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Report

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Valuing the Rain Forest: The Economic Value of Nontimber Forest Products in Ecuador

This study calculates the value of three ha of primary forest in the Upper Napo region of Amazonian Ecuador based on the potential extraction of nontimber forest products (NTFPs). Through ethnobotanical and market surveys, the annual harvest levels, market prices and extraction costs of seven fruits, three medicinal barks, and one resin are measured. The present value of net revenue from NTFP collection is USD 2830 in the upland plots and USD1257 in the alluvial plot which is significantly higher than the returns from alternative land uses in this area.

INTRODUCTION

Economic analyses of tropical forests have traditionally focussed on timber harvesting or land conversion for agricultural or livestock production, overlooking the value of nontimber forest products (NTFPs). Critics of these analyses argue that agriculture and livestock production in tropical forest areas have negative ecological impacts, tend not to be sustainable as practiced, and sometimes exhibit low economic value (1–5). In recent years, attention has shifted to the economic value of nontimber products from tropical forests. Studies are beginning to demonstrate that the sustainable extraction of these resources may provide significant benefits to local people while simultaneously conserving the biological resources of standing forests (6–8).

The extraction of NTFPs for sale in local markets in Iquitos, Peru, was more profitable than timber harvesting or cattle ranching in the same area (7). An investigation of medicinal plants in Belize reached similar conclusions (8). However, the results of these two studies cannot be extended to all tropical settings. The value of any single site will depend upon the species at the site, the proximity of markets, and whether the land is in private, public, or communal ownership. Numerous studies of this nature will be necessary before making economically efficient land-use decisions in other tropical forest areas.

In this study, we use ethnobotanical interviews and market observations to systematically value three separate hectares of mature forest in Amazonian Ecuador used for the extraction of non-timber products. We base the analysis on the current value of fruits, medicinal barks and resins from trees 10 cm in diameter at breast height (dbh). We then compare the potential income from the sale of these products to the net revenues obtainable from cattle ranching and timber harvesting in this area.

In this valuation, we augment the methodology developed in Peters et al. (7) by separately valuing trees on an individual basis, rather than at a per species level. This allows us to better account for the wide variations in production levels and harvesting costs among individual trees of the same species. We also report the uncertainty of our estimates so that future studies can focus on the parameters which are most poorly understood in these assessments.

SITE DESCRIPTION

We carried out this study using three one-hectare permanent forest plots at the Jatun Sacha Biological Station (1°04' S; 77° 36"W) on the south bank of the Napo River, 8 km from the town of Puerto Misahuallí, Ecuador. The research site is located in mature phase "tropical wet forest" and has a mean annual rainfall of 4100 mm (9) fairly evenly distributed throughout the year. The Jatun Sacha Biological Station currently owns approximately 500 ha of primary and secondary forest in this area, and has been managed as a private foundation since the mid-1980s.

Two of the study plots at Jatun Sacha are located in *tierra firme* forest with red clay Dystropept soils at an elevation of about 400 m. The third plot is along the bank of the Napo River in floodplain forest with alluvial soil at 350 m in elevation. These plots were chosen and demarcated independent of their species diversity or economic value, and they represent a range of soil types and floristic composition (10).

The indigenous people who inhabit this region are the Quijos Quichua. As resource managers, they engage in hunting, forest product collection, and the cultivation of yucca, plantains and home-garden crops. Many of the Quijos Quichua have only recently become involved in market transactions. The construction of a road in 1987 between the towns of Puerto Napo and Ahuano has increased market accessibility and contact with colonial entrepreneurs who have come to the area to raise cattle and cultivate cash crops.

METHODS

Between 1987 and 1991, Palacios, Cerón and Neill conducted a biological inventory of all of the trees and lianas 10 cm dbh on the three permanent plots at Jatun Sacha Biological Station. This inventory indicates that these forests are highly species rich with a range of 185 to 245 species of trees 10 cm dbh per ha. These botanical inventories provided scientific identification of each tree. Over the last three years, Alarcón and Bennett conducted ethnobotanical research on these plots recording the extensive use of the forest by the Quijos Quichua.

