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Wildlife Utilisation as an Instrument for Natural Habitat Conservation: A Survey of the Literature and of the Issues

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INTRODUCTION

There is undoubtedly a very substantial amount of value to be derived from the world's remaining natural habitat, and the biological diversity that it represents. (World Conservation Monitoring Centre [1992]). However, virtually all of this habitat resides in the developing world.[1] This is problematic because many of the values which derive from it are intangible (existence, options, information) and the bulk of this value probably resides in the developed countries.

The economic problem of natural habitat conservation, or <u>in situ</u> biological diversity conservation, is how to transfer the value existing in the developed world to the developing nations in a fashion that will create incentives to retain natural habitat into the future. It is a specific example of the general problem of identifying the instruments that are available to the international community in order to affect decisions concerning resources which are largely domestic in nature.

It is also an example of a very urgent international environmental problem, as significant irreversibilities are potentially implied over a relatively short time horizon. Throughout much of the developing world, population growth is occurring at historically unprecedented rates. In the next sixty years the world's human population is projected to nearly double (to about 9.1 billion), with 85% of these people in the developing countries. (Western,D. and Pearl,M. [1989]). Such population growth will contribute to the pressure to put all resources into their most valued use.

These forces have, over the past thirty years, already resulted in the conversion of vast amounts of natural habitat to specialised agricultural production. At current rates it is projected that in the next sixty years all remaining unprotected areas could fall victim to the forces of conversion. (Wilson,E. [1986]). Biologists predict, from the extrapolation of the current trend, that we are facing a period of mass extinctions in the next century which are nearly unrivalled in the fossil record. Many forecast a loss of 25 - 50% of all species over the next few decades. (Swanson,T. [1991]). Therefore, there is quite a significant amount of urgency involved in the need for a solution to this environmental problem.

To date, the approach to this problem which has been receiving the greatest emphasis has been the establishment of protected areas, of various categories, and the provision of international funding for this purpose. (Ledec,G. and Goodland,R. [1989]). Although this "preservationist" approach has had some marked success, there are two reasons why such successes must necessarily be limited. First, the international willingness to pay for intangible values must be less than the full value of the habitat.[2] Second, there can be no transfers across international boundaries regarding land use and development rights; hence, promises today regarding preservation do not necessarily represent immutable commitments to nondevelopment tomorrow.[3]

From this perspective the efficient utilisation of the tangible products of natural habitats may be one of the most effective instruments available for the conservation of that habitat. To a substantial extent the intangible values associated with natural habitat flow from the existence of the tangible ones, and from the synergism between them. Thus, development which creates incentives to invest in the maintenance of the tangible products of natural habitat has the ancillary benefit of conserving the intangible ones. Funds flowing from the North in payment for wildlife products should be able to act as direct and ongoing compensation for the wildlands retained in the South. Therefore, it is possible that a policy of managed wildlife utilisation could be an important instrument in the conservation of natural habitats.

The "preserve or convert" approach has previously implied that agricultural development cannot be compatible with biological diversity in any sort of a local or regional sense. Conversions of natural habitat have been compensated for by the establishment of small "banks" of biological diversity. This approach ignores the possibility that specific agricultural development projects might be made consistent with the maintenance of diversity.

The general purpose of this paper is to investigate whether other - intermediate - options exist. That is, this paper investigates whether there is the possibility of a strategy of sustainable agricultural development which is consistent with a given local stock of biological capital.[4]

The specific purpose of this paper is to investigate the role of "wildlife" - broadly interpreted as the flow of appropriable goods and services from a piece of natural habitat - in the maintenance of the habitat itself. Recently, a significant body of literature has developed within a wide range of disciplines concerning natural habitat utilisation; the object is to review this literature, and to place its diversity within the framework of the environmental economist.

I. Natural Habitat Production Versus Specialised Production

The process of converting natural habitats often represents a choice between natural habitat or specialised agricultural production on the land concerned. Of course, it is not the case that literally "natural" habitat exists, in the sense of habitat that is entirely devoid of human impact. With the possible exception of Antarctica, almost all habitat has evolved with a human component within it, to a greater or lesser extent. The distinction is then not a choice between habitat devoid of humans or that populated by them; rather, it is a distinction between different methods of production.

FIGURE I

DISTINCTIONS BETWEEN NATURAL HABITAT AND SPECIALISED PRODUCTION

Natural Habitat Production	Specialised Production
-diverse species	-one or few species
-little human intervention	-continuous intervention
-nonsegregated resource	-segregated resource base

Three key facets appear to distinguish specialised agricultural production from natural habitat production: specialisation, intervention and segregation. Specialisation arises when the methods of mass production are applied to natural resources. The mass production of a single commodity allows for the use of specialised capital goods (machinery, chemicals, bioengineered seed varieties) which have comparatively high rates of productivity when introduced. This means that specialisation results in substantial cost differentials between those resources processed by these methods and those for which such capital goods are not available or not utilised.[5]

Such capital goods require substantial minimum efficient scales in order to be cost-effective, both in their own production and in their application. This minimum efficient scale requirement means that only a few species are capable of production on a worldwide basis by use of these capital intensive methods. The logical consequence is that only a small number of species provide the bulk of the world's food. For example, of the thousands of species of plants which are deemed edible and adequate substitutes for human consumption, there are now only 20 species which produce the vast majority of the world's food. [Vietmeyer (1986)]. In fact, the 4 big carbohydrate crops (wheat, rice, maize and potatoes) feed more people than the next 26 crops combined. [Witt (1985)].

Another consequence of the mass production of a small number of species is the necessity of continuous human intervention. The introduction of these species into habitats to which they are not naturally adapted, and especially when intensive agriculture is being practiced, means that continuous human involvement is required in order to monitor the production process. Of course, nature is capable of producing biomass of its own accord through

natural photosynthetic processes, but once substantial components of the existing ecosystem are removed and new ones are introduced, continuous human intervention is usually necessary. In essence, the recalibration of the ecosystem production menu is a commitment to on-going (i.e. not a one-off) intervention.

The dynamics of this process are well-illustrated by the case of the recent introduction of synthetic organic pesticides throughout the agricultural world. The initial impact of these pesticides was phenomenal; increased production levels of 15-50% occurred with respect to many agricultural uses. In other applications, the World Health Organisation estimated that the use of DDT saved 15 million lives from malaria by 1965. (Conway and Pretty [1991]); (British Medical Association [1990]). However, these impacts were not long-standing. On the one hand, the natural predators of the targeted pests were often reduced to very small numbers. On the other hand, the use of pesticides triggered rapid evolutionary adaptation amongst many smaller organisms. The advent of pesticide-resistant pests in a system devoid of natural predators was the result. By 1984, 447 species of insects, 150 plant pathogens, and 50 weed varieties were known to have become resistant to various pesticides. (World Resources Institute [1984]).[6]

In this fashion, substantial human intervention becomes translated from a one-off into an on-going process, as the consequences of earlier activities require future interventions. Often the causal link between past intervention and necessary future intervention is not so obvious; however, it is generally true that the conversion to less diverse methods of production renders the resource base more vulnerable, and hence more continuous methods of monitoring and intervention become necessary as well.[7]

The third distinguishing facet of specialised agricultural production is the segregation of the resource base. Segregation by the clear designation of individual property rights, usually accomplished through fencing, is often necessary for optimal individual investments. This is because the incentives for optimal individual investments are most cost-effectively conferred by this method; it provides the means by which the expected returns to investment are internalised ex ante. The notion of asset ownership is especially important when the investment process is an on-going one. (Grossman,S., and Hart,O. [1986]). On account of the substantial capital investments required when specialised production techniques are introduced into natural habitat, segregation and specialisation go hand-in-hand

However, biologists have demonstrated a causal connection between the segregation of natural habitat and the extinction of species. Empirical studies have estimated that a reduction of 90 per cent. in the size of a particular piece of natural habitat will result in a halving of the number of species. (Wilson [1988]). Although it would seem to require dramatic changes to the habitat in order to achieve this magnitude of reduction, this

sort of impact could in fact be obtained by merely erecting two fences across the area.[8]

Therefore, the conversion of land from natural habitat production to specialised production results in a clear trade-off between productivity and variety. This is because the necessary components of specialised agricultural production, specialisation and segregation, foster the former while diminishing the latter.

The literature on natural habitat production raises the issue of whether this link between agricultural development and diversity destruction can be broken. There is a substantial amount of value being generated within the context of natural habitat; therefore, is it possible that, when this value is more fully fostered, appropriated and accounted for, the returns to natural habitat production might compare favourably with that of specialised production? If this is the case, then it is possible to contemplate a notion of sustainable development which is consistent with substantial amounts of diversity.

The literature which exists on this question can be broken down into three categories. First, there is the literature which demonstrates the **unaccounted for value** of natural habitat production. The implicit argument in this literature is that there exists substantial value from this method of production which is currently undervalued in systems of aggregate value measurement. This literature is the subject of Section II.

Secondly, there is a nascent literature on the issue of the **comparative value** of natural habitat production techniques. This literature attempts to assess the comparative value of production within a given habitat by either method, and several case studies show that the natural habitat mode of production is financially superior. This literature is the subject of Section III.

Thirdly, there is a developing literature which addresses some of the policy issues involved in natural habitat production. This literature addresses some of the **conflicts and problems implicit in fostering and appropriating the value** of natural habitats. Many of these problems are manifested in the nonsustainable utilisation of the habitat. These issues are the subject of Section IV.

To determine the form of diversity which is compatible with development, all of these issues need to be explored in greater detail. The role of "wildlife utilisation" in accomplishing sustainable development is part of this inquiry. Specifically, the nature of the human intervention required to more fully appropriate the value of natural habitat resources must be carefully explored, in order to ensure that the correct development paths are chosen.

II. The Appropriable Value of Natural Habitat Production

This section primarily surveys the various categories of appropriable value generated by natural habitat resources. It demonstrates that there is currently a substantial amount of appropriable value generated by resources retained as natural habitat. Much of this value is nevertheless unaccounted for, as it represents the contribution of such habitat to the subsistence of many societies; this value must be taken into consideration prior to conversion as it must be thereafter replaced. Natural habitats are also viable producers of many commodities which are not usually even thought of as "wildlife"; two-thirds of the value of natural habitat production is in the form of timber and fish. The other third of natural habitat production value derives from a wide range of species. These values appear to be increasing as the uniqueness, and increasing rarity, of the goods and services emanating from natural environments becomes more apparent. In fact, in some cases, consumers indicate a preference for the natural habitat produced commodity, and this preference can be expected to increase and to generalise as consumers are educated on this issue.[9]

This section is organised as a survey of the following categories of largely appropriable uses of natural habitat goods and services.

