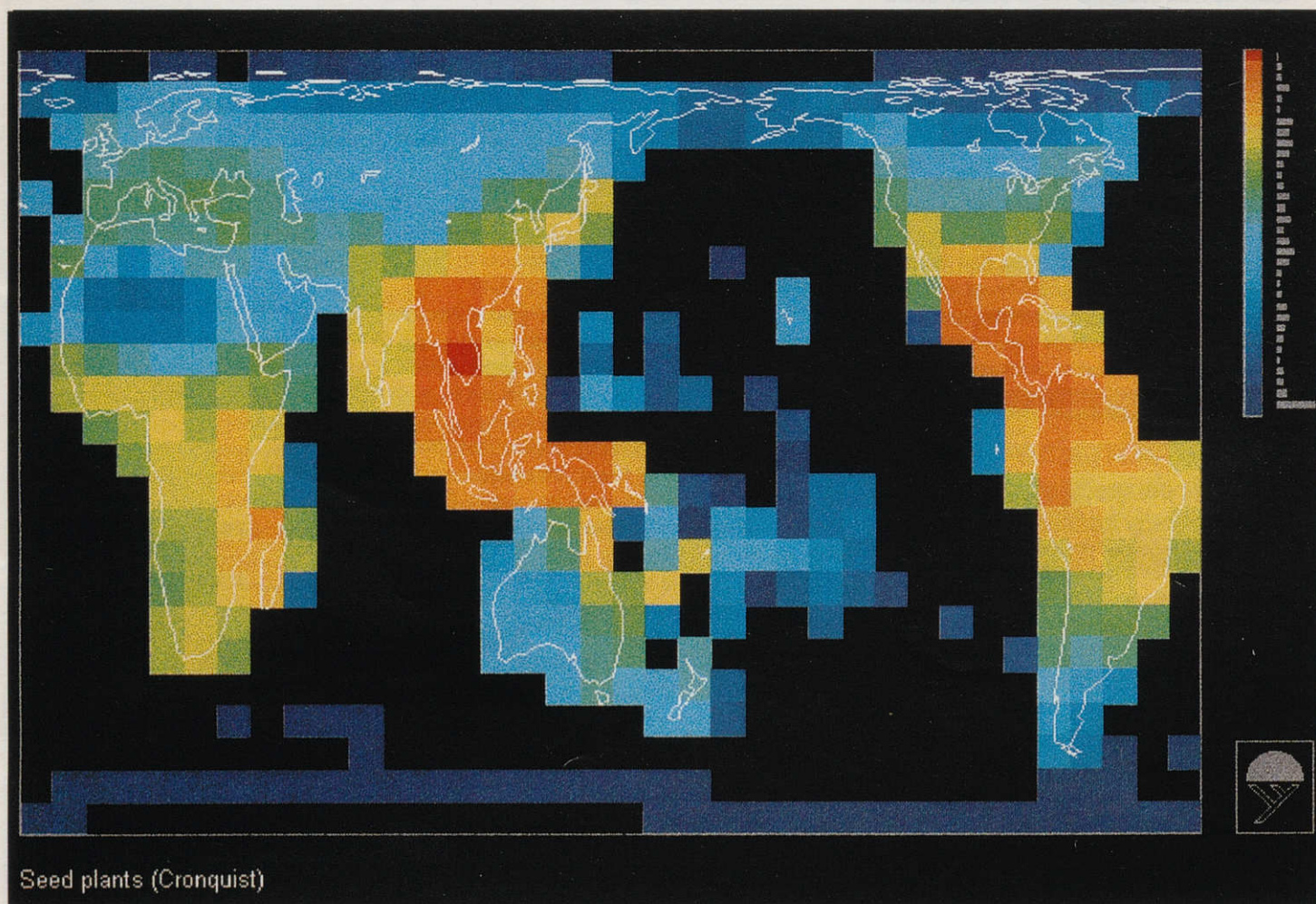


world

CONSERVATION



Are we losing it?

The science behind biodiversity conservation
as seen by Adrian Forsyth • Calestous Juma
E. O. Wilson • Stuart Pimm • Ron Heyer
Georgina Mace • Paul Williams • Robert Wayne
Robert Lacy • Charles Stirton • Michael Maunder
Ed Wiken • Lyle Glowka • Michael Soulé

world CONSERVATION

APRIL 1996

With this Issue, and after 44 years of publication under a variety of names, the *IUCN Bulletin* becomes *World Conservation*. The change of name reflects a change of emphasis, from reporting to advocacy, from simply giving an overview of Union news to providing a forum for debate of the most pressing global conservation issues. This move responds to the instructions of the Buenos Aires General Assembly to devote more of the Union's activities to advocacy and communication.

It seems appropriate that the first issue of *World Conservation* should focus on the science that underlies our policies and activities related to biodiversity conservation. We invite your comments and suggestions.

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Scientific perspectives in biodiversity conservation

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Cover: Map of regional richness in families of seed plants among equal-area grid cells worldwide, proposed as a predictor of relative regional richness in species. Such maps can help us to decide where to focus our conservation action. See page 12. *Paul Williams*

Sound science, socially delivered

The dramatic and sometimes manufactured confrontation on the high seas or in an endangered habitat – and the subsequent sixty second soundbite on the blue screens of a hundred million homes – have their place in conservation. The trick is to ensure they are based on sound science. Credibility suffers if they are not.

There may never have been a time in history when the science grounding of conservation is more important. For the conservation community is having to ask more and more difficult questions of the world's political and industry leaders, questions which more clearly challenge vested and powerful interests and will involve courageous decision-making. The conservation case is more easily accepted when it is seen to be derived from agreed scientific findings, so the scientists have a huge responsibility on their shoulders for underpinning the drive for ecological and wider sustainability.

What scientists? Not just the biologists. They are still in the vanguard. But the ecosystems managers, the social scientists and the information managers are up there with them now. And if we have learned anything in the past twenty years it is that no matter how sound the scientific message, it is not heard unless it is socially delivered – and this applies just as cogently at the community level as in global capitals. The fundamental importance of the science community working cross-sectorally and learning how to get its findings across to both villager and Cabinet minister has been proven again and again.

There are some limitations to what science can achieve in the short term. There are some areas of enquiry where there is still much to be done before anything approaching scientific certainty can be achieved, a point made by Adrian Forsyth in the article which follows. And it is equally relevant in areas like climate change research, though progress towards a consensus is emerging here.

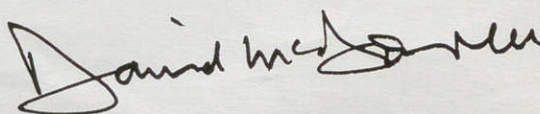
The scientific community itself would affirm, in the circumstances where there are threats of serious or irreversible environmental damage, that lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Public and private decisions should be ruled by this precautionary principle.

In this first issue of *World Conservation*, the successor to the *IUCN Bulletin*, several distinguished scientists from the wider IUCN family testify to the current state of affairs in biodiversity research: what we know, how we know it, and what we need to do to reverse the trend to biotic debacle. At the same time, they make clear how much the field is developing.

Adrian Forsyth introduces the debate, suggesting a two-pronged approach to biodiversity conservation based on particular circumstances and a great deal of knowledge we do not yet have. In a joint interview, Calestous Juma and E. O. Wilson debate some of the controversial policy aspects of biodiversity conservation. Stuart Pimm describes some of the evidence for an unprecedented rate of extinction, and Ron Heyer tells us what is being done to find out why amphibians seem to be disappearing everywhere.

The section then turns to the difficult question of deciding what to save. Georgina Mace and Paul Williams describe some of the approaches to priority-setting, including how to determine where the greatest biodiversity lies. Robert Wayne shows how the rapidly developing field of molecular genetics is being applied to conservation of ecosystems and species, while Charles Stirton and Michael Maunder outline how Kew Gardens is helping to save plant species through research and careful genetic management. Ed Wiken considers the use of ecological frameworks as a tool for managing ecosystems, and Lyle Glowka reminds us of an often-overlooked repository of enormous biodiversity. Michael Soulé closes the section by asking if the current extinction crisis is bringing an end to evolution as we know it.

We trust that you will enjoy the new format and the new emphasis on advocacy. Our next issue will focus more on the social context of conservation action.



David McDowell, Director General, IUCN

28 MAY 1996

Ground-truthing biodiversity science

"we convince by our presence"

Walt Whitman

By Adrian Forsyth

Slick, multi-hued Landsat images are impressive. But however carefully analyzed, they only take one so far towards understanding a biota, as we discovered in the Cordillera del Condor, a range of flat-topped sandstone mountains straddling the border of Peru and Ecuador.

As we approached the vertical wall along the upper edge of the Cordillera, we could see our Landsat-based guesses were dead wrong. Our reflectance data suggested that the blue splotches on the image were flat open areas where we could put a helicopter down. In fact, they were boggy mats of sphagnum, terrestrial orchids and bromeliads overlaying crevasses and subterranean streams. In any case, the Russian-built helicopter used by the Peruvian military to ferry us into this wilderness lacked the torque need to surmount the rim of the plateau. We landed 1000 metres below our target. As we worked upwards through the montane rainforest towards the summit, we were astounded by how the local biodiversity differed from our expectations.

One comes to places like the Condor with a mish-mash of biodiversity tools

and information at hand. The first sense of the importance of the place comes from expert opinion, the suspicions of a small handful of people who know enough about tropical biogeography and have enough field experience to know it represents a potentially valuable site.

On-the-ground reality

Then there is remote sensing information, readily available if you have the cash and invaluable in getting a regional view of vegetation cover, human settlement and other landscape features. There is a tiny corps of literature on peripheral forays to adjacent mountain ranges. But the most valuable asset of all are the dozen people riding in the helicopter, a tiny cadre of people with enough experience that they can spend a few weeks in an area and make intelligent commentary on the conservation significance of the region. Nothing else suffices because the on-the-ground reality of such places cannot readily be predicted.

The Landsat imagery did make clear that the rugged terrain above 1000 metres was utterly devoid of human settlement. In an area free from hunting pressure I expected an abundance of terrestrial mammals and associated with them, a complementary abundance of the dung scarab beetles that are one of my particular interests. But the area was sparsely populated by either taxon. In a few weeks I saw but one Cebus monkey troop and found a modest and uninspiring scarab fauna, putting the site well down on my list of priority areas for biodiversity. On the other hand, Robin Foster of the Field Museum and his Peruvian colleagues were overwhelmed by the outstanding plant diversity, walking into camp each day sporting beatific smiles and bales of extraordinary botanical specimens.

Richest in flora

In just three weeks the botanists collected fertile material from 800 species, the most productive collecting any of them had

ever experienced anywhere. On this basis, they consider the Condor area to have the richest flora of any area its size in the New World, be it Amazonian lowland, Atlantic forest of Brazil, Andean or Chocoran region. Much of the flora was new. For example, of 40 terrestrial orchid species collected on the mountain top, at least 26 species (65%) were new to science. In addition, we recorded new species of mammal, bird, fish, beetles and 21 new species of butterfly.

Many scientists denigrate the conservation value of inventory work.

Not long after our visit, a border war was fought in the region leaving a lethal legacy of thousands of landmines amidst the gold mining concessions which now blanket the region. Experiences like this have convinced me that one of the most valuable and cost-effective services biodiversity scientists can offer decision-makers and policy analysts is ground-truthed information about the remaining intact high-diversity ecosystems.

Identifying and rapidly assessing the status of tropical wilderness areas with high endemism and diversity is one prong of a dichotomous set of priorities for biodiversity conservation. The other prong is a focus on the salvage and restoration of known 'hots spots' (*sensu* Myers 1988), areas of high endemism that are threatened with nearly complete habitat conversion and high extinction risk.

This two-prong approach represents the obverse of triage – the World War I theory that stated the optimal strategy is to leave the badly wounded and the still



Botanist Hamiltan Beltran explores the Cordillera del Condor. Conservation International



In the Cordillera del Condor, areas that Landsat imagery suggested were flat open areas suitable for landing a helicopter (blue splotches) turned out to be boggy mats of sphagnum, terrestrial orchids and bromeliads overlaying crevasses and subterranean streams.

Conservation International

healthy and to concentrate on the middle group, i.e., the ailing yet salvageable. How much importance to give to each prong in this strategy is not something that can be objectively decided. The irreversibility of extinctions suggests a need for increased emphasis on 'hot spots'. Others argue that maximizing ecological integrity encompasses biodiversity conservation, i.e., maintaining pristine ecosystem processes is crucial because diversity cannot persist unless ecosystems are viable. (In my opinion, an increased focus on large tropical wilderness areas that contain large numbers of endemics absorbs this argument and is also perhaps the most cost-effective way to promote the persistence of great numbers of organisms.)

If this two-pronged approach is pursued, what sort of scientific investments will give us the most biodiversity conservation? Given that the pie of funding for biodiversity science is sadly small, how effectively are we dividing it?

It is clear that the sort of science needed by the two prongs differs radically in form,

function and cost. At one extreme, in the large, intact, biologically-rich wilderness areas, we need broad strokes, rapid inventory and observational field work – mere descriptive work whose purpose is to place such sites on the global conservation agenda.

It is worth remembering that there are entire countries such as Guyana that lack any semblance of a protected area system. The potential gains from supplying good biodiversity information to a receptive government are enormous. Recent events in Bolivia illustrate this point. The newly declared Madidi and Gran Chaco National Parks, which together protect close to five million hectares of tropical forest, achieved their current status only because a handful of biologists were willing to inventory them, experience them and thus be able to speak credibly of their importance.

At the other end of the spectrum, in the fragmented hot spots, we need expensive work in the form of intensive spatial analysis and conservation genetics, eco-

logical restoration and other high-cost technical inputs to salvage those species and habitats that totter on the brink of extinction. I think there is little doubt that this side of conservation science is better funded and equipped. Thus we see GIS and remote sensing technologies, computer modelling and population genetics flourish while museums languish and tropical field biology remains a pauper clinging to survival.

Ability vs need

The result is a mismatch of ability and need in conservation science. Vast areas of the pristine tropics are without a scientific presence while there is much scientific capacity in the regions that have already devastated their flora and fauna.

Excellent biodiversity databases exist in some countries. These make possible sophisticated Gap analyses and algorithmically-guided searches for optimal protected area configurations. Effective use of these quantitative conservation methodologies depends on a great depth of ecological knowledge about a local flora and fauna, knowledge that exists primarily in temperate zone habitats. In the United States, for example, many government agencies such as the National Biological Survey (NBS) are engaged in detailed Gap analyses. NBS Gap analysis uses vegetation mapping as a surrogate for wildlife populations. This is useful when both the vegetation is classified into habitats and mapped and the ecological links between a target species and habitat have been established.

But for many of the species-rich parts of the world, be they terrestrial or marine, we lack basic knowledge about what exactly constitutes a habitat, let alone how this relates to wildlife populations. For example, Peruvian Amazonia is usually mapped as a relatively homogenous zone of moist tropical rainforests. When more closely scrutinized by Hanna Tuomisto and her Finnish and Peruvian colleagues using a mixture of remote sensing analyses and ground truthing surveys, they found at least 100 different habitats in this zone. We don't even have names for the habitats in such places. We must applaud and reward people such as Tuomisto who sampled 30km transects through the forest. Such work does not fit readily into the paradigm of experimentally manipulated hypothesis testing that dominates academic biology. As Joel Cohen observed, "physics envy is the curse of biology".

The number of university-based biologists vastly dwarfs the meagre NGO science staff. Academic prejudices are thus one of the constraints that limit our ability to effectively apply scientific talent to biodiversity conservation. Academia, the National Science Foundation and other donors reward the authors of published, refereed articles. Such incentives will stimulate and motivate those young scientists who work at a problem in conservation genetics of a single endangered species, for example. The data used to analyze the problem are publishable. But this incentive system penalizes other sorts of biodiversity scientists including those who do basic inventory work and habitat description. What are the incentives for an academic to develop a species list for a protected area and to train park guards in biodiversity monitoring techniques?

If one doubts this, simply look at the employment tracks available to biologists. In theory, it ought to be possible for a university-based conservation biologist or one based in a conservation NGO such as WWF, The Nature Conservancy, Conservation International, Wildlife Conservation Society, IUCN and the like to move back and forth professionally between the two venues. But in fact the career paths facing a young conservation biologist are dichotomous – the scientists who choose to work on the pragmatic side of biodiversity conservation, in an NGO, do not readily move in and out of academia because their publication rate is inevitably less. Perhaps if university deans could recognize that a *prima facie* goal and requirement for a conservation biologist is to contribute to conservation and not just to journals, we could get more conservation mileage out of existing expertise.

