

Island biodiversity and ecosystem functioning: The melding of science and society

by PIERRE LASSERRE

Since the famous Charles Darwin's observations on the Galapagos Islands which were so fundamental in shaping his Theory of Natural Selection, approaches to island biogeography, population dynamics and endemism, have been much developed, and well documented (Groombridge and Jenkins 2000). This understanding is crucial to the complex picture of the conservation and management of island systems..

The presence of human activity on islands is not necessarily incompatible with the maintenance of rich biodiversity and healthy ecosystems. Nevertheless, in many islands, native endemic species and communities have been destroyed or replaced due to inadequate conservation measures, ill-advised agricultural mono-cultures, or inappropriate intensive mariculture, or sublittoral destruction of spawning areas. In addition, the invasion of alien species is now recognized as one of the major threats to biodiversity and ecosystem functioning in large and

smaller islands (Mooney et al. 2002). The current piecemeal invasion legislation lends itself, moreover, to the management of introduced species.

Scientists to help conservation practitioners and society to set priorities

In order to protect the processes that maintain islands and their surrounding marine habitats, it is necessary to thoroughly understand natural processes and be able to predict the consequences of species losses and invasions. Two big challenges in this quest are: 1) identifying parameters that can serve as appropriate indicators of ecosystem functioning and 2) taking long-range spatial (regional) and temporal views that could include evolutionary capacity and global

climate shifts. Given the complexity of these challenges, there is an urgent need for the scientific community to help conservation practitioners,

decision-makers and society to take appropriate measures that go beyond the obvious impulse to protect economically valuable species and landscapes providing services, or aesthetically appealing ones

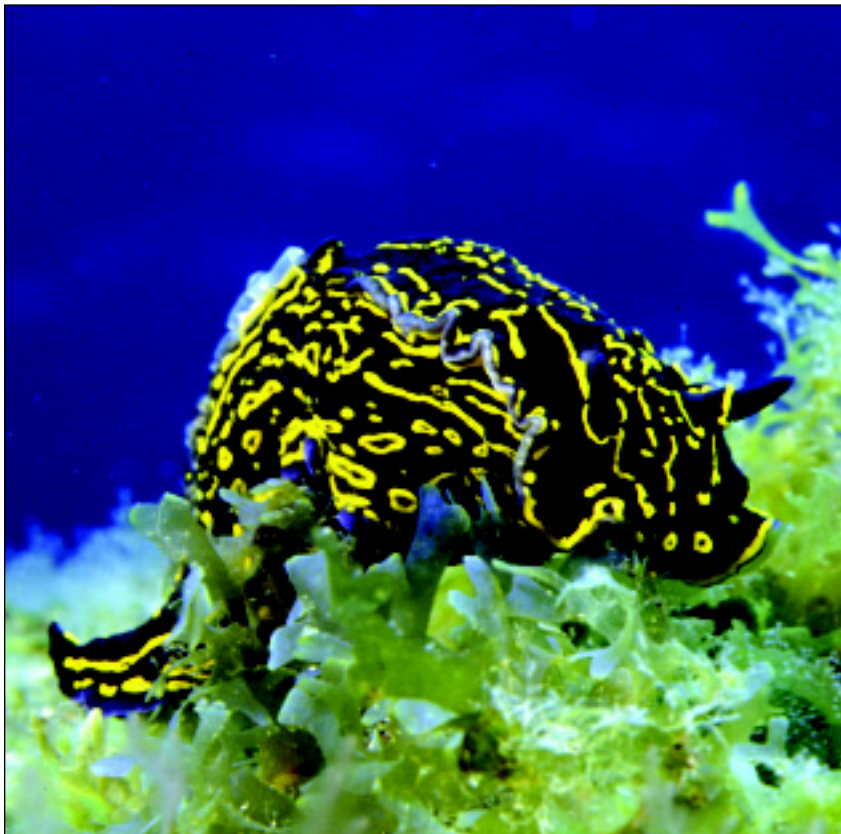
In fact, many of the hard decisions relating to nature conservation have nothing to do with science. They represent a choice of values which are of a political, ethical and philosophical nature. However, there is a need for scientists to respond to questions about the consequences of losing particular species or a segment of biodiversity. It is therefore the responsibility of scientists and their in-depth scientific exploration into how research can inform society about the choices



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it must make regarding species extinctions or species invasions. Science can clarify what is likely to happen if certain species are eliminated or are invading insular ecosystems.

