunities

While the theory of metapopulations has enabled a spatial dimension to be added to exchanges between individuals of a species, community ecology considers exchanges between species and their environment. Instead of taking communities of species as being isolated from eachother, they are condisered to undergo exchanges of organisms, of nutrients and of energy. The concepts of metacommunities and metasystems have seen the light. Metacommunities link communities together through processes of dispersion – e.g. of genes or of individuals – and metaecosystems link ecosystems by fluxes of energy and matter. The two are indissociable since an ecosystem, by difinition, encompases a community of individuals and its environment. These notions are used as soon as there is a pre-existing structure or when the characteristics of the organisms enable several scales of organisation. For instance, we can consider interconnected fish communities in a river catchment area or a coral reef; the plant communities benefiting from the presence of a fallen tree in a tropical forest; the microorganisms found in mosses, or on the leaves of carnivorous plants or of the bromeliad family.

These concepts are very new and still mainly theoretical, having been developed just over the last 5 years. Their greatest quality is to have enabled constructive dialogue to be established with the specialists of population genetics, who use similar concepts. In conservation sciences, their use in the study of the conditions required to maintain biological diversity is certain to have a rosy future especially in questions involving the fragmentation of habitats. How could it be possible to not reconsider the consequences of the modification of natural lanscapes by man if we accept that ecological systems are not just organised locally but make up complex spatial networks?

Nicolas Mouquet

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an area involves loss of surface area or changes in spatial configuration and connectivity for suitable strategies of conservation to be adopted. If the main threat is the loss of surface area, investment should be made towards the upkeep of the remaining patches. Isolation of patches, however, calls for the patches to be connected by corridors or the creation of new populations to minimise the isolation of the existing ones.

Close collaboration between ecologists, geographers and socio-economists is thus becoming necessary to identify the causes of the changes, areas at risk and develop strategies that are ecologically efficient and economically acceptable and viable in the long term. Habitat fragmentation can be crucial for deciding how to target conservation priorities beyond the simple identification of new areas for protection as suggested by Miguel Ortega-Huerta in his recent study of the fragmentation of habitat in three biosphere reserves and other biodiversity hotspots in Mexico. Our ongoing studies on the endemic and protected plants of the Mediterranean region suggest that the most efficient and cost-effective conservation strategy would be to develop a network of small reserves, as proposed for other areas (for instance in South Africa and the Appalachians in the USA). But, this type of network would not be sufficient to satisfy the demands of biodiversity in general, as most species cannot survive in small areas: they require large reserves to ensure their future.

Priority to innovation

A new strategy for nature conservation should now be thought out and applied, with larger areas of land needing less protection through regulation. A charter, using suitable scientific, legal and financial tools, could be drawn up to define ecological management. But, as noted by Jean-Claude Génot and Robert Barbault "the choice of global integrated management of areas of land where nature conservation occurs outside of the highly protected areas encounters a certain number of difficulties". A major challenge for interdisciplinary research is to provide decision-making tools that allow these problems to be resolved and the fragmentation issue to be integrated as a major priority. In this way, the conservation of the biodiversity of "fragments of nature" could be developed not only over a larger spatial scale where the fragments represent elements of a heterogeneous landscape but also in the broader perspective of the general impact of human activities on biodiversity. ■

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Naturalised species and biological invasions

By Éric Tabacchi
and Anne-Marie Planty-Tabacchi

With increasing demands placed on agriculture, growing trade and transcontinental transport, biological invasions following introductions of species to areas outside their original distribution, have increased in vast proportions. These invasions are often cited as the second cause of biodiversity extinction on a world scale, after habitat fragmentation. Interpreting this phenomenon and its consequences opens a debate which could cast doubt upon current practices in management of the environment.

Opinions about introduced species are greatly affected by their "alien" character. Society usually comes to the foregone conclusion that they are noxious, making any objective analysis of the phenomenon and its consequences virtually inapt. All introduced plants are taken as being hardened invaders. And yet, many finish by disappearing or becoming integrated into natural communities. Who, in metropolitan France would complain about the presence of the genet (*Genetta genetta*), an animal introduced in the Middle Ages as a pet and which is now protected? Has the sour fig (*Carpobrotus edulis*) not become the emblem of Sardinia, known there as "Garibaldi's Flower", even though it is a real threat to both habitats and species? Others remain latent for long periods after their introduction waiting for environmental or genetic changes to occur. This was the case with Pampas Grass (*Cortaderia selloana*) and the butterfly bush (*Budleja davidii*), grown for one and a half centuries and just for the last few decades invading roadsides, riverbanks and rough land. Others existed in our territory, disappeared during the ice ages and have been re-introduced, such as the common walnut (*Juglans regia*). Paradoxically, some of these species have changed our landscapes and have become a positive element in our mental representation of nature: the sweet chestnut (*Castanea sativa*), for instance. Finally some, the most spectacular invaders are accorded the worst attributes whereas we know nothing – or almost nothing – of the consequences of their presence on the native species or on the way the ecosystems function.

Well loved in gardens, pampas grass has spread to roadsides and rough land.

Domination is in their nature

If we do not take into account the responsibility of man – willing or not – in the transfer of species, then introductions are no different in terms of ecological mechanisms from the natural migration of species that has occurred over the millennia. There are however some basic differences. The first is the rate and the frequency of the introductions. We are permanently facing a large number of novel introductions, and the trend is increasing. The ease with which we can cross borders and particular behaviour patterns we have acquired – for instance the taste for novel pets – is exacerbating this pressure. The second difference is due to the fact that the newcomer has not co-evolved – in the Darwinian sense – with the invaded

In some cases, treatment with chemicals can provide a solution. (Camargue, France)

populations. This explains the high failure rate of invasions – due to lack of adaptation of the receiving environment. But, this can also be seen as an advantage, as after being introduced, a species no longer has its natural enemies – predators, diseases, parasites, etc. – conferring a clear advantage in the fight to dominate. Finally, what characterises invasions is that one species outcompetes all others in a habitat from which it had been absent. Note that even native species can cause invasions (see box on p. 56).

Biological invasion can be identified as being detrimental to the environment and to man but is this really the case? It is a fact that involuntary introductions often have a negative outcome, at least in the mid-term. But often, surprising results can come out of longer-term analyses. The introduction of ornamental fresh water molluscs in the West Indies was first perceived as a catastrophe since the local species could – and this was a real danger – become threatened. Then, later, it turned out that the decline in the population of intermediate hosts led to a strong decrease in the risks of bilharzia. Similarly, in Reunion Island, the massive invasion of the understorey by Kahili ginger (*Hedychium gardnerianum*), locally known as longose, led to a considerable decline of local biodiversity. However, in the longer term it became clear that the plant made a very useful refuge for endemic plants and animals, which were disappearing from their original habitat.

A lack of rules

Scientists now have sufficient information to conclude that almost no ecosystem, no type of organism and no region of the globe has escaped from introductions. The more an ecosystem is geographically isolated from its context, the more it appears to be vulnerable. Ocean islands like Hawaii, Reunion Island, the Kerguelen Islands, New Zealand and Australia, are rife with invaders each creating its own threat to endemic species. In a continental context, natural reserves paradoxically are particularly vulnerable targets. Ordinary landscapes are also heavily invaded but the environmental risks are less. A distinction should however be made between habitats simply having a large number of introduced species and habitats completely taken over by the 'aggressive minority' (see box on p. 56). In some cases, such as areas disturbed by normal hydrological events, exotic species represent over a quarter of the species present without the native biodiversity being adversely affected.

Pioneer or mature, all types of community are vulnerable. The most disturbed habitats host more introduced species while more mature and stable habitats are more vulnerable to invasion by a small number of aggressive species. Each case appears to be unique. As yet, none of the characteristics of an invasive species – its competitiveness, its growth, its size or its mobility – have been able to allow a rule to be established, which would be useful to predict invasions.

Once invasion has been achieved, eradication is extremely difficult. Examples of invasions that have been successfully prevented

A garden escape in France, the water hyacinth (Eichhornia crassipes) *has a world-wide reputation for being invasive.*

are extremely rare. Detecting them at an early stage proves problematic. Many remain totally undetected, either because of lack of historic information, or because nobody is interested in them – the organisms may be too small or not have a strong economic impact. Also, as mentioned, an invasion can take off a long time after the original introduction. This stresses the importance of surveillance, and even the prevention of introductions. A legal arsenal is starting to be built up in most countries but slowly and with little coordination. It is however at the very early stages that the invasions can be stopped. This is the case today in France, in the Gironde *département* where the American bullfrog (*Rana castesbeiana*) is threatening the diversity of native amphibians.

Once an invasion has been identified, it seems natural to want to eradicate the invader. But do we have the means to do it? It is clear that a considerable effort has been devoted to eradication the world over with a success rate that is often dismal. In addition, public policies most often lead to exorbitant costs borne by the people, who are clearly dissatisfied with the lack of efficiency. A critical analysis of the process thus starts to take form. Firstly, the real impact on biodiversity or on the positive effects of ecology is often masked by the identity of the invader. The estimated impact is frequently based on presumption or analysed in the extremely short term or just locally. Secondly, the invader can rapidly become a scapegoat, so we pretend not to see the real reasons behind the invasion or the perpetuation of the invasion – usually linked to a disturbance or dysfunction of the ecosystem. Finally, it is rare that studies take into account the beneficial effects of invasions.

Introduced, naturalised or invasive?

It is generally acknowledged that only about 10% of introduced species develop autonomous populations in the wild – species referred to as naturalised – and that 10% of these species become potentially invasive. So, the proportion of introduced species in a community only indicates a potential, and in no way does it indicate vulnerability. Recurrent physical disturbance of a habitat – fires, floods, ploughing – can regularly rejuvenate the habitat and redistribute the ecological resources. In these instances, there is often a very high proportion of exotic species, without affecting native diversity. Actual invasion only concerns a limited set of species, which become – or which are – super-competitors. This type of invasion, which is generally durable, can also be achieved by native species. This is the case, for instance, of a couch grass, which recently invaded the bay of St Michael's Mount in France, benefiting from an excess of nutrient from urban effluent and agricultural activities in the watershed to develop physiological defence against the salt. We can also mention the Great Cormorant proliferating in most waterways following protection measures voted at the European level at a time when the species was endangered.

Calling a species "invasive" therefore does not mean that it has any particular geographic origin, or that there is any prejudice towards it, and is also irrespective of the duration of the invasion.

E.T. AND A.-M. P.T.

©Eric Tabacchi

Imported from South America for its fur, the coypu (Myocastor coypus) *is considered to be a pest.*

The benefit of the doubt

Moreover, are there really any valid reasons for eradicating these species? The principle of precaution would require the eradication of any exotic organism. But, we can stress three reasons that stand in the way. The first is the impossibility to prevent, at reasonable cost, the recolonisation of the eradicated sites by the same species. The second is that the habitat can be modified to such an extent that that returning to the original state – turning back the clock – is impossible. The increased salinity of the banks of the Colorado due to invasion by the tamarisk (*Tamarix sinensis*) and the saturation

with organic matter of Canadian marshland by the invasion of loosestrife (*Lythrum salicaria*) are good illustrations of this. Thus, successive introductions following minor modifications of the habitat can make the native communities increasingly fragile and lead on to a cascade of invasions. Finally the cost of the eradication could become unjustifiable if it is thought that the species may become integrated or if its decline has been predicted. Environmental or economic benefits can even result. In India, an introduced tree, Mesquite (*Prosopis juliflora*) has very rapidly turned from being an invasive species to being essential for the survival of some of the poorest populations in the country. In Europe, the Himalayan balsam (*Impatiens glandulifera*), hated by environmental managers, has been reported to enhance bacterial denitrification in the riparian forests along waterways, and not to impoverish local biodiversity.

It should be noted that control or eradication methods are far from perfect. Wanting to eradicate the Melaleuca (*Melaleuca quinquinervia*) which was invading the Everglades National Park in the USA, the periods when the marsh was flooded were prolonged, also getting rid of Bahia grass (*Paspalum notatum*), another invasive plant. But, this left the habitat wide open to a third invasive – Torpedo grass (*Panicum repens*) – and controls have again become necessary. Direct, "non-surgical" methods such as the use of earth-moving equipment, extensive trapping, or the use of pesticides often pose as much threat to native species as to the invasive ones. As for the alternative of using biological methods to fight the invader by introducing its pathogens or predators, the results have in some cases proved disastrous: the predators and pathogens being themselves introduced species, their specificity to the invasive host and the immunity of the native trophic or functional chains are rarely guaranteed.

Resolving such a problem seems to be a serious challenge. Must we therefore be resigned to watching biodiversity become globalised and just ordinary? Probably – the increase of human disturbances, including man's involvement in global changes is a cause of invasion. But, certain basic rules should be applied in situations where eradication is a realistic possibility. First, it is essential to fully understand the process, without forgetting the mid- and long-term aspects as some invasions die out before they are even detected. In addition, invasions are often now multiple. We are no longer dealing with isolated species – whole future assemblages of species are being exported. This complexity must be taken into account in the analysis.

Acquiring this knowledge must, from now on, have a more cooperative basis, firstly between countries, then between social partners (scientists, managers, decision-makers, producers of goods). It is also important not to ignore the empirical experience of the users, which is an undeniable advantage for scientific analysis. Historians and sociologists will help us to describe the trajectories of the species in each of our societies over the years.

Finally, objective analysis of the costs and the benefits attached to the invasion and to possible curative actions, backed up by reasoning that is unbiased by appearances or by cultural prejudice, should allow the development of advanced management techniques and arguments for suitable decisions to be taken in each society and by each international consortium. ■

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Corridors: the need for thought

By Stéphanie Carrière
and Philippe Méral

Ecological, conservation or dispersion corridors, greenways, biological corridors habitat and landscape corridors, line corridors, landscape link, river corridors, wildlife corridors: the term corridor has become familiar not only in nature conservation, but also in landscape ecology, and town and country planning. But, although there is a general rush to protect or develop these "corridors", the lack of coherence and clarity that exists around the terminology should encourage more consultation and synergy between the various people involved, in their various disciplines. Since the 1990's, corridors have been presented as a cure-all remedy for all the conservation problems typically met by interconnected protected areas. In such a context, how is it possible to conciliate biodiversity conservation with sustainable development?

Several ecological functions have been attributed to corridors. Most frequently mentioned are habitat for species, providing a link between two similar ecosystems through which fauna and flora can move, or creating a barrier which would slow or even stop migratory movements of other species. On the subject of these functions, no two conservation biologists seem to be in complete agreement. In reality, very little data is actually available to enable a connection to be made between the theories used to justify corridors and the data collected in the field. Studies at different scales of investigation concern the appropriate size and the level of efficiency. Each corridor differs in the way in which the species use it and the scale of space and time considered.

In practice, an abundant literature shows the positive effects of the corridors on the flux of animals but much more rarely, the actual gene flux – genetic variability of the populations along a corridor – which would enhance the adaptation of the species in the long term. Moreover, some authors raise the question of the lack of knowledge about the possible roles played by corridors in the transmission of epidemics, diseases, predators, and invasive species. Considering the cost, in economic terms, of setting up corridors, their restoration and their upkeep, do they really provide the benefits anticipated?

No clear definition

In the absence of concrete information, a corridor would only play a positive role in a particular context dependent on a particular landscape or species. Scientists and conservationists generally consider that a connected landscape is better than a fragmented one, even if the acts carried out for the sake of conservation are costly. It is the principle of precaution that takes precedence in most arguments used to justify the actions of the large international conservation NGOs such as the WWF, WCS and IUCN.

Also, the absence of clear definitions makes it difficult to obtain concrete data concerning

Green Corridors

In expansion since the 80s, green corridors tend to follow the natural relief – mountains or rivers for instance – to create lines connecting protected areas in the centre with urban areas at the edges. American professors Julius Gy Fabos and Jack Ahern classified them into three groups. The first, which covers ecological corridors, are mainly found along rivers, following the coast, or in chains of mountains. Their aim is to conserve biodiversity. The second category corresponds to recreational corridors whose role is to link different natural sites that have tourist attractions. The last group concerns sites with high heritage value. Here, the corridor highlights the history of the economic and social relationships existing between the different points along its path. Most often the path follows rivers and embankments, and sometimes former roads or railways which have played an important role in economic exchange. The most famous example is that of the canal linking Chicago and Lake Michigan to the Mississippi.

S.C. and P.M.


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The village of Befijera is located within the limits of the forest corridor linking the national parks of Ranomafana and Andringitra in the region of Fianarantsoa (Madagascar).

one or several species directly usable by managers responsible for establishing and running conservation corridors. The situation has become even more confused since the concept has spread to other fields. In economy, there are transport corridors where the focus has been placed on the interconnectivity of merchandise with a strong territorial aspect, as well as development corridors which focus on networking (of varying degrees of complexity) of data flow. On the outskirts of certain urban areas, green belts were set up to stem the pressure of human activity and now act as migration corridors for wild species.

Consistency and inconsistency

Madagascar is, on several accounts, a case study to understand the life and evolution of environmental policies, but also the friction encountered in setting up protected areas in developing countries. The Madagascan story takes place in an international context where the "corridor approach" has been singled out as the preferred tool to mark out and justify future tracts of protected land. In 2003 in the 5th World Parks Congress in Durban, South Africa, the president of Madagascar, Marc Ravalomana, boosted environmental action in his country by expressing his wish to treble the area protected by 2008. Considering the extremely short period for such measures to be taken, urgency became a keyword in all the post-Durban conservation actions in the country.

In Madagascar, a large majority of the remaining forests – mainly in the east of the country – are basically strip shaped. It was therefore natural that the Madagascan forest corridors be designated to reach the aims of the "Durban Vision" in the framework of the Protected Areas of Madagascar (SAPM), in spite of the caution expressed by scientists concerning their potential ecological role.

While the NGOs specialising in nature conservation worked to protect these corridors, others involved in rural development and economic policies focused their efforts on the development of Integrated Growth Poles IGPs i.e. clearly defined locations for the development of a certain type of economic activity: in Nosy Be it is tourism, in Antsirabe it is agrofood, and in Tolagnaro it is mineral extraction.

Conservation through development

Run as a joint venture by the WWF and the *Coopération Française*, the pilot project around the Onilahy river in Madagascar was born from the desire to combat the deforestation of the Belomotse Plateau, where the forest was being cleared to grow maize and for timber. A social study revealed that the federating force uniting the people of the area was the river at the foot of the plateau. It was along this river that sacrifices were made and weddings celebrated but the river also served for fishing, and for transport. Moreover, biodiversity is greater there. The project therefore concentrated on the conservation and development of a much smaller area structured around the river. It provides an interesting comparison to the river corridors of Europe and certain North American greenways. One of the innovations made here was the creation of a structure known as the Public Organisation for Intercommunal Cooperation, which brought together the mayors of the 12 communes concerned. In reality, the protected area is made up of a strongly protected central core, the forest running next to the river, and a buffer zone containing an area in which usage rights are granted, and a restoration area. This approach makes a very useful addition to the national network of protected areas by enabling the creation of regional schemes run by decentralised structures, conciliating general conservation aims with local aims of development and the fight against poverty.

S.C. and P.M.

Corridors in Europe

Legal recognition of the corridors known to exist across Europe can be explained both by the individual history of each country and by ecological preoccupations. In eastern and central Europe, for instance, planning out the territory which today distinguishes natural areas, urban areas and agricultural areas was actually done following Soviet principles. In other countries of Western Europe however, the establishment of corridors appeared as the only solution considering the deterioration of natural spaces, the density of the population, the fragmentation and the isolation of the natural habitats responsible for the decline of biodiversity. The Czech Republic and Slovakia chose to integrate ecological corridors in a nature protection law. The law, of February 19th 1992 defined the "territorial system of ecological stability" as a complex of interconnected natural or semi-natural ecosystems. This ecological network is composed of "bio-centres", which make up the core areas, and of "bio-corridors". Composed of linear elements of the landscape, their legal recognition could facilitate their future conservation.

In the Flemish region of Belgium, the ecological network concept has also been integrated in the decree of October 21st 1997. The legislator attributed a distinct legal framework for the core areas which differs from that of the buffer areas and the natural transition areas. The transition areas are essential for the migration of plant and animal species between core areas and between certain natural areas of the region. They therefore more specifically constitute ecological corridors. The text stresses that they must form a strip or a line that includes small landscape elements. As the identification of these areas is difficult, the application of the law also remains difficult.

In France, the 1999 bill concerning "sustainable inter-regional planning" was the first stage in the legal recognition of the notion of ecological networks. It stipulates that the "structure of collective services in natural and rural areas" must identify the ecological networks, the continuities and the extensions of protected spaces (article 23). This structure, finally adopted in April 2002 plans the creation of a national ecological network over the coming 20 years. It should ensure continuity between all the sites of major ecological interest, via corridors serving as links between core areas, with the final aim of providing the biota with sufficient possibilities of dispersion, migration and genetic exchange. It is however difficult to evaluate the future impact of these laws as their wording is insufficiently precise. Estonia, Switzerland, Germany, Macedonia and Croatia have given legal substance to ecological corridors but their texts are very recent and need some time before they can be implemented. The effect at the local level of setting up the corridors is as yet unclear, but deserves to be followed carefully. Marie Bonnin

The future protected areas, are laid out all along either side of the great Malagasy Forest Corridor between the IGPs. Communication routes between the IGPs will probably contribute to the disruption of spaces and communities but will also improve their accessibility to tourists and can also have a positive effect on rural development. To avoid these contradictory undertakings, it would be necessary to consider the whole range of possibilities rather than driving for conservation at all costs without attempting to include aspects that will affect sustainable development. The approach used for the Territories of Development and Conservation (TDC), for instance, developed by the *Coopération française*, *Intercoopération Suisse*, the WWF and Fanamby association, is very different from the ecological corridors of the East of Madagascar. It is based on the notion of a coherent territory, where the local populations show strong attachment to their cultural and natural heritage (see box on p. 59). This territorial coherence can be made stronger and thus the notion of the corridor be put to the service of sustainable development and not just conservation. Without economic development, there cannot be efficient conservation. ■

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Local knowledge: limits and opportunities

By Yildiz Aumeeruddy-Thomas
and Éric de Garine

Since the environmental crisis of the 1970s and the signing of the Convention for Biological Diversity (CBD) in 1992, local knowledge has been recognised as being able to play a key role in environmental management and biodiversity conservation. The study of local knowledge, which aims to shed light on the relationships that human societies have with nature is based on an ethnological approach. It provides explanations for the role of local knowledge in its context and how that knowledge can be applied to environmental management.

However, even though the importance of local knowledge is recognised in biodiversity management and taken into account for instance in certain protected areas, farming and herding practices, as well as collecting wild products, are usually forbidden in areas given over to the conservation of nature. There is often a strict separation between cultivated land and areas entirely devoted to conservation. The use of the resources remains concentrated in the land surrounding the protected area where access is limited. It is becoming increasingly clear that if the integration of human practices into the management of protected areas is to be a success, the dynamic relationships between the mosaic of landscapes and the local practices that influence biodiversity must be taken into account.

Focus on the Dolpo

In the Himalayas, for instance, and more precisely in Shey Phoksundo National Park, the activities of the local farmer-herdsmen have transformed the landscape. The long evolution shared between man and nature has generated a unique patchwork of fields, forests and high-altitude pastureland. The landscape is the result of naturalist knowledge, and the practices that it allows, and local social organisation. The division of power between religious authority and laymen, as well as the transmission of property down patrilineages – filiation groups that for matrimonial rules and decisions, favour the male descendents – has led to the dispersion of homesteads over the whole area belonging to the village. The head of each household uses all that the complex landscape has to offer, even for specialised activities – Tibetan medicine for instance in families that practice it. The different usages of the various elements in the landscape are based on man's knowledge of the diversity of cultivated species, adventitious plants, and other species used in food, construction, religious ceremonies, and so on. The knowledge and the values associated to biodiversity vary with the user: farmer-herdsmen have a poor opinion of certain plants that occur with overgrazing but the same species are keenly sought by practitioners of Tibetan medicine who appreciate their healing properties. Thus, the heterogeneity of grazing and gathering activities at various levels – for instance due to measures taken to prevent overgrazing – favours the dynamic management of this patchwork landscape with its various plant communities.

An ethnobiologist identifies dried medicinal plants brought in by the herbalists of the Dolpo.

The greatest plant biodiversity is found in the high pastures subjected to intermediate grazing and gathering pressure. The areas of highest plant biodiversity lie half-way between the summer lodges and the most remote grazing areas. The summer grazing areas are not

within the agricultural part of the park but in the protected sector. This means that access is problematic and traditional means of management are no longer possible. The national park regulations are in fact relatively recent – enforced only from 1984 – and could, in the long run, completely destabilise the balance between local practices and the resulting biodiversity.

Classification a case study

Integrated management not only takes local practices into account, it also involves taking what local society feels about nature into consideration. Society has its own way of classifying the objects of nature, and this leads to a certain number of practices. Folk classification criteria are numerous and can overlap, unlike systematic scientific terminology. Overlapping is doubtless one of the universal characteristics of folk classification. Common names primarily refer to the role of objects in society and to the concrete or symbolic practices related to them. Various groups of plant species can for instance be gathered under a single name that could derive from their ecological attributes, uses, shapes or by analogy, for instance based on colour. In addition, symbolic classifications that cannot be accounted for by scientific taxonomy divide plants into species that are for instance hot or cold, male or female, and can make reference to mythological or superhuman entities, ceremonial uses, etc.

We experimented different ways of integrating scientific knowledge with the local knowledge in a conservation ecology experiment concerning Himalayan medicinal plants. Based on a co-construction approach, the aims of the experiment were firstly to better understand the practical effects of highly endangered species on population dynamics and secondly to set up a process to monitor the populations using information collected by the traditional practitioners themselves. This work required collaboration to determine e.g. which species were relevant, knowledge of the types of risk that they are subjected to, and the degree of heterogeneity of the populations on the scale of the landscape. Our experiments simulated local

This shared field at high altitude (4 200 m) belongs to the village of Pungmo (Dolpo). It is surrounded by pasture in which the plant community is different from that located half way between the summer residences and the furthest pastures.