A. Domestic and Subsistence Use;
B. Traditional Commodities;
C. Unique Commodities: Goods; and
D. Unique Commodities: Services, including:

1. Viewing;
2. Recreating;
3. Existence;
4. General Ecosystem Services.

A. Domestic Use - Unaccounted for Subsistence Value

Natural habitats are still a primary food source for many peoples. Official estimates (from consumer surveys) indicate that a minimum of 900,000 tonnes of game meat (from terrestial sources) are consumed annually; this represents about 1% of worldwide meat consumption. In some individual states, and especially when water-sourced foods are included, these figures increase substantially.

FIGURE II.1
PROPORTION OF ANIMAL PROTEIN FROM NATURAL HABITATS

Percentage	Number of States
20-29	15
30-39	17
40-49	12
50+	19

Source: (Prescott-Allan,R. and C. [1982], p.23).

Of course, in the regions which still retain substantial amounts of natural habitat, these proportions are far greater. Throughout the whole of the Central African Republic, game is still a significant source of meat, supply 30-40% of the national meat consumption. (Doungoube,G. [1990]). Estimates of reliance upon game meat for protein consumption exceed 80% in the Ucayli and Central region of Peru; in the tropical rain forest regions of Ivory Coast and Cameroon, the estimated reliance rate is over 70%, as is the estimate for some parts of rural Ghana. (Ajayi [1979); Sale [1981]).

This indicates that, where natural habitat production remains a possibility, many of the products remain highly valued by the local peoples. Surveys of the prices existing in these markets also indicate that substantial demand still exists among indigenous peoples for the traditional products of a given region. In Benin, Cane Rat is four times as expensive as beef in rural and urban markets, the latter because urbanisation has occurred so recently. (Baptist and Mensch [1986]). In Cameroon, Ghana, Nigeria, Ivory Coast and Liberia, relatively favorable prices are afforded to a wide range of indigenous animals: giant snail, bushpigs, duikers, monkeys, brushtailed porcupine, red colobus, mangabeys and bushbucks. (Ajayi [1979], Martin [1987]).[10] In general, and as would be expected, local cultures' tastes seem to have adapted to the species available; there is plenty of evidence that there is no general preference by local peoples for the standardisation of agricultural commodities.

There are also a number of other unaccounted for benefits from existing natural habitats. The primary one, besides food, being fuel. About 85% of all timber used is for this purpose, and fuelwood still supplies a substantial proportion of all energy requirements for most people. In Africa, fuelwood accounts for 66% of all (non-animal) energy production; in Asia, this figure is 29%; and, in Latin America, the relevant figure is 20%. Again, there is a large differential dependence rate, depending on the local availability of supplies. One source says that nearly all rural households in Southeast Asia and Africa are wholly dependent on fuelwood for energy consumption. (Arnold and Jongma [1978]). The average daily consumption, among fuelwood reliant peoples, is 0.5 cubic metres in North Africa, 0.38 cubic metres in South Asia, 1.03 cubic metres in South America, and 1.14 cubic metres in East Africa. (FAO[1981]).

Another subsistence requirement met from natural habitat supplies is the provision of dwelling construction supplies. In Zimbabwe, 40,000 to 115,000 bundles of thatch are gathered annually by local tribes from Matobo National Park. The same exercise is conducted in Nepal's Royal Chitwan National Park. The implicit income derived from such exercises, by substituting products from natural habitats for marketed products, is about $60,000 in Zimbabwe and $600,000 in Nepal. (MacKinnon [1986]; Mishra [1984]).

Another case of the substitution of natural habitat

production for otherwise necessary market expenditures is in the provision of freshwater supplies. This becomes more and more expensive with more intensive utilisation of a greater share of resources; extensive water treatment facilities must be instituted to provide for freshwater when watersheds are utilised intensively. In Venezuela, this relationship has been recognized and natural habitat has been preserved for the express purpose of providing high quality water supplies to metropolitan areas with minimal water treatment costliness. (Garcia [1984]).

Natural habitat therefore directly produces valuable contributions to national food, fuel, water and housing supplies. In addition, there are various contributions of a less direct, but equally valuable, nature; these result when the maintenance of natural habitat assists in the production from other resources: soil conservation, fishery conservation and flood control are the clearest examples of these external benefits from natural habitat maintenance. The maintenance of the Korup National Reserve in Cameroon generates most of its value through the protection of mangrove fisheries at a substantial distance from it. (Ruitenbeek [1990]).

These contributions to national output already exist, but have never been adequately accounted for. It is essential to recognise that there can be no net gain to national welfare from the mere substitution of more market orientated production for this natural habitat production; the only advantage of the former is that it is more readily displayed in the national accounts, but this is not a fault of the method of production but rather a fault of the national accounting practices. Such production and consumption must be accounted for in national statistics. (Pearce,D., Barbier,E. and Markandya,A., [1990]).

B. Traditional Commodities from Natural Habitats

Some of the most comon commodities in international markets are produced by harvesting from natural habitats. Although these commodities are not commonly thought of as "wildlife", they certainly do represent the bulk of the product from natural habitats. Properly managed they represent a substantial and certain return to the retention of the habitats in a largely natural condition.

For example:

The two most significant products from natural habitat are, by far and away, fish and timber. Fish accounts for about $5.5 b. in annual exports; timber accounts for about $6 b. Many developing countries benefit substantially from this production. 28 countries export at least $10 m. of fish, and 7 of these export over $100 m. (FAO [1980]). 23 developing countries export at least $10m. worth of timber; 8 of these export more than $100m. worth. (FAO [1980]).

Natural rubber, when harvested by rubber tappers in the

Brazilian rainforests, earns those tappers a return competitive with the wages earned by the best-paid industrial workers in that country. (Guppy [1984]).

Several varieties of nuts are harvested both from domesticated farms and from natural habitats. The pistachio nut is still harvested from the wild in Iran and Afghanistan. (Maggs [1972]). The Brazil nut is still largely harvested from natural habitats. (Woodruff [1979]).

Numerous spices and flavourings are still harvested from natural habitats. For example, nearly all of the Central American exports of allspice are harvested from these sources, amounting to about $2 m. in annual exports. (Purseglove et. al. [1981]).

Plants, seeds and bulbs are taken in large quantities from their natural habitats. There are about 70m. such bulbs collected and exported in Turkey alone, at a price of about £20-90/1000. (Oryx [1989]).

An important point concerning this production is its capacity to compete with domestically produced varieties of the same kind. This indicates that in some uses there is no inherent inefficiency in the production of a wide range of commodities from natural habitats.

It is also important to note that there is often an in-built consumer preference for the goods which arise from natural habitat production, even though the goods are not necessarily physically distinguishable. For example, the price of wild salmon has typically cost a premium of 10-20% over that of farmed salmon in the U.K. fish markets, although the two are not visibly distinguishable. (Luxmoore and Swanson in litt.). This is possibly attributable to the difference in taste regarding the two varieties. However, another explanation is possible; viz. that the consumers are expressing their preferences for this particular manner of production, thus affording the animals a less intensively cultivated existence.[11] Once consumers are educated to appreciate that other habitats than those of poultry or salmon might be subsidised in this fashion, it is reasonable to assume that this value should be appropriable by other producers of wildlife as well. This issue is discussed in greater detail in Section IV.[12]

C. Products Uniquely Associated with Natural Habitats: Goods

The value of the production and trade in those products more readily recognised as "wildlife" is approximately equal in aggregate to the value of either the trade in timber or in fish; that is, the trade in such products is estimated to be at least $5 billion annually. (World Wildlife Fund [1986]). Now there are several excellent sources which catalogue the value of this trade. (Fitzgerald,S. [1989]; Prescott-Allan and Precott-Allan

[1989]). An indication of the species which generate the majority of this value is given by the following table which indicates the usual makeup of a year's wildlife imports to the U.S.

FIGURE II.2

ANNUAL IMPORTS OF WILDLIFE PRODUCTS INTO THE U.S.

Furs	$ 800 million
Reptiles	250 million
Ornamental Fish	30 million
Ivory	30 million
Birds	15 million
Shells	13 million
Corals	6 million

Source: Fitzgerald [1989].

There is also good reason to believe that the future values of these types of products can only increase, possibly producing a comparative advantage in the production of such goods. This is because as habitats is reduced, consumers recognise the obvious limitations in the quantities of these unique goods and services; hence, their prices are caused to rise. This is the source of the potential comparative advantage in the production of natural habitat goods and services; since the limitations on the availability of these resources are obvious (and largely irreversible), a prospective monopoly is conferred upon those countries possessing these types of resources.[13]

Since certain resources are only associated with this manner of production, products from these resources are considered to be as limited as are their available natural habitats; hence, these products acquire some of their value simply by virtue of the obvious habitat scarcity. In addition, many of these products have been utilised by humans for centuries. All of these resources' attributes, both their usefulness and their uniqueness, represent the means through which the value of natural habitats might be appropriated.[14]

For example:[15]

Rhinoceros products have been utilised throughout Asia for centuries. (Martin, E. and C. [1982]). Informal survey evidence indicates that prices have been rising rapidly from about $1500 per kg. in 1979 to $4600 per kg. in 1988 (African horn). (Martin [1989]). This value, approximately $200 per ounce, places this substance in the same class as gold and other rare and precious substances. This an indication of the inelasticity of the demand for this commodity; as the populations of rhinoceros have fallen from 60,000 to about 6,000 over the past 30 years (and the

volumes of horn in trade have declined correspondingly), the price of the horn has increased correspondingly. As the species has become more scarce, it is apparent that substitutes are not acceptable to these markets and prices escalate through competition for reduced supplies; there is a clear value being placed upon the unique qualities of this species. Obviously, the plight of the rhinoceros is not a happy one; it is the prototypical example of both the existence of unique species value and the failure to constructively manage this value.

Elephants have been utilised for their ivory for centuries as well, initially by Asian carvers. Again, studies of the inelasticity of demand indicate the traditional consumers refuse to accept substitutes for the elephant's unique characteristics. (Barbier, et. al. [1990]). Again the benefits of a prospective monopoly in the production of elephant ivory are clear. The trade in the 1980s indicated an annual export value of at least $50 m. in African elephant ivory, yet given the inelasticity of demand it is apparent that this same value was obtainable from a harvest which was a small fraction of that then occurring. An "elephant ivory cartel" would have been capable of procuring this value while vastly reducing the quantities of elephants killed for their ivory. (Swanson,T. [1989]; Swanson,T. and Pearce,D. [1989]).

In addition, it has already been demonstrated in practice that the value obtained from ivory sales can be put to the use of conserving the African elephant and its habitat. Zimbabwe alone captured about $8 m. in ivory value during this decade from its elephant culling program, while maintaining a stable population of elephants (c. 52,000). Zimbabwe estimates that it receives $4.7m. annually from sales of elephant goods and services. This represents a return of about $75 per sq. km. of primary elephant habitat (74,018 sq. km.). (Zimbabwe Department of National Parks and Wildlife Management [1989]). As each elephant requires about half a square kilometer of grazing land and lives about 60 years, the recent ban on the ivory trade has placed the habitats of the elephants in Zimbabwe in serious trouble.

