

**MANAGING BIODIVERSITY:
POLICY ISSUES AND CHALLENGES
FOR MALAYSIA**

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ABSTRACT

This report outlines the policy issues and challenges facing Malaysia in the management of its biodiversity. It begins with a brief discussion of what biodiversity means, and the nature of the threats posed to it. It then describes the economics of biodiversity, in terms of costs and benefits of its protection, and how that economic framework can provide a guide to the development of policy. It then discusses in more detail three key elements of biodiversity management: bioprospecting; nature-based tourism; and endangered species protection.

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1. INTRODUCTION

Biological diversity is an important natural asset for Malaysia. The genetic material contained in Malaysia's abundant tropical plant species is a potential source of commercially valuable pharmaceutical products, and the richness of Malaysia's forest and marine environments offers some of the finest nature-based tourism opportunities in the world. This natural asset has the potential to deliver significant economic benefits, but the full realization of those benefits requires careful management of the asset.

This paper provides an overview of some of the key issues and challenges facing Malaysia in the management of biodiversity. It examines three broad areas pertaining to biodiversity management: bioprospecting (the search for biotechnology applications of natural biota); nature-based tourism; and legislation to protect endangered species and habitats.

1.1 What is Biodiversity?

Biodiversity (or biological diversity) refers to the number and variety of living organisms. It is useful to think of biodiversity at three different levels:

- genetic diversity;
- species diversity; and
- ecosystem diversity.

Genetic diversity refers to the variety of genetic information in all living organisms; species diversity refers to the variety of species; and ecosystem diversity refers to the variety of ecological processes or habitats. All three aspects of biodiversity are important from both an ecological and an economic perspective.

For the purposes of designing policy to manage biodiversity it would be helpful to have a definition of biodiversity more precise than a vague reference to "variety". However, such a definition is elusive, for two reasons. First, the physical scale of the issue, together

with the complex interrelationships between different life forms, makes the problem of defining biodiversity in terms of a manageable number of indicators extremely difficult. Second, we face an “index number” problem when attempting to choose those indicators; that is, the choice of index for measuring a multi-faceted entity like biodiversity depends on what aspects of it are deemed most important for the purposes of measurement, and that must rest on a value judgement. Thus, defining biodiversity is not simply an ecological issue; it is also about values.

This paper takes an economic approach to the question of value; that is, the value of biodiversity is taken to be its value to humans. This is in fact a very broad notion of value, since it encompasses a wide spectrum of different values, ranging from the physical utilization of biological resources for food and medicines to less tangible “spiritual” values.

1.2 Threats to Biodiversity

The main threat to biodiversity around the world is the destruction of tropical rainforests. Tropical rainforests, such as those found in Malaysia, are thought to hold between 50 and 90 percent of all species on earth, including 65 percent of vascular plants and up to 96 percent of insects. Only a small percentage of these species have been catalogued to date: around 1.4 million out of the estimated 10 million species on earth. Thus, much of the concern over the loss of biodiversity arises from the fact that we do not even know what we are losing.

The extinction of species is not a new or “unnatural” phenomenon. There have been many mass extinctions throughout earth’s history, involving biodiversity loss on a greater scale than we are currently witnessing. However, current rates of human-induced species extinction are extremely high. Moreover, the fact that species have been lost “naturally” in the past does not in any way reduce the value of species that we may lose today. At current deforestation rates, vast numbers of species will be lost over the next century, and with them we will lose potentially large economic values.

While deforestation is the primary threat to biodiversity, there are a number of secondary threats that must also be recognized in the design of effective policy to manage biodiversity. These include: other habitat destruction; damage to marine ecosystems from pollution and destructive fishing techniques; and the capture or harvesting of specific endangered species.

The main policy challenge in addressing these threats to biodiversity is to ensure that the values on which decisions are made with respect to the use and protection of biodiversity fully reflect the true social values of biodiversity. The key to meeting that challenge is the creation of the right economic incentives. To some degree this simply requires the use of regulation to shape market outcomes, as in the case of bioprospecting and nature-based tourism. However, there are important biodiversity values that cannot be easily captured through the market and so there arises the need for additional policy to correct private incentives, such as direct legislation to protect endangered species and habitats.

The rest of this paper elaborates on specific measures to achieve an alignment of private incentives with social values in the management of biodiversity. Chapter 2 sets out the basic economics of biodiversity. Bioprospecting and nature-based tourism are covered in chapters 3 and 4. Chapter 5 examines the design of legislation to protect endangered species and habitats.

2. THE ECONOMICS OF BIODIVERSITY

This chapter sets out the basic economics of biodiversity. It is intended to provide a brief overview of how economists have begun to think about the application of economic concepts to the management of biodiversity.

The economic approach to biodiversity management is distinguished by its focus on balancing relative costs and benefits. On one hand, the loss of biodiversity has associated costs for society, and hence its protection is valuable. On the other hand, activities like timber harvesting, agriculture, industrial development, and so on – activities that are often in conflict with the protection of biodiversity – also have value. An economic approach to the management of biodiversity resources takes into account both sides of this tradeoff. In some circumstances the benefits of land conversion for agricultural or industrial development will outweigh the costs of the associated biodiversity loss. In other instances the converse will be true: the costs of biodiversity loss will outweigh the benefits of land conversion. An economic approach to biodiversity management dictates that land conversion should be allowed if, but only if, the benefits outweigh the costs.

The policy challenge is to strike an optimal balance between the conservation of biodiversity and the pursuit of other development goals based on a complete assessment of relative costs and benefits. It must be stressed that meeting that challenge requires a long-term view. Biodiversity loss is irreversible: an extinct species is lost forever. This means that policy formulated today must take into account not only the value of biodiversity today but the value of that biodiversity in the future. In particular, the value placed on biodiversity – and on environmental resources generally – tends to grow alongside economic wealth. Thus, policy today should be based not just on current wealth levels but on a projection of wealth levels into the future.

2.1 Land Use Policy

The main threat to biodiversity is land conversion. Thus, the key to biodiversity management is the regulation of land use. Other policies are also important – pollution regulations, restrictions on agricultural and fishing practices, wildlife management, etc. – but land use policy must form the foundation for biodiversity management.

2.1-1 Theoretical Framework

Three basic principles should guide land use planning. In particular, planning should be:

- ecosystem based;
- integrated; and
- based on cost-benefit analysis.

Consider each of these in turn.

2.1-1-1 EcoSystem Based Planning

Land use policy should be ecosystem-based. That is, administrative jurisdictions should be partitioned for planning purposes according to key ecosystem types (marine, east coastal, west coastal, alpine, sub-alpine, wetland, etc.). Land use for a particular ecosystem type can then be assessed with respect to the particular biodiversity values associated with that type.

2.1-1-2 Integrated Planning

It is absolutely vital that land use planning be integrated across regions and across sectors. In particular, land use planning in one region should not be conducted independently of planning in another region; the likely outcome is a patchwork of incongruent development. Moreover, a lack of integration across regions is likely to lead to excessive development: each region perceives its own loss of biodiversity as relatively small on a national or state scale, but in aggregate these losses are considerable.

Similarly, planning should be integrated across sectors. For example, independent planning exercises for tourism and industrial development is likely to yield conflicting land uses, to the potential detriment of both sectors.

It is useful to view integrated land use planning as a multi-tiered process. At the first level we determine the allocation between developed land and undeveloped land for each ecosystem type. At the second level we determine the allocation of developed land to various alternative uses. This multi-tiered process is illustrated in Figure 2-1. Note that the land use types illustrated are meant only as examples; they are not intended to be comprehensive.

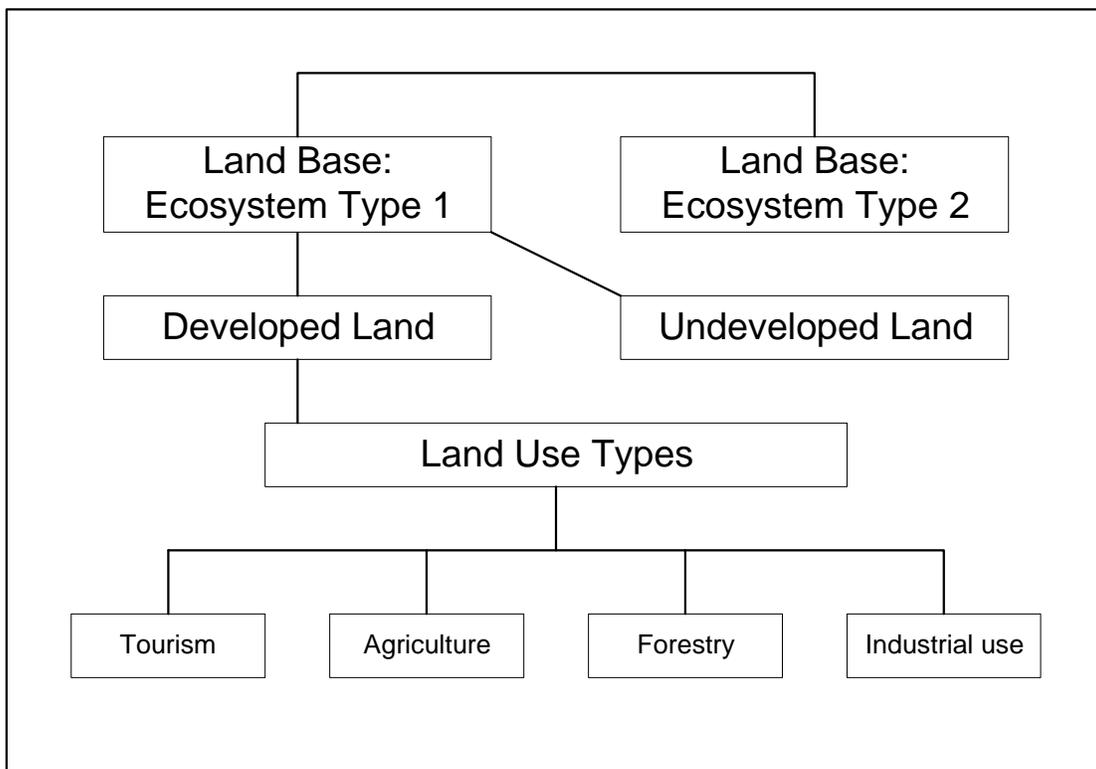


Figure 2-1: Land Use Planning

2.1-1-3 Planning Based on Cost-Benefit Analysis

The allocation of land at each tier of the planning process should be based on relative costs and benefits. Consider the first tier of Figure 2-1. Balancing costs and benefits at this tier yields an apportioning of land such that the marginal benefit of land development is just equated to the marginal cost associated with biodiversity loss due to that development. This balance between marginal costs and benefits at the first tier is illustrated in Figure 2-2.

