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Conflicts over biodiversity

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8.1 Introduction

There is one environmental issue that many environmentalists now believe surpasses all others in terms of long-term global impacts: the loss of our planet's biological diversity. Animal and plant species around the world are disappearing fast. Some scientists believe as many as 25% of the world's total complement of species could be lost over the next few decades (McNeely, 1992). Our planet is clearly facing a wide and disconcerting array of environmental problems and biodiversity loss is only one of them. Attempts to identify appropriate action present a daunting task. However, depletion of global biodiversity presents an urgent and unique set of concerns.

The key feature of this problem is the *irreversibility* of the damage (Cairncross, 1991). Whilst it might arguably be feasible to halt or even reverse other global problems by developing social and technological solutions, the loss of species cannot be mitigated by technological advances. According to some conservation biologists (e.g. Myers, 1993) we are witnessing horrifyingly rapid species extinctions, loss of habitats and even removal of complete ecosystems of an extent not seen since the disappearance of the dinosaurs some 65 million years ago. The irony of this tragedy is that it is occurring at a time when we are just starting fully to comprehend the diversity of living things and their immense potential uses.

This chapter explores the causes and consequences of and the possible solutions to the problem of world-wide biodiversity depletion. First it is necessary to establish what is meant by biodiversity, to understand the scale of the problem (section 8.2). When examining causes, we need to discuss the role of human activity in order to appreciate that biodiversity problems have both social and ecological dimensions (section 8.3). In the examination of the consequences of biodiversity depletion, the conflicts of interest which arise receive close attention (section 8.4). It will become apparent that the conflicts have both local and global implications that are relevant for biodiversity management. Management will be the subject of the final section (8.5), where I shall look at potential solutions by exploring important recent policy developments and their success. In the concluding section (8.6) I shall examine the future of global biodiversity.

However, as a preparation for these discussions we must first (briefly) establish an appreciation of what biodiversity is and how it has evolved.

8.2 Biodiversity: what is it?

Many nature lovers advocate biodiversity conservation on purely 'intrinsic' or aesthetic grounds, but it is also clear that biological resources can hold enormous immediate commercial value (Prescott-Allen and Prescott-Allen, 1982). Initial consideration quickly reveals a multitude of commodities of both direct functional value to human beings and wider indirect importance in the maintenance of the ecological processes on which human life ultimately depends. However, although less easily quantifiable, it would be prudent to avoid underestimating the recreational, aesthetic and spiritual value of biodiversity (Barkham, 1988). Before moving on to consider the major changes now facing global biological diversity and the causes of these problems, it is necessary briefly (but carefully) to consider how we should *define* the term biodiversity. Until recently, biodiversity was a word not widely heard outside circles of ecologists and conservationists but now it is almost a buzzword used by a wide spectrum of environmentalists and policy makers. Its wide use, however, does not detract from its essentially biological origins.

Defining biodiversity

The definition provided in Article 2 of the Earth Summit Biodiversity Convention (1992) provides a convenient starting point. According to it, biodiversity is:

> The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

This is a complex definition that harbours quite a number of distinct elements.

Clearly, *variety* is an explicit component of biodiversity, but variety of what? Few would deny that the species notion is crucial to demarcating organisms and that it provides the very foundation for our appreciation of what is meant by biodiversity. However, as taxonomists and ecologists are well aware, organisms cannot always be neatly partitioned into groups of distinct species (see Box 1). Later in the chapter we will examine some more problems associated with attempts to measure (global) biodiversity and its rates of change. Here we need to recognise that species are not without variation themselves and that such variation may be hard to measure. For example, in botanical taxonomic classification a single species may be further categorised into subspecies or varieties. Variation is also not confined to the subspecific level. The familiar woodland bramble (*Rubus fruticosus*) belongs to an aggregate of species; in other words, it constitutes a group of species (or hybrids) which are morphologically (roughly: in their external appearance) similar and very difficult to distinguish from one another.

Attempts to impose structural order on the living world are also complicated by the existence of taxonomically problematic groups such as viruses, fungi and lichens. Lichens, for example, are composed of a fungus and an alga living in a symbiotic

What is a species?

Defining the concept of a species has turned out not to be an easy matter. The old concept was a typological one: a species was conceived of as collections of organisms that could unequivocally be distinguished from other such collections. All that taxonomists, i.e. biologists who classify organisms, had to do was stick names on those collections. Though there still is a need to give organisms collective names, the idea that all organisms could be named uniquely has turned out to be an illusion. The reason is evolution. As a result the boundaries between closely related species are often blurred. Biologists do have a criterion to distinguish species, even though it only works for sexually reproducing species: They call a group of sexually reproducing organisms a species when those organisms have acquired mechanisms for being reproductively isolated from other such groups. In other words, organisms that belong to the same species can have fertile offspring whereas organisms that belong to different species cannot. Of course, morphological criteria are used as a convenient proxy for this *reproductive isolation* criterion, as it is called.

relation (Galloway, 1992). However, there is no need to be scared off by such difficulties; rather, they serve to highlight the incredibly wide range of biological diversity we are attempting to understand, manage and safeguard. In simple terms, biodiversity is a measure that attempts to describe in a holistic way the total variety of life on the planet. Holistic or not, some broad classification is inevitably required and the following three components to biodiversity are frequently recognised.

Species richness and *species diversity* are used to describe the total complement of species present within a particular area or ecosystem. Species richness is the simpler one, as it only counts the number of species; species diversity is more complex in that it also takes the number of organisms for each species into account. Both measures of biodiversity have the advantage of being relatively straightforward. At the same time this is their weakness because attempts to describe biodiversity only in numerical terms almost certainly undervalue the variety concerned.

A more holistic approach recognises *ecosystem diversity*. An ecosystem may be defined as a community of organisms and their physico-chemical environment interacting as an ecological unit; in other words, an ecosystem represents the entire biological and physical content of a locality (see also Sloep and van Dam, 1995). This definition is useful because it highlights the critical importance of the interaction between species and their environment. Indeed, assessments of biodiversity in terms of its biological components only must be considered inadequate and hence any policies for biodiversity protection based on them as likely to be ineffectual. The ecosystem concept rightly emphasises the interaction of species within a biological community and with their wider physical environment. The complexity and interdependence of these interactions should be stressed in the recognition that ecosystems are continually developing and changing.

Genetic diversity represents the biological variation, or capacity for variation, within each species. It is critically important since it allows organisms to adapt to changing environmental conditions and, consequently, to evolve into new life forms. Genetic

Plate 8.1 Tropical rainforest in the south of Surinam, close to the Brazilian border. Photograph by Ron Gilling/Lineair

diversity is vital to the maintenance of ecological stability, enabling different species to respond to environmental change and to fulfil different functions within the biosphere.

Biodiversity is an abstract concept, yet it aptly encapsulates the immense variety of living things found on Earth. Indeed, it is important to extend our appreciation of life beyond the obvious, the appealing or (anthropocentrically) valuable. An endangered species of bacteria or slime mould is unlikely to have the same appeal to a concerned public as a panda, for example, yet their importance in ecosystem functioning may be more profound. Our appreciation of the diversity of micro-organisms may be far from complete, yet its inclusion in the biodiversity definition is no less critical (Hawksworth and Colwell, 1992).

The evolution of diverse biological systems

In all our attempts to preserve biodiversity, we should realise that it denotes an essentially dynamic concept. Even without human interference, biodiversity is bound to change, by natural causes only. Why this is so becomes clear when one understands how the present diversity of life has arisen. Central is the process of evolution,which may be defined as the accumulation of heritable changes in the characteristics of organisms or populations (see also Sloep and Van Dam, 1995). If large enough, such changes may result in speciation, that is, the creation of a new species (see Box 1). Such

evolutionary processes are usually considered to operate over very long time spans and over wide geographical areas. However, environmental catastrophes and other forms of environmental 'harshness' (or stress) may also play a critical role in the evolution of new species.