Therefore it is apparent that the uniqueness of these types of wildlife products contribute greatly to their value. These types of products can also contribute to the maintenance of their natural habitats, if properly managed for maximum value.

D. Products Uniquely Associated with Natural Habitats: Services

In addition to the tangible products associated with the maintenance of natural habitats, there are also flows of services: viewing, recreating and even knowing that such habitat exists. The trade in services has been capturing an ever expanding proportion of world trade, and the services of natural habitats are no exception to this general rule.

1. Viewing Natural Habitats

Tourism is one of the most rapidly expanding industries worldwide. It is closely linked to income growth, and as incomes have grown worldwide in the past two decades, international tourism has grown by a factor of ten (from $18.2 b. to $197 b. in 1989, excluding airfares). (WTO [1990]). It has developed into a substantial worldwide industry (now equaling 5% of all international trade).

The distribution of tourism revenues has been relatively stable for the past decade. Travel to and in Europe still represents the majority of tourism trade, however, substantial contributions to earnings are made in a number of other regions.

FIGURE II.3
DISTRIBUTION OF INTERNATIONAL TOURISM REVENUES (1987)

Region	Arrivals	Receipts	Share of Domestic Exports
Sub. Africa	2.8%	2.6%	$ 3.5b./32b. (11%)
L. America	7.7%	11.2%	$13.4b./104b. (13%)
E. Asia	7.5%	11.4%	$18.5b./212b. (9%)
S. Asia	0.8%	1.4%	$ 2.0b./22b. (9%)

Source: Compiled from (WTO[1989]; World Bank[1989]).

Of course, these revenues are not distributed evenly throughout these regions. Some countries have relatively high proportions of their export earnings tourism-based: Kenya (30%), Tunisia (25%); others have a much lower level of earnings: Zambia (5%), Niger (2%), Madagascar (1.5%).

The two predominant factors contributing to the size of the tourism industry in a state with substantial natural habitat appear to be the proximity to a high-income country, e.g. Mexico receives $4.2b. (20% of export earnings) to top the earnings list among developing countries, and the availability of a coastline, (e.g. tourism constitutes a substantial portion of national income in Malta (10%), Cyprus (9%), Mauritius (4%)). (WTO [1989]).

The single largest wildlife-based tourism activity is probably whale watching, which generates about $1 b. annually in the U.S. and Canada. (Tilt [1987]). Other substantial wildlife based tourism industries are to be found in Africa (Kenya, Zambia and Zimbabwe) and the Galapagos Islands off Ecuador. One recent survey of wildlife viewing tourists discovered that substantial amounts of untapped value existed within this consumer group in Kenya; that is, this survey indicated that admission prices (usually zero or nominal) for the specific activity of wildlife viewing were set far too low. It was proposed that a fee of $50-100 per tourist would be able to capture a net value of $25 m. of consumer surplus. (Brown and Henry [1989]).

All of these earnings are once again linked to the real scarcity value of wildlife. Persons are willing to pay substantial amounts of money largely because it is related to the rarity of natural habitats. One of the primary methods for tapping this value will continue to be charges assessed to travellers who come to view this ever more scarce resource.

The uneven distribution of tourism revenues can be a very serious problem; for example, Kenya is estimated to have captured about 90 per cent of Sub-Saharan Africa's wildlife tourism market (excluding South Africa). (Child,B. [1990]). This is indicative of the importance of coordinating efforts in the marketing of natural habitat resources. That is, due to the shared nature of the resource (of "African wildlife" in this example), much of the investment in tourism infrastructure can serve only to redistribute tourism revenues, rather than to generate new revenues from this source. Therefore, replicating investments for the provision of the same service can be anticipated to generate very low returns. For example, much of the investment by Zambia in the 1970s in the development of tourism infrastructure failed to attract an adequate return although Kenya's industry was booming at the time. (Pullan [1984]).

In addition, a recurring problem in many countries is the dispersion of rents, either through foreign intervention (Swanson,T. [1989]), or through rent seeking activities (Barbier,E. [1991]). In regard to natural habitat, this often occurs when foreign operators access these "state-owned" resources. Frequently, much of the value captured by these operators (whether animal poachers, tour operators or film makers) is attributable wholly to the host country's habitat.

It has frequently been found that substantial infrastructural investments in tourism yield very low returns, very likely for these reasons. (Bugnicourt [1977]). Therefore, problems in the proper management of natural habitat require cooperative efforts between producers at many levels of interaction; these will be discussed further in Section IV.

2. Recreating in Natural Habitats

Besides simply viewing natural habitat and its products, there is also value to be had from allowing recreation within these environments. An indicator of the potential value of this activity comes from the fact that half of all U.S. adults partake of this manner of recreation each year, and spend about $55 b. in doing so. (U.S. Fish and Wildlife Service [1987]). Of this about $10.1 b. came from sport hunting, and about $28.2 b. came from sport fishing.

It is clear that, as worldwide incomes increase, much of the value of natural habitat will lie within its recreational potential. In the U.S., now, the fisheries are of much higher value for the purpose of recreation than for the purpose of production. In 1984, the value of the Great Lakes fishery catch

was about $6 m., while the value of the recreational fishing in the same area was about $500 m. (Robinson and Bolen [1989]). Similarly, in the North Atlantic Salmon fisheries of Scotland, sports fishermen are currently acquiring the licenses in many of the rivers long fished by commercial fisherman. (Luxmoore and Swanson, [1992]).

Recreational usage of natural habitats has also generated large amounts of value in Africa. Before it was banned, sport hunting represented a significant part of the total tourist revenue in Kenya, about 6.5%. (Clarke and Mitchell [1968]). Total revenues from recreational hunting in Botswana in 1974 amounted to $8 m.; licenses for hunters brought in $2 m. alone. (Von Richter [1976]). Zimbabwe sells about $6 m. worth of licenses annually; it realises about $1.5 m. from elephant hunting alone. (Zimbabwe Department of National Parks and Wildlife Management [1989]; Parker [1984]). In Zambia, about 75% of the revenues generated within the Luanga Integrated Resource Development Program have been derived from safari hunting. (Barbier [1989]). A single safari area in Zimbabwe generated a return of $0.33 per hectare from its use for hunting in 1981-2; a return competitive with its alternative use value. (Child [1984]).

Other active, but less consumptive, forms of recreation are also on the rise. Treks to visit mountain gorilla families in Rwanda and Zaire have been generating substantial tourism revenues since 1985. Zaire's revenues amount to £23,000 per mo. during peak tourist months. (Aveling,C. and R. [1989]). Of course, treks in Nepal and in the Galapagos have also been under substantial demand during the past two decades.

In general, the demand for recreational opportunities in natural habitats appears to be increasing substantially with the disappearance of such habitats and with increasing worldwide incomes. These examples indicate the present and past existence of this value, but the trend indicates that future values for these activities should be much greater.[16]

3. Existence Value of Natural Habitats

Another category of appropriable value lies in the willingness of some persons to pay for the maintenance of natural habitat, even though they themselves are not necessarily users of that habitat. For example, various volutary contribution programs in the U.S. raise millions of dollars each year for the state fish and wildlife departments. (Robinson and Bolen [1989]). Another indicator of the level of this appropriable value is the amount of funding donated to such organisations as the National Wildlife Federation and the World Wide Fund for Nature ($100m. and $50m. in the U.S. alone in 1990).

The above examples are intended to demonstrate the capacity of various uses of "wildlife" to appropriate the value of natural habitat. However, equally as important as the quantity of value

appropriated is the identity of the appropriator. The value of natural habitat uses must be appropriated by those who make the decisions concerning future uses of that habitat. Usually it is the local communities actually living near (or within) the habitat who have the greatest impact on that habitat; therefore, it is these communities which must be enabled to appropriate the natural habitat value. Otherwise, the dispersion of such value can be equally harmful to the habitat. [Swanson,T. (1989)]. For these reasons it is important to consider mechanisms by which the existence values mentioned above might be routed to local communities.[17]

4. Other Ecosystem Services

There is a wide range of other services rendered by natural habitat which have real value, but which are subject to severe difficulties regarding appropriability of that value. Therefore, these services contribute to the comparative value of the habitat but a strategy of "wildlife utilisation" remains incapable of registering that value under existing technologies.

For example, the role of a tropical forest extends to the preservation of coastal fisheries and the storage of carbon. (Ruitenbeek,J. [1989]; Pearce,D. [1990]). Also, as discussed further in Section IV, tropical forests and many other natural habitats act as the repository for vast amounts of irreplacable information. (Swanson,T. [1991]). Each of these functions is an example of a "collective good", and even perhaps (in the case of information) of a "public good". The correct quantities of these goods are unlikely to be supplied through private investment decisionmaking alone.

In some cases the flow of valuable, but inappropriable, services might exceed the appropriable value of the habitat. Wetlands are the prototypical example of a habitat type which lends substantial value, much of which cannot be directly appropriated. The functions of wetlands include: groundwater recharge, flood control, shoreline stabilisation, nutriment and sediment retention, and biological diversity. (Barbier,E. [1989]).

The strategy of "wildlife utilisation" cannot be successful at maintaining the correct quantities of natural habitat when much of its value is generated in the form of "public goods". Even when the full value of all tangible goods and services are appropriated, there will remain an additional inappropriable residual value corresponding to the public good functions of the habitat. It is necessary to invoke additional efforts at valuation, and then to combine other interventions with a strategy of wildlife utilisation. (Aylward,B. and Barbier,E. [1991]). Wildlife utilisation is therefore a complementary, not a substitute, policy for preservationist ones.

Even when much of a habitat's value is appropriable through utilisation, it is essential that the appropriated value be

properly attributed to the natural habitat. Many times, natural habitats can generate their values diffusely, conferring them upon neighbouring and distant habitats. These "externalised benefits", although utilised, will not contribute to the maintenance of the correct quantities of natural habitat, unless they are properly credited. This is the role of correct management in natural habitat, to be discussed further in Section IV, infra.

III. The Comparative Value of Natural Habitat Production

Irrespective of the absolute magnitude of the aggregate valuation of these goods and services, the most relevant indicator is instead the comparative value generated by natural habitat production. Several case studies reveal that the goods and services from natural habitats are economically more highly valued than the goods and services which can be generated from the same resource base after its conversion to more intensive modes of production. These are presented in part A of this section, below.

Although it might have seemed far-reaching to make the claim that natural habitat could pay its own way in the recent past, there is a growing literature containing a number of studies indicating that it can in fact do exactly this. This development is in part due to the increasing scarcity and hence increasing value of natural habitat, and its related production. It is also attributable in part to the prevalence of surpluses in the world's traditional commodity markets, and hence the decline in the prices of those goods usually produced through specialised agricultural methods. Therefore, the "dynamic" nature of comparative advantage might be such that future development is better orientated toward these scarcer commodities than the more abundant varieties. These issues are discussed in part B of this section, below.