Grimes, Burnham and Onthank in the summer of 1991 and Grimes, Loomis and Jahnige in the summer of 1992, interviewed eight Quijos Quichua forest collectors in small groups at the site. They examined each tree species (10 cm dbh) to obtain the common name, uses, and marketable products. Through this process, 13 species were identified on the study plots that produce goods of market value. Visits to local markets verified that these NTFPs are sold.

The Quijos Quichua guides examined every tree for each of the 13 species which produce market products in the three plots. The guides estimated the annual sustainable harvest amounts for each specific tree. Fruit yields and bark and resin yields were estimated separately.

In order to estimate the annual yield of potentially valuable fruit-producing trees, each tree was surveyed with at least two groups of guides. This provided multiple estimations of the production from each tree. The guides estimated average annual fruit yield in both number of units and by weight, the number of trips needed to collect a full harvest, and both the collection and transportation time per trip. To further ensure that the reported sustainable collection rates are ecologically sound, the reported harvest levels were reduced by 25% to take into account losses for wildlife, spoilage, and regeneration.

For bark-producing species, the Quijos Quichua guides and several traditional healers reported that annually removing a vertical strip 1–4 m in length up to one eighth of the perimeter of the tree would not result in mortality or critical damage. The specific height to which one could remove the bark depends on individual tree size, vigor, and convenience. The guides estimated the harvestable height for each tree and we calculated the harvestable width from the dbh measurements taken during the botanical inventory. Bark harvesting in other parts of the world has been carried out at similar degrees of intensity (11), although ecological research on the sustainability of bark harvesting is needed.

A variety of collectors reported that appropriate harvest levels from resin-producing trees range from one to five pounds annually depending on the diameter, height and health of the tree. However, long-term botanical studies should be done to confirm the sustainable levels of extraction and determine what factors may influence production.

There are advantages and disadvantages with the ethnobotanical approach used in this study. The Quijos Quichua guides are experienced harvesters of NTFPs from the forests near Jatun Sacha. They are familiar with the long-term fluctuations in production inherent in local species and attempt to account for this variance in their estimates. By examining each tree, growth form, age, height, surrounding light, and microsite can all be taken into account. Local collectors are also able to determine whether non-destructive harvesting from a given tree is feasible. For example, in order to harvest forest fruits without felling the tree, local collectors climb (without equipment) the fruit-producing tree or an adjacent pole tree. The potential for nondestructive harvesting, thus, often depends on the willingness and ability of collectors to climb a given tree, an important factor that generally cannot be ascertained by ecological studies.

The ethnobotanical approach also has drawbacks. For example, researchers must rely on estimates of amounts and weights that may never have been measured by scientific standards. Interviewers may misunderstand responses and guides may misinterpret the questions. Further, estimates by collectors may be influenced by incorrect assumptions regarding ecological processes, level of experience, and their relationship with the researchers. In addition, the Quijos Quichua are not accustomed to regularly harvesting maximum sustained levels for market sale. For these reasons, long-term ecological studies, though costly, may be necessary to verify the results of ethnobotanical studies. The information gained from such studies would indicate the reliability of ethnobotanical data in valuations such as this and clarify whether assumptions made in the course of these rapid studies are justified. By jointly conducting long-term ecological studies in conjunction with ethnobotanical surveys, researchers can check the accuracy of their data and 'calibrate' the estimates of local guides.

ASSESSING MARKET VALUE AND TOTAL COSTS

Having gathered data on yields and harvesting time through interviews on the plots, data on market prices, transportation costs, and retail costs for all products were collected. The weekly market in Tena was visited regularly and periodic visits were made to markets in the surrounding towns of Misahuallí,

Table 1. Marketed NTFPs from the Upper Napo Province, Ecuador.