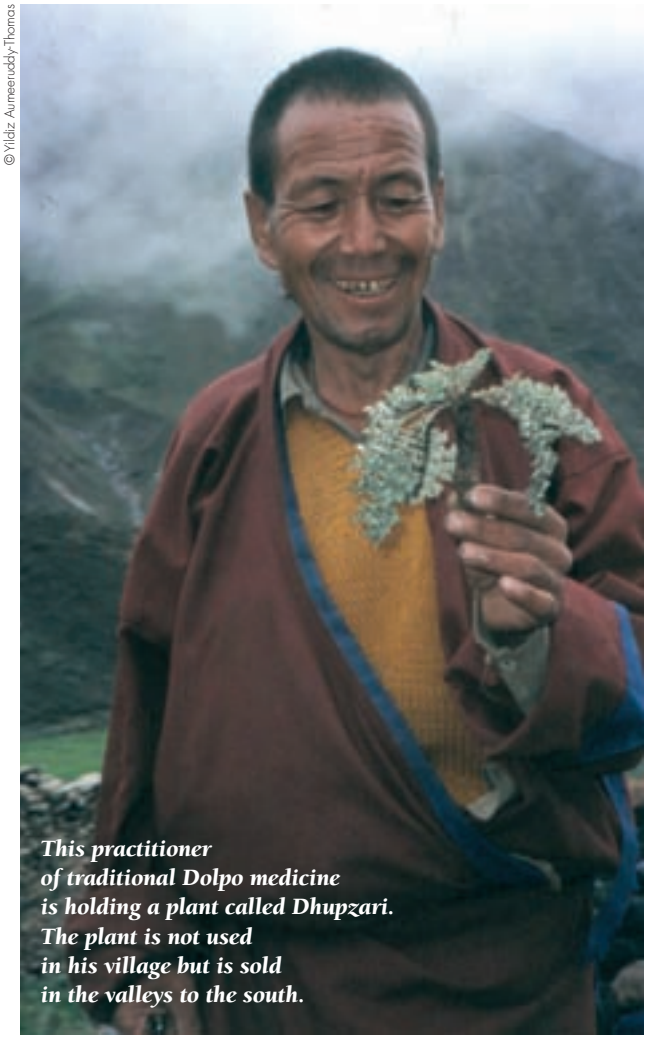
gathering techniques and an ecological follow-up was carried out that was based on indicators using local perceptions of the growth cycles of the plants. But, in addition to this knowledge, which was essentially that of a naturalist, the great success of the project was the creation of an association for practitioners of traditional medicine in the Dolpo region of the Himalayas. They became the driving force, on a national level, of the participation in debates concerning the conservation of the medicinal plants of Nepal. This demonstrates the role that folk knowledge can play in environmental debate.

Traditional knowledge also covers the hundreds of plant varieties occurring in a locality.

A very different situation occurs in the Cévennes National park, France, where the managers take landscape dynamics into account, especially those of open country, where biodiversity is dependent on human activities. The park does however come up against various problems arising from the modernisation of agriculture. Changing practices have had a negative impact on certain species and habitats of heritage value. This has led to tension between the farmers and the managers. The biodiversity managers then found themselves drawn between the will to integrate the dimensions of a vast landscape that includes remarkable and also more ordinary elements, and on the other hand the strict obligation to protect species of heritage interest and their habitats. Management by contract was adopted, aiming to compensate the farmers for their losses due to the perpetuation of less intensive ancestral methods of agriculture, integrating ancient knowledge and know-how. The contracts only affected relatively few farmers and the durability of this mode of management was questioned, considering the limited duration of the contracts. The issue in this case is not so much maintaining ancient knowledge and know-how – most of which is surviving, such as that surrounding transhumance (the yearly cycle of high and low-altitude pastures) – but the question of the decline in agriculture and the unavoidable changes occurring in local farming techniques which are giving way to a more modern approach. Do options exist for sustainable agricultural development favouring the conservation of biodiversity? The park has tried to promote local agriculture, for instance by setting up labels of quality such as the label "*agneau de parcours*" (free-range lamb reared by the ewe), which enhances the protection of biodiversity. This approach however is rather limited. On the other hand, the growing weight of the European agri-environmental measures seems to be a possibility to preserve agriculture. The measures assume that naturalistic and organisational knowledge and know-how of the farmers will evolve. These farmers have today become environment managers or, as some like to put it, the "Park gardeners".

Domesticated species

The layman's knowledge of nature not only concerns the species growing spontaneously in natural habitats but also all those which have "co-evolved" with various societies and have been domesticated. Domestication is a long-term process involving an often random blend of the evolutionary fate of species with the steady stream of inventions made by human societies throughout their history. Abstract knowledge as much as empirical knowledge or the unconscious practices of the farmers of yesterday and today have all played their part in the long history of domestication. An understanding of the local knowledge underlying the control of genetic resources of crop plants is a major issue, especially from the point of view of conservation, as manipulations of plant and animal material by indigenous farming societies have produced an astonishing variety of breeds and varieties. There are dozens, sometimes hundreds of varieties of the same plant, which occur in the same area – such as potatoes in parts of the Andes, or rice in Southeast Asia. This multiplicity cushions the ups and downs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This practitioner of traditional Dolpo medicine is holding a plant called Dhupzari. The plant is not used in his village but is sold in the valleys to the south.

and the general heterogeneity of the environment and contributes to a balanced diet and enables horticulturists and farmers the world over to pursue their various goals.

Although little is known of the underlying genetic mechanisms that are influenced by the knowledge and practices of the farmers, some improved local varieties are suitable for industrial applications, raising the thorny problem of the recognition of and even payment for this traditional expertise. A large proportion of the total number of diverse cultivars occurs in the habitats where the wild ancestors of many crops still grow and it is through complex crosses often involving a mix of spontaneous and cultivated forms that agrobiodiversity is reinvented on a daily basis.

To study the overall context, including the social context, of these practices and local knowledge, an interdisciplinary approach is required which could then become the basis of biodiversity and agrodiversity management. However, simultaneously using folk knowledge and know-how as well as scientific knowledge requires effective collaboration between researchers, managers and users. A formal framework for this type of approach does not always exist in public biodiversity or agrodiversity management policies. New approaches to governance have developed at the international level and in France using the concept of participatory management and negotiated approaches, involving different groups of stakeholders, including scientists on various boards and commissions and in applied projects. There are now a number of participatory tools such as multi agent systems. The results of these different efforts deserve to be evaluated. The position of the researcher as a mediator between scientific knowledge and folk knowledge has yet to be confirmed. ■

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On the access to and the use of biodiversity

By Raphaël Mathevet

Biodiversity is a global public good. It results from dynamic interactions between ecosystems which have, in the course of time, been modified by human societies. Societies, each with their own social standards, have created rules determining access to land and to natural resources. Thus, the decisions made by local communities, industry and government will determine the future of biodiversity, the goods and the services that future generations will rely on.

The rules of access and use have to be defined and guaranteed.

Until now, and on a world scale, biodiversity conservation politics usually focused on limiting rights of access and use by the local population. This is particularly the case during the creation of protected areas covering large areas of land – often common land where social organisation previously played an important role. By considering common property as property with free access, the restrictions have led to significant loss of social identity. And biodiversity continues to decline. Sustainable management of biodiversity and of common natural resources is possible if a system of legitimate authority defines and guarantees the rules of access and use.

In most societies, western or not, the use of natural resources is dependent on the behaviour of the users who are generally subjected to the rules and code of conduct laid down by society itself. Social groups own the rights to access and use land that belongs to them and these rights then structure the customs of the people and the way the land is used. In the Sahel for instance, rain is insufficient and too irregular to grow crops. Pastureland with grass and trees, also closely dependent on unpredictable rains, feeds the flocks of sheep and goats, the camels and the cattle. Stock breeding can therefore only be extensive – the cattle must follow the best pastures. When water starts to get scarce, animals must come and drink at wells , that are traditionally dug and maintained by a family or a group of herders who then have priority access. They can also ask passing herdsmen for a fee to use the water and acquire the right to use the pastures surrounding the well. During the last decades, the creation of new wells or the replacement of traditional wells has generally increased water availability. The herds then grew in size though the amount of pasture still depends on the same

In the Sahel area, the livestock is dependent on wells for drinking water, especially outside the wet season. The water goes first to the family or group of stockmen who dug the well and who look after it. (Niger)

Overgrazing contributes to the desertification of the semi-arid Sahel region.

variable rainfall. This has led, locally, to overgrazing and increased desertification, especially during the dry season. Easy access to water has led the owners of wells to increase the size of their herds without questioning traditional social relationships but it has also led to reduced mobility; exacerbating tensions with the herdsmen who do not have priority rights to water. For the new wells, as no customs regulated access to the water, there were no rights and free access and free use has led to the overexploitation of the resource. In the face of conflict and the need for regular maintenance, attempts to establish rules for a "water roster" have failed in many places and a lot of the herdsmen have returned to their traditional pasture, turning their backs on the new wells. This short example illustrates how technical progress can lead to unexpected ecological problems and social conflict through a lack of understanding of the traditional rules and customs in operation.

Over history, and in current practice, the occupation of land and the need to use a resource to live from one's work have fashioned the rights of access and use of the land. The European settlers in North America illustrate this pattern. But the rights of access and use can also have resulted from state legislation. This was usually the case of the land colonised throughout the world by the western countries. When the rights of access and use are managed by the collective legislation of a local population and if they are not recognised by the central state authorities, the resulting conflict between the two sides over access to the resources can degenerate into tragedy. In Indonesia, for instance, the state granted forestry rights to private companies that were incompatible with the management of the natural resources by the local population. This antagonism led to the overexploitation of the resources. The companies insisted on their rights while the local population continued to use the forest resources. The destruction, intentionally or by negligence, of the traditional systems of regulation leads to authorities from outside the local system claiming ownership of the resources – this can destabilise traditional societies. The creation of privileges for access and use of land have contributed to the erosion of the bonds of solidarity and confidence that were there to unite those who used the land. This situation has also indirectly participated in the degradation of the environment and of its biodiversity. The non-recognition of local rights by the central authorities and dysfunction, mainly due to corruption, of the official management of rights of access and use lead to conflict and penalise

The rules of access and exploitation

Typically, there are five types of rights related to access and exploitation:

- The right of access allows access to a resource whose use does not imply consumption.
- The right to extract authorises the extraction of elements from the resource.
- The right to management determines how, when and where extraction can take place.
- The right to exclusion defines the authorities with the rights of access, extraction and management and those that are excluded.
- Finally the right of alienation authorizes the sale or rent of the resource to a third party.

These rights are usually combined. Thus, management rights usually include the rights of access and extraction. The more rights the stakeholders have, the more they can exercise effective control over the resource and the development of the principles governing those rights. This means that any biodiversity management project would be inconceivable without first analysing the institutional arrangements that regulate the natural resources so as to better evaluate the social and strategic impacts of the conservation and development projects.

the poorer people. Thus, numerous social and ethnic groups such as the Inuit in Canada, the Kanaks in New Caledonia, and the Amerindian communities of the Amazon basin are now demanding autonomy to run their territories and manage their natural resources.

Each of these groups wants to preserve its fundamentals, control outside economic interests and recover financial returns for themselves. The whole question is then to know whether these political and economic claims allow real independence within national territories and how these societies intend to manage their biodiversity once the decisional power has been decentralised or handed over to them.

The implications for the planet

With the commodification of biodiversity, biological resources are no longer considered today as a free common heritage, with open access. Globalisation, of both exchange and production, has resulted in the creation of markets, patents and privileges in access and use, gene sequences, local knowledge, the rights to produce, to market, to hunt, to fish and to "pollute". This increase in the returns from ownership of both land and resources has an impact on the conservation of biodiversity. International conventions and certifications on sustainably exploited environmental resources have allowed certain rights to be respected and environment-friendly practices to be promoted. The Convention on Biological Diversity has helped in the recognition of the sovereignty of states over their genetic resources, mainly used in agriculture, pharmaceuticals and cosmetics through biotechnology. The Convention has also made the states face their responsibilities for the management and conservation of these resources. Each state must therefore define the rights of access and use of their plant, animal and microbial genetic resources. These rights have, since 1992, been granted either to the institutions – such as ministries in charge of forest operations, as in certain African countries – or to the local population within the framework of collective property rights – as in some forest ecosystems of Mexico – or to private companies through rights to private ownership of the resources in question – such as certain pharmaceutical companies in Latin America.

Knowing today that the management of biodiversity primarily concerns knowledge and local practices, we can no longer ignore the communities living off their own land. The desire to integrate these communities and to encourage sustainable development must be translated into the promotion of equitable sharing of the benefits from the use of the elements composing biodiversity. The protection of nature, which used to primarily consist in the exclusion of humans, has now taken the shape of creating biodiversity territories where nature is accepted as being the social product of local communities.

More than ever, the interdisciplinary interactions between researchers, stakeholders, funding institutions and managers are needed to develop collective arrangements guaranteeing access to the resources and equitable participation of the partners. While globalisation, the development of markets, immigration, poverty and a growing population contribute to a general weakening of traditional systems of social regulation, the challenge is to promote the values of equity, sharing the profits of material and intellectual property, safeguarding cultural identities and establishing access rules. ■

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Public policies and biodiversity: towards another "silent revolution"?

By Robert Lifran

In 2002, after ten years of blockade, France transmitted to Brussels, an extensive list of Natura 2000 sites with the conservation objectives for each site so as to be in compliance with the requirements of the European Union. However, owing to the lack of a legal instrument, and especially of a financial one with a corresponding budget, the transmission remained unimplemented in the field. This episode, which is still the current situation, shows how French political priorities do not include biodiversity conservation. Yet, there have never been so many conferences and international conventions signed on biodiversity protection. In fact, the resources devoted to the preservation of biodiversity remain meagre compared with those devoted to other public policies, especially concerning agriculture. This general remark includes both international policies and trade-off at a national level. So, what is at the origin of this contradiction between the national level of implementation of public policies and the rhetoric at an international level? Should this be taken as the effect of politicians' duplicity, playing with words and taking advantage of the ambivalence of the texts, or as a faithful representation of the values and priorities of society at large?

To answer this question, it is necessary to understand that the agricultural modernization of the twentieth century has conveyed a very particular model of the relationship between agriculture and nature. Today, the farming community – including the farmers and their organizations – show great resistance to European biodiversity policies, and, in general, to all environmental policies. These policies are taken as being technically unqualified, lacking credibility or as creating constraints whose social legitimacy is challenged. Nevertheless, going beyond the conflict it is a vital issue in the conservation of biodiversity in Europe and in developed countries, where nature is mostly managed by farmers. The training and education that has been received by farmers for more than half a century are not unconnected with this rejection. The agronomic model developed in the nineteenth century and completed in the last century was built on the progress of chemistry and generalised dissemination of insecticides and other pesticides. The objective was to free agricultural production from the "constraints" of nature, such as the natural fertility of the soil, to approach the conditions of industrial production. The mental framework

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Landscape and biodiversity are both a global public good – they concern humanity – and a local public good – they are linked to a territory and a population. (Côte d'Or, France)

Crops use just a handful of plant species – the same is true for livestock.

at work mechanically responded to each issue separately, by an action based on proportionality, without taking into account the interactions between variables, or phenomena of adaptation. Its slogan? "If man is not master of nature, then at least he can be master of his fields!" This "silent revolution", long praised by the leaders of agricultural modernization, such as Michel Debatisse, has imposed this model as a social norm and as an economic and organizational standard, mimicking the world of industry. The key words were specialization, economies of scale and growth, integration and social division of labour, with the consequences that production is concentrated in regions in the best economic position and that the link with the territory and landscapes has been brutally severed.

The strength of this model-cum-ideology is seen through the rejection long expressed by the farmers and their unions to be perceived and acknowledged as "gardeners of nature." Gradually, agricultural modernization began to rhyme with industrialization and mass production, while eroding the advantages of the diversity of production processes and products offered in favour of standardization and specialization. In economics, as long ago as the nineteenth century, the general line of thinking paralleled that of Thorstein Veblen who proclaimed the preference for diversity: diversity of assortment and of choice, was rapidly erased.

For example, in agriculture, it is worth noting that among all known cultivated species, just thirty are now sufficient to feed the entire world population . This figure could be challenged but will still remain small in comparison with the thousands of cultivars and local races previously grown on our planet. The species that did not seem directly useful or profitable have simply been consciously forgotten. Moreover, the new agricultural model has done everything to escape from nature, or at least it would appear so. The performance criteria used, such as productivity per unit labour or capital, have completely ignored the use of natural resources. The consequence is what we see today: over-exploitation of the resources and the destruction of biodiversity.

The success of the model though, rapidly reaches its limits. In developed societies, from the moment that basic needs were met by mass production, an interest in diversity again emerged among consumers, and among concerned producers too. People have different needs and each of us would prefer more than a limited range of choice. Standardization creates the need for diversity in consumption patterns and lifestyles. This need for diversity is a tremendous asset for biodiversity. By freeing time for recreation, the industrial society of tourism, which can be divided into both little concentrated local areas and industrialized and internationalised areas, has allowed the advent of tourism and the discovery of the multiplicity of landscapes.

Non-profitable species have been consciously forgotten.

Landscape and biodiversity are not only global public goods – they relate to mankind and its destiny on the planet – but also local public goods – they are linked to a territory and a specific population. Is it possible to hope that local initiatives based on a more refined perception of the challenges and benefits for local people, can compensate for the shortcomings of national governments? If the landscape becomes a resource for tourism, at both local and national levels, some states may see an economic advantage to becoming involved in the conservation of biodiversity. This is the case in the countries of southern Africa or Central America which benefit from their wildlife through luxury

tourism. These countries have reversed their priorities: tourists first, then agricultural development. In Southern Africa, elephants are preserved and farmers receive compensation when they are victims of elephant damage. This is also the case in Australia, where tourism receipts have exceeded those of the mining and agricultural sectors, and where protection of the Great Barrier Reef has become a national priority, imposing constraints on mining and agriculture.

In France, landscape diversity is recognized as having a heritage and identity value, but also as a resource to preserve. However, the landscape and biodiversity are closely linked through habitats and ecosystems. Would the local level not be more suitable than the national level for the collection and management of complementary interests? The difficulty here lies in the disparity between the resources that can be devoted by local authorities such as Public Establishments for Cooperation between Communes [*Établissement Public de Coopération Intercommunale*] and the "inter-municipality unions" and those that can be devoted by the large political sectors. Thus, the budget of the Common Agricultural Policy is much higher than that of all the Regional Natural Parks and that devoted by municipalities to develop their tourism. However, this does not mean that local policies are doomed to be inefficient. Quite the contrary. A strong consensus of opinion around a local development project or coordinated local initiatives can have effects that are far more lasting and that lead to more permanent structures than national policies of income redistribution.

When consumers feel the need for consumer products that are varied and for different lifestyles, they can more easily understand that biodiversity is also important in nature. This may induce a change in priorities at the local level first, then at national and European levels. But these new needs for diversity, service and environmental quality must be echoed by farmers who should then critically review all their

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Some countries have reversed their priorities: preserving wildlife to attract tourists from around the world. (W Biosphere Reserve, Niger)

references and their practices. We defend the idea that it is at the local level that this encounter should take place, especially because farmers have a direct interest in the development of new goods and services related to the landscape and to biodiversity. But we must be aware of the intellectual, social and information work needed to make farmers' practices and mental schemas coincide with the new expectations of society. It is quite clear that this "revolution", already well under way at the local level and put into practice by many farmers, will not be feasible without a parallel change in the ways of thinking and working in research itself, whether in ecology or agronomy.

One of the most striking examples of the rediscovery of the role of diversity in agriculture comes paradoxically from one of the most controversial innovations of recent decades. In the USA, genetically engineered varieties resistant to pests have been grown for several years, and it was soon realized that this had led to the occurrence of species of insects that had become resistant to the genetically engineered variety. Accordingly, the cultivation of genetically engineered-free zones – so-called refuges – is now advised to maintain parasite diversity and avoid the emergence of resistance. Neither new nor different from the emergence of antibiotic or pesticide resistance, it is the promotion of these refuges around genetically engineered crops that is an innovation which demonstrates an awareness of the limits of man's omnipotence over nature. But it is also the proof that it is in the interests of agronomy and economy to conserve biodiversity! Moreover, the model of production based on standardisation, mass production and the dissociation of agricultural production and nature – including biodiversity and landscapes – is beginning to be challenged by scientific studies, as illustrated by the report of Bernard Chevassus-au-Louis published in 2006.

By the end of the Second World War, scientists faced with the damage caused by the massive use of synthetic insecticides such as DDT imagined using the regulatory mechanisms observed in nature to control crop pests. The concept of biological control, symbolized today by the widespread sale of ladybirds to combat aphids, was born and showed that it is possible to use ecological knowledge of biodiversity for the benefit of agriculture. Today, the International Organisation for Biological Control (IOBC) identifies and explains examples of the effective use of the methods advocated, their failures and their protocols.

A final example of relevant research with a direct impact, both for biodiversity conservation and for agriculture, is the recent discovery of the positive role of habitat diversity at the local level. Landscape elements outside the fields: hedgerows, wooded strips along rivers and streams, copses, woods, and so on, are all habitats for species useful to agriculture. These functions of biodiversity are now internationally recognized by the Millennium Ecosystem Assessment. They must now be applied to the design of agricultural production systems integrated into the ecosystems. Now is the moment for the "silent revolution"! ■

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CHAPTER 3

Dynamic conservation where biodiversity occurs

- **References to define**
  - The city: a new reference
  - DEBATE: active management or letting things happen?
- **Societies that become involved and commited**
- **Evaluation: a dynamic approach**

Dynamic conservation where biodiversity occurs

By Frédéric Bioret
and Raphaël Mathevet

Learning by experience. This should now be the motto of many managers of natural areas. Implemented successfully in English-speaking countries, adaptive management still deserves better press in a number of other countries including France.

The approach responds to the challenge of conserving biodiversity in particularly complex ecological and social systems. By considering management options as hypotheses and management actions as experiments, it continuously adapts the choices made based on local experimental results. Different from learning based on trial and error, it concentrates on creating a close link between scientific research and the management of natural spaces – this supports the reflection and learning structures arising from the specific actions performed.

The dynamic management of species is part of the adaptive management approach. (Osprey, Camargue, France)

Adaptive management may be analogous to certain traditional practices. Constant feedback from local experiences has often helped people adapt to changes in their environment. In North America for instance, and especially in subarctic ecosystems, Cree Indians, managed their wildlife successfully and coherently, for several centuries. With capricious weather varying from one year to the next and affecting the distribution of animals, the number of individuals they hunted and fished was compatible with the biological productivity of that year. The ecological crises of populations of caribou or beaver, their main game, were usually quite well managed. Even today, Cree Indians consider the hunter as an integral part of their ecosystem. Thus, they apply to human-animal relationships, values not unlike respect and sharing. These values transmitted by the elders seem to have played a major role in their social system. It is they who legislate, adapt and enforce the rules of hunting in the community. Reality, however, is not always idyllic. During their history, the Cree Indians have sometimes questioned their values and changed their practices. The consequences were immediate: their natural resources became overexploited. But their social system based on cooperation and respect for the rules of access to resources, enabled them to take appropriate corrective steps to overcome these episodes.

Thus, the daily observation of wildlife, in conjunction with local institutions capable of adapting to prevailing situations, allowed man to manage his environment sustainably.

What is the similarity with adaptive management? Learning while being able to modify management practices from the analysis of one's experiences in the field. The effects of ecological thresholds that may threaten the existence of socio-economic activities are

thus partially avoided. A notable difference, however, emerges with respect to traditional systems: the decidedly scientific approach to adaptive management. Rather than relying on moral or religious beliefs, it is based on testing hypotheses and generalising theories. In the protected area of the marshes of Vigueirat in the Camargue (Rhone delta), for example, after making such an approach, the experimental results from the management of water and pasture in the plant succession occurring in fallow rice paddies, were successfully applied to ecological restoration operations in other wetlands around the Mediterranean.

Local decisions

However, owing to the risk of being unsuccessful, adaptive management must not be imposed but rather developed in conjunction with the local stakeholders. This is particularly important for the processes taking place in areas outside the reserve. In the lower plains of the river Aude in the south of France, for example, the organisation in charge of preserving the natural heritage and water management has developed an approach of joint management with the key players of the wetland. Rigorous monitoring of environmental variables – water levels, salinity, area covered by reedbeds – and a highly responsive decision-making mechanism allowed water management to be adjusted according to the needs of the local stakeholders, the ecosystem requirements and the hydrological variations. This co-management strengthened and enhanced the responsiveness of local management. It brought together the knowledge of scientists and laymen, arising from experience in the field, with established rules of usage that had been validated collectively. It also led to the replacement of informal management by a management plan and an *ad hoc* decision committee.

Adaptive management is a process of learning "as-you-go". It makes an effort to reduce the social and environmental costs of mana-

Biodiversity management in 7 steps

Adaptive management is a systematic and iterative process. It implies interactive management organized following seven steps.

- **1st Step: Phase of identification of the issues involved**

  It is based on an overview of the corpus of existing knowledge. It is assessed whether the knowledge is up to date, and complete, and if not, defines the gaps. This is also an opportunity to develop a theoretical model of the system to obtain estimates of what alternative methods of management could do. Different management scenarios are thus developed.

- **2nd Step: The selection of indicators**

  The development of a management scheme and a monitoring program is accompanied by the choice of indicators, which depend on the objectives and time scale taken into account: short, medium or long term. If gaps had been identified during the first phase, Step 2 is useful to try to fill them. Studies or specific updates are necessary in this case.

- **3rd Step: Implementation**

  The management methods chosen are implemented.

- **4th Step: Monitoring indicators**

  The information is collected in real time.

- **5th Step: Assessment**

  Comparing the results and the indicators for different scenarios can lead to the development of new hypotheses on the dynamic management of the ecosystem.

- **6th Step: Adjustment management plan and experimentation**

  Depending on the results of the evaluation, the management goals, procedures and predictive models can be revised.

- **7th Step: Use of the results**

  The last phase is the use of the experimental results to better understand the "cause and effect" relationship of the selected management practices. These practices will then be adapted depending on the evolution of the ecosystem and the management objectives. Finally, and in conclusion, returning to Step 1 can pursue improvement in knowledge and management practices.

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In North America, the Cree Indians managed their wildlife successfully for several centuries. (Jasper National Park, Canada)

gement experiments by increasing knowledge about the system. It seeks to facilitate social learning by setting in train a combination of evaluation, modelling and experiment to identify uncertainties and test hypotheses to explore questions asked by managers and scientists. But, despite the excellent press it has had for the last 25 years, too few managers and policy makers dare to implement it for fear of having to bear the monitoring and testing costs, but also of confronting its inherent uncertainties.

In the future, however, it will be desirable that these principles be included in the management planning documents of protected areas in France, and particularly in natural reserves and biosphere reserves. This is one of the keys to the co-construction of a viable project in a locality, involving all the stakeholders in the different approaches to modelling, dialogue and commitment of the local people. ■

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Taking global changes into account

The interactions between changes in our way of life and changes of climate – gathered under the term 'global changes' – and biodiversity make up a situation that our planet had never experienced before. Numerous protected areas have been created and are still managed with the aim of conserving 'representative' ecosystems, which might no longer exist following the changes in progress.

The improvement of the planning and management of these areas would, a priori, involve climate change scenarios and their potential effects on biodiversity. It is becoming necessary for managers to plan 30 to 50 years ahead, instead of the currently practiced 3 to 10 years. In this perspective, the improvement of management approaches for current and future protected areas must incorporate certain elements: the construction of climate change scenarios linked to analysis of model sensitivity, an increase in continuous surveillance monitoring, taking interactions into account in the biological inventories to conserve the potential of species to evolve, and finally critical analysis and the revision of management practices.