Dan Janzen once wrote an editorial urging botanists to leave their centrifuges behind and, with plastic bag and ruler in hand, go out into the field. Conservation scientists need to do likewise: each individual can be both a scientist and a real conservation presence in the field.

The first thing we need to know about a lot of places is simply what's there and what is its conservation status. Only people with a strong natural history and systematics background can reliably provide this information quickly. Nevertheless, many scientists denigrate the conservation value of inventory work. For example, systematist Suzanne Renner and ecologist Robert Ricklefs expressed concern that "biodiversity inventory will produce data of uneven quality and undemonstrated

Some systematists and ecologists are only dimly aware of the mechanisms by which large-scale tropical conservation occurs.

utility for conservation purposes, divert attention from more constructive approaches to conservation, and further weaken systematics, and other collection-based inquiry as scientific endeavors."

The fact that such an assertion could be written and published suggests that some systematists and ecologists are only dimly aware of the mechanisms by which large-scale tropical conservation occurs. Without the site-specific opinions and

information from taxonomically fluent biologists, conservationists have no ammunition whatsoever in discussions with policy analysts and decision-makers. Indeed, the best asset a conservation biologist can offer is personal experience. Reed Noss in a recent editorial argued that "without a solid grounding in field experience conservation biology is hollow... the public at large will not long be blind to the hollowness within us when we spew out models, maps, formulas and proposals that lack any connection to the real world." So too it will be impossible to convince policy and decision-makers if our observations are not grounded in real world experience.

In conservation science let us place a priority on presence. We need to put more biodiversity scientists in the field to study, understand and document, to witness, worship and defend the last best places on the planet.

Adrian Forsyth is Senior Scientist at Conservation International and Research Associate at the Smithsonian Museum of Natural History, Washington DC.

Problems with global priorities

Given the small amount of money available for conservation, it is essential that we set priorities. But how good is the scientific case we can put to donors rationalizing a conservation investment?

Past approaches to priority-setting have focused on patterns of species richness and endemism (see page 11ff.). This can lead to curious conclusions about what sort of area is most important. In the calculus of richness and endemism, a landscape largely converted to farmland or even suburban housing developments in Brazilian Atlantic forest will outrank a vast Arctic wilderness with walrus, narwhal and polar bear.

Does this make sense as a basis for prioritizing conservation investment? Inuits and Brazilians should logically disagree.

Conservation priorities are always scale-dependent. At the global level, the task of priority setting is confounded by two facts. First, much of the biogeography and taxonomy of biodiversity is unknown. New Phyla are still being found. Second, and more important, conservationists have not fully grappled with the fact that much of biodiversity is in the form of bacteria, fungi, beetles, nematodes, mites and marine invertebrates

(see page 23). Is it therefore reasonable to expect a few well-known taxa such as birds or butterflies to act as surrogate indicators for the bulk of biodiversity?

This situation is also compounded by the questions of ecological function and importance to humans. Do species of these rich but generally obscure groups measure equally with high-profile, keystone organisms such as the grey wolf, animals whose presence or absence radically alters the fundamental ecological dynamics, not to mention spirituality, of a region? We have neither the data nor the philosophy to make a scientific claim one way or the other.

Some priority-setting exercises side-step the problems with species richness and endemism data by elevating the issue to habitat preservation. But managers with restricted budgets must still decide whether to focus their efforts and funding on, say, tropical savanna or tropical rainforest.

The science needed to answer such questions will be slow in coming (the following pages present a variety of approaches). But a large amount of funding is now being allocated globally, so we can continue to expect much artfulness in the arguments over conservation priorities. AF

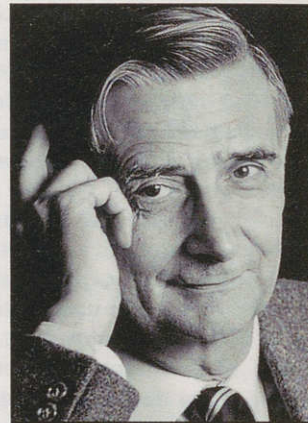
Biodiversity's 'hot spots'



Calestous Juma

Calestous Juma is a Kenyan scientist and policy analyst who founded and directed an African NGO, the African Centre for Technology Studies (ACTS). He is now Executive Secretary of the Convention on Biological Diversity. Edward O. Wilson is an American entomologist who has done ground-breaking work on island biogeography, biodiversity and sociobiology, a professor at Harvard University, and a Pulitzer prize-winning author. Both men work on the issue of biodiversity but view it from different angles.

Juma sees close-up the intergovernmental process from an international political perspective. Wilson remains one of the most influential academic thinkers in the field and a strong supporter of the controversial 'hot spots' approach to protecting biodiversity. In the following interview, IUCN's Ricardo Bayon explores the views and perspectives of these contrasting figures.



E. O. Wilson

Ricardo Bayon: Why has the term 'biodiversity' become so popular?

E.O. Wilson: I think because it is easily remembered. Also, the time had come for a word that encapsulated not only a range of scientific studies on the subject of nature and environment, but also the widespread social and moral issues related to conservation. The term 'biodiversity' fit that dual need, and has become very widely used in the United States and even in the popular press. Despite this fact, the US has not yet ratified the Biodiversity Convention. As an American, I am embarrassed by this, though I think we will eventually ratify it.

Calestous Juma: I'm not so sure that it is all that popular outside our own circles. I still meet people who ask what it means. In this respect, [US President George] Bush did us a great favour when he decided not to sign the Convention on Biological Diversity in Rio because he gave the term some publicity.

'Hot spots'

Bayon: One difficult issue within the Convention is that of determining priority areas for biodiversity conservation. There are those who say that we need to identify 'hot spots', places where a variety of key species live, and put our money there. Why was this concept problematic?

Juma: The issue became controversial because many countries felt that the international community should not make decisions that impinge on their national

sovereignty. They don't want to be told by others what they should and shouldn't do. It is a question we have not yet resolved, but the best solution might be to determine priorities at the national rather than the global level.

Wilson: I think the hot spots concept is extremely important, both scientifically and politically. We must have information as quickly as possible on exactly where the hot spots are – although we do know they are concentrated in the tropical countries. Once the hot spots are identified, then individual countries must make their own decisions on what to do with them, based on their own image of their country and their vision for the country's future. Nevertheless, I think that as global awareness of hot spots increases there will be a new era, not of coercion, but of encouragement and cooperation to preserve these areas. It is essential that we concentrate our global resources on those key places. For example, recent studies have shown that some 20% of the world's bird species are found on only 2% of the land. This indicates that the judicious use of the 'hot spot' concept, coupled with more knowledge of where biodiversity is, could lead to cost-effective preservation of biodiversity country by country.

Criteria

Bayon: How will priorities be established, and what criteria will be used?

Wilson: That is a scientific determination. We should begin by mapping the distri-

bution of the surviving ecosystems and determining the number of endemic species found there – that is, species which are found only in those places. We can hope to obtain such information over the next ten to twenty years for a few selected focal groups that are already taxonomically well known – for example, birds and other vertebrates, a few insect groups such as dragonflies and butterflies, and organisms living in aquatic and marine systems such as fishes and crustaceans.

Juma: I agree on the need to focus on hot spots or 'critical ecosystems', as they are coming to be known. I also agree that they provide the mechanisms through which resources can be allocated. But we have to be sensitive to the fact that governments, particularly developing country governments, have in many cases viewed this effort as an imposition.

Also, it turns out that some of these hot spots are also the areas with the highest concentration of people living in them. This is a good reason to want to protect those areas, but it is also a reason for governments not to risk the political fall-out that might arise from conservation programmes.

Who owns biodiversity?

Bayon: The preamble to the Biodiversity Convention first recognizes that biodiversity is a "common concern of humankind", and then affirms the sovereign rights of countries to their own biodiversity – an apparent contradiction. So who owns biodiversity?

Juma: The question of sovereignty over biological resources has played a central role in our negotiations. The Convention places considerable emphasis on the rights of nations to determine how best to formulate the goals and actions for conservation, based on the understanding that any international treaty has to be translated into national programmes. Countries also want assurance in advance that what they agree to at the international level is within their capability to implement at the national level. Of course, the concept of sovereignty has been applied to more than genetic resources – intellectual property and access to financial resources, for example. The institutions which protect these rights are well established and extremely powerful. Perhaps there is something we can learn from them.

Wilson: It is unfortunate that in many of the countries that participated in framing and signing the Biodiversity Convention there is a tendency to polarize the issues. Biodiversity was made a red herring by politicians and ideological commentators in many countries. In the United States, unfortunately, this issue came to the fore towards the close of the Bush Administration and Mr Bush and his advisors made an issue of it in terms of American sovereignty.

I know there has been a reciprocal suspicion from the South toward the North in terms of interference with national sovereignty. But I believe that the polarization should be recognized for what it is. We can get around it. There is now a vast body of information and new potential technologies that can be used to both serve the needs of populations in developing countries, including those in the vicinity of hot spots, and to preserve the hot spots at the same time. There are many ways of doing this: tropical forests can be sustainably managed to yield more products without serious disturbance; agricultural and industrial productivity can be vastly improved, especially for those people who would otherwise be forced to intrude on natural environments.

Access to resources

Bayon: People and companies from developed countries have historically had free access to the genetic resources of developing countries, while those who have traditionally owned and protected the resources did not receive any benefit.

Scientific research coupled with the refinement of the regimes regulating intellectual property rights are the keystones to protecting biodiversity.

How does sovereignty relate to rights of local and indigenous communities?

Juma: The Biodiversity Convention is a set of compromises. It balances three factors: access to genetic resources, access to technology, and access to the necessary finances. Many rules, laws, procedures and regulations pertaining to access to technology are already in place, but none with regard to genetic or biological resources. To get over this hurdle, the Convention calls on countries to allow access on the basis of their national laws, but many countries still do not have such laws. So the real challenge now is to formulate laws at the national level to regulate this access to genetic resources. That's a major shift from the previous regime of open access. I think we will need to work things out at those two levels: first in the context of international access to a particular country's resources, and secondly in the context of the rights and privileges of local communities.

Wilson: The whole biodiversity discussion has been extremely useful in this regard. It has made the world aware that the world's poorest countries in GNP terms, are also the richest in terms of biodiversity. It has also shown that it is entirely to the advantage of developing countries to save and make maximum use of their biodiversity. This provides a powerful argument for these countries to continue to refine the rules, laws and regulations on intellectual property rights so as to provide the maximum benefit to themselves. It also provides a powerful argument for these countries to encourage scientific research in order to identify their hot spots and endemic species and

to build a base of knowledge of their fauna and flora. At present, many do not have this knowledge. So, I think that these two things – scientific research, coupled with the refinement of the regimes regulating intellectual property rights – are the keystones to protecting biodiversity.

The rights of local communities and indigenous peoples, however, are a wholly different problem, albeit a very important one. I think it needs to be worked out individually by each country on its own, because the issue of national sovereignty becomes very sensitive.

Restoration

Bayon: Is ecosystem restoration an important tool for biodiversity conservation?

Wilson: I think some of the new initiatives underway to help restore ecosystems offer a great deal of hope and provide a psychological uplift for humanity. We should bear in mind that it is probably not possible to recreate an ecosystem that has been entirely eliminated – for example, a rainforest if it has been completely cut over. There is no way we could put together all the hundreds of thousands of species, even if they could be saved in some manner. To put them together would be a little bit like unscrambling eggs.

But there's a great deal of hope in allowing the remnants of natural ecosystems a bit of grassland here, a bit of rainforest there – to expand and recover lost ground, and in facilitating this through land preservation and careful cultivation methods.

Juma: I believe that ecosystem restoration is an extremely important issue, though we haven't yet addressed it in the context of the Convention. This is unfortunate, but I am sure that when we start to discuss terrestrial ecosystems next year it will figure prominently on our agenda.

Message for IUCN

Bayon: Finally, do either of you have a message for IUCN?

Wilson: In a very American expression: Continue to do your damndest!

Juma: The Biodiversity Convention must now move from negotiation to implementation. I think that IUCN could position itself strategically to become a very powerful actor in that implementation, and I would welcome its ideas. □

The lonely Earth

When ecologists such as Edward O. Wilson talk about extinction as a global crisis, we field biologists know what that means on the ground: more and more of us are spending our field seasons taking lonely, unproductive walks, wondering where all the animals went.

By Stuart Pimm

Field workers cannot understand critics who dismiss extinction as trivial or even mythical.

In a recent debate,* Julian Simon, a professor of business management at the University of Maryland, described claims of high extinction rates as "statistical flummery". Facts, not species, are endangered, he asserts.

To counter such charges, we wildlife biologists and ecologists are being compelled to back our claims with numbers. We do body counts; we calculate extinction rates; we consult paleontologists' analyses of the fossil record. In our work – my own with Pacific birds, for example – we conduct field studies, help devise conservation programmes to save endangered species, and develop theoretical models aimed at documenting the species already lost and tracing their numbers through time.

The facts say it all, in spite of Simon's misguided assertions: extinctions are happening, and they are irreversible. The real question is: how many species are disappearing? And is the rate of loss unusual?

Bone hunting in Hawai'i

When Polynesian settlers reached Hawai'i about 1000 years ago, they found abundant birdlife, but only two species of mammal – a bat and a seal. The birds were easy pickings for the early Hawaiians and for the pigs and rats they brought with them, and their habitats disappeared as the settlers cleared lowland forests for crops.

A second wave of extinctions followed after 1778 when Captain James Cook reached the islands. Trade and colonization brought new settlers followed by more forest-clearing and more introduced animals and plants. Cattle and

Those who suggest that high extinction rates are a fabrication are ignoring the facts.

goats destroyed the native vegetation, which were as unprepared for large mammalian herbivores as the birds had been for rats.

The European naturalists who arrived in the islands at this time were on hand to document the second wave of extinctions. The first wave, however, left behind nothing but bones. Unfortunately, bird bones are fragile and easily destroyed so we may never find bones of all the now-extinct species. But Michael Moulton at the University of Florida and I have devised a simple way of estimating how many species the bone-finders miss, based on what they do find (see page 9). We have calculated that across the Hawaiian islands, about 40 species are missing from the record. Add this number to the 43 known extinctions and the 'body count' now stands at 83.

This sad story is repeated throughout the Pacific. Moulton and I calculate that as the Polynesians colonized the Pacific south to New Zealand, north to Hawai'i, and east to Easter Island, they exterminated 500 to 1000 species. Some other 'bone-hunters' put the number even higher.

In the time it took humans to colonize the Pacific, perhaps 15% of the world's birds became extinct. Ornithologist David Steadman told me there could be 2000 species of rails alone that are missing from the Pacific. If he is right, then one of

the greatest evolutionary radiations of vertebrates – Pacific island rails – has almost completely disappeared.

Are current extinction rates unusual?

Raw numbers by themselves, however, cannot prove that a crisis is taking place. After all, extinction is the natural fate of all life. The majority of species that have ever existed are extinct, and in time the rest of us will join them. The relevant question is whether current rates of extinction are unusual. What we need is a benchmark to tell us how fast species normally go extinct – that is, how fast they disappeared from the fossil record before human beings came along.

One candidate for such a benchmark comes from the work of the paleontologist David Jablonski of the University of Chicago. By studying fossils of marine invertebrates, Jablonski estimated that – excepting mass die-offs such as that which ended the Cretaceous Period – species tend to last between a million and ten million years before they disappear from the fossil record. Therefore, out of ten species you should see an extinction every 100,000 to one million years.

At present there are about 10,000 species of birds in the world. Assuming birds go extinct at the same rate as marine invertebrates, naturalists should witness one extinction every 100 to 1000 years. Is that a realistic assumption? Oddly enough, it is. By studying the differences in DNA from species to species, biologists have been able to calibrate 'molecular clocks'. These show that closely related species of modern birds diverged from one another within the past few million years. Over that time, the fossil record shows, the number of new bird species formed has been about the same as the number of extinctions. So it looks as if a few million years is how long bird species normally last before going extinct.

* published in 1994 by W. W. Norton as *Scarcity or Abundance?*

For a naturalist, then, watching a species of bird go extinct should be extraordinarily rare – a once-in-a-lifetime experience at most. In the Pacific, it is more like an annual event. Extinction rates there lie in what I call the kilodeath range, thousands of times above the background level. Even if Pacific species were the only birds on Earth going extinct, the overall extinction rate for birds worldwide would still be between 100 and 1000 times higher than normal.

And birds are not the only victims. Records show that over the past century or so the Hawaiian islands alone have lost about 100 species of plant, more than 40 species of insect, and many others.

