Alternatives for Habitat Protection and Rural Income Generation

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Abstract

The Eighth General Increase in the Financial Resources of the IDB contains a call to take advantage of "opportunities to aid in the conservation of biological diversity," but also cautions that forest-dwellers must share in the "benefits of sustainable forest management" (IDB Document AB-1704, 18 July 1994, page 34). One way to reconcile habitat protection and local economic well-being is to promote economic activities that are both remunerative and environmentally benign. It has been suggested that nature-based tourism, the extraction of nontimber forest products, environmentally sound timber production, and genetic prospecting might fit these two criteria.

The key question the research in this paper tries to answer is whether those four activities truly represent a viable economic alternative in Latin America's environmentally fragile hinterlands. Several cases in each line of activity are analyzed to determine the level and distribution of the net financial returns they generate. Special attention was devoted to examining the degree to which net returns flow to local populations, as opposed to other economic agents. In general, examination of the rewards local populations can expect to derive from ecotourism and the harvesting of nontimber forest products suggests that allocating time and effort to those activities is unlikely to be very remunerative since unskilled labor is not particularly scarce in rural areas. In addition, little is to be gained by controlling access to natural resources, which for the most part are abundant. Moreover, making the sector-specific human capital and other investments needed for forest dwellers to capture more of the net returns from ecotourism, genetic prospecting, and so forth would probably not benefit them very much. Instead, furnishing them with education and training that is broadly applicable across the entire economy makes more sense.

Contents

Figures and Tables

Introduction

Few would argue that humankind as a whole does not have an enormous stake in the preservation of rainforests and other species-rich habitats in Latin America. Converting such areas into cropland and pasture results in biodiversity loss on a grand scale as well as increased atmospheric concentrations of carbon dioxide and other greenhouse gases. Furthermore, people in many parts of the world feel their lives are enriched as wild lands in Latin America are saved from encroachment, irrespective of whatever narrowly utilitarian values might be attached to avoiding species extinction or global warming.

International efforts to save natural ecosystems in the developing world, which date back more than a quarter century, originally centered on the establishment of national parks and reserves, of the sort found in the United States and other wealthy nations. Various limitations of this approach soon became apparent, however. By and large, the meager financial, technical, and human resources available to governmental park services in poor countries fall short of what is needed for effective management, the control of encroachment, and related tasks. Moreover, establishing nature reserves, where economic activities are proscribed entirely, tends to arouse the opposition of people living nearby.

Since park protection, pure and simple, has its limitations, interest has grown in finding ways to halt habitat destruction while simultaneously raising local standards of living. For example, the Eighth General Increase in the Financial Resources of the Inter-American Development Bank (IDB) contains a call to take advantage of "opportunities to aid in the conservation of biological diversity," but also cautions that forest-dwellers must share in the "benefits of sustainable forest management" (IDB Document AB-1704, 18 July 1994, page 34). Likewise, the president of The Nature Conservancy, which is active throughout the Western Hemisphere, has stated that his organization is "concentrating more on strategies that address …*the* conservation issue of the 1990s: integrating economic growth with environmental protection" (Howard and Magretta, 1995, page 111).

One way to reconcile habitat protection and local economic well-being is to promote economic activities that are both remunerative and environmentally benign. In a typical integrated conservation and development project (ICDP), for example, nature-based tourism, sustainable harvesting of forest products, or both are encouraged in a buffer zone surrounding an officially designated nature reserve. The intention is for people living in the area to give up lines of work like agricultural land clearing in favor of alternatives that create less environmental damage. Insofar as they make this switch, human pressure on renewable resources, in general, is reduced and encroachment on the park, in particular, is diminished.

ICDPs have been criticized on several grounds. For one thing, ecotourism and other preferred activities are not always environmentally benign. In addition, the roads and other improvements that are often needed for an ICDP to be successful also enhance the profitability of more depletive lines of work. Southgate and Clark (1993) point out that, where labor is underemployed, local populations can adopt ICDP activities without giving up what they were doing beforehand. For these and other reasons, Wells and Brandon (1992), who have evaluated twenty-three ICDPs in Africa, Asia, and Latin America, express doubts that parks and reserves can truly be saved by encouraging things like nature-based tourism or the sustainable harvesting of forest products in surrounding buffer zones. The same reservations are shared by Dixon and Sherman (1990) and other observers.

This report addresses the Eighth Replenishment's mandate to reconcile biodiversity protection with the improved economic well-being of forest dwelling people. In particular, the conditions under which nature-based tourism and the sustainable harvesting of forest products truly represent a viable economic alternative in Latin America's environmentally fragile hinterlands are investigated. The net returns generated by preferred activities are described. Distributional issues are also treated; special attention is paid to the degree to which net returns flow to local populations, as opposed to other economic agents.

The study yields recommendations for the improved design of initiatives that the IDB might undertake to prevent biodiversity loss. In addition, some ideas about how those initiatives can fit into an overall strategy for sustainable economic development are offered.

Four chapters, each addressing one kind of economic activity often incorporated in ICDPs and similar projects, contain the report's core findings. So that those findings can be put into proper perspective, those four chapters are preceded by a qualitative discussion of the circumstances under which sustainable economic activities benefit local populations.

In the first topical chapter, nature-based tourism in Costa Rica and the Galapagos Islands is examined. Both places have drawn large numbers of international visitors during the past ten to twenty years, and national economies have benefited enormously as a result. By and large, local communities are gaining little from foreigners' visits to nearby parks and reserves. In addition, there is a need to shore up the environmental base for tourism's continued success, which will have to be addressed by raising entrance fees and by taking advantage of other financing mechanisms.

Harvesting of nontimber forest products is the subject of the fourth chapter. Experience in the Amazon Basin indicates that there are various impediments to that activity's economic and environmental success, including weak property rights, thin markets, and production outside of forest settings. In addition, examination of nontimber extraction in western Ecuador reveals a general tendency toward meager financial returns for the households that engage in harvesting.

The fifth chapter is about environmentally sound timber production. Studies of various modes of timber harvesting and extraction in the eastern Amazon provide a clear picture of how logging evolves in frontier regions, and also yield the conclusion that sheer resource abundance discourages the sort of investment required for sustainable resource management. The latter conclusion is corroborated by experience gained in a sustainable forestry project carried out in the Peruvian Amazon with financial and technical support from the U.S. Agency for International Development (USAID).

In the sixth chapter, there is a review of the empirical literature on the value of tropical forests as a source of raw material for biomedical research. It seems clear that value estimates contained in earlier contributions to that literature are too high. The best available economic research suggests that the returns to genetic prospecting might be quite modest, particularly for forest dwellers. Those returns are almost certainly too small to justify the investment in property institutions required to establish efficient markets for genetic information collected in the wild.

As is indicated in the seventh chapter, ecotourism, nontimber extraction, environmentally sound timber production, and genetic prospecting can, under the right circumstances, contribute to biodiversity conservation and improved living standards in selected areas. In and of themselves, however, those activities cannot serve as a sound centerpiece for an integrated strategy for economic development and habitat conservation. Much more can be accomplished by raising crop and livestock yields, so that agricultural land clearing is no longer needed to satisfy increasing commodity demands. Of even greater importance is human capital formation, which reduces the number of people for whom converting natural ecosystems into marginal farmland is an attractive employment option. Available evidence suggests that a combination of agricultural intensification and human capital investment allows just about any country to raise material standards of living while keeping natural habitats intact. Indeed, achieving economic development through productivity-enhancing investment is probably the only way to protect biodiverse ecosystems in the developing world.

The Local Benefits of Environmentally Sustainable Commercial Ventures

Conservation approaches featuring the promotion of environmentally friendly commercial activities can and should be evaluated from various standpoints. Design and implementation of an ICDP, for example, should take expected biological impacts into account. To be specific, attempts should be made to identify how various buffer zone activities affect threatened species in an adjacent park.

Economic analysis is called for as well. Estimates of the costs of an ICDP must be compared to its expected benefits, the latter being defined as the maximum amount of money that people would be willing to pay for all marketable and nonmarket output. In addition, economists routinely examine the distribution of benefits and costs, and often recommend that mechanisms for effecting transfers from the rich to the poor be articulated if such a mechanism is not already in place and the project is found to contribute to income inequality.

Financial analysis (or private-level economic analysis) is also needed because it is important to know if there is some group that will find it unrewarding to cooperate in an initiative that, in aggregate, is efficient. For example, cash inducements may be needed to elicit the private expenditures needed to realize environmental benefits which are shared by all. The focus of this study is similar to that of financial analysis. That is, it addresses the interests that local communities might or might not have in participating in commercial activities, like nontimber extraction and ecotourism development, that are expected to cause little or no damage to the environment.

In this chapter, the problem of local economic viability is examined in conceptual terms. A static analysis, which reflects demands for goods and services that can be produced in biodiverse habitats and also the availability and productivity of labor and other inputs, is used to clarify the circumstances under which local populations involved in sustainable activities benefit a lot or a little. Static models serve as a point of departure for addressing dynamic issues, which merit careful thought because product demands and input supplies and productivities change over time as a result of technological innovation and investment.

This chapter furnishes a framework for interpreting the empirical findings reported in the rest of the document. Two findings of the discussion of dynamic issues, each having to do with investments that can be made to enhance the productivity of inputs that local people provide to environmentally preferred activities, are especially important to bear in mind. First, those investments have to feature a higher return than other investments that can be made on their behalf. Second, they must be more effective than other measures that can be taken to protect threatened habitats.

If the first condition is not satisfied, then promotion of environmentally sound economic activities is not the best way to help local communities. If the second is not met, then alternative approaches to habitat protection hold more promise. If neither condition is satisfied, then the rationale for ICDPs and related initiatives breaks down entirely.

Static Analysis

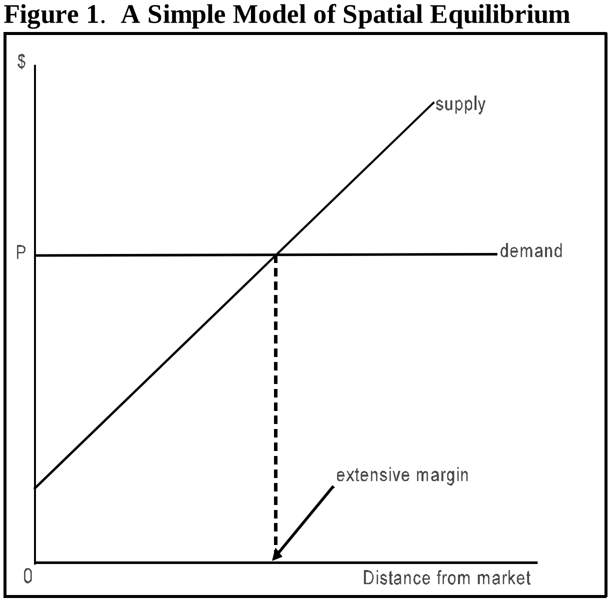
Although forest dwellers' knowledge of the environment that surrounds them is often quite sophisticated, their involvement in commercial activity consists almost entirely of granting access to natural resources and supplying labor. Of course, the earnings derived from that involvement depend on how scarce those two inputs are.

A good framework for understanding resource scarcity is a model of spatial organization of a rural economy that was originally developed by David

Ricardo, an economist of the Classical School, and fully elaborated in the Nineteenth Century by J. H. von Thünen. A simple version of that model applies quite well in a setting like the Amazon Basin. Environmental inputs, used to produce just one sort of good (e.g., timber), are assumed to be of uniform quality and nowhere close to being physically exhausted. Under these circumstances, those inputs have value only if they are advantageously located relative to a market of some sort (e.g., a port from which timber is shipped to foreign markets).

The decline in resource values, or economic rents, observed as one moves away from the relevant marketing node is illustrated in Figure 1. It is reasonable to suppose that the price paid at the node for the finished product (**P** in the figure) is determined by broader economic forces and, hence, can be treated as a constant. By contrast, the combined expense of producing that commodity and delivering it to a buyer is positively related to the distance between the production site and the market. This latter relationship is expressed in Figure 1 by an upward-sloping supply (**S**) curve. The vertical

Figure 1. **A Simple Model of Spatial Equilibrium**



distance between the horizontal axis and any single point on that curve represents the sum of per-unit production and transport costs at the corresponding distance from the market. Any difference between **P** and those costs is defined as economic rents.

Rents, which can be captured by resource owners, dwindle to zero as the market's extensive margin is approached. As is indicated in Figure 1, that margin occurs precisely at the point where the demand curve (i.e., the horizontal line extending out from **P**, the exogenously determined price, on the vertical axis) crosses the supply curve. Beyond the extensive margin, economic rents are negative (or, to say the same thing, economic losses are incurred) and commercial activity does not take place in the absence of subsidies.

A couple of circumstances under which economic rents are sizable merit some discussion here. The first pertains to the case of supply inelasticity. If transport costs are sensitive to distance, because the commodity in question is perishable or bulky, the supply curve will be steeply sloped, and there will be large gaps between the prevailing price and per-unit costs for centrally located firms. This situation, which is depicted in Figure 1, seems to arise in markets for a few forest fruits in and around Belém and other urban centers in the Amazon (Chapter Four).

High locational rents can arise in the tourism sector if there are at least some visitors whose willingness to pay for access to a site exceeds what it costs them to get there. It is fairly common, for example, for national park services to make an attempt at price discrimination. That is, tourists whose demand for access is fairly inelastic (because their desires are strong to visit a place that they consider to have few close substitutes, and because their incomes are high) are charged a high entrance fee. Meanwhile, there are those whose demand is fairly modest and elastic, since their incomes are lower, their preferences are weaker, or both. A price-discriminating agency will ask members of the latter group to pay a lower fee. This pricing strategy generates more revenues than does the practice of charging all visitors the same fee. Of course, the strategy can be implemented only if it is possible to treat various groups of tourists (e.g., foreigners, domestic students, etc.) differently.

In addition, the revenue gains of price discrimination depend on the precision with which different groups' demands can be estimated.

The circumstances under which economic rents are sizable having been reviewed, let us turn our attention to the factors that prevent resource values from growing large. If transport costs are not especially sensitive to distance, supply will be elastic, and the difference between price and per-unit cost will rise slowly as one moves in toward the marketing node from the extensive margin. Another thing that keeps rents in check is the mobility of other factors of production. For example, small mills for cutting logs into boards are not very difficult to move from one site to another. If the price of stumpage rises in one place, there is not much to stop those mills from being moved to a place where raw materials remain cheap.

The rental value of ecotourism sites should not be exaggerated either. Aside from a few highly unusual places, like the Galapagos Islands and volcanic craters in Costa Rica, destinations do not appear to be particularly scarce. For example, Huber (1996) reports that the total area protected by ecotourism operators in and around Manaus, which is a Mecca for foreign visitors to the Brazilian Amazon, is 4,000 hectares, which amounts to a small share of the total area with ecotourism potential. As a rule, facilities and transportation services that are safe, pleasing, and reliable are what is truly scarce in remote forests. The private firms that provide those services are in the best position to capture whatever a foreign visitor is willing to pay for his or her trip.

Where nature is bounteous, transport costs are low, factors of production other than environmental inputs are mobile, or some combination of the three, forest dwellers do not stand to gain very much by controlling access to the natural resources that surround them. They might still receive high incomes for their work and expertise. Of course, wages and salaries in any labor market are determined by the interplay of demand, which is a function of workers' productivity and the price of whatever is being produced, and labor availability. Where output prices are low, high earnings can occur if, and only if, productivity is high and the supply of labor is inelastic.

All available evidence suggests that the productivity of labor employed in logging, nontimber extraction, and other resource-based enterprises in Latin America's tropical forests is low. Biodiversity itself can be a cause of low returns to labor. In forests featuring a great variety of species, for example, it might well be the case that useful organisms are widely dispersed, which implies that workers will spend much of their time looking for something as opposed to extracting it.

At the same time, labor supply tends to be elastic in places like the Amazon Basin, mainly because worker mobility is high across regions and economic sectors. Romanoff (1981, cited in Browder, 1992b) has found, for example, that it is common for Amazonian rubbertapper households to migrate every few years in the hope of improving their meager earnings. Even when relocation does not occur, rural labor can move into and out of the cash economy (i.e., out of and into subsistence farming, hunting and gathering) with ease.

When labor supply is highly elastic, wages cannot be expected to rise much above subsistence levels even if major productivity increases occur in traditional occupations, like logging and nontimber extraction. The growth in demand resulting from the opening up of new lines of work (in ecotourism or genetic prospecting for example) is unlikely to lead to substantially higher earnings for people living in or close to tropical forests.

If launching or expanding an enterprise in a remote location proves to be remunerative the economic agents in the best position to benefit are those furnishing factors of production that have low supply elasticities. Management, organizational and marketing expertise is much more apt to fall into this category than natural resources and unskilled labor. In addition, the firms that provide this expertise may face limited local competition, or none at all. No doubt, this enhances their ability to capture the profits generated by activities like nature-based tourism and genetic prospecting.

Dynamic Issues

A finding that local people gain little or nothing from an activity yielding positive environmental spillovers would by no means imply that the activity should not be pursued. If the activity's benefits, including what people in other parts of the country or the world are willing to pay for spillovers, exceed its costs, then it satisfies the standard criterion of economic efficiency, and is worth pursuing.