Fluctuations of climate affect fish populations.

Projecting into the future is also indispensable to enhance dialogue between researchers, decision-makers and managers. The projections into the future concern both wild and domesticated or cultivated species. Certain models related to climate change already predict that species will have to migrate by a kilometre per year to reach suitable new distribution areas. This is the speed at which post-glacial recolonisations took place. The new distribution areas must therefore be the object of a redefinition of land use and new legislation.

Nevertheless, the species and their populations do not react simply by changing their distribution areas. Climate change is going to affect the processes of selection and the biotic interactions occurring (predation, parasitism, symbiosis). This should give a better picture of the adaptive responses and the ability for populations and species to evolve. Moreover, fisheries, forestry and agriculture will all be subjected to global changes. But in what ways? How can we foresee the adaptation to global change effects of human activities that involve the use of living resources?

Other questions concern biological invasions. Which regions are at risk and from what type of organism? What will their average effects be? If suitable anti-invasion management solutions are to be found for quarantine and other methods of control, answers to these questions are indispensable. The climate also has repercussions on health, in particular on the relationships that occur between the pathogens and their hosts. Climatic episodes such as El Nino are not only causing the death of coral, but also cholera epidemics among the human population. Increases in the levels of CO_2 can exacerbate plant pathogen attack.

The simulation and forecasting work done on the effects of climate change provide a better picture of the modifications that may occur in the distribution areas of species. But, the ecological footprint left by man could be too extensive to allow the necessary poleward ecosystem shifts owing to urbanisation or other land use. Great difficulties will be met in particular in the areas known for their high levels of endemism in the so-called biodiversity hotspots. These protected areas, which often coincide with political hotspots, compromising their durability in time, absolutely must anticipate the effects of global change.

SERGE MORAND

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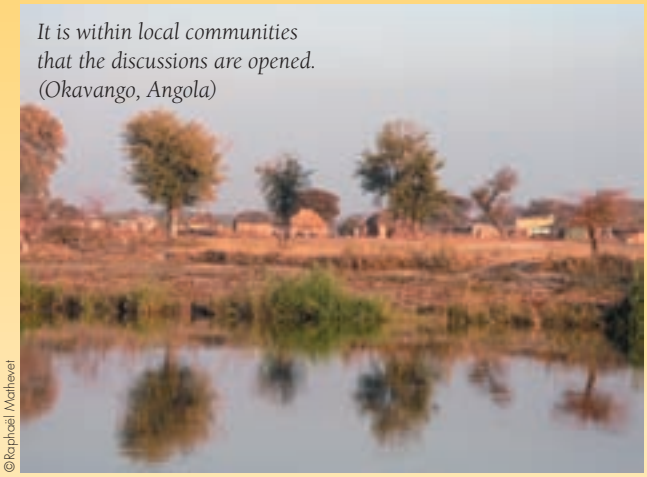
ZOOM

Six biosphere reserves to build together

By Harold Levrel

Putting hunters, livestock breeders, fishermen and beekeepers round the same table to work collectively on Society-Nature interactions – that is what co-construction is all about. Co-construction cannot, however, be done without the use of biodiversity and interaction indicators relevant for local stakeholders and which facilitate dialogue about biodiversity management (see the article by M. Etienne on p. 98 and by H. Levrel on p. 105). It is with this aim that a study was conducted in six biosphere reserves in West Africa: Pendjari in Benin, "*Mare aux hippos*" in Burkina Faso, Comoé in Ivory Coast, Baoulé loop in Mali, W in Niger and Niokolo-Koba in Senegal.



It is within local communities that the discussions are opened. (Okavango, Angola)

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Coordination of the co-construction work, which lasted a fortnight, was organized in each country by a person with experience of the indicators. Also taking part in the study were the managers of each of the biosphere reserves, scientists from the natural and social sciences, local arbitrators, and obviously representatives of local activities. The first step, which is to meet the representatives of the local communities – a group of villages, an association, an individual, an economic grouping – enabled the objectives of the program to be presented and discussions opened on the issues concerning access to and uses of biodiversity. In particular, the identification of resources, the decrease of some, conflicts of uses or of access, the relationship of local communities with the staff of the reserve, and so on.

Putting negotiation on the schedule

The second stage lasted between 3 and 4 days and brought together representatives of local activities. Those concerned could be the sedentary herdsman, the grower of bananas, cotton or peanuts, the forester, the weaver, and so on. The scientists' main function was to inform the participants and to organize the information without ever interfering in the process of negotiation and collective choice. The mediators noted the outcome of discussions by arrows in diagrams, using figurines and icons to formalize the point. They also established an atmosphere of trust evening out the balance of power in the negotiating process. The choice of stakeholders, resources and interactions was the object of the discussion necessary to reach a consensus. Which was not always possible.

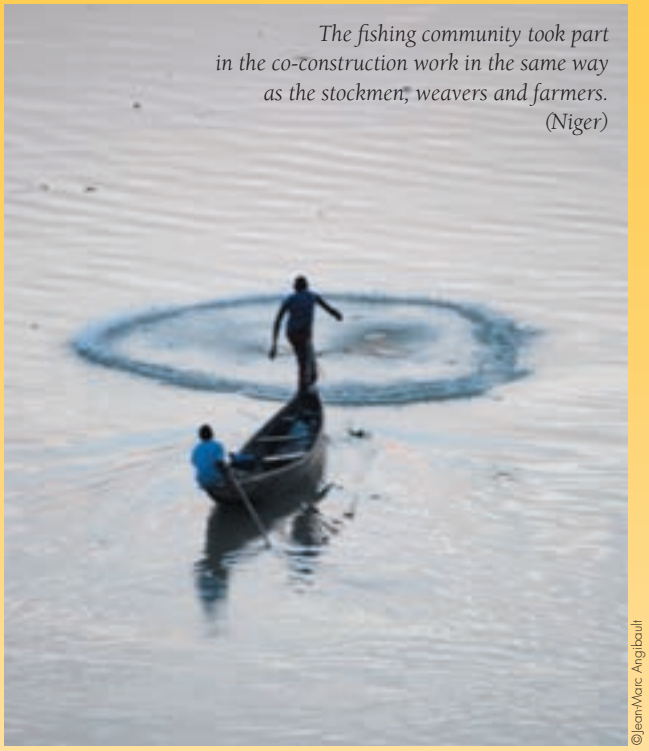
Several indicators were tested. The first, based on a Pressure-State-Response model, which can be used to assess the pressure of human activity on the state of biological diversity, in fact had the effect of exacerbating conflict rather than appeasing it. Even though participants often evoked pressures as causing resource degradation, their own work was never questioned. The pressures came from "use by others."

On the other hand, some of the pressures on the environment were not necessarily of human origin. Certain invasive plants that changed the working environment were felt to be causing pressure. Biodiversity itself was considered in some cases as representing a pressure for man – for instance, the warthogs and hippopotamuses that cause damage in

the banana plantations of Niokolo-Koba. The indicators focusing on the state of ecosystem services and how the services are used, were more successful. With local people first, who could take the indicators to describe their own experiences, but also with managers and scientists who saw an interesting opportunity to develop low-cost biodiversity management indicators.

Understanding others

To make the indicators more lively, setting up role-playing was especially appreciated because it gave the participants the opportunity to use them. In role-playing, effects due to customs and social interactions were made visible and the importance of certain individual or collective behaviours, on the dynamics of the relationship between man and nature became clear. This approach gave the occasion to launch a dynamic interaction between players not used to communicating with each other. It provided the opportunity to produce indicators that made sense for all stakeholders and that benefited from local legitimacy. ■



The fishing community took part in the co-construction work in the same way as the stockmen, weavers and farmers. (Niger)

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The co-construction approach is first based on the identification of territorial resources and on the access to biodiversity and its use. (Niger)

When the past recounts process dynamics

By Frédéric Médail

Because everything undergoes constant change in living systems and because time is irreversible, it is with caution that we should use the terms of naturality, stability, and reference ecosystem. Naturality proves to be quite relative and also subjective as virgin territories that have never been touched by man must be a rare thing indeed. In Western Europe, over 75% of the land has been completely transformed from its "initial" post-glacial state. The concept of naturality has, however, been widely used to choose territories for protection. An empirical selection was made of areas unaffected by human impact, at least not noticeably. The selection favours patches of vegetation where the species that are dominant and constantly present are native and where the structural characteristics of the ecosystems remain close to those presumed natural.

Paleoecology: the main fields covered

Paleoecology, in the strict sense, is the study of the ecological history of ecosystems, communities or species by means of localising, identifying, quantifying and dating biological remains – pollen (palynology), charcoal (anthracology), mollusc shells (paleomalacology), etc. – on time scales of a few hundred to thousand years. Historical ecology focuses on more recent periods – about 50 to 200 BP – and is based on archive documents such as the Doomsday Book, Napoleonic land-use records, religious records, old maps, such as the Cassini maps drawn up in the 18th century, or aerial photography. In parallel, disciplines such as historical biogeography, phylogeography and molecular phylogeny can provide precious information, with very fine taxonomic resolution on colonisation and evolution occurring in fauna and flora in a given biogeographical region.

Recent changes of land cover, such as woodland recolonisation, have imposed new management approaches. (Mont Ventoux, France)

Furthermore, some communities or populations that are isolated and usually considered as relictual by biogeographers – and thus to have a high priority for conservation – can even be the result of voluntary extensions by man. Most landscapes and plant communities in temperate Europe and the Mediterranean basin in fact date from the end of the Holocene – at the earliest 1000 to 1500 years BP – and have been fashioned by centuries of occupation by man and his flocks. In addition recent changes in the way land is used – shrinking agriculture, reforestation – impose new dynamics that must be placed in a broader time context.

75% of all land has been transformed from it's "initial" post-glacial state.

Aid for decision making

To get a better overview of the trends in process dynamics and hence the management orientations that should be promoted, we should try to understand the relatively recent history of areas of land and habitats – from a few decades to one or two centuries. Paleoecological approaches (see box on p. 80) can provide objective information about how native the key species are and allow decisions to be made about the real biogeographical significance of the habitats or the populations to be conserved. These approaches also indicate how the area to be managed is affected by natural local and regional disturbances and determine the type of effect occurring and its intensity. When conservation ecology is considered as something that is constantly evolving, the above notions play a determinant role because disturbances are the main driving force behind the dynamics and the heterogeneity – and thus the biodiversity – of ecological systems. Assessing the way landscapes change with time can enable an estimation to be made of whether their current structures and their animal and plant compositions are the result of historically traditional land management practices.

To evaluate the "fragility" of ecosystems and the status of endangered species – giving an overall picture of the sensitivity of the ecosystem, community or species in a changing environment – examining the resilience capacity appears to provide useful information. Some habitats must in fact remain on the knife-edge of instability to retain the biological interest attributed to them, and keeping them there requires taking specific management measures. Paleoecology can contribute to evaluating the fragility and the causes of change in the environment. For example, paleolimnology studies carried out in lakes in southwest Scotland showed that the disruption of the aquatic communities noted from the 1870s was due to the acidification of lake water due to a rise in levels of man-made sulphur dioxide..

While the expressions "balance", "equilibrium" and "ecosystem stability" are still frequently found in conservation ecology and biology, it would be more suitable to firmly

When one "natural reality" is masked by another

The forests of holm oak (*Quercus ilex*) of the Mediterranean basin were long considered to be in ecological equilibrium, commonly referred to as the climax. As typical Mediterranean forests, they were considered by many authors to be classic structures of the region and were used as a reference frame to mark out the extent of the Mediterranean bioclimate. However, paleoecological data show that the extension of these oak woods is linked to the actions of man. The holm oak in fact gained ground in pre-forest structures that include trees like junipers and pines but it also in post-glacial deciduous oak forests (pubescent oak, *Quercus pubescens*) when man probably already started to destroy it or at least make clearings.

Today, after almost half a century of non-use, the holm oak forest is again undergoing transformation. The species composition of this forest is starting to include deciduous trees or shrubs while the pre-forest species are disappearing. Finally just representing a transient stage in a dynamic sequence, the evergreen oak forest is thus the result of traditional land use over the past centuries. F.M and F.M

Naturalness: respecting spontaneous nature

Abandoned pasture and arable land, artificial lakes left to silt up, peat bogs drained and left to manage on their own, town parks, canal banks, etc. By ceasing all human intervention, how will these habitats evolve? What will the heritage of man be and what new trajectories will emerge from his landscapes? Naturalness is associated with the spontaneous state of nature. When man stops acting voluntarily on his environment, whether it be urban, agricultural or woodland, he is in fact acting on "ordinary nature" which, more often than not, leads to the proliferation of opportunistic plants such as nettles, brambles and neophytes, i.e. exotic garden escapes.

Not greatly appreciated because they are synonymous with human non-intervention, this type of growth is known as weed, scrub or wasteland. These terms are found all the way through to scientific literature. In the current context where in fact we preach the virtues of saving species and rare habitats, it seems peculiar not to attribute an intrinsic value to the spontaneity of processes. If there is no reference to a past situation, owing to the multiple modifications that have been made to the so called "natural environments", weed, scrub and wasteland will be the references of the future. New paths into the future will be taken via the occurrence of stages and series of unknown species, including "undesirables". It is for these reasons that, for the sake of a new biodiversity, spontaneous nature deserves to be protected.

Annick Schnitzler and Jean-Claude Génot

© Stéphane Durand

Rough land and scrub, synonymous of lack of human intervention, are not greatly appreciated.

establish a context of adaptation, migration, movement, opportunism, flexibility and resilience, concepts much more suited to study the complex dynamics of ecological systems which are undergoing constant change in both space and time.

The emerging concept of ordinary nature

If one were to plot a gradient of how artificial land is, ordinary nature would be the large section between the gates of the city and the entrance to the national park. It is that immense shared area where man and biodiversity must live together and where neither of the two can possibly be considered as negligible. The term 'wider countryside' has been coined for what ecologists would call anthropo-ecosystems. It is the countryside with its farmland, scrubland and commercial forests. Ordinary nature is now part of the scientific approach to conservation. Ordinary nature is closer to man than extraordinary nature – the way it changes is an indicator of our quality of life. Ordinary nature takes up a great proportion of the land area and provides us with the ecological services that we need. It governs the fertility of the soil, the quality of the water, the pollination of plants, the resistance of ecosystems to noxious introduced species, the control of crop pests, and on a different scale, the attenuation of the effects of global warming: creating carbon sinks, blunting the force of floods and storms, rapidly restoring biotopes following fires and other catastrophes. Finally global changes, particularly climatic changes, will lead to the complete reorganisation of biodiversity. Firstly, endangered species will be made to come out of their sanctuaries and move through ordinary nature, and secondly, the main body for the potential for evolution is located within large populations of common species – the reservoir for biodiversity of the future. Showing concern for the state of health of ordinary nature is therefore acting by anticipation on that of extraordinary nature.

Romain Julliard

The extension of evergreen oak forest in the Mediterranean basin is correlated to the extension of human populations. (Côte d'Azur, France)

Understanding from history

As nothing is stable, making conservation decisions and wanting to maintain the fundamental ecological processes of a landscape or an ecosystem requires taking a sufficient timescale into consideration. But, although conservation biologists have sufficient practice at working along spatial scales of various sorts, time scales receive much less attention. Conservation sciences – conservation ecology, conservation biology and restoration ecology – often ignore information to be gained from history and focus on a time window that is too narrow to correctly follow the dynamic trends of populations and habitats and the actual magnitude of man's impact, whether ancient or current. Conservation sciences therefore require a historical perspective as it is necessary to know which Nature needs protecting and in what way. ■

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City flora

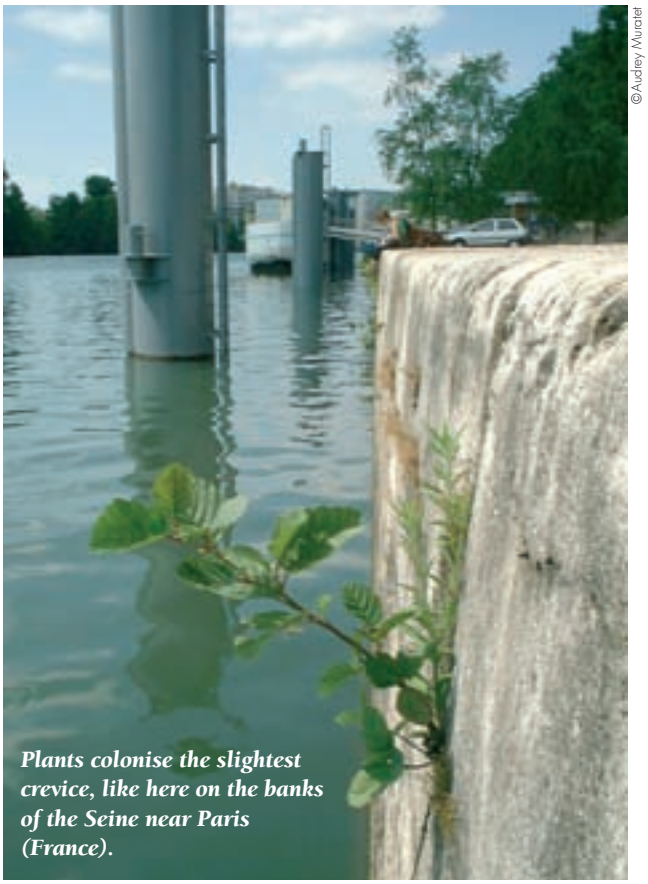
By Nathalie Machon
and Audrey Muratet

Trampled, squashed, dehydrated and even eradicated, wild plants in town have a hard life. Yet they resist and return to grow in the smallest of available cracks. With its hectic pace, the city is not built for nature but, in the midst of these entirely artificial surroundings, a flora and a fauna manage to live even though their future seems anything but secure. Extinctions and colonisations follow one after the other with plant populations that can contain just one or two individuals. At this density, reproduction is clearly a challenge!

Urban floristic inventories are not new – in 1635, Jacques Cornut was already listing the plants growing in the Paris region in his *Enchiridion botanicum Parisiense* – the study of urban ecosystem dynamics has today reached a peak. After having studied nature from which man was excluded, the scientist became aware of the interest of towns and cities as experimental laboratories. Also, with the impetus of sustainable development, cities have started to pay attention to their biodiversity. In Europe, cities like Berlin and Halle in Germany, Plymouth and Birmingham in the United Kingdom, Rome and Brussels have taken a closer look at the plant diversity growing out of their walls. In the National Natural History Museum in Paris, we looked at the flora of the *Hauts-de-Seine*, just outside the Paris city walls. This *département* is the most densely populated in France, with 8118 inhabitants per km^2.

Counting and naming

As seen in other studies, the mosaic of urban habitats favours a variety of species – in *Hauts-de-Seine*, we counted 626. In Halle, in Germany, the urban area contained almost 20% more species than the surrounding agricultural land. Mostly, these plants are cosmopolitan and do not represent much conservation value for biodiversity. Many colonise the cracks and gaps in the tarmac, paving and walls of the built-up areas. Others are found in urban lawns, wasteland, ornamental hedges, roadsides or railway embankments, along waterways, ponds, etc. But some rare species, usually living in rather special habitats, natural relicts in an urban setting, resist. In *Hauts-de-Seine*, we found 5



©Audrey Muratet

Plants colonise the slightest crevice, like here on the banks of the Seine near Paris (France).

plants that have heritage value, and three of them – *Cardamine impatiens L.*, *Cuscuta europaea L.*, and *Thelypteris palustris* Schott – live in the wet habitat bordering the river that flows through the *département*, the Seine. The cosmopolitan species live alongside a fair proportion of exotics – 16% in our study. Whether they were introduced voluntarily or not, they now behave like native plants. Difficult to eliminate when they become invasive, they sometimes cause management problems in parks and gardens. They are mostly found in sites left vacant by the local flora and thus in fact do not cause much disturbance of the urban ecosystems that they invade.

Are townsfolk ready to accept wild plants in an urban setting?

Questions around towns

Concerning the dynamics of gene flow in the urban habitat, it appears that in spite of the high proportion of built-up area in the *département* – it accounts for about 70% – the seed and pollen migrate from one habitat to another. The exchanges are however more numerous between sites of over 2500 m^2. A low density of buildings and an urban structure crossed by numerous communications networks favours exchanges between populations.

The floristic inventories will serve as references for the future and will allow the priorities of urban management to be better identified. Do we wish to preserve the natural mechanisms of species dispersion – facilitated for example by a lower proportion of built-up area – or have relict populations? Are city dwellers ready to put up with wild plants in town? As these questions try to make themselves heard at the city gates, it becomes increasingly necessary to find answers: one human being out of two today lives in an urban area. ■

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The city, a common denominator

By Anne-Caroline Prévot-Julliard
and Véronique Servais

In spite of popular images that reduce nature to virgin spaces, fauna and flora really are present right in the city centre. Closely linked to man, urban nature concentrates particular qualities that make it different from the surrounding communities. And what if the city became a place of exchanges, a place of reconciliation between two totally different concepts of nature? One concept, that of the protectors of nature, which is objective and rational, based on fact and the other, which is subjective and cultural, that of the general public, based rather on sentiment. Many authors express their regret at the increasing distance that separates the general public from nature. The population, mainly living in cities, imagines nature as something far away. Just like nature conservation, for which city dwellers consider that they can only act in a limited way. Paradoxically, many of those living in western countries say they would like to live outside town to get closer to nature but while they are in the city they look for areas that are clean, well kept, manicured.

Urban parks: a calming influence and place of liberty.

Cities do however offer a large number of ecological niches ready for colonisation by fauna and flora, even though they are strongly disturbed and present particular environmental conditions – temperatures, dryness of the air, etc. – generated by the urban layout and the architecture of the buildings. Finally, they also house a mosaic of human populations with various socio-economic statuses, which act on the colonisations and the long-term success of the plants and animals. Generalist wild species suited to the urban conditions are the first to benefit from this environment. Other "less wild" organisms were voluntarily implanted in the 19th century in the first urban projects – city parks – to bring light and greenness. Tamed via the garden, this nature is sought for its calming influence and the impression of security that it provides. Wild parks and urban wasteland, qualified by some people as dirty and even frightening, can in fact represent an area of freedom and exuberance for others. Finally the inhabitants themselves have introduced feral (usually exotic) species

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Which city-dweller has never been in a municipal park or garden? Light and greenery are sure to be there. (Buffon Park, Montbard, France)

into cities. They make up the third category of urban species and are a subject of active debate in the scientific community (see the article by E. Tabacchi and A.-M. Tabacchi on p. 52).

Voluntarily introduced species, such as the Florida terrapin released into decorative ponds and lakes, or escaped species, such as parakeets and coypus, give a perfect illustration of the opposing conceptions that divide the protectors of nature and city dwellers. The protectors consider them as dangerous because they threaten the nature around them whereas the public quite likes them. Not too frightened of people and easy to observe, they look like the pets they once were and give the impression that wild nature is in fact accessible. Sometimes, they can be the only link between certain city dwellers and nature on a daily basis.

When ecology and social work meet

These three categories of species show that there can be many conceptions of nature and that they all depend on the history and the culture of each person. Childhood is often described as being a key moment in the development of ecological awareness, which is reported to have consequences beyond simple superficial attraction and consumer attitude. Knowledge resulting from direct daily confrontation with nature is very different from that obtained from books.

Urban systems should therefore be considered to be socio-ecological systems for which biologists and social-sciences researchers should work in symbiosis. From an ecological point of view, the construction of shelters and feeding cats and pigeons, acts on animal and plant populations but, from the social sciences point of view, the presence of parks in town affects the physical and psychological well being of the city population. The need for a relationship with nature, also known as biophilia, is thought to be one of the reasons for which people surround themselves with animals and plants, feed stray cats and pigeons, and frequent public parks and gardens.

By working hand-in-hand, sociologists and biologists will help to construct operational

Plants act on the psychological health of urban populations.

models for these socio-ecological systems. They will be able to propose policies for the management of natural and urban areas that are more understandable for the city dwellers. We only wish to conserve what we know well. So, conserving and making urban biodiversity better known, represents an immense opportunity to conserve nature in general. ■

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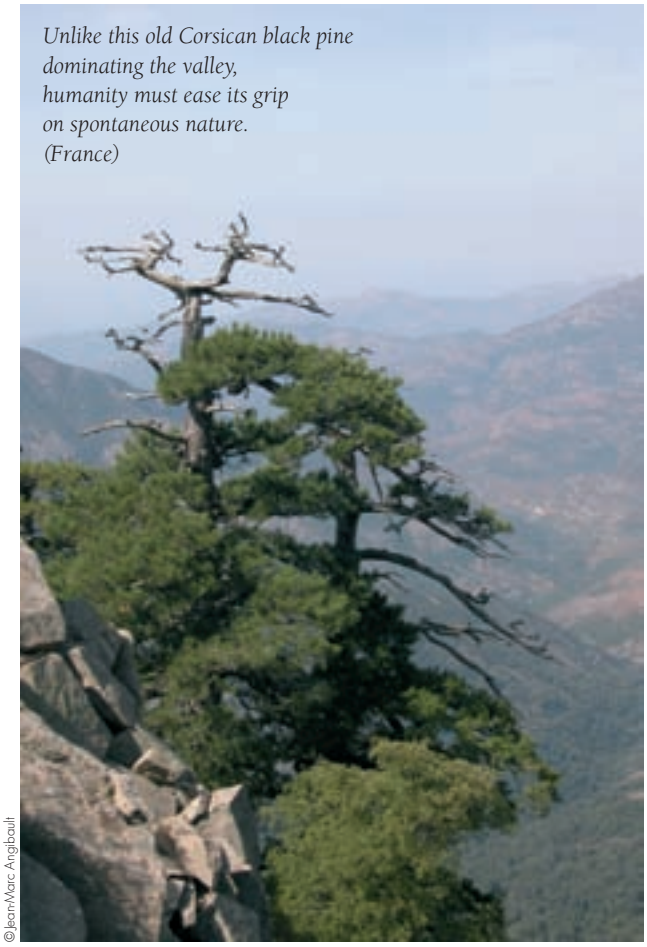
Towards non-interventionism

By Annick Schnitzler
and Jean-Claude Génot

Through "eco-gardening" practices, that are sometimes quite "hard", a certain number of managers of protected sites attempt to save species living in open habitats. This type of management usually consists of perpetuating traditional farming practices – mowing, cutting back scrub, grazing – on sites specially devoted to preserving biodiversity. This approach is not exempt from deviances, such as that, for instance of declaring war against habitats spontaneously evolving towards forest. This is the case on limestone meadows with large numbers of orchids, treeless peat bogs, alpine meadow no longer grazed. When these areas are protected, managers favour action by felling trees, and can even resort to the use of chemicals to eliminate tree-stumps and the stripping of areas of peat. Some specialists of marshland question the suitability of this interference by the manager recalling that the wooded stage is just one stage in the life of the bog and that it is not always incompatible with the continued accumulation of peat.