A. Case Studies Demonstrating Favourable Comparative Valuation

There are now quite a number of case studies which demonstrate the comparatively favourable valuation of natural habitat production over specialised agricultural production in various areas. For example, it is now the case that the overall value of game production in Zimbabwe compares well with that of beef ($106 m. vs. $260 m.). (Martin [1984]). Similarly, a year's use of natural habitat for wildlife in that country was found to produce an aggregate return of $2.49/ha., rivalling the returns from the most intensive forms of cultivation there. (Child [1984]).

Where natural habitat tourism is a significant factor, the comparison is even more favorable. Several studies of the value of national parks in Kenya indicate that natural habitat is by far the most profitable use. (Thresher [1981]; Henry [1978]; Western [1984]). Again, as was indicated above, the recreational

value of many resources will often outweigh its other production values; for example, throughout Arizona, sport hunting earns returns which are a factor of four times greater than the returns to beef grazing on the same lands. (Robinson and Bolen [1989]).

The removal of rainforests in Brazil in favor of beef production has been economically analysed as well. It was found that, whereas the former economy was sustainable, the transition to intensive beef production actually reduces value throughout much of this environment. The revenues from beef ranching cover only about 45% of recurring costs. (Browder [1988]). Similarly, the conversion of tropical forests in Malaysia for intensive cultivation results in a substantial net loss in value ($2455/ha. yr. for forest production vs. $217/ha. yr. for agricultural production). (Watson [1988]). Pearce has provided a general review of these studies. (Pearce,D. [1990]).

FIGURE III.1

COMPARATIVE VALUE OF NATURAL HABITAT AND SPECIALISED PRODUCTION

Country	Natural Habitat Use & Value		Alternative Use & Value
Kenya	Wildlife Tourism	>>>	Cattle Ranching
Zimbabwe	Wildlife Product. Z$4.20/ha.		Cattle Ranching Z$3.58/ha.
Malaysia	Forest Production $2455/ha.		Intensive Agric. $ 217/ha.
Peru	Forest Production $6820/ha.		Logging & Agric. $1000/ha.

Sources: Zimbabwe- Child & Nduku (1986); Kenya- Western (1984); Malysia- Watson (1988); Peru- Peters, et. al. (1989).

These case studies are indicative of the comparatively efficient performance of natural habitat production methods across a fairly wide range of conditions. It is clear that there are two prominent reasons to expect that this form of production would be competitive: its biological advantage as well as its market advantage.

With regard to the latter point, which is discussed in more detail in section B below, the advantage derives from the dynamics of the process of conversion to specialised production. As natural habitat has been converted to the production of one of a few commodities, the necessary result is an increase in the supply of the latter and a decrease in the supply of the unique goods and services from the former. At some point in this conversion process an equilibrium must be reached as supplies of traditional commodities are increased and supplies of diverse goods and services are noticeably diminished.

With regard to the biological advantage of natural habitat production, there are three general reasons to expect a favourable comparison to exist. First, natural habitat production allows for the tapping of a wider range of resources within the same habitat. For example, in Indonesia, it has been

found that the value of the non-wood exports originating from that country's tropical rainforests equals over 10% of the value of all rainforest exports (amounting to over $100 m. annually since 1979). (Gillis [1989]).

This diversity of benefits from natural habitat production has several positive implications. It means that a wider range of the resource base is being utilised; in general, domesticated species are only able to tap a proportion of the resource value tapped by the wider range of species indigenous to an environment (the replacement value). (Eltringham [1984]). It also means that there is a wider portfolio to rely upon, in the event of a unforeseen fall in production or value from the resource base.

The second general reason that natural habitat production methods can be expected to compare favorably with intensive cultivation of the traditional commodities is due to the better adaptation of indigenous species to prevailing environmental conditions. The substantial literature on this point indicates that the comparative advantages of indigenous species lie in their differential rates of growth, heat stress, water turnover, nutrient requirements (and the complementarity thereof), and disease tolerance. Several studies comparing zebu cattle with ungulate production in Africa have concluded that, across a wide range of conditions, the indigenous species compare favorably. (Eltringham [1984]).

Thirdly, a recent study in Zimbabwe indicates that there are land degradation costs implicit in the introduction of nonindigenous species. This study found that the introduction of cattle within buffalo range produced favourable returns over a short time horizon; however, over a 30 year period the resultant land degradation caused the cattle to become an inferior asset. (Child,B. [1990]).

Therefore, there are good theoretical reasons to predict that natural habitat production can be a relatively efficient method of production, and now there are beginning to be studies which empirically demonstrate that this is in fact the case under a variety of conditions. Nevertheless, the productive efficiency of specialisation is difficult to match, and it is not the case that these biological advantages would by themselves determine the favourable comparisons currently being registered.

The comparative valuation of a use of habitat is, however, the product of two factors: the relative productivity of that use and the relative value of the goods and services flowing from that use.[18] As was discussed in Section II, above, there already exists significant amounts of evidence indicating that a "premium" is frequently paid for the products of natural habitats, both on account of their "diverse" nature and also in recognition of their source. In addition, there is good evidence to indicate that as these products (or, equivalently, their source habitats) become more scarce their prices escalate correspondingly. These examples demonstrate the likely source of the recently recognised favourable comparison of natural

habitat uses, i.e. the favourable valuation of these products. Part B of this section investigates the reasons why it might be anticipated that natural habitat might be comparatively efficient in the future, even in cases where it was not so in the past.

B. Rates of Conversion and Rates of Return- An Indication of Future Trends in Natural Habitat Values

On a global basis, estimates on overall natural habitat loss in the past two centuries range from 25 to 50 per cent. (Myers [1980]) (International Institute for Environment and Development [1989]). This has been an accellerating process; current estimates indicate that 200m. ha. of forest and woodland and 11m. ha. of grassland were converted between 1960 and 1980. (Repetto [1988]).

Most of this conversion has occurred recently in the developing countries and the current trends indicate that substantial conversions will continue to occur there. One hundred million hectares of natural habitat came under cultivation for the first time in developing countries in the 1980s (an increase from 838 to 936m. ha.). (Holdgate, et. al. [1982]). The annual rate of deforestation in this decade was about 7.4m. ha. annually. (Repetto [1988]).

FIGURE III.2

CONVERSIONS TO AGRICULTURAL USE (million ha.)

Developing	1960	1980	Percent. Change
Sub. Africa	161	222	37.8%
L. America	104	142	36.5%
S. Asia	153	210	37.2%
SE. Asia	40	55	37.5%

Developed	1960	1980	Percent. Change
N. America	205	203	0%
Europe	151	137	-10%
USSR	225	233	0%

Source: (Repetto [1988], p. 3).

The substantial rates of conversion in some regions imply substantial recent losses of natural habitat. It is estimated that only 65% of natural habitats in Afrotropical regions remain, and that only 68% of Indomalayan natural habitats remain. (International Institute of Environment and Development [1989]).

During the past three decades the developing countries have engaged in "mass conversions" of natural habitats, thereby substantially increasing the proportion of their lands which are

dedicated to specialised agricultural production. During the same period, developed countries have ceased conversions altogether. In spite of this (as demonstrated in Figure III.2), the increase in the value of production of these agricultural commodities has been precisely equal in the two regions. That is, there has been no relative return to the increased rates of conversion.

FIGURE III.3

RATE OF RETURN TO AGRICULTURAL CONVERSIONS

Region	Conversion to Agriculture	Increase in Value
LDCs	37% increase	24% increase
DCs	No change	21% increase

Source: Holdgate,M. et. al. (1982).

A possible explanation for this trend is the absence of significant demand for the additional quantities of the same commodities. Recently installed agricultural specialisation in developing countries has focused primarily on meeting the demand for a small number of basic commodities that are already in mass production throughout the developed world.

However, western production already goes far toward completely satisfying this demand, and western agricultural subsidisation policies place developing country exports at the "end of the queue". This means that the relevant elasticity applicable to less developed countries' exports is that of the marginal consumer. Frequently, inelastic demand exists for the additional quantities placed on the market by expanding producers.[19] For example, in Sub-Saharan Africa it has been estimated that 60 per cent of export earnings come from commodities for which the price inelasticity is such that an increase in production of those commodities would actually reduce earnings. [Godfrey (1985)].

This pattern is much more general than a specific example demonstrates, however. In fact, the general index of commodity prices has fallen by 50% over the past thirty years, the same period in which the majority of conversions to specialised agricultural production have occurred.

FIGURE III.4

DETERIORATING COMMODITIES PRICE INDEX OVER 30 YEARS

Year	Commodities Price Index (1960=100)
1957	113
1960	100
1965	95
1970	91
1975	105
1980	85
1985	65
1987	62

Source: International Monetary Fund (1987).

The most severe declines in commodity prices have been in the non-food agricultural commodities, fairly consistently over the past 30 years, and the food commodities index over the past 15 years. (Grilli and Yang [1988]). However, it is generally argued that all of the non-petroleum commodities have seen a substantial and consistent downward trend over the past 30 years. (ODI [1988]; Sapsford [1985]). During the same period, the terms of trade between primary commodities and manufactured goods have fallen 35%. (IMF [1987]).

These figures are not included as an endorsement of "the Prebisch hypothesis" (that terms of trade between developing and developed countries are in a state of long run decline), nor do they constitute conclusive evidence of any definitive trend in relative prices. In the analysis of such trends, much depends on the choice of the period being analysed; rigorous long term analysis of these figures has not established a definitive downward trend extending over all potential periods of analysis. (Spraos,J. [1980]; Stern,N. [1989]). Also, recent evidence on price elasticities on agricultural commodities is inconclusive generally, although many case studies support the finding of inelasticity. (Lipton [1987]).

The sole purpose for the inclusion of this survey of commodity price trends is the demonstration that, over the period of this analysis (during the mass conversions of the past 30 years), there has been no obvious advantage to be had from continuing conversions. The price trends during this period, possibly but not necessarily on account of these conversions, have effectively negated any increase in value which might have accrued to these expansions in commodity production.

One theory of comparative advantage indicates that it is the uniqueness of the supply of a good which determines its terms of trade. Under this theory, for greatest comparative advantage, countries must produce those products which are most uniquely

within their exclusive capabilities, by reason of natural characteristics peculiar to those countries. Therefore, a good which is produced in obviously limited quantities will always produce the best exchange rate.[21]

This is the theoretical basis behind the expectation that the value of goods and services produced from more obviously limited resources, such as natural habitats, should be increasing as their supply becomes more limited. The empirical record developed during the recent period of mass conversions of natural habitat does not contradict this theoretical expectation. It is possible that the comparative advantage of countries which retain natural habitat resources might now lie in the fuller appropriation of their value as such, rather than their conversion into different forms of (more intensive) production.