Black spots

Naturalists have documented kilodeath 'black spots' throughout the world, in habitats ranging from deserts to rainforests to rivers and freshwater lakes. In much of French Polynesia, every native snail has disappeared from the wild following the introduction of a predatory snail from Florida in the 1950s. In North America, 40 kinds of freshwater fish have become extinct in the past century, mostly in the arid southwest. In the Mississippi and Saint Lawrence river basins, since the end of the nineteenth century 21 of the 297 North American species of freshwater mussels and clams have become extinct (a rate 1000 to 10,000 times the background



One of the greatest evolutionary radiations of vertebrates, Pacific island rails, has almost completely disappeared. Pictured is a rare photo of the endangered Lord Howe Island woodhen *Tricholimnas sylvestris* in the wild. Reduced to 26 individuals in 1975, the bird has been successfully bred in captivity and now numbers 220.

IUCN/Jim Thorsell



Australia has lost 18 of its native mammals in the recent past, many from Western Australia where 95% of the natural woodland has been cleared. IUCN/Nikki Meith

rate for species in general), and another 120 are at risk of extinction. In the southern tip of Africa, an unusual flora called the *fynbos* has lost 36 of its 8500 species in the past century, and 618 others are at risk of extinction. Australia has lost 18 of its native mammals in the recent past, most of them in the southern arid zone and in the southern wheat belt of Western Australia, where 95% of the natural woodland has been cleared; 43 other species have lost more than half of their former ranges or survive only on protected offshore islands.

Now what?

Those who suggest that high extinction rates are a fabrication are ignoring the facts. Extinction is real; it is everywhere; and in recent centuries, we humans have inflated its rate several orders of magni-

tude above normal. We know very well what the main causes are: deliberate and accidental species introductions; habitat destruction and alteration.

Of all the cases of extinction we have studied, every one has occurred in areas where human densities are low. This shows how easy it is for us to strike a severe blow to the Earth's biodiversity, with catastrophic and irreversible effect. So, the last and most important question we must ask ourselves is: do we have the political will to stop it?

Stuart L. Pimm is a professor in the Department of Ecology and Evolutionary Biology at the University of Tennessee in Knoxville, and a member of the IUCN/SSC Reintroductions Specialist Group. He is the author of *The Balance of Nature? Ecological Issues in the Conservation of Species and Communities*.

Crunching the numbers

How can we count what's not there – long-dead birds whose remains have disintegrated, for example?

Imagine that we list all the species that lived on an island before first contact. We create a second column by placing check marks against each species for which we have bones and create a third column by placing check marks against those species that survived contact, to be collected or seen by two cen-

turies of naturalists. Let's call these the "skins". There are four classes of species on our list: those for which we have (1) bones but no skins, (2) skins but not bones, (3) both bones and skins, and (4) neither skins nor bones. This last class is purely imaginary but we can estimate the number of species it should contain. For the species that have left bones, we know the ratio of the number of species

for which we have skins to the number for which we don't have skins. For the species that haven't left bones, the ratio should be the same. Suppose that on an island there were 15 species known from both bones and skins and nine found only as bones. The 15:9 ratio should also be the ratio of the five species known only as skins to the unknown number of missing species. That number has to be 3.

Vanishing amphibians: a real problem?

Are amphibians disappearing world-wide? If so, what does this mean for the rest of the Earth's inhabitants?

By Ron Heyer

In the 1970s a few biologists noticed declines or disappearances of amphibians from areas where there were no obvious reasons to expect such losses.

At the First World Congress of Herpetology in 1989, some of those biologists traded observations. Amphibian populations seemed to be declining or disappearing from places scattered over the world: the golden toad *Bufo periglenes* of Monteverde, Costa Rica, hadn't been seen for two years. Jasper's frog *Eleutherodactylus jasperi* couldn't be found any more in Puerto Rico. The gastric brooding frog *Rheobatrachus silus* was missing in the wild.

Was there some global cause for these apparent disappearances and declines? How could we find out?

Tackling the problem

From the beginning there was some doubt that the purported declines and disappearances constituted a real phenomenon. Most of the evidence was anecdotal, based on personal observations rather than on controlled scientific studies. And scientists knew that most amphibian populations undergo drastic year-to-year fluctuations in size under normal conditions; this makes determining if populations are really declining analogous to determining weather trends, such as global warming, where annual fluctuations greatly exceed the magnitude of any long-term trend.

But participants at several international meetings concluded that there were simply too many reported cases to ignore, and that the situation called for urgent international attention. The scientific community responded by establishing the Declining Amphibian Populations Task Force within IUCN's Species Survival Commission.

The goals of the Task Force are straightforward: (1) to determine which amphibians are experiencing declines and disappearances and where the problems are occurring; and (2) to determine the causes of those amphibian declines and

disappearances where they have been detected. The IUCN network would then be used to communicate the group's results to governments and relevant organizations.

How do we know?

How do we tell if an amphibian population is declining? Finding the answer will require a lot of effort over a long time, and the Task Force has faced a number of obstacles from the beginning. Standard research protocols for inventory and monitoring of amphibian populations were lacking. Also, the few scientific studies that were available for long-term population studies on amphibians used different techniques, so it was difficult to compare the results. The Task Force set up a Working Group on Protocols, which produced a set of recommended research procedures.

There are two approaches to detecting amphibian declines. Of these, the easier is to document the disappearance of local breeding units. For example, dedicated non-specialists using standardized procedures can listen for frog calls. Such an approach requires monitoring of the same site for several continuous years since many long-lived amphibians can skip reproduction for a year or more.

The second approach is a good deal more intensive and involves long-term mark-recapture studies of local breeding populations. Dr Ronald Brooks has been coordinating such investigations on frogs in Ontario, Canada. He recommends that such studies continue for 10-20 consecutive years if they are to show any meaningful trends. The documentation of local population disappearances (with a minimum of 3-4 years of investigation at each site) is the quickest method for determining whether amphibians are in decline.

Currently, there is a global network of over 1200 volunteers in 90 countries who are using both approaches in order to determine precisely where amphibian declines and disappearances are occurring.



Are they really disappearing? A global network of 1200 volunteers in 90 countries hopes to find out by 2001. WWF/Frédéric Merçay

Controlled experimentation

Determining the causes of the disappearances is more difficult, requiring controlled experimentation on populations shown to be in decline. The Task Force encourages such studies by:

(1) formation of specific interdisciplinary, issue-based working groups focused on potential causes – climatic and atmospheric change, chemical contaminants, disease and pathology; and

(2) awarding seed grants for promising areas of study on the causes of amphibian declines. One of the functions of the issue-based working groups is to evaluate and recommend promising research areas.

Cautious urgency

We need to find out the causes soon, because amphibian population declines can be important bioindicators of general environmental degradation. On the other hand, we have to be cautious not to

generate any false alarms and risk losing our scientific credibility.

For example, Dr Andrew Blaustein and his colleagues experimentally determined that increased ultraviolet-B radiation due to loss of atmospheric ozone could be the cause for the known decline of the frog *Rana cascadae* in the western United States. The media picked up this research and raised the question whether UV-B was the global agent responsible for all amphibian declines.

We do know that UV-B radiation is a likely cause for amphibian declines in high-elevation species that bask in the sun to thermoregulate. UV-B is not the cause of all amphibian declines, however. Other likely causes include estrogenic effects of pesticides, acid precipitation, fertilizers and herbicides, introduction of exotic competitors, predators, and pathogens – all these in addition to habitat modification, which is the single greatest threat to amphibian disappearances. Very likely there are interactive effects among all these causes as well.

But if amphibian biologists speak too soon, before we really know what we are talking about, we will have lost credibility and our further recommendations will be ignored.

Task Force effectiveness

The mission of the Task Force embraces three phases. The first has already been accomplished with the organization of the Task Force to coordinate a volunteer network and provide the communication link between the research community, Task Force volunteers, the media, and the general public.

The Task Force is now in its second phase, which involves gathering basic information on the extent of amphibian declines and elucidating their causes. We are trying to complete this phase by 2001.

The final phase will be to successfully communicate our findings, as they relate to general environmental conservation, to those who can effect change in the world community.

So far, a major success of the Task Force has been that it has inspired many biologists to redirect their research programmes towards the problem of amphibian declines and related issues.

Ron Heyer is a research zoologist at the Smithsonian Institution in Washington, DC, and Chair of the IUCN/SSC Declining Amphibian Populations Task Force.

What do we save first?

As conservationists watch the relentless growth of the number species and habitats that require our protection, the time and resources available to protect them dwindle. This means we have to make some hard decisions about what we'll do first.

By Georgina M. Mace

The issue of priority setting in conservation is very broad and complicated, and I will not attempt to review it here. Instead I shall outline the major kinds of biological approaches that have been taken.

In practical terms, conservation is directed at *areas*. But areas can only be evaluated in terms of the natural features they contain. Natural features can be, for example, habitats, communities, ecosystems or even landscapes.

Typically, however, species have been the most commonly used units of conservation, perhaps because they are the most easily defined. Three fundamentally different approaches use species for evaluating area-based conservation priorities.

First, since much information is gathered both globally and nationally in

threatened species lists, areas containing one or more threatened species might be an appropriate way to direct conservation actions. This was an approach taken by Collar and Stuart in the IUCN/ICBP publication *Key Forests for Threatened Birds in Africa*.

Secondly, species with very restricted ranges, or which are distributed only within specific regions (endemic species) can be a useful guide to developing key areas for conservation. In 1992, ICBP (now BirdLife International) put together data on all restricted range bird species, and identified 221 Endemic Bird Areas, where 26% of all bird species are found, confined to less than 5% of the Earth's land surface.

Finally, and perhaps most commonly, sites have been identified which represent high species richness. Early on, these were identified quite broadly as 'global

Red Lists help set priorities

Lists of threatened and endangered species have been used over the last 30 years to draw attention to species that are seriously at risk. Such lists have proliferated in national legislation (such as the United States Endangered Species Act) and international legislation (such as CITES – the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the Convention on the Conservation of Migratory Species). In addition to IUCN's global Red Lists, several countries around the world have produced their own national versions.

Threatened species lists inevitably simplify reality, and the lines that divide them into groups according to conservation status are inevitably arbitrary. Nevertheless, the existing classification systems left a great deal of room for improvement, and in 1992 IUCN began developing a better system for setting species conservation priorities (see *IUCN Bulletin* 4/95, page 27).

With the approval of the new Red List Categories by the IUCN Council in November 1994, the lists became much more authoritative and objective. The new criteria were more transparent and explicit, and consistent across all taxa. For example, the basis on which a tree is listed as threatened is not widely different from the basis on which a coral, or a butterfly, or a mammal is listed. They were designed to be practical and relatively easy to apply, and subject to possible future changes in status of the species. GMM

hotspots', but much effort has now gone in to the development of more sophisticated methods for identifying species-diverse sites at a range of spatial scales. This is described in more detail by Paul Williams on page 12.

Deciding what to maximize

Clearly the choice of what to maximize in site selections has an important effect on the sites chosen, and what is preserved there. The three kinds of selections described above do not necessarily identify the same sites.

Some of our recent studies show that for Afrotropical antelopes at least, sites selected by maximizing overall species diversity were ineffective at protecting many threatened or restricted range species. Similar analyses of the UK fauna and flora mapped on a 10km by 10km grid also showed poor correspondence between sites maximizing diversity for different major taxonomic groups.

A site selected for its high diversity of bird species per unit area may not be the best area for protecting the diversity of butterflies, and even worse at representing a group such as liverworts that has very different ecological requirements. This is a notion which challenges the conventional concept of 'flagship species'.

At broader scales, however, the correspondence across taxa and across measures becomes stronger. A global analysis of diversity in tropical countries published recently in the journal *Conservation Biology* by Balmford and Long (1995) shows that relatively simple measures such as the number of restricted range birds species per country (adjusted for country area) do provide a reasonably good measure of overall diversity and endemism within countries, at least at a global scale.

Of course, species are not the only ways to compare biodiversity across sites. Much work is now in progress using ecosystem, landscape and habitat measures. The challenge is to ensure that the measures being adopted for determining conservation priorities represent many different elements of biological diversity.

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She is a member of the SSC Steering Committee, and was Coordinator of the working group that oversaw the development of the new IUCN Red List Categories.

Measuring biodiversity value

Measuring biodiversity has become a growth industry during the last five years. We need measures of biodiversity so we can determine the 'where' of in situ conservation action rather than the 'how', to help us decide which combinations of available areas could represent the most biodiversity for the future.

By Paul Williams

Biodiversity can be seen as the irreducible complexity of all life. As such, no single objective measure is possible, only measures relative to some particular purpose.

For conservationists, a measure of biodiversity should quantify a *value* shared broadly among the people for whom they are acting. One such value is to ensure continued possibilities for adaptation and for use by people in a changing and uncertain world. But what does this mean? What are some practical indicators of such value?

Character (genetic) richness

Biologists have argued that this value for potential future use may be associated with richness in the different characters expressed by organisms. For example, a dandelion and a daisy represent fewer characters in total, and so less diversity value, than a dandelion and a pine tree. Thus *characters* could provide a 'currency' of biodiversity value, which we need to maximize within the conservationists' 'bank'.

The problem with this approach is that the numbers of characters cannot be counted directly. Biologists have responded by proposing phylogenetic or taxonomic measures of diversity, which estimate, as directly as possible, the relative character richness and biodiversity value of different biotas, based on patterns of genealogical relationships.

Of course in practice, detailed and reliable phylogenetic information is often not available.

Arguments for measuring biodiversity value as character richness do at least provide a reasoned starting point, as one pos-

sible answer to the question of what is valued in diversity. But accepting the use of genealogical pattern as a predictor of value also provides a possible key to the practical problem of how to measure it: there are other, even more remote predictors or 'surrogates', some of which have distinct advantages.

Species richness

When dealing with large numbers of species, species richness can be a reasonable surrogate for character richness, even though it is less direct (see page 14). This can work because with more species in total at least some representatives of the more divergent, higher groups (which are rich in different characters) will usually co-occur.

This method is still not a panacea, however, because there are probably too many species even within a suburban garden for complete enumeration, let alone for surveys extending across large regions such as the entire Amazon basin.

Hence, the use of surrogates must address two questions: for example, how good is the taxonomic diversity of bird faunas at predicting character richness of bird faunas; and how good is it at predicting the character richness of entire biotas (as an 'indicator' group)?

When our interest is in biodiversity in this broad sense, then both relationships need to be considered.

Higher taxon richness

The use of higher taxon richness (using, for example, genera or families) as a surrogate for character richness helps to broaden the taxonomic coverage within

Choosing surrogates to use in measuring biodiversity value

	Advantage: precision as a measure of character diversity	A scale of surrogacy for a value currency of character diversity	Advantage: inexpensive surveys & units more inclusive of viability enhancing process
	low		high
environmental surrogates	↓	'ecosystem' richness?	↑
	↓	climate class richness	↑
	↓	terrain class richness	↑
environmental/assemblage surrogates	↓	substrate class richness	↑
	↓	landscape class richness	↑
	↓	habitat class richness	↑
assemblage surrogates	↓	'community' class richness	↑
	↓	vegetation class richness	↑
taxonomic surrogates	↓	higher taxon richness	↑
	↓	species/subspecies richness	↑
	↓	taxonomic/phylogenetic subtree length	↑
molecular surrogates	↓	expressed gene richness	↑
	high		low

Table 1. If greater biodiversity value is associated with richness in a currency of the characters of organisms (equivalent to expressed or expressible genes), then higher levels of biological organization (or environmental factors affecting its distribution) will have to be used in surrogate measures (assemblages here are non-monophyletic groups of organisms; it is debatable whether ecosystems, if defined in terms of processes, may be mapped and counted). Choosing a surrogacy level from this scale is a compromise between precision of the measure on the one hand, and availability of data and cost of data compilation on the other. Higher level surrogates should have the additional advantage of implicitly integrating more of the functional processes that favour viability.

biotas and so reduce the enormous extrapolation of using small indicator groups (i.e., mapping 1000 families represents a larger slice of biodiversity than mapping 1000 species). The relationship is not dependent on the 'naturalness' or comparability of higher taxa, providing regional biases are not strong. The choice of taxonomic rank must be made with care, but the approach shows promise of substantially reducing survey costs. Early results show that it may be effective for mapping large parts of biodiversity (see cover photo).

Habitat surrogates

Other surrogates, including classifications of vegetation, land and climate are still more remote from the level of characters.