Why declare worthless the spontaneous return of the forest?

Ponds are another habitat that nature managers love. They have become a must for small, protected areas. In places where they never occur naturally, they appear alongside nesting boxes and sites where young trees are removed. Grazing appeared very early as a miracle tool in many protected areas to ensure the upkeep of the herbaceous habitat. It is, however an approach that can fail. Cultural attachment to the landscapes of the past prevents the intrinsic value of the spontaneous development of the forest from being acknowledged. Sheep are even introduced to places where they were all but absent; to prevent the growth of woody plants. This is the case of the German Islands in the upper Rhine.



Unlike this old Corsican black pine dominating the valley, humanity must ease its grip on spontaneous nature. (France)

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A different type of management

The management of biodiversity poses ethical, strategic and scientific problems. Ethically, in the protection of nature, the relationship between man and nature must be thought out again. A new approach should be imagined, not one of domination and control but of humility and refusing the temptation to actively model nature, allowing it to blossom spontaneously (see box on p. 82). The association of natural reserves in Belgium also regrets that nature is "washed, scrubbed and monitored". The sociologist Catherine Mougenot poses the question as to whether the usual expressions of "constructed or re-formed nature, tamed nature, intensive ecological gardening" do not simply signify "the end of nature". Strategically, the management of natural areas is part of a pattern of specialised areas: an area for agricul-

After many long centuries of land clearance, the region of the Allier gorges now has young forests with a high level of naturalness. (France)

Tomorrow's forests

The area covered by forests has risen significantly in France over the last two centuries. From 9 million hectares in 1820, the estimation for 2002 is over 15 million hectares, and more if heath and scrub are included. Of this expansion, a little over 2% corresponds to spontaneous recolonisation. These young forests, now aged between 10 and 130 years are the product of changes in society brought about by wars, the rural exodus, the shrinkage of agriculture, various economic crises through history, the Common Agricultural Policy (CAP) and its fluctuations.

The arrival of the forests indicates the end of a traditional rural society. They are not very attractive because they are dark and difficult to walk through owing to the high density of trunks, the presence of thorn-bushes and creepers, and the accumulation of dead wood. They are also poor for birdlife and, especially in the Mediterranean area, prone to fires. There is not much to attract hikers, or even naturalists, who prefer open spaces.

These considerations mask the numerous qualities of these unique and yet so poorly protected ecosystems. Recolonisation forests do however render multiple services to man: they are carbon sinks, enable conservation or reconstitution of forest soils, buffer climate fluctuations, shelter rare forest species. The larger the areas concerned and the less their fragmentation, the more efficiently they fulfil these roles. Their intrinsic value resides in the spontaneity of their forest dynamics which gives them a high level of naturalness rarely found in European ecosystems. This value increases with time if they are left to develop without disturbance. It also increases with the area of land that they cover: occurring in a single block of several thousand hectares, they make a powerful response to the increasing artificialness of French landscapes. The young Mediterranean forests are growing relatively undisturbed on the plateaux formerly used as pastureland and on the slopes of the left-bank affluents of the Rhone: the Ardèche, the Cèze, the Gard. After countless centuries of being constantly cut back and the resources exhausted, these new forests are showing strong dynamics and a large capacity for regrowth, suggesting that stable, resilient and rich forest systems are becoming established. These will be tomorrow's "virgin forests".

ANNICK SCHNITZLER

tural products, one for forest products a third for biodiversity. This unambitious vision abandons any idea of overall management of the land on an ecological basis. However, should the Defenders of Nature not show the example? From a scientific point of view, the opinion that biodiversity will be lost if areas are not actively managed is difficult to uphold. Why declare worthless the spontaneous return of the forest with the temporary clearings and maturation phases that sometimes last a long time? These areas with new assemblages of species deserve a second look. Of course habitats change with farmed land being abandoned but why is our attention attracted purely by the disappearance of emblematic species and "heritage" landscapes?

It would however be illusory to consider that the scrubland – one of the names given to forests undergoing spontaneous expansion – growing outside protected areas could be considered as future natural reserves. Since the 1950s, it is estimated that spontaneous forestation has covered two million hectares and no evaluation of its ecological situation has ever been made.

Humanity has built its traditional landscapes out of the original forests, whose associated processes and biodiversity have been changed forever. Without being able to put the clock back, expansion of new forest could create a forest landscape of a different type, with species that had become rare elsewhere. In the new situation we will have to accept scrub, species known as "invasive", the silting up of artificial lakes, the disappearance of peat bogs and we will have to stop using certain parts of forests, but this wild nature, spontaneous, unexpected, exotic even, with its own intrinsic value will be a new support for the understanding of our world. ■

All "ecological" gardeners must have a pond. Taming of nature that, for some, indicates its "end".

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Management at the service of nature

By Frédéric Bioret

The managers of protected areas, and particularly of natural reserves, continue practicing ecological gardening and should justify this by the elite character of the habitat in their reserves. This type of "gardening" could even lead to making nature like a sanctuary. It is however Utopic to preach that maximum naturalness should systematically be sought in all natural spaces and at all costs. This ideal is often too far from the realities encountered in the field and can in fact oppose the preservation of a certain level of biodiversity.

Maximum naturalness is Utopic.

The dogmatic approach of maximum naturalness is in fact based on scales of space and time that are remote from the current situation. The large spaces colonised by prairies or by nutrient-poor grassland, maintained by semi-intensive traditional agriculture are today fragmented, destroyed or replaced by intensive agriculture. The managers of these relict areas have a great responsibility for the conservation management of the species and the habitats that are there and can no-longer count on harsh climate or the action of large herbivores on closed habitats to favour the herbaceous community. The very great majority of current biodiversity is in fact located in secondary habitats most often generated by human activity.

Gardening endangered nature

In certain natural areas, immediately stopping all active management interventions would lead to the loss of the characteristic plant community and landscape diversity. This is especially true for open herbaceous habitats, resulting from centuries of traditional agricultural practice and fostering a specific biodiversity. No longer keeping flocks of sheep on the Causses Cevenols (limestone plateau) and the Plaine de la Crau (alluvial pebbles) would most probably cause the decline, if not the disappearance of the particular communities of animals and plants dependent on these steppe-like habitats. Their conservation, which must involve management by active intervention, would follow the principle of precaution whose aim is to preserve – or at least favour – threatened species, communities or habitats. In certain cases, gardening of nature is the only solution to keep a unique habitat or a population alive within a functional and dynamic whole. This is the case for instance of the Glenan narcissus, endemic to the Glenan Islands off the coast of Brittany. Over-harvesting of the flowers, the large numbers of visitors in the 70s, then the growth of shrubs in the mid 80s pushed the species to the edge of extinction. Without an interventionist approach, the Glenan narcissus would, in all likelihood, have disappeared from the flora of France. The probability that it had of reappearing on a site of hardly more than a hectare would have been extremely low.

Criticising the creation of ponds that had never existed in a natural environment is easy but what should be done about the ponds that are the mark of ancient human activities and which express a unique biodiversity. The natural reserve of Pinail in the Vienne *département* in France results from the long finished quarrying for millstones. Its own particular richness is in strong contrast with the original environment, currently destroyed and under fields of maize.

Practicing management through active intervention can be useful for teaching purposes. It allows public awareness actions to be carried out, stressing the interactions between man and nature. By looking back to former agricultural practices, the public becomes aware of its action on the environment. People discover that there is a whole range of biodiversity associated with certain landscapes known to have been fashioned by man – hedged fields for instance. These practices, encouraging local participations, can tip the balance towards getting people to accept protected areas or natural sites undergoing ecological restoration. Management strategies both involving intervention and those that are intervention-free should be considered as complementary. In

any case, intervention is rarely applied to a whole protected area. The same complex of habitats can be submitted to intervention in one area, leaving others free to evolve. Today, the management of the environment requires choices to be made: remaining at the service of sensitive natural areas or letting nature have the freedom to do as it will. ■

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Marshes and canals: man-made nature

Wetlands have been disappearing for many decades but the global demand by hunters for a ready supply of waterfowl is constantly increasing. In France, and particularly in the Camargue Biosphere reserve located in the Delta of the Rhone river, the leasing of hunting rights has become an economic resource that can outdo other traditional activities such as agriculture or stock breeding. To satisfy the demand, numerous areas of land are being transformed, in particular, certain sensitive habitats such as the temporary Mediterranean salt marshes. Natural wild areas are being steadily changed into areas devoted to hunting, and have lost their naturalness.

Located in Camargue Island, between the two branches of the Rhone and north of Vaccarès lagoon, the Grand Mar swamps are a vast low-lying area of fresh and brackish water covering 2500 hectares. This wetland, surrounded by rice paddies, has a high potential for hunting and, over recent decades, has been geared to increasing the numbers of waterfowl, especially ducks. Aerial photos show how its surface area has shrunk by about 10% since 1962. Also, the reed beds that used to cover 50% of the area now only cover about 25%. The salicornia steppes have had their area reduced by 40%, giving way to open shallow water with waterweed, and rushes. These open areas now cover over half the wetland.

Paralleling this change in land cover is a change in the infrastructures. The total length of linear features: dykes, canals and tracks for vehicles, has increased from 313 km in 1962 to over 500 km today. There is four times the length of dyke, 66% more tracks, and 35% more canals. The density per hectare of constructions has almost doubled during these last 45 years.

The hunting activity in this wetland, mainly done on private estates, generates an important income alongside stockbreeding and reed harvesting. The construction that has been done has improved the control of water levels and facilitated access throughout the swamps. However, the initial wetland has become fragmented and the water is becoming less salty owing to massive intakes of fresh water. Moreover, it will not be possible to conserve the area in its present state without extensive water management. The level of water in the swamps is regularly maintained by pumping with fixed and mobile units so the natural cycles of flooding have been replaced by stabilisation of the habitat through semi-permanent flooding. This management approach increases the food available for waterfowl and thus the potential hunting bag. So, the biodiversity dynamics of the area has been deeply modified with the Mediterranean flora being largely replaced by a more continental type. Making the wetlands artificial is not a recent trend; early work was carried out in the Middle Ages

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Irrigation channels are dredged in the Charnier-Scamandre marsh. (Camargue, France)

by religious orders, with the aim of improving water control in the delta. In recent decades, the swamps of the Grand Mar have become a different environmental object, with the presence of man being felt more than ever before. It is true that in spite of high pressure from agriculture, the wetland has been preserved. However, the diversity of its habitats, its biological diversity and the abundance of its birds are today the result of costly hydraulic works and maintenance in general. Is society willing to pay this price? Or does society wish to preserve the Mediterranean character of the Camargue wetlands? These questions surrounding the quality of the wetlands of the Camargue are not recent and stress the risk of a decline in its biological richness and its landscape value, which makes it more difficult to preserve its identity and the myth of the "Wild Camargue". So, to maintain both cultural and biological diversity, would it not be better to integrate the principles of wilderness and naturality in the future management decisions? Managers, hunters, scientists and protectors of nature will have to agree. Raphaël Mathevet

The participative approach

By Jean-Eudes BEURET

Not so long ago, to conserve nature intact, human populations were excluded from the territories scheduled to become places for the preservation of biodiversity. In Africa the term in usage at the time was to "clear out" the locals. This epoch is over and the Seville strategy, adopted by the MAB network in 1992, when referring to biosphere reserves speaks of the reconciliation of economic development, social development and the conservation of biodiversity, by means of alliances between the local populations and natural environments. The strategy talks of a "pact" between the local people and society as a whole and proposes to "Survey the interests of the various stakeholders and fully involve them in planning and decision-making regarding the management and use of the reserve". In the field, many reserve managers try to make these words concrete acts, leading to a very clear and pragmatic conservation approach: How can such immense spaces used in a multitude of ways, known by the local people better than anyone, be controlled without associating the locals to the project?

Different levels of public participation.

The population as an ally

Management regulations that are not respected, however strict and relevant they may be, are less efficient than rules and means of control established in agreement with the local population, adopted by those who participated in establishing them, who know them and who recognise that they are legitimate. In addition, they note that excluding the population and forbidding the use of the land by man in certain limited areas can adversely affect biodiversity. In this light it is no longer a question of considering the human population as an enemy of conservation but as an ally, not to be excluded from monofunctional spaces destined for conservation but included in the concerted management of multifunctional spaces. The population must be involved in constructing the various compromises between conservation and sustainable development. This involves setting up a participative approach based on dialogue. How is such dialogue instigated in biosphere reserves, with such diverse economic, political and cultural contexts? We have attempted to reply to this question by studying the mechanisms of dialogue and the participative approaches set up in twelve biosphere reserves in Benin, Brazil, Cambodia, Canada, Korea, France, Guatemala, India, Uruguay and Vietnam. The term "participative approach" covers very different levels of participation on the part of the public. First, we observed the mechanisms of participation through contribution. This approach is not without its strong points: although the public is not invited to give its opinion or to construct a proposition, it is asked to make a contribution to conservation, with benefits in return. There are two points of access. Through conservation, firstly, where the participants are paid for their work and authorised to carry out certain extraction activities. This is the case of the "protector families" in Vietnam, living in the heart of the Can Gio mangrove, who ensure permanent surveillance. Then, there is participation through an economic activity where the population holds a concession where they carry out their economic activities within a clearly defined framework, still contributing to conservation. This is the case of the cooperatives in Guatemala that have been accorded forestry concessions: they must balance the removal of forest products with the rate of self-replacement of the forest. If left unoccupied, the land would risk being occupied and exploited illegally, becoming difficult to control. These approaches can be efficient both in terms of conservation and development.

Public participation is most often based on consultation. Difficult problems can then be considered, but its irregularity prevents participants from becoming really involved. We observed three levels of consultation: informative consultations, where the exchange of information is

the central function, consultations through contribution that serve to collect opinions and propositions, and finally interactive consultations which stimulate interaction both between participants and also between the participants and the consultants.

Consulting and concerting

The term consultation actually covers some very different realities, the underlying parameters determining the actual quality of the consultation. These parameters include the clarity of the intentions, or of the questions raised, the extent to which the ideas expressed are actually taken into account, the timing of the consultation sessions – prior to or following technical work, and finally the inclusion of the consultation within a whole process followed through by the same people.

Although the primary aim of consultation is to collect opinions and propositions, the dialogue between the participants creates a collective picture of visions, aims and common projects in order to act or to decide together. Processes of this type have been observed either while a Biosphere reserve is being set up – what it will be and what it will do, or to inform the powers that be of a question dividing those involved.

The process involves taking the time, which can be before the reserve is recognised to exist: in Kho Kong in Cambodia the idea was to create a Biosphere reserve following a process of participative research and dialogue to draw up rules for the management of natural resources. The process has now been going on for several years. In fact it can be considered that the reserve already exists. The process has enabled private and public participants to consider the initiative their own. It will not be a UNESCO or a state reserve but their reserve and their project. The same is true at Manicouagan, in Quebec where a small team is consulting with the mining, forestry and hydroelectric industries working the resources of the area. If these industries had not been consulted, the reserve would carry very little weight in the management of the sector. The reserve will

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The aim of the discussions is the collective construction of common projects in order to act and to decide together. (A discussion in the Nanda Devi of India.)

be born from these dialogues. In both cases certain actors use their know-how, their savoir-faire and their specific skills to enable dialogue and to serve as translators between people moving in very different worlds. What is going to be the subject of the dialogue? The people involved in Biosphere reserves find themselves having to deal with two types of controversies. The first are specific, opposing people with divergent interests: some may wish to use grassland as pasture although it is home to an endangered species that others wish to preserve; a swamp can provide watering for crops, but this could disrupt the balance of the wetland, etc. The goal of dialogue is to construct an agreement as a solution to a particular problem. Controversy can also be more general, focussing on the model of development chosen for the territory in question. In Bañados del Este, in Uruguay, there is a movement to develop the territory along the lines of mass tourism, and construction was started on a bridge over a lagoon to improve access for tourists. But, there is a contrasting movement promoting a model of development that can be qualified as sustainable, more in harmony with nature. In the end, the bridge remained only half built. The Biosphere reserve must open dialogue to present the model of development which it intends to promote then motivate the translation of this idea into the acts of each of the parties involved: collective actions and publications.

The art of dialogue

This type of general controversy does raise the problem of the very existence of the reserve. Promoting a model of sustainable development is at the beginning an idea which can only take shape as a people's initiative if the people themselves adopt the idea, whether they are private individuals or representatives of the institutions at work in the area. It is only in this way that the Biosphere reserve can become a reality. This assumes real participation of the local population and effective dialogue. In reality, for a reserve to exist, it must become legitimate and does so via several types of process: constructing rules and regulations that apply to everybody, looking for recognition by a higher authority, performing local actions to show that having a reserve is an advantage and that the models of development proposed by the reserve are in fact valid, communicating to convince the various parties involved of the importance of each of their actions, communicating to make a place for the reserve in the institutional hierarchy, and finally enabling the dialogue that will lead to the establishment of the institutional structures required to ensure the success of the project. Dialogue with locals, from the simple citizen to the local administrations has a crucial role to play. For successful dialogue, the simplest solution is to set up dialogue centres close to the premises of the reserve manage-

Resolving conflict

The conciliation of development and biodiversity conservation is not a foregone conclusion. When those involved have not been associated to the creation of the reserve, they can start a conflict by anticipation. They fear, often with good reason, that the reserve management will carry out an act that they will be against. This type of conflict can be open. However, if no space for expression is found, other conflicts can remain latent hindering any future efforts for conciliation.

To handle a conflict efficiently, good analysis of the situation is a prerequisite. The main studies carried out in Biosphere reserves are most often limited to the analysis of conflicts in potential interests. They pay little attention to the mobilisation and the actual interactions between stakeholders. By dehumanising them, the studies give them "neither name nor forename", although doing so would bring the social conflict dynamics into the debate.

Then, rather than immediately attempting to get the stakeholders together in a discussion, a pre-agreement should be sought with all parties independently to open the door towards constructive cooperation. This can be done by determining the way in which the parties are represented, the rules of dialogue and even establishing beforehand concessions concerning what is acceptable or imaginable for those in conflict. The pre-agreement marks the transition from a period of confrontation to one of cooperation in seeking solutions.

At the heart of the conflict, making the participants feel they belong to a group involved in discussion or to the reserve is one of the key factors for the construction of a compromise. Making local stakeholders genuine participants in running the reserve is already accumulating a certain amount of credit for the resolution of any conflict that could arise. J.-E.B.

ment authorities. Some reserves have made an effort to sow the seeds of dialogue throughout society rather than in structures dependent upon the reserve. It is those people upon whom skills are conferred and who are supported in their initiatives, who will be the proactive advocates of sustainable development and who will stimulate dialogue. The Biosphere Reserve of Sao Paolo green belt offers an interesting example with eco-training centres set up in partnership with organisations scattered through the territory. The reserve trains students for two years, attempts to stimulate the eco-job market and continues to assist graduates in the ventures they undertake. The Lac Saint Pierre Biosphere Reserve in Canada reports multiple experiences between people involved in specific projects and comes to the conclusion that: "Dialogue Works!" Then, things snowball, leading to a general atmosphere of confidence where each of the parties involved is ready to seize opportunities. The initiatives and the creativity for sustainable development are stimulated by broad-scale information, the organisation of exchanges of experiences and making references available that the citizens can discuss. An example of this could be a trademark created for all products made in the reserve, as is the case in Rhön in Germany. It can be mixed technology models, optimised from both an economic and a biodiversity conservation point of view which the people involved can opt to use but which, in any case, they will have to adapt and discuss. The primary idea is therefore to create "an atmosphere of dialogue". Participation is not centred on the management structure aspect of the reserve but disseminated.

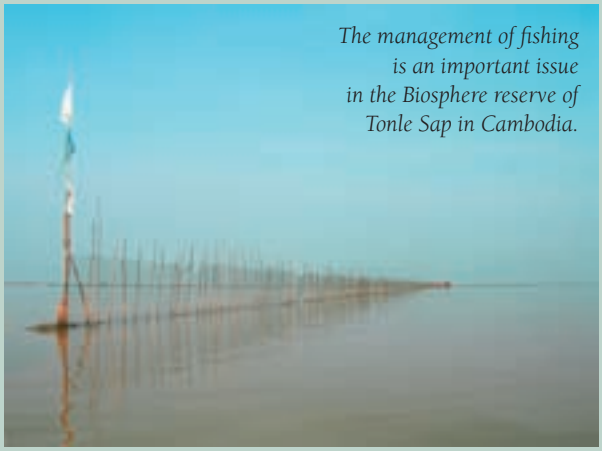
The choice of participating structures

Reserves wishing to establish "an atmosphere of dialogue" create structures where the public may participate in their running. The actual structures differ from reserve to reserve and the differences can be far-reaching. The participants are either groups with a vested interest – stakeholders – and it is then resource use and "involvement" that opens access to participation – or a territorial community involved in the way the territory's resources are managed. This distinction is important and deserves serious thought. In addition, either just the representatives or all the members of a collective body can be invited. The latter puts the accent on general mobilisa-

The four dimensions of governance

"Governance" amounts to bringing together people from the public and private sectors. It involves lowering the barriers, not only between the sectors but also, in the public sector, between the various people with powers in different fields. It assumes the existence of four types of dialogue area. The first type of area involves the participation of the local people in discussions. The second requires dialogue between local people. This is local territorial coordination. The reserve authorities can prefer to withdraw from active participation in order to stimulate direct dialogue between stakeholders wishing to resolve conflict and to decide on ways of running the territory, spaces, and specific resources in a concerted manner. The third area concerns dialogue between institutions. This plays a particularly important role, as reserves must fit into a territory already run by various other institutions. The authorities running the reserve can sometimes find themselves in a situation of "doubly indirect management": having no prerogatives itself, it must influence other public administrations, which must then in turn influence the end users.

Finally, the reserve management authorities must dialogue with their own hierarchy. This will gain acknowledgement and support from above. It is sometimes a prerequisite before being able to open dialogue between the local people and the reserve management. The local stakeholders are recognised as being rightful partners who can express their point of view, even if it is to contest a public action. The act is sufficiently meaningful to require approval from the hierarchy governing the reserve management. **J.-E.B.**



The management of fishing is an important issue in the Biosphere reserve of Tonle Sap in Cambodia.

©Jean-Eudes Beuret

tion, which again, deserves thought. Note that some structures are set up to stimulate initiative, some as an interface under the control of the parent body and some are simple "conveyor belts" for passing on prefabricated messages. The choice of the structure to set up must be based on precise elements for decisional aid. Finally the creation of a structure is one thing, setting it in motion is another. In some cases, dialogue sparks off on its own and social dynamics spring to life spontaneously simply through encouragement by an institutional rearrangement that has proved to be very powerful. For example, the Biosphere Reserve of Nanda Devi, in India created village committees for ecodevelopment. It obtained the right for certain villages on the busy pilgrimage route to manage the taxes levied on the pilgrims, on the condition that the funds be used for the restoration and upkeep of the site. The committees removed tons of rubbish and set up a system to sort waste, leading to the creation of jobs. The local dynamics that became established led to the site being run and promoted with objectives of conservation and job creation. This experience illustrates how, when the local population is given prerogatives and real and sustainable means of acting, dialogue and collective action emerge easily. But, what is the best way to obtain fruitful exchanges from the dialogue system? During meetings, participants are invited to get together and share their ideas in a given place and for a limited time (a few hours). The meetings where we were observers revealed the importance of limiting the number of participants and encouraging everyone to express themselves. But, participants should also provide accessible information and have objectives clear to everyone. A further question is how to make the dialogue attractive, effective and creative? Reserves can foster friendly relationships. In Canada, the South Nova Reserve replaced the standard meetings with "kitchen table groups", taking place in people's homes. Participants learn about the other's language and references in a friendly atmosphere, which stimulates curiosity and the desire to create something together. Reserves make use of a range of supports and tools for collecting local knowledge and visualising information to make it them sharable and discussable.

Excessive use of meetings poses the problem of dialogue time. It is clearly observed that the shorter the dialogue time, the greater the necessity of reaching results fast, which affects the results' quality: people tend to seek an honourable way out rather than seeking efficient and sustainable solutions. We have been present at conciliation meetings where participants have agree upon measures that everyone knew would not work. Real dialogue must be part of a whole system of mutual consultation.

Setting up a structure for dialogue is not as easy as it may seem and choices made at this level prove determinant. For instance, which of the stakeholders and local communities should participate? Who will be their representatives? Will the organisation involve consultation or dialogue? Dialogue and mutual concerting are very often considered as natural abilities. We are taught how to grow medicinal plants or how to perform an ecological inventory but we are not taught how to dialogue, it seems too obvious. In addition, meeting has become the ubiquitous means of exchange although mobilisation of specific tools is necessary, as is the relevance of the dialogue. That the parties involved will dialogue effectively is not a foregone conclusion. "The science of dialogue" deserves to be considered among the sciences of conservation. The skills of some should benefit the others via capitalisation and the exchange of experiences. ■

Excessive use of meetings reduces dialogue time.

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Companion Modelling: understanding the consequences of one's actions

By Michel Étienne

The complexity of sustainable development, addressed during the establishment or revision of a Biosphere reserve, makes it necessary to integrate a decision-making process able to adapt to new situations, but also which can be replicated, as required. Companion modelling is one of several approaches to facilitate collective decision-making processes. Dynamic and interactive, it goes farther than conventional participatory approaches, and recent mediation aid methods, by proposing the use of dynamic and interactive models as supports of exchange and mediation. The credo of this approach is the organization and management of the interactions between the ecological dynamics and social dynamics of a region. And to do this, it offers tools and approaches – often using computer models – which help to explain points of view and the subjective criteria, that are the implicit or even unconscious references for the various stakeholders. The idea is to make the probable future changes to the territory visible to those concerned. These changes result from a combination of ecological processes – regeneration, growth, population dynamics, and so on – and social issues – uses, economic benefit, history and so forth.

1st step: Setting up the work group and establishing the questions to be dealt with

The first step is to build up a group of researchers and stakeholders able to work together to identify and put into words the major planning and management concerns of the Biosphere reserve (BR). The work group will participate in creating an image of the Biosphere reserve by successively identifying the stakeholders and the management systems that govern them, the main resources of the territory, and major ecological and social dynamics at stake. Four questions will guide the work group - which will later become the structure of an agent-based model.

Viewpoints

To monitor the impact of each of the participants on the dynamics of the resources and social groups, a list of viewpoints is developed based on indicators reported as being relevant by each of the players participating in the preparation of a conceptual model. These views reflect what everyone is accustomed to seeing or wants to see in the territory they manage, administer or in which they carry out a regular activity. They allow the visualisation of landscape dynamics, action dynamics or production dynamics, in the form of animated maps or graphs.

