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Preface

Biodiversity provides the basis for life on earth, including human life, and is the key to safeguarding the wealth of the world for future generations. By conserving biodiversity, we not only ensure that our surroundings are richer and more diverse, but we secure the resources that will continue to provide improvements in the quality of human life. Far from competing with the security of food and other supplies of natural products, through its variety biodiversity is our best guarantee of protecting and enhancing our agriculture, health and leisure pursuits. But the whole range of the extraordinarily rich and diverse ecological inheritance of the tropical regions is now in jeopardy.

Although conservation has not yet succeeded in bringing about many favourable changes in the environment, it has had a beneficial influence in government and other institutions. The state of knowledge, access to expertise and awareness of the problems and how to deal with them, has been greatly enhanced over the past few decades. We are in a far better positions to make real strides towards conserving biodiversity than ever before. This publication provides a broad overview of the current state of biodiversity conservation and management in countries all around the world with an emphasis on Africa. It is particularly aimed at field practitioners and those with responsibility for designing and implementing biodiversity conservation projects and programmes, either within protected areas or in the wider landscape.

The first chapter begins by describing what is meant by the term biodiversity, providing a description of its main features, and a brief account of its distribution within the landscape and more widely across different ecosystems. It also indicates some of the principal values and uses of biodiversity. The second chapter introduces a framework for understanding the immediate threats to biodiversity, distinguishing between habitat loss, over-harvesting, the introduction of exotic or alien species, and pollution. It examines the principal means by which conservation attempts to address these threats, and discusses a number of impediments and constraints on the implementation of these approaches. The third chapter describes some of the ways in which conservation practice has developed over the past few decades. Among the issues discussed are biodiversity and conflict, park management, ecosystem management, and funding for biodiversity.

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Chapter 1: Introduction to Biodiversity

Biodiversity has taken centre stage in the planning and strategy of environmental and conservation bodies throughout the world. The term incorporates biological, geographical and human attributes which deserve some explanation before considering how biodiversity can be conserved. This chapter explores the principal features of biodiversity including the main components of the living world that it encompasses, how it is measured, where it is found and why it has a variety of associated values. In the following chapter, we consider the threats to biodiversity and the reasons for its decline.

What is Biodiversity?

The term biodiversity is a contraction of *biological diversity* and refers to the number and variety of living organisms in the world. It has its roots in the conservation movement of the 1960s and 70s which became increasingly aware of the importance of conserving complex natural habitats that supported a vast array of species. As advances were made in our understanding of the degree of genetic variation that can be found within even a single species, so the concept of conserving all biological diversity emerged, gaining widespread popularity in the late 1980s.

Management of biodiversity requires measurement, and because the term encompasses such a wide range of biological phenomena, it has become customary to define biodiversity in terms of genes, species and ecosystems, and to make comparisons based on quantitative values ascribed to one or more of these levels. So for example, the Convention on Biological Diversity defines biodiversity as "*the variability among living organisms from all sources including 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"*.

Biodiversity incorporates the ideas of distinctiveness at every level of life from molecules, to cells, to individuals, to species, to assemblages of species and to ecosystems. This distinctiveness derives from the influences of very many genes, their interactions with one-another and with the physical world around us.

Genetic diversity

A close look at the same species in different locations usually reveals variation in aspects of size, colour and shape. For example, spotted cats often vary in shading or in the character and density of spots in different parts of their range. Where the different forms are both distinctive and geographically separate, a number of subspecies may be recognised all belonging to the same species.

Sometimes two or more distinctive forms are found within the same area, such polymorphisms are caused by alternative genes that occupy the same position on the chromosome. They are quite common in the plant and animal kingdoms: banding pattern on snails (*Cepaea nemoralis*), colour pattern on *Heliconius* butterflies, the melanic and common

form of leopard (*Panthera pardus*) and the shape of the human ear lobe are examples.

Much of this genetic variation within species can only be assessed at the molecular level. Surveys using laboratory techniques, such as electrophoresis, have found that somewhere between 10 and 50 per cent of genes are polymorphic in the majority of species. The pool of genetic variation within and between populations of the same species represents its genetic diversity.

Species diversity

Biodiversity is frequently assessed in terms of *species richness* which is simply the number of species in a site or habitat or *species diversity* which is a similar measure but one giving greater weight to those species that are more abundant. Discussions of global diversity, for example, often centre on different estimates of the total number of species in different taxonomic groups.

Whilst species richness is relatively easy to measure, a simple count fails to reveal how unique a particular species might be. Species that have evolved in isolation or persisted as living fossils may carry many distinctive inherited traits that make them biologically unique. The ginkgo tree of China, also known as the Maidenhair tree, is the only living representative of a large ancient order of conifer-like trees. The two living species of coelacanth are possibly the sole remaining representatives of a once widespread family of fish.

A more comprehensive view of the biodiversity at a site may be obtained by looking at the variety of higher taxa (i.e. the number of genera, families and orders represented) in addition to the species richness.

Ecosystem diversity

The main biological properties of an ecosystem are to do with the energy source and food chain. In broad terms, the latter comprises four main components: primary producers (algae and higher plants), primary consumers (herbivores and frugivores), secondary consumers (predators) and decomposers. The smallest ecosystems are geographically discrete and biologically unique. Some large limestone caves have their own energy source of bat guano and dead bats and characteristic consumers such as beetles, crickets, spiders, centipedes and snakes. Deep sea hydrothermal vents are another example with sulphur-oxidising bacteria, tube worms, bivalve molluscs and gastropods. Ecosystems associated with wetlands, such as lakes and marshlands, are still relatively discrete and easily distinguishable.

In the wider landscape, ecosystems are recognisable by some degree of uniformity in the primary producers, such as grasses, shrubs and trees, which may in turn be reflected in unique communities of organisms at higher trophic levels, such as herbivores and their predators. Vegetation and physical features of the landscape may combine to determine clear ecosystem boundaries, as with a range of wooded hills. Occasionally a range of migratory animals is used to impose a boundary on the vegetation, as in the Serengeti-Mara ecosystem of Tanzania and Kenya, which is defined by the movements of wildebeest, zebra and gazelle. Ecosystem boundaries are also sometimes determined by the issue or problem that is being addressed. Pollution of river systems or the harvest of commercial fish species may give rise

to management at the ecosystem level.

Because of their diverse character, there is no single system of classification for ecosystems and it is thus difficult in practice to assess and contrast ecosystem diversity in different parts of the world. Various global classifications have been attempted using predominantly vegetation classifications, including one based on ecofloristic zones and another on ecoregions. Both take account of some abiotic factors, including localised features of soil, geomorphology and climate. For example, the Northern Andean Montane Forests ecoregion encompasses the exceptionally rich plant and animal life of the submontane and montane forests of the northern Andes of South America. The Tibetan Plateau Steppe ecoregion comprises the high plateau north of the Himalayas that sits at the confluence of the Palearctic and Oriental zoogeographical realms. It contains one of the most complex alpine communities on Earth.

Where is Biodiversity?

The diversity of life is revealed as much by the differences we find from place to place, as in the variety we find at any one place and hence a more complete answer to the question, "what is biodiversity?", can be elicited by a second question: "where is biodiversity?" At any given location, such as within a one hectare plot inside a protected area, the diversity of living organisms can be estimated from the number of species and their abundance within that plot.

The most commonly used measure for this estimation is known as *alpha-diversity*. Over time the species inhabiting a particular location may change as a result of migration, colonisation and local extinction, so that repeated measurement is required to more accurately estimate its diversity. As a general rule, *alpha-diversity* is higher in the following situations: moister habitats, such as cloud or rain forests; lower altitudes, for instance along river floodplains; nearer to the equator; and in undisturbed or old-growth habitats. But there are plenty of exceptions: ungulates (Artiodactyla and Perissodactyla) are more diverse in the African savannas than in the moist forests; moths (Lepidoptera) of South-East Asia are most diverse at mid-altitude; and the group of fig insects (Chalcidoidea) loses species towards the tropics in Africa.

If one measures the abundance of species present at intervals along a transect, it will be noticed that eventually some species become rarer and disappear altogether, whilst other species appear for the first time. This turnover of species from place to place can itself be measured, and is known as *beta-diversity*. A high *beta-diversity* is typically found in wet tropical regions, in areas with steep gradients in rainfall and altitude, and in areas where many habitat types are crowded together.

Some locations are truly exceptional in the number of unique species living within them. Such biodiversity "hot spots" often differ from surrounding areas in that they have experienced constant climatic conditions over many thousands of years. One example is the broken belt of ancient rainforest in south-east Nigeria, west Cameroun and Gabon which remained as a forest refuge during arid periods when the surrounding lands were covered in savanna vegetation. Other hot spots may offer a steep gradient in rainfall or temperature,

enabling species to easily escape unfavourable conditions, brought on by a changing climate. The highlands of western Angola offer one such example with their steep interface between extremes of climate and vegetation. Both factors (steep gradients and ancient refuges) may be present simultaneously as is the case for the remarkably rich and endemic flora and fauna of the Cape, at Africa's southern tip.

Values and Uses of Biodiversity

Current land use practices reflect the economic priorities of powerful interested parties, including governments, development banks and companies, private land holders, farmers and others. But it is now widely understood that the costs of depleting biodiversity are seldom factored into the accounts when decisions are made on land development. This may be partly because the value of biodiversity is not yet sufficiently explicit and partly because the benefits arising from the utilisation of biodiversity have been acquired in the past without recompense. It is possible to distinguish several properties of biodiversity which confer value in quite different ways.

Food

A great variety of both vertebrates and invertebrate species are included in the world=s food supply. The most conspicuous terrestrial source are the large mammals, particularly ungulates, primates and large rodents, although edentates (anteaters and armadillos) and fruit bats are also considered a delicacy in some locations. Meat and eggs are provided by many birds, especially colonial nesting seabirds, and also by the large reptiles, such as monitor lizards, iguanas and turtles. There are 1000 commercial fish species but many others are also eaten on a subsistence basis. Amongst the invertebrates, marine and freshwater molluscs are eaten in large quantities, as is the giant African land snail in West Africa. Insects are an important supplementary food in many regions, especially those that are easily gathered, such as termites, locusts and other grasshoppers, crickets, butterflies and moths (mostly as larvae), large beetles (both as adults and larvae), and the hymenoptera (bees and wasps, which are often eaten in the immature stages, and ants).

About 7000 (2.6 %) of all plant species have been collected or cultivated for human consumption although only 200 species of food plant make up the major crops. About a dozen of these - bananas, beans, casava, maize, millet, potatoes, rice, sorghum, soya, sugarcane, sweet potatoes and wheat - make up some 75 per cent of the global intake of plant-derived calories. Much modern plant breeding is directed toward developing varieties that respond to fertiliser so as to yield more per hectare than local varieties. It may also assume that pesticides and irrigation are available. The trend is towards smaller numbers of widely adapted varieties - a gain for production and a loss for diversity.

The continuing productivity of high yield varieties of food plant is underpinned by a reservoir of genes present in a much larger number of related wild species. For instance, centres of diversity for barley, castor bean, chickpea, coffee, linseed, sorghum and wheat are found in Ethiopia which is recognised as one of the world=s eight major centres of crop plant diversity. These wild genes can be incorporated through plant breeding programmes or direct

genetic exchange to confer resistance to disease and pests. As a rough rule of thumb, new forms of disease resistance must be bred into a commercial crop every 5-15 years to keep one step ahead of the evolution and spread of new pests and pathogens.

Intensive farming techniques have significant impacts on the community of soil organisms. The microscopic life of the soil includes mycorhizal fungi, *Rhizobium* bacteria and algae. They are the principal agents of decay, reducing plant and animal remains to their component minerals. As such, they facilitate nutrient cycling. They are also critical to soil conservation. Excessive fertiliser use can cause environmental problems by accelerating soil structure deterioration and soil erosion. Non-specific insecticides and fungicides are harmful to soil microorganisms. A balance between production and diversity is needed.

Health

A greater range of plants is used for medicinal purposes. The World Health Organisation lists over 21,000 plants that are used in traditional systems of health care, many of which are now threatened by over-collection and loss of natural habitats. In Sri Lanka for example, medical preparations make use of 1,414 plant species several hundred of which are being collected at an unsustainable rate. Some 5,000 plant species have been investigated as sources of new drugs for orthodox medicine and it is estimated that almost a quarter of all medical prescriptions are for drugs extracted or derived from plants and microorganisms. For example, the rosy periwinkle (*Catharanthus roseus*) of Madagascar has given rise to anti-cancer drugs vincristine and vinblastine which are difficult to synthesise in the laboratory, and so it remains cheaper to extract their precursors from leaves collected from living plants.

Natural products are seldom used directly in orthodox medicine, but the compounds extracted from them often form the starting point in a search for synthetic compounds that retain useful activity while minimising unwanted side effects. Some 56 per cent of the most widely prescribed drugs in the USA derive in some way from >wild= sources.

Valuation and valorization

The use of biodiversity in sustaining our food production and protecting our health provides strong justification for conserving biodiversity. But despite these benefits, the present market system does not provide economic incentives for conserving biodiversity. One problem is the lack of clear pricing in product development. Economists have estimated the direct retail value of genes and gene products taken from specific medicinal plants and wild relatives of crop plants, but the cost of developing them for commercial use is less-easily established. Conflicts over the marketing of biodiversity surfaced at the UN Conference on Environment and Development held in June 1992 at Rio de Janeiro and some of these difficulties are addressed in the Convention on Biological Diversity (Chapter 3) which was adopted at the Conference.