Family	Scientific name	Common name	Number of trees in 3 plots	Product use
Arecaceae	*Jessenia bataua* (Mart.) Burret	Ungurahua	15	Food/Med
Moraceae	*Batocarpus orinocensis* Karst.	Sacha Paparahua	9	Food
Sapotaceae	*Chrysophyllum venezuelanense* (Pierre) Pennington	Sacha Caimito	7	Food
Lecythidaceae	*Grias neuberthii* J. F. Macbr.	Piton	10	Food
Fabaceae-Mimosoideae	*Inga* aff. *spectabilis* (Vahl) Willd	Mangalpa Cachig	7	Food
Sterculiaceae	*Theobroma subincanum* Mart.	Cushillo Cambiag	7	Food
Clusiaceae	*Garcinia* sp.	Pungara Muyu	4	Food
Fabaceae-Fabaceae	*Myroxylon balsamum* (L.) Harms	Balsamo	1	Medicinal
Olacaceae	*Minquartia guianensis* Aublet	Huambula	8	Medicinal
Ochnaceae	*Cespedezia spathulata* (Ruiz & Pavón) Planch.	Amaron Caspi	1	Medicinal
Burseraceae	*Protium fibriatum* Swart	Shilquillo	23	Handicraft
Burseraceae	*Protium nodulosum* Swart	Shilquillo	8	Handicraft
Burseraceae	*Protium sagotianum* E. Marchand	Shilquillo	1	Handicraft

Archidona and Puyo during June, July and August of 1991 and 1992. From a combination of market observations and interviews with buyers and sellers, the prices of forest products were determined. Products were regularly weighed to confirm prices per unit weight (12). The indigenous guides frequently accompanied us in the markets to verify the tree names from which products originated.

All but one of the fruits included in this valuation were in season during the period of this study, allowing us to directly observe market transactions. The medicinal barks and resins are all sold and harvested throughout the year. To collect data for the one fruit not in season (*Chrysophyllum venezuelanense*), we interviewed several forest collectors and market vendors to confirm that the fruits are actually sold, and to verify the selling price and rate of sale. These reports were quite consistent.

To supplement our field and market data, we interviewed several tradespeople who regularly used the NTFPs found in the plots at Jatun Sacha. Three local pottery makers clarified the source, availability, and demand for a resin used as a ceramic varnish. Two traditional healers provided information regarding the sale and identification of various herbal medicines. We visited the homes of our guides to directly observe the use of forest products. In addition, our guides questioned their friends and family members to confirm market sale, harvest levels, and product uses.

During the extraction and sale of forest products, a collector incurs significant costs associated with the collection, transportation, processing, and sale of these products. A major component of these costs is the time spent conducting the above activities. Guides estimated collection times per tree as a function of harvest amounts. Transportation costs included both the time needed to carry products from the plots to the road, as well as the bus or truck fare to the nearest market. The site at Jatun Sacha is 30 km from the market and the transportation mode is a local bus. The time required for extraction, transportation, and sales was multiplied by the local wage of 500 sucres per hour. Market sellers also reported processing (i.e. cooking and preparing) and packaging costs per product. We collected and calculated all prices and costs in sucres and translated them into dollars using the exchange rate of USD 1 = 1450 s.

Forest collectors generally sell barks and resins to shop owners or intermediaries for wholesale values but market fruits themselves. For barks and resins, the gross revenue was calculated based on a wholesale price which we assumed to be 75% of the observed retail price (based on observations of wholesale and retail price differentials). This proportion between wholesale and retail prices was confirmed for one product, but this assumption should be verified in future studies.