The possibility that an initiative, like the promotion of nature-based tourism for instance, might not improve living conditions for forest dwellers is not necessarily a reason to decide against implementation. It is usually unreasonable to expect that a single project will accomplish efficiency and equity goals. Income disparities would be more sensibly addressed through separate measures such as progressive taxation. Where such measures are in place, even the finding that a project's benefits will be concentrated among the well-off should not raise undue concerns about its distributional impacts.

Transfers are an important component of project design, if they induce the behavioral changes needed to secure environmental benefits. For example, providing tree seedlings free of charge might be a good way to accelerate reforestation in upper watersheds. Likewise, furnishing financial and technical assistance for nontimber extraction, genetic prospecting, and so forth might diminish encroachment on rainforests and other species-rich tropical habitats.

Obviously the opportunity costs of supporting ICDPs and related initiatives should be given close consideration. This is especially true when the central thrust of a project is to build up local human capital that is specifically tailored to ICDP-type commercial activities. Investing in the specific skills that forest dwellers might need to run sustainable forestry ventures, for example, is questionable when and where private enterprises show little interest in managing stands of trees so as to enhance future yields, establishing market contacts, and related pursuits. Even where such interest has been exhibited, preparing local populations to take on these tasks might not make economic sense.

One criticism of sector-specific human capital formation has been offered by Simpson and Sedjo (1996), who contend that a much larger area could be protected if the money used to subsidize specific activities (like nontimber extraction) were instead used simply to pay forest dwellers to keep natural habitats intact.

Moreover, sector-specific training is not necessarily the most effective measure to raise the standard of living of forest dwellers. By and large, they derive more benefit from education that is generally applicable, and which prepares them to take advantage of whatever well-paying employment opportunities that might come their way.

Nevertheless, the spillovers generated by human capital formation, even of the sector-specific variety, cannot be ignored. At least some of the skills that a worker acquires by training for and holding a job in ecotourism are apt to transfer to other occupations. Also, preparing people for work in ecotourism, forest management and genetic prospecting can, under the right circumstances, diminish the cost of policing park boundaries.

The findings presented in this report indicate that sector-specific human capital formation is unlikely to lead to substantial income growth for large numbers of people living in or close to threatened habitats. In addition, as is mentioned in the chapter that follows, programs needed to conserve the environmental base for successful ecotourism and other sustainable activities tend to be underfunded in Latin America. Unless the spillovers associated with sector-specific local training are huge, the rationale for such approaches to conservation and development could turn out to be quite shaky.

Nature-Based Tourism

Of all the economic alternatives contemplated for threatened habitats in the developing world, none appears to hold as much commercial promise as the business of accommodating people who wish to experience those habitats firsthand. Tourism, in general, has grown rapidly in recent years and now accounts for seven percent of all international trade in goods and services (Whelan, 1991). Formerly the pursuit of an esoteric few, vacations taken for the purpose of viewing and learning about exotic flora and fauna in their natural settings now comprise an important part of the tourism market in many places (Boo, 1990).

This is certainly the situation in Costa Rica and the Galapagos Islands, which are the geographic focus of this chapter. As is reported in the pages that follow, international travel to the former country's national parks and private reserves and to the latter archipelago has increased dramatically during the last ten to fifteen years and now generates large sums of foreign exchange.

This growth has not been entirely free of adverse environmental consequences. Mountfort (1974) reports that careless photographers in the Galapagos occasionally interfere with the breeding of birds, and de Groot (1983) complains of people chasing marine iguanas, who must lie still under the tropical sun to recover body heat after emerging from the cold ocean. Also, ships and boats that carry tourists around the islands routinely discharge garbage and sewage. Even at the Monteverde Cloud Forest Biological Preserve (Figure 2), which many reckon is one of the best run protected areas in Latin America, soil sometimes erodes along visitor trails and tourists occasionally tap on the nests of resplendent quetzals (*Pharomachrus mocinno*), which are rare and finicky birds, to get them to take flight (Rovinski, 1991).

Yet, these impacts pale in comparison to some of the environmental deterioration that is indirectly related to tourism. The prospect of working in a souvenir shop or on a cruise ship has attracted a few thousand migrants to the Galapagos during the past quarter century. The towns where they have settled are sources of pollution. Furthermore, many island residents are unable to find steady work in the tourism sector and engage in activities, like fishing, that can damage natural resources.

Ecotourism often does not benefit local residents. As is documented in this chapter, it is almost always the case that only a small portion of what visitors spend reaches local communities. Admonitions to increase local benefits, through planning, consultation, and other measures, are standard fare in the literature (Boo, 1990; Drake, 1991). But notwithstanding a few successes, the effectiveness of those measures in Latin America has not been proved. Neither is it readily apparent that making the investments needed to enhance the local economic impacts of nature-based tourism would be efficient.

Local communities are not the only interest claiming more of the money spent by foreign visitors. In Costa Rica, the Galapagos, and elsewhere, maintenance and protection of the natural habitats that make ecotourism possible fall far short of what is required. In recent years, some of the money needed to run parks and reserves, and to hire guards to discourage encroachment has been raised through debt-for-nature swaps and other mechanisms. Another way to put parks and reserves on sounder financial footing is to raise the fees paid by tourists and the firms that serve them (Dixon and Sherman, 1990).

It is generally conceded that access to protected areas has been underpriced throughout Latin America, as it has been in many other parts of the world. However, caution must be exercised when fees are being readjusted for sites that have close substitutes. As David Simpson, an economist at Resources for the Future, puts it, "Every nice little hill and valley isn't going to be able to charge a lot for admission, since there are so many nice little hills and valleys that one could visit" (personal communication, 1996).

Raising and allocating the funds needed to protect habitats and to improve the well-being of nearby populations are bound to be primary concerns in Costa Rica and the Galapagos for a long time to come. Growth in nature-based tourism undoubtedly strengthens the economic case for habitat protection in both places. Except for a few special cases, emergence of the new industry does not appear to have enriched local communities appreciably.

The Ecotourism Boom in Costa Rica

Few places in the world are in a better position than Costa Rica (Figure 2) to benefit from the interest that people have in visiting tropical habitats. The country is compact, with a land area of just 51,000 square kilometers, and within its borders one can experience a wide variety of environments, from beaches, to jungles, to mountains. Costa Rica is also home to a uniquely diverse mix of flora and fauna since it sits on the land bridge connecting North and South America. As of the early 1990s, 850 bird and 208 mammal species had been identified in the country, as had countless insects and plants (Umaña and Brandon, 1992).

A serious effort has been made to promote travel to Costa Rica, which is easy to reach from North America and Europe. The results (Table 1) have been impressive, and tourism now makes a sizable contribution to the national economy. According to the Costa Rican Tourism Institute (ICT), the money that international visitors spent in 1994 was equivalent to 28 percent of the total value of the country's exports. Indeed, neither the value of bananas sold overseas ($522 million) nor coffee exports ($300 million) exceeded the $623 million in foreign exchange that tourism generated (ICT, 1995).

ICT surveys reveal that a large portion of international visitors engage in ecotourism. Of the foreigners who travel to Costa Rica, 82 percent enter on tourist visas and, of that group, approximately one-third engage in activities like bird watching (ICT, 1994). Likewise, visits to national parks have increased dramatically in recent years. As one official of the National Park Service (SPN) has documented, 404,342 foreigners entered Costa Rica's national parks in 1993, which was about five times the number recorded six years earlier (Bermúdez, 1992 and 1995, cited in Chase, 1995). There has been a decline during the past couple of years, in part because of entrance fee increases (see below). However, patronage remains much higher than what it used to be. Rovinski (1991) and Aylward *et al*. (1996) report that similar changes have occurred over time in visits to privately owned areas, like La Selva Biological Field Station (Figure 2) and the Monteverde Preserve.

Aylward *et al.* (1996) observe that many of the visits to Costa Rican national parks might not be consistent with some of the narrower definitions of ecotourism. The second smallest park, Manuel Antonio (Figure 2), which only encompasses 683 hectares, is consistently one of the most heavily visited (94,102 international and 33,921 national visitors in 1994), mainly because it boasts spectacular beaches and there are dozens of hotels and inns in the vicinity. By compariso
181,448 Costa Ricans went to Volcán Poas and Volcán Irazú (Figure 2) in 1994. Although these two sites contain high-altitude cloud forests that are important for watershed protection and interesting to biologists, they attract tourists almost exclusively because each offers views of an active volcano. Excluding patronage of Manuel Antonio, Volcán Poas, Volcán Irazú, and a few other sites, Aylward *et al*. (1996) estimate that there were 73,000 paid visits by foreign ecotourists to Costa Rican national parks in 1992, when 330,000 international visitors were recorded for the system as a whole. They contend that, when use of privately owned sites is taken into account, approximately 100,000 foreigners—one in every four vacationers from the United States, Canada, and Europe (ICT, 1995)—participated in nature-based tourism in Costa Rica in 1992.

Figure 2. Costa Rica

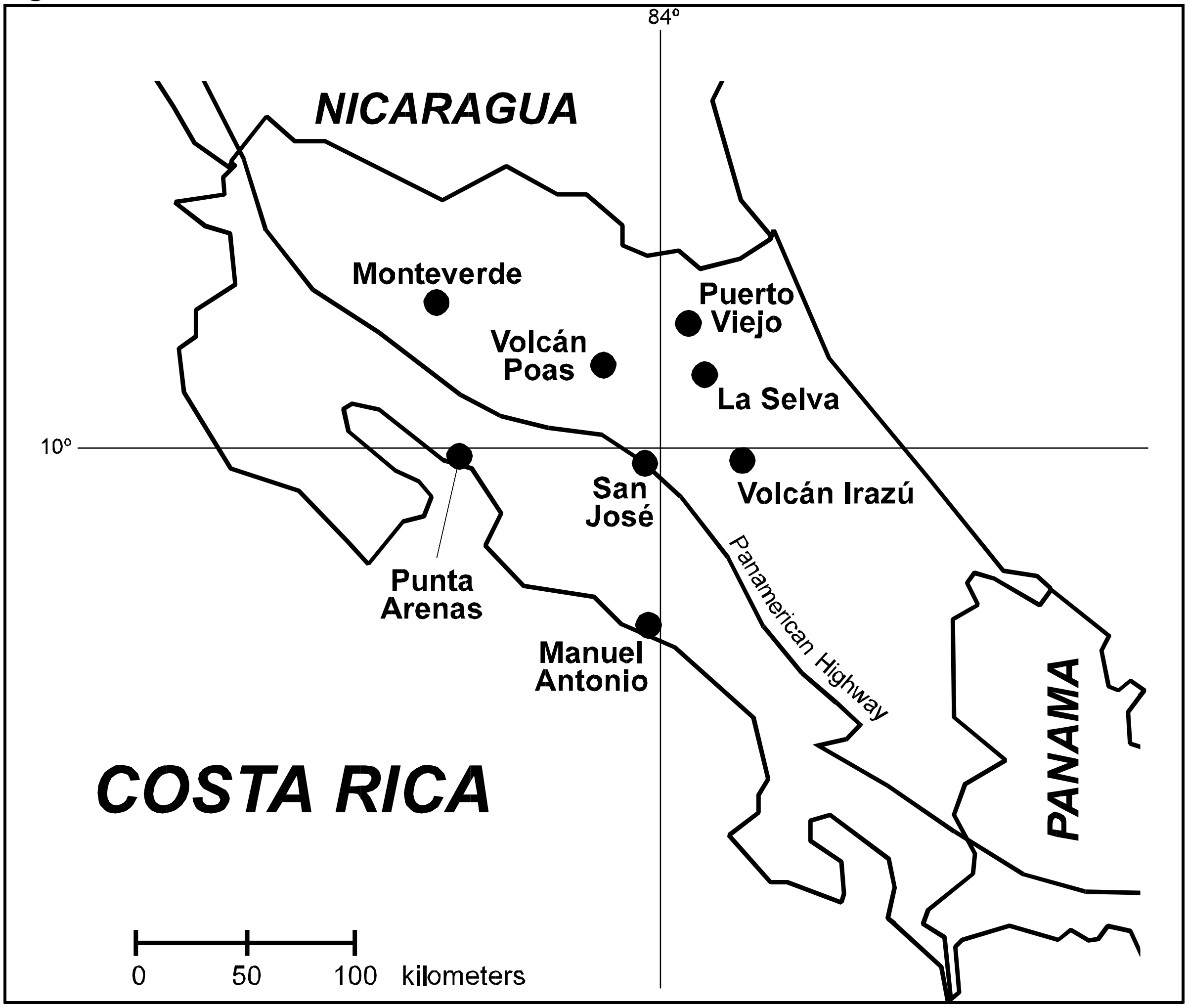


Table 1. Foreign Tourists in Costa Rica, 1985 through 1994

Year	Canada, U.S.A. and Mexico	Central America	Europe	Total
1985	89,825	112,623	28,179	261,552
1986	93,105	106,825	29,026	260,840
1987	104,841	108,543	32,354	277,861
1988	123,551	124,728	41,396	329,386
1989	153,112	135,376	45,355	375,951
1990	191,284	139,913	57,177	435,037
1991	223,126	164,809	67,319	504,649
1992	274,061	187,790	88,301	610,591
1993	302,741	193,512	113,943	684,005
1994	332,602	221,384	129,580	761,448

Source: ICT (1995)

Local Economic Impacts

Hard evidence concerning the local (as opposed to national) economic impacts of ecotourism is spotty. But by and large, claims made about the benefits flowing to individual communities are exaggerated.

It is widely accepted that the typical international vacationer spends a little more than $2,000 getting to, around, and back from Costa Rica. For example, a survey of 575 foreign visitors to the Monteverde Preserve carried out in 1991 by the Tropical Science Center (TSC), which is the owner and manager, revealed total expenditures of $2,207 per person, of which $1,273 were made somewhere i
those individuals who indicated that getting to Monteverde was a prime motivation for being in Costa Rica, average overall and in-country expenditures were $1,961 and $1,131, respectively (Aylward *et al*, 1996).

Ecotourism makes a significant contribution to the local economy of Monteverde. For the most part, relations are good between the Preserve and the neighboring town, which Quakers from Alabama founded in 1949. In addition, the town of Monteverde is pleasant, with clean restaurants and comfortable hotels, and the majority of foreign and national visitors to the region choose to eat their meals and to sleep there. Based on the finding from the 1991 TSC survey that the average duration of a foreigner's visit is three days and using a recent ICT estimate of international tourists' average expenditures ($86/day), Figueroa (1995) concludes that local spending by the 27,748 foreigners who visited the Pre
also points out that more than half of what those visitors paid to enter the reserve and to buy souvenirs at its gift shop—$616,111 in 1994—goes directly to wages for local workers and purchases of goods in the surrounding area.

But as a rule, spending close to parks and reserves comprises a small portion of tourists' expenditures in Costa Rica. It is interesting to note that, notwithstanding the recent expansion of ecotourism, very little lodging capacity has been constructed in the vicinity of ecotourism destinations. An ICT official reports that the spatial distribution of the country's hotel rooms is as follows: 31 percent are located in San José, 21 percent in other urban areas, and 31 percent along the Pacific or Caribbean coasts (Martín Quesada, personal communication, 1995). Moreover, the benefits that accrue directly to local communities from lodgings patronized by foreign tourists are mainly in the form of the low wages paid to waiters, maids and other unskilled laborers.

For some protected areas, local economic impacts are practically nonexistent. For example, nearly everyone who visits Volcán Poas or Volcán Irazú does so on a half-day excursion from San José, which any hotel or guest-house can easily arrange. Most
living around the park. Local returns at La Selva are similarly unimpressive. Rovinski (1991) reports that the 13,000 individuals who visited the station in 1989 spent just $291,000 in nearby settlements.

Challenges to Continued Success

Now that international arrivals are no longer increasing as rapidly as they did a few years ago, impediments to the future expansion of Costa Rica's tourism sector, generally, and ecotourism, specifically, are being given closer scrutiny. If more tourists do not choose to visit the country and its parks, the chances are small that local economic benefits can grow appreciably.

Some impediments to expanded tourism have to do with economic development in the broadest sense. The quality of major thoroughfares and secondary roads is not what it should be, particularly outside of the central valley where San José and most other c
worsened markedly in recent years, a poor transportation infrastructure is a major source of complaint among tourists and the firms that serve them (Ottaway, 1995).

Habitat conservation is another concern for the ecotourism industry. In past years, international development agencies and private organizations based in the United States and other wealthy nations have provided large sums to Costa Rica for expansion and improved management of national parks and private reserves. Additional projects are in the pipeline. However, the country faces increased competition for funds from other parts of the world, including its Central American neighbors, where systems of protected natural areas are much less developed.

At the same time, the demands inherent in managing existing national parks appear to be straining the budgetary and human resources allocated to the SPN. A benchmark for evaluating the adequacy of those resources is Monteverde. Over time, the preserve has expanded to approximately 10,000 hectares. In 1994, the TSC employed 38 people and spent more than 80 million colones ($509,327) on management (Figueroa, 1995). By contrast, the SPN assigned 58 employees and 35 million colones ($198,999) in 1995 to a region in the central highlands that takes in Volcán Irazú (2,309 hectares), Volcán Poas (5,600 hectares), two other national parks (with a combined area of 60,157 hectares), and a small national monument.