M.E.

1. Which are the stakeholders who seem to be able to or need to play a decisive role in the management of the Biosphere reserve?
2. What are the main resources of the Biosphere reserve territory and what information is essential to ensure their sustainable use?
3. What are the main dynamics involved?
4. How does each stakeholder use the resources and how do they modify the dynamics?

2nd step: Putting the questions in an understandable form

The answers to the four questions above are formalized in the shape of easy-to-understand diagrams and structured to be easily translatable into computer language. Each diagram is developed with the participation of all the stakeholders present, each one in turn.

1. The diagram of stakeholders and management units

This diagram consists of two lists of all the stakeholders in the area. One with those whose practices have a direct effect on the dynamics of the main resources of the territory, and one with indirect actors whose actions aim to encourage those of list one to change their practices.

Each direct stakeholder is attributed one or more management entities, which can be either spatially defined, such as a forest plot or grazing area, or not tied to a specific area, such as a herd. Exogenous variables such as climatic hazard are also indicated. Finally arrows are used to represent the major interactions between the various stakeholders considered.

2. The resource diagram

The resource diagram states the main types of resources used. They are generally divided into five main categories: buildings, water, stone, plants and animals.

3. Dynamic process diagrams

The processes identified by the participants cover the ecological, economic and social aspects. In the first instance, the group can develop diagrams of population dynamics or diagrams of transition. The latter explains the successive states that the vegetation can take and clearly indicates the natural and human factors that cause the transition from one state

How far to go?

A prerequisite to implementing the companion modelling approach is the initial willingness for exchange between researchers and managers. So a facilitator must be present all along the process, and must act as a group leader having already practiced the approach and capable of mobilizing a small group around a common issue for about 6 months. If the goal is simply to share knowledge on the way a socio-ecological system operates, the process may stop at the construction of the conceptual model. If the aim is to continue until the validation of the shared ideas, or even to test management scenarios, the process must go on through to computerisation, requiring the support of a specialist. A member of the Biosphere reserve staff can be trained in handling the agent-based platform used to develop the model. Finally, if the process is pushed to its limit with a determination to use the model as a means of communication or negotiation with users, the work must be more far-reaching, bringing in staff who are specialists in communication, education and negotiation. M.E.

Although concerting enables the collective construction of common projects,* Companion Modelling *is clearly more dynamic and interactive.

to another and the duration necessary for this transition to take place. The social dynamics can be represented by network diagrams and economic dynamics by flow charts.

4. The interaction diagram

The interaction diagram provides an overview of the previous diagrams focusing on the relationship between users and resources. The arrows symbolize the interaction between stakeholders and resources, or between different stakeholders in relation to the resources. They are attributed verbs to specify the type of action that generates the interaction and indicators to reflect the information used by the stakeholders to make decisions. This phase is often the richest and most interesting in the whole process of co-construction, but to gain maximum benefit, it is essential not to discard the history of the construction of the four diagrams to explain why and how this or that stakeholder, or such and such a resource or interaction was retained, eliminated or modified.

3rd step: The game

Once the ecological process, the territory and the key management entities are adequately represented and implemented in the computer model, it must be checked that the stakeholders consider that the behaviour simulated in the model is actually plausible.

To do so, those involved participate in a role-playing game that reproduces the context of the territory being developed. The aim of the game is to make the agent-based model easily accessible to any stakeholder, to make any representation of the processes involved in the development rapid, while giving free rein to the inventiveness of the players to come up with a strategy of action or negotiation. To make the players aware of the current and future natural dynamics, they are bound by the rules of vegetation dynamics that are simple yet sufficiently accurate to take proper account of the impact of management decisions. They also have to organise their activities in space and spend part of the game time in discussions and exchanges both between similar roles and between antagonists (multiple negotiation). Finally the players are projected into the future. The model simulates the landscape dynamics resulting from the actions taken individually or collectively by the players. ■

Agent-based models

Agent-based models are a particularly powerful tool to represent complex systems. They can account for the various components of the environment, the relations between social groups and interactions between stakeholders' practices and the major ecological dynamics. The environment is viewed as a collection of objects, which, depending on the way in which the stakeholders perceive them, will be the subject of decisions and exchanges. The different ways in which the environment is viewed gives rise to opinions on the system. These opinions are expressed by means of a range of indicators considered relevant by the stakeholders in the development of the Biosphere reserve project. M.E.

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Monitoring biodiversity

By Romain Julliard

Biodiversity monitoring is always launched to answer some question. That is why it is important to devote sufficient time for reflection to define those objectives as precisely as possible. Once the choices are made, the most relevant and most accessible information is collected to assess the situation.

Setting goals

Determining the conservation status of a population, i.e. its viability in the medium term, and assessing the impact of management on biodiversity are the main issues that the managers of a territory may face. However, the questions should be clearly defined in order to establish their limits. Is the question to know, for instance, whether a population is viable without a management policy? If the chosen policy is sufficient to maintain the viability of the population? (The viability may indeed depend on factors external to the sites managed). Moreover, should the monitoring help to understand why a species has a poor conservation status?

Isolated or network monitoring?

To assess the impact of management on biodiversity, the least that can be done is to perform censuses before and after implementation of a management policy. But, censuses cannot distinguish changes due to local management from changes due to the global situation, affecting biodiversity systematically. Moreover, the use of control areas, not subjected to any management policy, to allow comparison with managed areas is usually difficult due to lack of time, space or adequate facilities. An alternative solution is to bring together the monitoring results obtained on several sites, the basis of a national observatory for biodiversity. Within this framework, monitoring of sites of particular interest can be compared with that carried out on sites representative of the entire national territory constituting the reference network.

Monitoring several species (here a Tawny Owl chick) allows a comparison of their fate depending on their different ecologies.

Such a network is necessary for generalization of the results and comparison between sites. Its existence depends on a coordinating structure, which can also analyse the data collected by the network, for instance, producing indicators. In this context, the involvement of a team of scientists is desirable, or even necessary.

The reference network does not preclude the presence of other networks for which the site of the location is not random: protected areas, sites of long-term observation, and so on. On the contrary, these networks provide each other mutual support.

The choice of species

It can be tempting to restrict monitoring only to species emblematic for conservation or species well known to the public about which it is easy to communicate. These species, however, are generally few and not particularly representative of the complex networks of interactions that characterize biodiversity. One option to consider – material and human resources permitting – is the monitoring of common species, which provides complementary information (see also box on p. 82). As these species are most often abundant, reliable data on their numbers and their demographic characteristics are quick to acquire. On the other hand, following up several species can give a comparison of their future according to their ecology. Finally, there are a number of survey programmes of national importance on common species into which local studies may be inserted.

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Forest insects can be useful indicators for the ecosystem. They are captured, identified and counted following a strict protocol. (Vosges du Nord, France)

© Sébastien Morelle

To follow populations of the hazel dormouse correctly, the detection effort must remain constant in time and between study sites.

The choices of which groups of species are to be monitored are primarily made following feasibility criteria; yet, it can be recommended to choose groups from different trophic levels – such as plants, butterflies and birds – which will give a more complete picture.

Selection of variables

The status of a population can be characterized by variations in its distribution, its abundance or its demography. The monitoring of distribution, which is based on the presence or absence of species, is only of limited interest; in fact it only detects the final stage

of failed conservation – the disappearance of the population. Abundance monitoring could appear to be the best tool but it raises the issue of detectability. When only a portion of the individuals actually present is detected, what is the relationship between the variations in the observed abundance index and real changes in abundance? The main concern is to ensure that detectability remains constant over the years and across all the sites monitored.

The temptation is great to limit studies to heritage species.

In theory, it is the analysis of changes in demographic parameters which is used to evaluate the viability of a population over time. However, it is generally impossible in practical terms because it would require the follow up of reproduction, survival of breeding adults and dispersal. Nevertheless, monitoring certain demographic indices, such as the body condition and reproductive success, can give highly relevant information to diagnose the causes of any variation. If a reduction in a species is correlated with a low rate of reproduction, for example, it is most likely that the causes of its decline are linked to environmental conditions associated with the breeding period.

Note that it is also possible to monitor ecological processes, such as pollination, the degradation of dead wood, different material flows, and so on, to provide direct information on the state of biological diversity in ecosystem function.

The protocol and the sampling design

Any field operation required for the monitoring of selected variables must be accompanied by a preliminary description of the various actions and of the equipment used: this is the protocol. The distribution in time and space for these operations is the sampling design. For a given study, the protocol and the sampling design are established according to the goals. It is exceptional that a protocol and a sampling design are transferable from one study to another. In addition, they must be established in terms of the human and financial resources available.

Naturalist data usually reports the species observed, its location, the date of observation and the observer. But in the context of a survey, the way in which the data were collected is fundamental. The more is known about the way in which the data has been collected, the higher the quality of the monitoring programme. A protocol must be repeatable by others and must be very detailed concerning the observation effort made.

Finally, the sampling design enables generalisation and extrapolation of the measurements obtained. For example, 10 measurement points in a forest must give a picture of the state of what would be measured in the whole of the forest. The sampling design also enables the reduction of any estimation error by optimally distributing the points where the measurements are to be made in the field. ■

© PNR Corse

Putting up nesting boxes and ringing birds can be necessary to enable certain species to be followed.

When ordinary citizens help researchers

With 15 600 people enrolled and over 80 000 sightings reported, the Garden Butterfly Observatory – *Observatoire des Papillons des Jardins (OPJ)* surpassed all expectations from the first year of its existence! In 2006, the French association *Noé Conservation* (Noah Conservation) and the National Museum of Natural History in Paris accepted a new challenge: to carry out a participative science operation, involving non-specialists, on a national scale and aiming for scientific excellence. The strong mobilisation showed that amateurs today are keen to participate in acquiring knowledge, and that they have a real role to play. The public is no longer a simple spectator but becomes a stakeholder in science.

But, if the public is to be able to support the scientists efficiently, the protocols used must be suited to that purpose and a high level of interactivity between the participants must be maintained. The aim of the observatory was to collate and analyse sightings of common butterflies, on a national scale, in order to assess the quality of ordinary biodiversity and how it changes with time – in relation to gardening practices or climate change, for instance. However, the quality of observations made by non-specialists obviously has its limits. The first concern was therefore to design a protocol suitable for all the participants in order to be sure that the butterflies were counted and identified in the same way, in spite of their heterogeneity. The protocol also had to be as attractive as possible. Having a large number of participants tends to "compensate" for the dubious quality of the data reported.

Getting volunteers to accept a rigorous protocol, for instance counting butterflies for just one 15-minute period in a day, rapidly proved to be impossible. Such demands would have limited the number of participants – and therefore the amount of data collected – and still only have the appearance of being rigorous. This does not erase the heterogeneity between observers, does not correspond to what happens in practice – apprentice observers want to count much more often – and does not necessarily give more accurate results – butterflies presenting rather unpredictable behaviour over the day. This led to the idea of simply counting butterflies each time the volunteer felt like it! The problem of double counting was then resolved by only taking the maximum number of individuals seen together during a given month.

Many of the common butterflies that can be found in gardens are identified easily. We could have left the study at just that. However, some of the most frequently encountered species – the whites (pieridae) for instance – are not easy to name accurately. Excluding them would have frustrated the observers having identified a large number of butterflies "that didn't count". We therefore chose to group certain species together: whites, small blues and skippers, etc. next to individual species that are easily identifiable such as the Swallowtail, the Peacock and the Red Admiral.

To our great satisfaction, the participants proved to know their butterflies. The map of the Black-veined white obtained by the observatory coincided with its known distribution at mid-mountain altitudes – we had feared that it would be confused with the ordinary whites, for instance. Moreover, we had the pleasant surprise to find that the section "other observations" was very often filled in with all sorts of species: over 5000 observations were reported, often with the Latin names.

All the data collected were then processed by specialists. The highly unlikely or too far from normal were deliberately omitted. But the large numbers of observations meant that the results remained robust.

Our future aims include following the variations in the numbers of butterfly sightings in France and analysing the relationships between gardening practices and the diversity of butterfly species. We thus ask our volunteers to answer ten questions concerning the exact characteristics of their garden and its surroundings.

Participative science, which can be defined as the involvement of volunteers in scientific projects is one way to overcome the difficulty in obtaining regular information on the distribution and dynamics of animal and plant populations. There are two main advantages in such operations: i) the data collected are abundant and cover the whole country, ii) the participants' taste for observation is encouraged, as well as their involvement in conservation activities. Participative science is therefore a formidable means of stimulating public awareness.

Satisfying the expectations of the public does require us to question our old habits, but this novel approach is gaining momentum, and will make a great contribution to scientific knowledge in the protection of nature.

Romain Julliard

Further reading:

• www.noeconservation.org

Using indicators to assess interactions

By Harold Levrel

Since the adoption, in 1992, of the Convention on Biological Diversity, biodiversity monitoring tools have become a necessity. In 2010, each of the States that signed the convention is being called upon to demonstrate its progress in biodiversity conservation and in particular in reducing biodiversity erosion. Owing to their acceptance, both scientific and political, but also to their remoteness from the notion of "measurement" (see box below), biodiversity indicators have rapidly emerged as being most appropriate tools. Many organizations – national and international agencies, environmental groups, professional groups, etc. – have rushed to develop indicators.

A wide range of possibilities

Interaction indicators, which enable links to be established between ecological, social and economic dynamics, have gained importance. Indeed, as emphasised by Action 21 (the international orientation document to reveal sustainable development) "Methods for assessing interactions between different sectoral environmental, demographic, social and developmental parameters are not sufficiently developed or applied".

For a long time, the organizations responsible for the development of interaction indicators focused on the design of indicators of "the state of biodiversity" and of "human pressure". A simple pressure indicator, for example, is the level of fragmentation of a habitat: its variation may have an impact on a state indicator such as species richness.

To indicators of pressure and state were added response indicators, forming a framework often called the Pressure-State-Response (PSR) model. The response indicators reflect the human actions that can compensate for the adverse effects of human-induced stresses. Thus, the size of protected areas is one of these indicators – it is frequently used in biodiversity conservation.

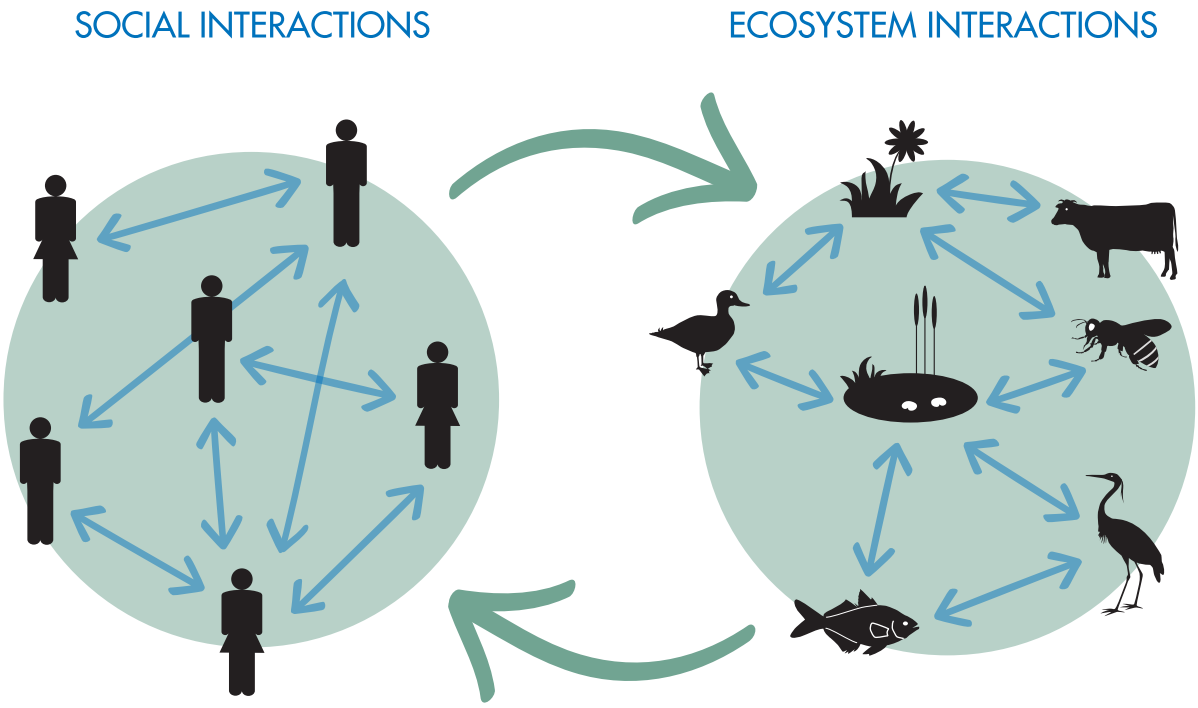
The PSR indicators have inspired most organizations responsible for the development of interaction indicators, like the United Nations Program on the Environment, the European Environment Agency or the Commission for Sustainable Development. Other categories of interaction indicators allow an integrated approach to the pressures that human activities impose on biodiversity. This is the case of the ecological footprint, which assesses the number of hectares of "natural spaces" consumed, considering the final consumption of an individual, a city or a country.

In recent years, pressure indicators have been supplemented by new categories of indicators that emphasize the interdependence between economic, environmental and social dynamics. To address the issue of biodiversity conservation, a growing number of practitioners and scientists are in fact calling for adaptive co-management policies to be set up (see the article by F. Bioret and R. Mathevet on p. 74). This form of management is based on the idea that, in a context of great complexity and uncertainty, it is necessary to adopt a modest local approach, based on collaboration and learning. Under these circumstances, there is no longer question of trying

The indicator – a complicated word for a simple definition

Emerging from accounting or statistical tables, the indicator is often perceived as a highly technical tool reserved for experts. Yet everyone uses them in their daily activities to guide their choices and actions. The time on the alarm clock indicates whether we must get up, the clouds give information on the weather, traffic lights regulate vehicle interactions in a complex road network, and so on. Each signal enables choices to be made and coordination to be achieved in a complex environment. The indicator is a tool for the interpretation of complex dynamics which it would be "too costly" in human resources, technology, time, etc. to measure directly. As an "information summary," it can cope with the grey areas that measurement abhors.

Choosing interaction indicators



Some indicators stress the interdependence between economic, social and ecological dynamics. Those of the Millennium Ecosystem Assessment take account of the services that biodiversity offers man – for instance the role of the bee in the pollination of crops.

to achieve a desirable "state" for biodiversity, which is socially difficult to express, or control the "pressures". The aim now is to reach an understanding of the co-evolution of ecological, social and economic systems to allow the integrated management of the dynamics involved.

Among these new interaction indicators, those of the Millennium Ecosystem Assessment (MEA) have been a great success. One of their most interesting characteristics is that they take into account the services, often impossible to translate into cash terms, that biodiversity provides humans. Grouped into four categories, these services highlight the interdependence between the state of biological diversity and the level of well-being. Hence their educational value. The first category includes regulation services. It includes such functions as water purification or control of invasive species through biodiversity. The second covers provisioning services. It includes diverse food and building timber. Support services correspond, in turn, to primary production and the major biogeochemical cycles. Finally, the cultural services refer to spiritual values – e.g. the case of sacred forests – and recreational activities like hunting, fishing and bird watching. MEA indicators also allow a better understanding of the interdependencies between dynamics occurring on different scales – in particular those occurring locally with those spanning the entire globe.

The main advantage of these indicators is to highlight the importance of the social choices to be discussed for all these services. For instance, it can be noted that over the last fifty years, the agricultural revolution has contributed to the increase in provisioning services and has satisfied the demands of the exploding population. But this was at the expense of regulation and cultural services. Today, the social

demand in OECD countries has been reversed. It claims more respect for these two latter categories of services, requiring the reorientation of agricultural policies. MEA indicators have led to questions being raised as to the social representations of the services provided by biodiversity. The concept of well-being is, in fact, largely subjective and based on particular symbolic systems. That is why greater attention must be paid to individual representations to take fuller account of the way in which nature contributes to these levels of well-being. The co-construction of the tools for the evaluation of Society-Nature interactions – could be an interesting approach (see article by M. Etienne on p. 98). Inviting local stakeholders and scientists to think together about social-ecological interactions, provides the opportunity to open up both scientific knowledge and layman's knowledge while cheaply generating indicators on the dynamics that drive biodiversity. On the other hand, with its educational virtues, co-construction can deepen democracy by facilitating a better apprehension by the local population of the social issues related to sustainable development. The co-construction of the interaction indicators then becomes the technical counterweight of the adaptive joint management of interdependence between natural and socio-economic systems.

Indicators are tools for providing insight into subjects under debate by society.

The co-construction processes have the advantage that they focus discussions on the key issues of the Society-Nature system, on the ecosystem services which these issues derive from and on the dynamics of use to which they are related. These processes lead to the emergence of the indicators that are the most "relevant" to the stakeholders. Their development will be followed with interest. ■

The cultural services rendered by biodiversity involve their spiritual and recreational value. And yet, the notion of well-being is highly subjective. It is therefore important not to underestimate the feelings of each individual.

Defining objectives: at the heart of evaluation

"However beautiful the strategy, you should occasionally look at the results". The interest in evaluation is not recent, as this quote from Winston Churchill shows. However, in natural heritage management, this procedure has only recently been developed, notably with the systematic introduction of management plans: nature reserve management plans, species recovery plans, etc. In France in 2001 a finance law was adopted (LOLF) and the reform of public policy that it calls for is engaged in supporting this move.

So, what actually is this "evaluation" that has now found its place at the heart of our activity. The parliamentary report at the origin of the LOLF proposed the following definition "the object of evaluating public policies is to assess the efficiency of the policies by comparing the results obtained to the objectives that were laid down and to the resources used" This definition stresses the central role of the objectives in the evaluation process. Indeed, it is the objectives that orientate public politics and constitute the reference point to which the results are compared and, in the case of efficiency evaluation, the resources used. Thus, the legitimacy of the management actions undertaken and also the quality of their evaluation and hence their ability to be improved depends on the quality of the objectives defined.

But, defining objectives is a difficult exercise. Let us take an example. When dry grassland is no longer grazed and tends to become forest, what management choice should be made? Return to the dry grassland stage? Stop the process at the shrub stage? Let nature take over and full forest become installed? When the area concerned is large enough, assemblages of the three types of plant cover can be considered and the possible combinations become very numerous indeed.

In order to understand the difficulties met when defining objectives, it is interesting to recall certain points specific to the management of natural heritage. It is an activity that focuses on objects – species, landscapes, etc. – that evolve over time and to which society grants a certain value. These values are classified by type: cultural, economic, scientific, aesthetic, moral, etc. as clearly laid out in the preambles to the Bern and Rio Conventions. Obviously, part of the value attributed to these objects, the aesthetic quality for instance, is subjective and personal, and thus difficult to quantify. Nevertheless, when the objectives are being defined, it is necessary to determine how society would like to see the objects evolve. At the same time, these goals must take into account the constraints imposed on society: interdictions, funding, etc.

To help managers define and justify the objectives in natural heritage management, various methods have been developed. They do however have their limits and three problems tend to be recurrent.

Firstly, one common method consists of defining the objectives with respect to a historical reference state – whether it is contemporary or past. As the objects considered are undergoing constant change, this is ecological nonsense. However, this is a widely applied solution as illustrated by the procedure used to set up the Natura 2000 site network. Future climate change will probably lead to this method being revised. The evaluation of the sites aiming to preserve the glaciers of the Pyrenees, for instance, will doubtlessly lead to some interesting theoretical debates.

A second procedure for the definition of objectives consists of establishing a rank order for the different goals identified on a territory, developing for each – in the words of the Technical Workshop for Natural Areas – "an objective and rigorous evaluation" based on the "quantification of numerous parameters" such as diversity, rarity, typicality, etc. Although this method presents "apparent rigour" it is most often based on "arbitrary choices" and "empirical foundations". For instance "upon what basis can it be decided that one species is more important than another?" The use of quantifiable parameters enables a more intelligible justification of the choices made but can only represent part of the solution. It is clear that while some aspects of the natural heritage are quantifiable, such as the number of species or the economic impact of the various management scenarios others, which depend on aesthetic, cultural or moral considerations for instance, are not. Thus, any method that is exclusively quantitative will necessarily divert the activity from some of its motivation.

In order to include all of the motivations of society that orientate our activity, the current development of participative approaches appears very pertinent. But, although this development is positive, it should still be considered as an open door to new difficulties rather than a miracle solution. What processes can be used to actually define the natural heritage management objectives of a territory with thousands of inhabitants each having differing wishes? Whose opinions should be taken into account? How can decisions be made? According to what criteria? If we do not grasp the difficulties brought about by these new par-

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A flower's objective is simple: to be pollinated. Success can be gauged by the number of seeds produced. But the success of a biodiversity manager's objectives is more difficult to find an indicator for.

ticipative procedures, the freshly initiated evolution of governance could well boil down to just a façade of democratic improvement in decision-making.

Generally, the difficulties encountered during the phase of defining objectives, as presented above, detract from the whole evaluation process. Poorly defined objectives often lead to an evaluation based on irrelevant, or even counterproductive, indicators. Some of the indicators of the National Strategy for Biodiversity (NSB) or the Finance Law Project (FLP), which aim to evaluate the public policy relative to biodiversity, illustrate this. In the NSB, the only indicator of genetic diversity is the "number of varieties of plants and races of animals recorded and certified for commercial purposes". In the FLP 2007, the only indicator for "areas protected by law" is "the annual cost per hectare, for the Ministry of Ecology and Sustainable Development, of the protected area". It seems that in the absence of clear objectives, the evaluation becomes constructed around indicators that are mainly related to scientific or technical considerations that do not represent the motivations of society upon which our activity is based. This evolution leads to a risk of deviation of public policy from the general interest that they should attempt to achieve. Considering the current situation, Albert Einstein's dictum "A perfection of means, and confusion of aims, seems to be our main problem" is, in our field, resolutely modern.

However, the current development of management plans and evaluation procedures in general do give grounds to hope for a clear improvement of the situation. This evolution means that the objectives pursued by our activity have to be clearly laid out and made available for the public. Although this brings into the open difficulties linked to the definition of the objectives, it also enables us to come to grips with the problem that has still been little discussed. The recent development of symposiums and research specifically into this question gives a clear indication of the growing interest that it is attracting. Owing to the nature of the difficulties encountered, this research will probably come to the conclusion that little adaptations of existing methodologies will not suffice to resolve the problem. The reconstruction of the whole theoretical framework of this activity today seems to be an unconditional prerequisite for the redesign of the objectives definition processes.

JOHAN CHEVALIER

Further reading:

• ATEN, 1996. *Les objectifs de gestion des espaces protégés*. ATEN.