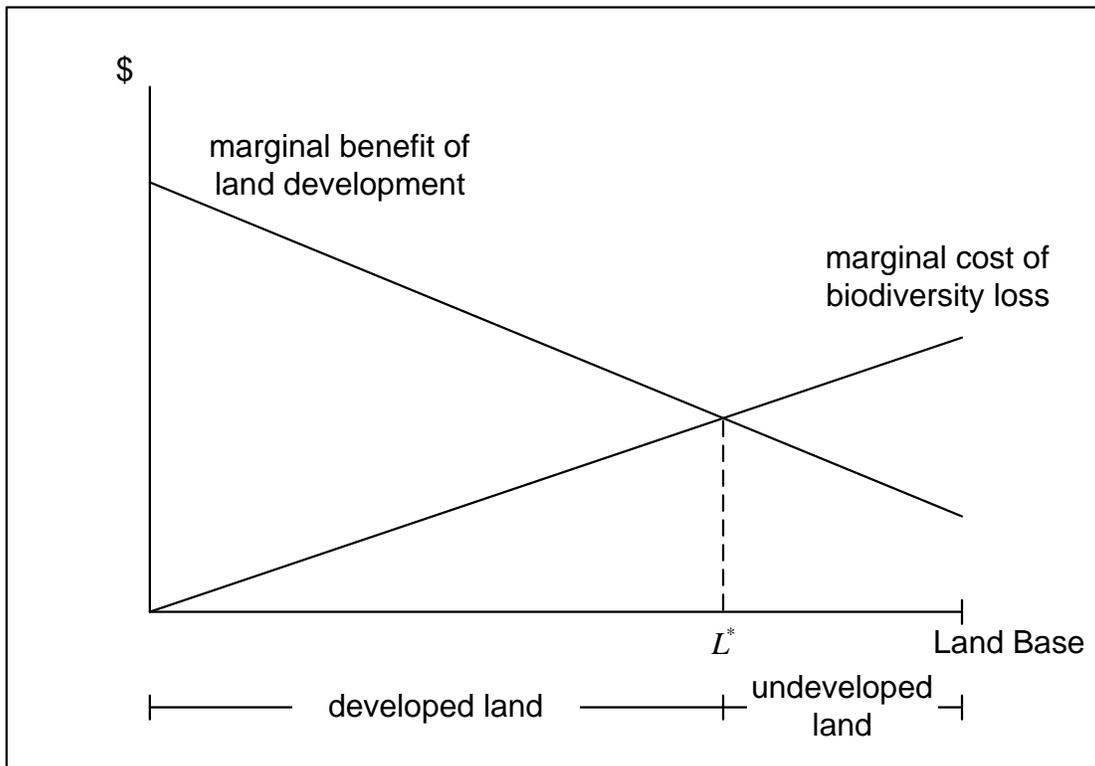


Figure 2-2: Optimal Land Development for Ecosystem Type

Figure 2-2 depicts the tradeoff between the benefits of land development and the costs of the associated biodiversity loss. Note that the marginal cost of biodiversity loss is depicted in Figure 2-2 as upward-sloping. This reflects the fact that the value of biodiversity rises as it becomes increasingly scarce. Conversely, the marginal benefit of land development is depicted as downward-sloping. This reflects the fact that as more land is developed, each additional hectare of land developed contributes less to the generation of wealth; there are “diminishing returns” to land development. (For example, as increasingly remote land is converted to oil palm plantation, rising cultivation and transportation costs reduce the associated return). In a rapidly growing economy like Malaysia, short-run returns may sometimes appear not to be diminishing at all; near-sighted planning can therefore lead to excessive rates of development. (For example, consider real estate development in Kuala Lumpur during the mid-1990s). However, it is vitally important to take a long-term perspective to land development. Accordingly, the curves in Figure 2-2 reflect discounted long-term benefits and costs of land development.

The optimal balance between developed and undeveloped land is depicted in Figure 2-2 as L^* . This optimal balance will in general differ across ecosystem types. In particular, some ecosystem types may have higher biodiversity value than others, or may have higher development potential than others, therefore requiring more or less land to be left undeveloped.

It should also be noted that some types of development have less adverse impact on biodiversity than others. For example, minimal development to support ecotourism has far less impact than large-scale land clearing for oil palm plantation. Thus, the position and shape of the curves in Figure 2-2 – and the optimal balance they imply – depend on the land use types that underlie land development.

This brings us to the second tier of the planning process depicted in Figure 2-1: the allocation of developed land to various alternative uses. This allocation should also be based on relative costs and benefits, as depicted in Figure 2-3. This figure illustrates the division of developed land between two land use types. Land should be allocated to the

use type with the highest marginal net benefit up to the point where those marginal net benefits are equated across types. Note that while it is possible to illustrate only two land use types in a two-dimensional figure, the logic behind the figure extends to any number of land use types.

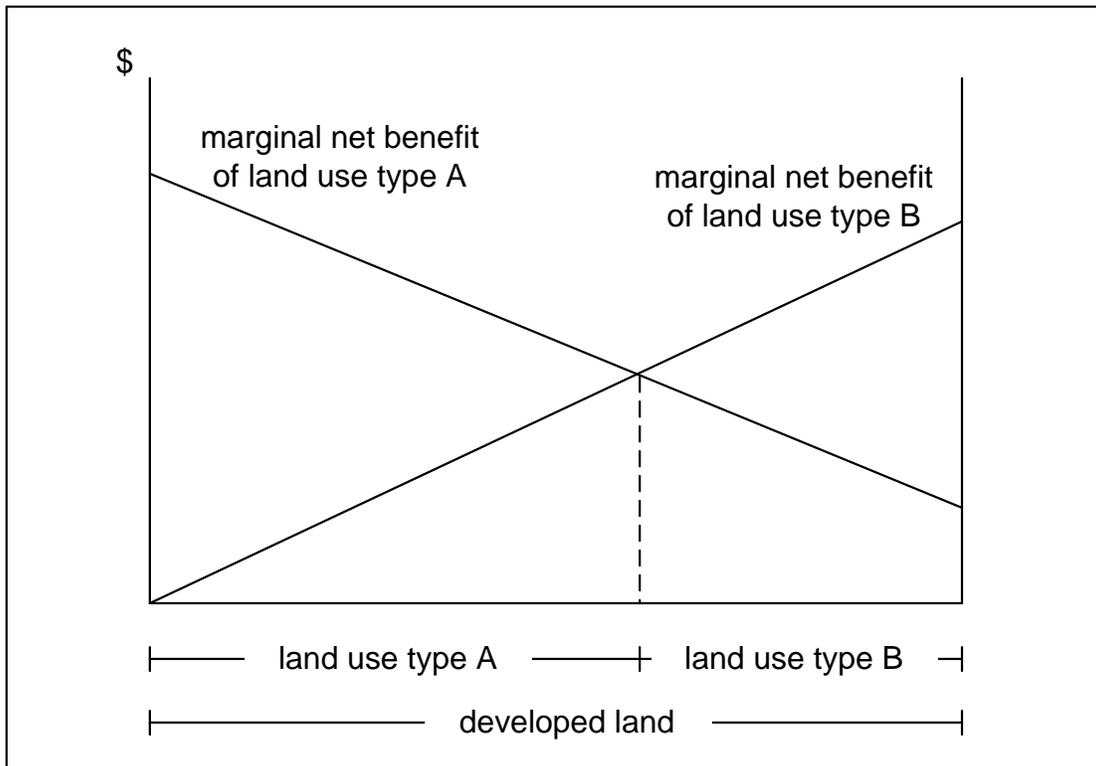


Figure 2-3: Optimal Mix of Land Use for Ecosystem Type

2.1-2 Application of the Theoretical Framework

Applying this theoretical framework in practice is a complicated task. In particular, there are three major hurdles to clear in progressing from theory to application:

- political interference;
- modeling complexity; and

- empirical calibration.

Consider each of these in turn.

2.1-2-1 Political Interference

Political considerations are an integral part of any policy formulation exercise. In particular, issues of wealth distribution and property rights assignment can only be resolved through a political process. However, it is important that political considerations should not be allowed to dominate a proper consideration of costs and benefits.