Support for the SPN and partner institutions in the public and private sectors will have to be increased substantially if proposals to expand protected areas in Costa Rica are adopted. For example, a team of consultants that worked for the World Bank has concluded that management of existing parks is successful in the sense that conspicuous fauna, with the exception of some large birds and a few other species, seem to be thriving. However, they advocate a 50 percent increase in the area under the direct control of the SPN, with special emphasis placed on the acquisition of lowland properties, and on the protection of corridors among existing parks to allow for the unmolested migration of wildlife (DHV Consultants BV, 1992). Even more ambitious would be full implementation of the scheme to create nine, locally administered conservation areas around the country, each containing one or more national parks (Umaña and Brandon, 1992).

That proposals of this sort are being given serious consideration suggests that recent years' growth in ecotourism has made habitat conservation a much higher priority in Costa Rica than it would be otherwise.

Pricing Issues

Over the years, many innovative approaches to financing habitat protection have been applied in Costa Rica. The country was one of the first to take advantage of debt-for-nature swaps. Through 1991, nearly $80 million of the country's foreign debt had been converted into $42 million in local currency bonds to benefit national parks and private reserves, at a cumulative cost of $12 million (Umaña and Brandon, 1992). Endowments to support the management of some protected areas have been established as well.

At least since the beginning of Costa Rica's ecotourism boom, economists have argued that financing for habitat protection could be shored up by increasing entrance fees. Several studies show that visitors' willingness to pay for access to protected habitats exceeds the nominal admission prices charged as recently as September 1994. The fee increases that went into effect at that time seem to have been predicated on the assumption that demand for access to the country's national parks is price-inelastic across all major groups of visitors, including foreigners who are being asked to pay the most. Some analysts, pointing to recent changes in park patronage, question that assumption.

Balderas and Laarman (1990) were responsible for one of the first attempts to estimate how much people were prepared to pay for visits to protected areas in Costa Rica. In a survey conducted by the SPN in 1989, when the entrance fee was 25 colones ($0.31), 860 visitors to Manuel Antonio, Volcán Poas, a national park on the Caribbean coast, and the Monteverde Preserve were asked what daily payments should be. There was support for charging international visitors more than Costa Ricans, although foreigners preferred a smaller gap. Both groups favored raising the domestic price to 50 colones and the international charge to 100 colones or so (Balderas and Laarman, 1990).

Two studies have addressed the value that visitors place on the Monteverde Preserve. In a travel-cost analysis, Tobias and Mendelsohn (1991) found that visitors' willingness to pay for access to the site was about $12.5 million, which was more than an order of magnitude greater than what all of them paid for admission. Using data collected in the 1991 TSC survey mentioned above, as well as contingent valuation techniques, Echeverría, Hanrahan, and Solórzano (1995) estimated that Costa Ricans' were willing to pay $137 each, above and beyond admission charges, to keep the reserve intact. On average, international visitors, who probably gain less from whatever watershed and climatic stabilization services Monteverde's forests provide, were willing to pay $119 for the reserve's continued existence.

Findings such as these helped to justify the fee increases for foreigners that the SPN adopted in September 1994. The uniform daily price, 200 colones ($1.25), did not go up for Costa Ricans, but charges for international guests were raised markedly. The top fee, paid by those who simply showed up at a park gate, was $15, paid in either dollars or colones, while someone making arrangements a day ahead was charged $10. Travel agencies were allowed to purchase tickets for $5 apiece. No discounts were made available to international students, which probably had a big impact on visits to privately owned sites, like the Monteverde Preserve (see below).

Needless to say, a brisk trade in discounted tickets emerged quickly. This evasion of the maximum fee was tolerated by some park administrators, particularly those responsible for areas that received relatively few visitors before and after the price increase (Chase, 1995). But the policy change still had a major effect on park use. During the previous peak tourist season, from December 1993 through March 1994, paid international visits totaled 199,408. By contrast, only 113,461 foreigners were admitted to national parks during the next peak season, right after the price increase.

That a four- to twelvefold increase in daily admission charges for foreigners only caused visits to decline by 43 percent seems to indicate that international demand for access to Costa Rica's national parks is price-inelastic and, hence, the policy change improved the SPN's financial position. But Chase (1995) cautions that there might be a greater response to higher entrance fees in the long term. Although demand for park access is probably not elastic, some tourists can be expected to choose different travel experiences, and growth in SPN revenues will not be as spectacular as what some might have been expecting.

Aylward *et al*. (1996) contend that international tourists have not waited very long to revise travel plans. Since admission prices at the Monteverde Preserve—a token amount for Costa Rican students, $1.50 or so for citizens and residents of the country, $4 for foreign students, $8 for foreigners not on a package tour, and $16 for international participants in a tour—were not adjusted in the wake of the September 1994 increases in national park entrance fees, it should have experienced a major increase in visits. Indeed, nine percent more foreigners came to the area from January through April of 1995 than did during the first four months of 1994. However, this was mainly because there was an 84 percent rise in visits by international students (who, to repeat, received no discount from normal admission prices at the national parks) which more than compensated for simultaneous reductions in the numbers of foreigners paying the $8 or $16 fee.

The impacts of park entrance fees on visits to Monteverde, and all that they might imply about substitute relationships between ecotourism in Costa Rica and ecotourism elsewhere, should not be exaggerated since prices for lodging and other services have been going up throughout Costa Rica as well. However, the point that international tourists are cost-conscious should not be forgotten. The possibility that price increases might be causing more than a few international tourists to stay away from the country entirely has not been lost on the SPN, which modified its fee schedule in July 1995. Foreigners not buying tickets ahead of time will continue to pay

$15 and the advance-purchase tickets to heavily visited sites, like Manuel Antonio and Volcán Poas, will still cost $10. However, advance-purchase tickets to other parks have been dropped to $7 or $5.

Additional revision of park entrance fees is probably warranted. Econometric analysis has demonstrated that there is considerable scope to use price variations to direct tourists away from heavily-used sites to areas that could accommodate additional patronage (Chase, 1995). Also, experience at the Monteverde Preserve indicates what is to be gained by having various sorts of visitors pay different entrance fees. Better pricing could do much to enhance protection of the natural habitats that draw so many foreign tourists to Costa Rica.

Conservation, Tourism, and Local Interests in the Galapagos

As in Costa Rica, habitat protection and park pricing issues have increased in importance as tourism has expanded in the Galapagos (Figure 3), the group of twenty-two islands and scores of smaller land formations, all of recent volcanic origin, 1,000 kilometers west of mainland Ecuador.

In the late 1960s, international cruise operators sought to bring groups to the Galapagos, which are well known to anyone familiar with the work of Charles Darwin. Ecuadorian travel firms were contacted, so that local arrangements could be made. At that time, the Ecuadorian Air Force possessed planes that could be used to fly passengers to an airfield that the United States had constructed on Baltra (Figure 3) during the Second World War. The travel industry soon linked up with the military's flight operations and the era of what would later be called ecotourism began (Southgate and Whitaker, 1994).

According to the Galapagos National Park Service (SPNG), which was founded about the same time that tourism began in the archipelago, visits have increased more than tenfold during the past quarter century, from 5,000 in 1970 to more than 55,000 at present (Table 2). There has been no pronounced trend since the late 1980s in the number of Ecuadorian tourists. By contrast, visits by foreigners have grown steadily over time. Variation in the upward trend occurs when wars or civil unrest cause North Americans or Europeans to fear traveling to Latin America or even internationally, and also when additional capacity is authorized for the islands' fleet of cruise vessels. In the past, peaks in authorizations have coincided with changes in the national government, presumably because incoming or outgoing officials feel especially able to respond positively to requests made by tourism operators.

Some of the economic impacts of Galapagos tourism are relatively easy to gauge. De Miras (1994) obtained a measure of total spending in 1993 by multiplying the number of visitors (10,136 Ecuadoreans and 36,682 foreigners—Table 2), by average estimated expenditures for each group ($505.61 and $1,336.82, respectively). The figure he obtained was $54,162,135.

This spending, however, represents just a part of the national economic significance of Galapagos tourism. All foreign visitors must pass through Quito or Guayaquil on their way to and from the archipelago, and many of those people choose to spend a few days or weeks on the mainland. At least some of what they spend during that time must be regarded as another direct benefit that Ecuador derives from the islands.

There is no denying that visitors' expenditures are sizable. In a survey conducted in August 1995, the Ecuadorian Tourism Corporation (CETUR) found that 24 percent of all foreign vacationers arriving by air identified the islands as their primary destination; another large portion of the sample included the Galapagos on their itinerary. Moreover, foreign exchange earned because people from other countries visit or live in Ecuador has increased at a rapid pace in recent years, almost entirely because of the expansion of tourism. In the first six months of 1995, those earnings amounted to $144 million, which was equivalent to 6.6 percent of revenues received in the same period from exports of petroleum, agricultural commodities, and other products (BCE, 1995, p. 53).

Clearly, many millions of dollars, marks, and yen flow into Ecuador because of the Galapagos.

Figure 3. The Galapagos

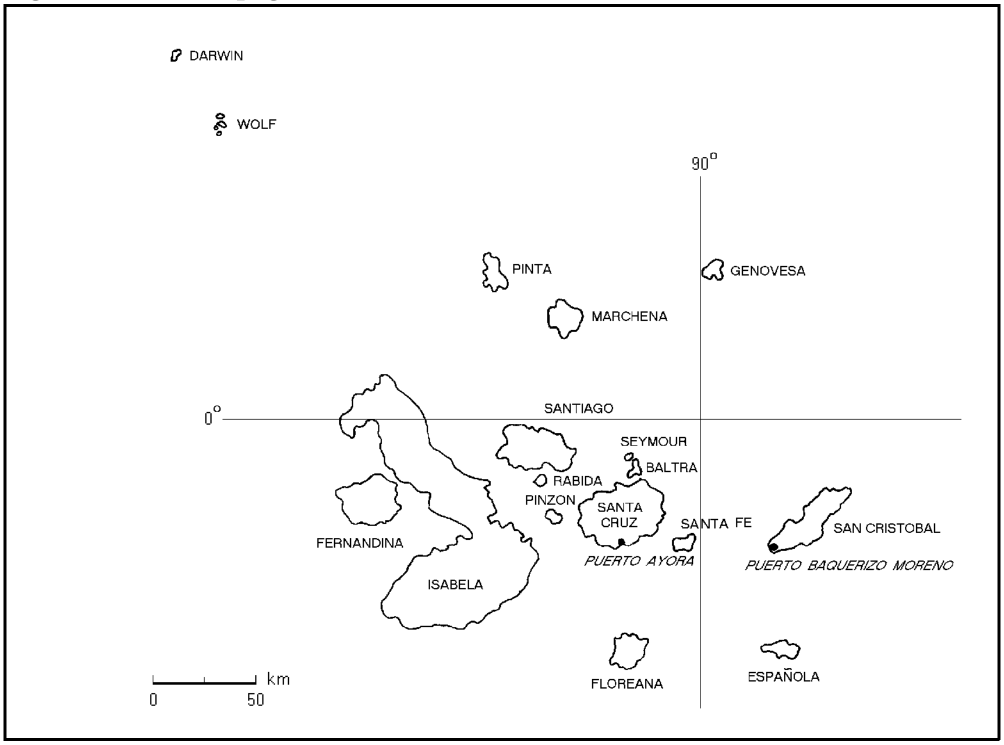


Table 2. Ecuadorian and Foreign Visitors to the Galapagos, 1979 to 1995

Year	National	Foreign	Total
1979	2,226	9,539	11,765
1980	3,980	13,465	17,445
1981	4,036	12,229	16,265
1982	6,067	11,056	17,123
1983	7,254	10,402	17,656
1984	7,627	11,231	18,858
1985	6,279	11,561	17,840
1986	12,126	13,897	26,023
1987	17,769	14,826	32,595
1988	17,192	23,553	40,745
1989	15,133	26,766	41,899
1990	15,549	25,643	41,192
1991	14,815	25,931	40,746
1992	12,855	26,655	39,510
1993	10,136	36,682	46,818
1994	13,357	40,468	53,825
1995	15,483	40,303	55,782

Source: SPNG

One reason for this is the substantial discretionary income typical foreign visitors from developed countries have for recreation, including visits to sites like the Galapagos. Most of the people making their way to the Galapagos are from rich countries; of the 457 tourists that Machlis *et al.* (1990) interviewed in the archipelago in July and August of 1990, 70 percent were from North America and Europe. The same investigators found that virtually all the foreigners had at least some university education, and quite a few had graduate or professional degrees. Country-of-origin and educational attainment are, of course, closely related to one's standard of living. Edwards (1991), for example, found that average income for 360 foreign and Ecuadorian tourists interviewed in 1986 was $32,000.

With time, the Galapagos are becoming a premium nature tourism destination, visited mainly by people who are well off. Hotel and restaurant operators observe that fewer young foreigners—who watch their budgets with great care—are visiting the islands. In addition, during the early 1990s the number of Ecuadorian tourists visiting each year fell off compared to the late 1980s (Table 2). Demand for visits by both these groups is fairly sensitive to airfares, expenditures on lodging and meals, park entrance fees, and other costs, many of which have been rising. By contrast, demand by affluent residents of wealthy nations appears to be price-inelastic, if the steady growth in their numbers (Table 2) is any indication.

Local Economic Impacts

Before ecotourism arrived on the scene, the Galapagos were one of the most isolated places on the face of the Earth. The islands had only 1,346 inhabitants at the time of Ecuador's first national census, in 1950, and 2,391 a dozen years later, when the second census was conducted (INEC, 1992).

The infrastructure development that has accompanied ecotourism has made it much easier to travel back and forth to the archipelago. The airport on Baltra has been improved and another facility was opened in 1982 next to Puerto Baquerizo (Figure 3), the provincial capital. A third facility, with a 1,800 meter landing strip, opened on Isabela (Figure 3) in February 1996.

To be sure, the possibility of finding employment in hotels, restaurants, or shops or on boats or ships also has stimulated immigration, which has been completely unrestricted since the Galapagos became a province, in 1973. Annual population growth has averaged five percent a year, due mainly to arrivals from the mainland. The total number of inhabitants, concentrated almost entirely in Puerto Ayora (Figure 3) and Puerto Baquerizo, was 9,785 when the last census was taken, in 1990 (INEC, 1992).

The attractions of the Galapagos remain strong for many potential migrants. Virtually every household in the two largest towns is connected to potable water and sewage systems and has electricity (INEC, 1992). Actual delivery of water and power may be subject to interruption, but no urban center along the Ecuadorian coast can boast of similar service. However, there are disadvantages to living in the islands. Prices for food and other consumer goods, nearly all of which are brought in from the mainland, are high, and many island residents have not found it easy to benefit from ecotourism.

Limited local earnings have to do primarily with how affluent visitors like to get around the archipelago. In contrast to foreign backpackers and Ecuadoreans, who often stay in hotels or inns and travel to different sites in small boats during the day, premium tourists generally prefer a cruise, either on ships carrying up to ninety passengers or on smaller craft that provide their six to twelve guests with more flexible itineraries. Operation of the larger vessels, in particular, requires few local inputs. The problem is compounded by a law that mandates a higher minimum wage and more restrictive work rules for Galapagos residents, as a result of which, cruise ship operators tend to hire crews on the mainland.

De Miras (1994) estimates that, of the $1,337 that an average foreign tourist spends getting to, around, and back from the archipelago, $102 goes into the local economy in the form of hotel and restaurant charges, receipts for souvenir sales, and moorage fees. Additional benefits, such as wages and salaries paid to park guards and cruise ship employees, are not very large. Sophisticated analysis, of the sort needed to estimate the total impacts on the local economy resulting from these stimuli, has not been carried out in the Galapagos. One would be surprised, though, if those impacts amounted to as much as one-third of what well-off foreigners are spending.

The Role of Public Policy

Local impacts could be enhanced by changing government policy. In particular, new development initiatives in the islands could be funded by raising the taxes and fees paid by tourism operators and the people they serve. There is some scope to do exactly this since some operators appear to be earning supernormal profits. For example, the two airlines that operate in the archipelago, one private and the other linked to the armed forces, charged international passengers $377 for a round-trip ticket in December 1995, when the price for Ecuadoreans was $192 (558,000 sucres).

The government also could collect more money directly from tourists. According to Edwards (1991) sizable revenues are being foregone because of the current arrangement of charging everyone who comes to the national park a single flat fee regardless of the length of stay. He estimated that imposing a daily fee of $214 in 1986, when the flat price for foreigners was $40, would have caused average trip duration to decline by 50 percent. Regulatory controls on the number of visitors could have been dispensed with entirely without any net environmental impact because the doubling in visitor numbers that would have occurred would have coincided with reductions in trip length. Entrance fee revenues would have risen from $40 to $770 per person (Edwards, 1991).

No fundamental change in the structure of visitor fees is being contemplated. However, entrance charges were raised substantially in 1993, from $40 to $80 for foreigners and from 600 sucres ($0.35) to 12,000 sucres ($7.00) for Ecuadoreans. In addition, there was an increase in the fees levied on passenger vessels. As a result of many years of high inflation, the annual charge assessed on each passenger berth had fallen below $10. Large ships, capable of carrying ninety guests, only paid about $600 apiece in 1992. University of Rhode Island researcher Bruce Epler found that such vessels were earning as much as $4 million in annual gross revenues (personal communication, 1992). Although data are unavailable, knowledgeable observers believe annual operation and maintenance expenses for ships carrying passengers around the Galapagos do not exceed $2.5 million .