CHAPTER 4

Managing biodiversity through innovation

- **Using market mechanisms to serve biodiversity**
- **Geographical indications, a contribution to maintaining biodiversity?**
- **MAB: an educational vocation**

CHAPTER 4

Managing biodiversity through innovation

By Michel Trommetter

The last 50 years has seen considerable progress in conceptual means for the preservation of nature even while extinction of species has reached alarming proportions. Attention, long focused on emblematic species, has little by little shifted to species occupying common places and performing services for human society. This new awareness of the importance of biodiversity, has mainly led to innovation in government policy, which has allowed the creation of a whole range of parks and reserves, and environmental and agricultural policies. The agricultural policies then led on to the development of agro-environmental measures. But the problem of the global decline in biodiversity is the diversity of the local situations. This is what makes it different from the problem of greenhouse gas emissions. Will the future then be devoted to the creation of new conceptual tools to manage local environments without causing irreversible changes around the globe? To do so, one of the main difficulties to be overcome would be to establish links – whether direct or indirect – between different local situations. The current environmental problems involving the fragmentation of habitats and corridors are indeed serious examples of this. Moreover, any local management decisions must be carefully thought out if they are to fit in the global context.

So far, biodiversity conservation has mobilized conceptual tools focused on dividing

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One of the keys to stop the decline of biodiversity is perhaps to change the way people think about it.

up the environment spatially to allow various strengths of interaction between biodiversity and human activities. The major objective of nature reserves and national parks is the drastic limitation of anthropogenic uses while regional parks and biosphere reserves have more varied goals that take into account the sustainability of human uses outside the core area.

Enlarging sustainable places

These areas seek to reconcile conservation, biodiversity and economic development. When remarkable ecosystems are particularly fragile, the creation of sanctuary parks can be justified but only if at least two conditions hold. First, that any use of the resources by local people would contribute to a decrease in the sustainability of the ecosystem. Second that the cost to the economy and to society must not be prohibitive for those affected by the park. To this end, a gradient must be sought between *in situ* conservation, parks and areas of sustainable development. One solution is the model given by the Biosphere Reserves, which reconciles conservation and local economic development. But, its success depends on the equity between cost and benefit sharing at a local scale, and therefore, usually, on negotiation of the terms of land use and resulting compensation. Nevertheless, the policy of reserves and parks, including Biosphere reserves, is based on fragmentation into areas with levels of protection. Is this the most efficient way for their flora and fauna to adapt and evolve faced with global change? These policy issues remain controversial today. One solution would be to demonstrate that biodiversity management systems based on species or ecosystem preservation are complementary with classic management systems. The basic principles of biosphere reserves deserve to be extended to cover all territories. It seems that the process is underway since the system of managing ordinary biodiversity in the buffer zones, and the areas around their edges is now included in the agri-environment measures of the CAP, the territorial operating contracts and sustainable agriculture contracts.

Acting locally for a global effect: a subject that deserves attention.

Managing pest and insects on agricultural plots by new methods

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On another note, we now know that ecosystems fulfil a number of functions that serve humanity. By pollinating crop plants, for example, insects contribute to agricultural production. This natural service can serve the farmer or gardener, but also business or the agro-food industry. The dependence of companies on biodiversity is therefore clear and can be assessed through raw material supply, turnover or the way the business uses technology based on living systems. Analysing biodiversity in terms of functions and associated services requires interactions between companies to be understood and organised.

Whether in strategic or in innovation terms, they do not have the same relationship with living organisms. A farm wishing to use the services of biodiversity in pathogen management should be, for instance, innovative in land use management. It will have to seek the best geometric combination – in terms of shape and size – to be able to make full use of the services biodiversity can provide, and in the most efficient way possible. Similarly, a business that receives ecological services, such as a company selling mineral water, must be innovative with its neighbours. If those neighbours are farmers upstream of the source, there is a good chance that conflict owing to the use of or pollution of the water will occur. The challenge for the company is then to keep the conflict of use to a minimum through the establishment of solid links with the farming community.

Innovation, often presented as a technical solution, can act over a much broader field. It may indeed occur in the form of new institutional or organisational tools. Appearing in the form of a constraint, legislation can in fact be very attractive and rewarding. In parks allowing human activities, certification and labels have been developed for the good of biodiversity (read the article by L. Bérard and P. Marchenay on p. 128). At the economic level, the new thinking focuses on the idea of co-evolution between biodiversity and business activity. Mitigations are banking compensation mechanisms, which request that companies wanting to settle on a site pay compensation based on the quality of the site and on the additional costs involved if it were to settle elsewhere (read the article by S. Hernadez on p. 122). To do so, knowledge of the basic references is fundamental. Determining biodiversity indicators will also help.

By scoring the different sites on an ecological basis, it will be possible to rank them and thus calculate the compensation due, which will then depend on the intrinsic qualities of the ecosystems and the people


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Humans are excluded from integral reserves. Till now, this solution has represented one of the tools to conserve biodiversity.

that live there. At the same time, however, it would be necessary to follow the way the system functions in the absence of a strategy for integrating biodiversity. Otherwise, it would be impossible to make comparisons or to put new tools into practice to improve or modify the initial situations. Other compensation mechanisms are now being considered, such as the mechanism used for compensation between businesses. When one of them benefits from free environmental services in an ecosystem, it is quite probable that another must then deal with a negative impact on the same ecosystem. This constraint can be taken into account - by calculating, for example, the compensation that should be equal to the maximum cost of an alternative to the service provided by the environment. The introduction of new legislation and more particularly accounting, in the form of an environmental tax or environmental accounting, will then be necessary.

An institutional, technical and economic innovation.

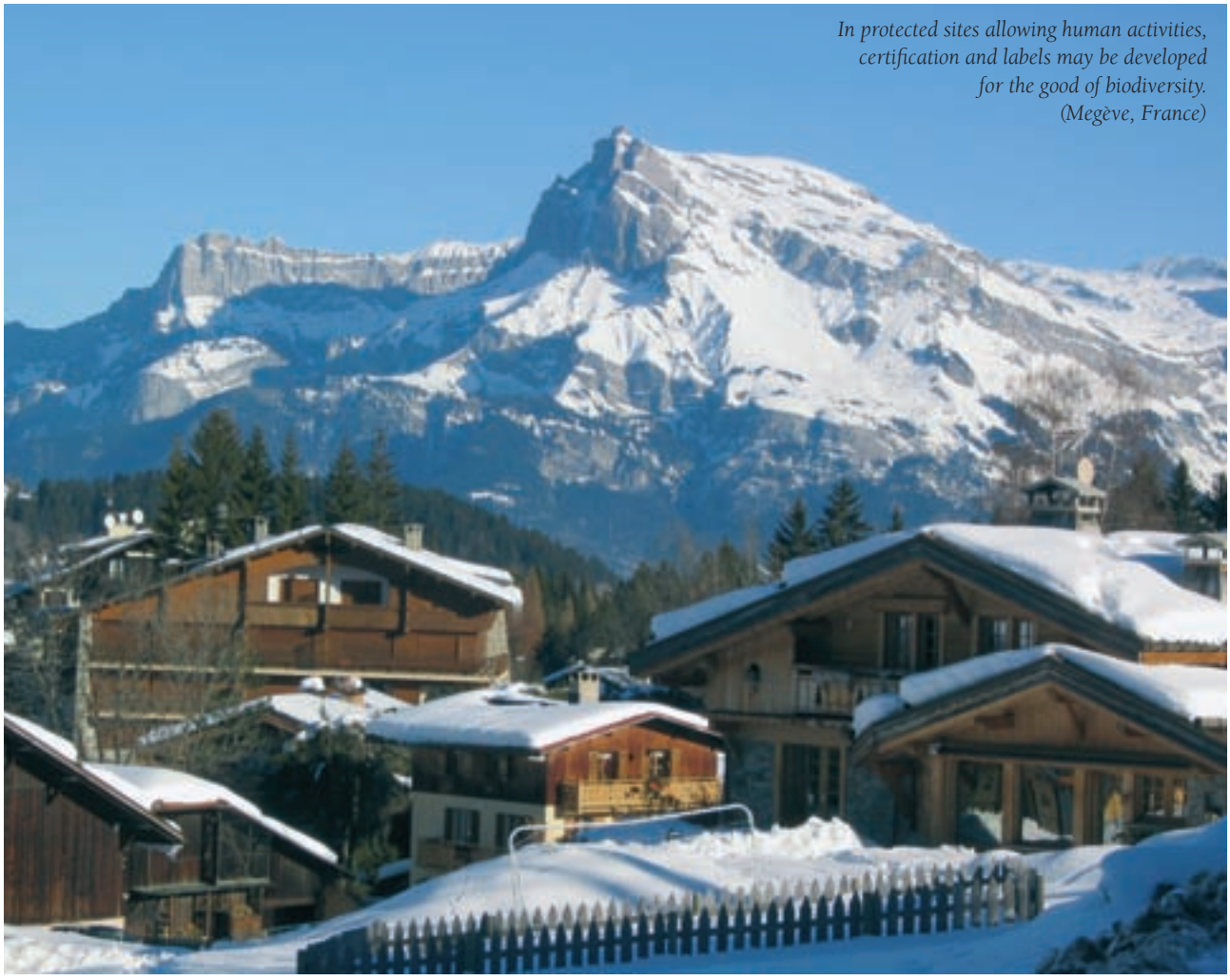
With technical progress, innovation can be used to improve the way some environmental services are used, especially those as yet unused. The creation of new seeds using classic selection procedures or safe genetic engineering is an example. Another is the substitution of services: like the replacement of chemical inputs by ecosystemic services. The best known is the use of natural enemies of insect crop pests. These innova-

tions may themselves require innovations in practice and in technology. Another example from agriculture is that if the geometry of the fields changes, the agricultural machinery will have to adapt.

Getting involved in short and long term

Regarding innovations of the institutions and of public policy, taking time into account so as to be economically profitable should not be overlooked. Although a technical innovation will be profitable to the farmer in the long run, it is not clear that it will be so in the short term. Indeed, economic time is not on the same scale as the time required to change practices or the reaction time of ecosystems before they provide the services expected of them. Public support policies will be welcome while the transition between two different systems has to be dealt with in the best way possible.

Last but not least, we must develop new communication and training tools in order for the implementation of these concepts and institutions to be socially acceptable (see the article by F. Fridlansky and J.-C. Mounolou on p. 134). Indeed, social acceptability will be facilitated if the stakeholders have been made aware of the problems of ordinary biodiversity management from an early stage. Finally, note that applying a single model in all situations will not solve the reduction in global biodiversity loss. The analysis should focus on the various characteristics at both ecosystem and decisional levels. The use of indicators will allow the identification of various types of problems, each with a different solution. Because the individual tools are not exclusive, it is their combination that will guarantee a lasting interrelationship between man and nature. ■



In protected sites allowing human activities, certification and labels may be developed for the good of biodiversity. (Megève, France)

The value of biodiversity is priceless

INTERVIEW of Jacques Weber,

director of the *Institut français de la biodiversité*

Over the course of history, man has always attached value to the things he is dependent on such as salt, bronze, honey, oil or domestic animals. Is the idea of attributing a value to "living" nature – by opposition to the past biodiversity that has left us deposits of chalk, coal, etc. – the follow-on of this way of thinking?

Jacques Weber: Imagine that you sell Leonardo da Vinci's Mona Lisa for a billion euros. This price would indicate the willingness to pay for the Mona Lisa. But would you know its real value? The price you got for the painting, however high, is unrelated to its artistic value. Abuse of terms and confusion between price and value have become extremely frequent. However, on this subject, economists and anthropologists do not have the same point of view. For some economists, the price of a good is an indicator of its value. For others and for anthropologists, the value of a good, of a being, or of a landscape cannot be measured by confronting supply and demand. Price is valid for an instant whereas the value of a work of art is timeless. The price can be affected by numerous other factors such as the political situation. The use of contingent valuations, giving a price for the elements and functions of ecosystems that are outside of any market, is tantamount to accepting a conception of the world that is entirely utilitarian with money being raised to the level of a universal standard of values. It must not be forgotten that a society's system of values becomes the system it uses for the classification of the universe, the world, objects, beings and relationships between beings and objects. A value can therefore be taken as that which cannot be sold, cannot be given or exchanged but which, at best, is shared. Here, we include the notions of friendship, love, God, courage, the constitution, and so on. Their value cannot be revealed by willingness to pay. Values do not have a price and public debate may also reveal the diversity of representations and values to be taken into account when making collective choices.

You have a lot of contacts with private companies – what are their first reactions to "biodiversity"? How do they open to the issue or do they close up?

J. W.: The evolution has been very rapid, and industry has deeply impressed me. Companies are not at all indifferent to the current situation. They understand that their survival depends on biodiversity and that this biodiversity provides their raw materials and their technologies and thus their own production – even those that depend on the diversity of beings long gone, such as quarry activity and cement production. And the companies are actively integrating biodiversity into their strategies, not through altruism but because they have fully understood that it is in their middle and long-term interests.

It could have been thought that they consider its preservation too expensive.

J. W.: "Preserving biodiversity" isn't costing them too much. They don't see the problem in those terms. Half of their raw materials generally come from biodiversity so its erosion can increase costs. A guide for integrating biodiversity into company strategies should be published before the end of 2007.

Is it harder to contact individual companies than the small and medium companies?

J. W.: The size of the company is irrelevant. It is the sector in which they work that is important. Fishing is a whole sector on its own, as is agriculture, to a certain extent. Fisheries are already exploiting the resource faster than it can be renewed. Each individual fisherman, taken on his own, is aware of this. When a fish is caught by someone, that's one fish less left to catch: if I don't get the fish as soon as possible – irrespective of the cost – it will be taken by someone else. The result is an endless upward spiral in the performance of the boats – with a decrease in their total number and an even greater decrease in the number of fishermen: the men have been replaced by technology and horsepower. Beyond the individual awareness of each fisherman, the system of exploitation of the sea's resources forcibly leads to overexploitation.
In other sectors, both small and large companies are rapidly becoming aware of the necessity to conserve as much biodiversity of living beings as possible

What can be done?

J. W.: For activities using renewable resources, we must shift from capture management to a management of the access to resources – by implementing rights which can possibly be exchanged. This holds for fishing, hunting, gathering activities and water.

The only way that current trends can be reversed is therefore to finally have the courage to put a stop to free access to the resources and to develop systems of exclusive permits and individual quotas, preferentially exchangeable ones. This means setting up systems to limit the access to resources on the same economic basis as milk quotas or taxi permits. Halibut fishing in Alaska was reduced to 24 hours per year in 1990 but today has again become profitable on recovered stocks, following the implementation of individual transferable quotas (ITQs). Companies in financial difficulty were able to get out of the fishery with the sale of their rights and sometimes the help of a grant, while the remaining companies, owners of the fishing rights, now seek to maximize profitability; instead of running a race to reach fishing capacity.

Do you think we need some sort of "Intellectual Revolution" to be able to change and reach the point where man recognizes the importance of the whole set of interactions?

J. W.: Yes. The first remark I should make concerns your use of the word "man" – it immediately eliminates women and separates culture from nature. Your intellectual revolution will have started when the word "human" is used. Humans are part of nature to the same extent as ants. What you call "nature" is made up of humans and non-humans interacting.
My second remark stems from an example. Look at cheese; it is created from collaboration between microorganisms and humans. It requires the milk of a cow itself feeding on grass. This grass can only be of good quality because it interacts with soil microorganisms. To digest the cheese, we need the help of our intestinal flora – about 4kg of bacteria per digestive system. From cheese to humans, there is a whole series of interactions. In nature there is predation and killing, but there is also cooperation, mutualism. Consider yourself to be in interdependence with the world around you and your point of view changes: you have a debt towards your bacterial flora. This vision of relationships between humans and non-humans in terms of interdependence abolishes the usual distinction between "nature" and "culture", between humans, who would be "subjects" and non-humans, who would be "objects".
We must accept that we are an integral part of biodiversity: biodiversity being another word for the living planetary system. That is the intellectual revolution we need! ■

Jacques Weber was interviewed
by Lisa Garnier

Wild mushroom gathering under exclusive permits and individual exchangeable quotas? It's one track to manage access to water and to fishing, hunting and gathering activities resources.

ZOOM

A quality label for a naturally grown product: the European king scallop in Normandy

By Éric Foucher

In 1996, the World Trade Organisation decided to generalise the generic term "scallop" or "coquille Saint-Jacques" to cover a whole range of Pectinidae collected throughout the world. Scallop then became the commercial name for the European North Atlantic king scallop (*Pecten maximus*) as well as for various other bivalves: *Chlamys sp., Argopecten sp., Zygopecten sp.*, etc. – of diverse origins (Chilli, Argentina, Canada, Island, etc.). This decision caused a serious competitive bias in the French market with the consumer no longer able to distinguish the European scallop, often sold fresh and having a larger adductor muscle (the "meat"), from other scallops imported deep frozen and intended for use in cooked dishes. The direct consequence for stakeholders, offering a fresh product but being in direct competition with the industrial deep-frozen products, was a significant drop in the price off the boat.

The origin and high quality of food products guaranteed

The first response by the profession concerning the image and the quality of the king scallop took place in Lower Normandy in Port-en-Bessin (Calvados, France) where the fish industry's quality group created a local seafood quality label "*Normandie Fraîcheur Mer*" (NFM) [Fresh Sea Products from Normandy]. They

© Eric Foucher

This is what the European North Atlantic king scallop – Pecten maximus – looks like when it is one year old.

Creating a label for seafood products improves their quality and enhances the reputation of the fishery.

had two aims: (i) improving the quality of the seafood and publicising seafood from Lower Normandy, which led in 2002 to the attribution of the nationally recognised "Label Rouge" which guarantees the origin and the high quality of food products. This "Label Rouge" was the first to be awarded to a wild fisheries product, which requires respecting strict conditions involving a whole series of checks, affecting the supply chain (the quality and freshness of the product) the taste (with blind tastings), the origin of the product with stages between producer and consumer being clearly stated. Moreover, a fishing season must be respected (to reduce the overall fishing pressure on the species, and indirectly the impact of scallop trawlers dredgers on the sea bed), and also a minimum number of individuals per kilo, so in effect those under three years of age are thrown back. Although the species can live to 15 or so years of age, it is still rare to find individuals of 7-8 years of more in heavily fished areas.

An approach that goes further

Again indirectly, the limited fishing season increased the proportion of breeding stock in the Bay of Seine: mature individuals only 2 years old are no longer collected and can therefore remain in the area improving the renewal potential of the resource.

A second step under consideration is setting up an "eco-label" guaranteeing responsible and sustainable management of the resource and the respect of biodiversity. The limited fishing season and the scientific follow-up of the resource are just two examples opening the way for application for the eco-label. The stock of scallops in the Bay of Seine has been scientifically monitored for many years by Ifremer, which carries out an annual stock assessment survey. Diagnosis issued from these assessments – overall condition of the scallop population, its demographic structure, geographic distribution across the seabed, etc. – has led to increasingly restrictive management rules being established, influencing both the resource itself (general annual quotas, daily local quotas) and limiting the fishing effort by shortening the fishing season, the number of hours of fishing allowed per week, the number of hours per day, limiting the length and the power of the boats granted a fishing licence, even the number of fishing licences granted.

What we now have is therefore a well-defined sedentary, coastal resource used by fishermen in a way that respects the ecosystem, guaranteeing the quality of the shellfish harvest. All these actions together have led to the creation of a modern and exemplary fishery. ■

A bivalve

The European king scallop *Pecten maximus L.* is a bivalve from the temperate and cold waters of the North-East Atlantic. It occurs from Norway to the north of Morocco but the main fishing grounds are in the English Channel, the Irish Sea, and the West coast of Scotland. Although it lives from just below low water to a depth of a hundred meters or so, it is only really abundant from between 10 to 50 meters depth on soft substrate. In France, king scallops are harvested in several geographically independent fisheries. The two main ones are located in the English Channel: bay of Saint-Brieuc and bay of Seine. Other smaller scallop fisheries can be found in Brest Harbour (*la Rade de Brest*), in Granville bay and in the Pertuis Charentais (inshore part of the Bay of Biscay, between the Isle of Ré and the French coast).

E.F.

How the market can help conservation

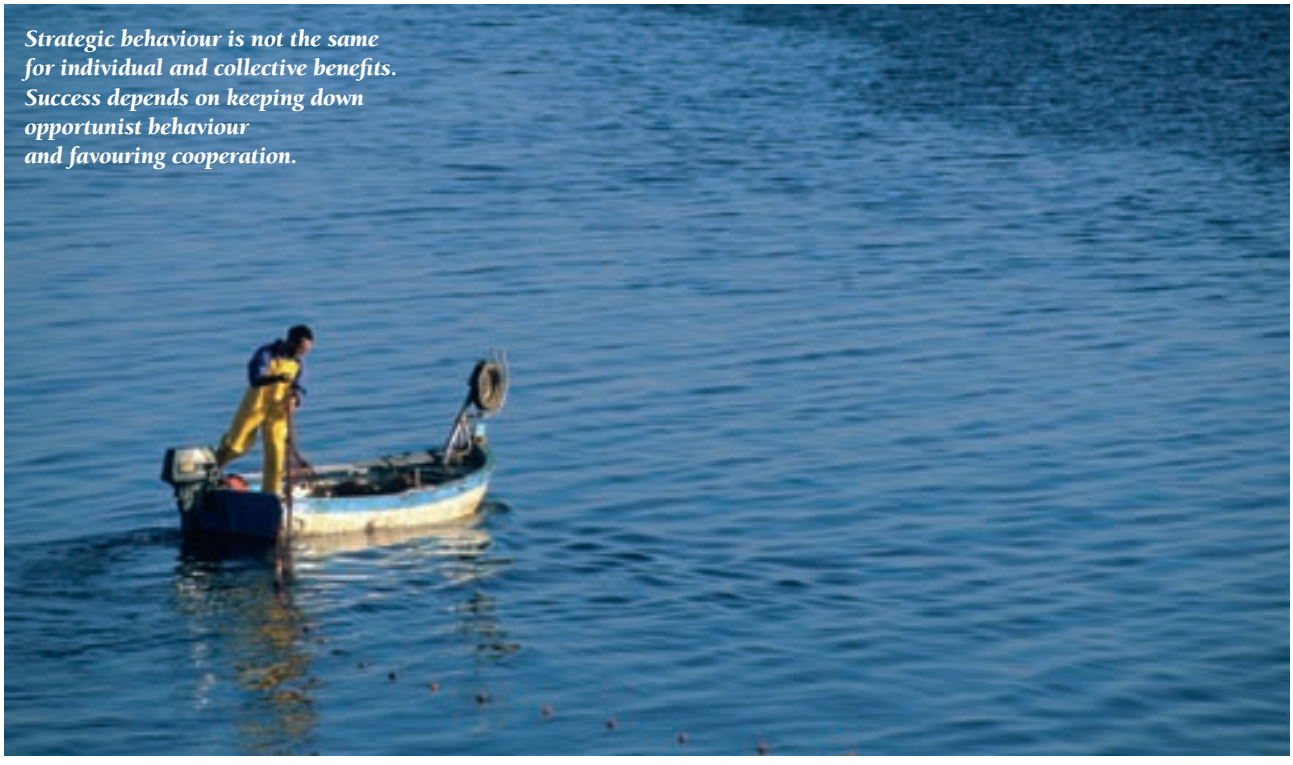
By Sarah Hernandez Perez

Associating the market economy or even using it to promote the conservation of biodiversity – the approach is gaining ground. And yet, the often quoted idea states that failures of the market are at the origin of the loss of biodiversity. In attempting to reverse this statement, it is necessary to understand the origin of markets' failures and the way in which the market can play a positive role in the conservation and sustainable use of biodiversity.

A "free" benefit is completely ignored.

The first failure of the market economy concerns the gratuity of goods and services taken from biodiversity. They are ignored by decision makers in relation to production and consumption. This is the case, for example, of goods using biological resources and traded on a market place, or the capacity of nature to absorb waste resulting from production and consumption processes. Commonly referred to non-market goods and services of nature, they are not considered in any value system established by individuals, the economy or society as a whole. At the individual level, no-one takes upon themselves the cost of maintaining a biological resource or the cost of the degradation of environments - which refers to the notion of externality in economics. In the calculation of national wealth (GDP) the economy, however, does not consider the cost of the loss of natural capital. Finally, society does not associate the level of well being with a quality of natural environments.

A benefit that is "free" and completely ignored as such has its corollary: namely, the cost of degradation, or even the irreversible loss of ecological services provided by nature. When that cost is ignored, policy makers have no way to detect the environmental constraint that weighs on the "natural" offer. In a conventional market, price fluctuations are a sign of a change in the conditions of supply and demand. But in the absence of any other form of regulation – laws, precautionary principle, etc., no signals warn of waste or erosion of



Strategic behaviour is not the same for individual and collective benefits. Success depends on keeping down opportunist behaviour and favouring cooperation.

natural capital except when it is too late and it inevitably becomes the desperate reality.

This natural capital needs to be valued and must be integrated into the decision-making process, so as to ensure proper management or rational management over time. The economic valuation methods, developed since the 1970's, try to emphasize this value, especially in monetary terms. The idea is to make visible what was invisible. It comes to valuing the importance of biological diversity on the basis of individual preferences. As our systems of choices are socially defined, collectively built and result from experience and observation, the value given by these methods, can only reflect a partial social desire or a limited vision of nature. Therefore, the value of biodiversity cannot be reduced to a price issue. There are indeed as many values associated with biodiversity that there are individuals or groups of individuals. If a society recognises the importance of these values, biodiversity conservation could become an aim for that society.

Creating a label for forest products i.e. trading goods produced by biodiversity.

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Making objectives compatible

Biological diversity and its ecological functions are considered important by mankind because man derives utility from them. But this notion of utility should not be the only reason they are valued. Biodiversity has an inestimable value simply by its existence, its beauty, or by the enchantment and the plenitude it provides. Biological diversity has produced cultures and civilizations, showing the strong interrelationship between man and nature. Thus, as a source of individual enjoyment or life insurance for our societies, biological diversity implies a different vision of the world that can only be promoted by ethics, solidarity and education.. Despite constant methodological improvements, this dimension still eludes current ways of valuing biodiversity, but provides further insight into its teachings for the management and conservation policies.

Simply putting a value on the goods and services of ecosystems will not solve the problems of biodiversity loss, but emphasizing their value will bring the economic actors - producers, consumers, and investors, inter alia - to recognize that compatibility between economic and financial goals and the objectives of biodiversity conservation is feasible. And it is in this sense that emerging markets have their place: when the way they work contributes to a policy of conservation and sustainable use of biological diversity.

The second failure of the market economy concerns a premise which is no longer valid. Namely those individual preferences are uniform among all people. Both institutional and experimental economics have shown that individuals do not always choose through monetary interest and that other motives are involved in their decision-making system.