When the productive capacity of indigenous species is combined with the favourable value of goods and services from natural habitats, it should not be surprising that these forms of production are now comparing favorably in the generation of revenues across many environments. In short, these case studies demonstrate that the comparative value of production from natural habitats clearly can exceed the expected value to be realised from the conversion of these habitats to specialised agricultural methods of production. In these cases, then, it clearly is possible to unlink sustainable development from the destruction of biological diversity through reliance upon the strategy of wildlife utilisation.

IV. Issues in Natural Habitat Production

There are six fundamental issues to be investigated concerning the feasibility of a general strategy of natural habitat utilisation. These concern the special difficulties of production and appropriation which attend operations in this context. Since the particular advantages of agricultural mass production, specialisation and segregation, are not available in natural habitat modes of production, many of these problems arise from this difference. However, there is also the special set of problems which arise from altering the way in which people currently behave, thus having to overcome the inertia in favour of the prevailing preferences, prejudices and patterns of production. This section will attempt to address both categories of problems from the perspective of the environmental economist.

A. Infrastructure Investments for Natural Habitat Production

The substantial differences in production techniques between methods of production often means that the infrastructure developed for agricultural production has little or no application to the potential products of natural habitat production. Transport, preserving and processing plants are often wholly geared to the domestic variety of production.

Many times this is another aspect of the economies of scale implicit in agricultural mass production. Investment is often in a single warehousing and processing plant at a central location which is served by transport linked to producers of a large quantity of a small number of products. Once again, this allows for large economies of scale in the provision of these capital goods.

Obviously, a very different form of infrastructure will be required to adequately service natural habitat production. Smaller plants on a local or regional basis which are capable of handling a wide variety of products are probably necessary. This is a cost of doing this manner of business, and it must be included and amortised in any assessment of feasibility; however, the prior existence of the alternative infrastructure should not prohibit these investments. Each should receive investment to the point of its maximum expected return.

B. Optimal Intervention in Natural Habitat Production

Production within a natural habitat may be enhanced without converting the resource to completely specialised modes of production. This would involve more emphasis on the development of the middle ground forms of resource use, between absolute preservation and specialised agriculture.

FIGURE IV

THE THIRD OPTION: THE STRATEGY OF OPTIMAL INTERVENTION

Natural Habitat	Minimally Modified Natural Habitat	Agriculture
Non-Intervention	Optimal Intervention	Intervention
characteristics:		
-nonsegregated habitat -diverse range of species -minimum intervention		-individually segregated -minimum diversity -continuous intervention
advantages:		
-adaptation -fuller use of habitat -diversity of portfolio -no inputs		-appropriation -minimal cross effects -specialisation (local, reg., global)

Figure IV is a modified version of Figure I presented in section I of this paper. It encapsulizes the polar differences and comparative advantages between the two primary modes of

optimal intervention, lies on the spectrum between the other two; it represents the attempt to strike a balance between the benefits of one strategy against the benefits of the other.

The strategy of optimal intervention is nicely illustrated by reference to the various examples of reptile ranching in the literature. With regard to reptiles, there are numerous points at which intervention might occur in order to enhance production. These stages might be considered as: breeding, nursery, juvenile, and adult. For example, optimal intervention at Stage I (breeding) might be desirable if that is the least expensive means of capturing young. Optimal intervention at stage II (nursery) might be desirable if that generates substantial reductions in infant mortality. Optimal intervention at Stage III (juvenile) might occur if, for example, additional food inputs generate substantial increases in growth rates. Intervention at Stage IV (adult) is almost always necessary in order to appropriate value from the species (although this might also be done earlier as well).

With regard to reptile ranching, it has been discovered that massive reductions in infant mortality can be achieved by means of intervention at the nursery phase of production. For crocodilians, infant mortality can be reduced through such methods from an estimated 97% in the wild to about 10% in the nursery. (Blake and Loveridge [1975]). This manner of intervention can therefore result in increases in productivity potentially in the range of 3000%.

Given that the benefits of this intervention can be later appropriated, it may then be optimal to return the animals to their natural habitat until maturity. An economic analysis of iguana ranching in Panama indicated that this was precisely the optimal strategy in regard to this species. The avoidance of further feed inputs during the two year maturation process determined the economic feasibility of the ranching project; that is, the ranching of iguanas was not economically viable unless they could be returned to their natural habitat after the nursery and then later appropriated from there. (Nelson [1986]).

Optimal intervention therefore presupposes that natural habitats could be used on an occasional basis, with the minimum disruption to the environment. It would involve incursions into the habitat whenever it was economically desirable to interject an input or to appropriate an output within the environment; however, it would not require the wholesale conversion of the environment as a precursor to these interventions. Instead, the object would be to take the naturally occurring produce from the habitat at the maximum feasible rates. This is the reason why optimal intervention is distinctly preferable to either total preservation or total conversion; the former implies the failure to appropriate substantial portions of the habitat's value (and therefore fails to maximise the amount of natural habitat preserved), while the latter attempts to maximise the value of an entirely distinct bundle of goods for which there is no reason to believe that a systematic advantage exists.[22]

C. Appropriating the Value from Natural Habitats- The Importance of Decentralised Management of the Resource

It should be noted from Figure IV above that the first-listed advantage of domesticated habitat regimes is that of appropriation. This is a very fundamental advantage which these regimes have had over natural habitat regimes in recent times, and in many cases it is the predominant reason for the rapid disappearance of natural habitats and their primary species.

Appropriation is important because it is the means by which individual investments receive their returns. With domestic production methods, it is very easy to see the direct link between these investments and the resultant flows of costs and benefits; for example, carefully monitored livestock responds more or less well to more feed, more water, or better veterinary care. It is the observed responsiveness of the animals to these inputs which causes the associated user to undertake them. When the link between inputs and outputs becomes less clearcut, then there is a much lower probability that the user will make these investments.

This is probably the single most fundamental reason for the maintenance of so much of the world's agricultural product is kept within pens or fences and under constant supervision, i.e. domesticated. The reason is not that constant intervention yields substantial productivity-based returns, but because it ensures appropriability. Many of the other facets of production and valuation predominantly favor natural habitat products, but the facet of appropriability clearly favors domesticated production.

In the absence of appropriability, the comparative efficiency of natural habit forms of production cannot be realised, simply because the optimal methods of production will not occur in the absence of assured appropriation. Without the continuous identification of the specimens in which the individual user has invested its efforts and resources, there is little chance that the individual would make these investments at all.

Alarmingly, with a renewable resource, one of the primary means of investment is the forebearance from harvesting, in order to maintain an efficient level of breeding stock. Clearly, this form of investment has not been occurring with regard to many valuable species occurring within natural habitats: rhinoceres and elephants are two leading examples of species of substantial market value but rapidly declining populations. Between 1981 and 1987 the black rhino population in Africa fell by some 70%. (Cumming et. al. [1990]) The African elephant has declined by some 40% in this decade. (Douglas-Hamilton [1989]).

These clearly are problems of insufficient investment in potentially profitable resources. Although the management of elephant for its consumptive products alone generates $75/ha. in

Zimbabwe, few of the animal's range states invest resources approaching anything like that amount in its maintenance. (Leader-Williams [1988]). For example, Malawi spends $49/km., Tanzania $18/km. and Cameroon $5/km. (Cumming, et. al. [1990]). One of the primary contributing factors to chronic levels of underinvestment in natural habitats must be the longstanding failure to appropriate returns from such investments. In the absence of appropriability, stocks of resources in natural habitats are predictably diminished far below optimal levels; this is known in economics as the open access resource problem. (Dasgupta [1986]). Thus, the species inhabiting these environments, and consequently the environments themselves, are allowed to deteriorate largely through neglect.

One of the fundamental roles of policymakers regarding wildlife utilisation must be the accurate channelling of the benefits from natural habitat production through the hands of the most important potential investors in that habitat. In general, the most important investors in any given resources are those who live in daily association with them. (Marks [1984]). To the extent that the benefits from natural habitat production are channelled through the hands of potential investors, the optimal level of investment can be expected to materialise.

There are two concrete implications deriving from this proposition. First, the rights to the resources contained within a natural habitat must be delegated to individuals (singly or in small groups). The entire thrust of modern economics is that optimal investment requires decentralised ownership of assets. (Hart and Moore [1989]; Williamson [1986]; Grossman and Hart [1984]). The entire world has been reshaped in this decade by this thinking and it is essential that it be applied in this context as well, in order to create incentives for investment in natural habitats.[23]

Secondly, there will always be a significant role for coordinating institutions, such as cooperatives, in the management of these resources. This is so because production in the context of natural habitats will often require the coordination of activities of many individual users in the context of a variety of common assets: productive assets held in common in order to capture economies of scale (e.g. nurseries); marketing boards operated in common in order to regulate trade and maximise revenues (e.g. exclusive commodity exchanges); and even the natural habitat itself.

It is important to note that, in many cases, these coordinating mechanisms are already in place. Many so-called traditional societies were in fact examples of systems of carefully assigned responsibilities within the realm of commonly held natural resources; for example, in Karnataka state in India, the various castes have carefully defined occupations and responsibilities regarding the use and maintenance of the region's common water and land resources. (Gadgil and Iyer [1989]) There are numerous other examples of such organising mechanisms in the use of common resources. (Berkes [1989]).[24]

Therefore, the delegation of the rights to natural habitat resources on a local basis is a requirement for the efficient usage of these resources, and local governance structures may be the appropriate unit of delegation, rather than the individual, in certain circumstances. This is necessary in order to assure appropriability of the value from natural habitats, because, without this, natural habitats will always be at a systematic disadvantage with regard to domesticated ones, due to the ease of appropriability in the latter.

D. Appropriating the Value of Production - The Difficulty of Capturing the Value of Collective Goods

As has been made clear from the outset, not all of the value of biological diversity lies in the tangible goods and services of natural habitat. Much of this value is in fact of the nature of "collective goods"; that is, these products are beneficial not to a particular user, but rather to a broad swathe of humanity. For example, one of the primary attributes of natural habitat is the untapped information which it represents. For example, there are at present 119 plant-derived drugs in use throughout the world, obtained from less than 90 species of plant. [Farnsworth (1988)]. Yet, there are about 250,000 to 750,000 species of plants yet to be tested. There is a substantial value to be placed on the maintenance of this stock of potential information, but the benefit is largely for all.

Similarly the value of the variety which exists in the wild is also of importance for the improvement of domestic species. The discovery of a species of wild maize (teosinte) in Mexico in 1979 which is naturally virus resistant was of potential billion dollar importance to the domestic species; yet, when its importance was discovered, all that remained of the species was a 6 hectare patch high on the Sierra de Manantlan. This is a simple but laborious process of collecting species and then undertaking careful analysis of their differences; for example, the collection of a species of wild tomato in the Andes in 1963 resulted, after 10 generations of crossing with the domestic species, in a marked commercial improvement valued at about $8 million per annum. [Iltis (1988)].