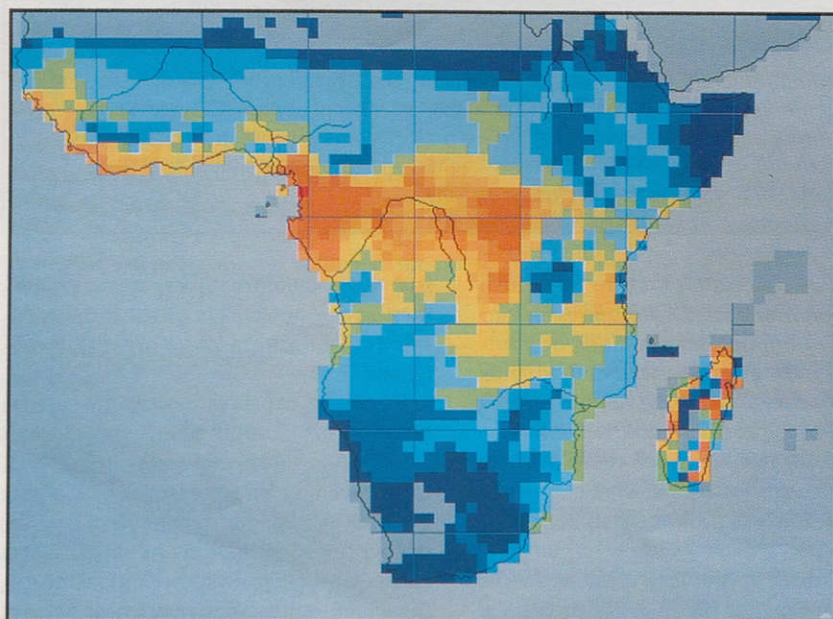
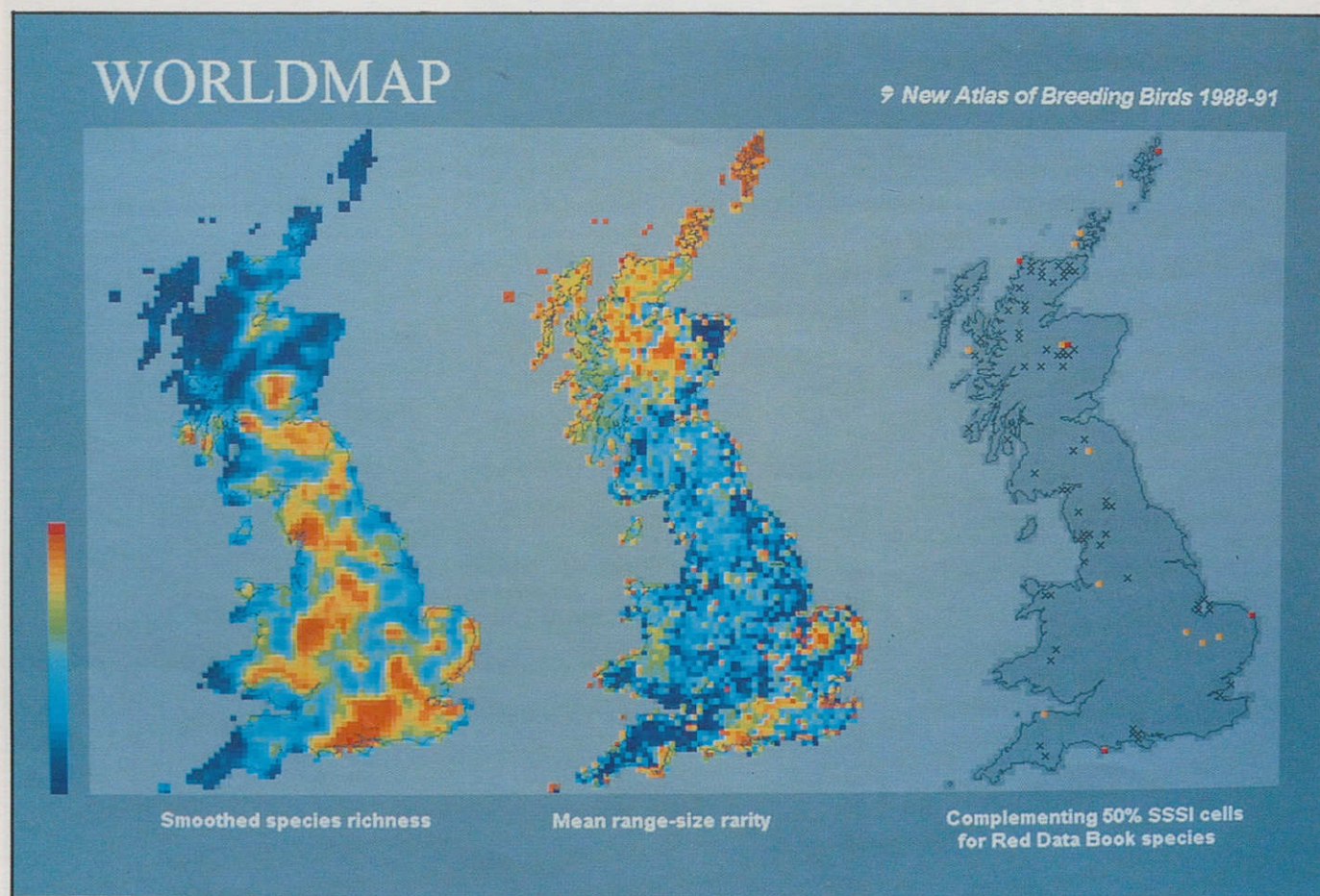
Yet this level of survey may be very much more practical because it requires less intensive sampling. Certain kinds of information may even be obtained in bulk relatively cheaply by using remote sensing technologies. Furthermore, these larger-scale surrogates are much more likely to include entire functional systems, which are more likely to promote viability.

We need to be very clear as to the purpose of biodiversity measures. In conservation this is likely to differ from that of earlier measures of ecological diversity, which were formulated initially with the narrower aim of representing differences in abundance among species, and used later for exploring distribution of resources within communities. If instead the value of biodiversity to conservation-

ists is associated with its use to people, then at the outset this ought to be separated carefully from issues of rarity, viability and threat.

Of course conservation can be seen as being fundamentally about viability and threat. But these concepts are distinct from diversity and measures of viability and threat may perhaps be deployed for maximum effect and accountability at a subsequent stage, in arguments concerning which representative areas or parts of biodiversity should receive priority action for conservation.

Paul Williams is a Research Entomologist at the Biogeography and Conservation Laboratory, The Natural History Museum, London. He has helped a number of SSC Specialist Groups to assess conservation priorities, especially based on character richness.



Primate diversity in sub-Saharan Africa and Madagascar

The map shows richness in lowest-rank taxa (either species or subspecies) plotted for cells in a 1° latitude-longitude grid. Maximum richness is shown in red and minimum richness in dark blue, with intermediate scores grouped into colour classes of approximately equal numbers of grid cells (grey cells have no primate records).

Data compiled by Jocelyn Hacker and Guy Cowlshaw.

WORLDMAP

Researchers at the Natural History Museum in London have used WORLDMAP software to test methods of assessing biodiversity. Whereas most Geographical Information System (GIS) software has been designed for flexibility, WORLDMAP is intended to give maximum speed with large datasets. It allows thousands of species (or habitat types or other area attributes) to be recorded while maintaining the speed required for fully interactive analysis.

The maps above show examples of patterns of diversity, rarity and priority. They were produced using data from *The New Atlas of Breeding Birds in Britain and Ireland 1988-1991*.

On the left is a map of species richness based on breeding records. The map in the centre shows patterns of rarity as indicated by the proportion of species in each cell that have highly restricted ranges. The map on the right illustrates how the consequences of area selection for the representation of biodiversity can be explored. It plots just one of the sets of areas that represents all of the species.

Similar procedures can be used to compare sets of sites with the aim of maximizing the amount of diversity that can be represented within a particular area extent.

Conservation genetics: apply anywhere

Conservation works at many levels, from entire ecosystems and communities to species and individual organisms. The field of molecular genetics provides tools that can be applied at each of them.

By Robert Wayne

Immminent extinction now threatens a large proportion of the world's species. What can we do about it? We first have to identify the threats and decide what kind of conservation action is appropriate; we then have to set our priorities, by selecting the taxa or sites where action needs to be taken most urgently.

Molecular genetics has an important role to play at every stage in this process. The long-term survival of ecosystems, species and populations is only possible if they carry sufficient genetic variability to withstand and adapt to future challenges from their environment – and from ourselves.

While it is relatively easy for species to lose genetic variation through bottlenecks in population size or inbreeding, there is almost zero chance that lost genes will ever "re-evolve". This means that conservationists must try to prevent the loss of those components of genetic diversity which determine the 'survivability' of a species or population.

Molecular genetic techniques are still largely under-appreciated as a tool to improve the management and preservation of genetic diversity, even though they can be used

- to identify parents, offspring, and close relatives in captive and wild populations so as to avoid inbreeding depression of rare and endangered species;
- to define the genetic units for conservation and the amount of gene flow between such units;
- to match samples of uncertain provenance and assign species to populations from specific geographic regions;
- to quantify the genetic variability of historical populations and their living descendants, and assess the rate at which genetic variation is being lost and restructured in populations in fragmented landscapes.

Here are some examples of these techniques and their applications in nature:



Hybridization between grey wolves and similar species threatens their genetic integrity. Pictured: grey wolf *Canis lupus*. WWF/JA. Mayvald/BILDARCHIV

Ecosystem conservation

How do we decide which natural areas are most important to protect? We generally rely on some measure of 'species richness' – an indication of the number of species found in a wide diversity of taxonomic groups (see page 12). This approach does not, however, give us an indication of the historical processes that generate diversity, and it does not differentiate between populations or regions with different evolutionary histories. Molecular genetics can provide both an estimate of the number of distinct forms in an area as well as a measure of how different they are.

Why is this important? Because areas that contain taxa representing long, distinct lineages are likely to preserve a greater degree of evolutionary heritage than ones with a similar number of species but containing a succession of closely allied forms. There is now an emerging consensus that selection of conservation sites should be based upon a phylogenetic tree constructed from molecular genetic data, and the aim should be to conserve a maximum diversity of evolutionary lineages.

Molecular techniques have recently called into question some of the assumptions around which rainforest conservation plans have been designed so far. For

example, research has shown that ecotones (between forest and savanna) may play an important role in generating genetic diversity, and small isolated ecotone populations may provide an important source of new genetic variation which ultimately enriches more centrally located populations. While central areas have been the main focus of rainforest conservation efforts, ecotonal regions are rapidly being lost to overgrazing, burning and wood harvesting with little or no effort towards their conservation. Molecular genetic analysis of ecotones can both document the level of genetic distinction of ecotone populations and better define the evolutionary processes that have generated rainforest biodiversity.

Species conservation

Which species should we protect? Molecular genetic data give us a powerful tool for both recognizing species and determining the appropriate evolutionary units for conservation.

An example is the tuatara *Sphenodon spp.*, a reptile which occurs on islands off the coast of New Zealand which represents the only extant genus of an entire reptilian order. Until recently, only one species, *S. punctatus*, was recognized. Molecular analyses have now revealed that in fact the species has a complex evolutionary history, and actually should be divided into three distinct groups. Conservation plans are now being designed to preserve these distinct units.

Another recent example concerns the rediscovery of Darwin's fox, *Dusicyon fulvipes*, once known only from the temperate rainforests of Chiloé Island, Chile, and considered a subspecies of the mainland gray fox *D. griseus*. Fewer than 500 individuals exist. About five years ago, Chilean researchers discovered a mainland population of Darwin's fox in Nahuelbuta National Park, 500 km north of Chiloé Island and apparently reproductively isolated from the mainland gray fox. Analysis of DNA sequence data showed that the mainland population of Darwin's fox was closely related, yet distinct, from the island population, suggesting that the mainland population was not trans-



Plans to reintroduce south African wild dogs to areas of east Africa where populations have recently gone extinct would mix populations with separate evolutionary histories. Pictured: African wild dogs hunt wildebeest. WWF/Fritz Polkin

planted from the island but was instead a relict population. Further work confirmed that Darwin's fox is a phylogenetically distinct species and likely an earlier invader to the Chilean coast. Its distribution was probably more widespread before the destruction of mainland forests for timber and agriculture. Darwin's fox is potentially a flagship species symbolizing the highly endangered and distinct temperate rainforests of Chiloé Island and mainland Chile, and therefore deserving of increased conservation efforts on its behalf.

Problems of hybridization

Interbreeding among individuals from closely related species and from populations within the same species is common, and may be of concern if it threatens the genetic integrity of an endemic rare or endangered species or population. Often hybridization may reflect habitat alterations or human introductions, such that non-native forms become abundant and widespread, and hybridization between them and the native form occurs. Examples include hybridization between coyotes and grey wolves in Minnesota and Ontario and in the American Southeast, the displacement of native fish stocks by hatchery-raised fish, and the subspecific hybridization of the Florida puma and a non-native subspecies.

Similarly, captive populations may often represent a blend of subspecies through unintentional interbreeding. For example, during a widespread survey of Asiatic lions in a zoo-based captive breeding programme, many were found to

contain genes only recorded from individuals of the African subspecies. This finding led to the removal of most animals from the programme.

Genetic screening of wild endangered populations or captive stocks suspected of hybridization may provide essential data for on-site conservation or captive breeding programmes.

Population genetics

Genetic relationships among populations can be used to deduce historic patterns of movement and the degree of gene flow among populations. This information is especially useful for documenting the

genetic isolation and distinction of vanishing populations, for tracing corridors of dispersal among populations and for identifying populations that might provide the source material for augmentation or reintroduction programmes.

Inbreeding and other factors can reduce the chances that an endangered population will survive. For example, the endangered Florida panther is a population of about 50 that appears to be suffering from the effects of loss of genetic variability. Plans have been developed to augment the population genetically by introducing unrelated individuals from other parts of the species' range. Molecular genetic analysis of North American pumas has shown that the nearest population in Texas is genetically very similar and therefore provides appropriate stock for the augmentation.

An analogous case study concerns the reintroduction of Yellowstone wolves. Here, a mitochondrial DNA analysis has shown that all North American wolves are genetically very similar and high rates of gene flow have caused genetic uniformity over large geographic regions. Hence, there need be no major concern about the reintroduction of wolves from British Columbia since these are likely to be quite similar to, and have been in genetic contact with, the historical population of wolves living in Yellowstone.

Evolutionarily significant units for conservation can also be identified using molecular genetic techniques. For example, the African hunting dog is a unique carnivore which has historically inhabited savanna-like habitats south of the Sahara

desert. Wild dog populations have declined precipitously during the last 20 years and perhaps no more than several thousand now exist. The east and west African populations are the most endangered, having recently suffered severe population declines.

Molecular genetic analyses showed that eastern and southern populations form two genetically distinct clades that warrant separate preservation. Thus plans to reintroduce south African wild dogs to areas of east Africa where populations have recently gone extinct would mix populations with separate evolutionary histories. In addition to causing the potential loss of genes that are unique and adaptive in the east African population, introduced south African dogs could put the native eastern population at risk with south African diseases to which they have not developed immunity. Moreover, wild dogs in zoos are all of south African origin indicating the captive breeding of the wild dog is not directed towards those populations most at risk.

Breeding success

In small captive and wild populations, some animals may have less reproductive success than others, with important implications for conservation management. Molecular genetic techniques can be used to deduce parentage in wild and captive populations if all potential parents and their offspring are sampled. Even in populations for which little information is available, inferences can be made about the breeding structure from molecular genetic data.

An important aim of the genetic management of captive populations is to reduce inbreeding by selecting breeding pairs of low relatedness. Newly developed techniques of DNA analysis can be used to assess genetic variation directly, and DNA fingerprinting can be used to group individuals into relatedness classes.

For example, in the captive breeding programme for the critically endangered Mauritius pink pigeon *Nesoenas mayeri* good parentage records stretch back over several generations, but all captive birds are descended from just six founder birds, and the relationships among these are not known. When researchers saw evidence for inbreeding depression in captive pigeons, DNA fingerprinting proved useful for determining levels of relatedness among them and deciding how to manage their breeding.

Molecular techniques have recently called into question some of the assumptions around which rainforest conservation plans have been designed so far.

Forensics

The forensic applications of molecular techniques are wide ranging. The species and regions that samples have originated from may be deduced and samples from the same individual obtained from different places and at different times can be matched. Genetic typing can often be done on trace materials such as hair, horn, tusks, faecal material, ruminant boli and mummified or museum preserved remains. One of the most intriguing recent cases concerns monitoring the legal market for whale meat in Japan. Whales taken under strict scientific collecting permits can be sold in the Japan's domestic market, but concern has been raised that such legal sales allowed a route for illegal marketing. Palumbi and colleagues have shown that the whale meat for legal sale in Japan does involve several banned species, suggesting that the legal market is a vehicle for illegal trade and may be difficult to police.

