

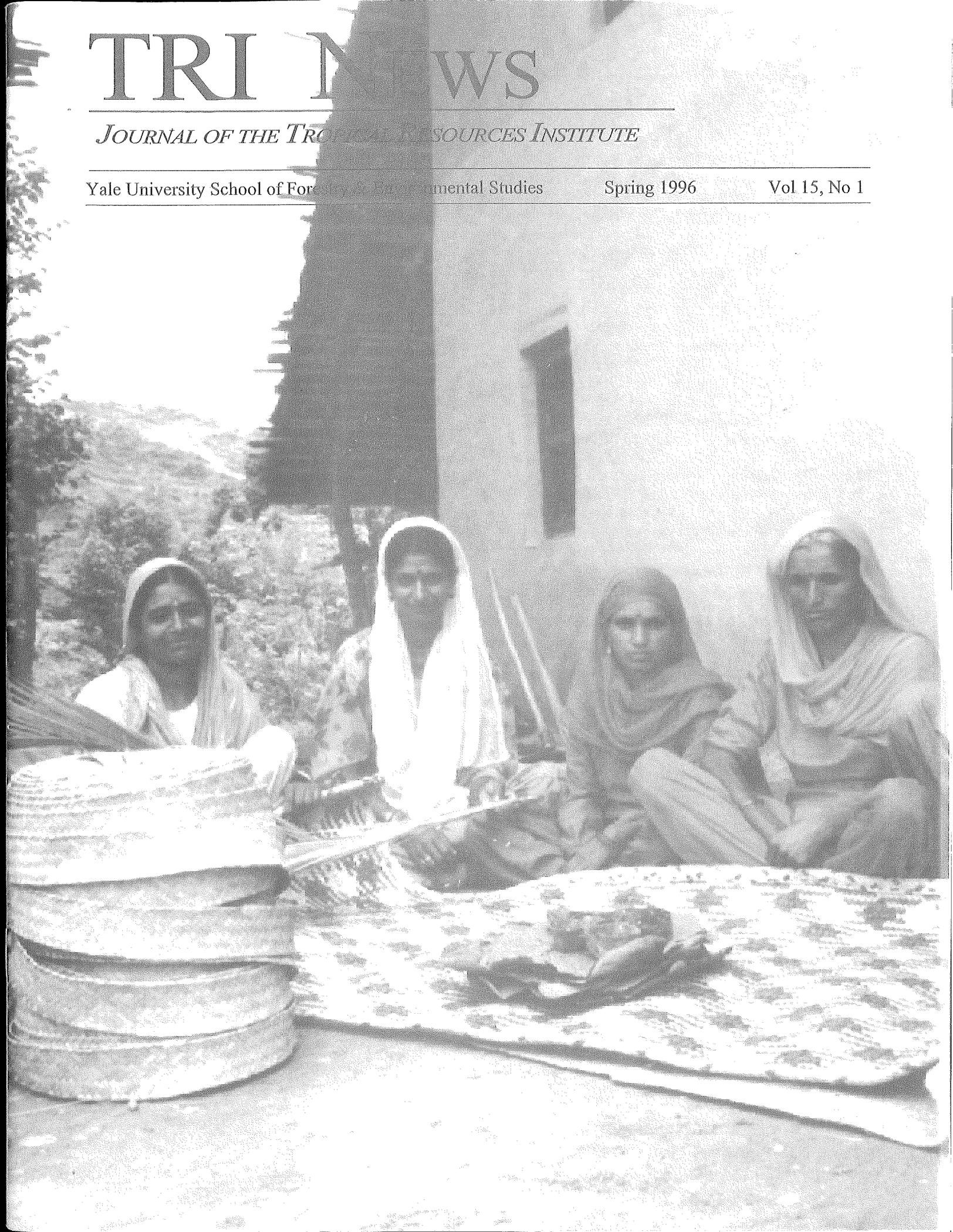
TRI NEWS

JOURNAL OF THE TROPICAL RESOURCES INSTITUTE

Yale University School of Forestry and Environmental Studies

Spring 1996

Vol 15, No 1



EDITORS NOTES

Greetings from a New Haven not quite fully into Spring. We welcome you to our 10th anniversary edition at a time when the Tropical Resources Institute is going through considerable changes. Budget cuts forced us to plan only one issue this year, but we are moving forward in our planning for coming years. In this issue, you will find our first ever reader survey, because we want to know who you are and what you want or need from TRI News. Please take a few minutes to fill out this survey and return it to us by 30 August 1996. The survey includes demographic information that we will use to update our database. To ensure your uninterrupted subscription, please be as complete as possible.