Economic benefits

According to the World Tourism Organisation, some 663 million tourist arrivals were logged throughout the world in 1999 of which 123 million (18.6%) were in the Americas, 97 million (14.6%) in East Asia and the Pacific, 27.3 million (4.1 %) were in Africa and 5.7 million

(0.9%) were in South Asia. The number of tourists visiting all regions has been increasing in recent years but their activities have not been evenly distributed. About 50 per cent of those visiting Africa have northern destinations and most of the rest are visiting southern or eastern Africa. Although many tourists are attracted by the biodiversity of developing countries, tourism itself does not necessarily promote conservation of biodiversity. One of the greatest challenges for developers is to direct the benefits of tourism in such a way as to encourage local populations to support biodiversity conservation.

Game hunting and sport fishing, sometimes known collectively as consumptive tourism, have been accused by some of having negative implications for biodiversity through overuse of the target species. Certainly, poorly managed hunting can give rise to both welfare and conservation concerns. On the other hand, when sport hunting is well managed, properly monitored and based on an understanding of population dynamics and animal behaviour, it can generate significant funds for biodiversity conservation, and provide incentives for habitat and species conservation. It is more likely to have a significant impact on local development in open savannas and coastal ecosystems.

Ecosystem services

Natural ecosystems regulate physical processes in many different ways that are of great benefit to human populations, although such benefits are sometimes hidden and unappreciated. Natural grasslands and catchment forests enable heavy rainfall to infiltrate the soil, releasing it more slowly than if vegetation were removed causing most of the rain water to run straight off the surface. The net effect is that clear water is released slowly and evenly into streams and river systems, so reducing the likelihood of floods during periods of heavy rainfall and continuing the supply of fresh water during periods of dry weather.

Some 90% of farmers cultivate the valley floors and so are dependent on the activities of the 10% who live in the watershed areas. If the latter remove natural vegetation cover, the majority of farmers suffer the consequences. Further downstream, high sedimentation loads associated with poor land management can severely damage coastal fisheries and coral reef communities. Given the increasing scarcity of reliable water supplies, and their vital importance to human agriculture and industry, the regulatory function of natural vegetation is of much greater value than other uses of these catchments.

Other important regulatory processes of natural ecosystems are their ability to remove pollutants in soil and water and to reduce atmospheric carbon dioxide which is now closely associated with climate change.

Biological pest control is of vital service to agriculture throughout the world, greatly reducing crop losses from pests. One example is provided by a small parasitic wasp, Diadegma semiclausum, that was introduced in the highlands of the Phillippines to control outbreaks of the diamondback moth that were threatening their high value vegetable crops. In order to increase the survival of Diadegma cocoons, the local farmers build >Diadegma Hotels=, small shelters in the fields that resemble miniature birdhouses.

Many biodiversity services remain under-valued despite having significant economic

implications. Bees have an important role in agriculture and horticulture as pollinators of fruiting crops. The value of bee pollination of eight crops in the USA is estimated to be in excess of US$3.6 billion. Bees also have considerable economic importance for honey production in tropical and temperate regions of the world. In tropical regions, fruiting trees may be pollinated by bats, birds, bees, beetles, moths and other specialists.

Intrinsic values

Science has so far revealed only a small fraction of the complex life of rain forests and other habitats and so, inevitably, it will be many generations before biodiversity can be appraised in terms that correspond directly with those of the market economy. However many recognise that there is an intrinsic value to complex habitats. In a survey of the opinions of opinion-leaders in matters concerning tropical rain forests, respondents were asked to state both their personal beliefs and the most forceful arguments for convincing others. It was found that the most forceful arguments given to convince others to conserve forests were those based on sound commercial management for timber and non-timber products, but that the most important reasons as regards personal beliefs were to do with the biological uniqueness of rain forest.

The depth of biological complexity in rain forests and other species-rich habitats imbues them with a sense of mystery and wonder in the minds of many who visit or dwell within them. Observations of wildlife in natural habitats have been woven into myths and stories since the dawn of humanity. This library of impressions has played, and continues to play, a central role in expanding the human imagination, and is believed by some to constitute the primary value of the natural world.

Intrinsic values may be deeply held but they have remained largely outside the development agenda. The challenge for conservationists is to direct such intrinsic value into an economic framework that strengthens the case for biodiversity conservation. One recent example is the creation of a sanctuary for hippopotamus near the Volta river in Ghana which enables local people, who consider the hippo to be a sacred animal, to exercise control over the reserve and to supervise all activities that may affect the animals, whilst providing local employment through tourism.

In conclusion, this chapter has defined biodiversity as encompassing the full variety of plants, animals, fungi, and microorganisms that are found at any given locality, and how they vary from place to place. This diversity may be manifested at the level of genes, species or ecosystems. Its value to humankind is expressed in multiple ways, from the provision of basic requirements for food, water, health and income to the filling of aesthetic and spiritual needs.

Chapter 2: Managing Threats to Biodiversity

As human pressure on the natural environment has increased, so inevitably biodiversity has declined. The ultimate reasons for increasing pressure can be linked to a long phase of exponential growth in the human population and a similar phase in which the per capita wealth in the more prosperous parts of the world has also risen. These two factors have combined to exert enormous pressure on the Earth's natural habitats and native plants and animals. Poverty exacerbates the problem. Poor people without access to financial and human resources, and without secure land tenure, have little incentive to invest in sustainable harvesting practices, and may be forced to migrate into unoccupied lands of marginal productivity.

Over the past few decades, conservationists have sought ways to decrease the human impact on biodiversity. In this chapter, we consider a number of complementary measures that have been taken to conserve biodiversity in the face of four major categories of threat: habitat reduction and fragmentation; over-harvesting; introduction of exotic species; and pollution. In implementing these conservation measures, inevitably weaknesses and problems have arisen. In the next chapter, we look at some recent developments in conservation practice which seek to overcome these difficulties and increase the overall effectiveness of biodiversity conservation.

Habitat Reduction

The diversity of species in any given area has been shown to relate directly to the abundance and diversity of natural habitats that it contains. Consequently, when land is developed, whether for plantations, pastureland or farmland, or as part of the process of industrialisation and urbanisation, the resulting conversion from a natural to a developed state represents a direct loss to biodiversity. The three ecological processes most closely associated with habitat reduction are deforestation, fire and grazing, each of which reduces the biodiversity of the natural landscape when present at high intensity.

According to the World Resources Institute, almost 40 per cent of Earth's land surface had been converted to cropland and permanent pasture by the early 1990s. This conversion has occurred largely at the expense of forests and grassland. Land transformation continues today, with the most dramatic changes occurring in developing countries where it is estimated that in just three decades -1960 to 1990 - fully one fifth of all natural tropical forest cover was lost.

Some of the rarer habitats have suffered disproportionately: approximately 50 per cent of all tropical mangrove forest has been cleared and half the remainder is degraded; less than half of the native forests of the Eastern Arc Mountains of Kenya and Tanzania, which are rich in endemic species, now remain; and on the Cape Peninsula, the epicentre of fynbos biodiversity, 65 per cent of the vegetation has been transformed by urbanization and agriculture or been degraded by invasive plants. As the total area of natural habitat declines, so the number of unique species of plant and animal is also reduced.

Protected Areas

The concept of conserving specific areas in the wild state has ancient and widespread roots. In Africa, local sites were protected by many tribes in many different parts of the continent, sometimes on religious grounds and sometimes to ensure the continuity of a resource. In medieval Europe, monarchs and noblemen commonly applied hunting restrictions as an attempt to manage the utilization of a resource, or closed off certain areas altogether from hunting so creating game reserves or game preserves. Similar reserves were established in Asia; for example, the Père David's deer (*Elaphurus davidianus)* was protected within the 72 kilometre wall of the Imperial Hunting Park just south of Beijing, possibly from the time of the Ming Dynasty (1368-1643AD) until about 1900AD.

The widespread decline of game animals in many parts of the world during the 19th century, even in countries and provinces where legislation to restrict hunting had been enacted, led to calls for the establishment of protected areas along the same lines as those of the medieval monarchs. The earliest of these modern parks were essentially created by the determination and drive of a small number of enthusiasts who had to lobby hard to persuade reluctant administrations (Box 1).

At first the number of parks and reserves rose slowly, but an increase in numbers of tourists in the 1950 and 60s led to an acceleration in the establishment of new protected areas. The increase in the area of land protected was apparent early on in Africa where governments accepted the need to conserve sites of natural beauty as part of the national heritage. In many other parts of the world, the area of new land being set aside for protection peaked in the 1980s as the remaining undeveloped territories were designated for protection or development, but this process is not yet complete and many new protected areas are still being established. In 1990, protected areas made up almost five million square kilometres, accounting for 3.2 per cent of the Earth=s land surface, although only half of this area was strictly protected. Projecting from historical trends, it is unlikely protected areas will cover more than 6 per cent of land surface in the future. he first of the modern parks in Africa were chosen for their concentrations of large mammals or spectacular scenery in areas that were not subject to immediate claims for agriculture or settlement, and which were reasonably accessible to major centres. At the time, little thought was given to siting parks in representative habitats. With the launch of the World Conservation Strategy in 1979, efforts were made to ensure that every country or region should conserve viable areas that are representative of every habitat or ecological zone. Some progress has been made but a recent survey reveals that the coverage of protected areas across the major habitats in the tropics remains uneven.

Box 1

The First National Parks

Yellowstone and Yosemite

The first protected area of the modern era was Yellowstone National Park in Wyoming, USA. Established in 1872 in an area famous for hot springs and geysers, it owes its existence, at least partly, to commercial reasons relating to the control of a projected tourist trade. By the mid-1880s, however, congressional defenders of Yellowstone were arguing for its continued preservation on the grounds of its natural scenery. Furthermore, Robert Johnson, John Muir and other pioneers of America=s system of national parks were successfully calling for the establishment of a park at Yosemite in California due to the area=s special natural beauty and the need for its protection from deforestation and overgrazing. They also recognised that without government acquisition, other selected sites of great beauty could become the private preserves of a few wealthy individuals and effectively closed to the public. The bill establishing Yosemite National Park was passed in 1890 but there were 15 years of further struggle before the famous Yosemite Valley was included in the park with the signature of President Theodore Roosevelt.

Kruger

Equally strong pressures on wildlife and natural habitats were developing in Africa over the same period. By the early 1800s, the Cape at the southern tip of the continent was almost entirely denuded of its larger mammals and whilst legislation placing restrictions on hunting was frequently enacted, it was universally ignored. A similar pattern of declining wildlife soon took place in the Transvaal but from the 1860s many private landowners began calling for government game reserves, and some established preserves on their own farms. Responding to these calls and the increasing pressure from newly fledged game protection societies, President Kruger proclaimed the Sabi Game Reserve in the eastern Transvaal in 1898 which, with the active support of the first warden, James Stevenson-Hamilton, was extended and enlarged becoming the Kruger National Park in 1926. At its inception, the function of the Sabi Game Reserve was to preserve species that were thought desirable from a sporting point of view. This meant not only pursuing poachers but also exterminating as vermin animals such as lion, cheetah, leopard, wild dog and hyaena, as well as raptors and reptiles, all of which are today considered ecologically vital and highly attractive to visitors. Under Stevenson-Hamilton, the early justification for the reserve as an area providing for sporting and utilitarian needs was disclaimed. In 1912 he recorded his revulsion at the killing of lions and his belief, far ahead of his time, that nature has an inbuilt capacity for maintaining its own equilibrium. By the 1920s game viewing in the Transvaal was becoming popular for a growing urban population and tourism became a central economic justification for wildlife conservation.

Serengeti

In the early 1900s, the area now known as Serengeti in northern Tanzania was described as an uninhabited game area visited by a few nomadic Masai and Waikoma hunters. But by the 1920s, sport hunting was so heavy and uncontrolled, particularly of lions, that the Tanganyikan Government proclaimed a 900 square mile (1450 square kilometres) sanctuary, appointing the first Game Warden in 1931. A larger area was proclaimed as the Serengeti National Park in 1940 coming under administrative control in the early 1950s. At that time the area was legally occupied by over 7000 pastoralists and 100,000 cattle. In an attempt to resolve the conflict between the Park and the pastoralists, the Government proposed a number of boundary changes to the Park including the excision of over 2,600 square miles (4184 sqare kilometres) of the Serengeti Central Plains which would be returned to the Masai as grazing lands. The proposal received much adverse criticism and the future of the ecosystem became a matter of world concern following a campaign by Dr. Bernhard Grzimek which culminated in the release of his book and film *Serengeti Shall Not Die*. By 1960 a compromise solution had been reached which recognised the rights of the Masai but assured the long-term future of the Park. The establishment of the Serengeti Research Institute in 1961 heralded the modern era in which management has been informed by an ever-growing body of ecological and behavioural knowledge about wildlife and natural ecosystems.

The results show that:

- Protected areas cover 7.7% of the tropics.
- Wet and moist major habitats are better represented in protected areas than dry major habitats.
- Poorly represented major habitats are premontane dry (2.9% protected) and montane dry (2.2%).
- Moist forest is well represented in protected areas of South America (15.1%), adequately in South and South-East Asia (10.7%) and Insular South-East Asia (10.4%), and somewhat less adequately in Central America and the Caribbean (8.7%) and Africa (7.6%)
- Of the moist forest types in Africa, mangrove (2.0%) and inland swamp forest (1.3%) are poorly protected but montane rain forest (20.2%) is well protected.