Gene conservation

Molecular genetic techniques can be used on small, isolated populations to measure the loss of genetic variability and identify those populations that have been most severely affected.

One example concerns the Northern hairynosed wombat *Lasiorhinus krefftii* in Epping Forest National Park, Queensland. Once abundant, this species now exists as only a single colony of less than 80 individuals as the result of drought and cattle grazing. Because this remaining

population is small, random genetic drift will cause loss of genetic variability, particularly of rare alleles, over time. Through the use of the polymerase chain reaction applied to DNA isolated from museum samples, researchers compared historical levels of genetic variability in a population from New South Wales to the levels found in the current Epping Forest population and to a related but abundant wombat species. The molecular analysis showed that the Northern hairy nosed wombat had only about 40% of the genetic variability expected in a widely distributed abundant species, and that the loss of genetic variation was well advanced even in the historical population. Such information can be used to estimate effective population size over the period of decline in Epping Forest wombats and expected future losses in genetic variability, and provide the basis for a captive breeding programme.

Limitations and problems

The preservation of evolutionary diversity is an essential part of conservation. Molecular genetic techniques are useful tools for this purpose, whether in choosing appropriate taxa or sites for conservation or for making plans that will increase the prospects for long-term viability. Our increased ability to measure genetic variation could result in both improved preservation of genetic variability and avoidance of inbreeding depression in captive and wild populations of rare and endangered species.

However, there are limitations to the use of genetic techniques and problems in their application: demand for laboratory services is growing, and resources are increasingly scarce. We must find cheaper, less demanding techniques, and greatly increase training. We now possess a powerful set of molecular tools with which to approach many important conservation questions; we have only to apply them more widely.

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This article was modified from "Molecular Genetic Approaches in Conservation – An Overview of the Issues" by Georgina M. Mace, Thomas B. Smith, Michael W. Bruford and Robert K. Wayne, to be published in *Molecular Genetic Approaches in Conservation*, T.B. Smith and R. K. Wayne, eds., Oxford University Press.

Fighting extinction with PVA

Any population of animals or plants faces threats to its survival. These threats can be human-induced or intrinsic to biological processes. If they cause a population to become small and isolated, then additional threats intrinsic to small biological populations can arise. Population biologists have come up with a number of ways to tell when a population is in danger of extinction.

By Robert Lacy

Threats caused by human actions include habitat destruction, over-harvesting, pollution, and the introduction of exotic predators, competitors and diseases. The combined effect of human-caused and intrinsic threats can be disastrous, leading to the extirpation of the population – or, if the local population was all that remained of the taxon, its ultimate extinction.

Population Viability Analysis (PVA) is a collective term for the various quantitative methods used to determine the probability of extinction of a population, and has become a useful tool in conservation assessment and planning.



When only a single population of the whooping crane *Grus americana* persisted in the wild, a PVA determined that additional populations needed to be established to avoid its decimation by a local catastrophe such as an epidemic or severe storm. PVAs showed that the black-footed ferret and the Puerto Rican parrot faced similar threats. WWF/Sture Karlsson

PVA can be used to measure "minimum viable population", or MVP. When a population falls below its MVP, its days may be numbered: subsequent chance events can cause it to fluctuate and decline even further. The smaller and more erratic its size, the greater the probability that its number will, by chance, hit zero.

In the 1980s researchers Michael Gilpin and Michael Soulé found that the destabilizing processes are synergistic: a combination of demographic, environmental, and genetic processes can exacerbate the instability produced by other factors, causing what has been depressingly referred to as "extinction vortices". Although Mark Shaffer first defined MVP as the size at which a population has a 99% probability of persistence for 1000 years, it might be more meaningful biologically to consider it to be the size below which a population's fate becomes determined largely by the intrinsic random factors that characterize extinction vortices.

How can we estimate MVPs?

Perhaps the best way to determine an MVP would be through empirical observation of the long-term fates of a number of populations of various sizes. In 1990 Joel Berger presented a good example of this approach, in which he observed that populations of bighorn sheep in the mountains of the western USA persisted only when the populations had more than 100 animals.

We need more such empirical studies, but the time and numbers of populations required for them are precluded in the cases of most species threatened with extinction – exactly those for which estimates of MVP are most urgently needed.

A more elegant approach would be to calculate the probability of extinction from a small number of measurable parameters. Although there have been

We are finally beginning to understand how extinction works.

some valiant attempts in this direction, our understanding of population biology is not yet sufficient to provide fully adequate analytical models of the extinction process.

A third method is the use of computer simulation modelling to project the probability distribution of the possible fates of a population. Such models can incorporate a very large number of threatening processes and their interactions.

Evolution of the MVP/PVA/PHVA approach

Shaffer's original term "minimum viable population" has fallen into disfavour among many conservation biologists, even as the PVA approach has risen in popularity. To some, the term MVP implied that there was a precise number below which extinction was certain and above which persistence was assured. In keeping with the probabilistic nature of the extinction process, a number of conservation biologists have focused on PVA methods for estimating the probability of extinction over defined time periods for a designated population exposed to a specific scenario of environmental conditions, threats to persistence, proposed management actions and other foreseeable events.

Beginning about 1989, we began to see that PVA can be most usefully incorporated into a conservation strategy if it were the focus of a conservation workshop. Such an event would encourage collaboration between conservation professionals, NGOs and local communities.

The Conservation Breeding Specialist Group (CBSG) of the IUCN Species Survival Commission has used workshops centered on PVAs to provide guidance to conservation assessment and planning. Over the past few years, the PVA workshops have expanded beyond the quantitative analysis of extinction probabilities. They now often incorporate consideration of such factors as resource use by local human populations (for example, in the PVA on the Tana River primates in Kenya; education programmes for local human populations (Aruba Island rattlesnake PVA); trade issues (Kenya black rhino PVA); and trends in human demographics and land-use patterns (greater one-horned rhinoceros PVA). Such workshops have thus come to incorporate more than population biology modelling, and are now called Population and Habitat Viability Analyses, or PHVAs.

How is a PVA used?

Which factors are important to consider in a PVA? This depends on the biology of the species, the present population size and distribution, and the threats it faces. For example, orang utans may be threatened by forest destruction, but inbreeding and randomly skewed sex ratios are unlikely to be problems, at least not on a species-wide basis.

On the other hand, even if the remnant Atlantic coastal rainforest of Brazil is secured for the future, the populations of golden lion tamarins *Leontopithecus rosalia* which can persist in that remnant forest may not be sufficiently large to be stable in the face of chance events.

The identification of the primary threats facing a taxon via a comprehensive PVA is important for conservation planning. For example, tamarin populations might be stabilized by the translocations and reintroductions that are under way and planned, but an orang utan PHVA recognized that releases of confiscated "pet" orang utans are unlikely to have a conservation benefit for those populations which are facing habitat destruction rather than stochastic fluctuations and inbreeding.



Inbreeding and demographic fluctuations are threats to Kenya's black rhinos, according to a PVA. WWF/Mauri Rautkari

For many species, such as the whooping crane *Grus americana*, the temporarily extinct-in-the-wild black-footed ferret *Mustela nigripes*, and the Puerto Rican parrot *Amazona vittata*, only a single population persisted in the wild. Although those populations may have been maintained or even increased for a number of years, PVAs helped to identify that the principal threat was that a local catastrophe (e.g., disease epidemic, severe storm) could decimate the population. The primary recovery actions therefore needed to include the establishment of additional populations.

PVA modeling also allows one to test the expected results of any given management action on the computer before implementation in the field. This process can help us select the best management option and define target recovery goals. For example, a PVA carried out on the black rhinoceros in Kenya's 11 rhino sanctuaries has suggested that periodic movement of rhinos between fenced sanctuaries to reduce inbreeding and demographic fluctuations would be necessary to stabilize the populations in the smaller parks.

What is the future of PVAs?

We are finally beginning to understand how extinction works. This was reflected in the recent decision to base IUCN categories of threat on quantified criteria indicating probability of extinction, or changes in such indicators as species

range, numbers, and trends. Much more needs to be done, however, to develop more comprehensive and predictive models, gather relevant data on status and threats, and apply the PVA techniques.

To date, most PVA models are too simplistic, treating organisms as independent actors in homogeneous environments. We also need to include other factors, such as dispersal patterns; complex social processes; effects of loss of genetic variation; interactions with other species; and the effects of changes in the global environment.

Unfortunately, the urgency of the current biodiversity crisis does not permit us the luxury of waiting until we have a better understanding of all the factors that drive population, community, and ecosystem dynamics. We are ethically required to take aggressive conservation action now, and PVA provides a way to make immediate use of the information we do have, in a well-documented process that is open to challenge and improvement.

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This text was adapted from an article in press in *Primate Conservation* by Robert C. Lacy, Daniel F. and Ada L. Rice Center, Brookfield Zoo, Brookfield, IL 60513 USA.

Saving endangered plants

The Royal Botanic Gardens at Kew has pioneered the science of plant conservation.

By Charles Stirton
and Michael Maunder

Botanists have a number of new techniques which show their usefulness in identifying areas of high biodiversity, thus building the scientific basis for the conservation of biological diversity. Some, such as Geographical Information Systems (GIS), help to convey complex scientific arguments to non-specialists particularly politicians and decision makers clearly and succinctly (see page 21).

The Royal Botanic Gardens at Kew, (RBG, Kew) represents a huge resource for international plant conservation at its two sites, at Kew just outside London and at Wakehurst in West Sussex. The two sites contain the world's largest collection of living and preserved plants, extensive glasshouses, laboratories and the Wakehurst seedbank. In line with the Convention on Biological Diversity and Agenda 21, these collections and research facilities are increasingly managed to support plant conservation programmes throughout the world. This utilization is based on collaborative projects with a wide variety of organizations. Key conservation priorities are botanical inventory, production

of floras and monographs of key plant groups, professional training, promoting a resurgence in economic botany, the continued development of applied plant conservation techniques and increased local capacity.

The new Millennium Seed Bank at the Wakehurst Place site, to be opened in 2000 and designed to house seed of 25% of the world's plant species, is a major *ex situ* conservation project involving many countries with dryland floras.

Species recovery

The Living Collections Department of RBG, Kew is managing several integrated species recovery programmes. For a number of species, now extinct in the wild – such as the sacred toromiro tree *Sophora toromiro* of Easter Island – the only hope of long-term survival lies in careful genetic analysis and management. RBG, Kew and the University of Reading are screening all known toromiro trees to verify their identity and assess surviving genetic diversity. Using the developing techniques of molecular fingerprinting, genuine toromiro trees have been identified in European, Australian and Chilean botanic gardens, whilst wrongly identified trees have been removed from the breeding programme.

This work is coordinated by the Toromiro Management Group, which is co-chaired by representatives from CONAF an IUCN member in Chile, and Bonn Botanical Garden, Germany. This is an international group, supporting the conservation and reintroduction of this species – the first international pedigree management scheme for a threatened plant.

Similar programmes are being undertaken with other island plant species as part of Kew's Island Plant Programme. This includes botanical inventory, habitat restoration and reintroduction projects in the Mascarenes in collaboration with the Mauritius Wildlife Fund, the government of Mauritius and the Indian Ocean



Local people watch as a toromiro tree is planted on Easter Island by a warden of the Rapa Nui National Park and Dr Wolfram Lobin, Curator of the Bonn Botanical Garden. *Alberto Bordeu*

Commission. This is funded by the Global Environment Facility (GEF) of the World Bank and the Indian Ocean Commission.

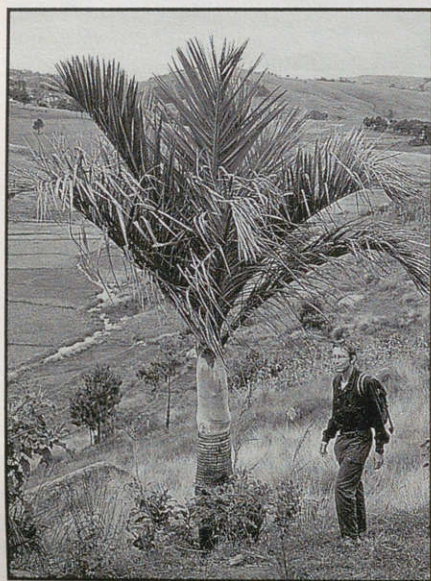
Botanical inventory

Much of Kew's work is based on the belief that without an accurate and comprehensive inventory of plant species, and a mechanism for identifying that diversity, a national or regional strategy for plant conservation is dead-on-the-ground.

For example, Madagascar has a diverse palm flora with representatives of several evolutionary lines, yet until recently information on these spectacular plants was incomplete. Since 1991, Dr Henk Beentje has worked with Dr John Dransfield to prepare a comprehensive book on the palms of Madagascar. So far, he has discovered some 35 new species and a rare aquatic palm. This book appeared in 1995, providing a definitive treatment of this difficult group.

Scientific exchange

The GEF is funding scientific exchange between Kew and the National museums of Kenya as part of its programme for institutional support for the protection of East African biodiversity. Kenyan and UK botanists are exchanging visits and collaborating on the production of the



Henk Beentje beside the endangered Madagascan palm *Chrysalidocarpus decipiens*. *John Dransfield*

Flora of Tropical East Africa. The Darwin Initiative is funding three plant conservation training courses for East Africa with the National Museums of Kenya.

The Royal Botanic Gardens is committed to using its unique resources to support plant, fungi and habitat conservation in the biodiverse regions of the planet. The newest techniques, such as GIS and genetic fingerprinting, are being utilized to resolve real problems in some of the world's most important areas for biodiversity. Their use can only be justified if it is accompanied by a real commitment to collaborative work and professional training.

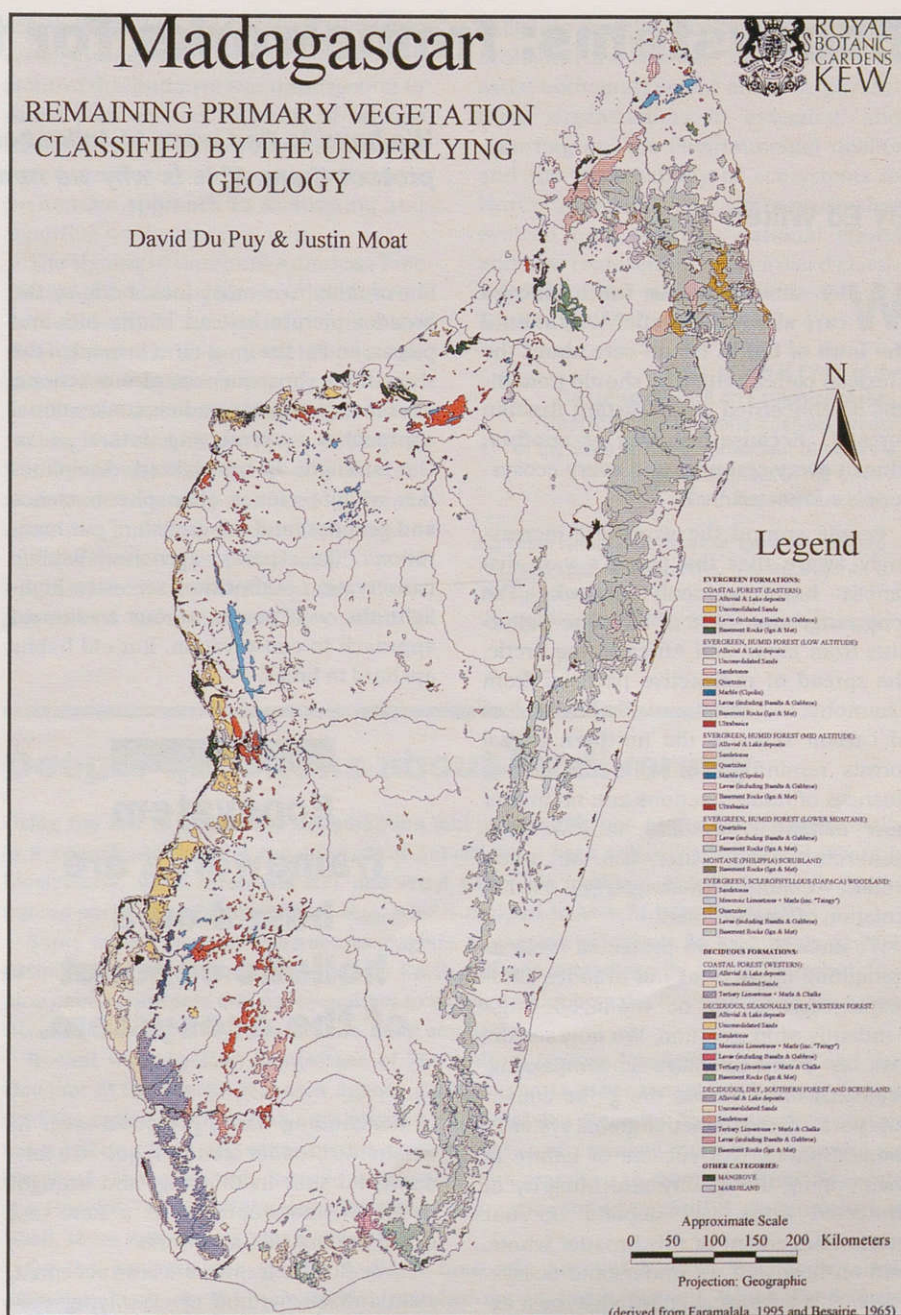
A sense of realism pervades Kew's work; plant conservation will always depend upon the practical skills of field botany and horticulture. A large proportion of these activities will continue to take place in collaboration with IUCN and its members and, increasingly so, as Kew aligns its plant and fungal conservation programme to the Convention on Biological Diversity and IUCN's plant action plans as they become available. This represents as important and significant shift in emphasis.