In the evolution of the UNESCO Man and the Biosphere (MAB) Programme, launched in 1971, it was unquestioned excellence of participating scientists which elevated applied research to its proper status. The connection between basic and more applied environmental research has emerged in several aspects of the MAB approach and of the highly successful Biosphere reserve concept that emerged from it. During the 1990s, ecological science increasingly turned its attention to environmental problems and the challenge of protecting biodiversity. For example, in 1991, the Sustainable Biosphere Initiative laid out a research programme aiming at providing answers to critical questions regarding environmental management (Lubchenco et al. 1991). The involvement of distinguished scientists as Robert Paine in the scientific review of the Exxon Valdez spill pushed him to review the monitoring programme that followed the spill, and to suggest ways in which environmental monitoring should be improved (Paine et al. 1996).

Recent trends in modern conservation ecology include a mix of: (1) controlled experimental removal of species and manipulations of ecosystems, (2) ecosystem approach, and (3) natural history and monitoring. The lessons learned from field experiments and recent research emphasizing the functions of species in biogeochemical or ecosystem processes and their role in ensuring reliable ecosystem functioning (Kareiva and Levin 2003, Loreau et al. 2001) have been impressive and are reshaping our understanding of ecological systems and ecosystem functioning.

Therefore, the fundamental ecological science and evolutionary ecology have the capacity to provide sound guidance on conservation priorities in islands. Three of the biggest challenges are:

- (1) identifying measurements that can serve as appropriate indicators of “ecosystem processes”,
- (2) learning how to scale local measurements of effects up to large-scale systems that span entire small islands, such as it is the case, in Europe, for a growing number of island Biosphere reserves (e.g. Canary islands, Balearic Islands, the Tuscan Islands, the

Iroise Archipelago, the Finland Archipelago etc.) and the small to larger islands recently selected as reference sites by the scientific network of excellence “Marine Biodiversity and Ecosystem Functioning” MARBEF, launched by the European Union (Carlo Heip, coordinator).

(3) taking a long-range temporal view that could include evolutionary capacity and global climate shifts.

On coastal and submarine parts of islands, few studies have focussed on the causes of latitudinal species distribution except at the smallest special scales. There is a pressing need for more large-scale, descriptive and experimental studies on community distribution and ecological processes within single habitats and across environmental gradients. The existence of marine biodiversity gradients (e.g. low versus high latitude) is not clear and their functional significance should be reappraised. The scale of marine systems and the mixing, dispersion and transport that occur in the oceanic medium require a



different mode of thinking about conservation and sustainable management (Lasserre et al., 1994). These specific features should be taken into consideration in future conservation and development plans of islands, not only for sublittoral and intertidal habitats but also for the terrestrial parts of islands.

Another challenge to achieve in islands biodiversity conservation and management is the need to adopt an evolutionary perspective on the relative importance of species. The tendency among ecologists is to emphasize ecosystem services such as productivity, nutrient cycling, and water purification; but species also represent an evolutionary potential in themselves that is difficult to assess in terms of the standard metrics associated with ecosystem services (i.e. species and community assemblages providing services of economic interest). In fact, it could well happen that today's rare species or an isolated community living on islands might be one of the crucial genetic

reservoirs of future evolutionary responses to our ever-changing global environment. It is perhaps because of their evolutionary potential that species may be least expendable.

The maintenance of island ecosystem goods and services is a goal that is hard to argue against but even harder to assess in a quantitative manner! How will we know whether we have succeeded or failed? Is it merely a matter of ensuring that total productivity in islands (measured as amount of carbon fixed) does not decline due to species losses? Or do we need to worry about "stability", a favoured concept among community ecologists, or the more recent notions of "resilience"? If so, how can these be assessed? The measurements that can best evaluate ecosystem functioning need to take account of both theoretical and practical dimensions.