The biodiversity in a given area is not determined by evolutionary processes only; ecological processes matter as well. These operate over short time periods (e.g. the lifetime of individual organisms) and on small spatial scales, influencing the extent to which species may coexist in the same area. Examples include the availability of resources such as food and space for territories. In situations where there is a high degree of environmental heterogeneity or where disturbance is a regular feature, it is likely that more species can coexist. The species diversity in a particular area or ecosystem is largely dependent on the range of different habitats available.

It is also important to recognise the role of human beings in creating new ecosystems and in modifying natural processes. Historically, this role has by no means been entirely negative for biodiversity. Many human activities were a critical component of the processes that gave rise to a diverse biota. However, recent trends in the ways in which human beings are choosing to manage biological resources are proving largely deleterious. Amongst the most important are the increasing emphasis placed on intensive forms of agriculture, wider use of specialist methods of mass production, greater global movements of products and capital and less and less adequate methods of measuring the true value of biological resources or the impacts of their exploitation.

Of course, individual organisms have always had to adapt to changing environments. Such adaptations drive evolution. Instability and environmental change are not new phenomena but rather continual processes, usually gradual in nature but sometimes the consequence of catastrophic events (natural or of human origin). However, what is new is the rate and extent of environmental change that tax the ability of organisms to adapt to change beyond their capacities. We are consequently witnessing large-scale losses of species.

Recent trends of species and habitat loss

Whilst it is clear that large numbers of species are being lost every year, it is difficult to establish current *rates of extinction* with any certainty. This problem is compounded by our lack of knowledge of the present number of *described* species; recent estimates suggest it lies between 1.4 and 1.8 million species. About the total number of *living* species one is even less sure – estimates run from 5 to 15 million. The estimated total contemporary rate of extinction is placed between 10,000 and 20,000 species per annum (Stork, 1993).

Whatever the exact figures may be, conservationists believe that, unless current trends are reversed, anything up to 50% of the Earth's species will become extinct in the next 30–50 years. Alarming as this already is, a general estimate of this type inevitably masks the fact that species are being lost at much higher rates in some habitats than others. Particularly in the tropics, where terrestrial biodiversity is considered highest, in many places horrifying destruction of wildlife occurs daily.

As already discussed in the previous section, extinction also is a natural process. The vast majority of species that have ever lived on Earth are now extinct. However,

it is not only the loss of species per se that is worrying, it is particularly the destruction and alteration of their habitats which is crucially important. Loss of habitat area and habitat diversity reduces the Earth's capacity to support viable populations. Indeed, the primary cause of biodiversity depletion in recent times has been the widespread destruction of habitats, as direct and indirect consequences of human activity. Although this destruction concerns an immense variety of habitat types we can single out a number of major habitat types and the principal threats that confront them.

Forests and *woodlands* are the first. They are cut for immediate exploitation of trees or cleared for conversion to agricultural systems, which are considered more productive. Clearance of rainforest for conversion to grazing has had devastating effects on biodiversity in developing countries. In the industrialised countries of Europe large-scale replacement of native woodlands has occurred as the consequence of the introduction of economically attractive monocultures. Remaining species-rich semi-natural woodlands are usually considered 'uneconomic' and left fragmented without further management, resulting in further depletion of variety in native woods. Semi-natural grasslands have similarly suffered from agricultural intensification. Application of fertiliser and other chemicals, reseeding, drainage and conversion to cultivation have all had major impacts on species-rich grasslands which are deleterious for wildlife.

Wetland areas come second. Belonging to the most diverse habitats, they nevertheless continue to be drained for conversion to agriculture, to be lost to development and to be disturbed by recreational and commercial activities. Many wetlands which have survived such impacts are undergoing ecological change from *eutrophication* (influx of nutrients) which often causes profound alteration of plant and animal communities.

Coastal zones, *coral reefs* and other diverse aquatic systems are also denuded as a consequence of increasing nutrient levels, pollution, 'reclamation' and other forms of degradation. Along the coasts of India, Pakistan, Sri Lanka and other countries, productive lagoons have become clogged with silt derived from the inland erosion of soil, mangroves have been stripped for firewood and estuaries affected by industrial and agricultural pollutants. In addition to the destruction of these habitats, wildlife faces further pressures from the over-exploitation of natural resources and a host of pervasive environmental influences such as acidification and climate change, which continue to pose questions about their long-term impact on global biodiversity.

Problems inherent in measuring biodiversity

For some, it might be surprising to learn that, in principle, it is not difficult to discover a new species of plant or animal (Attenborough, 1979). Biologists are certain that there are many new species yet to be discovered, mainly plants and invertebrates, but no doubt also higher organisms. However, without a reliable yardstick of current biodiversity, how can we be confident of estimates concerning rates of species extinctions or other rates of biodiversity loss? Yet, such estimates are the foundation upon which policy makers base their understanding of the global loss of biodiversity and their proposals for appropriate future environmental management.

Our brief examination of the factors which influence the evolution and coexistence of species should have made it clear that highly complex processes are involved, which are inherently difficult to measure. We find ourselves attempting to impose discrete

structures (e.g. a classification system for species and habitats) on a continuous diversity of living organisms which by its very nature does not fit into sharply delimited categories. We must also avoid the trap of measuring only those things which are easily measured and valuing only those things which exhibit immediate or obvious merit. If we are not careful, it is only what is counted that counts.

A good example here is the comparison of micro-organisms with pandas or other large appealing animals. Soil-dwelling micro-organisms play a critical role in soil formation, nutrient cycling and other necessary processes in terrestrial (including agricultural) systems. Therefore, ultimately most other terrestrial organisms, plants and through them animals, rely upon them. The extent to which the diversity of these useful organisms is being depleted is, except in very small study areas, virtually impossible to gauge. The effects of their depletion, however, can result in clearly detectable environmental problems of immediate concern. Large-scale application of fertilisers and pesticides will, at least temporarily, increase crop yields but the effects of such chemicals on soil fauna are difficult to measure and impossible to predict precisely. In the medium or long term agricultural productivity may well decline irreversibly.

So, from a practical perspective, those concerned with measuring biodiversity have no choice but to adopt a broad brush approach. Resources, such as finance, time and expertise, are unlikely ever to be available in quantities adequate to provide detailed and accurate assessment of changes in biodiversity, even in the relatively prosperous countries of the North. Technological developments such as remote sensing techniques using satellites and geographical information systems (databases that portray their

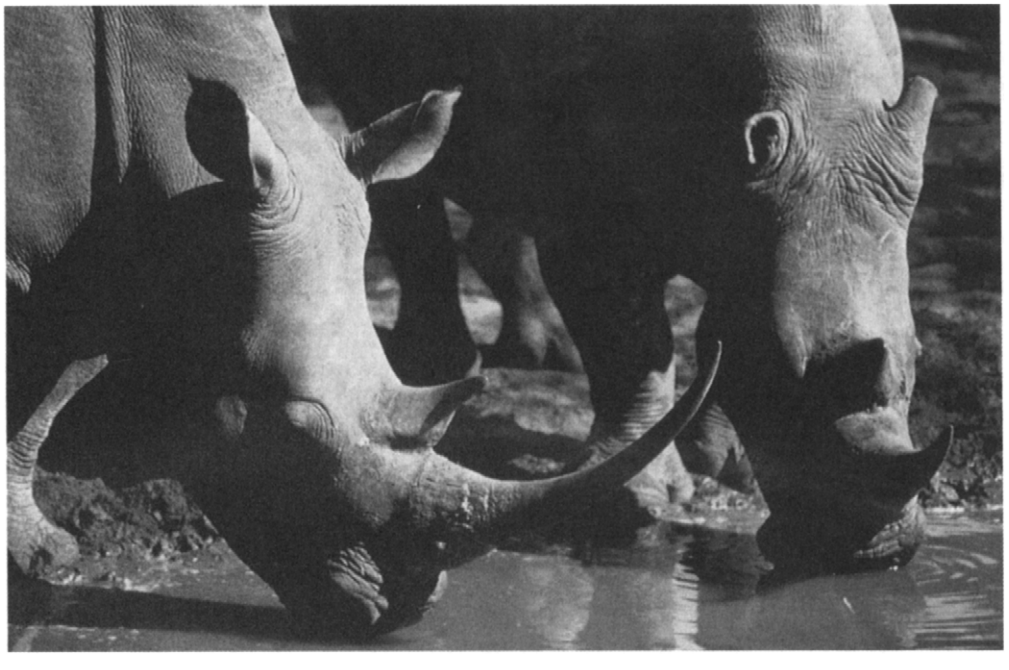

Plate 8.2 The rhinoceros, an example of an endangered species, seen here at a water hole in Natal, South Africa. Photograph by Philip Schedler/Lineair