2.1-2-2 Modeling Complexity

One of the main obstacles to integrated land use planning is the complexity of the exercise. Computer modeling technology provides the best route to dealing with this complexity. A computer model should follow the same basic structure depicted in Figure 2-1, with different modules for different ecosystem types, linked as part of an integrated model. Key relationships are represented mathematically and then calibrated using empirical parameter estimates (see below). Calibrated models can then be used to simulate different development patterns for consideration and assessment. Moreover, a variety of optimization exercises can be performed to identify the type of optimal allocations identified in Figures 2-2 and 2-3 above.

2.1-2-3 Empirical Calibration

The informational requirements for calibrating land use planning models are considerable. We can think of those information requirements as comprising two main types:

- information about the physical characteristics of the land; and
- information about economic costs and benefits.

The collection and organization of information about physical characteristics can be facilitated greatly through the use of geographical information systems (GIS). GIS is an information storage technology that allows large amounts of information about an area of land to be organized spatially, and overlaid on a map for visualization. An area of land

defining a particular ecosystem can be represented with various layers of information relevant to the management of that land, including information about human activity on the land, the number and variety of animal and plant species, topography, soil composition, water and air quality, water drainage patterns, rainfall patterns, wind patterns, temperature patterns, etc. A vital use of GIS is to keep track of changes in these characteristics of the land over time, which allows key relationships in the ecosystem, especially those involving human-induced changes, to be studied over time.

The second type of information required for land use planning is information about economic costs and benefits. Conceptually, this is a more difficult problem than acquiring information about physical characteristics. In many instances market prices provide good guidance to economic costs and benefits. For example, the price of palm oil provides a reasonable basis for estimating the marginal benefit of allocating land for palm oil production. However, in other instances market prices are either distorted or simply do not exist. In particular, prices generally do not exist for biodiversity: it tends to be under-valued by the market. The source of that under-valuation is a particular type of market failure: externalities. This important issue is discussed next.

2.2 The Problem of Externalities

An externality is an impact of an activity that is not taken into account by the individuals or firms who undertake that activity. For example, the destruction of coral reefs is an externality associated with dynamite fishing. The destructive impact is external to the fishermen – in the sense that they do not pay a price for the destruction – and hence it is not taken into account by them when assessing the private return from the activity. Similarly, the silting of rivers is an externality associated with poor logging practices; the cost of the silting is not reflected in the financial return from logging.

Externalities arise because of undefined or unenforced property rights. For example, logging firms do not have to pay a price for the silting of rivers because ownership of the rivers is not properly defined. In contrast, those same firms have to pay a price for the

labour they employ because ownership of that labour is defined and enforced (it rests with the workers themselves). Thus, the cost of labour is taken into account in harvesting decisions but the cost of river damage is not.

Externalities can be positive or negative but in either case they cause private (or market) costs and benefits to differ from true social costs and benefits, and thereby lead to a misallocation of resources. In particular, externalities associated with the use and loss of biodiversity have led to its under-valuation in the market and a consequent inadequacy in measures to conserve it.

Two broad types of externality are especially important with respect to the use and loss of biodiversity:

- open access; and
- public goods.

Consider each of these in turn.

2.2-1 Open Access

Open access refers to circumstances where the use of a resource is unrestricted; it occurs where ownership of the resource is not clearly defined or where ownership rights are too costly to enforce properly. Open access has contributed to the under-valuation of biodiversity in two main ways:

- the inability of host countries to capture a share of the returns from the utilization of biodiversity (for example, through the development of pharmaceutical products); and
- the uncontrolled destruction of tropical rainforests for land conversion.

We will discuss these two issues in more detail in chapters 3 and 5 respectively.

2.2-1 Public Goods

Public goods are characterized by two key features:

- their benefits can be enjoyed by an individual or group of individuals whether or not they contribute to its provision or protection; and

- utilization by one individual does not detract from the capacity of another individual to also utilize the good.

The textbook example of a public good is a lighthouse. It is not possible to restrict the navigational guidance provided by the lighthouse to those who have contributed to its provision (since the light can be seen by everyone); and no user of the lighthouse service causes less light to be viewable by other users.

Biodiversity has both of these public good properties. In particular, many of the services provided by biodiversity are enjoyed by the entire global population regardless of whether or not they contribute to the cost of its protection; this is especially true of the “passive use” values of biodiversity (see section 2.4).

These two externalities – open access and public goods – mean that the market valuation of biodiversity tends to understate its true social value. Thus, biodiversity loss receives too little weight in land use allocation decisions made through markets, and through public planning based solely on market values. This misallocation is illustrated in Figure 2-4. The optimal level of developed land is indicated by L^* in the figure, but the allocation of land for development based on market values is $\hat{L} > L^*$.

2.2-3 The Under-Valuation of Information

The under-valuation of biodiversity has also lead to a secondary impediment to its proper management: a lack of information about it. The value of acquiring information about a resource stems primarily from the expected value of the resource itself. Thus, an under-valuation of biodiversity leads to an under-valuation of information about it. This compounds the management problem and means that many decisions have to be made under considerable uncertainty about true costs and benefits. Research activity can help to reduce this informational shortfall but decisions nonetheless often have to be made without full information. Simulation and sensitivity testing in the context of the computer-based modeling described earlier can help to deal with this uncertainty.

2.3 Two Key Issues in Biodiversity Management

The under-valuation of biodiversity in the market, and the externalities that underlie that problem, raise two key issues to address in the management of biodiversity:

- how should we value biodiversity correctly?
- what measures can be implemented to ensure those values are taken into account in resource allocation choices?

The remainder of this chapter addresses the first of these questions. The chapters following this one examine the second question.

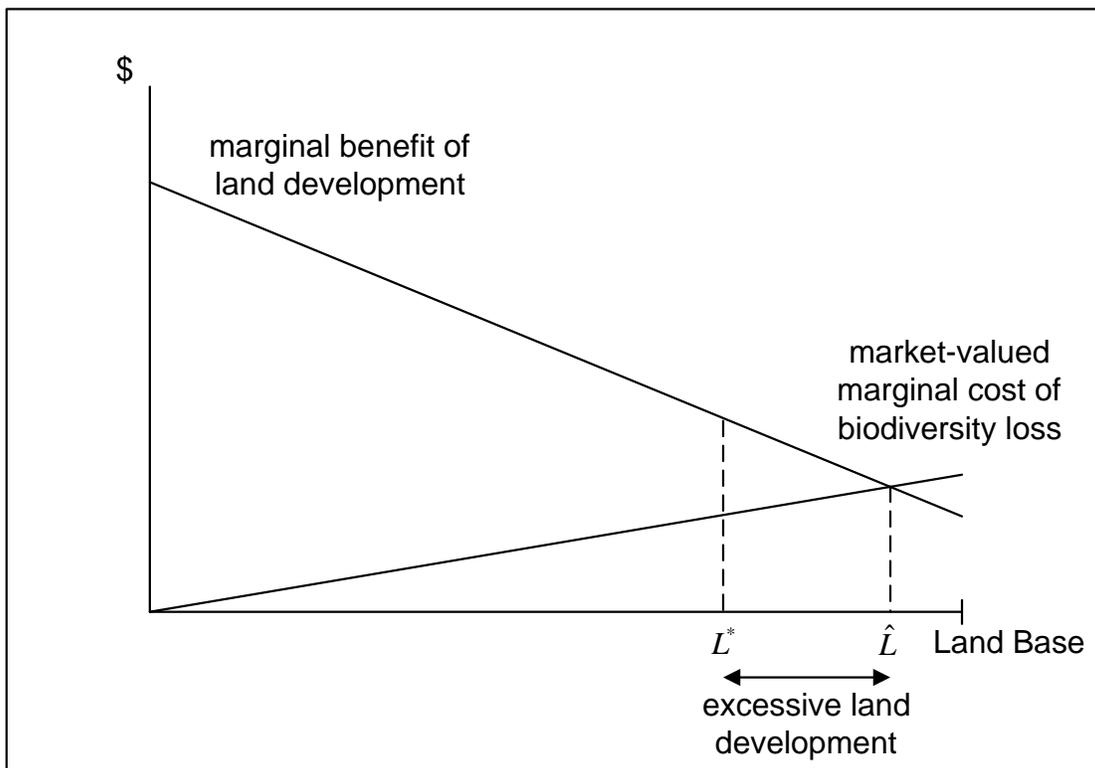


Figure 2-4: Distorted Land Development for Ecosystem Type

2.4 The Economic Value of Biodiversity

The total economic value of any environmental resource can be decomposed conceptually into separate components:

- use value; and
- passive use value.

2.4-1 Use Value

Use value comprises the value attached to “sensuous interaction” with the environmental resource or the ecological functions it performs. Biodiversity provides a wide array of ecological services that support human life and happiness. For example:

- the resilience and adaptability of ecosystems;
- the efficiency of nutrient storage and recycling;
- insurance against the risk of disease and pestilence in agriculture;
- the development of new food types, cosmetics and medicines;
- soil protection;
- water runoff regulation;
- pollution breakdown and assimilation; and
- recreation and ecotourism.

These are all use values of biodiversity.

2.4-2 Passive-Use Value

Passive use value (or “non-use value”) refers to values that arise from the protection of a resource even if the resource is not actively used. Passive use value comprises three elements:

- option value;
- bequest value; and
- existence value.

2.4-2-2 Option Value

Option value is the value of retaining the option to make active use of biodiversity in the future. An important example is the value of preserving biodiversity for the future development of medicines to fight hitherto unknown diseases.