RESULTS

Table 1 lists the eleven locally sold NTFPs found in the permanent plots at Jatun Sacha. Forest collectors harvest these products from thirteen tree species. The valued products include seven fruits, three medicinal barks and one resin. However, only 72 of the 105 individual trees of the species in Table 1 are actually valued because only 72 of the trees are deemed sustainably harvestable by Quijos Quichua forest collectors. The remaining trees were either too young to produce, too tall and dangerous to climb, or nonproductive. While this method may underestimate some of the forest's potential value, we believe that it offers a more realistic assessment of what local people could actually extract sustainably.

To determine the value of the Jatun Sacha plots for NTFP extraction, we calculate the net revenues obtainable from the sale of all the products from the 72 economically-viable trees

Table 2. Plot A valuation summary.

Species name	Number of trees	Number of trees valued	Total sustainable harvest	Price per unit USD	Gross revenue USD	Total costs USD	Net annual value USD
Jessenia bataua	10	2	163 lbs (35)[1]	14	22.55 (4.90)	5.34 (0.78)	17.21 4.96)
Batocarpus orinocensis	4	1	563 fruits (91)	0.023	12.95 (2.09)	4.46 (1.45)	8.49 (2.54)
Chrysophyllum venezuelanense	3	1	253 fruits (44)	052	13.11 (2.29)	2.72 (0.52)	10.39 (2.35)
Grias neuberthii	6	3	32 fruits (5)	0.07	2.22 (0.35)	1.16 (0.10)	1.06 (0.36)
Theobroma subincanum	2	1	46 fruits (14)	0.07	3.21 (0.98)	1.07 (0.38)	2.13 (1.05)
Myroxylon balsamum	1	1	17 doses[2] (6)	0.16	2.64 (96)	0.35 (0.13)	2.28 (0.97)
Protium sp.	18	18	27 lbs (15)	4.14	111.72 (62.10)	16.37 (6.14)	95.36 (62.40)
Minquartia guianensis	4	4	44 doses[3] (17)	0.26	11.38 (4.42)	1.37 (0.52)	10.01 (4.45)
Total plot A net annual value							146.93 (62.67)

1 The number in parentheses is the standard error.
2 The average dose of *Myroxylon balsamum* is 140 cm^2 of bark.
3 The average dose of *Minquartia* equals 120 cm^2 of bark.

on the plots. We compute the potential revenues from the products on a per tree basis and then sum across all trees to calculate the total revenues of each plot (Tables 2, 3 and 4). Net Annual Value (NAV) is simply:

$$NAV_{tree} = Gross\ Revenue_{tree} - Total\ Costs_{tree}$$

where Gross Revenue is price per unit times annual harvest and total cost is the sum of harvest, transportation, and sales costs.

Tables 2, 3, and 4 present the results for each of the three plots. The most important product in the three plots was from the genus *Protium*. Surprisingly, the economically valuable *Protium* product is neither a food nor medicine but rather a ceramic varnish used for local handicrafts. The three tables indicate several other species also contribute significantly to the value of the three plots. *Jessenia bataua, Batocarpus orinocensis, Chrysophyllum venezuelanense* and *Minquartia guianensis* provide about one third of the income of the two upland plots. *Garcinia macrophylla* and *Inga aff. spectabilis* provide over half of the value of the alluvial plot. By having a multiplicity of products to collect on each trip, harvest costs are kept low.

Also displayed in Tables 2, 3, and 4 are estimates of the uncertainty surrounding the productivity and cost numbers. The standard errors reported reflect discrepancies amongst collectors and inherent variation in different trees. This problem was especially troubling with the *Protium* spp. as different collectors disagreed which specific trees could yield the desired product. There is consequently considerable remaining uncertainty about the productivity of *Protium* trees on the plots. Assuming that these errors are independent across species, the variance of aggregate plot production is equal to the sum of the variances of each species. The 95% confidence interval of net annual income for plot A lies between USD 22 and USD 272, for plot B between USD 38 and USD 234, and for plot C between USD 29 and USD 97.