information on electronic maps) may help in assessing, for example, loss of broadleaved woodland in a given area. But loss of area is only part of the equation. A woodland may retain a given area but changes in the structure or composition of its floristic communities may only come to light after detailed ecological survey. Such changes may come about as a consequence of deliberate forms of management but may also arise in the wake of management neglect or, in other words, as a result of entirely natural ecological processes. Ecological processes which operate in the absence of human activity may have a large impact on biodiversity. Any gardener who has prepared an area of bare soil ready for planting and left it alone for a few weeks will be aware of the speed at which natural processes can bring about change in (local) biodiversity!

There is also a practical reason for seeking only broad measurements of change. Large-scale ecological surveys may be likened to painting a large metal bridge; once completed it is necessary to start from the beginning again. Consequently, any assessment of biodiversity is likely to become out of date very quickly, probably before it is even published (or rather, if it is published). Broad assessments are more likely to appear to retain their validity for longer periods, despite perhaps being inadequate reflections of the complex processes in operation.

Monitoring is therefore affected by constraints on the actions of policy makers. There are constraints on available resources and the constraints applied by the political necessity of achieving results and responding to further demands within a relatively short time span. But information provides power. What sections of society stand to lose or gain from adequate biodiversity monitoring? Who will see and use such information and to what ends? Potential conflicts arising from possession of information need to be examined critically during the policy-making process.

Regrettably, many countries, especially those in the South, face diverse and profound social and environmental problems and it is unsurprising therefore that politicians may see biodiversity monitoring as a low priority, even if resources are available to undertake the necessary work. Yet awareness and understanding of biodiversity is essential if biological resources are to be managed in the interests of long-term economic prosperity.

8.3 The causes of biodiversity depletion

Most, if not all, of the large-scale problems associated with losses of global biodiversity are linked to human activity of one form or another, in particular the endless consumption of natural resources of both physical and biological origin. Increasing demands placed on food production systems, spiralling consumption of energy, the inevitable requirement for clean water and ceaseless consumption of resources for the production of material items combine to pose huge threats to habitats and species. In this section, I shall investigate how human activities have influenced global diversity.

The role of human activity

Clearly, human activity has been causing immense negative impacts on biodiversity. However, the influence has not been all negative. Some of the most diverse selections of species can be found in habitats which have developed partly, but critically, in

response to long-term management by humans. Examples include ancient broadleaved woodlands and species-rich semi-natural grasslands in temperate regions. The value of such habitats for diverse communities of plants and animals lies in the variety of ecological structures available. Importantly, human beings have been involved in maintaining a favourable environment for diversity whilst simultaneously exploiting resources.

Historically, human management of ecosystems has been sustainable in so far that impacts have been relatively local. Habitats were maintained to allow removal of natural products on a long-term basis. For example, exploitation of *coppice* products (woods of small trees, grown for periodic cutting) in long established woodlands was usually undertaken on a rotational basis, which only affected a small part of the wood at any given time. This resulted in a variety of coppice compartments at different stages of growth with consequent ecological opportunities for numerous plants and animals. Unfortunately, recent economic trends have now conspired to make low impact environmental management systems such as coppicing 'uneconomic'.

So, it is a mistake to believe that past human exploitation of ecosystems invariably had deleterious effects. Similarly, we should avoid the temptation of thinking that conflicts surrounding biodiversity are only new phenomena. Even during times of significantly lower population size, when lifestyles were less consumption orientated (for most people) than today, pressures to maximise resource exploitation were present. Historical records clearly show that many conflicts concerning ownership and common rights have surrounded the management of the countryside over the centuries (Rackham, 1986).

The consequences of human activity on biodiversity can be broadly divided as either *intentional* or *unintentional*, with positive and negative outcomes within each of these categories. Unintentional negative impacts on biodiversity frequently result from people's everyday activities. This problem has become more acute as people lose their direct contact with management of living resources, especially in the developed countries of the North. Most large-scale consumers of products no longer directly experience the consequences of their consumption habits. Consequently, biodiversity is often lost inadvertently, as the unintended side effect of the activities which provide benefits to people. Initially, we may be unaware of our impact on natural resources. It is only later that we will feel the effects and learn of the problems to which we have unintentionally contributed. The global applications of pesticides is a case in point (McNeely, 1992). Another example is the link between consumption of hamburgers (or other beef products) and the pressure to clear species-rich forests for conversion to cattle ranching in some areas of South America.

Intentional activities, such as direct exploitation of resources for obvious financial (or other) gain, may affect biodiversity negatively, as in the case of rainforest clearance for timber extraction. Effects may be positive too, however, as in the case of conservation management aimed at reinstating coppice management. Another example of the positive effects of intentional exploitation is the small-scale quarrying activities which were once commonplace across Britain and other European countries. Although initially there would have been some loss of existing crop or habitat, the longer term outcome frequently resulted in greater ecological opportunities for the development of

diverse plant and animal communities. Environmental harshness can contribute to wider coexistence of species and our example of a quarry offers numerous forms of environmental stress (e.g. proneness to desiccation, lack of soil, unstable substrate). Plant species and their attendant fauna which are capable of colonising such environments find that such quarries offer a sanctuary where they can avoid competition with the more vigorous species commonplace in less hostile environments. The longer term results may be demonstrably diverse communities of flora and fauna.

We also need to recognise the importance of *time* in these processes. The problems facing global biodiversity today are primarily attributable to the pace and extent of human-generated change. Relative to the total history of our planet, our own species *Homo sapiens* has been around for a very short period of time and our presence in large numbers covers an even smaller period of time. Whilst the impact of human activity on the biosphere, like the number of people itself, continues to grow exponentially, the capacity of species to adapt is limited. At present, the capacity proves largely insufficient to cope with the exponentially growing threats, resulting in the large number of extinctions now occurring.

The planet is now undergoing a human population explosion. However, growth is unevenly distributed between relatively stable populations in the developed North and rapidly increasing populations of the South. Population growth undoubtedly contributes to the pressure on natural resources everywhere but it makes life particularly difficult for the majority of people facing poverty in the South. Some indeed believe that the focus on population growth is misguided and that it has drawn attention away from the (environmental) issues which require most urgent attention (see also Chapter 4). These might include implementation of sustainable resource management, poverty alleviation measures, promotion of public health, social and economic development, land reform, reduction of resource consumption and minimisation of resulting waste.

Although population growth is greatest in the developing countries of the South, where the so-called *biodiversity 'hot spots'* are located (Mittermeier and Bowles, 1993), the populations of developed, affluent countries have the greatest impact on wildlife because of their rate and quantity of resource consumption. Waste, for instance, is a problem which is principally derived from the activities of people in developed countries. It has been estimated that the extra 57.5 million people in the North expected during the 1990s will pollute the globe more than the extra 911 million that are expected in the South (Farrow, 1994). As populations continue to rise in many areas of the South and the average environmental impact of inhabitants of the North also grows, biodiversity is under increasing pressure from both. This process of polarisation between numbers and consumption also seems set to continue, creating ever greater tensions between the North and South.