2.4-2-3 Bequest Value

Bequest value is the value attached to conserving biodiversity for future generations. This value derives from altruistic concern for the welfare of future generations in general.

2.4-2-4 Existence Value

Existence value is the value attached to the continuing existence of biodiversity, independent of any potential use it might serve, either now or in the future. For example, many people attach a value to the survival of a variety of whale species in the wild even if they will never see one. Existence value is perhaps the least concrete element of economic value but it can nonetheless be very significant. In particular, many of the cultural, spiritual and so-called “intrinsic” values associated with biodiversity are all aspects of existence value.

2.4-3 Values at the Margin

Economists are not concerned with attempting to value biodiversity in its entirety. The collective value of the earth’s ecosystems is probably infinite: humans would not survive without them. More important from an economic perspective is the valuation of marginal changes in biodiversity; that is, what is the value lost when a species becomes extinct or a unique ecosystem is lost? These are the values needed to determine the optimal balance between land conversion and the conservation of biodiversity described earlier in the theoretical framework for land use policy. To value changes in biodiversity at the margin we need a framework for thinking about how an individual species or individual ecosystem contributes to diversity. The next section describes the current state of economic thinking on this issue.

2.5 Biodiversity: An Economic Framework¹

We will focus on a framework developed by Andrew Metrick and Martin Weitzman (1998). The Metrick-Weitzman framework is imperfect (for reasons to be discussed later) but it provides a useful starting point. Their framework is couched in terms of species diversity but we can also apply the framework at the level of ecosystem diversity.

Metrick and Weitzman use the following analogy to conceptualize biodiversity. Think of a species as a library, whose books represent the genes of that species. The book collections in different libraries overlap to some extent; that is, different species share some of the same genes. This idea is illustrated in Figure 2-5. The gene labeled B9 is common to species 1 and 2, while the gene labeled D8 is common to species 1 and 3. The other genes are unique to the species in which they are found.

SPECIES 1			SPECIES 2			SPECIES 3		
A2	A5	A9	A1	A4	A6	A3	A7	A8
B3	B6	B9	B2	B5	B9	B1	B4	B7
C1	C7	C9	C3	C5	C6	C2	C4	C10
D2	D8	D10	D1	D4	D7	D3	D8	D9

Figure 2-5: Genetic Diversity

¹ This section draws heavily on a presentation by John Livernois at an MIER Workshop on Environmental

Thinking about species in this way leads to the idea that the value of a particular species has two components:

- direct value (the value of the species itself); and
- diversity value (the value of the genetic information embodied in it).

In the library analogy: the library building itself has value and so too does its collection of books. Note that both components of species value may have both use and passive use elements.

Now suppose we are faced with the problem of valuing a particular species (as part of a policy analysis to assess resource use alternatives). Measuring the direct value of the species is relatively straightforward (at least conceptually). The more difficult conceptual problem is measuring the value of the genetic information embodied in the species, especially given that some of that information also resides in other species. The key is to determine the distinctiveness of that information.

We can think of distinctiveness in terms of evolutionary distance. Think of a species as arising from an evolutionary branching process, as illustrated by the evolutionary tree for six species of primate in Figure 2-6. The two most closely related (in terms of greatest genetic overlap) are the two species of gibbon. Thus, the smallest loss of genetic information from a single species extinction would occur if one of these two species was lost. However, if both species of gibbon were lost, a whole evolutionary line would be lost, and there would be a significant loss of biodiversity. An optimal conservation strategy in this example might be to devote relatively few resources to protecting the common gibbon if the siamang gibbon is reasonably safe. Conversely, the common gibbon might warrant strong protection if the siamong faces a high risk of extinction.

In general, the distinctiveness of a species can be represented by the length of its evolutionary branch off the rest of the tree. Under some conditions, a measure of diversity can be defined in terms of the total length of all vertical branches on the tree.

Now let us apply this framework to the problem of ranking different species (or ecosystems) in terms of their biodiversity value. This will not give us dollar values for biodiversity – that requires a few more steps – but it can provide a conceptual framework for setting conservation priorities. Metrick and Weitzman show that if our objective is to maximize the total value of biodiversity – the direct value of species plus their diversity values – then conceptually the solution is to rank species according to a *preservation index* (PI):

$$PI_i = [U_i + D_i] \left[\frac{\Delta S_i}{C_i} \right]$$

where U_i is the direct value of species i , D_i is the distinctiveness of species i , ΔS_i is the change in probability of survival if protected, and C_i is the cost of protection.

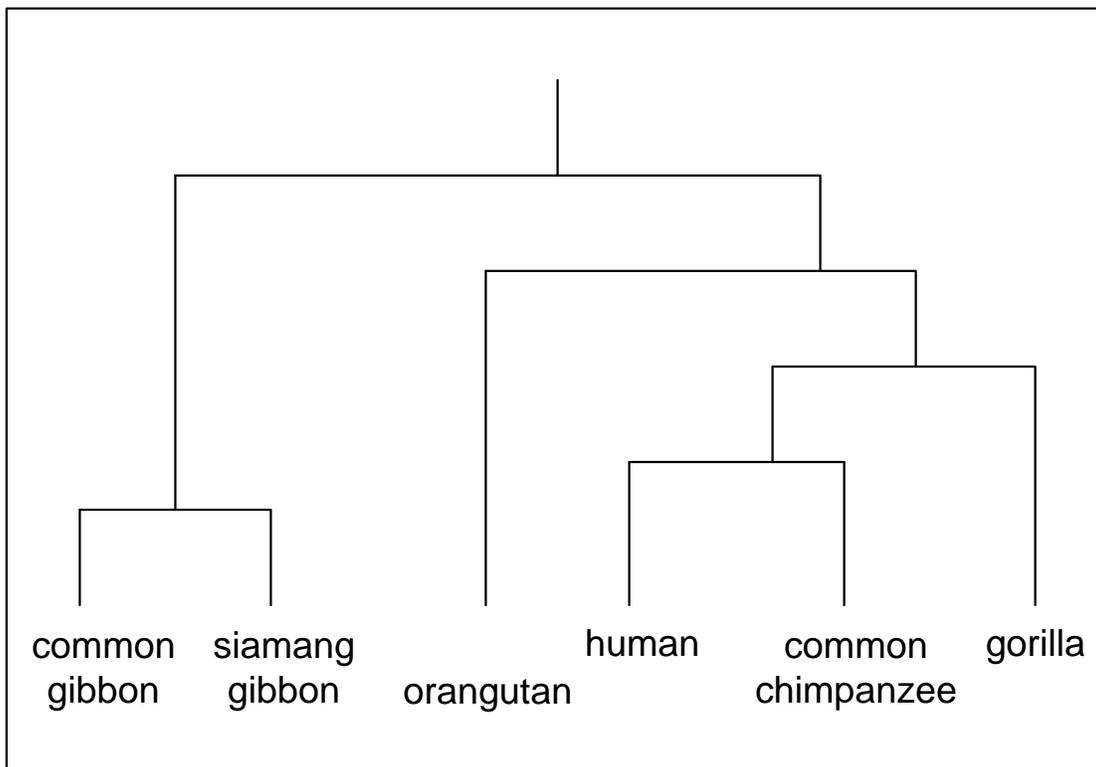


Figure 2-6: Evolutionary Distance in Primates

The PI ranks species in order of their biodiversity value (direct value plus diversity value) per dollar of cost, weighted by the increase in their probability of survival through protection. Quantifying each of these four variables is not easy; more work is needed in the area. However, the framework points to four key factors to consider in the design of a conservation strategy:

- the genetic distinctiveness of a species;
- the direct value of a species;
- survival probability with protection; and
- the cost of protection.

These same four considerations also apply at the ecosystem level (though the problem of defining distinctiveness at the ecosystem level is an order of magnitude more complex).

2.6 Measures to Protect Biodiversity

It was noted earlier that externalities in the use and loss of biodiversity have led to its under-valuation. The foregoing discussion provides some insights into how biodiversity should be valued correctly. The policy challenge is to implement policies and institutions to ensure that these values are internalized into resource allocation choices; meeting that challenge requires a multi-faceted approach. The remaining chapters in this paper focus on three particular directions:

- bioprospecting;
- nature-based tourism; and
- endangered species protection.

3. BIOPROSPECTING

A key message from the previous chapter is that many of the services provided by biodiversity are external to the market. Private incentives to protect biodiversity are therefore relatively small. In particular, the benefits derived from the commercial use of genetic resources have traditionally been external to the host countries.

The Convention on Biodiversity (CBD) of 1992 was intended to change this. A key element of the CBD was the guarantee of sovereignty to host countries over their genetic resources. That is, a key purpose was to define property rights. This had two motivations:

- to ensure a more equitable distribution of the benefits of commercial products developed from genetic resources; and
- to create incentives for host countries to protect those resources.

Bioprospecting opportunities can provide incentives for host countries to protect biodiversity because it offers them a financial return from doing so. We will later address the question of just how large that financial return might be (see section 3.6 below).

3.1 What is Bioprospecting?

Bioprospecting is the search for new biological structures that might lead to the discovery of new drugs and other commercial biological products. This is a potentially important market. For example, nearly 25% of prescription drugs in the US contain active ingredients derived from plants; others are synthesized to replicate or modify the naturally produced molecules. Biodiversity resources have already produced a number of successful and highly profitable drugs. High profile examples include taxol, used to treat ovarian cancer, derived from the Pacific Yew tree; vincristine, used to treat leukemia, derived from the rosy periwinkle plant; and hyoscine, used to relieve nausea, derived from the corkwood tree.