Responding to these findings, the Ecuadorian Institute of Forestry, Natural Areas, and Wildlife (INEFAN), which holds administrative responsibility for all the country’s parks, raised berth fees. In general, vessels equipped to accommodate foreigners in reasonable comfort pay the “luxury” rate of $200 per berth per year. Smaller tourist craft or those that lack escape boats or adequate fire control measures are charged annual berth fees of $100 to $150. Day boats pay $30 per annum.

In recent years, higher entrance fees and berth charges, along with growing international arrivals, have generated substantial revenue increases. In 1994 and 1995 revenues were $3.2 and $3.7 million, respectively, compared to $2.2 million in 1993. The portion of this money going to islanders, however, has been small. INEFAN and predecessor agencies have always used Galapagos tourism to help pay for the management of mainland parks, none of which come close to being financially self-supporting. In 1993, for example, the SPNG kept approximately 30 percent of the $2.1 million it collected; the rest was spent in other parks.

To capture a larger share of SPNG revenues, local governments will have to develop specific and viable proposals for development projects. It could also be that they will no longer have to compete just with INEFAN for funds collected in the Galapagos. In March 1996, the Ministry of Finance announced that, of INEFAN’s requests to budget 3.5 billion sucres (worth approximately $1.2 million at the time) for the SPNG and 5 billion sucres ($1.7 million or so) for mainland parks, only 850 million sucres (roughly $300,000) and 2.7 billion sucres (about $900,000) were actually to be allocated during the year. The decision to capture a higher portion of the entrance and passenger berth fees collected in the Galapagos for the central government might signify that, in the future, local governments, the SPNG and mainland parks will face growing competition for scarce financial resources from the national government.

Finally, it must be conceded that the fee increases instituted by INEFAN since 1992 might have been detrimental to islanders' immediate financial interests. Higher fees, along with increases in airfares and other prices, have discouraged visits by less affluent tourists who tend to patronize on-shore facilities, diminishing the earnings of many of the islands' hotels, restaurants and shops.

Crises Coming to a Head

Benefiting in only a limited way from international visitors' interest in the Galapagos, residents have been quick to seize upon other economic alternatives.

Some alternative economic activities, like fishing, involve substantial environment damage. Since the government has virtually no capacity for effective regulation, intense harvesting has led to severe depletion of various species. The latest episode of boom-and-bust exploitation of an open access fishery began in 1991, when those responsible for depleting sea cucumber (*Isostichopus fuscus*) populations along the coast of mainland Ecuador began to transfer their operations to the Galapagos. The bottom-dwelling relatives of the starfish, which are sold as an aphrodisiac in China and elsewhere in Asia, proved to be particularly abundant in the waters around Isabela. Furthermore, the island is far beyond the reach of the SPNG, the Subsecretariat of Fishery Resources (SRP), or the Ecuadorian Navy, making regulation of the activities of fishermen more difficult. During the early stages of the boom, a fisherman on Isabela could make as much as $700 a week, which stimulated a major increase in harvest rates as well as migration. By the middle of 1992, daily production for the entire archipelago was averaging 70,000 to 110,000 sea cucumbers and, by 1994, at least 116 fisherman had settled on Isabela (Zador, 1994).

The collapse of this new fishery, which will occur sooner or later, could be a catastrophe for the entire island ecosystem. There is no way to know, for example, which kinds of birds might depend directly or indirectly for their survival on sea cucumbers, which are the most plentiful form of marine life in the archipelago. Fishermen, of course, show little or no regard for these consequences and have resisted vigorously any attempt to regulate their activities.

Islanders (both those born in the Galapagos and those who have lived there for several years) and sea cucumber fishermen are largely, though not entirely distinct populations. In addition, many islanders have a stake in the success of ecotourism or hope to have one in the future, so they have some interest in ecosystem integrity.

Responding to the concerns of Galapagos residents, as the Ecuadorian government has committed itself to do, involves some serious conundrums. For one thing, undertaking more projects to benefit local communities could stimulate additional migration to the archipelago. The latter response, which would dissipate the benefits accruing to individual households, is widely recognized.

Ecotourism, Habitat Protection, and Local Economic Development

There is no denying that Costa Rica and Ecuador have been highly effective at responding to the burgeoning demand from foreigners for visits to rain forests and other tropical habitats. This success is manifested in increased patronage of protected areas in the former country, and the status the Galapagos now enjoy as a prime ecotourism destination. In turn, demand for access to natural habitats appears, in some places, to have strengthened the case for conserving them.

With the exception of backpackers and a few others, people who spend the time and money required to reach a place like Monteverde or the Galapagos are very quality conscious. More often than not, local communities find that it is a challenge to supply appetizing food, clean sheets, cold beverages, and safe and reliable transportation on a consistent basis. The firms that provide these services most successfully and receive the bulk of ecotourism revenues tend to be based in capital cities or foreign countries.

The distribution of the gains from nature-based tourism could be altered by investing in the human capital and other assets of local communities. Before making such an investment, though, some fundamental economic questions relating to opportunity costs would have to be answered. The returns local people are likely to enjoy as a result of investment specifically tailored to ecotourism would have to be compared to the returns they would capture if, for example, spending on general human capital, which is applicable across all sectors of the economy, were increased. Likewise, other investment options, in protected areas for instance, would have to be evaluated as well.

Opportunity cost questions are of central concern because, as is emphasized in this chapter, the environmental base for nature-based tourism is by no means secure in Costa Rica and the Galapagos. Environmental threats include encroachment by farmers, ranchers and loggers and competition from introduced flora and fauna. Ensuring that the habitats and species that attract international visitors do not disappear is costly, exceeding the financial resources of national park services.

Both Costa Rica and Ecuador are trying to raise more money by increasing the fees paid by park visitors and, in the case of the Galapagos, the businesses that cater to them. This sometimes arouses discontent among those accustomed to paying virtually nothing for access to unique natural habitats. But a more important lesson to be learned from the two countries' experience is that price discrimination can yield major dividends. As mentioned, nowhere is price discrimination practiced with greater precision than at the Monteverde Preserve, where different fees are charged domestic students, foreign students, international tourists visiting in groups, and so forth. Likewise, prices vary from one site in Ecuador to another. For instance, while foreigners pay $80 to visit the Galapagos, Ecuadorian citizens visiting one of the less frequently visited mainland parks pay only a nominal fee. By contrast, Costa Rica has only just begun to move away from a policy of charging all foreigners a uniform price for admission to any park and citizens of the country another price. Setting fees that better reflect the differences among various sorts of visitors and various parks would allow the country to capture more revenues while at the same time redirecting people away from places, like Manuel Antonio, where carrying capacities are probably being exceeded.

Another crucial aspect of pricing policy should be to link entrance fees to trip duration. Because a flat fee is assessed regardless of the duration of the visit, Galapagos tourists face no monetary signal about the impacts of their visit on the environment. Edwards (1991) has demonstrated that the average trip length would be lower and government revenues would be substantially higher if a daily fee were assessed.

Even if countries with appealing ecotourism destinations price access efficiently, it will be rare for revenues generated to exceed the expenses of protecting natural areas. The Monteverde Preserve is an excellent case in point. Practically all the revenues collected from tourists are dedicated to administration and maintenance of the site. Without intense maintenance and vigilant protection, it must be emphasized, even the best management plan has no utility.

The Galapagos appear to be one of those unusual places with the potential to be a net generator of funds, defined broadly to consist of foreign donations as well as user fees. Although it has long been a policy to use monies collected from visitors and tourism businesses to help pay for the management of mainland parks, it is important not to exaggerate the size of the annual financial surplus that ecotourism can be expected to generate. Once habitat protection has been provided for adequately, the sums left over for things like local development could turn out to be quite modest.

Extraction of Nontimber Forest Products

Although a sizable industry has emerged to cater to the needs of international traveler visiting tropical habitats, the benefits accruing to nearby settlements tend to be minor. Even in unique places, like the Galapagos and Monteverde, local populations are not in a good position to benefit because employment opportunities are limited. Furthermore, airlines, cruise-ship operators, hotel companies and other firms are in the best position to capture whatever values tourists attach to their vacations. In tropical settings that, for all the delights they might hold for visitors, are less unique, little possibility exists for redirecting rents from tourism operators to local communities or the government, which may or may not choose to protect the habitats that make ecotourism possible.

Employment for forest dwellers in the extraction of nontimber forest commodities (which is usually defined by those with a conservation agenda not to include animal skins and other wildlife products) presents a different picture altogether. In northern Guatemala, for example, there are more than 7,000 chicle (*Manilkara zapota*) collectors, whose work generates $4 million in annual exports (Nations, 1989, cited in Salafsky, Dugelby, and Terborgh, 1992). Also, 68,000 households engaged in the collection of wild rubber (*Hevea brasiliensis*) in the Brazilian Amazon at the time of the 1980 census (FIBGE, 1982, cited in Allegretti, 1990). According to local newspaper reports, the harvesting, processing, and marketing of hearts of palm employs nearly 30,000 people and generates an annual cash flow of up to $300 million in the Amazon estuary (Pollak, Mattos, and Uhl, 1995). In the whole river basin, 500,000 to 1,500,000 rural people derive a significant portion of their income from the extraction of Brazil nuts (*Bertholletia excelsa*), fruits like *aguaje* (*Mauritia flexuosa*), and other commodities (Gradwohl and Greenberg, 1988; Schwartzman, 1989).

Almost without exception, however, this employment is not very lucrative. Indeed, all available research indicates that extractor households are desperately poor, even by the modest standards of Latin America's forested hinterlands. Citing research carried out in Bolivia and in two sites in Brazil, Browder (1992b) contends that households that collect nontimber products tend to be nomadic and illiterate, suffer from high rates of infant mortality, and are especially likely to be in debt. In addition, they often have found it difficult to win governmental recognition of their natural resource rights when faced with the competing claims of loggers, ranchers and agricultural colonists (Allegretti, 1990).

The Movement to Establish Extractive Reserves

It was out of struggles over land that the movement arose to create extractive reserves, defined as communal holdings where the inhabitants support themselves by harvesting nontimber products. During the 1970s, cattle ranching expanded in the Brazilian Amazon, and large numbers of rubber tappers were dispossessed. In response, they began to organize themselves, with assistance from agrarian unions and Catholic social activists (Allegretti, 1990). By the late 1980s, the movement had a high political profile and also had succeeded in attracting international backing.

Support for the rubber tappers was galvanized in December 1988, when ranchers killed Francisco Mendes Filho and two of his associates in Acre state, in western Brazil. "Chico" Mendes had been an adept and charismatic union organizer whose international accolades included the United Nations Global 500 Prize. After his murder, the momentum to establish extractive reserves grew inexorable.

As far as collector households and their representatives are concerned, the new sort of land holding was never intended to exist for nontimber extraction alone. A Brazilian anthropologist, who has worked with the rubber tappers since the 1970s, conceded that it is only to be expected that residents of extractive reserves will raise crops and livestock and also cut down and sell timber whenever it suits them to do so (Allegretti, 1990). Browder (1992a) confirms that crop and livestock production and logging are major sources of livelihood for the typical collector household. He also has warned foreign environmentalists who have lent support to rubber tappers and other extractor populations against forgetting that the latter groups' agenda is primarily social, aimed at achieving legal recognition of their informal tenure in forested land, and only secondarily environmental.

The potential discord between the desires of forest dwellers for land rights and international conservation interests was obscured by a case study that appeared to demonstrate that environmentally sound nontimber extraction can be much more profitable than any other economic alternative available to forest dwellers in the Amazon Basin. The study involved estimation of sustainable production of *aguaje* and other commodities on a one-hectare site near Mishana, in the Peruvian Amazon. Output was multiplied by market prices in Iquitos, a port city with more than 250,000 inhabitants 30 kilometers downriver and to the northeast, and harvesting and transport costs were deducted. The resulting estimate of potential annual income was $422 per hectare. When the net returns generated by a selective timber cut every twenty years were taken into account, the present value of exploiting the site for fifty years was found to be $6,820 per hectare, assuming a real interest rate of five percent (Peters, Gentry, and Mendelsohn, 1989).

These estimates compare very favorably with the returns to other land uses, which usually create more environmental destruction. As Peters, Gentry, and Mendelsohn (1989) indicate, the potential income associated with nontimber extraction alone is two to three times the per-hectare gross revenues that cattle ranchers in the Brazilian Amazon, for instance, are accustomed to earning. Likewise, the combined present value of all estimated extractive and logging income turns out to be more than a dozen times the price at which rural real estate in the Amazon Basin normally changes hands.

The authors of the Mishana study concluded that "without question, the sustainable exploitation of nonwood forest resources represents the most immediate and profitable method for integrating the use and conservation of Amazon forests" (Peters, Gentry, and Mendelsohn, 1989, page 656).

Impediments to Successful Nontimber Extraction

Especially during the first year or two after Peters, Gentry, and Mendelsohn (1989) published their findings, many groups and organizations working to arrest tropical deforestation seemed to be convinced that the case for extractive reserves was irrefutable. But as Browder (1992a and 1992b), Redford (1992), and others were quick to stress, estimates of potential earnings at one site in eastern Peru could never be treated as conclusive proof that a way has been found to keep rain forests intact while simultaneously raising forest dwellers' standards of living.

A number of issues were beyond the scope of the Mishana case study. For example, the production increases that would have resulted if large forested tracts had been dedicated to commercial nontimber harvesting undoubtedly would have driven down prices, and hence extractive income. Peters, Gentry, and Mendelsohn (1989) left analysis of this impact to other researchers. Likewise, they did not examine the marketing impediments that various entrepreneurs have encountered as they tried to sell nontimber products in markets outside the Amazon Basin. Neither is it clear that post-harvest losses were factored into the analysis. If, say, one-third of the potential harvest were never consumed or sold, then annual extractive income would drop from $400 to less than $200 per hectare.

Something else to keep in mind is that Mishana is advantageously situated in two important respects.

First, it is close to a sizable market. Iquitos is by far the largest urban center in the Peruvian Amazon. Moreover, the city is somewhat isolated, with no good road connections to the outside world, and a large share of the population is descended from Indians and Rubber Boom colonists and therefore is familiar with and likes rain forest products.

Access to markets is critical to the commercial viability of nontimber extraction elsewhere. For example, much of Brazil's, and the world's, palm hearts are produced close to the mouth of the Amazon River (Anderson and Ioris, 1992). A crucial advantage of the area is that there are quite a few exporting firms in the nearby port of Belém. There is also a very strong market in that city for the fruit of the multi-stemmed *açaí* palm (*Euterpe oleracea* Mart.), which is the source of palm hearts in the Amazon estuary.

The second advantage that Mishana enjoys is that it is in a floodplain that happens to be dominated by trees bearing *aguaje* and a few other commercial fruits. Like market access, location in a riparian area subject to periodic inundation is an advantage shared with the Amazon estuary, where *açaí* palms are abundant. Pointing out that only two percent of the Amazon Basin can be categorized as floodplain forests, Browder (1992a) quotes Richard Howard, a former Vice President of the New York Botanical Garden: "The most important point is how poorly the Peters *et al.* Peruvian Amazon hectare represents the tropical forests (of the entire region); it is the rare exception rather than the rule" (page 228). The Mishana investigators, it must be said, have been careful to avoid giving the impression that their site is representative of Amazonia as a whole (Peters, 1990).

Even if nontimber extraction at a favorable site like Mishana has commercial potential, actually realizing that potential is far from a straightforward matter. Property rights in nontimber species, like property rights in other resources, tend to be weak in the Amazon Basin. Whenever demand is strong and harvesting practices are damaging, deterioration of the resource is all but assured. For example, one of the authors of the Mishana case study warns that wild fruit populations "are being rapidly depleted by destructive harvesting techniques as market pressure begins to build" (Vásquez and Gentry, 1989, page 350).

On the basis of detailed field observations, Pollak, Mattos, and Uhl (1995) describe why those who gather hearts of palm in what is, in effect, an open-access forest have no more interest in conservation than do individual fishermen whose activities are leading to the depletion of resources that no one owns around the Galapagos (see preceding chapter) and in other places.

> Consider the extractor, who has to wade through mud, hacking away vines and other undergrowth, to reach the base of an *açaí* clump. Once there, he is inclined to cut all stems, even the small ones, before trudging through the forest in search of the next clump… [There] are certain advantages to cutting smaller stems… [In addition] delaying palm heart extraction may mean losing the palm hearts altogether to another interested party" (pages 376-377).

A sure sign that open-access predation is taking a toll on resource quality is that the average diameter of harvested palm hearts has declined dramatically since the early 1970s (Pollak, Mattos, and Uhl, 1995). It was during that period when much of the Brazilian palm heart industry relocated from southern Brazil, where destructive extraction had led to the depletion of *Euterpe edulis* Mart. (Ferreira and Paschoalino, 1987, cited in Pollak, Mattos, and Uhl, 1995). Unlike its Amazonian cousin, the latter plant is single-stemmed, and therefore does not recover easily after a harvest.