Natural habitat represents a library of such information, but the value of that information accrues to all, and is likely to be considered by no one individual when deciding whether to convert the habitat. This indicates the difference between financial analysis and economic analysis; the latter states that, even when individuals do not take real values into account, systems must be created which do.

Other collective benefits of natural habitat are equally difficult to value through ordinary mechanisms. For example, forested habitat often plays an important role in both the maintenance of watersheds and the fixing of carbon. (Ruitenbeek,J. [1990]; Pearce,D. [1990]). These values must also be taken into account in determining the amount of natural

habitat that must be maintained.

Finally, the mere existence of habitat is of significant value. This is indicated in part by the fact that individuals are willing to contribute money to organisations whose stated objective is the preservation of natural habitat and wild species. However, there is only a very small proportion of these funds which goes directly to the maintenance of natural habitats.

A substantial hurdle to the maintenance of significant quantities of natural habitat is the creation of mechanisms which are capable of capturing some of these less tangible, but equally important, values. The optimal amount of habitat can be maintained only if the sum of these values are in some way revealed, appropriated and directed to the maintenance of biological diversity.

E. Conflicts Between Uses - Utilization versus Preservation

Obviously, there is a role to be played by the traditional nature preserve and the flow of goods and services which such a designation represents; however, the demand for these products represents only the tip of the iceberg of the aggregate demand for the unique products of natural habitats. At present, only about 5% of the remaining natural habitat has been given any sort of protected status. In order to maximise the value of resources which are produced in natural habitats, it is necessary to consider a wider range of interventions, rather than simply the nonconsumptive ones. This is the object of wildlife utilisation from the perspective of environmental economics; it provides the mechanism by which the full return to natural habitats is able to be appropriated.

To some consumers, however, the concepts of utilisation and natural habitat are inconsistent. For this reason, the value of the produce of natural habitats is not simply additive. In some cases, in fact, consumers will withdraw their valuation of the products if they believe that any nonconsumptive use is occurring. For example, during the debates concerning the future of the ivory trade in 1989, the WWF-US initially advocated the continuation of the trade in those states in which it was sustainably managed; however, this position had to be later withdrawn due to the mass withdrawal of membership subscriptions from the organization on account of this stand. The membership was not willing to allow their nonconsumptive valuations (existence value) to continue in place in combination with consumptive usage of the same resource.

Therefore, it is not simply a matter of aggregating the values of the various uses of the natural habitat. Due to the implicit conflicts between the various forms of (consumptive and nonconsumptive) uses, it is necessary to evaluate the various uses to be allowed regarding a particular piece of natural habitat on a case by case basis.

F. Marketing the Products - Consumer Education and Consumer Confidence

Another implication of the conflict between consumptive and nonconsumptive uses is the importance of educating conservation minded consumers regarding the role of wildlife based consumption. At present the bias appears to be reversed; environmentally sensitive consumers tend to be more willing to purchase domesticated products than natural habitat products. It needs to be brought home that a purchase of natural habitat products is a vote for natural habitat methods of production. This manner of marketing has been successful with regard to less intensive agricultural methods, such as "free range" products, and precisely the same rationale applies to natural habitat products marketing.

Another substantial hurdle to be crossed involves the nature of the management of natural habitats. Usually, natural habitat production methods will require a significant amount of land to be held in an undivided state; interventions which subdivide (e.g. fencing) natural habitat necessarily reduce the range of species which will exist within the habitat. The management of parcels of substantial size is a difficult proposition because it makes it difficult to ensure that all users are acting in common interest. Much of the activity in natural habitat is currently being undertaken on an unsustainable basis, to the detriment of all users, precisely because it is undertaken on "the common".

As discussed previously, the first step to the resolution of this problem is the decentralised management of the resource. That is, it is essential that the local users of the resource are also the owners of the resource, because their investment is essential to its success. However, the mere delegation of the resource to the local users is not sufficient to solve the problem; due to the unsegregated nature of natural habitat production, it is not possible to rely on explicit property rights in this context. Therefore, although the essential investors can be identified (i.e. the locals), the mechanism of individualised private property rights (i.e. fencing) cannot be used to induce the optimal level of individual investment.

It is the failure of common management which has very likely resulted in the lack of consumer confidence in natural habitat produce. In fact, much of this produce is taken on an unsustainable basis. Consumers cannot support natural habitat produce without also supporting its unsustainable utilization.

There is one clear measure which could be undertaken in an attempt to constrain unsustainable utilization and thus to foster consumer confidence. In essence, this problem is an example of the "lemons problem" in the context of natural resource production. (Akerlof,G. [1971]). That is, so long as consumers lack the necessary information to discriminate between a sustainably and a nonsustainably produced wildlife product, the market equilibrium will produce only the latter. This is because

the competitive harvesting of natural habitat will result in the dissipation of all rents of the resource, leading it to be necessarily less costly to produce. In essence, the price of natural habitat products derived from competitive harvesting in the common contains only a component for the opportunity cost of the labour involved; there would be no return to the resource itself. Therefore, sustainably produced and priced goods and services cannot compete in a market with the nonsustainbly produced ones.

The general solution to such a lemons problem is a system of certification, which generates the resource's rent for the sustainable producer. That is, any system which is able to assure consumers that a given product is sustainably produced provides the measure of confidence necessary for the sale of these products at the necessary premium. This allows consumers to vote for natural habitat production with confidence, and it creates incentives for producers to regulate the natural habitat to preserve the rent. (Swanson,T. [1989]; Swanson,T. and Pearce.,D. [1989]).

There has been a natural reluctance to believe in the feasibility of a regulated trade in natural habitat products. Yet, precisely this notion of certification has been utilised to preserve rents in many other markets. For example, most securities exchanges were established in the inter-war years on account of rampant fraud in the sales of security papers (because consumers could not discern whether the papers represented real shares in real corporations or just papers); the securities of both good and bad firms were rendered valueless as a consequence. The certification of a firm's securities for listing on an exchange validates those securities for consumers' purchases. Thus, the idea of an exchange as a public good devised to provide the information required to discriminate between "good" and "bad" products is now more than half of a century old.

Therefore, there is a possible role for consumers as well as producer management of natural habitat production which needs to be investigated. The resolution to all of these various problems and issues will require substantial well-focussed effort.

CONCLUSION

This paper has attempted to investigate the role of wildlife utilisation in natural habitat conservation. The use of the tangible products of natural habitats which are inextricably associated with many of the intangible ones may be the best option for the conservation of biological diversity.

This paper has also investigated whether development can be made compatible with biological diversity. On account of the tradeoff between diversity and productivity implicit within specialised methods of production, there has been a built-in tendency to destroy diversity in the process of development. The resultant reduction of natural habitats and increasing rarity of its products has greatly contributed to these products' comparative advantage. It is now possible that natural habitat modes of production could be the optimal development path in some situations.

Importantly, the issues concerning the future viability of natural habitat methods of production can be enumerated and analysed. These are the special difficulties of both creating value and appropriating it within the context of the "common". The proper management of natural habitat methods of production will be crucial to the resolution of most of these difficulties.

The specific objective of this paper has been to provide a review of the existing literature on natural habitat production, which is to be found in a wide range of sources, from applied biology to cultural anthropology, and to place this literature within the framework of the environmental economist. The general objective has been to illustrate the meaning of sustainable development with regard to biological diversity. The conclusion is: hopefully, the variety which exists (literary and natural) can be put to good use.

NOTES

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1. One survey puts the global amount of "wilderness" at about 39% of the terrestrial surface. Only about 4% of the United States land mass qualifies under this definition, and virtually 0% of the European territory qualifies. (World Resources Institute [1990]).

2. The full value of the habitat would be made up of both its tangible and intangible products. Irrespective of the relative contributions of the different product types, it will always be difficult to tap the full amount of intangible values due to demand revelation problems which arise with regard to "public goods". (Dasgupta,P. [1982]). In addition, intangible values must usually be channelled through governmental institutions rather than market institutions, which in some cases are less effective methods of channelling values.

3. The hypothesis is that countries which designate "protected areas" in return for international funding will do so with reference to the current opportunity cost of the lost development rights, but as circumstances change this opportunity cost may increase and the government may reoptimise, resulting in the "nationalisation" of the previously withdrawn development rights. This is merely another example of the dynamic policy problem known as "time inconsistency". (Kydland,F and Precott,E. [1977]).

4. Sustainable development implies the maintenance of some natural capital stock, but a fundamental issue involves <u>where</u> that capital is maintained; <u>i.e.</u> should the capital be maintained in the context of <u>each</u> development project or solely as one piece of a larger portfolio? Preservationist approaches to development emphasise the latter; utilisation approaches emphasise the former. It is probably a combination of these approaches which will result in the correct amount of sustained resources. See Markandya,A. and Pearce,D. [1991].

5. There is also the tendency of numerous independent producers to select the median consumer's preferences in determining the quality of the product to be produced, as Hotelling demonstrated with regard to the economics of product differentiation. This means that cost differentials will usually outbalance demand considerations in determining the range of products which will be produced by a given industry. (Hotelling,H. [1938]); (Shaked,A. and Sutton,J. [1988]); Spence,M. [1978]).

6. Interestingly, it has been noted that when traditional forms of "wildlife" are brought within the domesticated agricultural system, then they also require continuous intervention for their successful production (e.g veterinary care not otherwise required). (Kiss,A. [1990]).

7. This is the workings of the "portfolio effect" in the context of a species, and it provides one basis for a trade-off in the movement toward mass production of a few species. Such specialisation allows for productivity gains from mass production methods, but only at the cost of increasing the risk of complete crop failures due to nondiversification. One of the important reasons for preserving diversity is the maintenance of gene banks in order to provide for unforeseen risks. (Iltis [1988]).

8. Since the area of a given piece of natural habitat is proportional to the square of its radius, dividing a continuous piece of habitat into three equal but fragmented pieces will result in each of the new habitats having one-ninth the area of the previous.

9. However, it should be noted that, with regard to all of the examples given within this section, there are substantial problems remaining to be solved in the production and appropriation of the value of goods or services emanating from within natural habitat. These problems are surveyed in Section IV, infra. At this juncture, it is important to emphasise that these problems can often materialise as unsustainable yield levels with regard to the products of natural habitats; therefore, the figures surveyed in this section might not indicate sustainable returns from natural habitat production (and they obviously do not with regard to some species such as the rhinoceros). Nevertheless, these problems do not negate the existence of the various forms of value flowing from the goods and services produced within natural habitats. These values exist by reason of their obvious and increasing scarcity, and the clear desire of the international community for their continued use.

10. It is important to note that the correspondence is between indigenous peoples and indigenous species. Attempts to export many of these products even slightly beyond their natural ranges have met with disaster. Hence, the attempted marketing of elephant meat from Zambian culls in the copper mining areas met with little interest. (Parker [1984]). Also, various attempts at canning and distributing seal meat have met with little or no success. (Eltringham [1984]).