Natural organisms contain genetic codes which are like “recipes” for chemical compounds of potential commercial value. Biotechnology researchers use these recipes as chemical “leads”: promising molecules that can be synthetically modified to give the desired effect. The final chemical product can then often be produced synthetically in its entirety so that further harvesting of the natural raw material is not required. For example, the active ingredients of taxol are now produced exclusively in laboratories.

Bioprospecting begins with the collection and taxonomy of biotic samples (from plants, soil and marine organisms, insects, etc.). Samples are then subjected to “screening” by biotechnology researchers; screening is a search for particular targets or reactions. It is worth noting that the screening process only rarely produces a “hit” (a reaction of potential commercial development value). Thus, while useful discoveries can be extremely profitable, the probability of making such a discovery from any given biotic sample is very small. This has important implications for the bioprospecting value of biodiversity (see section 3.6 below).

3.2 Fostering Bioprospecting in Malaysia

The CBD sets broad parameters for the design of bioprospecting agreements between host countries and foreign companies. It commits treaty countries to the principle that host countries have sovereign rights to their biological resources. It also commits biodiversity-rich countries to facilitate access to biological resources for environmentally sound use in exchange for the equitable sharing of the associated benefits. Responsibility for the execution of that commitment rests with individual countries through the enactment of appropriate legislation and the design of facilitating institutions.

Malaysia has already made significant progress towards establishing an effective institutional framework for regulating and fostering bioprospecting. Work at the Federal level is already quite advanced (as of mid 1999) and Sarawak has had legislation in place

since late 1997. The Sarawak model is an interesting one, and it is worth discussing their approach in more detail.

3.2-1 The Sarawak Biodiversity Council

The Sarawak Biodiversity Council was established by legislation in late 1997. It is a corporate body, which can own property, enter into contracts; and sue and be sued. The council was charged with establishing the Sarawak Biodiversity Centre, the purpose of which is to:

- create an inventory of biodiversity in Sarawak;
- identify uses and values of biodiversity;
- manage biodiversity resources (determining policies for research);
- plan and initiate programs for utilization and protection of biodiversity;
- establish linkages with other parties to enhance utilization and protection; and
- promote education and knowledge about biodiversity.

The regulation of biodiversity is supported by additional legislation (November 1998) that sets regulations pertaining to:

- access to and collection of biological resources;
- research;
- protection and propagation;
- ethnobiology; and
- inventory and depository.

The following describes some the most important elements of the first three of these areas.

3.2-1-1 Access and Collection

Access and collection (except from private land) is allowed only by permit, issued by the council. A permit applicant must have a Sarawak-based sponsor. A collection permit specifies the location for collection, the species and quantity to be collected, and time(s) of collection. Collected materials cannot be removed from the state without an export

license. The penalty for unauthorized collection is a fine of RM20,000 and/or 3 years imprisonment.

3.2-1-2 Research

Research on biological resources requires a research permit and a research agreement. The research agreement includes terms on the location of research, access to and ownership of data, intellectual property rights over discoveries resulting from the research, and technology and knowledge transfer.

3.2-1-3 Protection of Biological Resources

The council can declare any species of animal, plant, insect or aquatic life “protected” if it could be used for pharmaceutical or biotechnology development. Protection restricts research and propagation.

3.3 International Experience

The Sarawak model is one possible approach to regulating and fostering biodiversity, but other approaches have also been used with some success in other parts of the world. Attention here focuses on experience in Costa Rica and Suriname.

3.3-1 Costa Rica

The Instituto Nacional de Biodiversidad (INBio) is a nonprofit, private scientific organization established at the direction of the government. INBio acts as the national biodiversity agency for Costa Rica. INBio has the task of creating an inventory of Costa Rica’s biodiversity and making it available for commercial utilization. INBio also contributes to capacity building through training members of local communities as “parataxonomists” to collect and identify species.

INBio’s cataloguing activity is conducted exclusively in national conservation areas. These conservation areas cover 25% of Costa Rica’s land area and form a vital base for the protection and utilization of its biodiversity resources.

In addition to its cataloguing and training activities, INBio has created a number of bioprospecting partnerships with commercial organizations. The most publicized partnership is with Merck and Co., one of the largest pharmaceutical companies in the world.

3.3-1-1 The Merck-INBio Agreement

In 1991 INBio and Merck signed a two year renewable contract under which INBio agreed to provide biotic samples to Merck for pharmaceutical screening. In return INBio received:

- US\$1 million;
- a percentage of royalties from any drugs developed from the samples (thought to be between 1% and 3%);
- technical training and assistance; and
- scientific equipment worth around \$135,000.

The agreement specifies that 10% of lump-sum payments and 50% of any royalty payments go to the Costa Rican Ministry of Natural Resources to fund conservation.

3.3-1-2 Has INBio Been Successful?

INBio is generally regarded as a success on three fronts:

- building an inventory of biodiversity;
- education and training; and
- initiating formal contracts.

The success of INBio has hinged on some factors that are unique to Costa Rica. In particular, the large area of protected land available for biotic sampling has been a key factor in that success.

The Costa Rican approach is sometimes held up as a model for other countries to follow. However, each country has characteristics and requirements that are particular to it, and a “one model fits all” philosophy is generally not appropriate. Moreover, INBio is not without its critics, who argue that it has set too low a price on bioprospecting, and that it has not done enough to improve the lives of the rural poor. However, it should be noted

that INBio was never intended to be a mechanism for general development. Its focus was made deliberately narrow to ensure that the mandate assigned to it is properly executed. On balance, the Costa Rican model should be seen as an instructive example but not necessarily a model for Malaysia.

3.3-2 Suriname

Suriname, a small country in northeastern South America, has taken a very different approach to bioprospecting. Its bioprospecting initiative has been funded by the International Co-operative Biodiversity Groups (ICBG) Program. ICBG is a program funded by three US government agencies (the National Institutes of Health, the National Science Foundation, and USAID). Its purpose is to foster biodiversity conservation through bioprospecting. The Suriname project is one of five currently funded by ICBG.

Suriname has no formal agency like INBio. Instead it has a formal agreement with Conservation International and the Missouri Botanical Garden who are charged with conducting a national biodiversity inventory. Biotic samples are collected and subjected to preliminary screening by a local pharmaceutical company, BGVS. Further screening and potential development is undertaken by an international pharmaceutical company, Bristol Myers Squibb (BMS) Pharmaceuticals.

In return for providing samples, Suriname receives training and equipment from BMS; and a specified share of royalties from drugs developed by BMS through the project. Half of any royalties are shared between Suriname University, the Suriname Government, and BGVS. The other half goes into a “Forest People’s Fund” for the indigenous people of Suriname. The project incorporates a program whereby shamans (traditional healers) are helping to direct the selection of samples. Shamans are eligible to hold joint patent rights with the pharmaceutical partners.

3.4 The Value of Bioprospecting²

The extent to which bioprospecting can create private incentives for biodiversity conservation depends primarily on its potential financial value. The long term market value of bioprospecting contracts – such as between INBio and Merck – is so far uncertain. A more direct approach to estimating bioprospecting values has been conducted by Simpson and Sedjo (1996); the following is a brief review of their study.

3.4-1 The Simpson-Sedjo Study

The Simpson-Sedjo study develops a simple theoretical framework for the estimation of bioprospecting values and applies that framework to the valuation of plant species in some biodiversity “hot spots” around the world.

A key element of the Simpson-Sedjo study is their focus on the value of the marginal species. The willingness to pay for biodiversity contracts by pharmaceutical companies is determined by the value of the marginal species, not by the total value of species. For example, the price of copper is not determined by the total value of copper in the world, but by the cost of production at the marginal mine. Similarly, the “price” of biodiversity is not determined by the total pharmaceutical value of all species, but by the contribution to this value made by the marginal species.

Simpson and Sedjo model the screening process as follows. Suppose there are n species that can be screened for a particular target reaction. Species 1 is screened first. With probability p , the test is a success and testing for the target reaction stops. With probability $(1 - p)$, no reaction is found and screening proceeds to species 2. Again, with probability p , the test is a success and testing stops, but with probability $(1 - p)$, the test is unsuccessful and testing continues to species 3. This pattern continues until a successful test is made, or all species have been tested. Based on this model of screening, we can derive the following expression for the value of the marginal ($n+1^{\text{th}}$) species for the particular target reaction:

² This section draws heavily on a presentation by John Livernois at an MIER Workshop on Environmental Policy and Resource Valuation, Kuching, November 1998.

$$v(n) = (pR - c)(1 - p)^n$$

where R is the net revenue of a successful product and c is the cost per screening. The meaning of this expression is as follows. The expected value of the marginal species (for this particular target) is the product of two terms: the expected payoff in the event that the marginal species is sampled; and the probability that it is sampled (i.e. the probability that the discovery is not found in the other n species).

In order to make an estimate of the empirical value of $v(n)$ it is necessary to have an estimate of p , but in reality, very little is known about the size of p . Simpson and Sedjo deal with this problem by using the value of p that would make $v(n)$ highest; this will provide an upper-bound on $v(n)$. Note that a higher value of p has two opposing effects: it increases the expected payoff of the marginal species in the event it is sampled (the first term in the above expression), but it reduces the chance that the marginal species is needed (the second term in the above expression). Thus, there is a value of p that maximizes $v(n)$. Simpson and Sedjo use that maximizing value in their estimation.