Rapid expansion of nontimber extraction, in response to high demand for the plant in question, its relative abundance, or both, often has been followed by resource depletion and a collapse of the activity. *Cascarilla roja* (*Cinchona* spp.), which is the natural source of quinine, is a case in point. During the Nineteenth Century, the British established plantations of the species in India, to ensure a ready source of medicine to combat malaria. But at least one of the botanists who was sent to gather seedlings along the western slopes of the Andes reported that his work was made difficult by the depredations of extractors, who often stripped medicinal bark in ways that killed trees (Spruce, 1970, pages 240-241).

In addition to illustrating the problem of open access, the history of *cascarilla roja* exploitation in the Andes is representative of two things that can, and often do, occur as a nontimber resource gains commercial value: production of synthetics and agricultural domestication. Neither extraction in the wild nor plantation production was able to compete with the manufacturing of synthetic quinine. The most famous episode of domestication occurred nearly one hundred years ago, when plants smuggled out of the Amazon Basin were used to establish rubber plantations in Asia, where production costs were lower. Once Asian production began, world prices fell and the Amazonian Rubber Boom came to an end.

Indeed, if a close look is taken at successful examples of nontimber extraction, one is apt to detect many, if not all, of the key elements of agriculture, or agroforestry to be more precise. For example, Pollak, Mattos, and Uhl (1995) have determined that the most profitable way to produce palm hearts in the Amazon estuary is with a system of low management intensity, which involves gradual improvement of a stand through dispersal of *açaí* seeds and periodic thinning of undergrowth and canopy species. At current prices, applying the system for twenty years yields a net present value of $119 per hectare, assuming a six percent real interest rate. Another benefit of applying this system would be that resource depletion would no longer lead to the relocation of processing facilities to progressively more remote locations (Pollak, Mattos, and Uhl, 1995).

Even though it creates little or no environmental damage, low-intensity management of *açaí* stands, like what can be done with an *aguaje* "orchard," is not exactly what some advocates of nontimber extraction have in mind. However, there really is no alternative, if the purpose is commercial production as opposed to the gathering of forest products for household use. (The latter, of course, is an important feature of rural life in many forested areas of the world.) Reviewing historical experience in the Peruvian Amazon, Coomes (1995) observes a consistent pattern of harvesting far in excess of sustainable levels followed by some combination of resource depletion, agricultural domestication (usually outside the region), and synthesis. Invariably, the earnings of extractor households have been marginal even during periods of peak activity. Once the peak has passed, those earnings either dwindle to negligible levels or evaporate entirely.

Extractive income is still very low. Financial analysis in one Brazilian community, for example, reveals that extraction's net returns at the household level are inferior to those of intensive or extensive agroforestry (Anderson, 1989, cited in Browder, 1992a). In a survey of 164 rubber tapper households he conducted in the Bolivian Amazon in 1981, Romanoff (1981, cited in Browder, 1992b) found that 96 percent were in debt and 71 percent suffered periodic food deficiencies. Significantly, Brazilian rubber tappers' earnings have been similarly meager in spite of the national government's efforts to maintain prices above international levels (Allegretti, 1990).

Vegetable Ivory Production in Western Ecuador

Insights into the commercial potential of nontimber extraction, and how the income generated by that activity ends up being distributed, can be gained by examining the collection, transport, processing, and trade of vegetable ivory, which is obtained from the seeds of a hardy tagua palm species (*Phytelephas aequatorialis*), in western Ecuador.

Ecuador began to ship tagua disks to button manufacturers in Italy and other countries around 1900. According to Central Bank annual reports, exports peaked during the 1920s and 1930s, nearly $20 million (in 1995 dollars) being sold in 1925. Plastic buttons were introduced shortly after the Second World War, which greatly reduced demand. For three decades beginning in the early 1950s, foreigners' purchases of vegetable ivory were negligible (Coles-Ritchie, 1996).

The tagua industry has rebounded in recent years, with annual exports regularly exceeding $4 million since the late 1980s. Italy continues to be the main importer, having purchased 81 percent of Ecuador's production in 1991. However, button manufacturers in other parts of the world are showing an interest in tagua, which is more appealing than plastic to many up-scale clothing buyers. In addition, the small handicraft market has strengthened somewhat because of the ban on international trade in products derived from elephant tusks.

Modes of Production and Marketing Channels

Available research suggests that tagua can live for more than a century and that its seeds can lie dormant for well over a year (Acosta-Solis, 1944; Barfod, 1991). Practically all productive stands date back to the 1920s or 1930s and were established through secondary succession, not planting. Since the plant yields various useful products, including roofing materials and livestock fodder, the trees were not uprooted during the years when Ecuador exported almost no vegetable ivory. Maintenance, such as it is, involves little more than the occasional removal of dead fronds.

After being collected by rural households, tagua is sold to intermediaries. There are no significant barriers to entry in this business and have found, marketing margins comparable to those observed in other competitive industries (Southgate, Coles-Ritchie, and Salazar-Canelos, 1996). By contrast, the top end of the domestic marketing chain is much more concentrated. Only a few firms slice dried tagua seeds into disks. The two largest processor-exporters accounted for about 45 percent of total shipments in 1991; another three firms shipped 30 percent (Southgate, Coles-Ritchie, and Salazar-Canelos, 1996).

Lack of competition in processing and exporting has nothing to do with economies of scale in production since capacity can be expanded capacity simply by installing more slicing machines (each of which is run by a single operator), and by enlarging the yard where raw tagua is dried. Instead, concentration is a consequence of barriers to entry on the marketing side. Historically, it has been all but impossible to get into the tagua exporting business without good contacts among Italy's button manufacturers. A current initiative to promote tagua production in Ecuador (Calero-Hidalgo, 1992), which is supported by Conservation International (CI), seeks to develop new markets. This is a challenge since clothing manufacturers that have not used tagua in the past need to be assured that large volumes of high-quality vegetable ivory will be available before they stop using buttons made of other materials.

Findings of a Survey of Vegetable Ivory Producers

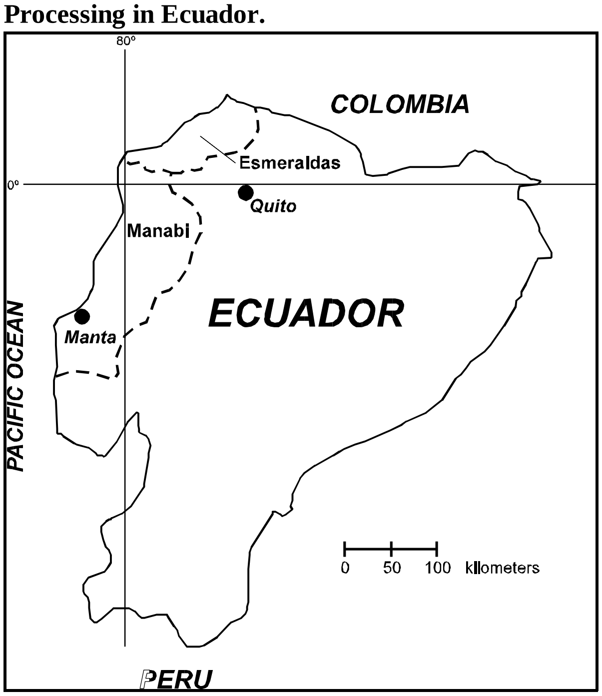
Surveys of collector households, intermediaries, and processor-exporters were conducted in 1993 to determine the distribution of net benefits from tagua production as well as possible responses to price changes (Southgate, Coles-Ritchie, and Salazar-Canelos, 1996) conducted surveys in 1993. Also participating in this effort was the *Fundación de Capacitación e Inversión para el Desarrollo Socio-Ambiental* (CIDESA), which is responsible for local implementation of the CI Tagua Initiative. CIDESA has substantial field experience in the two provinces, Esmeraldas and Manabí, where tagua harvesting is concentrated. It also helped the investigators make contact with processor-exporters in Manta, a coastal port city, and Quito, the national capital (Figure 4).

The household survey revealed that production is higher in Esmeraldas (400 pounds obtained from a representative site during a single peak season harvest) than it is in Manabí (200 pounds per harvest). Also, there are differences in labor inputs between the two provinces: 2.9 person-days per harvest in Esmeraldas versus 2.0 person-days in

Manabí. Furthermore, producer-level tagua prices rose between April 1993, when Esmeraldas households were surveyed, and November, when interviews were carried out in Manabí. CIDESA employees and individuals involved in the vegetable ivory business suggest that prices went up in both provinces by roughly 80 percent, from 4,900 sucres ($2.58) to 8,800 sucres ($4.63) per hundred pounds in Manabí, for example.

Daily payments to labor employed in tagua collection were estimated for median peak-season harvests in Esmeraldas and Manabí. Calculations were made both with the lower prices that prevailed in April 1993 and the higher values observed in November of the same year. In addition, all estimates reflect a small deduction for nonlabor inputs (e.g., the burlap bags used to carry tagua to market). In April 1993, median daily returns to labor employed in vegetable ivory harvesting ($2.36 in Esmeraldas and $2.32 in Manabí) compared poorly with off-farm wages which, averaged 5,000 sucres ($2.63) per day plus a lunch. By November 1993 prices had increased, raising daily returns—$4.40 in Esmeraldas and $4.37 in Manabí —above prevailing rural wages.

Figure 4. Centers of Tagua Harvesting and Processing in Ecuador.



One factor that has held down household-level earnings in the past has been limited competition among processor-exporters. As demonstrated in Table 3, those firms appear to be highly profitable.

The analysis of vegetable ivory processing and exporting (Southgate, Coles-Ritchie, and Salazar-Canelos, 1996) suggests that the industry is not in long-run equilibrium, with earnings well above the norm for the Ecuadorian economy as a whole. Understandably, then, entry has been taking place. Several new enterprises have begun to operate in Manta and Quito during the last two to three years. Without a doubt, greater competition helps to explain recent increases in raw material prices at the household level. Similar adjustments can be expected in the future as long as processor-exporters continue to earn super-normal profits. Interpretation of Table 3 suggests that, even if raw tagua prices rose to three times what they were in April 1993, profits would still equal 33 percent of revenues.

Real tagua prices have not stayed at the levels prevailing in late 1993 when Southgate, Coles-Ritchie, and Salazar-Canelos (1996) completed their study. In November 1995, the prices producers in Manabí received were between 10,000 sucres ($3.45) and 12,000 sucres ($4.14) per hundred pounds. In Esmeraldas, where tagua seeds tend to be larger, producer-level prices have been 15,000 sucres ($5.17) to 16,000 ($5.52) per hundred pounds. The director of CIDESA attributes price weakness to diminished demand for premium clothing in Europe and other affluent parts of the world (Rodrigo Calero, personal communication, 1995).

Table 3. Revenues, Costs, and Profits in Tagua Processing
(US$; April 1993 Prices)

Gross Revenues	$645,880
- sales of 225,000 pounds of disks	640,497
- sales of tagua flour and other byproducts	5,383
Expenses	$255,079
- purchases of raw tagua	89,905
- wages and salaries	102,337
- administrative, electricity, and other costs	62,837
Profits	$390,801
Profits as a Share of Revenues	61 percent

Source: Southgate, Coles-Ritchie, and Salazar-Canelos (1996)

Nontimber Extraction and Rainforest Conservation

In a few places, like the regions around Belém and Iquitos, demand for products like *aguaje* and *açaí* is strong, and commercial species are not too widely dispersed. As a result, harvesting nontimber commodities can be more remunerative than other activities in which a rural household can engage.

Elsewhere, the earnings associated with nontimber extraction are much more modest. Until very recently, for example, the net returns to tagua collection were no better than the opportunity cost of unskilled rural labor. The same has been true of rubber tapping and other forms of nontimber extraction in the Amazon Basin, both now and in the past. By contrast, super-normal profits are probably being captured by the few Ecuadorian firms that process and export vegetable ivory. This is similar to what happened, on a larger scale, during the Rubber Boom. The Manaus Opera House, for example, is lasting evidence of the wealth that lodged at the top of the domestic rubber marketing chain at the turn of the century.

It is fortunate that tagua palms suffer no damage as a result of harvesting, as has been the case for *aguaje* and *cascarilla roja* extraction. However, vegetable ivory collection is representative of commercial nontimber extraction in that it usually does not take place in locations that are biologically diverse. As has been mentioned, most tagua is harvested in stands that have emerged as a result of secondary succession. The users of those stands, needless to say, weed out other species that have no household or commercial value. The typical *tagual* bears little resemblance to an undisturbed primary forest. Instead, it represents a transition to agricultural domestication, which along with synthesis is what usually happens when demand for a forest product stays strong. Once domestication or synthesis is commercially successful, plants in the wild continue to have value only insofar as there is a need for repeated genetic improvement.

Outside of a few economic niches, characterized by strong demand and relatively favorable harvesting conditions, the environmental wealth on which extractive activity is based is abundant. This means that, even if resource rights are strengthened (which would help to forestall wasteful harvesting of some products), resource owners are not likely to derive much rental income and their incentives to engage in intensive management (i.e., quasi-farming) will remain weak. Likewise, the skills needed to gather nontimber products are not particularly unique. All this implies that, outside of a few unusual niches, nontimber extraction can only provide forest dwellers with limited amounts of supplementary income. That activity, then, comprises a very shaky foundation for an integrated strategy for habitat conservation and local economic development.

Environmentally Sound Timber Production

Many of those who advocate arresting the loss of threatened habitats in Latin America by promoting sustainable development of selected forest resources, like latex and *aguaje*, staunchly resist any form of timber harvesting. Their aversion to the latter activity is easy to understand since, for many years, most of the region's loggers exhibited little if any concern for environmental impacts.

No one denies, however, that there is considerable scope to contain those impacts. New systems that reconcile the growing and harvesting of commercial timber with biodiversity protection and watershed conservation are being developed. Better felling and skidding practices can be applied as well, thereby eliminating much of the long-term damage associated with logging. Where timber regeneration after an initial selective harvest is the objective, logging proceeds only after inventories and zoning, which includes the demarcation of sensitive areas to be left undisturbed. After that, vines are cut and directional felling is practiced in order to foster the regeneration of commercial species. Also, roads and skidder trails are designed and built with an eye toward avoiding soil erosion.

Research carried out by investigators affiliated with the *Instituto do Homem e Meio Ambiente da Amazonia* (IMAZON) reveals that the adoption of improved practices in the eastern Amazon is often hampered in forested hinterlands by low stumpage values, which are a consequence mainly of bounteous supplies of timber from unmanaged lands. That research is reviewed in the first part of this chapter. The second part contains an analysis of a project undertaken in the Peruvian Amazon, which yielded an innovative harvesting and management system. No attempt was made to continue applying the system after external support for the project ended. Outside technical assistance proved to have been vital. Also, the attractions of sustainable timber production were diminished by the disruptions associated with guerrilla activity and low stumpage values, which had to do with adverse governmental policies, inefficient marketing, as well as resource abundance.

The findings presented in this chapter suggest that, just as there are limited opportunities to keep natural habitats intact and to raise forest dwellers' standards of living through the promotion of ecotourism and nontimber extraction, it is important not to exaggerate the merits of environmentally sound logging. Like nontimber resources, timber is cheap in many places, which makes it difficult to justify the sorts of investment needed for sustainable management.

Logging in the Eastern Amazon

The challenge of sustainable development of standing tropical forests in Latin America is brought into sharp focus by a group of four studies organized by IMAZON, a private, non-profit research institute located in Belém, Brazil (Figure 5). Each study addresses one contemporary mode of timber production or another in Pará state, which was where 87 percent of all the Brazilian Amazon's roundwood was produced in 1988 (Verríssimo *et al*., 1992). Taken together, the four pieces of research furnish an idea of the forestry sector's evolution over time and across the landscape from an initial stage, in which timber is readily available and mechanization is minimal, to a situation characterized by higher capital intensity and incipient resource scarcity resulting from cumulative depletion.

Riparian Logging

Although it was the last of the four IMAZON studies to be published, a paper by Barros and Uhl (1995) addresses the oldest form of forest exploitation in the Brazilian Amazon. As the two investigators point out, high-quality timber began to be harvested from the banks of navigable rivers for shipment to Europe in the Seventeenth Century. The first sawmills and veneer factories were built in the Amazon estuary during the 1950s. These plants were internationally financed and powered by steam. Two species, *Virola surinamensis* and *Carapa guianensis*, accounted for most of the production, which was destined primarily for foreign markets. An active program of road-building, which began in the 1960s, has made exploiting forest resources in places away from navigable waterways financially feasible. Nevertheless, timber harvesting close to the Amazon River and its navigable tributaries continues to this day.

Figure 5. **The Eastern Amazon**

One sort of riparian logging is not very different than what could have been observed during the colonial era. In *várzea* lands that have built up over time in floodplains, small independent teams, normally comprising three men, fell timber and drag or float it to nearby riverbanks manually. There it is sold and assembled into log rafts that are pushed to mills by small boats. Clear evidence of low mechanization in this business has been obtained in a survey of sixty-three plants, both cottage-style facilities with circular saws as well as mills with bandsaws that employ thirty people on average, that process *várzea* timber in the Amazon estuary and around Santarém (Figure 5). In particular, Barros and Uhl (1995) found logs that had been cut with chainsaws at just twelve of those sixty-three plants. The rest had been felled with axes.