The idea that centres of endemism and species richness which fall within the major habitats deserve yet higher priority still is an even newer concept. Many acknowledge the unique importance of endemic areas, but equally emphasise the importance of parks that sample broader ecosystems.

The type of management and level of protection provided by parks and reserves depends partly on the purpose of the park and partly on socio-economic factors in the area. Some parks are primarily for protection of nature and natural processes, others for the maintenance of natural features, but requiring human manipulation such as fire or grazing management, some are managed for the production of natural resources, and yet others as multiple-use management areas. Following revision in 1994, six categories of protected area are now recognised by the World Conservation Union (IUCN), of which National Parks are category II and Managed Resource Reserves are category VI (Box 2).

Box 2

IUCN Protected Area Categories

Consistency in comparing protected areas across the world is achieved by the allocation and use of an internationally defined set of management categories, known as IUCN (World Conservation Union) categories. There are six IUCN Protected Area categories which vary according to the nature and level of utilisation permitted. The six categories are:

Ia Strict Nature Reserve: Protected Area managed mainly for science.

Ib Wilderness Area: Protected Area managed mainly for wilderness protection.

II National Park: Protected Area managed mainly for ecosystem conservation and recreation.

III Natural Monument: Protected Area managed for conservation of specific natural features.

IV Habitat/Species Management Area: Protected Area managed mainly for conservation through management intervention.

V Protected Landscape/Seascape: Protected Area managed mainly for landscape/seascape conservation and recreation.

VI Managed Resource Protected Areas: Protected Area managed

Few studies have quantified how effective are protected areas in conserving biodiversity. Data released by the Kenyan government show that the country lost 44% of its wildlife in the 18 year period, 1974-1994, but that losses within protected areas amounted to 31 per cent as compared with 48 per cent outside. The level of protection in parks and reserves varies enormously between countries, and between individual protected areas within a country. Some well-managed parks have successfully protected wild plants and animals over many decades, others have provided little active deterrence against illegal hunting but have protected habitats, and yet others are encroached upon by farms and settlements.

As land pressure increases in Africa, protection of locally unpopular parks falls down the list of priorities of poor governments, and there is pressure on conservationists to seek agreement for multiple-use management within protected areas. But studies of resource use have found that genuine sustainable management of wildlife resources has rarely been achieved. If they are really to operate as protected areas for biodiversity, then the evidence is unequivocal: every park and reserve established for that purpose must have an area that is undeveloped,

and where protective status is backed-up by law enforcement. There is widespread acknowledgement that the single most important measure for conserving biodiversity, in the face of massive reduction in the area of natural habitats, has been the establishment of parks and reserves with the express purpose of protecting wildlife and wildlife habitats.

The global status of protected areas and the critical issues facing them are reviewed by the World Parks Congress every ten years. These meetings also determine the future agenda for protected areas, including their wider role in society and how they may be integrated in to the broader economic, social and environmental programmes. The opportunity will be taken to focus on African protected area issues at the Durban meeting in September 2003.

Habitat Fragmentation

It is not just the overall loss in habitat that is a problem for wild plants and animals but also the degree of fragmentation of their habitats. Animals are always on the move, seeking out fresh supplies of food and water, searching for mates and seeking to defend their territories. For instance, in the forest a ripening crop of figs may attract primates, frugivorous birds and wild pigs from many kilometres distance. The animals may need access to the fig tree to overcome famine conditions elsewhere, whilst at the same time the fig needs the animals to disperse its seeds. In the savanna, movements can be even more extensive as large mammals migrate with the start of the rains from lake and riverside refuges to the dry plains and hill country. Without access to both wet season and dry season habitats, the populations quickly succumb. Consequently, many species are vulnerable where human developments begin to fragment natural habitats and limit the freedom of animals to move from one resource area to the next.

Barriers

In some cases, animals are so specialised that they cannot even cross a small gap in their habitat. Small forest birds, such as the ant birds of the South American rain forest, can be boxed into an area of forest by a narrow dirt track just as effectively as sheep or cattle penned by a fence. Some forest mammals may cope with fragmented habitat more easily, crossing small roads or open countryside to utilise a number of undisturbed forest patches, but they still remain vulnerable to linear barriers which can be erected almost overnight in association with land developments.

Fences must rank as the most widespread and potent of barriers to the movement of wildlife in more open habitats. One of the commonest applications for fencing is in the delineation of the boundary of farms, partly to demarcate ownership and partly to control the movements of livestock. But when a number of adjoining farms erect fences, the result can be a continuous long barrier that entirely prevents wildlife moving between former ranges. Other equally damaging fencing applications are along roadsides and railway lines where the fences are often erected to prevent domestic animals from wandering onto the road or track. High, multi-strand fences are also used in some African countries as a quarantine measure to prevent livestock from coming into contact with wild animals. Veterinary fences are often many hundreds of kilometres in length and are considered to be as vital to the maintenance of

disease-free livestock as they are notoriously lethal for large mobile animals, such as zebra, eland and wildebeest which must have access to seasonal pastures and water supplies.

Islandisation

An additional danger for species which become isolated in small fragments of their natural habitat has come to light from studies of biodiversity on coastal islands. It was noticed that the smaller populations of plants and animals associated with small islands are inherently more prone to local extinction than are the larger populations on large islands. As numbers are low, each species easily succumbs to chance incidences of predation, disease, famine or drought. If the islands are far from the mainland, then new immigrants are less likely to arrive to replace those dying out, and in consequence the species diversity of small, isolated islands remains low.

It is now recognised that the same problems can effect patches of natural habitat surrounded by land developments on the mainland, such as might be found where a small forest reserve has been established within an area set aside for agriculture. As the forest patch becomes smaller and more isolated, the number of species associated with it quickly declines as a result of chance events. The most vulnerable species are the first to become extinct. These include the larger-sized animals which have particularly small population sizes when confined to small patches of habitat, and those species of plant or animal with a narrow geographic range, poor dispersal ability and/or specialised ecological requirement. The overall process of impoverishment has been dubbed islandisation.

Regional conservation

Even with the addition of new parks and reserves from as yet undesignated lands, it is inevitable that only a small area of land overall will be held primarily for the conservation of wildlife, and even that will not proportionately represent all habitats. If the parks and reserves continue to become more and more isolated, they will conserve successfully fewer and fewer species. On the other hand the wider countryside is not yet completely impoverished: indeed many native plants and animals can and still do persist outside of protected areas. The combination of the threat from islandisation and the continuing existence of wildlife in rural areas has prompted conservationists to broaden their approach from a focus on individual parks to a vision of entire biodiversity-friendly landscapes.

Off-reserve conservation refers to the management of land where conservation is not the overriding priority, but nevertheless where limits on certain specific activities and the presence of small-scale conservation developments, will protect some species and habitats and greatly increase the representation of biodiversity in the overall landscape. It can be incorporated with protected area networks to form a regional approach to biodiversity conservation.

Regional conservation falls roughly into three categories: reserve networks that include protected areas and the land linking individual parks and reserves; land surrounding parks and reserves designated as a buffer zone in which natural resource management programmes and other strictly controlled activities are permitted; and land used primarily for production, such as farmland, pastoral land, production forests and forest plantations, but where

modification of certain activities and limited conservation development can facilitate dispersal between reserves and enhance biodiversity. One of the principal tasks for conservation at the landscape scale is to coordinate the activities of many management authorities so as to achieve a unified programme which reduces the isolation of parks and reserves whilst minimising conflicts arising between people and wildlife.

Habitat corridors and passageways

The most immediate means of reducing the isolation of parks and reserves is by the creation of habitat corridors or passageways which link habitat islands. Passageways may be small, as in the case of underpasses for European badgers which allow the animals to walk beneath busy roads when following traditional trails, or larger as in the overpasses for deer which permit them to walk between forests that have been bisected by major highways. There is room for innovative features in engineering passageways. A ranch in central Kenya has a 30 metre wide gate along its northern boundary fence consisting of piled stones about 0.5 metres high by 2 metres deep. It permits elephants to cross freely, enabling them to access both forest and plains habitats, but confines rhinoceros which require close surveillance due to their endangered status and the high risk of poaching.

Corridors are wider strips of natural habitat that link reserves, so aiding dispersal and facilitating gene flow. Critics have pointed out that corridors might have negative effects such as helping to spread disease and fire or increasing pressure from hunting and predation. They have advocated capture and translocation of individuals between reserves as an alternative form of management. Neither the need for translocation as a means of staving off inbreeding depression, nor any harmful effects of habitat corridors, have been empirically demonstrated by scientists.

In practice, corridors are often created to preserve existing movements across the landscape, rather than to engineer new features. Corridors are sometimes planned when traditional routes for dispersal and migration are in danger of being closed off by new developments. They can be established by purchasing land that is situated between reserves and designating it for conservation purposes. Fences and other barriers are then removed so as to allow uninterrupted passage of animals without disturbance. One such corridor links the Tarangire and Manyara National Parks in Tanzania protecting the traditional migration route of wildebeest and zebra.

Dispersal zones

Animals and plants do not necessarily require a continuous corridor of suitable habitat in order to make use of a larger landscape, as may be illustrated by the example of the northern spotted owl (*Strix occidentalis caurina*). This owl thrives in the old-growth conifer forests of the western coast of North America preferring to nest in the broken tips of conifers, particularly the lightning-sheared tops of still-living Douglas fir. Much of the juvenile mortality in this species apparently occurs during attempts by young owls to disperse across areas that have been recently logged, or which contain early successional stands of timber.

Studies have demonstrated that suitable habitat for dispersal comprises forest stands of larger trees with sufficient canopy closure to provide protection to young spotted owls from avian

predators, and which also allow the owls to hunt for prey. The US Fish and Wildlife Service accepts that such dispersal stands provide a linkage amongst larger blocks of old-growth forest, which constitute the nesting habitat, and that they need to be distributed within the landscape over the entire range of the northern spotted owl to ensure conservation of the species.

Biosphere reserves

Biosphere Reserves are intended "to foster a balanced relationship between people and the natural world by bringing together and reconciling conservation and development goals." They are organised into three interrelated zones, known as the core area, the buffer zone and the transition area, that are united by a single management plan. The core area provides legal protection to the landscape, ecosystem and species it contains. It is not normally subject to human activity except for traditional extractive uses by local communities.

The buffer zone (or zones) surrounds or is contiguous with the core area. Activities are organized here so that they do not hinder the conservation objective of the core area but rather help to protect it. The buffer zone may be used to try out new ways of managing natural resources which ensure their sustainability.

The outer transition area is an area of cooperation which may contain a variety of agricultural activities, human settlements and other uses. This is where local communities, conservation agencies and other stakeholders must work together so as to manage and sustainably develop the area's resources.

The name "Biosphere Reserve" was chosen in the early 1970s to identify the first of these sites shortly after the launching of the Man and the Biosphere (MAB) Programme within UNESCO. Critics point out that the model of management offered in biosphere reserves suffers from nebulous goals that offer something for everybody without answering the hard questions. There has been little attempt to determine how large a buffer zone needs to be in order to support sustainable use, or how dynamic aspects of nature can be linked with areas outside the reserves. Nevertheless, there are currently 393 such sites in 94 countries providing some level of protection for biodiversity.

Transfrontier Conservation Areas

One of the most successful recent instruments for expanding the protected area network, whilst promoting regional cooperation and improving biodiversity conservation, is the establishment of transfrontier conservation areas (TFCAs), sometimes known as Peace Parks. TFCAs usually extend far beyond designated protected areas, and can incorporate such innovative approaches as biosphere reserves, bioregional planning, dispersal, buffer or support zones, migration corridors and programmes enhancing Transboundary National Resource Management (TBNRM) and community-based natural resource management.

At the time of writing, the global list identifies 136 TFCAs of which 23 straddle the boundaries of at least three countries, and the total area of land surface protected is at least 1,127,934 km2. Africa=s first peace park, the Kgalagadi Transfrontier Park was formally opened in May 2000 bringing together the Gemsbok NP in Botswana and the Kalahari

Gemsbok NP in South Africa. The European Commission had previously helped to establish the Niokolo-Badiar Transnational Park of Senegal and Guinea. The world=s largest transfrontier park, the Gaza-Kruger-Gonarezhou TFCA, may soon link Mozambique, South Africa and Zimbabwe.

In recognition of the unique biological importance of the Central American region, the Mesoamerican Biological Corridor was formally established in July 2000. It comprises a developing system of natural protected areas under a special administrative regime. A series of core, buffer, multiple use and interconnected areas are to be organized and consolidated in order to protect biodiversity and improve the quality of life of inhabitants in the region. The main aims are to promote investments in the conservation and sustainable use of natural resources, and to provide spaces for social harmonization.

These beginnings in regional conservation have shown the potential of transfrontier parks and resource management programmes in protecting biodiversity, improving security, creating jobs through the growth of tourism, and helping to promote a culture of peace between participating nations.

In planning TFCAs, a number of benefits need to considered:

- dropping the bordering fence between conservation areas to allow wildlife movements;
- constructing new border posts and entrance gates;
- clearing landmines;
- preparing joint conservation management plans which include systems of involvement of local communities and other stakeholders in conservation;
- harmonising law enforcement, customs regulations, and human inheritance in conservation areas;
- standardising legislation for visitor behaviour to facilitate free movement between participating countries;
- developing regional databanks of vegetation and species information to assist management and monitoring; and
- promoting investment opportunities.