Simpson and Sedjo then use the following estimates of the other parameters:

- $n = 250,000$. This is a lower-bound estimate for the number of species of higher-order plants most likely to contain phytochemical compounds known to have exceptional pharmaceutical value;
- $R = \$300$ million; and
- $c = \$3600$.

Using these values and the maximizing value of p , they obtain a value for $v(n)$ in the search for one product. They then assume that an average of about 10 new products are created each year forever (based on data showing that the US FDA approves an average of about 24 new drugs per year of which 1/3 are plant-based). The value of the marginal species, $V(n)$ can then be calculated as the present valued sum of all these $v(n)$'s.

Using a discount rate of 10%, they obtain the following estimate for the value of a marginal species: $V(n) = \$9431.16$ (1994 US dollars).

To put that figure into perspective, consider its implications for the bioprospecting value of a hectare of rainforest. Simpson and Sedjo make an estimation of that value using the “island biogeography” model of species dispersion. This model implies that the number of species in a marginal hectare of habitat equals $0.25D$, where D is the average density of species (species per hectare). Based on that assumption, they derive bioprospecting values per hectare of rainforest in selected biodiversity “hot spots”; these values are presented in Table 3-1.

Table 3-1: The Value of the Marginal Hectare in Selected Biodiversity “Hot Spots”

	Estimated endemic plant species per hectare	Value of marginal hectare
W. Ecuador	.00875	\$20.63
Philippines	.00198	\$ 4.66
Pen. Malaysia	.00062	\$ 1.47
SW Australia	.00052	\$ 1.22
North Borneo	.00042	\$ 0.98
Central Chile	.00032	\$ 0.74

3.4-2 Bioprospecting Benefits vs. Opportunity Costs

How do these bioprospecting values compare with the opportunity cost of protecting the rainforest (in terms of foregone agriculture and timber values)? Barbier and Aylward (1996) estimate the opportunity cost of protecting a hectare of rain forest in Costa Rica at \$200. Thus, the bioprospecting benefits of protection are very small compared to the cost

of that protection. It should be noted that some other studies have produced higher bioprospecting values than the Simpson-Sedjo study, but they still fall far below all reasonable opportunity cost estimates.³

These sobering results on bioprospecting values suggest that bioprospecting values alone cannot provide sufficient incentives for the protection of biodiversity. However, as noted earlier, there is more to the value of biodiversity than commercial bioprospecting benefits. The next chapter deals with a potentially important one: nature-based tourism.

³ It should also be noted that Simpson and Sedjo assume that species are perfect substitutes in producing the product (which is why sampling can stop after a discovery is made). In reality, a number of different species may be capable of producing the discovery, but each will have slightly different attributes, effectiveness, side effects, and so on. Allowing for these factors could make the estimated value of the marginal species higher, but not by enough to make up the shortfall relative to the opportunity cost of protection.

4. MANAGING NATURE-BASED TOURISM

Nature-based tourism creates clear incentives to protect the environment because the profitability of the industry depends on it. However, even nature-based tourism development can conflict with biodiversity conservation goals; the policy challenge is to strike the right balance. Well-managed nature-based tourism can help to protect biodiversity resources, and at the same time generate substantial financial returns to that protection.

4.1 Tourism Development Planning: A Policy Framework

The framework for tourism policy should be one based on relative costs and benefits. In particular, policy should seek to strike an optimal balance between the benefits of tourism development and the cost of any associated environmental impacts. Striking that balance necessarily means that some developments will be allowed to proceed despite adverse environmental impacts; and at the same time, some development proposals will be rejected despite potential financial viability.

There are four levels at which we need to think about relative costs and benefits with respect to tourism development:

- how much land to develop;
- the split between tourism and non-tourism use of developed land;
- the composition of tourism development (across different types of operations); and
- the degree of environmental impact within tourism types.

These four levels of the policy problem are illustrated in Figure 4-1. For the purposes of tourism development planning, it is useful to think about the overall problem as a sequence of optimization problems, “from the bottom up”. Each of these levels of the planning problem is discussed in turn.

4.1-1 Environmental Impact within Tourism Types

Each type of tourism development will have some degree of environmental impact. This is illustrated as the lowest level of Figure 4.1. The optimal degree of environmental impact for any particular type represents a balance between the cost of the environmental impact and the cost of reducing that impact (in terms of foregone profitability of the development due to environmental safeguard requirements). That is, the optimal level of environmental impact is that which maximizes the net social benefit of the development. Note that this optimal level of environmental impact will generally not be zero; moreover, it will generally not be the same across all tourism types.

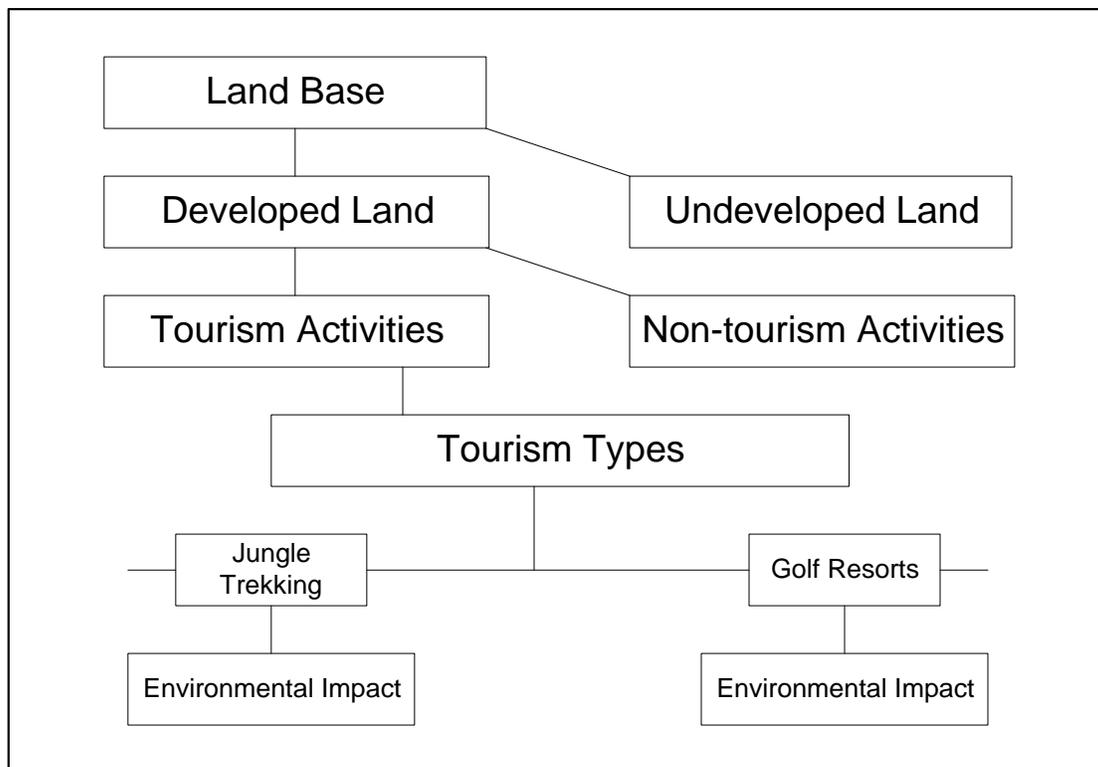


Figure 4-1: A Policy Framework for Tourism Development Planning

4.1-2 The Composition of Tourism Development

The next stage in the sequence of optimization problems is the mix of tourism developments along a spectrum from relatively low environmental impact to relatively high environmental impact. This spectrum is represented in Figure 4.1, with a relatively low impact type like jungle trekking at one end, and a relatively high impact type like destination golf resorts at the other end. An array of tourism types lie between these highlighted examples along this spectrum.

The key to choosing an optimal mix is “balance”. It will generally not be optimal to concentrate all tourism development at either end of the spectrum, whether it be the very low impact end or the very high impact end. For example, a sole focus on jungle trekking will in general not constitute an optimal tourism plan. While this activity has little adverse environmental impact, it appeals to a fairly small market and so the returns to investment in this sector are limited. Similarly, the relatively high environmental impact of destination golf resorts means that a sole focus on this type of development will also be inappropriate. Ideally, the objective is to choose a distribution of tourism types such that the net social benefit of each type is equated across types. That sort of precision is difficult to achieve in practice, but the underlying idea of “balance” is a realistic policy goal.

4.1-3 Tourism Vs. Non-Tourism Land Use

The next stage in the planning process, as we move up through the levels of Figure 4.1, is the allocation of land to tourism activities versus non-tourism activities. Once again, the key to this allocation choice is “balance”. The overall net social benefit of tourism development – as determined by the optimal planning in the lower levels of the planning problem – should ideally be equated to the net social benefit from non-tourism activities.⁴

⁴ A separate, but integrated, planning process for non-tourism activities would have a structure similar to that in the lower levels of the tourism planning process.

4.1-4 Developed Vs. Undeveloped Land

The last stage of the bottom-up planning process is the allocation of land for development versus the setting aside of undeveloped land. The planning problem at this level was discussed in chapter 2. As at the lower stages of the planning problem, the key to optimal planning is to strike a balance between developed and undeveloped land, based on net social returns. Note that the social returns from development are a function of the decisions made at the lower levels of the planning process.