Logging is more mechanized in riparian areas outside floodplains. The teams of five or so men that operate in these areas always use chainsaws, and trucks are used to carry logs to rivers or roads. The scale of such operations is more than twice the scale of a typical *várzea* enterprise (2,311 cubic meters versus 873 cubic meters per annum), and annual production per person is higher in the former (492 cubic meters) than it is in the latter (265 cubic meters). The more mechanized system carries higher average costs as well. But the additional expenditures are compensated because timber harvested outside the floodplain is typically of higher quality, and therefore fetches a higher price (Table 4).

Loggers who operate in *várzeas* and adjacent dry lands tend to go about their business with little regard for forest regeneration. Barros and Uhl (1995) contend, though, that sustainable production is possible, especially in floodplains. As mentioned in the chapter on nontimber extraction, these areas feature a less diverse array of species. In addition, *várzeas* are well stocked with commercial timber, growth rates are twice what is observed in dry land forests, and logging involves less damage to the canopy and ground because there are fewer vines connecting trees being cut down to those in which loggers have no interest (Barros and Uhl, 1995).

The two IMAZON investigators also identify three prerequisites for the sustainable development of *várzea* forest resources. First, the environmental knowledge that local people have must be complemented by training in inventorying, felling, extraction and thinning techniques so that they can become effective resource managers. Second, their property rights in forested land must be stronger. Third, stumpage values must rise.

Table 4. Riparian Logging Costs *(US$ per m^3)*

Cost Category	*Várzea* Enterprise (873 m^3 per annum)	Dry Land Enterprise (2,311 m^3 per annum)
Labor Expenses	3.83	2.06
Stumpage Payments	2.90	5.85
Equipment and Fuel for Felling	0.00	0.48
Equipment and Fuel for Transport to River's Edge	0.00	5.93
Combined Costs	6.73	14.32
Payment Received at River's Edge	9.00	18.00
Source: Barros and Uhl (1995)		

A small investment in technical assistance and modest policy and institutional reforms would satisfy the first two prerequisites for sustainable forestry development. However, meeting the third condition is apt to be more of a problem. An existing ban on log exports, instituted to protect wood processors, would have to be eliminated. However, it is possible, even likely, that the main impact of such a change would be to encourage logging in more remote areas. Barros and Uhl (1995) have found that the cost of transporting one cubic meter of harvested timber 100 kilometers is as follows: $30.02 using a truck, $7.94 with a barge, and just $1.02 when logs are rafted. With transportation costs this low and standing timber as abundant as the two IMAZON investigators report it to be, stumpage values in a free and competitive market are unlikely to rise very high, even in the most favorably located *várzea* forests. Instead, the main consequence of increased demand for stumpage resulting from the lifting of the log export ban or some other event, would be to accelerate loggers' progress up the Amazon River and its tributaries, which Barros and Uhl (1995) report is already occurring.

Extracting Mahogany in Primary Forests

The high cost of reaching the outside world and its markets has always hampered commerce in the Amazon Basin. To this day, economic activity remains largely confined to areas served by highways and navigable waterways, only the most valuable forest products being taken from less accessible places. One such product is mahogany (*Swietenia macrophylla* King), a wood prized for its durability, workability, and attractive color.

Commercial harvesting of the species did not begin in earnest in the Brazilian Amazon until the 1960s, when the national road network started to extend into the region from the south. At that time, a standard pattern of operations for mahogany firms was established, which continues to hold as the industry has spread to the north and west. Instead of comprising large numbers of independent firms and households, each specializing in logging, timber transport, or processing, the industry consists of integrated businesses. A typical enterprise employs crews to search for and harvest mahogany, arranges to move logs to mills (which the same company owns), and sells the boards produced at its mills to foreign buyers, mainly in the United States and Great Britain (Verríssimo *et al*., 1995).

Since mahogany is so valuable, it is common for scouting and harvesting crews to operate several hundred kilometers from their employer's mills, and far away from public roads and highways. This mode of operations is expensive, since it usually requires road construction, delivering supplies by air, and so forth. In the second of the four IMAZON studies of the eastern Amazon's timber industry, Verríssimo *et al*. (1995) documented the costs incurred by a single firm active in southern Pará, to the west of the Belém-Brasilia Highway and to the south of the Transamazon Highway (Figure 5). Table 5 does not furnish a completely accurate picture of the extra expense of obtaining logs far from processing facilities. In particular, reconnaissance, felling, and extraction costs tend to be higher in more remote locations. However, stumpage payments and transport expenses are especially sensitive to distance. When harvesting takes place 600 kilometers away from a mill, the former drop to zero, because locational rents are negligible and also because there typically is no owner around to demand money for standing timber. By contrast, transport costs are more than an order of magnitude higher than what they are for a logging operation carried out just 50 kilometers from a mill.

For all intents and purposes, mahogany logging in primary forests amounts to mining. In inventories of three 100-hectare plots in southern Pará where felling and extraction had occurred in the recent past, Verríssimo *et al.* (1995) found virtually no representatives of the species with a diameter at breast height (dbh) of 10 to 30 centimeters; saplings were rare as well. Similar findings were obtained at four other recently logged sites in the region. The IMAZON investigators also cited evidence obtained in Mexico, Central America, and other parts of the Amazon Basin of poor regeneration of mahogany after harvesting, due to the absence of extensive light-rich openings in the forest and large seed trees (Lamb, 1966; Snook, 1993). They conclude that more than one hundred years might need to pass between an initial mahogany harvest in natural forests and a second cut.

Table 5. Mahogany Felling, Extraction, and Transport Costs *(US$ per m^3)*

Cost Category	**50 Kilometers from Mill**	**600 Kilometers from Mill**
Stumpage Payment	70.00	0.00
Reconnaissance and Felling	4.60	4.60
Extracting Logs from Forest	23.80	23.80
Transporting Logs to Mill	12.00	144.00
Taxes on Logs	3.00	3.00
Interest Charges	4.60	4.60
Combined Costs	118.00	180.00
Source: Verríssimo *et al*. (1995)		

The implications of poor regeneration are straightforward. The mahogany industry can be expected to continue along its current track of venturing ever farther into primary forests in search of undisturbed stands of timber, at a progressively higher cost. As the second column of figures in Table 5 indicates, the expense of delivering a cubic meter of timber to a mill approaches $200 as the distance between logging and processing sites exceeds 600 kilometers. This expense is easy to justify, since mahogany boards fetch very high prices in world markets. But at some point, the option of raising mahogany outside of a natural forest setting is certain to be commercially appealing. That point appears to have been reached in southern Pará, where a substantial amount of mahogany is starting to be raised, often in fields where pepper or rapidly growing timber species are planted (Steven Stone, personal communication, 1996).

Cultivation's profitability is diminished by the slow rate at which mahogany matures and also by the damage done to saplings by the shoot-borer moth (*Hypsipyla grandella*). However, financial analysis carried out by Browder, Matricardi and Abdala (1996) suggests that these difficulties may no longer be insurmountable. In particular, they have found that raising mahogany on a plantation, and perhaps as part of an agroforestry enterprise, is profitable if stumpage can be sold for $150 per cubic meter. If the cost estimates in Table 5 are accurate, this price is about what mills should be willing to pay, without diminishing their profit margins (which can be substantial), for standing mahogany close by instead of obtaining supplies several hundred kilometers away in previously inaccessible forests.

Regardless of which path the mahogany industry takes in the future, either continued ecosystem mining or tree farming, forest dwellers will be in a poor position to derive much benefit. Except for those fortunate enough to possess advantageously located stands, resource owners are unlikely to receive high one-time stumpage payments. Once harvestable stocks in the wild are sufficiently depleted and mahogany begins to be raised on plantations, the industry's interest in natural forests will relate only to its needs for seeds and other genetic material.

Logging along Active Frontiers of Colonization

When mahogany was being harvested mainly in areas beyond the reach of ranchers, farmers, and other settlers, environmental impacts consisted mainly of the eradication of commercial stocks of that same species, for several decades as far as Verríssimo *et al*. (1995) and other researchers have been able to determine. Otherwise, the IMAZON team has found that forest recovery, including the regeneration of some commercial timber species, was well under way a short time after mahogany loggers had left the scene.

The same sort of forest recovery can occur in more accessible places, as the third of the four IMAZON studies makes clear. Uhl *et al.* (1991) studied timber production in the late 1980s around Tailandia (Figure 5), a town that was connected to Belém, which is about 200 kilometers to the north, with an asphalted state road in 1985. As in other places experiencing rapid settlement and expansion of the wood products industry, loggers working in the vicinity of Tailandia tended to be highly selective. At most, they were interested in twenty species; on average, just two trees, each with a useful volume of 6.2 cubic meters, were being extracted per hectare in the late 1980s. Even though felling and skidding resulted in substantial damage to trees left in the forest, including commercial species, timber was regenerating rapidly. On ten plots, each measuring 5 meters by 15 meters and located in separate harvest openings, an average of 14.3 small individuals (standard deviation 6.7) of species that loggers in the region were harvesting were counted, although *Manilkara huberi*, which is the most commonly extracted kind of timber, proved to be rare (Uhl *et al*., 1991).

The depletion of commercial stocks is certainly a concern when and where the intention is to use natural forests as a long-term source of wood. However, there is another aspect of timber production in frontier regions that carries far greater consequences for the environment. As Uhl *et al*. (1991) documented in the case of Tailandia, 69 percent (in terms of linear distance) of all side roads suitable for vehicular traffic in the area were built entirely or partially by loggers. Constructing these roads, which were and continue to be a commercial life-line for local farmers and ranchers, often led to the conversion of forests into cropland and pasture.

That the upgrading of transportation infrastructure was linked to rapid agricultural land clearing around Tailandia had much to do with low timber values. In addition to whatever improvements loggers might leave behind, resource owners only received about $0.80 per cubic meter for their stumpage. At prices this low, the present value of a few seasons of crop production or a few years of cattle ranching exceeded the present value of a second timber harvest twenty years or so after loggers' initial intervention. For example, Uhl *et al*. (1991) estimated that the crops harvested during a single season were worth $460 per hectare in the late 1980s. By contrast, the value of timber extracted from a secondary forest after twenty years of good regeneration would have been $770 per hectare, assuming that the price paid for felled timber in 1989, $15.10 per cubic meter, exhibited no real growth over time (Uhl *et al*., 1991). Obviously, managing intervened forests so as to enhance future timber production would not have been remunerative, even at a very low real interest rate.

Uhl *et al.* (1991) contend that there was some scope to raise stumpage prices, and thereby to enhance resource owners' interests in sustainable forest management in the vicinity of Tailandia in the late 1980s. In particular, they argue that the mills that were purchasing timber (for $18 per cubic meter on average at the time of the study) and converting it into boards could pay more for their inputs.[1] Resource owners, they also observe, could have used the additional monies to pay for improved management of production forests. The IMAZON researchers point out that a typical mill's monthly operating and maintenance costs ($23,440), defined not to include depreciation and interest expenses, amounted to 81 percent of its monthly revenues ($28,800). They also found that the industry was not using raw materials very efficiently; two cubic meters being lost in processing for every cubic meter of finished product manufactured.

These observations do not add up to convincing proof that the wood products industry's profits were excessive. Indeed, net returns were actually quite modest, particularly after allowances were made for depreciation and other capital charges. Profit margins were certainly exceeded by what has been earned by firms that process and export vegetable ivory in western Ecuador, for example (see chapter on nontimber extraction). Also, the competitive market forces containing profits appeared to be strong, there having been forty-eight sawmills in and around Tailandia in 1989 (Uhl *et al*., 1991). In addition, low processing efficiencies are more a consequence than a cause of low stumpage values. After all, there was little reason to make the investments required to utilize a higher portion of raw materials when those materials are abundant, and therefore cheap.

Timber Production in More Settled Areas

As of the late 1980s, some of the land owners surveyed by Uhl *et al*. (1991) were refraining from selling stumpage in the hope that prices would rise appreciably with time. These expectations could well have been ill-founded, if the findings obtained in the fourth IMAZON case study (Verríssimo *et al*., 1992) are any guide.

The setting for the latter research was the area around Paragominas (Figure 5), which is on the Belém-Brasilia Highway. Since that road has been in operation since the late 1960s, it is accurate to describe the region as an old frontier, one in which settlement processes, of the sort that were in full swing around Tailandia in the late 1980s, have largely run their course.

Much of what Verríssimo *et al*. (1992) have to report about timber production in the vicinity of Paragominas is similar to what Uhl *et al*. (1991) have to say about Tailandia. Logging takes a toll on the forest, twenty-seven trees greater than or equal to 10 centimeters dbh were damaged for every tree extracted. But regeneration is robust, 4,300 seedlings and saplings of commercial species were registered per harvested hectare.

As one might expect in a place where both cumulative depletion of timber resources and agricultural land clearing have reached an advanced stage, timber values have risen. In 1989, when Verríssimo *et al*.

[1] Currently, the going price is between $30 and $35 per cubic meter (Steven Stone, personal communication, 1996).

(1992) conducted their field research, small logging firms, typically comprising thirteen individuals with a pair of chainsaws, a bulldozer and a log loader, as well as three trucks, were receiving $27.50 for a cubic meter of roundwood. This was 50 percent higher than what mills around Tailandia were paying for timber at exactly the same time (see above) and also the price for logs extracted from dry lands close to navigable rivers a year or two later (Table 4). Responding to those higher prices, wood processing firms had chosen to operate at somewhat higher levels of efficiency. Instead of three cubic meters of raw materials used to produce one cubic meter of output, as was the case in Tailandia (see above), 47 percent of the roundwood going into a typical mill was emerging as finished product (Verríssimo *et al*., 1992).

Stumpage prices, however, were not much higher in the old frontier region than they were where resources were more abundant. As of 1989, a cubic meter of uncut timber in the Paragominas region was worth $1.84 (Verríssimo *et al*., 1992).[2] One reason why prices were low in the 1980s was that it was, and continues to be, fairly inexpensive to bring logs in by truck from other places. In addition, processing capacity (e.g., small band-saw mills) can be moved from place to place without great difficulty. In general, high factor mobility diminishes locational rents.

In the vicinity of Paragominas, as in other places studied by IMAZON investigators, regeneration of commercial species after an initial harvest is an option. However, vine removal and refinement thinnings, which Verríssimo *et al*. (1992) estimate would cost $120 per hectare, makes financial sense only if stumpage prices rise substantially.

[2] By 1996, stumpage values were above $5 per cubic meter (Paulo Barreto, personal communication, 1996).

The Palcazú Forestry Project

IMAZON's program of research, conducted in a region where large volumes of timber continue to stand in spite of many years of logging and agricultural colonization, reveals that incentives for managing natural forests for wood production are weak in the Amazon Basin. Nevertheless, natural forest management has been promoted in various parts of the region. An innovative harvesting and processing system was developed and applied, with the participation of local indigenous communities, under the auspices of a USAID project, carried out during the 1980s in the Palcazú Valley of central Peru. That system was abandoned, however, soon after outside financial and technical assistance was withdrawn. A fundamental reason for the project's collapse was low stumpage values, which in turn had much to do with resource abundance.

As an expert from the Tropical Science Center (TSC), which provided technical assistance to the forestry component of the Central Selva Resource Management Project (CSRMP), has stressed, the challenges of sustainable timber resource development in a place like the Palcazú Valley were considerable (Hartshorn, 1990). Government policies have accelerated the degradation and removal of forests and public sector institutions have had little or no capacity to furnish useful advice to resource owners. Low concentrations of commercial timber and high extraction costs were additional problems. Moreover, there was negligible understanding of tropical forest dynamics and the regeneration requirements of canopy tree species.

The CSRMP did not address policy issues or attempt a thorough overhaul of Peruvian forestry institutions. However, TSC investigators were convinced that an opportunity existed to depart from the usual pattern of high-grading a few premium species, which is described in the first part of this chapter. It was determined that, along with national and international demand for fine tropical woods, local and national markets exist for a wide variety of species. The implication of this is that the volume extracted from any given unit area could be increased appreciably, which would in turn diminish average extraction costs (Hartshorn, 1990).

Due to the requirements of project implementation, there was no time for a thorough analysis of forest dynamics in the Palcazú Valley. However, the TSC team was able to draw on observations of critical importance made in Costa Rica. Scientists at La Selva Biological Station (Figure 2 above) had documented that the growth of shade-intolerant species in gaps that open up when large trees are pushed over by the elements is an intrinsic feature of tropical forest ecology. Half of all the tree varieties at La Selva, and 63 percent of the canopy species, require well-lit areas for regeneration (Hartshorn, 1978; Hartshorn, 1990). Gap-phase dynamics became the central feature of the TSC management plan for the CSRMP (Hartshorn, 1990).