This is why significant attention has been paid to factors such as trust, social norms, and the punishment or the prestige that influence the behaviour of an individual within a given group. The consequences of collective actions such as overexploitation of forests or fisheries depend on individual actions. Therefore, the benefit of an individual is interdependent on decisions made by the rest of the members

of the group. The individuals may decide to cooperate with the group, or to ignore collective interest. The group in turn can develop ways to contain and control any opportunism expressed by individuals.

The interdependence between the individual who acts and the group that observes and intervenes on the basis of the actions of the individual promotes the diversification of strategies in the context of what *must be done* or *not done* in the group. Whether the context is management of fisheries, forests or wildlife the strategic behaviour still varies between individual interests and collective interests. The resulting fundamental question is: once the rules of biodiversity management have been established between the parties involved, how can cooperation be maintained?

'New' or reformed markets

Below are different types of markets related to biological diversity. They allow us to identify goods that, by nature, are already tradable and others, which by the complex relationship between the various stakeholders, require the development of institutions for their generalization. The aim is to develop new forms of partnership, new forms of contracting or institutional association so exchanges favour the conservation of biological diversity.

Trading goods produced by biodiversity but marketable in conventional markets.

This is the case of the produce of organic farming or forestry, *inter alia*. The promotion of these markets implies a public policy involving incentive systems – market and production subsidies – or the improvement of information systems such as labels.

The tradable quotas applied to resources.

This is the case of individual transferable quotas. In France, the quotas system exists for fishing, but the opportunity to negotiate the quotas is not yet allowed.

Payment mechanisms for environmental services

This system identifies the contribution of private stakeholders in conservation of goods and services from biodiversity. It is a compensatory mechanism between the direct users of the resource and those who can contribute to its conservation, while sharing the costs. A good illustration is the case of water conservation, which is a partnership between users and farmers. The farmers receive compensation for changes in practices to avoid adversely affecting the water quality. The brand of bottled water Vittel has established such a partnership.

The offset mechanisms for biodiversity.

Having complied with the obligation to avoid any impact on species and their habitats, infrastructure projects can offset the residual damage that they cause to biodiversity. To that end, it directs its activities toward the preservation of the richest areas in terms of biodiversity in such a way that there is a gain in terms of ecological value. At the international level, the USA pioneers this area with *Mitigations Banks*, which through the Clean Water Act (1972) created across, led to a significant increase in the number of hectares of conserved wetlands. In Australia, the *Biobanks*, established in 2006, can help enhance biodiversity on private land. The particularity of these mechanisms is the development of a financial intermediary structure for exchanges between the different stakeholders.

The ecological or environmental right of way or easement

It is a legal tool, developed mainly in English-speaking countries, allowing any private landowner to transfer part or all of the rights of use of a portion of land with a significant ecological value, to the benefit of a public or private person, association or environment manager. This translates into a legally binding voluntary contract between the owner and the public or private entity, for the conservation of natural assets, clearly identified by the environmental authorities – conservation of forested areas, wetlands, areas for migrating birds, for example – for a long period, and possibly for ever. The contract of ecological easement commits the owner to certain arrangements for the use or non-use of the land, in exchange for tax benefits. The advantage of the ecological easement is twofold: it ensures continuity in the conservation of natural assets because the commitment continues even in the event of sale or transfer to a third party and guarantees the ecological value of the private property by protecting it against any future development. Depending on the case, the environmental easement may be accompanied by a tax incentive for the benefit of the private owner.

To set up a place for negotiation and transaction for better management of biodiversity, it is first necessary to act on the individual's system of incentives and on the group's capacity for self-control – i.e. to keep down opportunistic and uncooperative behaviour. Some authors even suggest the creation of institutions at various scales, which would give rise, at the same time, to the problem of individual strategies, their incentives and governance of the resource management.

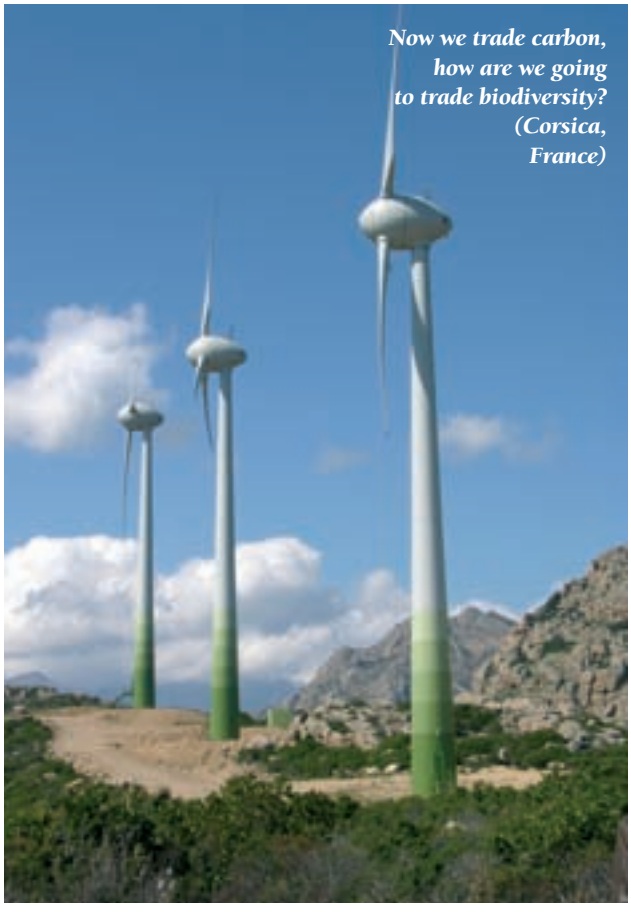
The question of private goods

Property rights that are insufficiently clearly defined is the third and final element of the market's failure to address biodiversity. To illustrate the question of ownership – free access, private property, collective or public – the tragedy of the common goods, for example, is commonplace. Indeed, free access or lack of property rights leads to overexploitation of the resource, a situation that is exacerbated by the absence of any form of regulation. But it turns out that the tragedy of common goods is just one situation among many in which long-term use of biodiversity has proved to be fairly rational.

These situations have been successful in managing two important attributes inherent to the goods and services derived from biodiversity: That of rivalry implies that the consumption of the goods or services by a person does not reduce its consumption and that of exclusion, which means that once the goods or services have been provided, it is possible to prevent anyone from consuming them. Some goods and services feature public, or common or private good. The private good is characterized by strong rivalry and high exclusion. It is found under a regime of private property or collective property – the forest, for example. Common property shows strong rivalry, but low exclusion – this is the case of wildlife. Finally, public goods, the most frequently observed situation, are defined by non-rivalry and non-exclusion – as illustrated by natural parks. It may be under a system of public ownership or free access.

In this way, we can see that there may be an overlap between the attributes of the goods and the property regime applied to it. It is only important to note that it is not necessary to change the property regimes in place but to define management rules that can maintain the quality of the environment and also monitor and control its use.

Based on the above observations, the idea of a market for goods and services from the ecosystems becomes true, as an area of transaction or institutional arrangements. The effort must focus on the construction of the market as an institutional space for the exchange, but also on the nature of the goods or services from ecological diversity that are exchanged there. The market becomes a reality if these goods and services feature the characteristics of private good. These "new" markets must take into account the nature of the goods and services of biodiversity and the governance requirements entailed. Eventually, this should lead to the foundation of new institutions for biological conservation. ■



Now we trade carbon, how are we going to trade biodiversity? (Corsica, France)

© M. Etienne

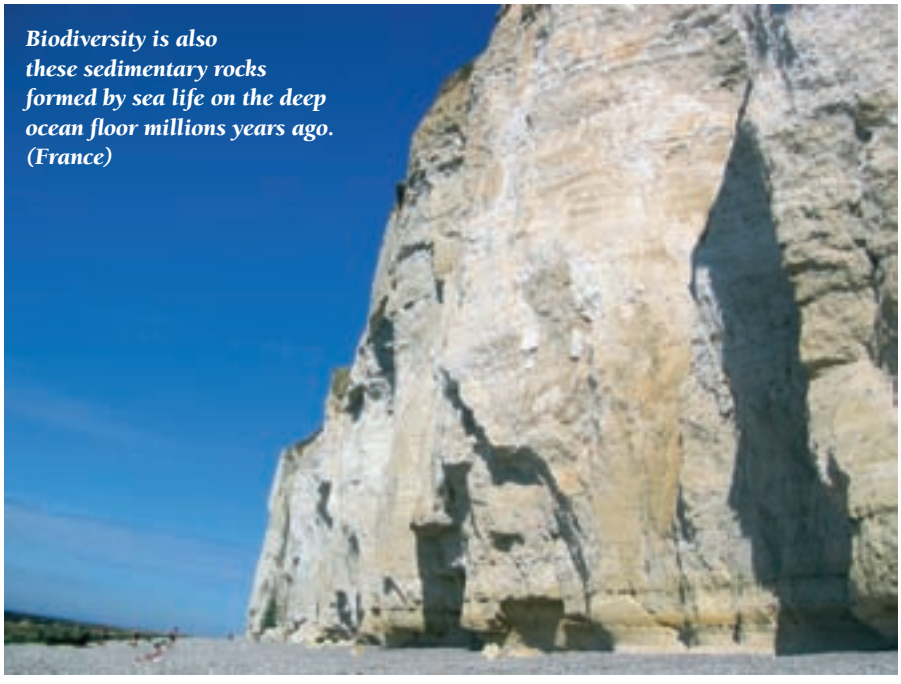
Biodiversity and business

By Joël Houdet
and Nadia Loury

How have companies come to worry about biodiversity? And why?

Since the Rio Conference on the Convention on Biological Diversity, companies have to deal with several difficult questions: i) taking into account the equitable sharing of benefits arising from renewable resources derived from biodiversity, ii) the way in which they contribute to the conservation and sustainable use of biological diversity and iii) the way in which international policies and targets regarding biodiversity are integrated within their strategies and activities. Indeed, local and national associations such as the *France Nature Environnement* and the *Ligue pour la Protection des Oiseaux*, international non-governmental organizations – IUCN, WWF and FFI, and extra-financial agencies such as *Vigeo*, specialised in the evaluation of the social and environmental responsibility of corporations listed on the world's stock exchanges no longer hesitate to ask for accountability. These issues cover all the scales concerned by the erosion of biodiversity: from the land around industrial sites to international trade networks. A primary objective for all these organizations is to help industry become aware of the extent of its impact on the fabric of life.

Faced with these expectations from stakeholders, firms concerned perceive the problem in different ways. Some consider biodiversity as a heritage to be preserved by Nation States on behalf of society. Among these companies, biodiversity is mainly seen as *a constraint external to the organisation* that only concerns them directly when it negatively affects their own daily activities. For example, in France, this external constraint is illustrated by the requirement for environmental impact assessments to be undertaken before exploiting any new industrial activity, a process guided by regulations concerning classified installations for the protection of the environment (*Installations Classées pour la Protection de l'Environnement* – ICPE). For others, like pharmaceutical, cosmetics and food companies, elements of biodiversity are, like raw materials, at the heart of the production process. In other words, biodiversity is a source of income, innovation and new markets. In the end, the conservation of biodiversity can be a particularly sensitive subject. Within the mining industry, for instance, the ecological restoration of old quarries has gradually become a strategic priority for survival. Indeed, people are increasingly wary of both new mines and the expansion of existing ones, notably because of their impact on the landscape and their daily lives, so that the end-of-life of the quarrying activity becomes a central issue.



© Lisa Garnier

Biodiversity is also these sedimentary rocks formed by sea life on the deep ocean floor millions years ago. (France)

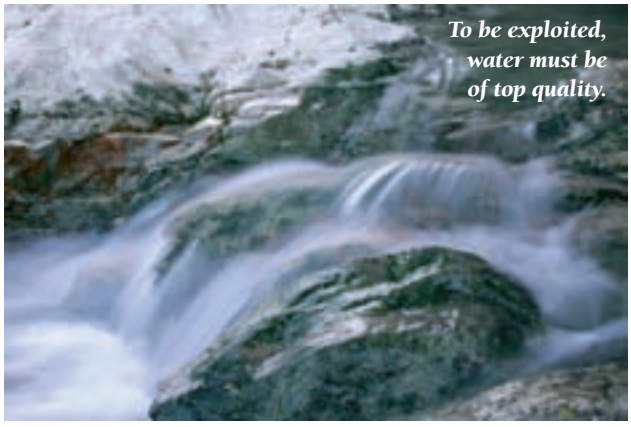
Firms' perceptions change rapidly with respect to biodiversity loss. In fact, they are starting to think in terms of risk management. Regulatory risks may involve compensation measu-

res for companies setting up a new site. Risks associated with the company's image or reputation may influence access to new markets as well as their relationships with their customers and shareholders, both becoming increasingly sensitive to these issues. Risks associated with the availability and costs of raw materials are an essential part of production processes – water, fish stocks, biomass, and so on. Lastly, business sectors that present higher risks in terms of biodiversity could experience increased costs regarding access to capital. The company may for instance be excluded from the investment portfolio of certain financial institutions or be subjected to an increase in interest rates or insurance costs. Note that risks involving regulations and the company's image can have a decisive effect on the firm's license to operate.

For the moment, the only firms fully aware of the situation are the large groups and multinationals, i.e. those most visible in the public eye and also those likely to be subject to pressure from multiple organizations. Most of these large firms meet current regulations. In France, the law on new economic regulations (art.116) establishes the obligation for French companies listed on the stock exchange to report annually on the management of their social and environmental impacts. However, biodiversity still remains a very peripheral issue.

What can companies do for biodiversity?

As part of the recommendations of the Global Reporting Initiative (GRI) – an organization that has developed a methodology used to measure environmental, social and economic performance of firms – any material impact of a company on the natural environment must be reported, the nature and level of impacts depending on the type of activity. In fact, the way a firm interacts with ecosystems depends on its needs for land, air, and water, but also on where its assets are located – e.g. in an area of great plant species diversity – as well as its efforts to take biodiversity into account. Several non-governmental organizations, such as the IUCN and WBCSD, have also been trying for several years to assess


To be exploited, water must be of top quality.
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the biodiversity issues relevant to business. They have proposed tools for avoiding, minimizing and offsetting the direct and indirect impacts of companies.

Companies may capitalise on their impacts – if they are positive – through communication campaigns. A good illustration of this would be the agreement signed between farmers and the company marketing Vittel bottled water for the sustainable management of catchment areas and hence secured water quality over the long term.

A company may also act upstream or downstream within the supply chain. In terms of research and development, it may develop new production processes better suited to biodiversity – through the use of standardized procedures, labels and codes of conduct, or by financing conservation projects through sponsorship. These initiatives can be carried out with other businesses within the same industry wishing to cooperate over the issue.

Both at field and institutional levels, partnerships with NGOs and public bodies are thriving. There is increasing cooperation regarding the location of new industrial sites away from biodiversity-rich areas as well as the development of policies to monitor and restore biodiversity. For instance, the *Compagnie Nationale du Rhône* invests in infrastructures to facilitate ecological continuity along the River Rhone corridor by forging partnerships with key local players, including NGOs and research centres. For the group Séché, a major new initiative concerns its collaboration with the Paris *Muséum national d'Histoire naturelle* on the long-term monitoring of common birds on its waste storage site in Changé, Mayenne.

The general atmosphere is therefore no longer one of systematic opposition between businesses, the scientific community and NGOs. However, certain issues remain problematic. The need for open debates on the development choices of our societies cannot be discarded, notably regarding the future of biotechnology.

What are the main problems?

Despite these improvements, expertise today remains insufficiently widespread and is often limited to case studies on major development projects – infrastructures, storage sites, harbours, major factories, and so on. In addition, it is often difficult to do more than simply pay lip service to the general recommendations, namely to develop effective action plans in the field, and create meaningful changes in attitudes within companies. The main difficulty lies ultimately in the complexity of the very notion of biodiversity, which cannot be reduced to a universal indicator and, hence, is impossible to express in monetary terms – like, for instance, the Carbon Dioxide Equivalent or CO_2 Eq so useful for communication and action within the climate change agenda.

Accordingly, despite their good will and their strategy to anticipate new laws on biodiversity, companies have to deal with many uncertainties and find it difficult to define meaningful targets as well as the associated range of suitable indicators. In the field, managers of industrial sites are often faced with thorny choices. For example, what taxonomic groups should be used to monitor the health of an ecosystem in the face of limited financial resources? What are the tools or catalysts that can be used to encourage the production line to work differently, especially when the company must operate in a particularly difficult customer-supplier power balance? What is the initial state that should be used as a reference for ecological restoration?

How can we reconcile the many needs and expectations regarding environmental issues at both local and international levels? Indeed, there are often contradictory aims, such as promoting hydropower so as to satisfy Europe's targets for renewable energy while at the same time ensuring a good ecological status of aquatic ecosystems as required by a recent European directive. In addition, this raises questions about the allocation of costs associated with a better consideration of biodiversity at the ecosystem level and the roles to be played by business in an effort to rethink the way we live and consume. Areas in need of improvement are thus numerous. An awareness campaign designed to reach businesses and their stakeholders would be necessary to promote a real change in mentality and in behaviour, especially in terms of staff training and external communication by firms.

Orée – Business, territories and environment

Since 1992, *Orée* has been bringing firms and local authorities together so as to develop a joint reflection on their environmental impacts and, in particular, on environmental management and its practical implementation at the landscape level. In February 2006, *Orée* and the *French Institute of Biodiversity* initiated a working group entitled *Integrating biodiversity into corporate strategies*. Some twenty companies, including major corporations and SMEs, are on board. The goal is to rethink firms' strategies and activities within sustainable ecosystems, i.e. to replace the standard approach of exploitation and impacts management by that of valuing interdependences. **J.H. and N.L.**

Can we rethink the nature of the interactions between firms and biodiversity? What would be the strategic implications for companies?

In a state-pressure-response framework, one can underline the magnitude of the impacts generated by businesses – especially in terms of the abundance and distribution of certain species, but also more importantly in terms of ecosystem resilience. These impacts include the modification of habitats, the over-exploitation of renewable resources and pollutions of all kinds. They originate from a diverse range of industries, such as agribusiness, construction and civil engineering, primary industries and financial institutions. In such an approach, it


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Forests retain and purify rain water, which helps fill the water table.

seems appropriate to avoid, minimize or compensate for any inevitable ecological damage.

From a perspective of valuing interdependences between biodiversity and firms, a conceptual and operational shift is required, away from a system based on national or international public policies external to the firm towards one of reciprocal interaction between changes in biodiversity and the growth of companies. Indeed, there are two opposite ways to take into account the complexity of ecosystems in production processes. The standard approach is to minimize uncertainties by artificialising and simplifying living processes, a good illustration being soil-free crops. The ecological consequences of this approach are often disastrous. The recommended approach involves understanding the way ecosystems operate so as to use their properties to produce goods and services for consumption and sustain the ecological services they provide. Among the latter, we can mention climate regulation, the water cycle, the formation and retention of soil, etc.

For instance, instead of building standard sewage treatment plants, an ecological engineering approach would use the ecological functions of plants and microorganisms to purify wastewater in artificial wetlands built on industrial estates and, hence, trigger the return of wetland biodiversity within such areas.

Implementing such an approach would require, for most firms, a thorough review of their strategies, particularly in terms of research and development. It would be necessary to reconcile different sources of knowledge, through interdisciplinarity and participatory science. In particular, the goal would be to develop new accounting, tax and management tools, suited to the economic constraints of firms, which would complement the existing range of tools – such as natural reserve networks – favouring biodiversity conservation. ■

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Geographical indications, a contribution to maintaining biodiversity?

By Laurence Bérard
and Philippe Marchenay

At the interface between man and nature, a growing interest is being shown for origin-based products. In the context of globalisation, this can appear paradoxical, but increasing numbers of customers are being attracted. Belonging to the plant or animal world, processed or not, these products are most often related to biological processes, through growing, breeding, fermenting and so forth. Their relationship with the locality is defined by the association of a history and shared know-how. Some products are based on a complex organisation involving the upkeep of a broad spectrum of biodiversity, which affects the landscape down to the microbial ecosystem and sometimes includes local varieties of vegetables or breeds of animal. Many of these products carry the name of the geographic locality they come from. This association is a clear indication of the link that exists between the quality, the origin and the reputation gained. Some problems do however arise with this practice, since the reputation associated with a place does encourage others to usurp the name to enhance their own sales. The geographic name first became protected in France, then in Europe, then in the rest of the world.

PDO, AOC and PGI

The European legislation is based on the Protected Designation of Origin (PDO) which corresponds to the long-established French *Appellation d'Origine Contrôlée* (AOC) and the Protected Geographical Indication (PGI) with precise specifications and a clearly determined production area outside which the use of the name is forbidden. In the case of PDOs, the quality or the characteristics are due essentially or exclusively to a particular geographical envi-

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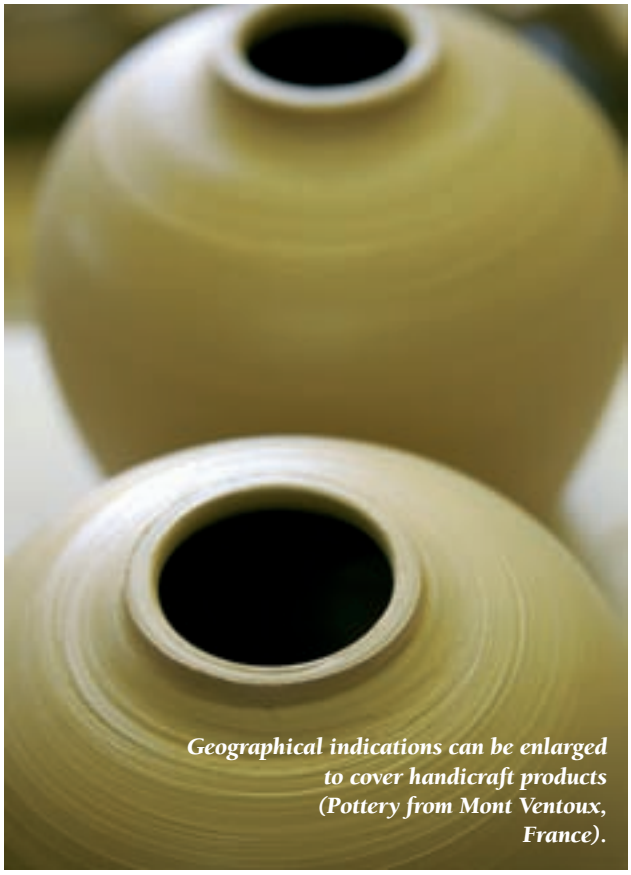
Certain cheese AOCs are particularly attentive to the way the herds are run, the importance of local breeds and the composition of the pastures.

ronment with its inherent natural and human factors. By according a determinant position to natural factors and the way they interlock with human factors, the PDO definition becomes implicitly linked to biocultural diversity. This is not the case for PGIs where a specific quality, the reputation or other characteristics can be attributed to this geographical origin (Council regulation (EC) N° 510/2006).

Natural factors, which are not mentioned, can take a secondary place and the link to the place of origin becomes established via practices and through history.

The AOC is always the result of a subtle blend of history, natural factors, and the will to define a production procedure that is so demanding that it can only apply to an individual product. The instigator of the best thought-out geographical indications is often a well-known local character who is convincingly attached to the product he is trying to defend. In some cases, a virtuous circle can bring the local stakeholders to modify their geographical indications through revision of the specifications. On the other hand, economic reasoning that is too remote from the culture of the product can reduce the AOC to an empty shell.

Biodiversity and sustainable development tend to occupy an ever-increasing place in the preoccupations of the National Institute of Origin and of Quality (*Institut national de l'origine et de la qualité* (INAO)) which, in France, is responsible for Geographical Indications (GI). The AOC "*Poiré Domfront*" obtained in 2002 for a perry, and the AOC "*châtaigne d'Ardèche*" (chestnut from the Ardèche *département*) also made an effort to take into account the whole ecosystem. Certain cheese AOCs such as the Tome des Bauges (2003) or Comté – its decree was revised in 2007 – are particularly attentive to the way the herds are run, the importance of local breeds of cattle, the composition of the pastures and the natural microbial flora of the milk. The AOCs that respect the INAO doctrine the closest participate in the upkeep of the landscapes and in a certain number of cases, the conservation of local resources *in situ*.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Geographical indications can be enlarged to cover handicraft products (Pottery from Mont Ventoux, France).

In the French agricultural law of January 5th 2006, the section concerning AOC imposes external controls by an independent certifying organisation. This new situation may lead to a standardisation that appears to be less suited to taking cultural biodiversity into account. Indeed, for economic reasons only the characteristics that are the easiest and the least numerous to check will be taken into account. The significant cost of the controls could add to the financial strain on already precarious smaller AOC's. On the other hand, this reorganisation could give impetus to the collective trademark and the collective certification trademark, the two labels not requiring the regulations to be followed in the same way. For instance the denomination "*Parc naturel regional*" followed by the name of the park is a collective label for the natural parks of France registered in 1997 as the property of the Ministry of the Environment. The collective label "*Sites remarquables du gout*" (Sites of remarkable taste), registered in 2001, associates a food product, a

Cultural biodiversity counts.

remarkable heritage – such as architecture or landscape – and a tourist setting.

The principle of protecting the geographical indications was adopted internationally in the framework of the TRIPS agreement (Agreement on Trade-Related Aspects of Intellectual Property Rights). But, its application does raise many questions, considering the great diversity of situations and human cultures. This agreement, generated by the World Trade Organisation (WTO) defines GI: "Geographical indications are, for the purposes of this Agreement, indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin." The actual geographic environment, with its natural and human factors, does not appear as such but the simple act of acknowledging the existence of geographical indications, often *de facto* bearers of biodiversity, is a step in the right direction. Just like in the set of obligations laid down in the TRIPS agreement, the definition is that of a minimum standard that the members must respect – it is the member state's responsibility to plan a stricter GI if they wish or to enlarge the system to take in other products such as wild plants, wickerwork or pottery.

The ADPIC agreement includes a general basic protection, which concerns all products, and an "additional" protection for wines and spirits, which protects the use of names much more efficiently. Applying this higher level of protection to the whole agro-food sector always comes up against strong opposition. Many unknowns remain concerning the establishment of such legislation in developing countries considering the enormous differences there are in the levels of development. France took a hundred years to perfect its system of protection, which long remained limited to wines and spirits in a relatively calm international context. The atmosphere is quite different today. Free exchange has led to acceleration in the circulation of goods. This is the case for origin-based products from emerging countries, often valued in the rich countries which then go on to register the trade names. This happened for the emblematic name of rooibos (south African "red tea"), which was registered as a trademark by a private company in the USA in 1994. Following a legal battle

Collective trademarks poorly suit the fight against outsourcing.

The «Grenoble walnut» is a French AOC since 1938. (Orchard, Royans, Isère, France)

Long limited to wines and spirits, the notion of Appellation d'origine contrôlée *was extended in 1990 to all agricultural and food products, both fresh and processed. (Mont Ventoux, Vaucluse, France)*

won by South African state-backed operators in 2005, rooibos was recognised as a generic name, belonging to the public domain.