11. There clearly is a part of the consumer market which is willing to pay for "free range" (or natural habitat) modes of production. This varies substantially from country to country, from poultry and eggs in the U.K., to venison and hares throughout continental Europe.

12. Ironically, to date consumer preferences have been biased in the reverse direction; that is, consumers appear to prefer to patronise "domesticated" animals over "nondomesticated". Hence, the trade in furs has been severely dampened by reason of consumer "bans", while the leather trade has not. If the value of furs taken from natural habitats is all "appropriable", then it is the former which is in fact more conducive to the maintenance of "natural habitats". This preference probably derives from consumer recognition that little of this value is returned to "natural habitat" conservation, due to institutional limitations. See Section IV, infra.

13. This category is obviously in flux as certain species become wholly or partially domesticated. Although some of the "uniqueness" value of these species might therefore be lost, a greater share of overall value can be made appropriable by these methods. See Section III, infra.

14. As the price of these resources are caused to increase by reason of obvious scarcity, this also results in increased incentives to "domesticate" the resource. The price threshhold at which domestication becomes a feasible strategy varies between resources and management systems. In addition, the impact of domestication on the resource as it exists in the wild is also a complicated matter to predict. See Luxmoore,R. and Swanson,T. [1991].

15. This paper does not attempt to compile the aggregate value of this trade in "wildlife" products. Please refer to the companion report by TRAFFIC International for this purpose.

16. Of course, there are conflicts implicit in the use of natural habitat even in this "non-consumptive" fashion. See section IV, infra.

17. Therefore, the capture of existence value by such organisations as those mentioned in the text may or may not have any positive impact regarding the maintenance of natural habitat. It can be anticipated that actual users of habitat will modify their uses in accordance with the perceived value of alternative uses; thus, it has been found that the Masai of Kenya have willingly accepted and protected the neighbouring park once they were entitled to a flow of revenues from the use of this land by tourists. [Kiss,A. (1990)]. The channeling of "existence values" to local communities could be anticipated to have a similar positive impact, if such were possible. In any event, this points to the importance of local appropriation of such value as is easily channelled to local communities, such as tourism revenues etc.

18. As discussed above, the emphasis of this paper is on the value of the natural habitat which is most readily appropriable by local users (as they are the persons most capable of affecting the use of that habitat). Therefore, a third factor might be

added to the two in the text which determine local decisionmaking regarding natural habitat, viz. appropriability. This factor is however implicit throughout the analysis of this paper. Other authors focus on this same problem from the perspective of national and international decisionmaking regarding habitat usage. [Aylward,B., and Barbier,E. (1990)].

19. It could be argued that the primary impact of present agricultural subsidisation policies in the developed world is the preservation, for western producers, of the inframarginal portion of the western demand for agricultural commodities. This is, obviously, the reason why these subsidies remain a linchpin in the current round of GATT talks.

21. This is one theory behind the relative terms of trade between "North and South"; that is, the North has benefitted from favorable terms of exchange due to the obvious monopolies which it has upon its products (due primarily to exclusive rights in higher technologies), while the South has sufferred from the less obviously restricted nature of its exports. Krugman, P., "A Model of Innovation, Technology Transfer and the World Distribution of Income", Journal of Political Economy, 1979, p. 253.

22. "Purists" might argue that only "preserved habitat" constitutes "natural habitat"; however, so long as the produce of the environment remains the same (i.e. the level of biodiversity is constant despite the human intervention), there would appear to be little scientific basis for objection. To the extent that aesthetic or moral objections are raised, these must be balanced against the prospect of substantial losses of "minimally modified natural habitat" for the sake of maintaining the distinction.

23. There have been initial steps taken in this direction. The CAMPFIRE program in Zimbabwe, (Martin [1984]), and the LIRDP program in Zambia are two of the prototypes. (Barbier et. al. [1990]).

24. This paper discusses only the importance of coordinating institutions with regard to the regulation of access to the common "natural habitat". This is because this is the most fundamental problem to be solved if any of the value of "natural habitats" is to be realised. However, there are numerous other potential areas for coordination advantages, including production (for example, economies of scale in the maintenance of "nurseries") or marketing (for example, for the prevention of wasteful competition and the maximisation of joint revenues). The former is essential for the economic viability of most reptile ranching operations; the latter is necessary to render the elephant an economically viable asset. (Swanson [1989]).

BIBLIOGRAPHY

Ajayi,S. [1979], Utilisation of Forest Wildlife in West Africa, FAO: Rome.

Arnold,J. and Jongma,J. [1978], "Fuelwood and Charcoal in Developing Countries", Unasylva, v. 29(118), p. 2.

Aveling,C. and R., [1989], "Gorilla Conservation in Zaire", Oryx, v. 23(2), p. 19.

Aylward,B., and Barbier,E., [1991], "Valuing Environmental Functions in Developing Countries: A Challenge for Economics and Ecology", unpublished manuscript, January.

Barbier,E., [1989], "First Review Mission of the Luangwa Integrated Resource Development Project", mimeo.

Barbier,E., [1989], "The Economic Value of Ecosystems: 1-Tropical Wetlands", London Environmental Economics Centre Gatekeeper No. 89-02.

Barbier,E., Burgess,J., Swanson,T., and Pearce,D., [1990], Elephants, Economics and Ivory, Earthscan:London.

Barzdo,J. and Caldwell,J., [1982], "A Review of International Trade in Marine Mammals", TRAFFIC Bulletin, vol. 4, p. 40.

Baptist,R. and Mensch,G., [1986] "The Cane Rat: Farm Animal of the Future?", World Animal Review, no. 60, p. 2.

Baron,R., [1989], Travel and Tourism Data, Euromonitor: London.

Bell,R. and McShane-Caluzi,E., (eds.) [1984], Conservation and Wildlife Management in Africa, U.S. Peace Corps: Washington.

Berkes,F. (ed.), [1989], Common Property Resources: Ecology and Community Based Sustainable Development, Belhaven:London.

Blake,D. and Loveridge,J. [1975], "The Role of Commercial Crocodile Farming in Crocodile Conservation", Biological Conservation, vol. 8, p. 261.

Browder,J. [1988], "Public Policy and Deforestation in the Brazilian Amazon", in Repetto,R. and Gillis,M. (eds.), op. cit.

Brown,G. and Henry,W., [1989], "The Economic Value of the African Elephant", London Environmental Economics Centre Discussion Paper, London.

Bugnicourt,J., [1977], "Tourism with No Return", Development Forum, v. 5.

Child,G., [1984], "Managing Wildlife for People in Zimbabwe", in McNeely,J. and Miller,K. (eds.), op. cit.

Clarke,R. and Mitchell,F. [1968], "The Economic Value of Hunting and Outfitting in East Africa", East African Agriculture and Forestry Journal, vo. 33, p. 89.

Cumming,D., Du Toit,R. and Stuart, S., [1990], African Elephants and Rhinos: Status Survey and Conservation Action Plan, International Union for the Conservation of Nature: Gland.

Dasgupta,P., [1982], The Control of Resources, Blackwell: London.

Dalal-Clayton,B. [1989], "Wildlife Working for Sustainable Development", International Institute of Environment and Development Gatekeeper Series SA9.

Davis,R., [1985], "Research Accomplishments and Prospects in Wildlife Economics", Transaction of N. American Wildlife and Natural Resource Conference, v. 50, p. 392.

Dixon,C., [1990], Rural Development in the Third World, Routledge: London.

Douglas-Hamilton,I. [1989], "Overview of the Status and Trends of the African Elephant", in Ivory Trade Review Group, The Ivory Trade and the Future of the African Elephant, 2 vols, unpublished manuscript.

Draz,O. [1983], "Rangeland Conservation and Developments in Syrian Arab Republics", World Animal Review, no. 47. p. 2.

Eltringham,S. [1984], Wildlife Resources and Economic Development, John Wiley:New York.

Fitzgerald,S. [1989], International Wildlife Trade: Whose Business Is It?, World Wildlife Fund: Washington,D.C.

FAO, [1980], Production, Consumption and Trade of Minor Meats - Trends, Prospects and Development Issues, Rome.

FAO, [1981], Yearbook of Forest Products, Rome.

FAO [1983], Yearbook of Fishery Statistics, Rome.

Gadgil,M. and Iyer,P. [1988], "On the Diversification of Common Property Resource Use in Indian Society", in Berkes,F. (ed.), op. cit.

Garcia, J. [1984], "Waterfalls, Hydropower, and Water for Industry: Contributions from Canaima National Park", in McNeely,J. and Miller,K. (eds.), op. cit..

Gillis,M. [1988], "Indonesia: Public Policies, Resource Management, and the Tropical Forest", in Repetto,R. and Gillis,M., (eds.), op. cit.

Grilli,E. and Yang,M. [1988], "Primary Commodity Prices, Manufactured Goods Prices, and the Terms of Trade of Developing Countries: What the Long Run Shows", World Bank Economic Review, v. 2(1), p. 1.

Guppy,N. [1984], "Tropical Deforestation: A Global View", Foreign Affairs, vol. 62(4), p. 928.

Hart,O. and Moore,J., [1989], "Property Rights and the Nature of the Firm", Harvard Law School Discussion Paper.

Hemley,G., [1989], "International Wildlife Trade", in Audubon Wildlife Report 1988/1989, The National Audubon Society: New York.

Holdgate,M., Kassas,M., White,G. (eds.), [1982], The World Environment 1972 - 1982, United Nations Environment Programme: Nairobi.

Hutton,A. [1985], "Butterfly Farming in Papua New Guinea", Oryx, v. XIX, p. 158.

Inskipp,T. and Wells,S., [1979], International Trade in Wildlife, Earthscan: London.

Inskipp,T. [1981], Indian Trade in Reptile Skins, World Conservation Monitoring Centre: Cambridge.

International Institute for Environment and Development [1989], World Resources 1988-89, Basic Books: New York.

International Monetary Fund [1987], International Financial Statistics, Washington.

International Monetary Fund [1988], World Economic Outlook 1988, Washington.

de Kadt, E. (ed.) [1979], Tourism - Passport to Development?, Oxford University Press: Oxford.

Kydland,F. and Precott,E. [1977], "Rules rather than Discretion: The Time Inconsistency of Optimal Plans", Journal of Political Economy, v. 85, p. 473.

Lea,J. [1990], Tourism and Development in the Third World, Routledge: London.

Leader-Williams,N. and Albon,S., [1988], "Allocation of Resources for Conservation", Nature, vol. 336, p. 533.

Ledec,G. and Goodland,R., [1989], Wildlands: Their Protection and Management in Economic Development, The World Bank:Washington,D.C.

Luxmoore,R. and Swanson,T., "The Impact of Domestication on the Remaining Wild Populations of a Species - The Case of the Scottish Salmon Fisheries", work in progress.

MacKinnon,J., MacKinnon, K., Child,G., and Thorsell,J., [1986], Managing Protected Areas in the Tropics, International Union for the Conservation of Nature: Gland.