Because alternative land uses provide returns over different time frames, it is necessary to compute a single common index across time to compare each alternative. By discounting all future returns to the present, one can compare very different streams of revenue with one another. The Net Present Value (NPV) of each land use is the value of all future income in today's dollars. We assume annual harvests of NTFPs are sustainable. Although the numbers and production levels of trees will certainly change with time, these changes should offset each other.

For a land use which provides constant annual returns, the NPV is:

$$NPV = NAV / r$$

where r is the inflation-free discount rate. In this analysis, we assume that the discount rate is 5% (18).

As shown in Table 5, the Net Present Values for NTFPs from the two upland plots are estimated at USD 2939 for plot A and USD 2721 for plot B. The alluvial plot C has an NPV of USD 1257. The average NPV of the two upland plots is USD 2830, and the average per ha value of NTFPs from all three sites of mature phase forest at Jatun Sacha is USD2306.

ALTERNATIVE LAND USES

To determine the value of timber resources in this area, two local wood contractors conducted a timber cruise on the upland plot A. They surveyed the entire plot, identified all potentially

Table 3. Plot B valuation summary.

Species name	Number of trees	Number of trees valued	Total sustainable harvest	Price per unit USD	Gross revenue USD	Total costs USD	Net annual value USD
Jessenia bataua	5	3	216 lbs (98)	0.14	29.79 (13.72)	7.55 (3.18)	22.24 (14.08)
Batocarpus orinocensis	3	1	1476 fruits (360)	0.23	33.95 (8.25)	10.73 (2.37)	23.22 (8.68)
Chrysophyllum venezuelanense	1	1	7.5 fruits (4)	0.052	0.39 (0.21)	0.23 (0.08)	0.15 (0.22)
Garcinia macrophylla	2	1	188 fruits (61)	0.034	6.47 (2.07)	1.67 (0.63)	4.81 (2.16)
Grias neuberthii	2	2	37 fruits (11)	0.07	2.53 (0.77)	1.30 (0.37)	1.24 (0.85)
Theobroma subincanum	2	2	150 fruits (19)	0.07	10.34 (1.33)	5.07 (0.68)	5.28 (1.49)
Minquartia guianensis	3	3	47 doses (12)	0.26	12.16 (3.12)	1.30 (0.30)	10.85 (3.13)
Cespadezia spathulata	1	1	8 doses (4)	0.16	1.24 (0.64)	0.30 (0.13)	0.95 (0.65)
Protium sp.	11	11	19 lbs (11)	4.14	78.62 (45.54)	11.30 (4.24)	67.32 (45.74)
Total plot B net annual value							136.06 (48.82)

1 The number in parentheses is the standard error.
2 The average dose of *Minquartia* equals 120 cm^2 of bark.
3 The average dose of *Cespadezia spathulata* equals 140 cm^2.

merchantable trees on the ha and reported the stumpage values for each individual tree of worth. Summing across all merchantable trees yields an average value of USD163 ha^{-1}. We chose plot A for this valuation because it is closest to the road, thus minimizing extraction costs and maximizing stumpage values.

The NPV for the timber resources on Plot A can be calculated for a 40 year rotation length (14) using the formula $NPV=V/(1-e^{-rt})$, where V is the net value of one cutting and t is the rotation length in years. Substituting USD163 for V yields an NPV of USD189 ha^{-1}.

To estimate a per ha value for cattle ranching we interviewed several area ranchers. The ranchers estimated their annual veterinary and pasture maintenance costs, and gross revenues associated with raising cattle. From these figures we calculated per ha annual net revenues for each farm of USD 2.90 ha^{-1} resulting in an NPV for cattle ranching of USD 57 ha^{-1}. Alternatively, given a carrying capacity of one cow per two hectares, 400 pounds of beef per mature cow, a 3-year maturity and a gross price of USD 1 per pound yields gross revenue per hectare of USD 200 every 3 years. Assuming that costs are about 80% of revenue, the net revenue is USD 40 every 3 years. Using the same formula as with timber, yields a net present value of USD 287 ha^{-1}. These figures for timber harvesting and cattle are reasonable considering local land prices of USD 50 to USD 220.