Conservancies and sanctuaries

Private land has been used to safeguard endangered species like the black rhino in Kenya which is threatened by poaching. Increasingly, private landowners have recognised the potential of combining the management of their ranches and farms in order to promote photographic tourism or safari hunting. In some cases, boundary fences have been pulled down between neighbours to allow wildlife to move unimpeded across a larger areas of land, and a joint management committees established to set hunting quotas for the conservancy.

Privately run conservancies are becoming increasingly popular, especially in habitat that is marginal for intensive farming. They constitute an important additional component of biodiversity conservation in the landscape. However, long-term dependency on private land without a covenant to ensure protection is risky. Land ownership can change, as can government land policy, and it needs to be remembered that the predominant impetus for

management of private land is commercial rather than for long-term conservation.

Legal settlement of land claims by indigenous peoples has advanced considerably over the past two decades, transferring large areas of land to titled ownership or community management In some indigenous lands, sanctuary areas have been established by local people and managed for tourism or safari hunting or for sustainable harvesting of other natural resources. Community sanctuaries can be set up in partnership with a government wildlife department or NGO, and often in collaboration with the private sector. From the standpoint of the local community they provide an important alternative source of income and employment and may conserve cultural traditions.

Local communities in Africa are naturally quite in tune with approaches to land management that combine wildlife with other uses of the land. Pastoralists and farmers usually respect wildlife and have been found to happily grant time and space allocations to large wild animals within the overall framework of their other activities.

Both privately owned conservancies and community-owned sanctuaries can contribute to the overall management of biodiversity across a fragmented landscape. Attempts to defragment the landscape through coordinated land management are in their infancy, but hold much promise for the future conservation of biodiversity.

Over-harvesting

Despite the expenditure of considerable scientific and political effort, more than 70% of the world's commercially important marine fish stocks are described by the Food and Agricultural Organisation of the UN as either fully fished, over-exploited, depleted, or slowly recovering. This grim statistic indicates how difficult it to design and implement policies that ensure sustainable use of natural resources. Over-harvesting occurs when heavy pressure on stocks of natural resources precipitates a collapse in their abundance.

The depletion of natural resources has been greatly accelerated in the past few decades by the combination of strong demand for wildlife products in domestic and international markets, improved harvesting technology, and easier access to hitherto remote areas. Some particularly destructive practices for harvesting animals are found in the world's fisheries where one super-numerous fish stock after another has collapsed. Equally destructive has been the use of explosives and poisons for fishing in the vicinity of tropical reefs.

On land, a combination of automatic weapons and 4-wheel drive vehicles have cleared many savanna and semi-arid terrestrial habitats of large animals; the use of wire snares has emptied tropical forests of small ungulate species; and the application of bird lime to trees ensnares large numbers of small birds, especially passage migrants, which are caught for food.

The most vulnerable species to over-harvesting are those with a slow recovery rate (known as k-selected species); they include deepwater fish, parrots, condors, elephants, whales and tropical hardwoods.

The conservation strategy for controlling over-harvesting depends on whether the market is local or international. For international trade the main priorities are to control imports and exports and to provide information and educational programmes in consumer countries, but for local trade, the emphasis is on sustainable harvesting or non-consumptive utilisation.

International trade in wildlife

The impact of international trade in natural products on wildlife populations has been long recognised. The ancient Egyptians, for example, are known to have brought ivory down the Nile from at least 1580 BC. By the time of the Roman empire the demand for ivory was so great that Pliny wrote in AD 77: "an ample supply of tusks is now rarely obtained except from India, all the rest in our world [i.e. North Africa] having succumbed to luxury."

The demand for tusks in Europe from 1500-1900 AD was so enormous that the elephant population throughout the African continent had collapsed by the beginning of the 20th century. At this time, legislation to control elephant hunting, and a slackening in demand allowed populations to recover. The situation changed again in the early 1970s when new markets for ivory opened in east Asia with the result that tusk exports rose to pre-1914 levels and the continental elephant population declined by 45% in the ten years 1979-1988.

Many species other than elephant are also traded on international markets and by the latter part of the 20th century both the scale of international trade, and the variety of plant and animal species effected, had increased dramatically.

CITES

By 1973 the amount of trading aroused such concern for the survival of species that an international treaty was drawn up in Washington DC to protect wildlife against overexploitation and to prevent international trade from threatening species with extinction. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) establishes the necessary international legal framework for the effective prevention or regulation of trade. The Convention regulates international trade in specimens of wild plant and animal species through a system of permits and certificates which can be issued to authorise shipment if certain conditions are met and that have to be presented before consignments of specimens are allowed to leave or enter a country.

The animal and plant species subject to different degrees of regulation are listed in three appendices: Appendix I includes species threatened with extinction, such as cheetah, the rhinoceroses and some orchids. Appendix II species are not necessarily now threatened with extinction but may become so unless trade is strictly regulated, for example some fur seals, birdwing butterflies and the African Stinkwood. Appendix III contains species that are subject to regulation within the jurisdiction of a Party and for which the cooperation of other Parties is needed to prevent or restrict their exploitation, for instance several gazelle species from north African countries.

Abuses of the CITES trade measures have been detected in the past. They have included forgery of documentation and laundering of illegally smuggled specimens by the issuing of

re-export certificates for smuggled plants and animals. At the national level, enforcement measures usually involve instituting close working relations amongst the national management authority and enforcement agencies such as customs officials, wildlife inspectors and police authorities. The sister organisation, TRAFFIC (Trade Records Analysis of Flora and Fauna in Commerce), also cooperates closely with national enforcement authorities and the Secretariat, whilst INTERPOL has recently established a sub-committee on wildlife crimes.

The present value of international wildlife trade (both legal and illegal) has been estimated at between $5 billion and $8 billion, although such figures are difficult to arrive at or substantiate. These figures do not cover fish and timber, the two categories of wildlife for which trade has the highest value: their inclusion would push these figures six to ten times higher. Even so, the exploitation of wildlife for international trade is much less extensive than the domestic trade for the vast majority of wildlife species.

Bushmeat trade

Humans have lived alongside wild species in tropical forests for thousands of years without jeopardising wildlife populations, but only at a low population density. In recent years, as access to the remaining forests has opened up to expanding rural and urban populations, the level of hunting and gathering has grown enormously. The illegal use of wild meat, termed "bush meat", is now believed to involve more people and to have a greater effect on wild populations, including those in protected areas, than any other wildlife activity. A wide range of animals are utilised, including the apes (chimpanzees and gorillas), monkeys , duikers and other artiodactyls, elephant, pangolin, crocodiles, rodents and insects. Most investigations of the trade in Africa have focussed on lowland forest areas of west and central Africa but there is also a significant local trade in bush meat in eastern and southern Africa.

Improved access to wildlife may have stimulated a traditional sustainable harvest in bush meat, but commercial trade is now becoming an important supply mechanism that is gradually replacing subsistence hunting in most areas. An emerging trend is that rising prices are stimulating trade from a dwindling resource. Attempts to improve the hunters= catch per effort has led to an increase in more effective and, in most cases, unsustainable hunting techniques such as night torching, long-line wire snaring, and hunting with semi-automatic weapons. For example, in the Ituri Forest in northeastern DR Congo hunting by net and snare led to reductions of 85-90% of red duikers in some areas.

Some trade occurs between African nations but it is thought to be negligible by comparison to domestic use. The predominance of national trade in bush meat exploitation means that a different approach to conservation is required from that applied to animal and plant products destined for international markets. Domestic trade in bush meat has been shown to threaten many wild animal species but, on the other hand, bush meat is also a source of much-needed protein and cash for subsistence farmers. .

A number of approaches have been taken by conservationist and wildlife managers in order to promote sustainable harvesting, including several different models of community-based management of natural resources, ecotourism development and private sector involvement. In seeking solutions to these issues, it is recognised that wildlife ownership laws and land tenure

policies must create a conducive environment to the sustainable management of natural resources.

Wildlife harvesting in forests

It was envisaged in the World Conservation Strategy (IUCN/UNEP/WWF 1980) that wildlife could be harvested on a sustainable basis without affecting wild populations and might therefore provide some compensation to local communities that forego timber harvests to conserve forest ecosystems. A comprehensive review of hunting in the forests of tropical regions around the world has concluded that hunting rates for many species are clearly not sustainable (Robinson & Bennett 2000). In the traditional systems, hunting territories belonged to specific hunters or families and the ownership of land acted to disperse hunting pressure and to encourage stewardship of the local wildlife populations by a single person or group. But hunting practices are changing. The loss of traditional systems, and the lack of experience and knowledge amongst recent arrivals in the forest, allows more open access to wildlife resources. This, together with advances in hunting technology such as the use of firearms, powerful torches and wire snares, decrease the probability that hunting will be sustainable.

The problems of developing a management system that ensures sustainable harvesting of wildlife are substantial. In the first place limits on offtake have to be set for numerous different wildlife species - limits on numbers of duikers and monkeys that can be shot or trapped, limits on numbers of eggs, nestlings or plants that can be collected, and limits on trees that can be cut. Then the limits must be enforced, often in a local context where the demand for those products inevitably exceeds their supply. Finally, the populations of plants and animals (which constitute the wildlife resources) have to be monitored. It was once thought that sustainability of resource use could be achieved by ensuring local control over resources, but this view is no longer considered to be correct.

Community-based conservation

Conservationists and wildlife managers working in developing countries in the 1960s and 1970s came to realise that local people were commonly hostile to state-imposed conservation programmes and foresaw that without their cooperation wildlife conservation would frequently be impossible. They advocated a different approach, one in which local communities could join with government and private enterprise as stakeholders to manage a given natural resource. The two principal aims of this new form of conservation, which has been variously described as “Community-based Wildlife Management”, “Community-based Conservation” and “Community-based Natural Resource Management”, are firstly to involve local people in resource planning and management in such a way that sustainable harvesting of wildlife is achieved; and secondly to ensure that the local people gain economically from the wildlife utilization.

The community model of resource management has rapidly become dogma in conservation circles to a large extent because it is more in tune with current political thinking than is the more conventional top-down management model that nevertheless is still practised in many countries. A growing number of Aintegrated conservation and development projects≅, or ICDPs, have sought to assist protected area conservation by promoting socioeconomic

development and providing alternative income sources in the forest environment. It was hoped that the alternative sources of income would relieve the pressure on wildlife and other threatened resources, but developers have frequently not considered that local people are most likely to adopt the new income opportunity in *addition to* the old one - rather than *instead of* it.

ICDPs are even suspected of making existing conservation problems worse. The improvement in living standards that the projects bring to the communities living close to parks and reserves has sometimes attracted new people to the area. The in-migration has in turn increased pressure on wildlife resources. Sadly, two recent reviews have concluded that examples of sustainable socioeconomic development through increased wildlife harvesting in the tropical forests of Africa are nonexistent (see books by Oates 1999, and Robinson & Bennett 2000).

Implicit within the promotion of community-based conservation is the belief that communities will regulate themselves. In reality, threats to biodiversity do not disappear with the granting of land-rights and other legal measures that enable community management of natural resources. Where communities are close-knit with a strong tradition of managing resources, it may be possible to devise harvesting systems that can be enforced within the community. Even so local enforcement will need to be backed up by the state when outsiders move in to exploit resources. Prior to the international ban on ivory trading in 1989, military-style forces were required to defend elephant populations from organised poaching gangs in many regions of Africa.

The difficulty experienced in achieving sustainable harvesting of wildlife populations and other natural resources also underlines the need for greater involvement of wildlife ecologists and natural resource specialists within rural development projects. Expert technical assistance is needed so that communities can be advised of the biological limits to harvesting resources and helped with managing and monitoring them. One promising new approach is to substitute a spatially controlled harvest system for the more usual quota control system, as discussed in *Wild Species as Commodities* by Curtis Freese. In the spacial system, hunters may remove all or part of the population from a small number of concessionary areas while the remainder are protected. It then becomes more important to monitor the compliance of hunters than the population being harvested.

Given the widespread problem of illegal harvesting, it remains crucially important to monitor wildlife populations in most settings. Monitoring biodiversity is as exacting a task as it is crucial to the long-term success of any conservation programme. Biological indicators are first chosen which are tractable to quantitative measurement and indicative of ecosystem health, then methods are tested and refined on site, and personnel trained in their use.

It should be born in mind that most community-based projects are recent in origin and conservationists are still learning how to integrate community development with biodiversity conservation. Neither past failures or emerging difficulties should detract from the efforts made to involve local communities in conservation as without their active support it will be quite impossible to conserve biodiversity.

Some valuable lessons have been learned already. Integrated Conservation and Development

Projects are more likely to succeed where economic developments are tied closely to the success of conservation measures (Box 3). Community-based wildlife harvesting programmes in forested areas are most likely to be successful where human population density is low, and the pressure on forest resources remains light. When competition for resources is high, a more realistic solution might be to ban hunting and harvesting, at least from a core area, and to promote other forms of use such as ecotourism. The major economic developments should be established well away from the protected areas, so that if anything, they relieve population pressure in the vicinity of core areas.

Community-based conservation projects in the vicinity of wildlife parks and reserves have often had to cope with a legacy of hostility. In many countries, the relationship between people and parks got off to a bad start. As more parks and reserves were established, so many governments became involved in the expulsion of people from large areas of natural habitat, and followed this up with the enforcement of anti-poaching policies using para-military forces.