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The rare orchid *Cymbidiella humblotii* only grows on rapidly-disappearing *Raffia* palms of Madagascar. D. J. Du Puy



D. J. Du Puy

GIS shows the way

Geographical Information Systems (GIS) technology can be an extremely useful tool when making the case for plant conservation. For example, Kew's Dr David J Du Puy and Justin Moat have undertaken a series of GIS studies in Madagascar to analyze distribution patterns of vegetation types and plant biodiversity with reference to the underlying rock. They overlaid satellite images of the remaining primary vegetation on to maps of geological structures and parks and reserves, revealing which vegetation types are poorly represented in the current system of protected areas, and identifying the remaining large, intact areas of primary vegetation suitable for conservation.

Shown above is the resulting new map of 'Remaining Primary Vegetation in Madagascar', derived from Faramalala's 1988 map of broad vegetation types and digitized by Conservation International in 1995.

Such techniques allow scientists to convey complex scientific arguments to non-specialists – particularly politicians and decision makers – clearly and succinctly, and have begun to show their usefulness in identifying areas of high biodiversity.

Ecosystems: frameworks for thought

We have to find ways to talk about ecosystems if we are to protect them. This is why we need ecological frameworks.

By Ed Wiken

Why should people from Chicago care about the Arctic? Why should the Inuit of Baffin Island care about the Mexican coffee belt? Why should Canadians be concerned about distant Russian forests? Because one way or another, almost every resource and every ecosystem is connected.

People around the world are increasingly aware that the planet's vast distances have suddenly shrunk. The long-range transport of airborne pollutants from Japan and Africa to the Arctic, the spread of radioactive particles from Chernobyl to Labrador or the further loss of carbon sinks in the northern boreal forests remind us of what the consequences of human actions are, no matter how distant. They also indicate that resources – land, water, fish, air, trees, wildlife – cannot be managed and used in isolation of one another.

We once looked on protected areas as something apart from the broader landscape/seascape, to be managed independently or in isolation. We now see the task as a much more encompassing. Protected areas across the globe constitute parts of an interactive global system – the ecosphere. Our success or failure in maintaining the quality and integrity of protected areas will depend on our acknowledgement of this broader whole, and on how well we understand ecosystems. This ecological knowledge must extend well beyond the formal boundaries of protected areas.

A lost perspective

The irony of history is that an ecosystem view seemingly had more holistic roots in the past. In the late 1800s, scientists tended to reflect on natural systems in their entirety first, and examine given parts of those systems afterwards. 'Units of nature', whatever they were called, were considered individual, independent, isolated and controlled by specific natural laws.

Yet decades later, this way of thinking about the Earth and its component ecosystems is scientifically and conceptually

out-of-date. We must look both at the broader picture instead of the bits and pieces, and at the long-term instead of the short-term consequences of our actions, even though this contradicts conventional approaches to protecting natural areas. Our strength in specialized disciplines (i.e., wildlife science, atmospheric science and genetics) and the growth of our institutions (i.e., parks agencies, wildlife conservation authorities) serves to highlight the weaknesses of our traditional approach to conservation. But old habits are hard to break.

Ecosystem frameworks are based on a holistic concept of the ecosystem.

Understanding where protected areas fit within the broader context required a fundamental shift in thinking, and brought about the development of a new tool called 'ecological frameworks'.

An ecological framework is an accepted, standardized method of classifying ecosystems, and an essential tool for talking about them, based on a holistic concept of the ecosystem. Use of ecological frameworks will lead us to a better understanding of ecosystems as to their kinds, and how those kinds vary both geographically and throughout time.

Ecological frameworks help us build an ecosystem perspective, understand ecological diversity, and manage resource use. They help government agencies deal with their basic operational requirements in an era of down-sizing and growing demands, by promoting cooperation (e.g., in their administrative duties, strategic planning, cross-border operations, consensus-building projects, and multiple-resource use programmes), and sharing

(e.g. of information, research capabilities, financial resources, expertise, and monitoring capabilities).

Assembling the bits and pieces

Naturalists, scientists, and others have contributed to this piecemeal approach. They have generated a wealth of information from their thematic or single-purpose studies of ecosystem components: biologists described forests, wildlife and peatlands; geologists wrote about climate, bedrock types, permafrost patterns and soils; social scientists addressed human activity (e.g., rural land use or patterns of settlement) or cultural groupings.

But the picture is far from complete. Even in North America, for example, the home of many active field researchers, there are still large areas which have little basic, reliable information on factors such as soil quality, plant communities, or surface water bodies. This leaves us with little hope that we can piece together a larger picture from the bits and pieces. After decades of research, we still lack an understanding of the relationships between human activity and ecological integrity, between species and their habitat, and between carrying capacity and resource use.

A case for ecological frameworks

Ecosystem classification, based on the use of biophysical characteristics to describe ecologically distinctive areas of the Earth's surface, has evolved considerably over the past twenty years. To describe an area we must envision it as a discrete system resulting from the mesh and interplay of geologic, landform, soil, vegetative, climatic, wildlife, water and human factors. Even in the non-technical world, people intuitively capture the meaning of a regional ecosystem by the simple phrases they use to describe the areas of which they are a part. For example, consider all the attributes and relationships that are implied by phrases such as the Himalayas, the Sonoran desert, Russia's breadbasket, or the Amazon delta.

For protected area work, the ecosystem concept must assume these qualities. There is little point, for instance, in having a classification system that interprets ecosystems merely on the basis of plants and ignores the setting of which they are a part; that looks at only large ecosystems and ignores smaller ones; that isolates natural ecosystems from human-modified ecosystems; that ignores the impact and influence of natural forces and human activities; and that fails to account for temporal and spatial interactions.

Ecosystem concepts have to go beyond the common biological bias. The broader link is with "life-support systems", whether natural, modified, cultivated, degraded or built.

Ecosystem mapping: a triumph of content over form

Ecosystem concepts based on biological or physical factors must include spatial and other descriptive qualities if they are to provide a realistic basis for renewed attitudes and practices to safeguard protected areas. People are used to seeing their house, neighbourhood, city and country represented on a map, so depicting ecosystems in a spatial sense seems natural.

Maps define spaces in an ecologically meaningful way – a continuum that must be seen from the local, national, international, and global scales. Ecosystem map units provide a basis for understanding the context of protected areas and the structure and composition of different ecological settings.

Of course, maps have their limitations. The all-encompassing nature of an ecosystem is difficult to translate into mere lines. The content of the ecosystem map unit is more important to describe than its boundary. An ecosystem framework reflects the realization that environmental, social, and economic factors are basic elements of ecosystems, and that these factors do not occur in isolation of one another. It must therefore describe their characteristics and linkages.

Think 'ecosystems'

In the 1980s, governments, non-governmental groups, universities, and industry in Canada worked to establish a common and hierarchical ecosystem framework for terrestrial and marine areas to help them exchange information, develop a national strategy for protected areas and

assess the status and trends of protected areas throughout Canada. One cornerstone of this initiative was the direction to think, plan and act in terms of ecosystems; to move away from an emphasis on individual elements towards a more comprehensive approach to monitoring and reporting on the environment.

The signing of the North American Free Trade Agreement by Mexico, the USA and Canada outlined the commitments of the three governments to new policy thrusts to manage resources prudently and to encourage sensitive environmental decision making. A continent-wide ecological framework was required for communication and reporting between different countries, jurisdictions and disciplines.

A collaborative project was sponsored by the three countries and the Commission on Environmental Co-operation

(CEC) to jointly develop a continental ecological framework. Its purpose is to assist both government and non-government organizations in assessing, and reporting on, the environmental quality and the sustainability of ecosystems in North America. This framework has evolved from previous national efforts and now represents a standardized classification of the terrestrial ecosystems of North America.

Ed B. Wiken is Chair of the Canadian Council on Ecological Areas, Director of the Ecozone Analysis Branch of the State of The Environment Directorate, and a member of the CNPPA North American network.

For further reading and references, see Wiken, E.B. and K. Lawton 1995. *North American Protected Areas: An Ecological Approach to Reporting and Analysis*. The George Wright Forum 12:(1):25-33. Hancock, Michigan.

Deeper questions about biodiversity

Using the law to ensure the conservation and sustainable use of the Earth's biodiversity is a complicated matter requiring clear definitions – both scientific (what and where is biodiversity, what threatens it?) and legal (who has national jurisdiction, who is the injured party when biodiversity is lost, who is entitled to benefit from its use?).

Some recent work by deep-sea ecologists is causing scientists to look again at their estimates of the number of species on Earth and where biodiversity is concentrated. It is also causing lawyers and policy-makers to wonder about how the Convention on Biological Diversity can best be applied to the deep sea-bed.

Recent work by John Lamshead of The Natural History Museum in London and Guy Boucher of the French research agency CNRS supports other recent work in suggesting that the bathyal depths of the ocean have a rainforest-like diversity. They appear to contain more species than any other marine environment, and certainly more than anyone ever imagined. Their research came to light when Shell proposed to dump the Brent Spar into the Rockall Trough off Western Scotland, where, according to the UK government and Shell, there wasn't very much alive.

On the contrary, the Shell EIA didn't take into account benthic meiofauna (small animals), such as the nematodes (roundworms in the sediment) which Lamshead studies. He reports finding so many new ones that it could take the existing 20 or so marine nematode taxonomists in the world 5000 years to describe the organisms found. The numbers are indeed staggering – there may be 100 million undescribed species of nematode alone in the deep ocean.

"The UK may be a 'low biodiversity' country on land, but offshore it's a biodiversity powerhouse," is how Lamshead puts it.

Conservationists have a hard enough time convincing policy-makers that terrestrial biodiversity is important for human well-being. Given that the huge number and variety of organisms in the deep sea may play a significant role in carbon cycling and therefore in climate change takes the question beyond the realm of aesthetics and scientific curiosity. The genetic and biochemical potential of these organisms in biotechnological applications may also make them quite valuable. It certainly complicates the work of marine lawyers when it comes to questions such as ocean disposal, deep sea exploration and marine bioprospecting.

Lyle Glowka, Legal Officer (Biological Diversity), IUCN Environmental Law Centre, Bonn, Germany

For further reading, see *New Scientist*, 16 September 1995, and *Oceanis* Vol. 19.

The end of evolution?

"Death is one thing, an end to birth is something else."

By Michael Soulé

The current extinction episode is unprecedented, if not in degree then in causation. Unlike other major extinctions since the Cambrian, this one is caused by one of nature's own – us.

Some commentators dismiss the significance of anthropogenic mass extinction, taking refuge in "the fallacy of equivalent rates" as expressed in the following syllogism: (1) extinction is a natural process; (2) nearly all species that have ever lived are now extinct; therefore (3) the extinction of most contemporary species is normal.

The flaw in this assertion of normality is the implicit premise that differences between past and present extinction rates are not important. Yet, since about the

year 1400, when European exploration and colonization began in earnest, hundreds of vertebrates have become extinct, and, now, extinction rates are increasing exponentially. All but a handful of the thousands of extinctions that have occurred in recent centuries have been caused by human activities. Soon, according to E. O. Wilson, the anthropogenic extinction rate will reach 1000 times that of the average background rate. Such rates are anything but normal.

Most of the surviving species of big tropical animals (larger than pigeons and rabbits) will soon disappear outside of protected areas. Even in reserves, sad to say, large species are vulnerable except in

the larger and most secure parks. These larger animals – including most tortoises, alligators, mammalian carnivores, the primates, ungulates, parrots, woodpeckers, bats, and hundreds of fresh water fishes – often determine the physical structure and spatial distribution of other species in ecological communities. When the large animals disappear, the ecological changes are often swift and profound.

Even the survivors of the current extinction will face an unprecedented situation; their evolutionary capability will be greatly diminished. The reason is that evolution in large animals is impossible without a lot of space. Consider speciation, the splitting of a single species into two (or more) species. The process usually proceeds as follows. First, a change in climate, in land form, or a shift in the geographic distribution of the species, leads to subdivision – the isolation of some part of a species from the rest. In other words, the first step in speciation is a long-lasting barrier that prevents genetic contact between two or more units of the species.

Another requirement is that the isolated units must persist a long time; they must be viable. Numbers are the best guarantee of persistence, and populations must number in the thousands of individuals to survive long enough – usually for thousands of years – for the isolates to become genetically differentiated. Finally, by the time the isolating barrier no longer functions, the units must be sufficiently different so that mating between them will not produce many fertile offspring.

Thus, the birth of a novel species is impossible unless there is sufficient space for isolation. How much area is needed? According to our best estimates, the sizes of land masses that are probably necessary for speciation for various groups of animals are far greater than even the largest national parks. In fact, these are too small for speciation in small mammals, let alone the larger mammals.

The end of speciation for most large animals rivals the extinction crisis in significance for the future of living nature. As we said in 1980, "Death is one thing, an end to birth is something else."



Most of the surviving species of big tropical animals – including some of our closest relatives – will soon disappear outside of protected areas. WWF/R. Wiederkehr

The biotic debacle

Even if we assume that speciation in a few large animals (such as polar bears and caribou) continues in high latitudes, it will be far too slow to compensate for the biotic debacle now underway in the relatively diverse and species-rich lower latitudes. The most optimistic scenario is that speciation will resume in a few centuries when humanity learns to control its economy and fertility, restricting its habitat impacts to a fair share of the planet's surface.

A potential criticism of this "evolution is ending" scenario is that speciation is just one kind of evolution, and that other kinds of evolution will certainly continue. But will they? The other major mode of organic evolution is adaptation, genetic change within a population or species. Adaptation is the result of genetically-based changes that permit a species to keep up with modifications in other species and fluctuations in the larger environment. Hence, adaptation usually implies refinements in survival tactics, competitiveness, overall vigour, and reproduction. Adaptation and speciation, of course, are not mutually exclusive.

Drifting to disaster

The motive force of adaptation is natural selection. Natural selection means that any genetic advantage possessed by an individual is likely to increase that individual's chances of surviving and breeding. Thus, modification or enhancement in adaptation is almost inevitable – "almost" because natural selection can be overwhelmed by another force, genetic drift, the effects of which can be devastating.

Genetic drift refers to the random changes in the frequencies (percentages) of different forms of a gene (alleles). The power of genetic drift is inversely related to population size; the smaller the size of a population and the more isolated it is, the greater the likelihood that random changes will overwhelm the non-random ones driven by natural selection. Thus, in populations with less than 50 to 100 breeding individuals, some good genes are quite likely to disappear and some bad genes can become fixed, merely by chance. In other words, chance instead of natural selection is more likely to determine which genes win and which lose when a population is small. Genetic drift also reduces the amount of genetic variation. So, the smaller the population, the less raw genetic material it has to adapt to changes in its environment.

The Cenozoic, the Age of Mammals, is over.

Mutational meltdown

One type of genetic drift, "mutational meltdown", is the slow accumulation of slightly harmful new mutations. It can erode fitness in populations with up to as many as a few thousand or so breeding individuals, a higher number than the population size of the average species that is officially declared to be endangered. After hundreds or thousands of generations, the gradual buildup of these mildly deleterious mutations can undermine every aspect of fitness. In the long run it means that small populations are not ecologically viable. The good news is that with generation times of five years or more, and assuming that managers will be able to maintain at least 100 or so pairs of every endangered species for the next few centuries, solutions may be found to this problem before genetic meltdowns become a serious threat for large animals.