As Table 5 demonstrates, in the Upper Napo region of Amazonian Ecuador, nontimber forestry can provide substantial net revenues to local people when compared with the NPVs of other local land uses. The potential NPVs per ha from NTFPs are an order of magnitude greater than from any other land use. In addition, the value of NTFPs from the forest of Jatun Sacha compare favorably to revenues obtainable from agriculture in other areas of Latin America. In Northwestern Ecuador, most farmland earns less than USD 25 ha^{-1} annually, suggesting an NPV of less than USD 500 (15).

MARKET POTENTIAL AND STABILITY

This study reports the current market value of NTFPs from a specific site 30 km from market. How do these values apply to other sites? One factor which affects the value of all sites is access to markets. Across tracts currently used for NTFP collection, sites which have lower transportation costs to markets will have higher net value. Given any transportation system, there is a maximum distance where it is just barely worthwhile to harvest the NTFPs for market. At this maximum distance, the value of the forest as a source of NTFPs is zero. Over the landscape, there is a topology of land values associated with NTFPs. The NTFP values will start highest near the market and fall with distance eventually to zero. If the primary transportation is by river, values will fall slowly up the river but rapidly as one moves onto land. The more sturdy or longlasting the product, the slower the values will fall with distance.

Table 5. Comparative land NPVs.

Land use	Net present value USD
NTFP-Upland Plot A	2939
NTFP-Upland Plot B	2721
NTFP-Alluvial Plot C	1257
Local Land Prices	50-220
Agriculture	<500
Timber, Upland Plot A	188
Cattle Ranching	57-287

Table 4. Plot C valuation summary.

Species name	Number of trees	Number of trees valued	Total sustainable harvest	Price per unit USD	Gross revenue USD	Total costs USD	Net annual value USD
Batocarpus orinocensis	2	0	0	0.023	0	0	0 (0.00)
Chrysophyllum venezuelanense	3	1	7.5 fruits (4)	0.52	0.39 (0.21)	0.22 (0.07)	0.17 (0.22)
Garcinia macrophylla	2	2	793 fruits (333)	0.023	18.22 (7.66)	2.65 (0.95)	15.57 (7.72)
Grias neuberthii	2	2	24 fruits (3)	0.07	1.66 (0.21)	0.80 (0.10)	0.85 (0.23)
Inga aff. spectabulis	5	3	1219 fruits (306)	0.023	27.99 (7.04)	6.36 (1.16)	21.63 (7.13)
Theobroma subincanum	3	2	56 fruits (6)	0.07	3.92 (0.42)	0.51 (0.06)	3.41 (0.42)
Minquartia guianensis	1	1	8 doses (2)	0.26	2.07 (0.52)	0.40 (0.11)	1.67 (0.53)
Protium sp.	3	3	5.5 lbs (3.2)	4.14	22.76 (13.25)	3.19 (1.20)	19.57 (13.30)
Total plot C net annual value							62.87 (16.97)

1 The number in parentheses is the standard error.
2 The average dose of *Minquartia* equals 120 cm^3 of bark

The value of the NTFPs, as with any commodity, are subject to supply and demand. If the supply of forest for harvesting were greatly expanded, prices would fall. Similarly, as existing forest is eliminated, supply should contract and prices would rise. This study measures the value of the site given existing supply conditions. It basically argues that forests which are currently being used for collection earn more than competing land uses. It does not necessarily follow that all remaining forest should therefore be used for NTFPs. Before land developers and agencies commit vast new areas to NTFP collection, they should first undertake a careful study of demand and supply.

With respect to demand, existing NTFP collection is largely devoted to serving only local demand. This could reflect a lack of interest in these products outside of the regions in which they grow or simply a lack of information. At a minimum, businessmen should be encouraged to explore the potential of expanding the markets for NTFPs both to regional cities and abroad. If there is substantial untapped demand, then it is likely that additional forests should be drawn into NTFP collection.