The TSC scheme called for extracting everything with a diameter of 5 centimeters or more on production blocks that were 30 to 40 meters wide and 200 to 500 meters long (Hartshorn, 1990; Hartshorn, Simeone, and Tosi, 1986; Tosi, 1986). This represents a dramatic departure from standard practice in and around the Palcazú Valley. Like their counterparts in Pará (see above), loggers in eastern Peru normally cut down fewer than ten mature trees from a hectare of primary tropical forest. All other vegetation remains, often in a damaged state because of careless harvesting. Industry sources report that per-hectare extraction rates in the region rarely exceed 15 cubic meters and that high-quality hardwoods, cut with chainsaws into crudely dimensioned planks, comprise most of the output (Southgate and Elgegren, 1995).

In spite of high electricity prices, which made processing expensive, and other unfavorable economic conditions (Southgate and Elgegren, 1995), making use of timber with a small diameter was judged to be important to the functioning of the harvesting scheme based on gap-phase dynamics. Accordingly, a small mill was installed to convert timber of varying dimensions into different sorts of wood products: treated utility poles and fence posts, charcoal, as well as the sawn lumber normally exported from the region (Hartshorn, 1990; Simeone, 1990).

Project Performance

Reflecting subsequently on the forestry activities he carried out with Yanesha Forestry Cooperative, Limited (COFYAL), Simeone (1990) observed that outside technical assistance would be needed for many years if the production, harvesting, and milling scheme and marketing initiatives were to succeed. Poor performance of the system in the years immediately following USAID's departure proved him right.

Foreign technicians and scientists withdrew in 1989, largely in response to guerrilla activity in the vicinity of the Palcazú Valley, but not among the Yanesha, themselves. Before that time, up to a dozen such individuals were active in the project. During the next four years, the World Wildlife Fund (WWF) and the *Fundación Peruana para la Conservación de la Naturaleza* (FPCN), an environmental organization based in Lima, provided limited support (Benavides and Pariona, 1995). But in 1993, even this assistance came to an end.

COFYAL's performance before the latter date compared poorly with what had been expected when the CSRMP was being designed, ten years before. Using data obtained from USAID reports and other sources, Elgegren (1993) replicated the ex ante financial analysis of the forestry component. He estimated the base-case internal rate of return to be 20 percent, and also found that profitability was especially sensitive to changes in output prices and unit production costs. The same investigator also evaluated the cooperative's forestry operations in 1991, when harvesting took place on three strips, with a combined area of 2.87 hectares. Significantly, he found that revenues ($5,491.83 per hectare) were lower than costs ($5,614.89 per hectare).

Earnings were disappointing partly because the prices received for COFYAL timber were low. On average, hardwood boards, which accounted for 40 percent of total production, were sold for $88.98 per cubic meter locally and for $135.59 per cubic meter in Lima. These prices were well below FOB border values, which exceeded $500 per cubic meter at the time (Southgate and Elgegren, 1995). The discrepancies had to do with high transport costs, uneven quality and marketing practices, and also with discriminatory public policies.

By the early 1990s, the Peruvian government was not regulating or taxing the export of unprocessed lumber. However, exporters were obliged to deposit foreign currency earnings with the Central Bank and then wait for several weeks to be paid back in Peruvian soles, at exchange rates set at the time of deposit. During 1991, when Peru suffered one of the highest rates of inflation in Latin America, this arrangement diminished the revenues received by wood exporters by 30 to 35 percent, on average (Southgate and Elgegren, 1995).

Depressed revenues were also a consequence of low production. Overall yields, which approached 45 cubic meters per harvested hectare, were three times what is extracted when normal logging practices are employed (see above). However, practically all of the difference was accounted for by the utility poles and fence posts (55.40 and 188.85 units per harvested hectare, respectively) manufactured from smaller timber; production of sawn tropical hardwood only amounted to 18.68 cubic meters per harvested hectare (Elgegren, 1993). In addition to being little more than what is obtained with standard extraction techniques, the latter yield compares poorly with inventories of standing timber in the Palcazú Valley: 150 cubic meters of saw logs and 90 cubic meters of posts and poles per hectare (Hartshorn, 1990).

It is revealing that the net losses COFYAL suffered as it tried to implement the TSC system, $123.06 per harvested hectare, exceeded the net losses suffered by a private logging firm operating in adjoining lands. The latter, which were calculated taking all capital and operating and maintenance expenses into account and using data provided by the firm, amounted to $34.57 per harvested hectare (Elgegren, 1993).

After WWF and FPCN support came to an end, the Yanesha disbanded the cooperative, which had never operated profitably. The latest word from the Palcazú Valley is that strip harvesting and production of wood products of a small diameter have ceased; high-grading of timber and agricultural land clearing is taking place in the places set aside for sustainable timber production by COFYAL (Benavides and Pariona, 1995).

Lessons Learned

Abandonment of the CSRMP does not mean that the efforts of USAID, environmental organizations, technical assistance contractors, and COFYAL were entirely futile. The regeneration that is occurring on harvested strips suggests that the logging scheme developed under the project's auspices is biologically sound. Economic performance was much less encouraging, although a conclusive test of feasibility was preempted by disruptions caused by guerrillas and adverse public policy.

To be sure, domestic prices for lumber and other tradable goods would have been higher and incentives to apply the TSC harvesting and processing system would have been stronger had exporters been able to choose when to convert foreign earnings into domestic currency. It can even be argued that, without price distortions, the opportunity cost of land dedicated to sustainable forestry would have been covered. Suppose, for example, that payments to COFYAL in 1991 had not been depressed by 30 percent (i.e., that revenues had been $7,700 instead of $5,500 per harvested hectare). With no improvements in the efficiency of timber extraction or milling, average annual income on a 40-hectare site where a 40-year TSC-style rotation was being followed would have been $52.50 per hectare (equal to one-fortieth of the difference between $7,700 in revenues and $5,600 in costs). At a real interest rate of 10 percent, the present value of maintaining this income level indefinitely is $525 per hectare. If anything, this amount exceeds average farmland values in and around the Palcazú Valley (Elgegren, 1993).

But whether or not the TSC system is truly feasible in the Peruvian Amazon remains in doubt. For the feasibility issue to be settled, one would have to examine not just the opportunity costs of land, labor, and other factors obtained locally, but also the scarcity values of management, marketing, and technical expertise brought in from outside. COFYAL experience demonstrated just how critical the latter group of inputs were; the mill, for example, proved to be all but impossible for local people to operate on their own (Benavides and Pariona, 1995). The possibility needs to be faced squarely that, unless and until standing timber grows much more scarce, it will not make economic sense to devote a great deal of time or effort to forest management and related tasks in places like the Palcazú Valley.

The Prospects for Sustainable Timber Resource Development

Covering the opportunity costs of *all* the inputs needed for forest management, timber processing, and the marketing of wood products is proving to be a major challenge in other sustainable forestry initiatives. Performance of a Bolivian project that is very similar to the CSRMP is a case in point, one of the participants arguing that it would be impossible to practice good silviculture while at the same time carrying out processing and marketing operations without outside financial and technical assistance (Olivera, 1995).

Attracting management, technical, and marketing expertise to environmentally sound forestry ventures is sometimes made more difficult by public policy. The recent experience in Costa Rica of one of the TSC scientists who worked in the Palcazú Valley is instructive in this regard. That individual is currently trying to upgrade timber quality on a 600-hectare forested parcel, located in humid lowlands about 100 kilometers north of San José (Figure 2), where logging has taken place in the past. To promote regeneration, large specimens of the most valuable species will be left to stand for at least a few years to serve as seed sources; only less valuable trees are to be harvested and extracted, preferably with oxen so that erosion and damage to remaining vegetation are minimized. However, the TSC scientist complains that this sort of innovation is being frustrated by public officials, who are accustomed to officially sanctioned selective logging (which normally involves the removal of all commercial timber larger than 60 centimeters dbh), and who grant permits to transport logs to mills in and around the capital city (which can only process raw material with a large diameter). He also complains that forest taxes, which amount to 10 to 15 percent of the value of harvested timber, diminish stumpage values, and therefore resource owners' interest in conservation (Joseph Tosi, personal communication, 1995).

The rules and procedures of international development banks and agencies likewise inhibit the free flow of skills and expertise to forestry ventures in Latin America and other parts of the developing world. Just about any project that USAID proposes to carry out in a tropical forest setting must be preceded by a thorough environmental impact statement. Likewise, IDB Document AB 1704 (18 July 1994) stipulates that:

> In primary tropical forest settings, the Bank may support operations to enhance the ability of responsible agencies to manage forestry resources in a sustainable manner. *However, the Bank does not finance commercial logging in these forests, nor the purchase of equipment for such purposes*" (italics added, page 34).

Foresters employed by the World Bank, where similar requirements are in force, indicate that they would be reluctant to spend a great deal of time working on a promising venture to develop timber resources in either a primary or secondary forest. Their concern is that it might end up being too difficult to prove that a substantial risk of unacceptable environmental damage is not being run.

One place where the ingredients for sustainable forestry seem to be present is Quintana Roo, in southeastern Mexico. Local communities have organized to solidify their control over tree-covered land and also to develop alternative marketing channels, so as to receive higher prices for timber (Bray *et al.*, 1993). In addition, Quintana Roo holds major advantages over alternative sources of mahogany, which is the region's main wood product. For example, the cost of delivering logs to local sawmills has been estimated to be $80 per cubic meter (Richards, 1991), which is considerably less than the expenses that mahogany companies in the Brazilian Amazon face (Table 5).

But even in Quintana Roo, there is no guarantee that environmentally sound development of timber resources can pay for itself. The German Agency for Technical Assistance (GTZ) has been providing advice and support since the early 1980s, and private foundations are supporting attempts of local forestry cooperatives' to tap into fledgling markets for tropical timber certified as having been produced sustainably. Also, production and exports from Guatemala, much of it illegal, is exerting downward pressure on mahogany prices. Furthermore, a 25-year cutting cycle has been selected (Bray *et al*, 1993; Richards, 1991). Since all available research suggests that mahogany requires much more time to regenerate (see above), the latter decision presumably reflects a finding that a longer cycle is not feasible.

The conclusion seems inescapable that, despite modest increases in stumpage value in the eastern Amazon and other places, timber in the American tropics remains fairly cheap. Applying sustainable management practices where resources are not very scarce is not commercially remunerative.

Genetic Prospecting

Even though it is not particularly scarce, standing timber is the most important commercial resource that tropical forests contain. For humankind as a whole, though, the genetic resources of that ecosystem are probably of greater concern. Although they occupy less than 10 percent of the world's land surface, tropical forests harbor at least half of all plant and animal species (Myers, 1984; Wilson, 1988). Many of those species are threatened with extinction; Myers (1988), for example, has identified several "hot spots" in Africa, Asia, and Latin America where forests rich in endemic flora and fauna are being encroached on rapidly (Myers, 1988).

The consequences of biodiversity loss are not easy to quantify or evaluate. It is conceivable that vital ecosystem functions, like hydrological cycle regulation, could break down if species diversity fell below some critical threshold. However, the risk of such an outcome is less than remote in most places. By contrast, great alarm has been aroused by the prospect that avenues of pharmaceutical and other research might be foreclosed because of deforestation. There are, indeed, reasonable grounds to worry that cures for cancer, AIDS, and other diseases might never be found because too much biological raw material has perished irreversibly. It is worth remembering, for example, that the rosy periwinkle (*Catharanthus roseus*), which is the source of two uniquely effective drugs for treating leukemia, grows in the forests of Madagascar, which comprise one of the hot spots that Myers (1988) has identified.

Convincing though the story of the rosy periwinkle may be, anecdotal evidence is no substitute for thorough empirical study of the value of tropical forests as a source of inputs to pharmaceutical research. Without value estimates of this sort, it is hard to determine when and where deforestation is inefficient. Analysis of what the flow of biological inputs is worth to laboratories and other research venues is also needed to guide decisions about the legal and institutional arrangements governing access to genetic information.

The best available evidence, which is surveyed in this chapter, suggests that there is no strong reason for pharmaceutical companies to pay a great deal to maintain supplies of genetic inputs from tropical forests. To be sure, society as a whole, either now or in later years, might attach a very high value to the lives saved because specimens can be gathered in the wild. But none of this matters very much to forest dwellers, who are unlikely to derive substantial income from whatever medicinal products might be obtained from the habitats that surround them.

This is true even when forest dwellers collect a substance that, with limited processing, is consumed directly by people, rather than just being used in research. Consider the case of the *sangre de drago* (*Croton* spp.) tree, which grows in lowland Ecuador and produces a sap that has been used for generations to cure various maladies. The product is starting to be sold in health food stores in Europe. Also, Shaman Pharmaceuticals Incorporated, of San Francisco, California, has been conducting clinical trials to test the safety and effectiveness of the substance as a topical treatment for drug-resistant herpes. Its usefulness in combating respiratory cyncytial virus, which afflicts children, is being investigated as well (Burton, 1994).

As a result of foreign interest, the Ecuadorian market for *sangre de drago* has strengthened a great deal. A local entrepreneur who works with Shaman Pharmaceuticals reports that a hectare in the Ecuadorian Amazon with 100 trees (10 meter by 10 meter spacing) yields approximately 300 liters of sap eleven years or so after the trees are planted, at a cost of $2 apiece, or emerge of their own accord (Douglas McMeekin, personal communication, 1994). As of January 1994, the producer-level price of the sap was $4.25 per liter. If that price were to hold steady in real terms over time, then the present value of a single planting and harvesting cycle would be a little less than $250 per hectare, assuming a real discount rate of 10 percent. That value is comparable to but certainly does not greatly exceed the opportunity cost of land in the region.

Harvesting a medicinal product like *sangre de drago* is about as remunerative as collecting tagua, *aguaje*, or any other nontimber product in a South American forest. Since the net returns to the latter activity, which are modest, are examined in a preceding chapter, this chapter is focused exclusively on the value of tropical forests as a source of biological inputs to pharmaceutical research and development. The literature addressing that value is reviewed and the difficulties facing any party, be it an individual landowner or a national government, attempting to capture rents are described.

Value of Biological Raw Material to the Pharmaceutical Industry

Various approaches have been used to evaluate the resources exploited by genetic prospectors. Laird (1993), for example, reports that payments for samples range from $50 to $200 per dry kilogram. But as Simpson, Sedjo, and Reid (1996) correctly point out, the people receiving these payments often have no property rights in the plants they collect, which means that prices would not fully reflect *in situ* values. To arrive at the latter, of course, labor and other expenses, which can be sizable, would have to be deducted.

A more commonly used approach for estimating the gross value of wild genetic resources is to draw on the pharmaceutical industry's experience with medicines derived from plants. In particular, the probability that an individual species will yield something commercially useful (i.e., the "success rate") is multiplied by the returns associated with success. The resulting product is supposed to indicate what an untested species is worth. Practitioners of this approach, and there have been quite a few (Table 6), do not always distinguish between the gross and net values of a discovery. This can be highly misleading since pharmaceutical research and development is usually very expensive. In addition, a distinction is not always made between average values of past discoveries and marginal values of new discoveries. This is a significant oversight because, as Aylward (1993) stresses, the gap between the two values is large and probably widening because the value of medicines derived from plants seems to be diminishing.

Farnsworth and Soejarto (1985) were among the first to base value estimates on industry experience. In an earlier study, Farnsworth had analyzed the origins of drugs prescribed in the United States from 1959 through 1973; he found that plants were the source of one or more active agents in 25.4 percent of those drugs. Multiplying that share by the average price of a prescription, $8 in 1980, and by the 4 billion prescriptions filled each year in the United States, Farnsworth and Soejarto (1985) concluded that the gross value of all prescriptions derived wholly or partly from plants was a little more than $8 billion. They also reported that, as of the early 1980s, only 5,000 species had been examined thoroughly and that, of that number, 40 were found to contain commercially useful medicinal ingredients. Applying the implicit success rate, 1 in 125, to one-fortieth of the gross value of plant-derived prescriptions, Farnsworth and Soejarto (1985) contended that the worth of an untested species is $1.62 million, in 1980 dollars.

Principe (1989) carried out a study much like Farnsworth and Soejarto's (1985), but focused on all countries belonging to the Organization for Cooperation and Development (OECD), and not just the United States. Much of the data used by the former investigator was the same as what the latter team had used, although he assumed much lower success rates, between 1 and 10 per 10,000. For a rate of 5 per 10,000, values in the OECD market turned out to average $300,000 per species (Principe, 1989). This estimate, like the larger number Farnsworth and Soejarto (1985) had arrived at a few years beforehand, is a flawed indicator of *in situ* value because research and development costs were not deducted. In addition, it really amounts to an average historical value, not the marginal worth of an additional untested species.

Table 6. Summary of Research on the Value of Genetic Raw Material with Pharmaceutical Potential.