Increasing global trade

Trade is another cause of biodiversity depletion that gives rise to conflict between North and South. The international export value of particular components of a nation's biodiversity is relatively easy to quantify, at least temporarily. Many forms of biological resource have a readily attainable commercial value and for countries facing large debts and other economic, social and environmental problems, the export of such

products is highly attractive. Increasing such exports may yield short-term financial benefit but it will ultimately generate its own problems (see Box 2).

Expanding global trade is bringing ever greater threats to biodiversity but this is not restricted to problems which arise from overexploitation of a particular species or product in particular nations. More insidiously, global trade brings devastating impacts to local, sustainable management systems of biodiversity which primarily supply local needs from local ecosystems. As international economic competition grows more intense, pressures for commercial interests to keep costs down also heighten. Furthermore, as international capital movements become more widespread, investors inevitably seek out opportunities to exploit cheap resources, notably labour. This results in a two-way pressure on biodiversity.

First, habitats are converted to more 'productive' systems of agriculture (at least initially) in an attempt to gain competitive advantage. Such systems invariably mean either complete conversion (as in deforestation for commercial ranching) or conversion via application of chemicals, input of energy, introduction of non-local species or a combination of these. Second, as goods become cheaper to obtain, local industries become uncompetitive relative to those in other nations and eventually have to cease operation. Experience and knowledge used in these local sustainable systems is then lost as local people move to other, usually urban, areas in search of alternative employment.

Both these pressures can bring devastation for existing native wildlife communities and usually a simultaneous increase in unemployment, with consequent increased social and economic problems. Many economists hold the belief that an efficient agriculture is one that produces the most food for the least cost, using the smallest possible number of people. Agricultural intensification is therefore favoured. The ensuing significant reduction in the number of people employed on the land results in the socially undesirable desertion of rural areas. If a forest ecosystem on which a given community depends is clear-cut for cattle pasture that community must either import foreign or regionally made products to replace those that were lost. Local independence is lost and sustainable management may be disrupted.

Goldsmith (1993) estimates that approximately 3.1 billion people make a living from the land. If intensive agriculture continues to grow as a result of free trade measures, he believes that anything up to 2 billion of these people will become redundant. Some will inevitably move to urban slums, but the capacity for such problem areas to accommodate yet more people is limited. The only available alternative is mass migration. Inevitably, such mass movements of people attempting to cross national borders in search of biological resources which can provide the basis of their livelihood increases the scope for conflict between nations. The problem is exacerbated by rapidly growing populations in many developing countries, resulting in severe unemployment and low labour costs. This leads to the ever increasing number of (economic) refugees, as we are already witnessing.

Goldsmith and others conclude that global free trade will simultaneously ravage developing nations and impoverish and destabilise developed countries (see also Faber, 1996). However, free trade between nations and regional groups of nations is widely regarded by policy makers and economists as an unquestionable objective. They argue that the total absence of *tariff barriers* provides the conditions for the

Export of frogs from Bangladesh

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In the mid-1970s Bangladesh, along with India and Indonesia, was amongst the most important exporters of frogs' legs. The destination was primarily the US and other Western countries which were importing an incredible 6500 tonnes of frogs' legs a year. Estimates of frog numbers in Bangladesh were put at 1 billion, a massive biological resource which had successfully exploited the vast areas of paddy fields which were primarily farmed by smallholding peasants. For over ten years Bangladeshi farmers exploited these amphibians on a massive scale. By 1988 it was estimated that more than 50 million frogs a year were being exported from Bangladesh and only some 400 million frogs remained. Environmentalists recognised that the trade was not sustainable on this scale and the frog populations were facing imminent devastation.

The complexity of ecological interactions means that the consequences of wildlife exploitation are difficult to predict. Nonetheless, environmentalists pointed out that in Bangladesh's paddy fields the frogs played a key role in controlling insects, which included vectors of disease and many crop pests. Even so, the role of frogs in the nutrient cycles of these agricultural systems had not been adequately understood. Nobody, however, heeded their advice and, as frog numbers declined and pest-related problems increased, farmers looked to chemical forms of pest control to replace the biological control exerted by frogs. Between 1977 and 1989 imports of pesticides cost the country an equivalent of over 89 million US dollars. It became apparent that expenditure on chemicals was significantly outstripping the income derived from exporting frogs' legs. The government was spending some 30 million dollars a year to earn only 10 million dollars from the trade. Worse still, social problems associated with the poverty of peasants were exacerbated because traditional smallholders could no longer compete with large landholders, since the latter had access to cheaper chemicals by purchasing in bulk. The situation became so bad that smallholders were paying about 5 dollars on chemicals for every 2 dollars they made from catching 100 frogs. The wider environmental problems which this trade contributed to were incalculable, with no adequate way of estimating the impacts of pesticides on other biota, including humans.

Despite these ecological and social consequences the trade continued, driven by the Westerner's willingness to pay highly for these delicacies. Large profits were made by restaurateurs and traders but little of this found its way to the Bangladeshi smallholders. Who were the exporters of the frogs' legs who took the substantial part of the profits? According to Friends of the Earth (Vidal, 1994), they were none other than the companies which were profiting from importing chemicals. After finally realising the untenable nature of the situation and the environmental damage stemming from the actions of commercial vested interests, the Bangladeshi Government banned the export of frogs' legs. Within a short period imports of pesticide fell dramatically as frog populations started to increase. Unsurprisingly, the powerful pesticide companies soon lobbyed hard for an end to the ban.

Frogs are just one illustration of the issues involved in world trade. Countless other biological 'commodities' are exploited with little appreciation of the wider environmental consequences. Production processes and transport also exert environmental pressures. These costs are 'externalised' and effectively passed on to the people as a whole, including future generations. Neither are the wider ecological consequences of biodiversity exploitation fully appreciated, predicted or accounted for, as aptly demonstrated in the smallholders' increased need for pesticides.

optimal, and therefore most efficient, allocation of resources enabling countries to specialise in the production of commodities in which they have a comparative advantage over other countries. Not only environmentalists, though, predict the increased environmental problems which such policies seem set to bring. In many developing countries large numbers of ordinary people are poised to lose both their livelihoods and the biological resources on which they are based if the effects of free trade policy continue to grow.

As this process continues, it is important to distinguish between populations on the one hand and ruling elites on the other. Free trade may bring benefits to a select few via the increased profits available from exploitation of lower labour costs, but the net effect will be a downward trend in wages (Daly and Goodland, 1992). The principal reason for this is the rapidly increasing populations of developing countries. The result will be that workers in Northern developed countries will simultaneously face greater job insecurity and lower wages, whilst labourers in developing Southern nations will stay largely impoverished. Clearly, pressures to exploit natural resources will grow in rich and poor countries alike. In Britain and other developed countries, where species-rich habitats are reduced to a tiny fragment of the land area, many of those remaining continue to be under threat of development from commercial interests. Powerful arguments about 'job creation' meet ever more passionate pleas to conserve threatened species and habitats.

In developing countries, areas rich in biodiversity may (presently at least) be relatively extensive but the pressure to address urgent social and economic problems means that development and trade which generate international currency are highly attractive options for policy makers. Short-term 'solutions' to these economic problems, which are frequently based on the exploitation of biological resources, become more feasible as international barriers to free trade are reduced.