Genetic downsizing

Is there a silver lining to this cloud? Some biologists argue that the current extinction crisis is analogous to a healthy pruning in an expanding corporation, and that the extinctions are ultimately non-consequential because Gaia (the Earth seen as a self-compensating, homeostatic chemical-climate being) has extraordinary resilience and will replenish itself with a diversity of human technologies, even if none of the megafauna survive the current one.

Other optimists have argued that evolution will regenerate replacement species during the next 10 or 20 million years. I refer to such ideas as the "fallacy of homeostasis". Indeed, evolutionary restitutions have occurred following previous mass extinctions, but such earlier recoveries happened when the world was free of agriculture, livestock, chainsaws and bulldozers. Therefore, faith in the homeostatic power of evolution is like asserting that depleted petroleum reserves will quickly recover because the oil will be replaced,

somehow, by the same natural processes that produced it. This is cheerfulness to the point of, to quote Voltaire, "a mania for declaring when things are going badly that all is well."

Adapt or die

A law of nature is "adapt or die". With speciation ending and adaptation seriously compromised, the megafauna cannot follow new evolutionary pathways; instead of adapting, they can only quiver, virtually helpless before the increasing challenges in their environments. It is an awkward situation because animals need all the evolutionary plasticity they can muster, given the high rate of ecological change that human beings are inducing. If one of our conservation goals is to maximize the biological potential of nature, for its own sake as well as ours, then we must commit to protecting evolutionary potential. This means that we must restore and protect large, geographically extensive populations, as organizations like the Wildlands Project proposed for North America.

Enter the catastrophozoic

Soon a millennium will end. With it will pass four billion years of evolutionary exuberance. Yes, some species will survive, particularly the smaller, tenacious ones living in places far too dry and cold for us to farm or graze. Yet we must face the fact that the Cenozoic, the Age of Mammals which has been in retreat since the catastrophic extinctions of the late Pleistocene, is over, and that the 'Anthropozoic' or 'Catastrophozoic' has begun. Our task now is to salvage some samples of the megafauna and protect enough habitat to give future human beings an opportunity to restore a semblance of evolutionary integrity in the 22nd century.

Michael E. Soulé is on the Environmental Studies Board, University of California, Santa Cruz, and is a member of the IUCN/SSC Conservation Breeding Specialist Group

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Europe

Ministers endorse landscape strategy

In October 1995 European Environment Ministers endorsed the Pan-European Biological and Landscape Diversity Strategy and agreed to maintain the Task Force set up for its implementation. At their meeting in Sofia, Bulgaria, the Ministers also named IUCN and OECD as the supporting organizations for Strategy implementation.

IUCN President Jay Hair and staff of the European Programme were on hand to lobby in favour of Europe's biodiversity and to distribute 500 copies of the Union's *Best Practices Guide to Biological and Landscape Diversity Projects*. Ministers welcomed the Guide and encouraged its application in mountain areas of central and eastern Europe.

Jay Hair addressed the plenary session on biodiversity, pointing out that the Strategy marks an important stage in the development of government consciousness about the importance of conserving Europe's biological and landscape diversity. He stressed that NGOs must be included as active partners in implementation of the new Strategy, and promised strong support from IUCN's membership. He also called for more attention to sustainable rural development: "A whole sector of European life with inestimable impact on biodiversity conservation has been omitted thus far in the process."

At a Round Table on Biodiversity hosted by the Swiss Government, IUCN's European Programme Coordinator Zbig Karpowicz presented a paper on the ecological network concept as a tool for integrating of biodiversity conservation into economic sectors.

Africa

Collaborating in Uganda

In October a workshop on "Collaborative management of protected areas: exploring the opportunities in Uganda", sponsored by Uganda National Parks (an IUCN member) with support from the IUCN Uganda Country Office and Social Policy Group. Following the workshop's positive results, IUCN has been invited to support the Uganda Ministry of Tourism, Wildlife and Antiquities to further plan and

implement the new Wildlife Policy, with specific reference to collaborative management approaches. Funding is being provided by the European Union.

Uganda launches wetland policy

In December the Government of Uganda launched a national policy for the conservation and management of wetland resources, the first of its kind in Africa and the second in the world (after Canada). The policy is the result of a joint effort of Ugandan authorities and the Wetlands Programme of IUCN, initiated in 1989 with support from the Governments of Norway and the Netherlands.

Planning for forests

East Africa's forests were the focus of a strategic planning workshop for IUCN forest conservation activities in East Africa (Nairobi, 30 November–2 December), and a subsequent regional coordination meeting for heads of Forest Departments, Forestry Universities and Forest Research Institutes from Uganda, Kenya and Tanzania (Arusha, 4–5 December).

West African members meet

The third West Africa Regional Members Meeting, held on 24–26 October in Burkina Faso, was attended by some 40 people, including the 17 regional members, partners and observers; Regional Councillor Mohamed Ali Abrougi; the IUCN Country Representatives from the five Regional Offices; and staff from Headquarters.

New Regional Representative

Dr Eldad Tukahirwa is IUCN's new Regional Representative for Eastern Africa. Dr Tukahirwa has been serving as Acting Regional Representative since his predecessor, Mersie Ejigu, was appointed IUCN's Assistant Director General, Policy and Programme, in October 1995. Dr Tukahirwa, a Ugandan citizen, brings to the post of Regional Representative a long experience in environment and development issues. In 1987 he established and became Director of the Institute of Environment and Natural Resources at Makerere University, and in 1993 was appointed IUCN Country Representative for Uganda. Educated in zoology and biochemistry at the University of Makerere, Uganda, and with a PhD in Ecological Entomology from Cambridge, UK, Dr Tukahirwa has taught zoology at Maker-

ere since 1980 and has worked as a consultant for the World Bank, GEF, UNEP and IUCN.

Central Africa: call for IUCN involvement

Central Africa, one of the richest biodiversity areas in the world, is facing major hurdles in its pursuit of environmentally-sound development. The Union's members and partners in the region held their second meeting in Yaounde, Cameroon, on 13–15 September 1995, to assess their problems and recommend ways to tackle them together. High on their list: the need to strengthen the role and capacity of IUCN, CNPPA and SSC members in the region, and communication and exchange among them.

Asia

New agreement with Nepal

In September 1995, IUCN and Nepal's Department of National Parks and Wildlife Conservation (Ministry of Forests and Soil Conservation) formally agreed to further develop their conservation partnership. The agreement promotes conservation education and interpretation services in natural World Heritage sites; conservation of wetlands and aquatic biodiversity; and enhancement of national capabilities for implementing international conventions such as CITES and the Convention on Biological Diversity.

Meeting of minds in Nepal

On 3–8 December 1995, IUCN Nepal organized a meeting of the people of upper Gorkha (Manaslu, Shringi and Ganesh Himal Areas) with top officials of His Majesty's Government of Nepal. Its main objective was to acquaint the officials with the development aspirations of the local people and ecotourism potential of this remote and beautiful region.

The group of 30 participants represent seven Village Development Committees of the region. While in Kathmandu, the group met with the Prime Minister, the Ministers of Finance, Communications, Education and Culture, and Tourism and Civil Aviation, and the Speaker of the Lower House of Representatives. The team also visited model horticulture farms, a herb processing factory, and technology manufacturing units.

Biodiversity Action Plan for Viet Nam

Viet Nam ratified the Convention on Biodiversity in November 1994. On 22 December 1995, the Prime Minister of the Socialist Republic of Viet Nam formally approved the Biodiversity Action Plan (BAP) for Viet Nam. The "Decision of the Prime Minister" was signed by the Vice-Prime Minister, Mr Nguyen Khanh.

The Viet Nam BAP has been prepared by the Ministry of Science, Technology and Environment (MoSTE), with technical assistance from IUCN and WWF, as part of a UNDP/GEF-funded project. The document contains a comprehensive review of the current status of biodiversity in Viet Nam, and provides recommendations for policy review, programme actions and specific project activities which need to be carried out to safeguard Viet Nam's rich biodiversity.

The first action which will be taken is to organize a number of workshops to explain to local authorities what the BAP is about; the second step will be to develop and implement the BAP projects. IUCN has already launched some related initiatives, specifically the development of a wetlands conservation and management plan for Viet Nam and a project to establish marine protected areas.

Communications planning in the Middle East

Twenty-three experts in environmental information and communications from nine countries of West Asia, representing governments and non-governmental environmental organizations, met in Manama, Bahrain, on 25 October 1995 to define regional communications priorities, promote communications skills and elaborate an agreement on collaborative projects.

The workshop, a cooperative effort of the United Nations Environment Programme (UNEP) and IUCN, attracted participants from Bahrain, Iraq, Kuwait, Lebanon, Oman, Saudi Arabia, Syria and Yemen.

"We can no longer afford to ignore the importance of communications planning in this part of the world, where environmental bodies are newly-established and regional cooperation on environmental information and awareness activities are greatly needed. We will be working to build the capacity of members bodies and help them target their communications to

better serve both the public and decision-makers," says Dr Adel Orabi, Deputy Director of the UNEP Regional Office for West Asia.

Riyadh Conservation Forum

During the first week of October 1995, some 80 members of IUCN and three of its Commissions (SSC, CNPPA, CEM) from West Asia, Central Asia and North Africa met in Riyadh, Saudi Arabia, to lay the groundwork for an Action Plan and for the Union's draft Triennial Programme for the region.

"This was the first time that a full members' meeting was convened in the region," noted Dr Abdulaziz H. Abuzinada, Secretary General of the National Commission for Wildlife Conservation and Development (NCWCD).

Addressing the group, David McDowell mentioned three important areas for regional collaboration: action plans, regional networks, and capacity-building. He noted that the Forum set a model for other regions, particularly in its integration between members and the IUCN Commissions.

Biodiversity Forum: people are the key

Members of government and non-governmental organizations worldwide gathered at the third Global Biodiversity Forum (GBF) in Jakarta, Indonesia on 4-5 November 1995. Participants formulated recommendations on how to conserve the Earth's biological diversity through active involvement of people.

The Forum, co-hosted by the Indonesian Biodiversity Foundation, WWF-Indonesia Programme, and IUCN together with four other partners, took place just before the second meeting of the Conference of the Parties to the Convention on Biological Diversity (COP2).

The GBF gave participants the opportunity to discuss and debate key ecological, economic, institutional and social issues related to saving, studying and using biodiversity. It had four parallel workshops, addressing marine biodiversity, regulation of access to genetic resources, forests and biodiversity, and decentralization of governments and the management of biodiversity.

"This was by far the best-attended in the Forum series, with well over 400 participants," reports Jeff McNeely, Chief Scientist at IUCN. "The Forum was

mentioned frequently throughout the COP and clearly was well-appreciated by the participants. It has become an important mechanism for dialogue prior to COPs, a development with important implications for IUCN."

Arab countries unite to save leopard

Growing concern for the survival of the Arabian leopard *Panthera pardus nimr*, in its range of Saudi Arabia, Yemen, Oman and UAE led to the convening of a workshop in Sharjah, UAE, sponsored by the Arabian Leopard Trust and IUCN. Twenty participants from the four range states, including IUCN members from four countries, discussed conservation and management, examined reports on its status, and then focused on actions to save the critically endangered animal.

"Only 100-200 leopards may survive, and they are severely threatened by livestock owners and hunters," comments Peter Jackson, chair of the IUCN/SSC Cat Specialist Group.

The meeting set up a technical working group, the Leopard Group of Arabia, to coordinate conservation efforts.

Americas

Agreement on Argentina's parks

An agreement has been signed between IUCN and Argentina's National Parks Administration (APN) to strengthen IUCN activities in the Southern Cone of South America and provide technical assistance to Argentina in protected area planning. The costs of the assignment are being covered by the two organizations and a grant from the US National Park Service.

Allen Putney, who previously was Director of Western Hemisphere Relations at IUCN's Office in Washington, has been transferred to IUCN's Office for South America. He has been outposted to Argentina and is cooperating with the APN in developing visitor use plans for the most heavily used national parks, using a team approach. Allen is also working with IUCN's regional office and partners to develop CNPPA activities in South America, and is assisting IUCN National Committees and promoting National CNPPA Groups in Argentina, Chile, Paraguay and Uruguay. Special attention is being given to the development of national programmes and plans of action.

SPECIES SURVIVAL COMMISSION

Plant alert

The Species Survival Programme is in the process of completing the first-ever IUCN Red List of Threatened Plants in collaboration with the World Conservation Monitoring Centre (WCMC), as well as global conservation Action Plans for palms, orchids and cacti and succulent plants.

"The number of threatened plant species makes the number of threatened vertebrates pale in comparison," notes Plants Officer Wendy Strahm. "We are on the brink of losing a tremendous number of plant species which are essential for human well-being and for maintaining the functioning of entire ecosystems."

To highlight the urgency of the situation, some of the SSC Plant Specialist Groups are working on a 'Top 50' campaign, which is to come up with a list of species most in danger of becoming extinct and for which urgent conservation action is needed.

COMMISSION ON EDUCATION AND COMMUNICATION

Biodiversity in Arabic

As a result of CEC input to a workshop on biodiversity education in North Africa, a project has been launched to prepare biodiversity information on the region in Arabic. Five country coordinators met in November to plan activities. Leaflets on some 60 topics, each to be written simply, will be prepared by the five countries, based on a model project presented by a South African Commission member.

Latin America: shared experience

In October, the second IUCN-UNESCO regional meeting on management of national education and communication programmes was held in Quito, Ecuador. An initiative of CEC, the meeting was organized by regional IUCN members, Commission members and the Meso- and Latin American Regional Offices. It brought together experts from governments and NGOs from 17 Latin American countries to share their experiences – both successes and difficulties.

Follow-up will include promoting environmental education as an issue for the Cumbre de las Americas in La Paz, Bolivia; and the formulation of a project on biodiversity education for the region with the members. The case studies presented and the report on the meeting, in Spanish, are available from the IUCN Regional Office in Quito.

COMMISSION ON NATIONAL PARKS AND PROTECTED AREAS

Lessons from Lake Louise

For the first time in recent memory, CNPPA members in North America met to consider the role of the Commission in this hemisphere and prepare a Regional Action Plan. "The enthusiasm of members at Lake Louise was infectious," commented Bruce Amos, CNPPA Vice Chair for North America. "The action plan contains volunteer commitments to lead a range of global and hemispheric actions in support of the CNPPA Strategic Plan. The meeting demonstrated one way to harness the strength and diversity of our volunteer networks. It also reminded us all that the mission of the Union 'to influence, encourage and assist societies throughout the world' must be delivered in all regions of the world."

Proceedings of the meeting and the Regional Action Plan are available from David Sheppard, IUCN Headquarters.

PARKSHARE proposal gets a nod

The CNPPA Steering Committee met in late November at IUCN Headquarters. Members gave their final approval to the CNPPA Strategic Plan; agreed ways to improve IUCN support to World Heritage; and reviewed the work of CNPPA Task Forces on economic benefits, training, tourism, and information management.

The Committee also decided on the structure of a CNPPA proposal "PARKSHARE" which will share experience on protected areas between different parts of the world, and identified cooperative programmes between CNPPA and the WCMC/Protected Area Data Unit, including the development of a Protected Area Resource Centre (PARC).

Other important decisions involved a new CNPPA structure in Africa and a new fundraising strategy.

Looking ahead, participants discussed their coordinated input to the World Conservation Congress, the forthcoming mid-term review of the Caracas Action Plan and some 13 regional meetings.

COMMISSION ON ENVIRONMENTAL STRATEGY AND PLANNING

Groundwork in Brazil

In February 1996, CESP and the Brazilian Foundation for Conservation of Nature held workshops and informal discussions in Rio de Janeiro and the north-eastern city of Maceio. Their purpose was to explore how the 'Groundwork' concept might be applied in Brazil.

Groundwork is a highly successful British environmental partnership programme.

The workshops were led by Groundwork Chief Executive John Davidson. Participants included eight state government secretaries, key federal and municipal officials, business leaders and NGO representatives.

COMMISSION ON ECOSYSTEM MANAGEMENT

Strategic Plan approved

In December, members of the CEM Steering Committee approved a new 1996-1997 Strategic Plan, including a statement of the Commission's organization and objectives, an Action Plan, and an operational plan.

"The newly revamped Commission, which takes the place of the old Commission on Ecology, will provide expertise related to the management of both natural and modified ecosystems," explains Jean-Yves Pirot of IUCN.