Maggs,D. [1972], "Pistachios In Iran and California", Plant Introduction Review, vol. 9(1), p. 12.

Marks,S., [1984], The Imperial Lion, Westview: Boulder.

Martin, E., [1989], "The Taiwanese Connection - A New Peril for Rhinos", Oryx, v. 23(2), p. 8.

Martin,G., [1987], "Carcass Composition and Palatability of Some Wild Animals Commonly Used as Food in West Africa", World Animal Review, no. 53, p. 12.

Martin,R. [1984], "Wildlife Utilization", in Bell,R. and McShane-Vicuzi,E. (eds.), op. cit.

McNeely,J. and Miller,K., (eds.) [1984], National Parks, Conservation and Development, Smithsonian Institution: Washington.

McNeely,J., Miller,K., Reid,W., Mittermeier,R., and Werner,T., [1990], Conserving the World's Biological Diversity, International Union for the Conservation of Nature: Gland.

Mishra,H. [1984], "A Delicate Balance: TIgers, Rhinoceros, Tourists and Park Management vs. The Needs of the Local People in Royal Chitwan National Park, Nepal", in McNeely,J. and Miller,K. (eds.), op. cit..

Myers,N. [1983], A Wealth of Wild Species, Westview: Boulder.

Myers,N. [1984], The Primary Source, Norton: New York.

Nelson,L. [1986], "Economic Analysis of Iguana Ranching", unpublished manuscript.

Nilsson,G., [1980], Facts About Furs, Animal Welfare Institute: Washington.

Norton,B. (ed.) [1986], The Preservation of Species, Princeton University Press: Princeton, New Jersey.

Office of Technology Assessment [1988], Technologies to Maintain Biological Diversity, Lippincott:Philadelphia.

Overseas Development Institute [1988], "Commodity Prices: Investing in Decline", Briefing Paper, March.

Parker,I. [1984], "Perspectives on Wildlife Cropping or Culling", in Bell,R. and McShane-Vicuzi,E. (eds.), op. cit.

Pearce,D., Markandya,A., and Barbier,E., [1989], Blueprint for a Green Economy, Earthscan:London.

Pearce,D., [1990], "An Economic Approach to Saving the Tropical Forests", LEEC Discussion Paper 90-06, IIED:London.

Pearce,D. (ed.), [1991], Blueprint 2: Greening the World Economy, Earthscan: London.

Prescott-Allan,R. and C., [1982], What's Wildlife Worth?, Earthscan: London.

Prescott-Allan,R. and C., [1989], The First Resource, Cambridge University Press: Cambridge.

Pullan,R. [1984], "The Use of Wildlife as a Resource in the Development of Zambia", in Ooi Jin Bee (ed.), Natural Resources in Tropical Countries, Singapore University Press.

Purseglove,J., Brown,E., Green,C. and Robbins, S. [1981], Spices, (2 vols.), Longman: London.

Repetto,R. (ed.) [1985], The Global Possible, Yale University Press: New Haven.

Repetto,R., [1986], "Soil Loss and Population Pressure on Java", Ambio, vol. 15, p. 14.

Repetto,R. and Gillis,M., (eds.) [1988], Public Policies and the Misuse of Forest Resources, World Resources Institute: Cambridge.

Robinson,W. and Bolen,E., [1989], Wildlife Ecology and Management, (2d ed.), MacMillan: New York.

Ruitenbeek,J. [1990], Evaluating Economic Policies for Promoting Rainforest Conservation in Developing Countries, unpublished Ph.D. dissertation, London School of Economics.

Sale,J. [1981], The Importance and Values of Wild Plants and Animals in Africa, International Union for the Conservation of Nature: Gland.

Sandford, S. [1983], Management of Pastoral Development in the Third World, Wiley & Sons: New York.

Sapsford,D., [1985], "The Statistical Debate on the Net Barter Terms of Trade Between Primary Commodities and Manufactures", Economic Journal, v. 95, p. 781.

Spraos,J., [1980], "The Statistical Debate on the Net Barter Terms of Trade Between Primary Commodities and Manufactures", Economic Journal, v. 90, p. 107.

Stern,N., [1989], "The Economics of Development: A Survey", Economic Journal, v. 99(397), p. 597.

Swanson,T., [1989], "The International Regulation of the Ivory Trade", London Environmental Economics Centre Discussion Paper.

Swanson,T., [1991], "Conserving Biological Diversity", in Pearce,D., (ed.), Blueprint 2: Greening the World Economy, Earthscan: London.

Swanson,T. and Pearce,D., [1989], "The Ivory Exchange - A Proposal for the Regulation of the Ivory Trade", International Union for the Conservation of Nature.

Thresher,P. [1981], "The Present Value of an Amboeseli Lion", World Animal Review, no. 40, p. 8.

Tilt,W. [1987], "From Whaling to Whalewatching", Trans. of N. Amer. Wildlife and Nat. Resource Conf., vol. 52, p. 567.

Todaro, M., [1989], Economic Development in the Third World, (4th. Ed.), Longman: New York.

U.S. Fish and Wildlife Service [1987], National Survey of Fishing, Hunting and Wildlife-Associated Recreation, Washington.

Von Richter,W., [1976], Recreational and Subsistence Hunting in a Semi-Arid Country: Botswana, FAO: Rome.

de Vos, [1977], "Game as Food: Its Significance in Africa and Latin America", Unasylva, v. 29(116), p. 2.

Watson,D. [1988], "The Evolution of Appropriate Resource Management Systems", in Berkes,F. (ed.), op. cit.

Western,D. [1984], "Amboseli National Park: Human Values and the Conservation of a Savanna Ecosystem", in McNeely,J. and Miller,K. (eds.), op. cit.

Western,D. and Pearl,M. (eds.) [1989], Conservation in the Twenty-first Century, Oxford University Press: Oxford.

Williamson,O. [1986], The Economic Institutions of Capitalism, Free Press: New York.

Wilson,E.O. [1986], Biodiversity, Smithsonian Institution: Washington.

Wolf,E. [1988], "Avoiding A Mass Extinction of Species", in Brown,R. (ed.), State of the World 1988, Norton: New York.

Woodruff, J. [1979], Tree Nuts: Production, Processing and Products, AVI: Westport, Connecticut.

World Bank [1989], World Development Report, Oxford Univ. Press: Oxford.

World Conservation Monitoring Centre [1992], Global Biological Diversity, forthcoming.

WTO [1990], World Tourism and Travel Statistics, New York.

World Wildlife Fund [1986], TRAFFIC (USA) Wildlife Trade Fact Sheets, Washington,D.C.

Yeager,R. and Miller,N., [1986], Wild Life, Wild Death, State University of New York: Albany, New York.

Young,G. [1973], Tourism: Blessing or Blight?, Penguin:London.

Zimbabwe Department of National Parks and Wildlife [1989], Elephant Management in Zimbabwe, Harare.

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GK 91-02

Edward B. Barbier, Bruce Aylward and Joshua Bishop
Guidelines for Applying Environmental Economics in Developing Countries
May 1991 (£2.50)

GK 91-03

Bruce Aylward
The Economic Value of Ecosystems: 3 - Biological Diversity
June 1991 (£2.50)

BOOKS

Edward B. Barbier

Economics, Natural-Resource Scarcity and Development: Conventional and Alternative Views, Earthscan, London, 1989 (paperback £15.00)

The history of environmental and resource economics is reviewed; then using insights from environmentalism, ecology and thermodynamics, Barbier begins the construction of a new economic approach to the use of natural resources and particularly to the problem of environmental degradation. With examples from the global greenhouse effect, Amazonian deforestation and upland degradation on Java, Barbier develops a major theoretical advance and shows how it can be applied. This book breaks new ground in the search for an economics of sustainable development.

David W. Pearce, Anil Markandya and Edward B. Barbier

Blueprint for a Green Economy, Earthscan, London, 1989 (paperback £6.95)

This book was initially prepared as a report to the Department of Environment, as part of the response by the government of the United Kingdom to the Brundtland Report, *Our Common Future*. The government stated that: '...the UK fully intends to continue building on this approach (environmental improvement) and further to develop policies consistent with the concept of sustainable development.' The book attempts to assist that process.

Edward B. Barbier, Joanne C. Burgess, Timothy M. Swanson and David W. Pearce

Elephants, Economics and Ivory, Earthscan, London, 1990 (paperback £8.95)

The dramatic decline in elephant numbers in most of Africa has been largely attributed to the illegal harvesting of ivory. The recent decision to ban all trade in ivory is intended to save the elephant. This book examines the ivory trade, its regulation and its implications for elephant management from an economic perspective. The authors' preferred option is for a very limited trade in ivory, designed to maintain the incentive for sustainable management in the southern African countries and to encourage other countries to follow suit.

Gordon R. Conway and Edward B. Barbier
After the Green Revolution: Sustainable Agriculture for Development, Earthscan Pub. Ltd., London, 1990 (paperback £8.95)

The Green Revolution has successfully improved agricultural productivity in many parts of the developing world. But these successes may be limited to specific favourable agro-ecological and economic conditions. This book discusses how more sustainable and equitable forms of agricultural development need to be promoted. The key is developing appropriate techniques and participatory approaches at the local level, advocating complementary policy reforms at the national level and working within the constraints imposed by the international economic system.

David W. Pearce, Edward B. Barbier and Anil Markandya
Sustainable Development: Economics and Environment in the Third World, London and Earthscan Pub. Ltd., London, 1990 (paperback £9.95)

The authors elaborate on the concept of sustainable development and illustrate how environmental economics can be applied to the developing world. Beginning with an overview of the concept of sustainable development, the authors indicate its implications for discounting and economic appraisal. Case studies on natural resource economics and management issues are drawn from Indonesia, Sudan, Botswana, Nepal and the Amazon.

David W. Pearce and R. Kerry Turner
** *Economics of Natural Resources and the Environment*, Harvester-Wheatsheaf, London, 1990.

This textbook covers the elements of environmental economics in theory and in application. It is aimed at undergraduates and includes chapters on sustainable development, environmental ethics, pollution taxes and permits, environmental policy in the West and East, recycling, and optimal resource use.

David W. Pearce, Edward B. Barbier, Anil Markandya, Scott Barrett, R. Kerry Turner and Timothy M. Swanson
Blueprint 2: Greening the World Economy, Earthscan Pub. Ltd., London, 1991 (paperback £7.95)

Following the success of *Blueprint for a Green Economy*, LEEC has turned its attention to global environmental threats. The book reviews the role of economics in analyzing global resources such as climate, ozone and biodiversity, and considers economic policy options to address such problems as global climate change, ozone depletion and tropical deforestation.

FORTHCOMING PUBLICATIONS

Jean-Philippe Barde and David W. Pearce (eds.)
Valuing the Environment: Six Case Studies, Earthscan Pub. Ltd., London, available June 1991 (paperback £9.95)

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