Chief amongst the instruments which have sought to achieve global free trade is the General Agreement on Tariffs and Trade (GATT) now replaced by the World Trade Organisation (WTO). The aim of both is to lead to global economic integration, increasing the volume of world trade by freeing it of the barriers erected by countries or regions. Goldsmith and others criticise the WTO as an unelected, uncontrolled group of international bureaucrats, identifying their detachment from the people who are likely to suffer as a consequence of their policies. However, efforts have been made by the WTO to identify ways in which trade and environment policies can be effectively integrated. What hampers such efforts is the fact that biodiversity protection will only be possible if it can be financed from economic growth. Unfortunately, economic growth depends more and more on global trade which, as we saw, is such a potent threat to biodiversity.

As attempts to foster free trade and break down tariff barriers gather pace we may expect a continuation and intensification of the deleterious consequences for biodiversity we have already witnessed. Now that movement of goods and capital occur on a scale never witnessed before, the capacity of the global natural resource base to support such activity comes increasingly into question.

8.4 Consequences of biodiversity depletion

So far we have been looking at the processes that underlie biodiversity losses. Now we shall turn our attention to the consequences of biodiversity depletion, particularly to the conflicts of interest to which they give rise. First, we shall focus on impacts on the resources themselves, then on the impacts on society.

Impacts on resources

Even a cursory examination of the values that biodiversity has for human societies will reveal the impact of its depletion. Most immediate in this respect is biodiversity's function as *foodstuffs* of both plant and animal origin, including meat, fish, vegetables, nuts, fruits, flavours and spices. The recent depletion of rice and wheat varieties, for example, has caused many ecologists to raise questions about the capacity of crops to withstand new diseases and climate change. The potential *medicinal value* of plants, both as unprocessed herbal material and as complex biochemical extracts, remains unknown without proper evaluation. Many examples are available of 'new' medicines originating from plants which had previously been considered 'expendable'. Numerous *fuel sources*, *fibres* and other natural materials can be added to the list of commercially valuable natural products.

By focusing on such single products, however, we should not forget the critical importance of diversity in the ecological processes which underpin living systems (Box 3; see also Box 2). Amongst these 'indirect' functional values we can identify many locally and regionally important roles of biodiversity, including retention of groundwater in highly variable climates, the evolution of natural pest control mechanisms and protection of coastal areas from erosional processes. However, from a human perspective the most important ecological process is *soil production* which is reliant on a multitude of different micro-organisms. As discussed in the previous section, without the proper functioning of these microecosystems terrestrial-based life, including that of agricultural systems, would be threatened.

Nations and regions experience the results of biodiversity depletion in many ways. These experiences ultimately generate conflicts of interest, particularly between the North and South. In developed countries such as the UK the vast majority of species rich semi-natural habitats have already been lost and it is now expected that underdeveloped countries should simultaneously conserve and exploit such resources. For underdeveloped nations, their remaining natural areas may be the only immediately available resource and, faced with problems of debt and internal social tensions, the pressure to exploit them is intense. Affluent nations may have the luxury of being able to care about their remaining fragments of species-rich habitats, yet poor nations, understandably, aspire to similar affluence and the trend of biodiversity depletion continues. The consequences will be further disparity of wealth, more environmental degradation and increasing tensions between North and South. Arguments that technological development and increased scientific understanding will allow appropriate measures to be taken to 'offset' the environmental problems associated with biodiversity depletion should be questioned. Technological approaches ultimately depend on a biological basis and their application and benefits are invariably not shared equitably.

3

Declining amphibian populations – a global or local problem?

Alarming declines in natural populations of amphibians have been reported in many areas of the world in recent years (Blaustein and Wake, 1990; Phillips, 1990; Hedges, 1993). The decline in amphibian populations has also become evident in the United Kingdom where populations of two of the six indigenous amphibian species have declined dramatically over recent decades (Halliday, 1995). Numbers of the crested newt (*Triturus cristatus*) and the natterjack toad (*Bufo calamita*) are now sufficiently low to warrant protection under the United Kingdom Wildlife and Countryside Act 1981 but local declines have also become apparent in more widespread species such as the common frog (*Rana temporaria*) and common toad (*Bufo bufo*). Inevitably, declines have caused considerable concern amongst herpetologists, wildlife conservationists and researchers, which has generated considerable media attention (e.g. Barnes, 1993; Privor, 1993; Reed, 1993) reflecting a wider concern amongst people who value amphibians. The problem is now seen as sufficiently serious by the International Union for the Conservation of Nature to warrant the instigation of a worldwide Task Force on Declining Amphibian Populations (Vidal, 1991), with the aim of obtaining more information about the status of the global amphibian populations and the possible causes of their decline.

A number of explanations have been suggested as possible causes of decline. Habitat loss and modification are clearly partially responsible. However, these cannot offer a complete explanation since decline has also occurred in protected areas such as nature reserves. It is thought that amphibians may be particularly susceptible to environmental change for two reasons. Firstly, as a result of the nature of their lifecycles, amphibians are potentially exposed to environmental hazards in both terrestrial and aquatic habitats. Additionally, a soft permeable skin may make them particularly vulnerable to pollutants (Cooke, 1981). For these reasons some scientists believe amphibians may provide useful *bio-indicators* of environmental change, providing early evidence of global change. Other herpetologists believe that the scale of 'natural' fluctuations inherent in amphibian populations precludes their use as environmental indicators (Barnes and Halliday, 1993). One thing is certain: evidence (albeit often anecdotal in nature) continues to arise which confirms that many amphibian populations are in a long-term process of decline.

Part of the problem concerning the quantification of declining amphibian populations lies in the shortage of long-term monitoring studies in defined study areas. Long-term studies of field populations of amphibians are rare (Pechmann *et al.*, 1991), a situation which needs to be rectified if a proper assessment of the extent of amphibian decline is to be made and the causative factors understood. This paucity of long-term information about amphibians also highlights a more general problem for biodiversity managers attempting to evaluate population changes and their causes. Where information is available it can still be extremely difficult to establish cause and effect. A comparative survey of over 120 amphibian breeding habitats (ponds) in Milton Keynes showed that approximately one-third of these habitats had been lost over a ten-year period (1984–94) of development in the city (Barnes and Halliday, submitted). Despite this loss of habitat, one species of amphibian was found in a greater proportion of the remaining ponds, although populations of other species were apparently in severe decline presumably as a consequence (partially at least) of reduced habitat availability.

Impacts on society

Persistent and debilitating international debt, increasing global trade, rapidly growing populations in underdeveloped nations and intense patterns of consumption in developed countries continue to conspire to place ever greater pressures on global biodiversity. Such pressures may be expressed as social and political problems both within and between countries and the scope for local, regional and international conflicts consequently heightens. Against a background of these tensions, the role of biodiversity has become central, primarily because it provides the natural resource base of ecological support systems which underpin the coexistence of communities, nations and ultimately regions.

Some observers make the important point that biodiversity has a critical role to play in the maintenance of global political stability, a concept termed by some as *ecosecurity* (Mittermeier and Bowles, 1993). In developing countries, loss of biodiversity causes direct hardship to local people. Shortages of fuelwood, food or other biological products cause social and economic difficulties which may initially be localised but gradually spread and coalesce. As people move, searching to fulfil their basic needs, the political impact of biodiversity loss is felt across wider and wider areas. It is not difficult to see that such problems can soon spread across national barriers which in turn creates greater social tensions and scope for conflict. If not adequately addressed, relatively small-scale degradation can, through a feedback process, result in national and even regional conflicts.

In addition to the social and economic pressures already recognised, the scope for international conflict has been increased as a consequence of environmental trends which are physico-chemical in nature and global in scale. Acidification of surface waters, atmospheric pollution and widespread habitat loss add further unquantifiable environmental stresses on biodiversity in all parts of the world. The extent to which these phenomena are responsible for species extinction or the global decline of populations of plants and animals remains a central topic of much research and considerable speculation. If we are unsure of the scale of environmental problems and the loss of biodiversity associated with them, how can we be sure of the scale needed for the most appropriate policy response?