Author(s)	Research Approach	Finding(s)
Farnsworth and Soejarto (1985)	Multiply portion of prescriptions with at least one active ingredient derived from plants (25.4 percent) by number of prescriptions issued each year in U.S. (4 billion) and by average price ($8 per prescription); then divide by number of species from which medicines are derived (40) to come up with gross annual value of successful species ($203 million); then multiply that gross value by success rate (1 per 125).	U.S. willing to pay $1.62 million (1985 dollars) per annum for each untested species.
Principe (1989)	Multiply gross value of successful species in U.S. ($203 million) by 3 (to reflect relative size of total OECD market) and then multiply by success rate (5 per 10,000).	OECD willing to pay $300,000 (1989 dollars) per annum for each untested species.
Ruitenbeek (1989)	Assume countries providing genetic raw material for pharmaceutical research expect to capture 10 percent of the value of any patented discovery, which has an average value of $7,500; multiply the host country payment ($750) by the number of discoveries resulting each year from protection of a forest in the Cameroon and divide by the number of species (500).	Cameroon can expect to receive $15 per annum for each protected species.
Pearce and Puroshothaman (1995)	Multiply number of at-risk plant species in the world's tropical forests (60,000) biodiversity times success rate (0.0001 to 0.001) times value of a success ($390 to $7,000 million) times portion of value captured by country where genetic raw material originated (0.005 to 0.05); then divide by the world's remaining tropical forests (1 billion hectares).	The annual biodiversity protection value of tropical forests is between $0.10 and $21.00 per hectare.
Reid *et al*. (1993)	More detailed modeling of plant screening and various assumptions regarding success rates and discovery values.	Net present value of an untested species is between $52.50 and $46,000.
Simpson, Sedjo, and Reid (1996)	Identify what the maximum value of an untested species would be, given of untested screening costs, the value of a discovery, and redundancy among species; in addition, combine maximum value estimates with biogeography models to estimate marginal value of habitat protection.	Maximum value of untested species is $9,431, and the highest marginal value of habitat is $20.63 per hectare (in western Ecuador).

In an evaluation of biodiversity values associated with a forest protection project in Cameroon, Ruitenbeek (1989, cited in Aylward, 1993) improved considerably on the notions of economic worth underlying the estimates provided by Farnsworth and Soejarto (1985) and Principe (1989). The values of patented discoveries, rather than the prices charged for retail drugs, were examined. Aylward (1993) suggests that patent values may not be the best possible indicator to use in this sort of evaluation, but concedes that new discoveries are an appropriate measure of the output of genetic prospecting and pharmaceutical research and development.

To get at *in situ* values, specifically, it was assumed that only 10 percent of the value of new discoveries would accrue to the country in which the genetic material was originally found. For the scenario in which ten research successes, each worth $7,500, could be expected to result each year because of project implementation, the benefit to Cameroon would be $7,500 per annum (Ruitenbeek 1989, cited in Aylward, 1993). Aylward (1993) suggests that, if the forest to be protected by the project contains 500 species, then the average annual return that the country collects because of species conservation is $15 per species.

The approach developed for evaluation of the Cameroon project has been applied, with modification, in other settings. Pearce and Puroshothaman (1995) sought to evaluate the biodiversity losses resulting from tropical deforestation. They used the range of success rates that Principe (1989) has identified, from 1 to 10 per 10,000, as well as rough estimates that the same investigator has provided of the value of lives that would probably be lost in the United States because of the extinction of species with medicinal properties. Supposing as well that 60,000 plants are at risk in the world's tropical forests, which extend across 1 billion acres, Pearce and Puroshothaman (1995) conclude that, from a U.S. perspective, the expected cost of lost genetic resources resulting from deforestation ranges between

$0.01 and $21.00 per hectare.

A comparably wide range of species values has been estimated by Reid *et al*. (1993). That group has modeled the screening process in a more detailed fashion than other investigators have done. In particular, they assume that there is a 1-in-10,000 chance that a biotic sample will contain a lead compound and also that only one-fourth of the latter will end up yielding commercial pharmaceuticals. Notwithstanding this insight, available data only allow them to conclude that the range within which the value of untested material falls is between $52.50 and $46,000 per species.

Aylward (1993) observes that more recent studies of biodiversity values reflect a better understanding of genetic prospecting and pharmaceutical research and development and also that the sort of conceptual errors that characterized earlier contributions to the literature are being avoided. Not coincidentally, claims about what biodiversity is worth to drug companies and their customers have grown more modest over the years.

However, Simpson, Sedjo, and Reid (1996) argue that there is an upward bias in any estimate of the value of an untested species which is obtained simply by multiplying an expected success rate by the value of a new discovery, regardless of how accurately those two factors have been measured. Such an approach neglects any redundancy that can exist between one organism's genetic information and what another contains. Redundancy can occur because the same useful compound might be found in more than one species. Also, different compounds can have the same curative properties.

Redundancy and the marginal value of untested species are closely interrelated. As Simpson, Sedjo, and Reid (1996) point out, a low level of redundancy implies that the chances are small that examining a given species will reveal anything useful. But marginal value is also low if redundancy is high since there is little chance of finding something that is both useful and unique. Between these two extremes are levels of redundancy at which the probability of a useful and unique find is higher.

Taking redundancy into account, the three investigators explore the linkages among screening costs, the value of a unique and useful discovery, and the size of the sample of unscreened genetic material in theoretical terms. Among other things, they find that, as sample size increases, the marginal value of untested material grows small, even if screening costs are not very high. They derive an upper bound on the value of what they label the "marginal species." Using data from the pharmaceutical industry, they assume an average screening cost of $3,600 per sample and the value of a research and development "hit" of $450 million. From these figures, and their calculation of the probability of success at which the value of the marginal species reaches an upper bound (0.000012), they estimate the maximum possible value of one of the 250,000 untested species of higher plants.

Simpson, Sedjo, and Reid (1996) begin by examining the case in which the success rate is 0.000012, which turns out to be optimal given some assumptions they make concerning the random distribution of useful compounds. At that rate, there is a 95 percent chance that the 250,000-sample collection will yield a hit and the marginal value of the untested species is $9,431. However, that value is highly sensitive to the success rate. For example, if the rate falls by one-third, to 0.000008, then marginal value dwindles to zero. Marginal value also declines if the success rate rises above its optimal level. At a rate of 0.00040, for instance, an untested species is only worth $67.

Simpson, Sedjo, and Reid (1996) show that marginal value is also highly sensitive to sample size, the returns associated with a hit, and other variables. In addition, they address the costs resulting from encroachment on natural ecosystems by combining estimates of the marginal value of untested species with a model of island biogeography (MacArthur and Wilson, 1967), which relates species extinction to habitat loss. The three investigators find that western Ecuador is the place where the pharmaceutical industry would be willing to pay the most to halt the conversion of forests into cropland and pasture. Myers (1988) considers the region to be among the world's most active hot spots of threatened biodiversity since a huge number of species, many of them endemic, continues to survive there and because cumulative deforestation has reached an advanced stage. However, Simpson, Sedjo, and Reid's (1996) maximum estimate of the marginal value to the pharmaceutical industry of habitat protection in western Ecuador, $20.63 per hectare, is little more than a tenth of what the region's farmers and ranchers are willing to pay for cleared land.

The remnants of natural habitats on three islands, where levels of species endemism are high, also feature relatively high biodiversity values at the margin: southwestern Sri Lanka ($16.84 per hectare), New Caledonia ($12.43 per hectare), and Madagascar ($6.86 per hectare). Next come three hot spots with biodiversity values just below $5.00 per marginal hectare: India's Western Ghats ($4.77), the Philippines ($4.66), and the Atlantic Coast of Brazil ($4.42). Elsewhere, saving one forested hectare is worth a couple of dollars or less to the pharmaceutical industry (Simpson, Sedjo, and Reid, 1996).

The industry certainly behaves as if tropical forests are not worth very much, in terms of the market (as opposed to social) value of medicines they might eventually yield. Much has been made of the agreement that Merck and Company signed in September 1991 with Costa Rica's *Instituto Nacional de Biodiversidad* (INBio), under which the pharmaceutical manufacturer committed itself to paying the latter agency $1 million in exchange for plants and other raw materials as well as royalties on useful products derived from those inputs (Harvard Business School, 1992). However, one might speculate that Merck's interest in the deal had more to do with a desire to win favorable publicity than with sample collection, pure and simple. In any event, the amount of compensation involved is negligible relative to what many commentators claim biodiversity values to be. (INBio has signed similar agreements, with comparable payments involved, with a few other companies.) Other firms have tried to make similar arrangements. In early 1995, Pfizer Incorporated began negotiating access to Ecuador's biodiversity with INEFAN, the country's forestry institute. Originally, the company proposed to spend $998,000 on the acquisition and management of three small holdings and on a laboratory at which sample extracts would be prepared for export. INEFAN requested that, instead of being used to buy land, the funds be made available for the management of existing public parks and nature reserves. Also, both parties agreed that a 1 percent royalty would be paid for any patented veterinary drugs derived from Ecuadorian materials and a 2 percent royalty for human medicines (Roberto Ulloa and Joseph Vogel, personal communication, 1996). However, in December 1995 Pfizer decided to break off negotiations, hinting that it would shift its operations to Brazil.

Controlling Access to Species-Rich Habitats

As the actions being taken by INBio, INEFAN, and their counterparts in other countries demonstrate, national governments in the developing world are attempting to control access to diverse genetic resources indigenous to the tropics. INBio, for example, is trying to become a monopoly supplier of the biological samples that Costa Rica ships to laboratories around the world.

Local communities' ownership of traditional environmental knowledge is recognized in Article 8J of the Global Convention on Biodiversity. But the same treaty states that national governments have sovereign rights over germplasm *and* its derivatives (e.g., proteins and alkaloids).

The legal and institutional structures that need to be erected for such a regime to operate effectively are monumental. Vogel (1994), who favors extending the existing system of intellectual property rights, including 15 percent royalties, so as to include genetic material, acknowledges that a "gargantuan" data base would have to be developed and maintained for the expanded system to work. Such a data base would comprise far more than simple botanical and zoological inventories. For example, detailed information on the spatial distribution and the genetic distribution of each species would have to be included.

As Vogel (1994) emphasizes, nothing less than this sort of system would suffice for the emergence of robust markets for genetic information. Such markets, of course, would generate the price signals required for the efficient development of that information. Likewise, a well-articulated data base of the sort he describes would be a necessary, though not sufficient, condition for the successful functioning of a cartel, made up of tropical country governments, for controlling access to biodiversity in the wild, as some have proposed (Asebey and Kempenaar, 1995).

Investing in the detailed mapping of the world's biodiversity resources, so that a royalty system or a cartel can work, does not seem viable at present. The social benefits associated with using medicines derived from species collected in the wild might be substantial, comprising as they do human beings' willingness to pay a great deal to extend life spans and to escape the ravages of disease. But unless it can be conclusively demonstrated that those benefits exceed the legal and institutional costs of a royalty system or cartel, setting up either of those two arrangements will not be economically practical.

Conclusions and Recommendations

Under the right set of circumstances, nature-based tourism and the harvesting of forest products are commercially promising and can be carried out in ways that benefit local communities and keep renewable resources intact. Nontimber extraction is a case in point. As is indicated in the fourth chapter of this paper, *açaí* production in the Amazon estuary, which can be accomplished with little or no environmental damage, has improved living standards for thousands of the region's families.

However, the findings reported in this document suggest that it is somewhat unusual for ecotourism or forest product harvesting to be economically, socially, and environmentally successful. Many forest fruits are perishable or bulky, which makes it uneconomical to produce them far from major markets, and poorly defined property rights encourage wasteful extraction. There are only a few species of timber, like mahogany, that have become scarce enough to justify private loggers' interest in replacing what is harvested. Likewise, most tourism destinations are not unique and desirable enough to justify the high entrance fees needed for full funding of habitat conservation and local economic development.

If the conditions for social, economic, and environmental success are satisfied primarily in selected "niches," then there are few opportunities to promote environmentally sound commercial activities in forested hinterlands through large projects, of the sort that large multilateral banks, like the IDB, are accustomed to mounting. Rather, those activities are best supported through selective application of limited amounts of financing and technical assistance.

Quite a few development agencies and private organizations are involved in the latter kind of initiative. It is not immediately apparent what would be gained if the IDB, which to date has not supported many ICDPs, were to join that group. However, the Bank can help to achieve economic progress and habitat conservation by continuing to emphasize two things in its agenda for rural development. The first is agricultural research and extension, which contributes to environmentally sound intensification of crop and livestock production. The second is human capital formation.

The relationship between agricultural intensification and habitat conservation in Latin America is revealed by a simple regression analysis of the factors driving agriculture's geographic expansion. Annual percentage growth in cropland and pasture during the middle 1980s (AGLNDGRO) is the regression's dependent variable. The right-hand side variables include annual percentage growth in population, export, and yield growth (POPGRO, EXPGRO, and YLDGRO, respectively). A dummy variable indicating that land not yet cleared is poorly suited to agriculture (NOLAND), which is based on a comparison of actual and potential land use during the early 1980s (Southgate, 1994), is also included.

With data for twenty-three countries, ordinary-least-squares estimation of the regression model (Southgate, 1994) yields the following results (*t* statistic in parentheses):

$$\begin{aligned} AGLNDGRO = \; & \underset{(2.876)}{0.463} + \underset{(3.773)}{0.249}\,POPGRO + \underset{(-2.214)}{0.031}\,EXPGRO \\ & - \underset{(-6.000)}{0.198}\,YLDGRO - \underset{(-3.127)}{0.641}\,NOLAND \end{aligned}$$

$ADJ\ R^2 = 0.669 \quad SSR = 3.489 \quad F = 12.098$.

The signs of all parameter estimates are consistent with what should be expected and interpretation of the coefficients is straightforward. In a country where natural conditions do not favor frontier expansion (i.e., where the value of NOLAND is 1 instead of 0), the annual increase in cropland and pasture is expected to be 0.641 percentage points lower than would be the case if soils that lend themselves to crop or livestock production were unoccupied. Furthermore, a 1 percent increase in yields either offsets nearly four-fifths of the agricultural land clearing induced by 1 percent population growth or compensates for 6 percent growth in agricultural exports.

Commodity demand in Latin America is bound to increase for many years to come. Notwithstanding recent declines in human fertility, population growth is continuing. Also, incomes are beginning to rise. In addition, agriculture and other sectors of the rural economy are growing because policies that discriminate against exports, like currency overvaluation, are being reformed. Without agricultural intensification, expansion of the agricultural frontier will be hard to avoid. But the preceding regression results, which are corroborated by what is being achieved in Chile and other countries, show that demand growth can be accommodated without additional loss of natural habitats (Southgate, 1994).

Alone, agricultural intensification will not be enough to save rainforests and other threatened ecosystems in Latin America. The reason is that, in large measure, habitat destruction represents an environmental symptom of a flawed approach to economic development in the countryside, which marginalizes the rural poor. One element of that approach, which has been applied in just about every part of the region at one time or another, is to apply macroeconomic and sectoral policies that make it hard for small farmers to compete successfully for prime inframarginal land. Rural credit subsidies and the de facto exemption of agricultural income from taxation are two policies that inflate large farmers' bids, and which drive others to the frontier (Heath and Binswanger, 1996; Schneider, 1995).

A more prominent feature of the inequitable approach to rural development, though, is inadequate human capital formation. Because spending on education, public health services, and the like have been deficient in the Latin American countryside, millions of households now find their options limited to migrating to the slums that ring the region's cities in the hope of finding some sort of employment, informal more often than not, or moving to remote hillsides or jungles to engage in what Schneider (1995) terms "nutrient mining." As the findings reported in the fourth and fifth chapters of this document show, the returns associated with the latter activity are meager.

Rural people who acquire skills can be counted on to seek out and to find jobs that pay better than what could be earned along agricultural frontiers, either from sustainable activities of the sort examined in this report or from nutrient mining. To recognize this is to understand that human capital formation should be the centerpiece of an integrated strategy for habitat conservation and rural development.

The IDB has been at the forefront of efforts to strengthen agricultural research and extension and to improve rural education throughout Latin America. Additional progress in these areas, which is sorely needed, will require financial backing and technical assistance on a scale that few organizations other than the Bank can provide. It only makes sense for the IDB to serve the dual goals of economic progress and habitat conservation by playing to its strengths.

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Abbreviations

CETUR	Corporación Ecuatoriana de Turismo (Ecuadorian Tourism Corporation)
CI	Conservation International
CIDESA	Fundación de Capacitación e Inversión para el Desarrollo Socio-Ambiental (Foundation for Training and Investment for Socio-Environmental Development)
COFYAL	Cooperativa Forestal Yanesha Limitada (Yanesha Forestry Cooperative Limited)
CSRMP	Central Selva Resource Management Project
FPCN	Fundación Peruana para la Conservación de la Naturaleza (Peruvian Foundation for the Conservation of Nature)
GTZ	Gesellschaft für Technische Zusammenarbelt (Agency for Technical Assistance)
ICDP	Integrated Conservation and Development Project
ICT	Instituto Costarricense de Turismo (Costa Rican Tourism Institute)
IDB	Inter-American Development Bank
IMAZON	Instituto do Homem e Meio Ambiente da Amazonia (Institute for Man and the Environment of the Amazon)
INBio	Instituto Nacional de Biodiversidad (Costa Rica's National Institute of Biodiversity)
INEFAN	Instituto Ecuatoriano Forestal, de Áreas Naturales, y de Vida Silvestre (Ecuadorian Institute of Forestry, Natural Areas, and Wildlife)
OECD	Organization for Economic Cooperation and Development
SPN	Servicio de Parques Nacionales (Costa Rica's National Park Service)
SPNG	Servicio del Parque Nacional Galapagos (Galapagos National Park Service)
SRP	Subsecretaría de Recursos Pesqueros (Ecuador's Subsecretariat of Fishery Resources)
TSC	Tropical Science Center
USAID	United States Agency for International Development
WWF	World Wildlife Fund