"It will be a repository of up-to-date science and scientific opinion, and will use and communicate that information to advocate sound management practices, to influence decision-makers, and to help people who actually manage ecosystems on-the-ground."

The plan will be submitted to the World Conservation Congress for approval.

Year of the turtle

The sea turtles of the western Indian Ocean may have a better chance for survival, thanks to a new regional conservation effort.

The turtles are "a shared resource of inestimable value to the region's coastal nations; yet only a few of the numerous discrete populations of the five species occurring in the region are stable or growing, three populations are extinct; most are either in decline or have not yet begun to recover from many centuries of irrational use; the long-term survival of the marine turtles of the region cannot be achieved by any single country and the maximum collaboration and cooperation is necessary."

These words open the Sodwana Declaration, an important statement of a region's determination to take action on behalf of their shared natural heritage.

The western Indian Ocean hosts five species of turtle: the green turtle *Chelonia mydas*, the hawksbill *Eretmochelys imbricata*, the loggerhead *Caretta caretta*, the leatherback *Dermochelys coriacea*, and the olive ridley *Lepidochelys olivacea*. A regional approach to the conservation and management of these turtles is essential: it has to cover the ranges of distinct breeding groups or populations – the natural "management units" of the far-ranging turtles, which swim many hundreds, even thousands of kilometres between their nesting and feeding sites, crossing through the waters of several different national jurisdictions in the process.

Regional workshop breaks new ground

The Global Strategy for the Conservation of Marine Turtles lists actions needed at local, national and regional levels to conserve sea turtles, and specifically calls for "... management through regional and international cooperation and coordination."

The Western Indian Ocean Training Workshop and Strategic Planning Session, held in Sodwana Bay, South Africa on 12-18 November 1995, was the first regional meeting on marine turtles to be convened under the umbrella of this Global Strategy. It was organized by the IUCN Eastern Africa Regional



The workshop coincided with the nesting season in Sodwana Bay for loggerheads and leatherbacks and offered an excellent opportunity to practice recording and tagging techniques. Pictured: a member of the Natal Parks Board staff teaches trainees how to measure turtles. IUCN/Rod Salm

Office (EARO) and the IUCN/SSC Marine Turtle Specialist Group.

The workshop's major sponsors were WWF International, the Convention on the Conservation of Migratory Species of Wild Animals, and UNEP OCA/PAC. It was hosted by the Natal Parks Board, which has worked for more than 33 years under the leadership of George Hughes to conserve the turtles and their nesting beaches.

The workshop brought together representatives and scientists from African mainland countries of Eritrea, Kenya, Mozambique, South Africa, Tanzania and Zanzibar; island nations including Comoros, Mauritius, La Réunion (France) and Seychelles. They had several objectives:

- to formulate a regional conservation strategy for turtles;
- to initiate networking among marine turtle researchers and managers; and
- to train senior researchers and managers.

The workshop also issued the **Sodwana Declaration**, recommending government endorsement and support for the strategy.

The regional strategy identifies twelve priority actions. Key among these are

provisions for communication, information exchange, training and capacity building; a permanent turtle database for the region; standardized methodologies; and monitoring of turtle harvest and fisheries interactions.

The meeting agreed to establish a steering committee and name a regional coordinator; to provide tagging kits for those countries without the needed facilities; and to declare 1998 the "Year of the Sea Turtle for the Indian Ocean" – a high-profile event designed to generate awareness of the importance of sea turtles and of their conservation needs among the general public and decision makers.

EARO has already begun developing a proposal for a regional sea turtle conservation programme, to include national action plans for conservation management of turtles and their habitats.

In the words of Kenyan turtle expert George Wamukoya Kenya, "through this workshop, IUCN has laid a strong foundation for progress in turtle conservation. The onus is now on us (the nationals of the region) to take the progress forward."

Rodney V. Salm
Sarah Humphrey
IUCN Eastern Africa
Regional Office

Council gets ready for Montreal

At their 42nd meeting at Headquarters in late November 1995, members of the IUCN Council welcomed Japan and Malawi as State Members and admitted 32 Government Agencies and NGOs from all the Union's eight regions.

In other decisions, Council:

- appointed Joseph Ki-Zerbo as Regional Councillor to replace Dr Mankoto Ma Mbaelele, who resigned his position upon accepting a job with UNESCO in Paris;

- reviewed the first draft of IUCN's "Vision for the 21st Century";

- stressed the need to prioritize IUCN's activities in the light of the Union's reduced income;

- approved 1996 workplans and reviewed the draft Programme for 1997-1999.

Council also noted the excellent progress in preparations for the World Conservation Congress by its Canadian hosts. They appointed Dr Martin Edwards as Election Officer for the World Conservation Congress; set up the Resolutions Working Group; and approved preliminary drafts of the Statutes, Regulations and Rules of Procedure for circulation to the membership.

1995 Golden Arks

In 1995 several members of the IUCN family received the Order of the Golden Ark from the Government of the Netherlands for outstanding accomplishment in conservation. Among them was Chief Scientist Jeffrey A. McNeely, cited for his "dedicated and innovative work in South East Asia, including his role in the introduction of protected areas in the Mekong Delta, and, in particular as a long-serving and highly respected member of IUCN, during which period he was Secretary General of the IV World Congress on National Parks and Protected Areas and helped develop and implement new concepts relating people to protected areas".

Fundraising summit

In January IUCN President Jay Hair, SSC Chair George Rabb and Regional Councillor Dave Runnalls joined Director General David McDowell and key staff for a two day in-house 'fundraising summit' held at Headquarters. The meeting noted that as global development assistance spending shrinks, the Union needs to be much more active and imaginative in its fundraising.

The group came up with a fundraising strategy for submission to Council.

New faces at HQ

Hans Beggren has joined IUCN as Director of Human Resources Management Group, on loan from the UN's International Trade Centre (ITC). He brings to IUCN more than 30 years of experience in trade promotion and international marketing, human resources management and financial management.

Carmel Mbizvo joined the Regional Office for Southern Africa (ROSA) in September 1995 as Regional Social Policy Services Programme Officer. Carmel has a MSc in Sociology/Social Anthropology, and specializes in social issues pertaining to community-based natural resource management. Before joining ROSA, she headed the Research and Consultancy Unit of ZERO, a regional environmental NGO based in Harare.

Alex de Sherbinin began a two-year stint with IUCN in January as the third University of Michigan Population-Environment Fellow. He will work with Regional and Country Offices to integrate population concerns into environmental conservation and sustainable development activities. Alex has a masters degree in geography, spent two years with the Peace Corps in Mauritania, and worked for seven years with a population NGO in Washington, DC.

An appreciation: Hugh Lamprey 1928-1996

Dr Hugh Lamprey died on 10 February 1996 at his home in Devon, UK, after a long illness.

Hugh was a man of many aspects. He was a gentleman, in the true sense of the word, and a calm, steadfast family man of high principles. He was a pioneering ecologist, having carried out fundamental studies on wildlife in what was then Tanganyika in the early 1950s, where he became Director of the Serengeti Research Institute. Hugh was also a committed and influential conservationist. As first Principal of the School of African Wildlife Management at Mweka in Tanzania he served as an inspiration to hundreds of students and staff. He played a major role in the critical 1961 Arusha Symposium on Conservation in Africa which was convened by IUCN and the Commission for Technical Cooperation in Africa. Indeed, his "Introduction to the Landscape", prepared with Lee and Martha Talbot, still stands as one of the best field guides ever written on eastern Africa. Hugh served as IUCN/WWF Representative in the region in 1974/75 before moving on to work with UNESCO's Man and Biosphere programme in Northern Kenya. He then served as WWF's Representative for East Africa until his retirement in 1989.



The photo above shows former IUCN Director General Kenton Miller giving CNPPA's Fred Packard Merit Award to Hugh at the IV World Parks Congress in Venezuela in 1992. An excerpt from the citation sums up the man that so many admired: "His consideration for others, his energy and dedication will continue to be reflected through those he has trained as well as in the projects he has established."

Hugh's many friends and colleagues in IUCN send their heartfelt condolences to his family.

Jim Thorsell

REVIEW: Understanding biodiversity loss

Over 140 countries have now ratified the Convention on Biological Diversity. This means that over 140 countries are officially "concerned that biological diversity is being significantly reduced by certain human activities." They also have agreed "that it is vital to anticipate, prevent and attack the causes of significant reduction or loss of biological diversity at source."

Two recently published collections of articles, both released in 1995 by Cambridge University Press, offer new interdisciplinary thinking and understanding of the implications and causes of biodiversity loss. These are: *The Economics and Ecology of Biodiversity Decline: The Forces Driving Global Change* edited by Tim Swanson and *Biodiversity Loss: Economic and Ecological Issues*, edited by Charles Perrings, Karl-Göran Mäler, Carl Folke, C. S. Holling and Bengt-Own Jansson.

The two collections are in most respects complements rather than substitutes. (This is indicated in part by Swanson's contribution to the Perrings volume and Perrings' contribution to the Swanson volume!). The collection edited by Perrings *et al.* takes as its starting point understanding the nature of the problem of biodiversity loss and the significance of this loss on the biological services required for human activity. The collection edited by Swanson starts with the question "Why is biological diversity in decline?" Thus taken together the two volumes help us to understand why biodiversity is a problem, why the problem is significant and why it is happening.

As evidenced by the global support for the Biodiversity Convention, biodiversity loss is now politically recognized as a significant problem. We need to now to understand better why it is happening and what is to be done about it. In this respect, the two collections explore the complexity of the forces driving biodiversity loss.

Swanson states that "the problem is rooted in the expansion of human society" and that "human societies must be deterred from continued expansion." His perspective is actually deeper in that he argues that the expansion of human society is intrinsically linked with specialization in production and consumption which in turn is fundamentally anti-diversity.

Perrings also recognizes the global nature of biodiversity loss, but wonders

whether the localized costs of biodiversity loss are significant enough to allow for local remedies. He states: "If it is understood that a large part of the social costs of biodiversity are local, not only is the problem easier to deal with in the nation state, but the relative values of the transfers needed to induce international cooperation is reduced." In other words, are there viable and cost-effective local solutions to a global problem?

As Perrings *et al.* point out, "the policy implications of an ecological-economic approach to the problem of biodiversity loss have yet to be spelled out clearly." What these two collections show, however, is that economics can help us to understand the phenomenon of biodiversity loss and that economics may also be able to help us understand what to do about it.

What is now needed is a framework for biodiversity loss assessment that will enable governments to determine what policy measures can be implemented at the local and national levels, as well as what policy measures will be required for regional and global cooperation through the Convention on Biological Diversity. These two collections provide serious intellectual background for the development of such a framework for biodiversity loss assessment. Economists, ecologists and policy-makers interested in attacking biodiversity loss would do well to start with these two insightful collections.

Frank Vorhies
Environmental Economist
IUCN Biodiversity Programme

New from IUCN

From Care to Action – Making a Sustainable World

By Martin W. Holdgate. Financially sponsored by the WCS/Caring for the Earth partners, coordinated by IUCN and published in association with Earthscan/Kogan Page.

This powerfully written and thought-provoking book, by one of the world's leading environmentalists, will be useful for students and researchers in the field, as well as of value to all those interested in the environment and conservation.

ISBN 1 85383 306 1, 1996, x+346pp., £15.95, US\$24 Order no. B124. Available from: IUCN Publications Service, 219c Huntingdon Road, Cambridge CB3 0DL, UK.

IUCN

The World Conservation Union

World Conservation
(formerly the *IUCN Bulletin*)
is a publication of
the International Union
for Conservation of Nature
and Natural Resources

Rue Mauverney 28,
CH-1196 Gland, Switzerland

Volume 27, Number 1

January-April 1996

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Spanish edition: ICONA, Spain

Design/layout: Maximedia Ltd.

Published primarily as a service to the
IUCN network

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member organizations,
1996

Opinions expressed in this publication
do not necessarily reflect the official
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Annual subscription to non-members is
US\$60 or equivalent (exceptionally, \$45
in 1996) in other convertible currencies
(includes airmail postage)

PLEASE NOTE:

There will be only three issues of
World Conservation in 1996
owing to financial constraints.
The first issue of 1997 will report
at length on the World
Conservation Congress.

MARTIN HOLDGATE

FROM CARE TO ACTION



MAKING A SUSTAINABLE WORLD



The first national park is on the danger list. Andrej Avcin

Yellowstone under threat

The world's first National Park, Yellowstone, has been placed on the list of World Heritage in Danger.

The action of the World Heritage Committee at its annual meeting in Berlin (4-10 December 1995) was based on extensive evidence of both ascertained and potential threats to the park ecosystem, and overshadowed the inscription of six new natural sites.

"The major threat to Yellowstone is a proposal for a major mine site four kilometres from the park boundary," explains IUCN's Jim Thorsell, Senior

Advisor, Natural Heritage. "The mining of gold, silver and copper just two and a half miles from the park would endanger three major watersheds of the Yellowstone River, threaten the water quality in the park, destroy important wildlife habitat and degrade the natural beauty of this renowned wilderness."

Another US World Heritage site, the Everglades, was put on the danger list in 1993.

The World Heritage Committee added six new natural sites to its list, out of the ten nominated. They are: Waterton Glacier International Peace

Park on the Canada/United States border; the Messel Pit fossil site (Messel, Germany); the Caves of the Aggtelek and Slovak Karst (Hungary/Slovak Republic); the Virgin Komi Forests (Russian Federation); the Gough Island Wildlife Reserve (United Kingdom); and Carlsbad Caverns National Park (United States).

The Committee also discussed the monitoring of existing World Heritage sites, including a report on 12 sites submitted by IUCN.

Legal protection for Antarctica

A Working Group of Legal Experts convened under the auspices of the Antarctic Treaty System is developing an Annex on Liability to the Protocol on Environmental Protection. The IUCN Environmental Law Programme has provided comments and suggestions to the Working Group on (a) the role of compulsory insurance and (b) the establishment of a compensation fund.

"All activities in Antarctica are potentially hazardous to its fragile environment, so it is important to make sure that those who cause environmental damage are held responsible for dealing with the consequences," commented Richard Tarasovsky of the IUCN Environmental Law Centre (ELC).

New hope for the houbara bustard

The houbara bustard is a species of great cultural and economic importance in the many countries of West and Central Asia through which it migrates.

On 13-14 January 1996, the first meeting of the SSC Working Group on the Asian Houbara Bustard was held in Muscat, Sultanate of Oman, to discuss measures for the bird's conservation and set up a network of researchers.

"The survival of the houbara bustard, and particularly its vulnerable Asian subspecies *Chlamydotis undulata macqueenii*, depends on cooperation between its dozen-or-so major range countries," said the Working Group's new coordinator, Frédéric Launay.

"The Group will help researchers exchange information, maintain a central database, provide advice and training, and recommend effective conservation measures."

Those wishing to contribute to the Working Group may contact Dr Launay at the National Avian Research Center, PO Box 45553 Abu Dhabi, United Arab Emirates. Tel: (971) 3 747 555; Fax: (971) 3 747 607; Email: narc@emirates.net.ae

Coordinated conservation

For the first time two global conservation Conventions will officially coordinate their activities. In February, heads of the Convention on Biological Diversity and the Ramsar Convention, Calestous Juma and Delmar Blasco respectively, signed a Memorandum of Cooperation between their secretariats. The agreement will also allow their staff to exchange scientific and technical information more easily, by way of a new 'clearing-house mechanism' being set up this year.

The agreement fulfils one of the key decisions of the recent meeting of the Parties to the Biodiversity Convention in Jakarta, Indonesia (see page 27), calling for increased coordination.

Montreal Congress: time is running out!

Members, are you ready to submit your World Conservation Congress motions to the Director General? Remember that all motions, leading to resolutions, must be received by 16 June 1996, complete with the names of three sponsors.

IUCN members planning to attend the Montreal Congress are asked to send in their **registration forms** together with the duly signed **Statement of Credentials** and the **registration fee** as soon as possible. Note: the fee will be held at US\$50 until 31 July 1996. The Host Country also urges all members to book their **hotel rooms** as soon as possible, but not later than 30 June 1996: past this date, neither hotel rooms nor the special Congress tariff can be guaranteed.

All members should now have in hand a description of the workshops; the revised Statutes, draft Regulations and User's Guide; and a call for nominations for Regional Councillors.

"The Montreal Congress will be the first such event open to the public, and we are expecting good attendance," notes Ursula Hiltbrunner, Head of the Union's Membership Unit. "The Canadian organizers have produced a Workshop Participants' Registration Brochure in response to the great interest shown by the public." The Congress poster produced by the Host Country is being made available to IUCN members at their Regional and National Committee meetings.