The results of this study also raise an important paradox. If the value of NTFPs exceed alternative land uses, why does the region seem so intent on adopting these alternative uses? There are three possible explanations. First, the relevant actors may not be aware of the potential of NTFPs. To the extent that powerful land owners and government officials come from the cities and temperate oriented cultures, they may not be aware of the potential of NTFPs. If this is the case, then the simple publication of studies such as this one should be sufficient to change their behavior. Another explanation is that forests in the Amazon tend to belong to the government. If the government is unaware or chooses to ignore that the highest use of the forest is for NTFPs, then no one will get permission to use the forest for this purpose. The collection of NTFPs may be unattractive for the government because the products generally are not exported (less visible), they are collected in dispersed locations making them hard to tax, and they currently benefit the rural poor who are not politically powerful. Third, land tenure in Ecuador requires that owners "occupy" the land. Occupation is often interpreted as removing the forest cover and planting crops. An owner who resorted to collecting products from an existing forest, stands a nonzero probability of losing his land.

Another alleged problem with NTFPs is that their markets may not be stable. The reported NPVs in this study are based on the harvest and sale of a multiplicity of products. This minimizes the potential impacts of individual product price fluctuations on the value of the forest for all NTFPs. Because there is no distinct dry season in this area of Ecuador, different forest products are available throughout the year. This also leads to overall income stability because as one product goes out of season, alternative products become available for sale. Market security is thus an asset of NTFP collection.

ADDITIONAL FOREST VALUE

While the Net Present Values calculated here represent the potential benefits from products of trees 10 cm dbh, they are not indicative of the total values of these forests for NTFPs. We do not include the value of medicinal herbs or shrubs, flowers, wildlife, tourism or the wide range of environmental services provided by intact forests, each of which could be significant in its own right. For example, one "guanta" (*Agouti paca*), a large forest rodent, is sold in the local markets for roughly USD 20.69, and decorative butterflies sell on the tourist market for a similar price. On Plot A, a medicinal liana (*Petrea maynensis*) yields net revenues of USD 9.56. In addition, these forests provide a rich array of subsistence products such as tools, thatch, food and medicines not sold in markets. These products serve as important substitutes for market goods.

It is also possible to combine the harvest of NTFPs with timber extraction. In Plot A, 16 palms and 16 timber trees could be harvested to increase the NPV for the plot by 10%. Of course, if this harvesting damaged just 10% of the valuable NTFP trees, the timber harvest would only break even. Timber harvesting thus needs to be done carefully and selectively in order to be worthwhile in combination with NTFP harvesting.

DISCUSSION

Forest values depend upon many local factors such as floristic composition, site quality, disturbance history, local policy, and distance to markets. For example, at this Ecuadorian site, the upland forest is more attractive for NTFP collection than the alluvial forests. Further, it is important to note that in the three disparate sites (Peru, Belize, and Ecuador) where NTFPs have been valued, NTFP collection has consistently been worth more than alternative land uses. These results imply that harvesting NTFPs from standing forests deserves to be considered more seriously as part of the portfolio of viable development alternatives for the world's tropical forests.

This study demonstrates the economic value of intact forest resources. Adjusting policies to create incentives for long-term forest management by local users is fundamental to the conservation and sustainable use of tropical forests. On the fragile lands of Amazonia, forests represent a vast store of wealth, provided they are managed responsibly. NTFP extraction will often be the key to sustainable management in many areas of the humid tropics.

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13. The analysis is robust with respecto to the interest rate. However, it is straightforward for the reader to apply alternative interest rates in calculating Net Present Values.
14. A 40-year rotation length is what foresters in the Palcazu Valley in Peru have calculated to be optimal, however, silvicultural management generally is not practiced in Amazonian Ecuador and optimal rotation lengths are not known for this specific area.

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