4.1-5 Implementation

The policy framework described above sets out some basic principles for tourism development planning. The next issue that must be addressed is the implementation of those principles. Market forces will produce a particular outcome with respect to the allocation of resources; the policy problem is to ensure that these market forces are directed correctly in order to produce the best outcome in terms of social costs and benefits. The need for policy intervention arises because the market outcome can be distorted away from the social optimum by externalities (external effects that are not properly priced in the market). The next section discusses some important externalities in the tourism development context.

4.2 Tourism and Externalities

The pattern of tourism development is potentially distorted by two sets of externalities:

- the unpriced effects of non-tourism activities on the tourist industry; and
- the unpriced effects of tourist activity itself.

That is, tourism is both a recipient and a source of externalities. Consider each of these in turn.

4.2-1 Tourism as a Recipient of Externalities

A variety of legal and illegal activities impact on the tourism industry through their impact on environmental quality. Examples include timber cutting, wildlife poaching,

polluting industries, dynamite fishing, agricultural runoff, etc. The adverse impact of these activities on the profitability of tourism can create a substantial barrier to the growth and viability of the tourist industry in general, and on nature-based tourism in particular. For this reason, it is crucial that land use planning for tourism and non-tourism sectors be integrated.

4.2-2 Tourism as a Source of Externalities

Tourism can also be a source of externalities, affecting activities outside the tourism industry, and also affecting activities within the industry itself. That is, externalities caused by tourism can occur at two levels:

- extra-industry externalities (unpriced impacts that the tourist industry has on aspects of the environment not directly related to tourism); and
- intra-industry externalities (unpriced impacts that tourist developments and tourist operators have on each other).

Consider each of these in turn.

4.2-2-1 Extra-Industry Externalities

Extra-industry externalities arise because the industry as a whole undervalues environmental characteristics that are not central to generating tourism income. These include elements of biodiversity that have little or no direct tourist appeal (such as spiders, bugs and microorganisms). For example, the clearing of jungle land for a golf resort may reduce bioprospecting values and passive use values; wastewater discharge from a resort may spoil commercial or subsistence fishing grounds; jungle tourism development may disturb the way of life for indigenous peoples.

These externalities lead unregulated market forces to outcomes in which too much land is developed; development is skewed towards the high environmental impact end of the spectrum; and tourist operations all along the spectrum have excessive environmental impact.

4.2-2-2 Intra-Industry Externalities

Externalities between firms within the tourism industry – resorts and tour operators – can lead to excessive impacts even on elements of the environment that are of direct value to the tourism industry itself. For example, waste-water discharge from a marine resort may reduce revenues for a local dive operator; the use of a gasoline engine by one tour boat operator may reduce revenues for another operator specializing in providing a serene natural experience to tourists; too many dive operators may cause congestion of a dive site; a new resort development may spoil the viewscape of an existing resort.

These intra-industry externalities damage the tourism industry as a whole. They can in principle be resolved through self-regulation facilitated by industry associations, but conflict is likely to arise between different types of tourist operations along the spectrum. In particular, high impact operations naturally tend to have a greater impact on lower impact operations than vice versa. This can adversely affect the relative profitability of low impact operations and thereby skew development towards the higher impact end of the spectrum.

The distorting effect of externalities on market outcomes creates a need for regulation. Regulation is required for the activities that impinge on tourism, and for the tourism industry itself. Discussion here focuses on the latter.

4.3 Regulating Nature-Based Tourism

Regulation should not be stifling; its purpose is to foster the tourism industry but in a way that balances the benefits of tourism with the cost of its environmental impacts. Three key foundations should frame the regulation of tourism:

- the designation of land areas according to the type of tourism operations allowed;
- licensing; and
- optimal pricing for access to public natural assets.

Consider each of these in turn.

4.3-1 Land Designation

Land designation ensures the physical separation of potentially conflicting activities; it thereby reduces the incidence of distorting externalities. Different designated areas should be distinguished by the regulations that govern activities in those areas.

Appropriate land designation will also set some land aside permanently as entirely undeveloped wilderness. Moreover, some land should also be left temporarily development-free to allow for flexibility in the growth of the industry. Note that land designation for tourism should be set in the context of broad-based land use planning that integrates tourism and non-tourism sectors (as described in chapter 2).

4.3-2 Licensing

Effective regulation requires that tourist operations be licensed. A license allows an operator to operate in a particular designated area governed by particular regulations.

Licensing has three main functions:

- to ensure compliance with land designation;
- to facilitate the maintenance of safety and quality standards; and
- to control the number of operators.

Note that controlling the number of operators in a particular area can diminish competition but it serves to limit congestion. The optimal degree of control is one that balances these two effects.

4.3-3 Optimal Pricing

Many of the benefits from nature-based tourism tend to accrue primarily to foreign visitors because access to the host country's natural assets – such as national parks and reserves – is not priced. The next section elaborates on this important element of a well-designed nature-based tourism policy.

4.4 Pricing National Park Access

Foreign visitors enjoy the benefits but incur few of the costs associated with maintaining a national park. Pricing national park access can address that issue; it serves two main purposes:

- to capture a share of the benefits; and
- to control congestion and consequent damage.

However, an arbitrary and uncoordinated approach to pricing is inadequate; proper analysis is needed. In particular, estimates of own-price and cross-price park visitation demand elasticities can be used to develop management strategies for simultaneously generating revenues and reducing overcrowding in specific parks. The next section illustrates these points in the context of a case study from Costa Rica.

4.4-1 Case Study: Costa Rica⁵

Costa Rica is one of the world's richest countries in terms of biodiversity; it is estimated to have more species per hectare than any other country. However, that biodiversity has not always been well-managed. Between 1950 and 1990 the country lost one half of its forest cover, due mainly to conversion to agricultural uses. The national parks system has been a key pillar in building better policy for biodiversity management.

4.4-1-1 Background

The national park system is extensive: there are over two dozen national parks, reserves and wildlife refuges. The national park system has preserved over ten percent of the primary forest, and is a key element in the success of the country's ecotourism industry. Tourism is now Costa Rica's largest single source of foreign earnings.

However, the preservation of forest land in the national parks system has a significant opportunity cost: the land could be used for other purposes, with an estimated value of \$200 per hectare. These costs are borne almost exclusively by the people of Costa Rica, yet to a large degree the benefits of the national parks system accrue to foreign tourists.

⁵ Source: Chase et. al . (1998).

Costa Rica has attempted to capture a larger share of these benefits through the imposition of user fees for foreign tourists.

In 1994 entrance fees for foreign tourists were increased by 1100%: from 200 colones (US\$1.25) to 2400 colones (\$15). Fees for residents remained at 200 colones. Strong objections to the fee increases were raised by some park administrators and tour operators, concerned over a loss of business, and some parks refused to implement the increase. An uncontrolled patchwork of policies developed across the park system.

4.4-1-2 Demand Elasticities and Differential Pricing

This less-than-perfect introduction of the new entrance fee system was due in part to the fact that the policy was not based on a systematic analysis of tourist demand. Moreover, no allowance was made for differential pricing across parks according to their popularity and the willingness-to-pay of the tourists who visit them. Differential pricing is based on the fact that different parks have different characteristics and have different degrees of appeal to visitors. These differences are reflected in different visitation demand curves, with different “demand elasticities”.

Demand elasticity refers to the responsiveness of demand to price; it determines the relationship between price and revenue received. Two types of elasticity are important for national park pricing policy:

- own-price elasticity: the responsiveness of demand to the price of the good; and
- cross-price elasticity: the responsiveness of demand to the prices of substitute and complementary goods.

The key to optimal pricing policy is to have reliable estimates of the demand elasticities for the various parks. This was the main goal of the case study.

4.4-1-3 Study Methodology

The study covered the three most frequently visited national parks:

- Manuel Antonio;
- Volcan Oas; and

- Volcan Irazu.

A “contingent behavior approach” was used for the study. This is a survey-based stated preference valuation technique. (See chapter 5 for further discussion of this technique). Data was collected through in-person, on-site interviews with foreign visitors during January - March 1995 at the three parks. A total of 311 surveys were usable. A “payment card approach” was used to elicit responses on actual and hypothetical demand responses. A sample payment card is illustrated in Table 4-1.

Table 4-1: A Sample Payment Card

Park	Actual Fee	Fee	Fee	Fee
Irazu	\$10	\$10	\$12	\$10
Poas	\$10	\$12	\$10	\$10
M. Antonio	\$10	\$10	\$10	\$12

Respondents were sequentially shown each of the four columns of a payment card and each time asked to state how many days they intended to stay at each of the three parks based on the fees indicated. The bold amounts on the sample card in Table 4-1 differ across payment cards, so that a range of demand responses are elicited from the survey group. Data was also collected on key socioeconomic variables, including household income, nationality, age, education, etc.

The collected data on socioeconomic variables and payment card responses allow a system of demand curves to be estimated:

$$Q_j = Q_j(P, M, Z)$$

where Q_j is visitation in days at park j ; P is a vector of entrance fees; M is the average income of park visitors; and Z is a vector of average demographic and trip-related characteristics.

4.4-1-4 Empirical Results and Policy Implications

The demand elasticities estimated for the study exhibit a number of key properties:

- own-price elasticities are negative and vary across the three parks (lowest for Manuel Antonio);
- cross-price elasticities are positive between Irazu and Poas; and
- cross-price elasticities are close to zero between Manuel Antonio and the other two parks.