Galapagos Islands (© Photo: Yann Arthus-Bertrand/ Earth from Above/UNESCO)

Considered by Darwin as a «living laboratory for evolution» the Galapagos islands were inscribed on the World Heritage List in 1978 and were recognized as a Biosphere Reserve under the UNESCO-MAB Programme in 1984. Formed some 3 to 4 million years ago, the archipelago experiences intense volcanic and seismic activity. The endemic Galapagos vegetation and fauna is famous worldwide. Over 700 scientific missions to the Galapagos have been organized using the Charles Darwin Research Station (jointly supported by the Government of Ecuador, IUCN and UNESCO). In early 2001, an oil spill adjacent to the Galapagos threatened many species and habitats across some 2000 km², underlining the fact that environmental protection measures may never be foolproof. Increasing human populations can cause heavy pressure on islands natural resources for food (e.g. fishes) and income opportunities (e.g. tourism). Here, the biosphere reserve concept can help to develop an ecosystem approach that should consider all stakeholders, all forms of information, including scientific and local knowledge as well as different land use innovations and practices.



The melding of science and society: research sites and biosphere reserves.

Policy-makers and managers require practical, defensible recommendations. They are usually forced to proposing quick partial solutions, often based on very local scientific observations. The scale of the research effort needed to obtain adequate knowledge to understand, conserve and restore insular systems demands regional and broad range collaboration. Moreover, scientists typically work to the rhythm of multi-annual funding and project cycles. They monitor complex phenomena whose changes may sometimes be confirmed only after many years or even decades of study. Therefore, scientists being asked for advice by managers and policy-makers are confronted by the following dilemma: should they respond by providing the “best practices” scenario? Or should they reply that they cannot provide advice in the absence of data or reliable records? Possible answers are:

1. to encourage long-term research and an intensification of scientific effort, along with other appropriate actions in biodiversity conservation;
2. to build on regional networks of excellence.

Achieving these ambitious goals require a diversity of skills, expertise, resource and networks of researchers and sites. A critical mass of research workers and island conservation managers, and decision-makers needs to be reached. Once attained, this should significantly boost appropriate basic scientific studies and applied measures for appropriate conservation and regional development of islands and their surrounding marine biota. This can be done by:

- 1) Producing communication tools for scientists and managers involved in island biodiversity research within and outside their region (e.g. electronic conferences, newsletters and discussion lists);
- 2) Developing strong training programmes designed to spread excellence outside of the participating networks;
- 3) Creating data banks of primary data and metadata, through the web by participants and beyond;
- 4) Producing high-impact scientific publications, and

promoting public information; 5) Promoting submission of collaborative proposals for joint research by natural and socio-economic scientists.

In this context, the scientist today has more than ever the responsibility of entering into the “social demand” arena, of probing into how decisions regarding nature conservation and regional development are made, and who they affect. There are now strong reasons for reinforcing cooperative initiatives between existing networks with complementary targets and geographical distribution. These include INSULA, the UNESCO-MAB World Network of Biosphere Reserves, and its regional MAB networks, and the EU-Network of Excellence Marine Biodiversity and Ecosystem Functioning (MARBEF) initiate by the Network of European Marine Research Stations (MARS).

Of a total of 100 European marine biodiversity research sites, identified by the EU Network of Excellence MARBEF, 8 insular “Reference sites” and 21 “Focal sites” have been selected for intensive and comparative research activities (see Warwick et al., 2003). Furthermore, Biosphere reserves offer privileged arenas for melding science and society. Multi-purpose management can be achieved through the use of zoning (with core, buffer and transition areas), with different requirements for protection, scientific research and human use (UNESCO 2000). Recent successful examples of island biosphere reserves (such as the Lanzarote, in the Canaries or the Iroise Archipelago, Brittany) have shown that the principles and guidelines for biosphere reserves are indeed adaptable to the coastal-marine area. People living permanently or occasionally on islands cannot be separated from studies on community and ecosystem dynamics. In islands, the loss of species can greatly alter patterns of human settlement, employment, agriculture, fisheries, tourism (UNESCO Island Agenda 1994).

Attaining such cooperation will require a significant increase in cohesion, interaction and reciprocal understanding amongst the diverse members of this wide community. The future challenge lies in combining the pressing need for environmental monitor-

ing with the needs for basic research and predictive modelling. At the same time, improving public participation, and re-orienting regional planning toward observation and sustainable use of biodiversity is required. This understanding must relate directly to the changes brought about by evolving human societies and their resource uses, perceptions, and values.

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