Much progress has been made recently in redressing past wrongs and in positioning conservation so that it serves local people as well as wildlife populations. One conservation programme in southern Ethiopia succeeded in establishing agreements by which profits from wildlife tourism would be partitioned amongst a range of local communities representing many different language groups and protected areas authorities at local, regional and national levels. Similar hard-won agreements have been reached in other regions. Their success is more likely where national policy supports tourism and where the mechanism by which revenue is shared is transparent and flexible. A willingness for constant dialogue and negotiation is a pre-requisite of successful community conservation.

Box 3

Project CAMPFIRE

The best conditions for sustainable harvesting of wildlife by local communities occur where the wildlife can provide some resource of exceptionally high value, such as through trophy hunting, the presence of a well-managed tourist lodge or a cash return from the harvest of a particularly valuable resource such as honey. One of the most often-cited examples of community conservation in action is Zimbabwe=s Communal Area Management Programme for Indigenous Resources (CAMPFIRE).

The aim of the CAMPFIRE programme is to raise income levels of poor rural communities through the long-term development, management and sustainable utilization of natural resources. The programme was initiated in 1989 when two districts were granted appropriate authority to manage and market their wildlife resources, and rapidly expanded to include 26 out of 57 districts by 1997. Today, trophy hunting represents 90% of the income from CAMPFIRE, with the remainder coming from photographic tourism and the sale of hide and ivory. Whilst the central thrust of the programme has remained in wildlife, local authorities are increasingly calling for control over forestry, grazing and water resources.

In general CAMPFIRE has been successful in achieving its broad aim of handing control of natural resources from government to local communities. As an innovative and ground-breaking programme it is hardly surprising that it has also come across unforeseen difficulties and been criticised over a number of inherent weaknesses. One of the most serious problems is that the implementation of CAMPFIRE has resulted in a concentration of power in Rural District Councils, the lowest level of government, and not at the village or Ward level, as intended. In some districts, villagers have little knowledge about CAMPFIRE or view it as an extension of government. It is clear that without rigorous appraisal, community-based resource management programmes can become yet another means by which central government extracts economic benefits from local people, thereby undermining the fundamentals of the approach.

Other criticisms are that where CAMPFIRE has been successful, it has sometimes failed to manage the increased immigration of people into programme areas. Also, it is estimated that the programme has absorbed $33m in aid from international donors over a ten year period and there is some concern over its sustainability.

CAMPFIRE epitomizes the economic approach to biodiversity conservation contained in the slogan: “use it or lose it”. It has had an effective lobby from within the conservation profession in southern Africa and similar programmes are being integrated into conservation programmes in many parts of the world. Whilst sustainable economic use is a powerful approach to conservation, it is not the only one, and if misapplied it can be responsible for actually increasing the damage to threatened communities of animals and plants.

A recent study at the village level in Zimbabwe revealed that many farmers think of elephants as both enemies and friends: enemies because of the damage to crops and the danger to people; friends, not because of the economic return through CAMPFIRE safari hunting, but because elephants are attributed with aesthetic and spiritual values. In future, state-imposed programmes will need to divest themselves of overly simplistic notions about use, and take more account of local values, meanings and traditions, if they are to be successful in conserving biodiversity at the community level.

Ecotourism

Ecotourism is a form of wildlife or nature-based tourism which should be consistent with the aims of conservation because of its small scale and limited ecological and social impacts. On the other hand, ecotourism attracts visitors to fragile and remote ecosystems and therefore has the potential to damage habitats, disturb wildlife and impact negatively on traditional values and culture. Ecotourism offers the prospect of providing a source of revenue in poor regions that are not currently visited by many tourists. Whilst the potential is apparent, it should be remembered that the redistribution of tourist revenues is a promise that has been widely made to local populations, but which has not always been forthcoming.

The statistics for wildlife viewing in developing nations of west and central Africa offer limited encouragement as few of the tourists travelling to such countries as Côte d=Ivoire and Senegal visit the national parks. There are exceptions, however, such as the imaginative rain

forest developments in Kakum National Park in Ghana and the progressive viewing programme for mountain gorillas in Rwanda=s Volcanoes National Park. They provide optimism for a limited role for ecotourism in the conservation of less developed regions.

Role for the private sector

Some success in the sustainable harvesting of wildlife has been realised through government granting concessions to the private sector, as for example in Botswana and Namibia. Indeed the private sector is emerging as a key partner for conservationist in Africa in several distinctive ways: by establishing their own conservation areas, by assisting in park management and through the management of concessionary wildlife areas. The main economic incentive for the concessions is safari hunting but photographic and adventure tourism also play a role.

It needs to be recognised that most of the private initiatives involve the management of large mammals only, rather than protection of all natural and cultural resources in the area. Another potential problem is the tendency for private initiatives to be restrictive, denying the general public access to government land and excluding hunter-gatherer groups from traditional hunting grounds.

A great many technical and political issues need to be resolved in order to develop successful community-based conservation projects. Whilst the high hopes expressed for this new paradigm in conservation are not inappropriate, community-based conservation cannot provide a quick and easy fix to problems of declining biodiversity.

Exotic species

Many plants and animals have been deliberately introduced by humans to new areas: amongst the plants are crops, timber trees and ornamentals; and amongst the animals are the domestic species used for food products, companion animals such as the domestic cat, those species introduced for sport such as the trout, and those introduced to control pests. Many others have been dispersed accidentally by their adhesion to vehicles or ocean-going vessels, or through unintentional inclusion with other consignments, such as wild seed amongst crop seed, insect pests with host plants, or parasites with host animals.

Once they have been introduced, the establishment of exotic species (also known as aliens) can proceed rapidly leading to losses of native plants and animals either directly through competition and predation, or indirectly by alteration of indigenous habitats (Box 4). In the pampas grasslands of Argentina, for example, it is estimated that only one-tenth of the plants now growing are native because of the invasions by European plants. The rate of accidental introduction has risen rapidly along with the increasing frequency of international flights and voyages leading some conservationists to fear that this threat is likely to increase substantially in the future.

Box 4

The European Rabbit in Australia

Originally native to the western Mediterranean lands, the European rabbit was introduced to Britain in early medieval times and to Australia as a game animal in 1859. With no natural predators, rabbits flourished in Australia especially after the introduction of the merino sheep which created favourable pasture lands. In less than a century they increased from a handful to about 500 million in 1950, by which time they were causing enormous crop losses over much of the country despite almost continual eradication programmes.

Rabbits are implicated in the decline of many species of native animals, particularly the small to medium sized marsupials. By increasing grazing pressure, rabbits have displaced the wombat, greater bilby (now an endangered species) and burrowing bettong (now extinct on the mainland). The bilby is found only in isolated areas of central Australia where the rabbit is absent.

Native mammals are also vulnerable to various indirect threats related to the introduction of rabbits. Foxes have spread rapidly across the sheep country of Australia, living primarily upon rabbits. As secondary prey, they also take bettongs, wallabies and other marsupials. After a crash in the numbers of rabbits during a drought, the predation pressure on the small populations of native mammals increases. These species are not such prolific breeders as the rabbit and their populations recover slowly.

Another indirect threat to native animals is caused by the steps taken to control rabbits. For example, numbers of the northern hairy-nosed wombat were affected by a poisoning campaigns directed at rabbits as well as by competition with cattle and sheep. It is now one of the rarest mammals in the world.

Islands and lakes

Oceanic islands are particularly vulnerable to introduced species as their native plants and animals have been selected primarily for their dispersal ability and not because they were particularly competitive in their original setting. In many instances, the founding species have diverged noticeably from the mainland parental stock, as for example have the large sunbirds of São Tomé and the Giant tortoises of Aldabra, so creating a unique but vulnerable endemic biota. Today, it is not uncommon to find that more than half the plant species and many of the animal species on oceanic islands are exotic, whilst many of the endemics have become extinct.

Continental lakes can be just as isolated from other large bodies of fresh water as oceanic islands are from the mainland. Each of the three great river systems of Africa is associated with a large lake at its headwaters: Lake Malawi flows into the Zambezi River; Lake Tanganyika into the Congo River; and Lake Victoria is the source of the Nile. Each lake contains its own endemic fish species, and one particular group of fish, known as the haplochromine cichlids, has speciated into a great variety of forms. In Lake Tanganyika, for example, a very small number of the ancestral riverine species are thought to have given rise

to a huge variety of lake fishes, now classified into 33 endemic cichlid genera . Some of these species show a striking similarity to well-known marine fish, such as barracuda, grouper, snapper and tuna, to the extent that for many years it was assumed there had once been a connection between the lake and the sea.

In Lake Malawi there is evidence that the full radiation of over 500 species of cichlid fish evolved from a single common ancestor within the last one million years. Similarly in Lake Victoria, it is thought that as many as 400 species of cichlid have descended from five ancestral species. Such diversity is all the more remarkable when it is considered against the geological evidence which indicates that only 13,000 years ago, Lake Victoria was completely dry. The introduction of just one species, the Nile perch, has had a profound impact on the biodiversity of Lake Victoria (Box 5).

Box 5

The Nile Perch in Lake Victoria

Just as island species are vulnerable to introduced predators so too are lake species. Nobody knows exactly when or by whom, but just such an incident was unwittingly enacted in about 1962 when Nile perch were introduced into Lake Victoria probably in an attempt to improve fish catches. In 1973, a survey found that 80% of the biomass of the lake consisted of haplochromines, whilst only 1% was Nile perch. By 1985, there had been a complete reversal in biomass composition: Nile perch now constituted 80 per cent of fish biomass and haplochromines 2-3%. The number or recorded cichlid species had dropped to just 200, and the Nile perch was blamed for the extinction of at least 30 species of food fish.

Although it is easy to blame the 80 kg predators for the decline in native food fishes, several major changes have occurred concurrently in the lake since the early 1970s (further details can be found under Pollution) so that it is not clear to what extent the Nile perch is really responsible for the decline of other species. Given the importance that the introduced fish has assumed in the local economy, and the technical difficulties in obtaining full eradication, the main approach to conservation of cichlids has been to establish breeding programmes in aquaria in the United States and Europe. Meanwhile an IUCN programme is attempting to restore the health of the lake ecosystem.

Endemic areas

It is not only island and lake communities that are threatened by the introduction of exotic species, any area with high endemism can be at risk. The Cape flora and fauna has evolved a high degree of endemism despite being a part of the mainland, at least partly because it is effectively isolated from tropical Africa by dry deserts and cold uplands. Of the 8550 individual plant species in the Western Cape, nearly 6000 are endemic. This distinctive community of plants is known as fynbos. It has been invaded by a number of introduced plants, some of the more common species being the Australian wattles. Many local plant species are endangered to the point of extinction by these trees.

The uniqueness of the fynbos has prompted a number of conservation measures. There are at present 12 nature reserves and four wilderness areas protecting fynbos, although coastal regions are relatively under-represented. Frequent fires have become a further problem. The optimum fire frequency in fynbos is considered to be 10 - 15 years and an ecological burning programme attempts to maintain this period. The main approach to the problem of introduced species in the Cape has been programmes to root out invaders. In addition, research on germination of fynbos plants at Kirstenbosch is supporting the efforts of breeding programmes.

Introgression

A more insidious problem associated with introduction of exotics occurs when there is crossing or interbreeding between introduced and native species. This leads to an introgression of new genes into the genotype of native species resulting in a net loss of biodiversity. The scale of the problem has only recently been appreciated. For instance, recent studies in Scotland have revealed that genes of Japanese sika deer are now present and increasing in all native red deer populations.

Many plants and animals show distinct local variations, for example giraffe show a wide range of coat colours and patterns in Africa that separate according to four geographical populations. Within these, further regional varieties or subspecies are commonly recognised. Introgression also occurs, but even more quickly, when animals are translocated. Translocations to geographically distant parts of the species range are often arranged as part of well-intentioned conservation projects. Separate subspecies or locally adapted varieties may then meet for the first time. For example, movement of giraffe between the centres of each variety dilutes the overall variation within the giraffe species and reduces diversity.

This problem of introgression is becoming more frequent as the technology for capturing and transporting large animals has improved and the market for game viewing has opened up to private enterprise.

Pollution

Heavy pollution of soil, water and atmosphere is most commonly associated with the industrialised nations of the northern hemisphere, but it is increasingly affecting the biodiversity of developing countries in the vicinity of urban centres, in areas of mining, and more and more frequently in lakes, marshes and other wetlands where chemical poisons collect (Box 6).

Box 6

Pollution in Lake Victoria

The problems of water pollution are well illustrated by the deterioration in the aquatic ecosystem of Lake Victoria. The beginnings of the problem can probably be traced to the 1920s with the construction of the railway line linking the lake with Nairobi. As the human population grew, so the intensity of fishing increased; the quantity of nutrients being discharged into the lake also increased as a result of bush clearance and farming. Since the 1970s, the transparency of the water has decreased from about 8 metres to 1.5 metres as algae production in the lake has doubled. Near to urbanised areas, the combination of habitat destruction in the littoral zone, decline in water quality and increase in nutrient load, has given rise to anoxic conditions that have triggered massive fish die-offs.