Developing countries should now set up, and quickly, a system to protect their GIs, to avoid being dispossessed. They can do it using the tools they already have or new tools gained through contacts or establishment of long-term relationships with industrialised nations. In these countries where the approach is new, private brand names that are collective or related to certification, have been found to be easier to use than the complex systems established in Europe and can be encouraged to set up the whole system. This is the case in South Africa for products other than wines and liquors. Three examples of highly reputed products with their own trademarks are Swakara pelts, produced by the karakul race of sheep – this is the commercial name for this astrakhan in South Africa, Botswana and Namibia – and in South Africa there is also Camdeboo mohair, from the Angora goat and Karoo lamb giving quality meat flavoured by the animal's diet of wild aromatic plants.

A few countries have taken inspiration from the French model, others set up hybrid systems between GIs and trademarks or they innovate, like Brazil. In 1988, Brazil promulgated an ambitious new constitution; one of its aims is to protect biological and cultural diversity by institutionalising the registration of immaterial cultural goods. The geographical indications, then not used much and poorly known, were defined in a 1996 Brazilian law as being collective intellectual property rights.

The difficulty of spot-checks

In France, the GIs are based on a large institutional and technical system. They are upheld by public policies on national and European levels. But, among the developing countries, how many have sufficient institutional and financial resources to do this? The same can be said for routine controls, which are complex and expensive to set up. Biodiversity considerations will involve the participation and the motivation of the people responsible for drawing up

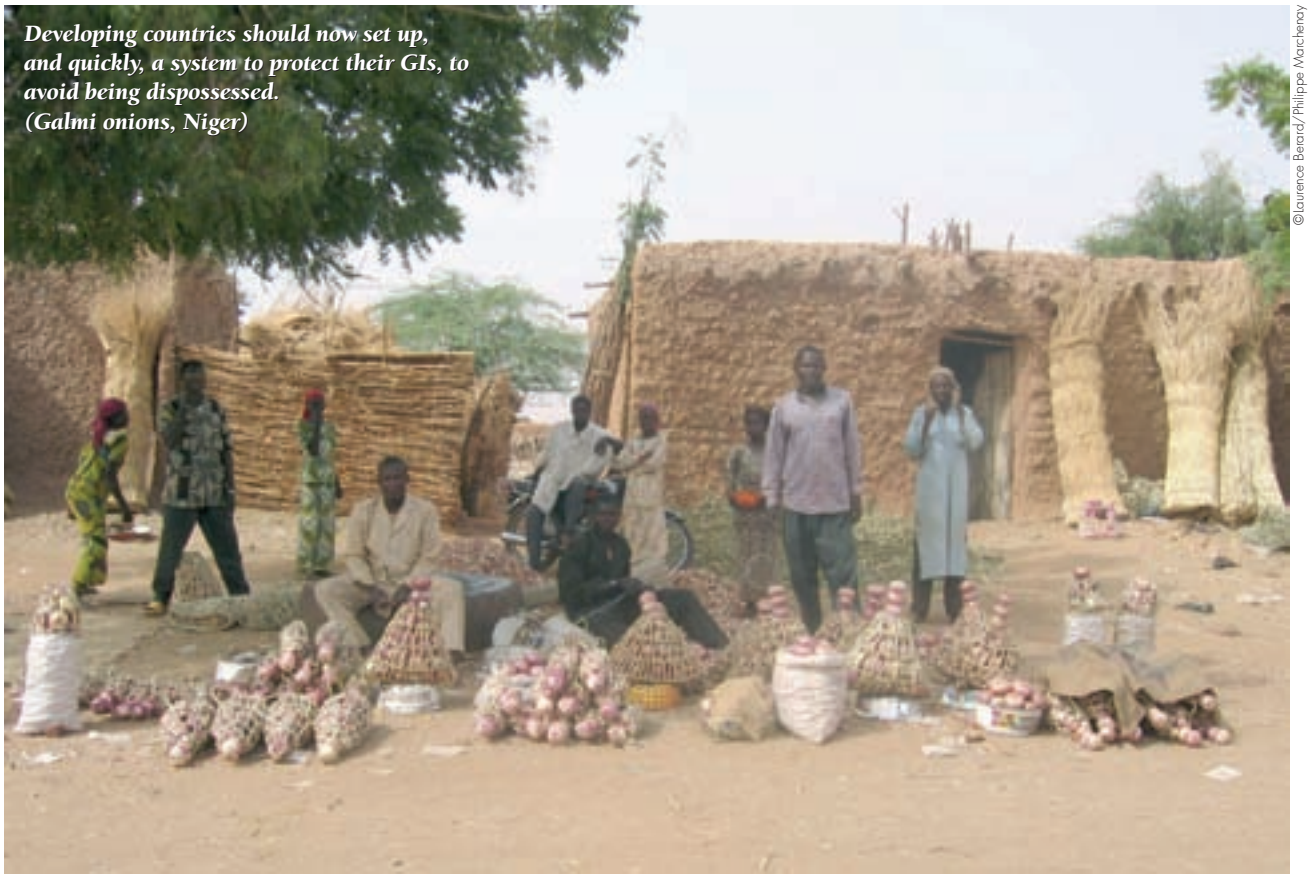
the specifications. The specifications are the cornerstone of GIs, precisely determining their level of specificity. But again, a prerequisite for this is organisations capable of supporting the producers and setting up controls. Could collective trademarks then be a more accessible alternative? In any case, trademarks seem to be poorly suited to the fight against outsourcing.

The driving force behind the approach

Now, who are the applicants and what is the role of the state for a given product? In certain developing countries, it is governments that are sometimes behind requests for neo-colonial products such as coffee or cocoa, export cash crops. It can also be the middlemen: the negotiators and the wholesalers – the merchants – interested in benefiting from this type of protection for the purposes of speculation. Who – the producers or the state – is in the best position to take biodiversity into account when drawing up the specifications to be as close as possible to local characteristics? The example of Ethiopia shows that some countries are very sensitive to this issue. In Ethiopia it was the Ministry of the Environment that directly instigated the protection of geographical indications. But, in 2005 in the same country, the Ethiopian Intellectual Property Office counselled by the *United States Agency for International Development* (USAID), tried to register as trademarks the names of three Ethiopian regions famous for the quality of their coffee – Harar, Sidamo and Yirgacheffe. The polemic that followed, between the multinational Starbucks, defending the principle of the GI, and Ethiopia, supported by the NGO Oxfam, provides a good illustration of the current confusion on the subject attributing a certain value to origin-based products.

In Europe, it is the producers who must file the application on their own initiative, although this does not prevent battles of strength within a given sector. The cheese sector, in particular is increasingly under the power of industry. It can happen that small producers in Europe have a hard time getting their rights respected, reporting a similar experiences to those in less developed countries.

Finally, the NGOs are omnipresent and inevitable partners. They have their own objec-



Developing countries should now set up, and quickly, a system to protect their GIs, to avoid being dispossessed. (Galmi onions, Niger)

The case of France

The protection of geographical indications is the result of a long chain of events that ran right through the 20th century. In 1919, a law introduced the notion of designation of origin associated with collective property rights. A decree-law in 1935 created a committee which was to become the *Institut National des Appellations d'Origine* (INAO) (National Institute for Designations of Origin) in 1947 (now known, since 2006, as the *Institut national de l'origine et de la qualité*) and laid down the foundations for the *Appellations d'Origine Contrôlée* for the wine industry. The French law of July 2nd 1990 broadened the measures to the whole of the agro-food sector. In 1992 it was adopted by Europe in the regulations concerning the protection of Geographical Indications and Designations of Origin of agricultural products and foodstuffs (revised in 2006). Since then, two legal instruments ensure the protection in France: the Protected Designation of Origin (PDO) – which can be considered to replace the French *Appellation d'Origine Controlée* – and the Protected Geographical Indication (PGI). **L.B. and P.M.**

tives and their own interpretation – often that of an activist – of the geographical indications, which they count on heavily for maintaining biodiversity. Article 8j of the Biological Diversity Convention takes account of local skills: "knowledge, innovation and practices of indigenous and local communities embodying traditional lifestyles…". This acknowledgement is taking an increasingly important place in international negotiations associated with the Biological Diversity Convention.

The regulations to protect GIs were first laid out to protect the interests of the producers faced with unfair competition and legally remain focused on the protection of the name. In Europe, the system tends to become a rural planning tool and more recently a way to conserve characteristic animal races, cultivated varieties, local know-how, and ecosystem elements modelled by human activities. GIs could have an important role to play throughout the world.

Local knowledge aiding biodiversity! The temptation is great to consider GIs like protection tools integrating biological diversity, especially the management of genetic resources, essential foundations of traditional agriculture

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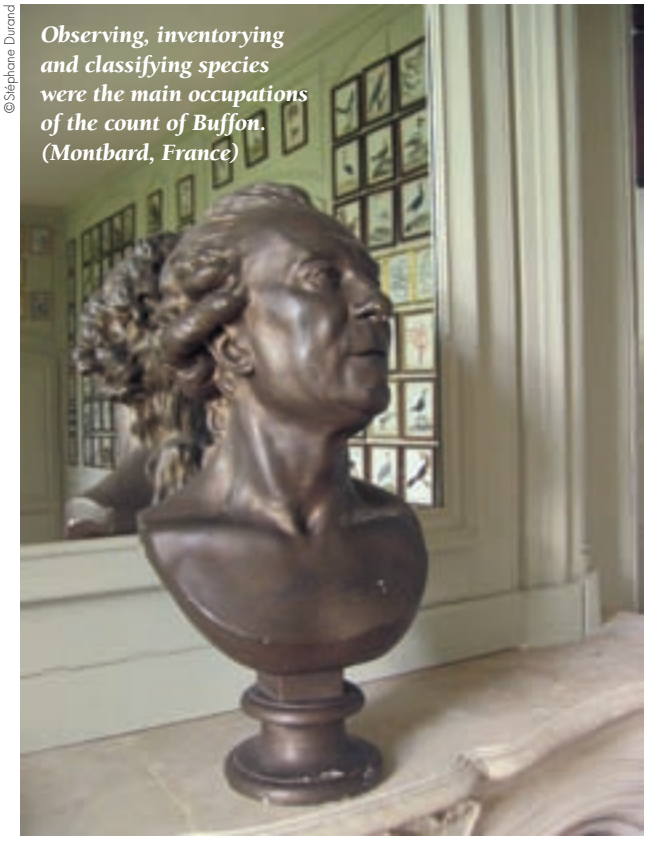
MAB: an educational vocation

By Françoise Fridlansky
and Jean-Claude Mounolou

1971: UNESCO launched the Man and Biosphere programme. After the trauma caused by the Second World War, the advances in technology, the exploitation of natural resources and environments, the widening gap between rich and poor, the ever increasing domination of just a few major cultures, the idea was to get a fuller understanding of the relationship between man and his environment and to work towards a sustainable and equitable future. Conserving biological diversity and yet ensuring economic and social development seemed to be divergent aims. UNESCO however managed to bring together, in many different countries, men and women who gave their time and energy – often on a voluntary basis – to make this ambition become reality. In 1974 they set up the MAB programme, which proposed the creation of "Biosphere reserves", territories for experimentation, well before "sustainable development". In France, this impetus was given and supported by the founders of MAB-France, devoted to the cause. Today MAB-France has a basis of ten Biosphere reserves all respecting the UNESCO recommendations. Practical actions involved in the day-to-day existence of the reserves involve: conserving biological diversity, making respectful use of the resources available locally, promoting the economic and social development of the people living in the territories concerned, making the territories demonstration exhibits and places of education for everyone.



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Observing, inventorying and classifying species were the main occupations of the count of Buffon. (Montbard, France)

In 1974 these aims appeared generous but utopian. UNESCO had very little funding to offer and the various governments involved were extremely sparing in their support. Biosphere reserves were "integrated" into other operations, most often oriented towards conservation – parks, protected areas, conservatories, natural reserves, etc. The operations aimed to follow the works of Buffon which were to observe, inventory and protect the species making up the fauna and flora and to classify them according to their relationships with man well separate from the universe. In the 1850s, ethnologists had already dealt with the question of cultures and societies. This was the period when expeditions and colonial victories brought back a rich harvest of objects from all sorts of cultures. Adolph Bastian, director of the Berlin Museum of Ethnography, wrote "We should first massively buy up the products of the savages' civilisation and store them in our museums, to save them from destruction." This is very reminiscent of current operations in parks or other areas and of various conservation actions concerning everything from monkeys to lichens. These objectives of conservation do, of course, have their place in the MAB programme but ever since its beginnings, MAB has added an educational dimension whose main tool is demonstration.

Educating is much more than communicating, as proposed by others. Educating means

One objective of biosphere reserves is biodiversity and social understanding of young generations. (Vosges du Nord, France)

offering knowledge, giving training, demanding a high level of civil responsibility, preparing everyone for freedom of decision and social responsibility. From the start, MAB-France had upheld this education with its conservation and development policies. In 1991, this was already clear in the very first French "Biosphere Letter". Today, MAB-France is publishing Letter N° 78 (www.mab-France.org) and educational demands are still present.

Education as the priority

However, with the few resources available to Biosphere reserves, education is only possible through partnerships with institutions: partnerships with mixed aims. The partners are infant, junior and senior schools, universities, local communities, and regions. Working with regional councils, and with research organisations, MAB-France participates in the advancement of knowledge that must be disseminated to all and especially made available to children. To do so, MAB organises open days, visits, practical actions and locally concerted actions, conferences for the general public and for specialists, research projects. But, the initial objectives were more ambitious. Biosphere reserves have to help men and women living inside them to improve their techniques, their practices and their economy – in forestry or in water use for instance – in order to respect others as much as the surrounding environment is respected. So, beyond elementary communication and in agreement with the facilities available, actions must be carried out in cooperation with local and territorial institutions: communes, the Regional Agricultural and Forestry Board (DRAF), the Forestry Commission (ONF), etc. MAB can be seen to cover the whole spectrum of Mr and Mrs Everybody's daily life such as the economic life, the environment (whether it is ecological or social), some quite special – even egotistical – and the requirement for greater equity and respect. In balance the educational role has been highly satisfactory, appreciated and praised by all those who have learned of its

Partnerships with institutions, schools, local communities and regions contribute to educative efforts.

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existence or benefited from its teachings. Now, if all this is so wonderful, why have MAB's activities not spread further through France? Of course, it would be simple to say that all the abnegation and self-sacrifice of those involved is not sufficient to satisfy the demand and to regret the lack of funding. But, looking at it the other way round, funding is linked to external acknowledgement. Beyond the financial questions and the resulting compulsory negotiations and concessions, several other causes have hampered the educational impetus of MAB-France.

The first cause is time: in 1971 MAB was launched by UNESCO; 1974 the first Biosphere reserves were set up in France. At the time, UNESCO and MAB-France proposed an actual social construction centred around biological diversity. Today, the desire for such construction is commonplace, present in the mouths of all citizens and politicians, running through various ecological pacts, and even in the work of communication and marketing agencies. But, this trend emerged very recently. In the 70s and 80s few were ready for the questions posed or the risks explained by UNESCO. In France, at best, the response was polite attention. Then, in the 90s, under the pressure of biological, economic and social necessities, emerged the preoccupations of sustainable development and biodiversity, with rallying cries at the various international conferences – which it was well thought of to echo in France, not to be left behind. In the wake of all this, important research programmes were funded by ministries and institutions, only to be cleverly put to the credit of politicians and other professional communicators. Modest MAB-France has been swallowed up by the movement of which it was the founder. The good word must therefore have been spread too early to be audible.

The second cause for the limited recognition accorded to the efforts made by Biosphere reserves appears to be the MAB programme itself. As mentioned, one of MAB's aims, and indeed demands, is education. This aspect is not covered by the large institutions, either in their political declarations or their economic

programmes, although simple communication is well placed. Educating means giving others, especially the young, knowledge and training to make their own decisions without automatically following proposals from above and even sometimes having the strength to question the hierarchy. Such possibilities are difficult to accept for those in power as they are for all social groups that use dogma for a basis and that ensure their own perpetuation by keeping controversies alive rather than by making the generous effort proposed by UNESCO in 1971.

To illustrate the slowness and the reticence, let us look at how the meaning of the word "biodiversity" has evolved. It appeared in the 1990s and since often replaces the expression "biological diversity", man implicitly remaining outside the notion of "nature". For some, this is still the case, as seen in a pamphlet called "Biodiversity through examples" published in 2007 by the French Ministry for Ecology and Sustainable Development. It was not before 2000 that general opinion considered biodiversity as a social construction concerning the living world, including man and his societies. MAB-France has been aware of this for a very long time and the word "biodiversity" became fully accepted in Biosphere reserves very early on.

The good word was spread too early to be heard.

The third cause is related to the ambiguous use of the word "interdisciplinary". This fashionable word is willingly used as a synonym for "multidisciplinary", which is quite understandable. By asking experts to contribute their different skills to the collective debate, the powers that be obtain multidisciplinary counselling which implies their own ability and authority to decide. MAB teaches and in contrast uses a genuine interdisciplinary approach, covering the living to the social, providing *for everyone, through education*, the knowledge necessary to exercise freedom and responsibility with respect to the community. This vision of society differs from institutional power and, in spite of some lip service, only receives minimal support.

But, let us now look to the future. Making biodiversity a social construction of the living and preparing sustainable development gives society a new dimension, a new perspective of education. MAB's initial objectives, upheld with difficulty, are receiving just and legitimate acknowledgement. Consequently, educational actions, efforts made, networks and relationships woven with society deserve to be pursued and developed in their current form.

MAB can still be a pioneer and innovator today, just like in 1971, for a new education that will be justified by the progress in knowledge and the transformation of societies. The foundations for this step forward seem to exist at several levels. Analysis of socio-ecological interactions underway will most likely bring more relevant knowledge and new ways to apply it.

But beyond this, questions of complexity arise. Are associations of biodiversity elements the sum of the properties of each individual element or do new collective properties emerge that were not foreseeable. Although it may be too early to answer yet, questions are clearly arising, for instance concerning microclimates,

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In forestry, the "marteloscope" is an exercise that enables foresters to evaluate their abilities using sustainable development criteria.

localised transformation of soils, the possibility that new forms of life will emerge – maybe in human hands. Investigating these issues is clearly within the scope of Biosphere reserves. And what about chance? Chance is inevitably involved in the renewal of individuals, genera-

tion after generation, as in social and ecological dynamics. How does chance affect biodiversity? Must man simply be submitted to it or can chance become a partner?

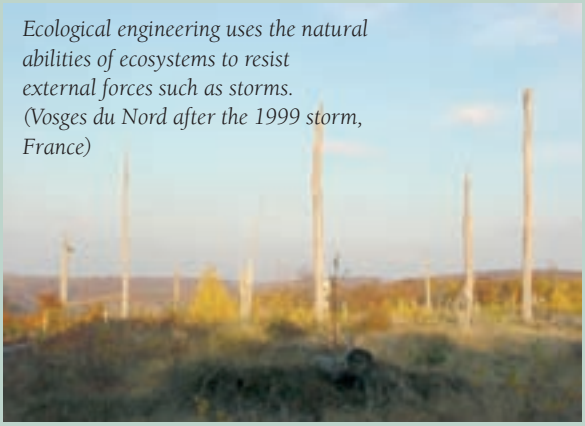
From a philosophical point of view, these questions illustrate how, in matters concerning biodiversity, the notions of static conservation, equilibrium and optimum are myths. Quite the opposite is true, in France and throughout the world a multitude of ways of providing explanations are offered depending on the situation and the culture. MAB's viewpoint is that they should be respected and given the freedom to express themselves and to evolve. These notions need to be integrated into education with successful transmission only in the long term. New knowledge and new questions will find their place in education – programmes, structures, diplomas – and will lead on to more. The men and women involved in Biosphere reserves will have the double responsibility of first learning then teaching. Finally, for the future of Biosphere reserves, this might not be enough. Having the right diplomas will not be sufficient, the next generation will have to show their professional skills, the ability to adapt, and should accept MAB's ideals and objectives.

Historic propositions of UNESCO were the constant transformation of education and the renewal of biodiversity. Through its achievements, MAB-France can transform the future concerns of the stakeholders into educational material and thus pursue the work of the pioneers. ■

These numbered trees are included in a database which participates in a "marteloscope" exercice.

Ecological engineering and the sustainable redesign imperative

Designing and implementing sustainable environmental management is a major science and engineering challenge for the 21st century. Maintaining human well-being amidst population growth and a demand for improved living standards in the developing world will require a major shift in human attitudes towards the value of nature and profound changes in how humans conduct many activities. It will require rethinking the design of industries, cities, agriculture, forestry, transportation, and energy use; how best to restore degraded ecosystems; and how to protect remaining wild areas.



Ecological engineering uses the natural abilities of ecosystems to resist external forces such as storms. (Vosges du Nord after the 1999 storm, France)

Ecological engineering is central to this sustainable redesign imperative. It has the general strategic goal of maintaining or increasing natural processes, and hence the goods and services they provide to humans and other species, with minimal human intervention and minimal adverse collateral impact. This strategic goal reflects the original 1962 definition of ecological engineering by H. T Odum as "those cases in which the energy supplied by man is small relative to the natural sources, but sufficient to produce large effects in the resulting patterns and processes".

Ecological engineering uniquely combines ecological understanding of the functioning of nature with engineering – using science, mathematics and experience for solving problems within constraints – to design ecosystem management practices that are environmentally, socially and economically viable, and that sustain both humans and nature. Ecological engineering uses the natural tendencies of ecosystems to self-organize, to resist external forcing, to be resilient (e.g.,

to recover from disturbance), to adapt to change, to be multifunctional, and to be self-sufficient because they use solar energy and recycle materials.

Prior to industrialization and globalization, ecological engineering was widely used by humanity, even if it did not go under that name. It is still used today by many indigenous populations. Ecological engineering can be used to restore ecosystems; for example, replanting hedgerows into intensive agricultural landscapes, or restoring wetlands, following gravel mining. It can also be used to substitute for technologies that use non-renewable fossil fuels. For example, "green roofs" provide insulation for buildings, purify rainwater and provide habitat for species that use the native plants on the roofs. In another well-known example, New York City chose to maintain forests in the city watershed rather than constructing a vast new water purification plant. Acting as a natural purifier, the forest filters the water supply for the whole city, while also providing other goods and services. Forest protection was the cheaper option.

While there many examples of ecological engineering already in use, there are many opportunities for further use of the approach and much remains to be done in developing the underlying science. For example, how did human techniques used for millennia but now becoming lost in modern culture, effectively use natural processes? A central challenge is how to put our current ecological understanding into practice and to develop ecological engineering best suited to today's world.

Particularly well developed in the USA (e.g., the *American Ecological Engineering Society*), the discipline has now spread to many parts of the world (e.g., the *International Ecological Engineering Society*). In France, the *Institut Supérieur d'Ingénierie et de Gestion de l'Environnement* (Higher Institute for Environmental Engineering and Management) has been teaching ecological engineering since 2005, and a new ecological engineering program has just been developed by the national research agency (CNRS). Our Ile de France group, GAIE (*Groupe d'Application de l'Ingénierie des Ecosystèmes*) helps develop and promote ecological engineering and was created in 2006.

As Peter Vitousek and colleagues pointed out, sustaining human/natural coexistence means "we cannot escape responsibility for managing the planet", and this will require "active management for the foreseeable future". Ecological engineering will play a major role in this future.

"Green roofs" provide insulation for buildings, purify rainwater and participate in the conservation of species.

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CLIVE G. JONES, ISABELLE DAJOZ AND LUC ABBADIE

Further reading

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Forests are "water purification plants". (Mont Ventoux, France)

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ADEME:	Agency for the Environment and Energy Management (France)
BRG:	*Bureau des ressources génétiques*
CBD:	Convention on Biological Diversity
CEESP:	IUCN Commission on Environmental, Economic and Social Policy
CIRAD:	Agricultural Research Centre for International Development (France)
CNRS:	National Committee for Scientific Research (France)
CRDI:	Research Center for International Development
CEMAGREF:	Agricultural and environmental engineering research (France)
C3ED:	Centre for Economics and Ethics of the Environment and Development, (France)
DATAR:	Regional Land Planning Administration (France)
ECOPAS:	Protected Areas of Sahelian Africa Project. Funded by the European Commission in the transboundary 'W' Region Biosphere Reserve (Benin, Burkina Faso, Niger)
ENGREF:	French Institute of Forestry, Agricultural and Environmental Engineering
ENS:	*École normale supérieure*
ENSCP:	*École nationale supérieure de chimie de Paris* (France)
FAO:	Food and Agriculture Organization of the United Nations
FEM:	Fonds mondial pour l'Environnement / GEF : Global Environment Facility
FFI:	Fauna and Flora International
FNE:	*Fédération française des associations de protection de la nature et de l'environnement*
GELOSE:	Law for securing local resource management (Madagascar)
GICC:	*Gestion et impact du changement climatique*
GIP-ECOFOR:	*Groupement d'intérêt public des écosystèmes forestiers*
GRI:	Global Reporting Initiative
ICPE:	*Installations classées pour la protection de l'environnement*
IFB:	French Institute for Biodiversity
IFREMER:	French Research Institute for Exploitation of the Sea
INRA:	French National Institute for Agricultural Research
INSERM:	*Institut national de la santé et de la recherche médicale*
IRD:	French Institute for Research and Development
IUCN:	World Conservation Union
LPO:	*Ligue de protection des oiseaux*
MAB:	Man and the Biosphere Programme
MEDAD:	French Ministry for Ecology, Sustainable Development and Spatial Planning
MNHN:	French National Museum of Natural History
NGO:	Non-governmental Organization
OECD:	Organisation for Economic Cooperation and Development
PNR:	Regional Natural Parks (France)
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
EU:	European Union
UNESCO:	United Nations Educational, Scientifc and Cultural Organization
UNITAR:	United Nations Institute for training and research
WBCSD:	World Business Council for Sustainable Development
WCS:	Wild Life Conservation Society

Man and
the Biosphere
Programme

www.unesco.org/mab
www.mab-france.org

For more than thirty years, the Man and the Biosphere (MAB) Programme, particularly through its World Network of Biosphere Reserves, has initiated and supported studies on the interactions between human societies and natural resources in various cultural and socio-economic contexts.

The diversity of the biosphere reserves' objectives along with the diversity of their ecological, economic, social and cultural situations makes them ideal laboratories for research and training in conservation and the sustainable use of biodiversity.

The Division of Ecological and Earth Sciences, through its MAB intergovernmental Programme, wishes to make a substantial contribution to meeting the challenges of biodiversity management in multi-use areas with the objective of sustainable development.

BIOSPHERE RESERVES - TECHNICAL NOTES 3-2008 : **Man and nature, Making the relationship last**