The results on these estimated elasticities were used to perform a policy experiment: what pricing structure would maximize joint revenue from the three parks? The results indicate that revenue maximization calls for lower entrance fees at Irazu and Poas, and a higher fee at Manuel Antonio than is currently the case. This experiment demonstrates that differential entrance fees, based on demand analysis, can be used to improve the design of park pricing policy and help to capture a greater share of park benefits.

However, it should be noted that factors other than revenue maximization are also important for pricing policy, including:

- creating a sense of “good value” for visitors (to build a reputation);
- local economic impacts (on hotels, etc.); and
- impact on tour operators.

An optimal park pricing policy must be designed in this broader context. It should also be noted that short-run elasticities (estimated in the study) are smaller than long-run elasticities, due to income effects and international competition. Thus, a full study should also take into account country-destination choices. Nonetheless, the results of the Costa Rican case study illustrate how careful economic analysis can be used to improve pricing policy and generate higher returns to the host country from a national parks system.

5. ENDANGERED SPECIES PROTECTION

It was noted in chapter 2 that the economic value of natural resources can be decomposed conceptually into use and passive use values. Bioprospecting and nature-based tourism are most successful at capturing use values; passive use values are much more difficult to internalize. This does not mean that these values should be ignored; on the contrary, various studies have shown that passive use values can be very high. In particular, some people are apparently willing to pay considerable sums to protect endangered species. However, these passive use values attached to biodiversity protection are difficult to translate into financial returns precisely because they are not associated with use. User fees for park access and similar mechanisms are not applicable. Thus, a sole reliance on private returns to biodiversity (through bioprospecting and nature-based tourism) will not create sufficient incentives for protection. Additional mechanisms are required, such as national conservation areas and legislation to protect endangered species.

This chapter examines some important issues in the design of endangered species legislation. One of the most complex issues is the problem of ascertaining the appropriate trade-off between the costs and benefits of protection, since the passive values that underlie those benefits are not directly observable in markets. Thus, the chapter begins with a brief discussion of how these passive use values can be measured.

5.1 Estimating Passive Use Value

Economists have developed two sets of techniques for estimating environmental values:

- revealed preference techniques; and
- stated preference techniques.

Stated preference (SP) techniques are best suited to estimating passive use values; the discussion here is confined to these SP techniques.

SP techniques are a set of valuation techniques that use surveys to elicit from respondents, either directly or indirectly, their valuation of environmental goods. They are “stated preference” techniques in the sense that they measure what individuals state to be their preferences (in contrast to revealed preference techniques). The various SP techniques differ according to the manner in which they ask respondents to state their preferences. The following provides a brief overview of the main SP techniques.

5.1-1 Contingent Rating

Contingent rating provides respondents with a proposed or hypothetical environmental project and asks that they rate the project according to some scale. For example, for a hypothetical project to protect 5000 hectares of orangutan habitat in Sabah, the contingent rating survey question might be: “How important to you is this project? Answer on a scale from 1 (not very important) to 5 (very important)”. A shortcoming with this type of rating question is that it provides the respondent with no objective benchmark (since “importance” is relative).

5.1-2 Open-Ended Contingent Valuation

A special case of the contingent rating method that does use an objective benchmark is “open-ended contingent valuation”. This method asks respondents to state their rating in monetary terms; this provides an objective benchmark for “importance”. For example, the survey question might be: “How much are you willing to pay, in additional taxes, for this project?” This survey question is “open-ended” in the sense that there is no limit placed in the survey question on the amount the respondent can state. An alternative (and more common) approach is the closed-ended “referendum format” contingent valuation method (discussed below).

5.1-3 Contingent Ranking

The contingent ranking approach provides respondents with a set of alternative hypothetical environmental projects and asks them to rank those projects from “most preferred” to “least preferred”.

5.1-4 Stated Choice Methods

The key characteristic of stated choice methods is that the survey forces respondents to choose between two or more hypothetical projects. These methods more closely resemble familiar market settings, where individuals choose whether or not to buy a product, or choose between different product varieties. There are two main types of stated choice method:

- attribute-based stated choice methods; and
- referendum format contingent valuation.

5.1-4-1 Attribute-Based Stated Choice Methods

Attribute-based stated choice methods present respondents with a choice (usually pair-wise) between hypothetical projects that differ according to their environmental attributes and according to the price to be paid (hypothetically) by the respondent. For example, the respondent might be asked to choose between trips to two alternative national parks:

	Area (hectares)	Number of mammal species	Number of bird species	Entry fee
Park A	5000	67	262	RM 25
Park B	1000	15	59	RM 10

The choice made by the respondent provides useful information about the relative values placed on the two trips as a whole, and about the attributes of those trips.

5.1-4-2 Referendum Format Contingent Valuation

Referendum format contingent valuation is a special “all-or-nothing” case of the stated choice method in which the respondent must choose between a defined environmental project for a given price, and no project at all.

5.2 Endangered Species Legislation

Many countries have endangered species legislation of some type. The most comprehensive – and the most studied – is the United States legislation. This section begins with an examination of the merits and shortcomings of the US legislation.

5.2-1 The United States Endangered Species Act

The US Endangered Species Act of 1973 is one of the most comprehensive US environmental laws. The Act recognizes that species have “ecological, educational, historical, recreational and scientific value” inadequately accounted for in the process of “economic growth and development”. Thus, the Act recognizes implicitly the externalities associated with biodiversity loss. The stated aim of the Act is to “provide a means whereby ecosystems upon which endangered species and threatened species depend may be conserved”. Note the emphasis on “ecosystems”.

The administrative process supporting the Act involves five steps:

- listing a species as “threatened” or, more seriously, “endangered”;
- designating critical habitats for its survival;
- prohibiting activities that enhance extinction;
- creating and executing a recovery plan; and
- removal from the list when out of danger.

The apparent intention of the Act is to save *all* species; there is no provision for setting protection priorities across species. However, resource constraints necessarily mean that priorities are set. These priorities appear to be based principally on the preferences of the natural scientists who make the determinations, and there is an apparent bias towards “megafauna” (large mammals and birds).

The Act allows virtually no role for economic analysis in setting protection priorities based on relative costs and benefits. In fact, in a 1978 interpretation of the Act, the Supreme Court ruled that the Act is intended to “reverse the trend towards species

extinction – whatever the cost”. The only point at which any form of economic analysis can be brought to bear is in the designation of critical habitat. The Act allows an area of land to be excluded from critical habitat designation if the benefits from doing so outweigh the costs, *unless exclusion would lead to extinction*.

Failure to take account of costs and benefits more generally has led to considerable controversy in the implementation of the Act. This has arisen largely because the benefits of species protection are widely dispersed – it is a public good – but the costs of protection tend to be highly concentrated. In particular, the costs of protection fall heavily on private land owners whose land use choices can be severely restricted by the requirements of the Act. The cost of foregone land use opportunities include loss of economic rent from restricted development projects, agricultural production, timber harvesting, mineral extraction, recreation activities, wages lost by permanently displaced workers, reduced consumer surplus due to higher prices, and reduced capital asset values. These costs can be substantial. For example, the estimated cost of raising the survival odds of the northern spotted owl in the Pacific North-West to 95% is \$46 billion (1990 US dollars). These costs would be borne most heavily by producers of intermediate wood products in the Pacific North-West states.

Moreover, failure to recognize these costs can lead to perverse outcomes. For example, land owners have an incentive to hamper the collection of information about species on their land in case it leads to a listing. Worse still, landowners may destroy habitat before a species is listed: the “shoot, shovel and shut-up” strategy. Thus, while the Act has the potential to support good policy, its failure to take account of economic considerations is a serious shortcoming.

5.2-2 Key Lessons from the US Experience

The US experience provides a number of important lessons for other countries in the design of endangered species legislation. First, legislation to protect endangered species should be based on a cost-benefit framework. Estimating costs and benefits of protection

is a difficult task but the alternative is to use arbitrary criteria for setting protection priorities.

Second, protection should take an ecosystem-based approach rather than one focussed on individual species. This can also help in the assessment of extinction risks, since the main threat to many species is habitat loss. This ecosystem-based approach should be coupled with the protection of habitat in wilderness reserves where ecosystems and the species they support can be left undisturbed.

Third, legislation should incorporate mechanisms for compensating private parties who bear the costs of biodiversity protection (such as private land owners). Properly designed compensation mechanisms could enhance incentives for protection. A variety of potential mechanisms are available, including: direct compensation to land owners for restrictions on land use; tradeable rights in habitat disturbance; insurance programs; and tax breaks for habitat protection. The relative merits of these mechanisms will depend on particular circumstances.

5.4 Enforcement

Even the best-designed endangered species legislation is ineffective without appropriate enforcement. Similarly, policies to regulate and foster bioprospecting and nature-based tourism will have little impact unless adequate enforcement is available to support those policies. The intrusion of illegal timber harvesting and agricultural expansion into protected areas can be difficult to stop. Similarly, poaching and destructive fishing techniques are difficult to detect and prevent. Appropriate enforcement is needed to prevent these threats to biodiversity.

There are two key elements to effective enforcement: well-designed monitoring and penalty policies; and an adequate enforcement budget. Monitoring and penalty policies have to be creative. For example, the best way to control an illegal activity can sometimes be to partially legalize it; this pertains particularly to the question of trade in

endangered species. However, even the most creative policies require resources for their implementation. Budget constraints are the single biggest obstacle to effective enforcement, especially in developing countries. If serious efforts are to be made to protect biodiversity then there must be an equally serious commitment of resources for enforcement.

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