A recent study found a range of industries close to the lake, varying from textile and leather-tanning to sugar factories, paper mills and breweries, which add to the large volumes of industrial waste and untreated sewage flowing into the lake each day. This pollution may have contributed to the recent spread of water hyacinth to large areas of the lake in the territories of Kenya, Tanzania and Uganda. The hyacinth is a free-floating aquatic plant which reproduces rapidly forming such dense mats that at one time it took ships five hours to push through the weed to dock at the Kenyan port of Kisumu. The dense coverage of water hyacinth blocks sunlight from organisms below and depletes oxygen levels, causing a major change in the composition of aquatic communities. The net result is that the once clear, well-oxygenated waters of Lake Victoria are now muddy and stratified leaving little oxygen in its bottom layers.

Although the problems facing Lake Victoria and other African lakes may appear discouragingly severe and complex, international and domestic efforts are being made to reverse the deterioration. In 1992, representatives of all three lakeside countries met to form the Lake Victoria Organization which will coordinate rescue efforts. A Kenyan group, OSIENALA or “Friends of Lake Victoria” is working to protect the interests of local fishermen and to encourage aquaculture as an alternative source of protein and income. In addition, crucial information on the ecology of the lake is being gathered by the Lake Victoria Research Team formed in the late 1980s.

Despite concerns about introducing yet another species to the lake ecosystem, scientists have been considering the use of biological control agents. The water hyacinth is a native of Brazil and natural predators are being sought in the Amazon basin. A beetle that pupates solely under the leaves and which was successful in massively reducing the water hyacinth in southern USA has been released, but so far with little result. Other possibilities are being investigated including a fungus that is naturally occurring in Lake Victoria. Uganda=s fisheries department is proposing the use of two herbicides to kill the water hyacinth but there are concerns over the toxicity of these chemicals. Furthermore, killing the weed by physical or chemical means, and allowing it to decompose in the lake could potentially kill huge numbers of fish as the decay process consumes oxygen.

Even if the water hyacinth can be controlled that still leaves the underlying problem of a huge added influx of nutrients into the lake which is likely to encourage algae blooms or proliferation of other weeds. Two primary problems that will need to be solved if biodiversity is to be conserved are nutrient run-off from agricultural lands and the discharge of untreated sewage.

Pesticides

Another source of chemical pollution that affects the biodiversity of wetlands is the application of pesticides in association with intensive agricultural practices. Most of the adverse criticism has been directed against the chlorinated hydrocarbon group of insecticides which include DDT and Dieldrin. These chemicals are toxic not only to target pests but to other organisms as well, and they are highly persistent. They can be ingested by algae and bacteria at the bottom of the food chain, and then be taken up by zooplankton, and they in turn are consumed by insects, shrimps and small fish. These creatures are preyed upon by larger fish, until the chemicals reach the fish-eating birds, such as cormorants and ospreys, and humans at the top of the food chain. As the chemicals progress up the food chain, they accumulate the chemicals at higher and higher concentrations, until they begin interfering with the metabolism and reproduction of organisms. In birds of prey, DDT has been found to reduce the thickness of eggshells which in turn has reduced the number of successful hatchings.

It is seldom that comprehensive impact studies of pesticide use can be undertaken in poor countries. Not long ago, huge volumes of insecticide were sprayed over Botswana=s Okavango swamps in an attempt to eradicate Tsetse fly. The impact on other organisms was not quantified.

Habitat restoration

Soils are also subject to pollution. Excessive amounts of heavy metals in the soil are toxic to plants, fungi and soil microbes and permit only a few resistant species to flourish. But toxicity is only one of the problems associated with soil pollution. Some of the principal obstacles to reclaiming spoil heaps and surrounding lands at the massive Wankie Colliery in Zimbabwe derive from the mudstones left on the surface. They include:

1. the acidity of mudstones which prevents plants from growing and causes pollution in the rivers;
2. the deficiency of both phosphorus and nitrogen which are essential nutrients for plant growth;
3. compaction of the surface which makes it difficult for water to enter the soil and reach plant roots;
4. spontaneous combustion of the carbonaceous shale found above the coal seam;
5. rain running off steep slopes causes erosion and gullies and a shortage of water in the soil; and
6. steep slopes which prevent machine access for adding lime and fertilizer.

Despite these impediments, there is a successful rehabilitation programme at the colliery which addresses each of these problems in turn. Shale piles are flattened and compressed by bulldozers, shutting out the oxygen before fires begin. The surface of the land is then ripped by large machines just before planting to ensure that water and roots can penetrate. Acidity is neutralized with lime which is mixed with phosphorus as a fertilizer. Plants selected for re-vegetation are chosen for their capacity to withstand hot and dry conditions: their seeds are collected locally and legume seeds are inoculated with rhizobium bacteria to encourage the rhizobium nodules to start growing. These nodules enable the leguminous plants to fix nitrogen from the air leading to further enrichment of the soil. Beyond this, whole baobab trees are transplanted and ponds and pans have been created enabling the restoration of a diverse assemblage of species in a relatively short period.

Atmospheric pollution

Industrialised regions suffer the worst affects of air pollution from soot, smog, sulphur dioxide and other noxious gases. These atmospheric pollutants are known to have particularly severe impacts on biodiversity, raising the acidity of rain which in turn causes acidification of rivers and lakes, often at considerable distances from the factories. In developing countries, urban related problems are usually confined to coastal regions and localised pockets of industrial development.
One aspect of atmospheric pollution which is affecting all parts of the world is the rising level of emission of greenhouse gases. Carbon dioxide, methane, chlorofluorocarbons and other greenhouse gases are implicated in the warming of the Earth=s climate. In northern countries, burning of fossil fuels is releasing large quantities of carbon dioxide. The rapid depletion of vast areas of woodland and forest in tropical countries is also contributing to elevated levels of atmospheric carbon dioxide. It now appears inevitable that climate will change rapidly around the world over the current century.

If even the most conservative projections of global warming prove to be correct, the world=s fauna and flora will be trapped between two deadly processes. On the one hand, they are being swiftly reduced by deforestation and the loss of other natural habitats, on the other they are being threatened by climate change. As the warmer climate moves north and south in each hemisphere, reaching out towards the poles and upwards to the mountain tops, the plants and animals that are isolated within small parks and reserves will be unable to migrate to, or colonise, suitable land within their tolerated climate range.

Conservationists have only just begun to grapple with the consequences of climate change. One priority will be the need to modify protected area networks so that they provide a continuous coverage across a wide range in precipitation and temperature. Existing parks and reserves rarely provide a continuous zone of protection across a wide range in climate, so new corridors and additional protected areas will be needed to enable specialist species with a narrow tolerance in climate to migrate along a gradient to more suitable locations. Only in this way will the full spectrum of plants and animals be conserved over the coming decades of change.

Chapter 3: Current Issues in Conservation Practice

The rate and scale of the activities and environmental changes indicated in Chapter 2 threaten to overwhelm biodiversity in many parts of the world. Conservationists recognise that they must improve the effectiveness of the conservation business itself if they are to slow down and eventually reverse the decline in biodiversity. Success is more likely to follow where the vision to conserve is accompanied by clear objectives, careful and well-informed planning, sound management practice and sufficient resources. In this chapter, recent developments in the conservation movement, and in the funding of conservation, are described together with some new approaches to biodiversity management.

Recent History of Conservation

In his opening speech at the Symposium on Conservation of Nature and Natural Resources in Modern African States held in the town of Arusha in September 1961, Mwalimu Julius K. Nyerere made a statement about the survival of wildlife which has guided biodiversity conservation in Tanzania and far beyond over the past four decades. In what has become known as the Arusha Manifesto, the President declared:

"The survival of our wildlife is a matter of grave concern to all of us in Africa. These wild creatures amid the wild places they inhabit are not only important as a source of wonder and inspiration but are an integral part of our natural resources and of our future livelihood and well-being.

In accepting the trusteeship of our wildlife we solemnly declare that we will do everything in our power to make sure that our children's grandchildren will be able to enjoy this rich and precious inheritance.

The conservation of wildlife and wild places calls for specialist knowledge, trained manpower and money and we look to other nations to co-operate in this important task - the success or failure of which not only affects the Continent of Africa but the rest of the world as well"

The conference was organised by the International Union for the Conservation of Nature (subsequently renamed as the World Conservation Union, but it has kept the earlier acronym, IUCN) and held under the auspices of the Food and Agriculture Organisation of the United Nations (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). In the same week, the World Wildlife Fund (WWF, now known as the World Wide Fund For Nature in all countries except USA) was officially founded and the age of international concern for wildlife conservation was about to begin. At this stage the main concerns of the conservation movement were to protect endangered species of wildlife and threatened habitats, but it soon became apparent that a deeper analysis of conservation problems was required.

A new paradigm for conservation emerged in the 1980s with the publication of the *World*

Conservation Strategy (1980) by IUCN, WWF and the United Nations Environment Programme (UNEP). It stressed the interdependence of conservation and development and recommended a new approach based on the idea of sustainable use of natural resources. Wildlife habitats were viewed as systems which provided valuable commodities, including building materials, food and medicines; they also performed essential economic services, such as watershed protection and provided a sources of employment through tourism. Ten years later, the same three organizations formulated a new strategy for the 1990s: *Caring for the Earth* (1991) builds on all that had been learned in the previous decade about the complexity of the problems and shows just how radical and far reaching are the actions and objectives that will be needed in order to bring about sustainable living.

Recognising that poorer countries in the tropics are often the most wealthy in terms of biodiversity, the IUCN began in the late 1980s to explore the use of economic incentives as a means of supporting the conservation of biodiversity *in situ*. In particular it recognised the rights of producer countries that are rich in biodiversity to share in the benefits generated in rich countries using their resources. IUCN proposed new funding mechanisms such as trade tariffs and royalty payments on the sale of commodities that incorporated products of biological resources from other countries. These ideas stimulated extensive discussion which led to the recognition that existing international conventions addressed only specific components of biodiversity (Box 7) and that a new global treaty on biodiversity conservation was urgently needed.

Box 7

Biodiversity Related Conventions

There are a number of legally binding conventions including:-

The 1971 **Ramsar** Convention on Wetlands seeks to protect these biologically-rich but undervalued ecosystems;

The 1972 Convention for the Protection of the **World** Cultural and Natural **Heritage** identifies sites of outstanding universal value, and provides support for their protection and management;

The 1973 Convention on International Trade in Endangered Species (CITES) is a binding international treaty, regulating trade in plants and wildlife to help protect species threatened with extinction;

The 1979 Bonn Convention on Migratory Species co-ordinates regional and global efforts to protect some 10,000 migratory species, including birds, dolphins and marine turtles;

The 1992 Framework Convention on **Climate Change** was negotiated in response to anticipated environmental damage, and aims to mitigate climate change impacts;

The 1994 Convention to Combat **Desertification** is a comprehensive approach to reducing desertification and drought.

Conceived as an ambitious international framework for reversing the losses to global

biodiversity, the Convention on Biological Diversity (CBD) was adopted on 22 May 1992, in Nairobi, and signed by over 150 states on 5 June 1992 at the United Nations Conference on Environment and Development. The overall aims of the Convention are the conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising from utilisation of genetic resources.

The Convention, which has global coverage, recognises the Asovereign right≅ of nations to Aexploit their own resources pursuant to their own environmental policies≅. However, each Party to the Convention also has responsibility for the conservation and sustainable use of its own biological diversity, and is expected to integrate consideration of the conservation and sustainable use of biological resources into national plans, programs and policies for sectors such as agriculture, fisheries and forestry, and also to take account of biodiversity within cross-sectoral matters such as land-use planning and decision making.

The Convention also calls on the Parties to take into account the special needs of developing countries, with new and additional financial resources and appropriate access to relevant technologies. The Global Environment Facility (GEF) is the interim financing mechanism for the Convention and provides grants and concessionary funds.

Despite worldwide publicity and a high level of commitment to the Convention demonstrated by world leaders in Rio de Janeiro, nine years later it is clear that the world=s biodiversity has continued to deteriorate rapidly. However, lack of progress on the ground does not necessarily mean lack of progress in society. The profile of biodiversity and conservation issues has increased rapidly in governments, other organisations and the world=s media. The move towards sustainable development has greatly increased the acceptance of conservation goals by politicians and society in general. Major advances have occurred in the environmental sector in relation to the state of knowledge, strength of institutions and technological expertise, all of which could contribute to the sustainable use of our environment.

Park Management

The early parks and game departments in Africa were organised along paramilitary lines in which uniformed staff followed strict codes of discipline and conduct. The wardens usually had a military background and took command of a ranger force that was responsible for policing the park and neighbouring communities and intercepting and arresting armed poachers. In many respects the management of the park depended on *ad hoc* decision-making. If the Chief Park Warden thought wild dogs were a threat to other animals, they would be shot. On the other hand, a wildebeest might be shot to provide food for lion cubs if they looked thin.

The modern style of park management began to appear in the 1970s with the advent of ecological research and monitoring programmes within parks and reserves. Scientists demonstrated that wildlife populations could fluctuate in number because of natural processes operating at the ecosystem level, and that sound management required an understanding of the ecology of parks and of the status and trends of animal and plant

populations. At the same time, long-term studies of individual animals revealed that even the fiercest predators displayed aspects of social behaviour, including maternal care, altruism and play. These discoveries and their portrayal in films and books changed the image of predators in the public=s eye to the extent that they no longer could be excluded from the protection afforded to other animals.

By the 1980s, the tough line being taken on local villagers caught inside national parks was being questioned, particularly where poaching activities were confined to subsistence gathering or hunting on lands that had traditionally been occupied or used by the local communities prior to the establishment of the protected area. In some countries, relations between the parks and local communities deteriorated to such an extent that parliamentary members with constituencies that bordered upon parks were being elected on an anti-parks ticket. Concerns about the future of protected areas within an increasingly hostile local environment led to the first community-oriented conservation programmes and the introduction of the concept of benefit sharing and community participation in management decision-making.