Attempting to separate the extent to which global phenomena (e.g. acidification) are responsible for population decline as opposed to local causative changes can be extremely problematic. However, without such an evaluation it is obviously difficult to establish international agreement about what (if any) concerted action is required. With this in mind, I will now turn to an investigation of possible solutions to the biodiversity loss problem.

8.5 Solutions to biodiversity depletion

Having recognised the central role that humanity plays in the development of biodiversity and its loss and having surveyed what the consequences of the losses are, it is appropriate to move on to consider *biodiversity management*. The question to be solved is, how can we reverse current trends of habitat loss and species extinction? In

an attempt to answer this question, I shall first look at the possible role of the concept of sustainable management, before moving on to explore two important areas of international policy development which have evolved recently in an attempt to address the need for a collaborative approach to biodiversity management. At a global level the Earth Summit was an attempt to achieve a collaborative approach to the management of biodiversity. Similarly, the European Community has attempted such management at the regional level.

Sustainable management of ecosystems

The principal problem with the concept of *sustainable management* is the difficulty of defining it in practical and operational terms. The term 'sustainable' is likely to mean different things to different people but the idea of continuation over prolonged time periods is a central one, if insufficient on its own. We need, somehow, to include an element above and beyond purely existing (at least for human beings) and to accept that a definition for sustainability is probably only possible relative to each particular circumstance. The role of management, however, in sustainability is critically important. It is a common misconception that wildlife can be effectively conserved by merely leaving it alone and erecting barriers between habitats and external pressures. Unfortunately it is rarely that simple and in many situations diverse habitats can only be effectively conserved by active management, both within and across ecosystems. It is necessary to recognise that no ecosystem exists in complete isolation and, in some ways, the notion of an ecosystem is inadequate in that it implies separation and self-contained regenerative capacities which are not always inherent. It therefore becomes apparent that effective management of biodiversity frequently requires a transnational perspective, highlighting the need for international policy and co-operation (but see Box 4).

Central to the theme of sustainable management of biodiversity is the concept of *carrying capacity* or, to put it in a more familiar way, *living within our means*. Intuitively it is easy to see that the potential for exploitation within a given environment is limited by its capacity for ecological production. It is possible to extend this concept to a global dimension and estimate the scope for the Earth's capacity to support increased human numbers and economic activity (Daly, 1992). Such analyses are

4

Sustainable management by indigenous people

Interestingly, it is the indigenous peoples of developing countries in the South which offer the most convincing examples of low impact, long-term sustainable living and biodiversity management. It is informative to note that in some sectors indigenous peoples are often portrayed as 'primitive' with cultures in need of 'development'. How did such images arise and whose interests do they serve? Here we should briefly note that development may imply new markets (or consumers) and potentially cheap supplies of natural resources, including biodiversity in a variety of forms.

complex and necessarily based on many assumptions but they prove valuable in that they highlight the essentially limited nature of ecosystems on a global scale.

A practical demonstration of this can be observed when grasslands are overgrazed. A small paddock may provide adequate grazing for (say) three horses on a long-term basis. Addition of more animals will soon lead to overgrazing with consequent problems such as damage to flora due to the intensity of grazing or compaction of soil. Ultimately this might lead to severe deterioration of the grassland; possibly the grassland may lose its capacity to support any animals at all. In this example, the carrying capacity of the paddock would obviously depend on other factors beside density of grazing animals, such as composition of floristic communities, soil type, mineral status, size of grazing animals and external factors such as weather. The factors involved in this simple example demonstrate the potential for the complexity involved in sustainable biodiversity management. The implicit core idea, however, is that systems must be managed (or exploited) within, not beyond, their carrying capacity.

The quest for sustainability in the management of global biodiversity, like sustainable management of other planetary resources, is now confronting policy makers everywhere. Whilst it is clear that the practicalities of sustainable management are dependent upon the details of each particular situation it may be possible to recognise general approaches and characteristics which are widely applicable. What are the characteristics of such approaches?

Firstly and critically, there must be adequate natural resources available. This might be expressed in area, extent, size of population, diversity of species or a variety of other biological characteristics. Having recognised the resource at our 'disposal', there is a need to engage appropriate expertise in the management process. Recruitment should not only be directed to persons with skills and knowledge from formal qualification, but also (and critically) to those with expertise gained from long-term contact with, and use of, diverse ecosystems (e.g. the local indigenous peoples). Furthermore, the desire to maximise exploitation needs to be tempered with wisdom, realism and a longer term perspective of sustainability. Ideally we might hope that such guidance could come from policy makers who have based their decisions on adequate research and well-informed advice! Finally, the necessary social and political structures for resolving any conflicts, which would inevitably arise, need to be in place to ensure outcomes which are seen as fair and appropriate.

In conclusion, sustainability needs to be implemented rather than just seen as a convincing theoretical objective. The urgent problems facing biodiversity require solutions which are achievable by ordinary people in all nations. It is becoming clearer that biodiversity plays a critical role in global processes including climate regulation, watershed protection and sequestration of carbon. Policy makers confronted with the breakdown of these systems need to orientate policies so that practical actions for sustainable biodiversity management can become part of the daily experience of most, if not all, people.

Recent international policy developments

During the last ten years biodiversity has been the subject of increasing international attention and this expressed itself most notably through the gathering of representatives of over 160 nations at the Rio Earth Summit in 1992. After decades of relative

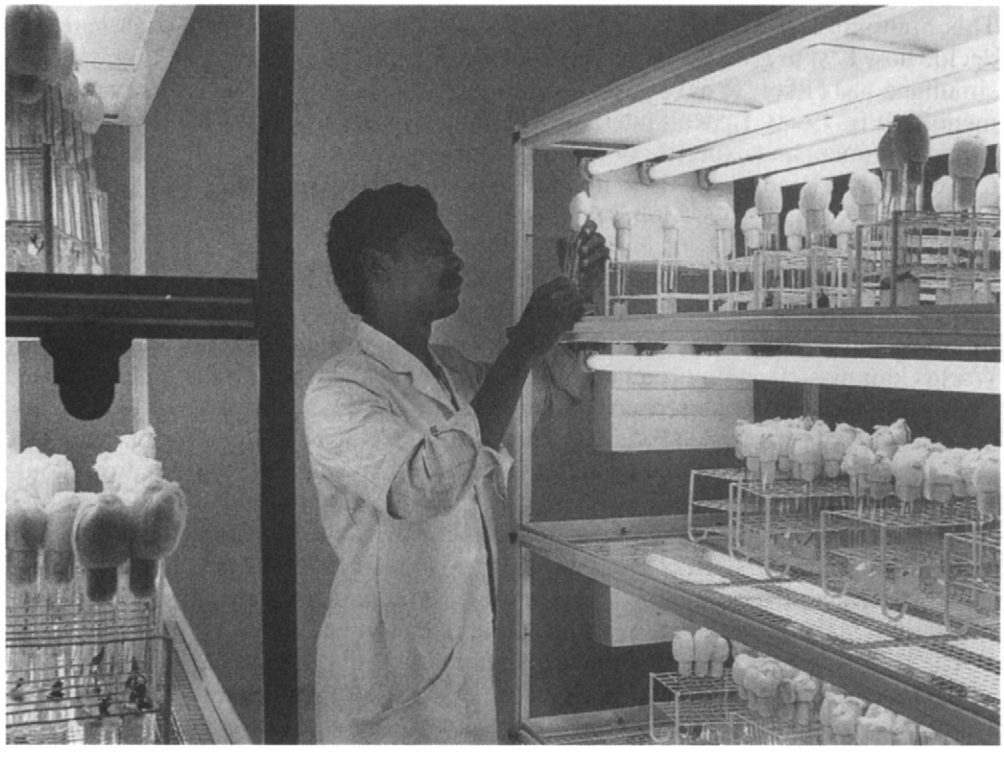

Plate 8.3 A scientist working in the growth room for mangrove clones at the M.S. Swaminathan Research Foundation in Madras, India. The foundation conducts research into methods for promoting sustainable agriculture and marine biology, including, for example, the restoration of coastal mangrove forests. Photo: Heldur Netocny/Lineair

obscurity, the biodiversity issue began to gain momentum. At first, it was confined mainly to biologists with a professional interest in conservation issues. Later it became the concern of increasingly large numbers of local people who are on the 'frontline' of habitat destruction and witness first hand the reality of biodiversity loss. As the biologists came to influence larger sectors of the scientific and professional community and the group of local people grew rapidly in size, policy makers became more aware of the problems facing biodiversity and of the need to address them. This process culminated in wide-scale support for the Convention on Biological Diversity at Rio. A number of signatory countries attempted to put policy into action quickly. Ironically, much of the international attention which focused on the convention during the Summit and immediately after arose as a result of the initial unwillingness of the United States to sign the convention.