Management plans

As the task of managing parks became more complex, there was an increasing need for a more rational basis for planning and decision-making. The first park management plans appeared in the 1970s and it soon became a basic principal of protected area management that every park should develop its own management plan, although not until the1990s were they in widespread use in Africa.

Before preparing a management plan, an assessment is made of the conservation value of the area, including its biological, physical and cultural attributes, and of the threats to these values. The management plan itself sets out the permitted uses of the protected area and its natural resources, and the conditions which regulate development of facilities needed to support the management of that use. It should also identify all those parties and organisations having a direct interest in or authority over resource use in the protected area, or who are affected by resource use therein.

Central to the plan is a statement of goals and objectives: they are of the greatest importance as they will guide all management actions to be implemented in the area. Ideally, there should be a single overall goal that is carefully and precisely worded. Plans containing more than one primary objective, such as Afor recreational use and wildlife preservation≅ can lead to confusion. Lesser objectives are devised for each operational area which will support the primary objective, for instance sub-objectives might be formulated for law enforcement, the community programme, tourism and infrastructure development.

Management plans provide guidance for a specified time-period, commonly five years. They are part of an ongoing process and subject to modification as new information is obtained, particularly feedback on the effectiveness and impact of actions taken.
The goals and objectives of the management plan are the basis for determining what actions to take, when they will be taken, and the budget, personnel and equipment needed for their implementation. In planning activities and resource requirements, some management plans

presuppose ideal conditions that do not recognise real weaknesses in the present management system. Whilst they can be valuable as a fund-raising tool and as a basis for negotiations with government or potential donors, such plans are of little use to park wardens with a limited budget. Hence, it is important to distinguish between plans that aim to develop effective management over the longer term from an increased source of revenue, and those operational plans that use currently available resources to schedule implementation of feasible priorities.

Zoning parks
Most protected areas will be zoned for different objectives and uses. This allows management to provide for a variety of needs whilst minimising conflict between them. For example, a large Park might contain the following zones:

a) High Density Tourism Zone;
b) Low Density Wilderness Zone;
c) Protection Zone (for endangered species or habitat);
d) Research Zone (as a control area for monitoring changes in plant and animal populations); and
e) Buffer Zone or Utilisation Zone.

Different uses are allowed or prohibited in each zone, and management can also constrain specific activities to within permitted levels, by setting limits of acceptable use or change for each zone. For example, these limits might be applied to the following indices of use:

a) number of beds for tourist accommodation;
b) number of campsites;
c) road density;
d) vehicle density; and
e) frequency of poaching incidents.

These limits on human activity should not be confused with ecological limits. Some conservationists argue for close management of ecosystems by imposing strict limits to animal population size or tree density. Past experience has shown that intense management of animal populations can have unexpected and undesirable consequences. Any such limits should only be applied after detailed ecological studies of the species concerned and in the presence of a well-established, properly funded, ecosystem monitoring programme.

Biodiversity and Conflict

In the wider landscape, conflicts between development and biodiversity arise as a consequence of the over-exploitation of natural resources bringing about a direct loss of wildlife species and habitats. Equally problematical to biodiversity is the intensification of production systems. In replacing mixed production with monocultures, diverse low input cropping systems are replaced by genetically uniform production systems. Equally damaging to biodiversity are the intensive control measures taken by the modern farming system against weeds, pests and vermin. Many of these species have useful functions in the ecosystem.

National and international policy change in the form of subsidised prices or trade liberalisation impact strongly on the intensity of resource use. Without support at the local level, policy reform can bring about large scale losses in biodiversity through over-exploitation of natural resources or over-intensification of land use.

Resource-use Conflicts

Growing tensions are evident in many countries between proponents for alternative forms of land use. Disputes typically arise where natural resources are exploited for commercial gain and where biodiversity is perceived to be harmful to the production process (Box 8).

In Africa and Asia there is a growing incidence of conflict between people and elephants. The causes of the increasing conflict are instructive as with minor modification they can be applied to many other species. Firstly, the intensification of agriculture and its expansion into formerly marginal areas of land has greatly increased the zone of contact between people and wildlife populations. Secondly, the demands on resources of the management authorities in many countries have increased, but budgets and staff numbers have declined. Thirdly, the specific reasons why elephants raid crops have not been fully explored, nor have cost-effective and non-lethal methods of deterring this behaviour been adequately developed.

A number of national and international projects are pioneering a new Conflict Resolution Management approach that aims to reconcile environmental conflicts by developing and testing smart management systems. New methodologies that enable more precise management of biodiversity include: acoustic and chemical repellents; aversive conditioning; pheromonal deterrents; improved design of barrier systems and refugia; supplementary feeding; animal translocations; indirect vaccination; and the management of reproduction and breeding.

Box 8

Resource-use Conflicts in Scotland

The natural resources of Scotland have long been exploited for the production of income by its people, firstly as a means of making a living in farming, forestry and commercial fishing and secondly in the sporting pursuits of hunting, shooting and rod fishing. More recently a greatly increased demand for recreational and aesthetic qualities of the Scottish environment has brought into play a conflict of interests between traditional and contemporary values in society.

The historian, Chris Smout, identifies three post-romantic attitudes to the Highlands that have an increasingly powerful impact in the environmental debate: firstly a sporting recreational use by outside visitors including climbing, rambling, skiing, sailing, biking and many other outdoor pursuits; secondly the desire to experience “unspoiled landscape as refreshment to the spirit”, an attitude that led to the recent establishment of the first national parks; thirdly an attitude that regards land and water as habitats for plants and animals worth preserving for their own sake.

The principal means of environmental intervention by Government has been a combination of regulatory controls and subsidies, including improvement grants, compensation payments and other incentive schemes.

Trade Policies

The integration of subsistence farmers and other small-scale producers into national markets is assisting in the process of rural development, but at the same time it is increasing the influence of global markets and global prices on local patterns of production. Natural resources are frequently undervalued in global markets because little or no account is taken of external costs and benefits in the environment. The removal of policy barriers has stimulated a global decline in primary commodity prices which may in turn give rise to short cuts in production methods that are damaging to the environment. On the other hand, trade liberalisation can also stimulate markets for new products. The changes can have both positive and negative effects on biodiversity.

Trade liberalisation impacts negatively on biodiversity in a number of different ways: it may increase demand for natural resources; through price competitiveness; it may encourage poor environmental standards in production; it tends to shift production in the type of crops grown to those that serve export production rather than domestic consumption; it leads to the importation of fertilisers, pesticides and other goods that may deplete biodiversity; it encourages standardisation of products and uniformity in their size, colour and taste; and it brings sophisticated new technologies, including weapons and more efficient machinery for extracting resources.

There are also opportunities for bringing benefits to the environment with trade liberalisation. Voluntary labelling is becoming popular. It informs the consumer about the biodiversity consequences of their choices and may operate in association with fair trading practices. Green fair trade products can add value to biodiversity and help to improve its conservation.

Ecosystem Management

The management of natural resources such as timber, antelope, tuna or shellfish for large scale production purposes has usually concerned itself with single target species, or small numbers of similar species. Sometimes annual harvests have been limited to a sustainable level by the introduction of quotas or by restricting hunting and harvesting effort in other ways, but all too often populations have been exploited with little restraint until they no longer offer an economically viable yield.

In the case of sport hunting, a sustainable annual harvest is more likely to be achieved because of the high added value of the sporting or trophy aspect of the target as compared with the value from the meat, skin or other direct product. But usually nothing is done to ameliorate the impact of sport hunting or wildlife harvesting on other, non-target plants and animals in the ecosystem, or for that matter, on the habitat and wider ecosystem. In fact, gamekeepers often reduce populations of predators, such as eagles, hawks, foxes and mink (*Mustela* spp.) on grouse moors and duck marshes, or formally, hyaenas and wild dogs in African game reserves.

As the old static view of nature has been replaced with a more realistic one which recognises that life=s processes are cyclic, dynamic and interactive, the need for integrated management

of ecosystems has become more apparent. Ecosystem management has been defined as the management of natural resources using systems-wide concepts to ensure that all plants, animals, fungi and micro-organisms in an ecosystem are conserved in their natural habitats, and that basic ecosystem processes are perpetuated indefinitely. In other words, the aim is to manage ecosystems not just for the immediate goods and services that they provide to society, but also so as to ensure that the extraction and use of these commodities and amenities does not damage the functioning of the ecosystem (Box 9).

Box 9

Some Conservation Issues in the Management of Ecosystems

Keystone species: certain species are important in determining the ability of large numbers of other species to persist in ecosystems. For instance, flying foxes (genus *Pteropus)* are often the only pollinators and seed dispersers of hundreds of tropical plants on islands of the South Pacific. Protecting such keystone species is a priority for conservation efforts.

Critical resources: some habitats may contain critically limiting resources that occupy only a small area. For example, mangrove forests occupy shallow intertidal coastal areas with muddy bottoms and provide essential feeding and breeding grounds for many estuarine and marine fishes and crustaceans. Salt licks provide essential minerals for wildlife, particularly in areas of heavy rainfall where salts are leached from the soil. Protecting such Acritical resources≅ is of crucial importance in maintaining many animals populations.

By-catches: in fisheries this is the name given to the accidental harvesting of non-target species, which can be sufficiently great to cause concern over their conservation. For example the by-catch from netting yellowfin tuna in the tropical Pacific Ocean includes dolphins, whilst that of long-lining for tuna in the southern oceans includes albatrosses (*Diomedea* spp) and other seabirds. In terrestrial ecosystems, one of the problems with the use of wire snares is that they are unselective and can pose a threat to rare species.

Ecologically-and Economically sustainable harvests: hunting of target species can be so intense as to threaten their future, as with the stocks of many marine fisheries. In terrestrial systems, it has been noted that intensive hunting in tropical forests may actually be sustainable, but that populations are driven to such a low level that some species can no longer perform a critical function in the ecosystem, such as dispersing seeds. It therefore becomes necessary to determine *ecologically sustainable* methods in order to manage the ecosystem wisely.

Managing entire ecosystems requires a broader vision and much greater capacity on the part of management authorities. In the first place, there is the need to consider what effects harvesting of target species will have on other species and on ecosystem processes. Then, there is the need to adjust to the scale at which these natural processes operate, usually at a

much broader scale than that dealt with by single agencies in the past, perhaps encompassing vast landscapes and stretches of ocean. In this expanded world, managers learn to cooperate across political and sectoral boundaries, are guided by leadership at the national or international policy level and accept a high level of monitoring of their work (Box 10).

Box 10

Mesoamerican Barrier Reef System

Lying on the western edge of the Caribbean Sea, the MBRS is the largest barrier reef system in the northern hemisphere, with offshore atolls, sandy cays, mangrove forests, beds of seagrasses, coastal lagoons and estuaries. It has spectacular underwater scenery with Ablue holes≅ and is an important habitat for threatened species such as leatherback, loggerhead, hawksbill, and green turtles, Caribbean manatees, American and Morelet=s crocodile; and many species of birds, including the red-footed booby, magnificent frigatebird, brown pelican, brown noddy and sooty Tern

Maya Indians used the cays (sandy islets and reefs) between 300 BC and 900 AD. Today the reefs are still used by fishermen and are extremely important to the well-being of the fishing industry. There are small tourist industries, but the full economic potential of reef resources has yet to be realized, and the protection they give to the shoreline is under-valued. Potential threats arising from human activities include siltation from soil erosion (which smothers coral preventing photosynthesis and filter feeding), pollution from herbicides and pesticides, coastal construction and developments, oil production, collection of coral and shells, poaching of manatees and sea turtles, and overfishing of commercially valuable fin fish.

The governments of Belize, Guatemala, Honduras and Mexico have agreed to manage the entire reef cooperatively. Institutional development to achieve effective management of regional fisheries and a network of protected areas will be an essential part of this agreement.

Uniting and coordinating different management authorities and other interested parties behind a single ecosystem management plan is never an easy task, but there is no other way in which an ecosystem can be managed effectively. The ecosystem management plan itself specifies the biological limits that can be imposed on the system: the number of trees cut, monkeys shot, fish harvested, medicinal plants collected and so forth. It should also set out the law enforcement programme which ensures that those harvesting natural resources within the ecosystem comply with these limits. It may proscribe additional limits on the harvesting effort in terms of the length of closed season, size of open areas, or ceiling in the numbers of people, guns, vehicles or boats taking part in the harvest. The plan can also specify the type of harvesting equipment that is permitted, banning the use of damaging and unselective equipment and gear.

Funding Conservation

Increasing demand for wildlife and wildlife products over the past few decades has been linked to higher levels of income, especially in urban centres. The inflated prices that are offered for products such as ivory, horn, bone, fine wools and bush meat have increased pressure on populations of elephant, rhinoceros, tiger, many primates, duikers, antelopes and other wild species. Economists have warned that the trend is bound to continue. As the threats to biodiversity have increased, so inevitably the demands on management have risen, and conservation has become steadily more complex and more expensive. The modern tools of the wildlife manager now include stakeholder participation projects, park management plans, sophisticated law enforcement measures, monitoring of private enterprise, educational campaigns, surveys of wildlife populations, and performance evaluation, all of which require more resources.

Increasing demands for conservation have come just as government revenues of many developing countries have been static or declining. The smaller incomes have to be spread further so as to cope with growing populations in need of education and health care and to service burdensome foreign debts. Not surprisingly, the financial resources put at the disposal of wildlife authorities in many of these countries have dropped by 90 per cent or more over the past 30 years. The annual budget for protected areas conservation in the poorest developing nations can be as little as US$100,000.

At the international level, the need for financial assistance to help less developed countries to meet conservation targets has long been recognised. Some bilateral and multilateral development aid has been directly targeted at biodiversity conservation in response to this need. But biodiversity issues also crop up in a number of traditional sectors, such as energy, transport, agriculture, health, mining, forestry etc. The international development assistance provided in these sectors has impacted on biodiversity in many ways, some of which have been far from beneficial. In recent years conservationists have begun to persuade these sectors to give biodiversity an explicit role in project and policy formulation and in funding commitments.

In the past, the private sector has played only an indirect role in biodiversity conservation, largely dependent on the inclinations of particular land-owners, but in recent decades some governments have encouraged the private sector to play a more direct role in supporting conservation measures. Today biodiversity conservation is being pursued in a variety of different sectors, through a diverse mix of projects and programmes, and with funds that derive from both public and private sources.

Government treasury

The principal source of finance for most protected area systems is still the government treasury: it remains central to the whole conservation effort in that it represents the nation’s commitment to conservation and provides a secure funding base that, if sufficient, allows long-term strategic planning. Governments may recover their outgoings on biodiversity conservation by capturing some of the global willingness-to-pay for biodiversity through

nature-based tourism. Traditionally, park revenues from entrance fees, permit fees and fines are passed directly to national treasuries, so that these funds are not necessarily reinvested in conservation. In fact, government funding for protected area systems in many developing countries is typically both inadequate and unreliable; a state of affairs which undermines staff morale and interferes with the essential long-term planning process.

Some governments allow protected areas or the central protected area institution to retain revenue. For instance, revenue raised from gorilla trekking in two national parks makes up one third of the annual income of the Ugandan Wildlife Authority. In another example, all foreign visitors entering Belize pay a small fee which goes directly into the Protected Areas Conservation Trust fund. It is expected to contribute US$2 million per year for conservation.

Concern has been expressed about the growing reliance on tourism for revenue to self-finance conservation. The international tourism industry is known to be volatile, being affected by political instability and unpredictable events such as foreign exchange rate fluctuations or the sudden imposition of quarantine restrictions. There may also be pressure on park managers who are dependent on tourism revenues to manage biodiversity for tourism benefits rather than for conservation.

International assistance

Funding for beleaguered protected areas networks and conservation programmes has been forthcoming form a variety of international sources, including multilateral institutions (principally the World Bank Group, UN specialised agencies and regional development banks), individual donor governments, non-governmental organizations (NGOs) and private foundations. Studies have shown that the level of foreign aid for protected areas is positively, if weakly, related to the diversity of habitats in tropical countries, suggesting that donors have appraised the biological richness of a country in their allocation of aid.

The Global Environment Facility (GEF) is the interim financing mechanism for the Convention on Biological Diversity and provides grants and concessionary funds to developing countries for projects and activities that aim to protect the global environment, including biodiversity. Developing countries can obtain GEF funding to meet the added cost of protecting some unique environments within the overall framework of their national development programmes. The GEF will also meet the costs of preparing national biodiversity strategies and programmes.

Despite these measures, there are indications that donor funding in support of protected area conservation is inadequate; moreover, it is unreliable in that donors may withdraw support or lose interest in biodiversity conservation. The biggest problem, however, is that the typical 3-5 year project cycle of donor-led conservation is insufficient for overseeing the fundamental changes now widely accepted as essential, involving biological limits to harvesting, sustainable use of natural resources, democratization of institutions, decentralization and stakeholder participation. Starting dialogue on these new approaches and then letting people down before they are working effectively, only serves to disappoint and reverse the hoped-for outcome.

A small number of donors, more usually NGOs have made a longer-term commitment to conservation in a specific protected area or species-conservation programme. For example, the Frankfurt Zoological Society has given 30 years of financial support to the Serengeti National Park in Tanzania. It is more difficult for a donor government to make such a long commitment because it has to work within shorter-term budgets.

Trust funds

One successful approach to providing the financial security for long-term conservation programmes is through the establishment of trust funds. These use the income from a large capital endowment to provide financial support in perpetuity. In most cases they are managed by a board of governors representing both the public and private sectors. The board disburses the income from the capital investment to executing agencies (usually government authorities or NGOs) for conservation projects deemed eligible according to the Trust's by-laws.

For example, the Mgahinga-Bwindi Impenetrable Forest Conservation Trust (MBIFCT) in Uganda raised funds from bilateral donors to support operations and projects for its first seven years, so that income from the endowment could be capitalized rather than spent. Conservation trust funds are most successful when the trust itself gets involved, participating in developing national conservation strategies, working with other public and private agencies to develop management approaches, and supporting community groups and other organizations that are becoming involved in biodiversity conservation for the first time. A recent review has recommended that trusts could also improve their effectiveness by defining more closely their intended impacts on biodiversity conservation and sustainable use, and by developing performance indicators and simple but useful monitoring and evaluation systems, to measure progress toward objectives.

A variety of international donors have been involved in establishing trust funds including WWF, IUCN, UNDP, GEF, and several donor governments. Private foundations have also played a leading role, as have some commercial banks. But despite the many advantages of trust funds they have not yet achieved widespread acceptance. There are few internationally funded trusts in Africa for example, and some major multilateral donors have yet to participate in their establishment. Considering the lack of secure long-term financing at present in many poor countries, Trust funds would appear to provide a very appropriate mechanism to address the needs of long-term biodiversity conservation.

Private sector involvement

Many of the successful conservation efforts in tropical regions have benefited from private sector involvement or ownership in one form or another. At the institutional level, some wildlife agencies are taking steps to privatise parts of their operation, for example, making use of private contractors to manage such operations as tourist bookings, transport, computer networks and monitoring of animal populations. This restructuring of the organisation frees senior management to focus on essential services such as planning, legislation and law enforcement.

At the project level, a number of innovative conservation programmes have sought to raise funds for conservation by breeding endangered or threatened species in captivity and then marketing wildlife products, often with the assistance of the private sector. A new exemption on ranching was introduced by CITES in 1981 to allow commercial exploitation of Appendix I species which had been taken from the wild as part of successful conservation programmes. For the moment, essentially only crocodilians have benefited from ranching although a successful crocodile farming operation could indirectly benefit many other species as well. A recent study concluded that revenue generated by a single crocodile ranch in southern Ethiopia could potentially support the operation of all protected areas in the region, provided that the crocodile skins were marketed efficiently under a management contract. Records show that illegal trade in the larger alligator and crocodilian skins has all but disappeared thanks to the careful ranching practices that include registration of commercial breeding operations, quota setting, and tagging of hides from legal sources.

Whilst these are impressive achievements, opinion varies as to whether success is solely because of the biological characteristics of this species. The recent recovery of the vicuña following a trade ban and protection, indicates that the ranching model provided by the Nile crocodile may indeed be transferable to other species under the right management conditions In the case of the vicuña, traditional systems of management and harvesting of Peruvian populations have been re-instated to allow regulated trade that is supplied by sustainably harvested wool (Box 11). Proposals for the farming of marine turtles and some timber species, have already been submitted or are being considered by CITES.

Some Parties to CITES are not satisfied with the nature and pace of the opening-up of trade, others consider that the conservation aims dictate continued dominance of the precautionary principle. For instance, some Parties in southern Africa have requested permission to supply stocks of ivory to Japan where there is a strong demand, but others point out that opening up the legal trade in ivory will inevitably lead to renewed escalation in poaching of eastern, central and west African elephant populations.

Recent liberalisation of trade policies is influencing biodiversity in numerous ways. One important effect is an increased demand for the natural resources of developing countries. It is rightly feared that this may lead to over-exploitation of wildlife resources and conversion of natural habitats for more intensified agricultural use. But under the right circumstances, increased demand can provide economic incentives for sustainable management of natural resource use. The latter scenario is more likely where management institutions place high value on the future benefits to be gained from natural resources and can provide effective monitoring programmes. To date, there have been few examples of such wise use. One of the major challenges for conservationists in the future is finding a proper balance between the sustainable use principle and the precautionary principle.

Box 11

Commercial harvesting of Vicuña fleece

The smallest of the camelid species, the vicuña is adapted to alpine habitats at high altitude in the Andes. In the time of the ancient Incas, vicuñas were rounded up in large groups through a communal effort involving thousands of people known as chacu. The Incas captured vicuñas primarily to shear their fleece which was so prized for its fineness and softness that if anyone was found in possession, other than the ruler and his court, they faced execution. In today's open market a kilogram of fleece sells for more than US$500.

In more recent times, the value of the fleece worked against the species, and numbers declined as poachers shot whole family groups. By 1974, fewer than 8,000 animals survived. Widespread concern for the future of the species led to the vicuña being listed in Appendix I of CITES in an attempt to stop the illegal trade in the animals and their fleece. The ensuing conservation programme involving Peru, Chile, Argentina and Bolivia was so successful that numbers quickly recovered to reach over 100,000.

This recovery encouraged the Peruvian government to recommend a change in management involving the relaxation of Appendix I status to Appendix II in most habitats, together with the reinstatement of a village chacu programme to provide a commercial harvest of the fleece. Peru now has a labelling system that identifies all garments created through a government sanctioned chacu.

Genetic resources

In recent years it has become recognised that genetic material could provide an additional source of value in tropical regions which are home to a great diversity of living organisms. Genes, and the biochemicals that they encode, may have actual or potential value in a number of commercial applications, including the pharmaceutical and horticultural industries, in crop production, biotechnology and the manufacture of cosmetics, and in herbal medicines and personal care products.

The benefits from the commercial use of genetic resources have largely been enjoyed by the companies and research institutes of developed countries that have the technology and large investments required for product development. They are able to obtain intellectual property rights on plant varieties and patents on novel products as a means of protecting their investments.

The concern felt by many over the inequality of these arrangements was addressed by the Convention on Biological Diversity which requires "*the fair and equitable sharing of the benefits arising out of the utilization of genetic resources"*. The Convention emphasizes that access should be subject to the prior informed consent of the Party providing the resources, and on mutually agreed terms. Benefits can include finance, technology and participation in research.

Biodiversity has a regional distribution pattern and many of the genes and biochemicals represented in forests, crops, livestock or fish are shared across the region. The geography of genes provides an opportunity for regional cooperation in sustainable systems of

production and marketing, as illustrated by the rice crossing and gene conservation programmes of the West Africa Rice Development Association.

The Convention also highlights the need for benefit-sharing with local and indigenous communities, although it leaves benefit-sharing policy to be defined in national law. Indigenous and local communities have an important conservation role in the management of genetic resources: they depend on these resources for their livelihoods and cultural traditions, and have developed traditional knowledge about the uses and benefits of plant and animal products. In practice, few local communities have benefited from bio-prospecting so far.

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Some Useful Web Sites . . .

International Organizations

http://www.cgiar.org/cifor CIFOR
http://www.un.org/esa/sustdev/ United Nations, Division for Sustainable Development
http://www.fao.org/forestry Forestry Programme of the FAO
http://www.greenpeace.org/ Greenpeace International
http://www.itto.or.jp/ ITTO - International Tropical Timber Organisation
http://www.iucn.org IUCN - The World Conservation Union
http://www.oneworld.org/odi/ ODI - Overseas Development Institute
http://www.worldbank.org/ The World Bank Group
http://www.undp.org/ UNDP - United Nations Development Programme
http://www.unep.ch/ UNEP - United Nations Environment Programme
http://www.grida.no/climate/index.htm UNEP Climate Change pages

http://www.unesco.org/ UNESCO - United Nations Educational, Scientific and Cultural Organization
http://www.wcmc.org.uk World Conservation Monitoring Centre
http://www.iucn.org/themes/wcpa/index.html World Council of Protected Areas
http://www.wri.org World Resources Institute
http://www.panda.org WWF - Living Planet

Conventions

http://www.biodiv.org Convention on Biological Diversity
http://www.ramsar.org Ramsar Convention on Wetlands
http://www.unesco.org/whc Convention for the Protection of the World Cultural and Natural Heritage
http://www.wcmc.org.uk/CITES/index.shtml Convention on International Trade in Endangered Species (CITES).
http://www.wcmc.org.uk/cms Convention on Migratory Species
http://www.unfccc.de Convention on Climate Change
http://www.unccd.int Convention to Combat Desertification

Other

http://www.wcmc.org.uk/biodev/ Biodiversity in Development Project
http://www.nhm.ac.uk/science/projects/worldmap Biodiversity and World Map
http://www.ruwpa.st-and.ac.uk/distance Distance - for estimating animal abundance
http://endangered.fws.gov/cfr1711.pdf Endangered Species List (worldwide)
http://www.ghcc.msfc.nasa.gov/corredor/ Mesoamerican Biological Corridor project.
http://www-sp2000.nies.go.jp Species 2000 - Locates scientific names of organisms
http://www.campfire-zimbabwe.org CAMPFIRE Project
http://www.ecofac.org ECOFAC - The EC's Central African Forest Ecosystem Project
http://www.peaceparks.org.za Peace Parks Foundation
http://www.traffic.org TRAFFIC - the wildlife trade monitoring programme