The convention requires each contracting party to:

> ... develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity, or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in the Convention relevant to the Contracting Party concerned. (Article 6A)

This highlights the role of each individual signatory state, allowing each nation to decide how best to go about implementing the obligations of the convention, which is simultaneously likely to have positive and negative outcomes for biodiversity management (RSPB, 1994). Like all international initiatives, its success will fully depend on the commitment and expertise of the individual signatories. Although the new Global Convention on Biodiversity is an important international policy instrument, inevitably it does not contain everything that conservationists would like to see included (Holdgate, 1992).

Some consider that the financial resources available to implement these obligations will be inadequate with available finance being administered through the Global Environment Facility. This facility for administering resources originated when the World Commission on Environment and Development (better known as the Brundtland Commission) identified a serious lack of funding for projects that directly addressed biodiversity conservation or sought to improve the resource base for development. One of the recommendations of the Brundtland Commission was that consideration should be given to the development of a special banking programme or 'facility' to fund conservation projects. Following this recommendation, the United Nations Development Programme (UNDP) commissioned the World Resources Institute to undertake a study to evaluate the situation and propose new recommendations for the financing of international conservation (World Resources Institute, 1989).

The report suggested the creation of an international environmental facility. Its brief would be to identify conservation projects and provide assistance to their realisation. The facility would act as an intermediary between the numerous organisations and agencies involved in large-scale international projects. Chief amongst these agencies are the non-governmental organisations (NGOs) usually responsible for implementing the work, aid organisations, multilateral development banks which allocate finance, intergovernmental agencies and government representatives. There are inevitably complex and contentious issues associated with international conservation projects, which involve diverse political interests and aspirations. But it was hoped, at least, that such a facility would facilitate real progress. A year later, in 1987, following a proposal from the German and French governments, a Global Environmental Facility was created. Two principal agencies are responsible for its implementation: the World Bank and the United Nations Development Programme, with the United Nations Environment Programme serving as secretariat for an advisory panel to the Facility's Scientific and Technical Advisory Panel.

Conservation of biodiversity was one of the four main environmental issues which were the remit of the Global Environmental Facility (the others being reducing the quantity of ozone-depleting emissions, addressing global climate change and protecting international waterways; see also Chapter 7). The allocation for biodiversity conservation was approximately 40% of the total of 1.3 billion US dollars, which is significant when compared to previous allocations to international conservation projects. In fact, this is the largest commitment ever made to this issue. Of course, it remains to be seen how effectively it is used. The political complexity of the role of the facility was further compounded when it was designated the interim financial mechanism for the Biodiversity Convention. Nevertheless, considerable hope and expectation were generated in some quarters of the conservation community as a consequence of

the scale of support now available for biodiversity protection. Others, with past experience of working with the agencies responsible for its implementation, may be less optimistic. Whatever the perspective, there are a number of important questions surrounding the Environmental Facility: who will decide policy, who will oversee its implementation, and for whose benefit will these projects be undertaken?

There is a clear challenge to all international and national institutions concerned with biodiversity protection and management to work together to make the objectives of the convention become reality. Given the disparity of political viewpoints and the inequalities in economic prosperity amongst signatory nations, the challenge is daunting. We can only hope that the immense problems facing biodiversity and the ultimate consequences for all nations will be a sufficiently powerful incentive for policy makers to overcome these differences.

If plans for a concerted and effective global response to the biodiversity issue are considered too problematic, can adequate policy measures be implemented on a regional basis? Over the last 20 years or so, a range of measures have been agreed by the member states of what initially was called the European Community and later became the European Union. In the main, these measures initially developed in response to the need to address pollution issues of air, water and land, which inevitably involved transnational boundary considerations. Whilst these measures indirectly have implications for EU biodiversity, there have also been a number of measures agreed to deal explicitly with the protection and management of European flora and fauna. The environmental policy of the EU has developed in response to several main objectives which centred on the protection of human health, maintenance of acceptable environmental quality, promotion of rational natural resource use and fostering international co-operation (Department of the Environment, 1992).

The original principal concern of the European Commission was the promotion of free trade in the region and there was initially no specific mention of environmental issues, including biodiversity. It was not until 1987 that the Single European Act gave the EU's environmental policy explicit legal backing for the first time. Measures to conserve wildlife and landscapes were, until recently, taken at the national level of each member state but EU policy concerning biodiversity is now increasing in importance. Policies originally orientated towards the protection of particular species have, through recent legislation, shifted in emphasis to address the conservation of important habitats and endangered species generally. There are a number of important measures which have been directly aimed at the protection and appropriate management of European biodiversity. The Birds Directive, implemented in 1979, was the first piece of major EU legislation dealing specifically with an aspect of biodiversity. It aimed to provide adequate protection for all birds and in particular to control the hunting and killing of wild birds, as well as outlawing the taking of eggs from nests. The directive recognised the critical importance of habitat availability and requires the provision of sufficient area and diversity of habitat to support bird populations.

The CITES Regulation aims to ensure that the Convention on International Trade in Endangered Species is uniformly applied across the Union. The convention utilises a licensing system to attempt to regulate or prohibit trade in species which have been identified as endangered. It extends its cover to products which are derived from listed species.

The Habitats Directive was published in 1992. It addresses the conservation of natural habitats and wild flora and fauna in EU countries (Faulks, 1994). Building on the measures taken in the Birds Directive, it outlines a new system for creating an ecological network of special areas of conservation in Europe ('Natura 2000'). The network comprises a range of important and threatened habitats including those already designated under the Birds Directive. In addition to habitat protection measures, a number of species of plant and animal are identified as being of Union-wide interest and are afforded explicit protection.

Finally, we can recognise a measure which, rather than implementing protection for a particular species or habitat, seeks to ensure that adequate appraisal of biodiversity is undertaken prior to development work, together with assessments of their potential impacts. The Environmental Impact Assessment Directive imposes a legal requirement for developers engaged in major projects to commission and publish statements concerning the environmental impacts of the proposed work. Examples of such projects include power stations, motorways and sites used for storage of toxic wastes. The statement must evaluate the potential effects on biodiversity directly, as well as wider impacts on landscapes, water quality and other physico-chemical components of the environment. The directive also explicitly recognises the critical importance of the relationship between living things and the habitat they need in order to survive.

We should also note that the EU played a key role during the negotiations at the Earth Summit for the development of the Convention on Biodiversity, highlighting the potential value of regional co-operation on the world stage. The role of EU measures continues to increase in scope and complexity in an attempt to implement appropriate regional responses to environmental management issues. Directives, regulations and other measures become increasingly potent forces for the protection and appropriate utilisation of biodiversity in member states. It is therefore important to question the extent to which these have (so far) been successful. We have already recognised that pollution and other environmental problems frequently fail to respect national boundaries and, consequently, an EU-wide approach should be considered an essential part of our attempts to provide solutions. Conversely, we must also recognise the validity of the argument that imposing large-scale regional solutions will always fail to be a completely adequate response. Such solutions can never be completely appropriate for all biodiversity which is inevitably placed in a context of different social and environmental pressures in each individual country.

Integrating conservation with economics

Many conservation biologists believe that most of the economic analyses of biodiversity which have been conducted so far focus too heavily on the foreign exchange value of biological resources (Mittermeier and Bowles, 1993). I will argue that the full potential of ecosystems and their uses to humanity have been inadequately explored. Indeed, a recognition of the wider values of natural resources would lift many of the threats currently facing biodiversity (see Boxes 5 and 6). I will also argue in favour of the widely held belief among environmentalists that the existing emphasis on the short-term *trade* value of biodiversity needs to change quickly and fundamentally if biological resources are to be protected adequately in the future.

5 The wider economic values of biodiversity

Bennet and Reynolds (1993) examined the economic and employment value of selected tropical forest areas (mangroves) in Sarawak, Malaysia. In addition to the conservation arguments often advocated for rainforest protection, they identified strong economic incentives for conserving these areas, in particular exploitation of fisheries, timber production, tourism potential and employment relating to these forms of commercial activity. The important role of mangroves as coastal protection areas also needs to be taken into account since highly expensive civil engineering works would be necessary to avoid coastal erosion, flooding and other environmental problems.

Attempting to convert the mangrove areas to other economic uses such as aquaculture or oil palm plantations have been suggested, but the researchers predict that this would result in decreased revenues if all factors were taken into consideration. The area is recognised as an important refuge for flora and fauna in Sarawak but it is the economic, employment and coastal protection values which may offer the most compelling evidence to planners for its protection and appropriate management. Such factors, which are in addition to the species conservation arguments, are likely to be more effective agents for the protection of the mangroves.

One form of recognition of the wide value of ecosystems are the so-called *debt for Nature swaps*. These are agreements under which a developing country's debt is effectively written off in exchange for a commitment to protect some of its biodiversity assets. Such a transaction may have the dual benefits of reducing the debt burden of impoverished countries and simultaneously promoting wildlife conservation. It is clear that such deals offer considerable potential as the basis of international agreements for the preservation of global commons, including rainforests and other biodiversity 'hot spots'.

There have been a number of large-scale debt for Nature swaps involving developing countries such as Ecuador, the Philippines and Costa Rica. The first occurred in Bolivia in 1987 when Conservation International bought $650,000 worth of Bolivian debt from Citicorp Bank at a highly discounted price. The debt was then 'swapped' in exchange for promises from the Bolivian government to conserve an area of some 9 million hectares of rainforest. In addition, Bolivia agreed to set up a trust fund to provide local currency to finance the administration of the new reserve. Possession of the land is still retained by the Bolivian government, although where title deeds have been recognised, indigenous Chimane Indians have regained some ownership rights.

Critics of these deals argue that the swaps have the unwanted side effect of legitimising what was illegal or of doubtful legitimacy to begin with. First, debt for Nature swaps do not address underlying problems concerning current models of development in many poor countries of the South. Reducing some of the debt burden, so the argument goes, will only open the door for further loans to be taken on in the future. This may result in new development projects of the type which have already caused destruction of biodiversity. Another argument levelled at these deals concerns the 'legitimacy' of the original loans. Some environmental groups point out that these

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Example of biodiversity products proving economically viable

Munthali and Mughogho (1992) explore the economic viability of two forms of wildlife-based enterprise in Malawi, namely beekeeping and caterpillar utilisation, and consider their value in relation to conventional forms of the country's agriculture (e.g. maize, beans and groundnuts). These latter forms of management have depleted biodiversity outside protected areas and have not, generally, been effective in raising the living standards of most rural people.

Although a significant part of Malawi's biodiversity is protected in national parks and other designated reserves, local people have developed negative attitudes to wildlife as a consequence of their removal from these areas and denial of access to protected natural resources. Utilisation of honey and caterpillars by rural people in Kasungu National Park offers an example of how economically advantageous activity can be integrated with conservation management in protected areas, thus fostering more positive attitudes to biodiversity. The study suggests that there are strong economic incentives for rural people to engage in wildlife management to provide additional forms of income to those gained from subsistence agriculture alone. The researchers argue that this could be most effectively achieved if the Malawi Department of National Parks and Wildlife introduced economic incentives for the integration of biological conservation with economic development.

were often incurred by unelected regimes which resulted in financial benefits for ruling elites but left many poor people facing severe environmental degradation. As such, these original loans may be considered 'immoral' and therefore have no place in further transactions which may again bring benefits to large financial institutions.

If debt for Nature swaps involve land which has traditionally been used by indigenous tribal peoples there are likely to be serious problems if these people seek to re-establish their own rights to the land. As these areas become the focal points of intergovernmental dealings in the course of which commitments are made to future management strategies, ownership claims by local people may be highly jeopardised. Finally, there may be important internal economic consequences for poor countries which have committed themselves to paying significant funds in local currency for the management and administration of new reserves. This can cause additional inflationary pressure in economies which are often already suffering very high inflation and where currencies may be facing severe difficulties on international markets.

8.6 The future for biodiversity management

Some observers believe that the only appropriate way forward to safeguard adequate reserves of biodiversity is to set priorities which focus heavily on the protection of those areas which are considered richest in species and under greatest immediate threat. Methods for the setting of such priorities have already been developed and

commonly quoted amongst these is the *threatened hot spots approach* (e.g. Myers, 1988). This approach focuses mainly on terrestrial habitats, in particular tropical rainforests, as these are considered the richest ecological systems. The logic of such an approach may seem convincing, although this is inevitably a reactionary rather than proactive course of action. Constant re-evaluating of which areas are richest or most threatened and targeting the modest resources available to address their problems may alleviate some of the worst symptoms of a problem in the short term. Essentially, however, it is a frustrating and never-ending process because it fails to address the fundamental reasons for biodiversity loss. There can be no argument that resources available for biodiversity conservation (whether modest or generous) should be targeted after a process of rational appraisal and priority setting. However, given the social and economic causes of the problem, should we not attempt to deal with these causes at the same time? Pessimists would argue that the ever more desperate attempts to safeguard priority areas of species-rich habitat, which are becoming ever more isolated and remain under continuous threat, may be likened to rearranging deck chairs on a sinking ship.

A set of more overarching approaches have been suggested by McNeely (1992) and others. They stress the need to integrate a number of lines of action which can be succinctly expressed as a *'Five-I' approach*: *Investigation*, *Information*, *Incentives*, *Integration* and *International support*. The first two of these go hand in hand with appropriate research and investigation, generating the information necessary for informed decision making. The use of economic incentives to provide support and pressure in favour of biodiversity conservation will help ensure that ordinary people can play a positive role.

The need for integration stresses the importance of cross-disciplinary expertise. In this chapter we have examined some of the social, economic and ecological elements involved in biodiversity depletion and if policy is to provide effective solutions, it must necessarily be based on an understanding of all such relevant factors. Finally, as we have also seen, the international dimension of environmental problems surrounding biodiversity will inevitably require international co-operation if they are to be adequately addressed. Again, the 'Five-I' approach offers appeal not least because it advocates a need for coherence and integration. In the end, however, whilst being of high theoretical value, it needs careful interpretation in different circumstances and conversion to appropriate action on the ground. A critical step is the development and introduction of new accounting systems which attempt to determine the full value of biodiversity and its environmental functions or the full costs incurred when habitats and species are lost (Aylward and Barbier, 1992). This will not be easy, not least because of the highly complex nature of biodiversity which makes evaluation difficult. But it will also be difficult because conflicts are bound to arise with the powerful vested interests whose continuing benefit and prosperity lie in the status quo.