We are continuing to improve the quality of the work we publish here. Towards this goal, we instituted a peer-review system this year. TRI Interns read each other's work and make written comments directly to authors. Our first group of reviewers and reviewees found the system tremendously helpful in improving their final products and learning from others.

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and to provide our resources to the widest audience possible, we now have an email address and have put a TRI home-page on the World Wide Web.

TRI News articles are as complete as they can be at publishing time. However, all articles are shorter versions of TRI Working Papers, the complete research product of a TRI intern. Working papers usually include more detailed information about the study. If you would like to order any Working Papers, see page 18 for the most recent publications, and write to us at the address below.

Have a great summer.

Sharon Katz, MES '96

Jon Kohl, MES '97

All photos are taken by authors.



Allison Ormsby conducts research in Belize

ASSESSING THE FUTURE OF NON-TIMBER FOREST PRODUCTS IN GUYANA

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Guyana boasts a great floral diversity in its large forested tracts covering approximately 85% of the country (Daniel 1984). Intense mechanized exploitation of these resources, however, had not taken place on a wide scale until the early 1990s when concession licenses for large areas were granted to foreign timber and mining interests. In addition, extraction of non-timber forest products (NTFPs) has been increasing as more value-added goods and raw materials themselves are being produced for export in addition to domestic consumption. But the ecological ramifications of increased harvesting are unclear due to a scarcity of ecological data about NTFP species. Thus, although there is market potential for NTFP products, long-term ecological viability is unknown. This study examines the prospects of three NTFPs (manicole cabbage palms, balata resin, and lianas) by looking at market trends, harvesting techniques, and implications for future availability of these natural resources. I investigated these NTFPs because the goods made from them are already being produced for export and expansion of their markets shows strong potential (Marshall and Kellman 1995).

METHODS

For each NTFP, I determined its economic range by literature research, combining its geographic range with the accessible areas actually being harvested. Although many of the species are found throughout the country, only certain areas are exploited due to physical accessibility, availability of labor, and proximity to processing factories. I examined harvesting methods and biological characteristics of the species to understand the effects of extraction on regeneration. Finally, I explored the market trends for each NTFP to determine how market expansion would affect its future availability. To gather this data, I conducted interviews with business people, government officials, (especially those in the Forestry Commission) local people, and scientists. Archival research was undertaken at several libraries in Georgetown, the capital.

NTFP DESCRIPTIONS

Manicole Palm (*Euterpe oleracea*)

The manicole palm is a clustering, delicately stemmed palm which grows in lowland forests, swamps, and frequently along river banks. Areas rich in manicole palms are found near the coast, specifically in the Pomeroon, Essequibo, Mahaica, Mahaicony, Berbice, and Demerara regions of Guyana (see map). Although native people have used many parts of this palm for a variety of purposes such as temporary thatching and as a balm for scorpion stings (Fanshawe 1950), the main product harvested for commercial export is its "cabbage," the unfolded leaf sheaths forming part of the stem. The "heart" or inner portion of this cabbage is pickled, canned, and exported as a gourmet food to markets in Europe, especially France.

Amazon Caribbean Guyana Ltd. (AMCAR), a French com-



pany, has monopolized the palm cabbage industry in Guyana since 1987 when AMCAR obtained a concession of 50,200 ha in the northwestern region of the country. Before this agreement, France imported most of its palm hearts from Brazil. But quality control problems in Brazilian production (some cabbages were too hard) prompted the French to undertake their own production of this gourmet food; Guyana with its abundant distribution of *Euterpe oleracea* was considered a prime site. In 1994, over 2,300,000 220-gram cans were exported to Europe. This represented a 10% increase over 1993 production and was worth more than US\$1,500,000 (Catholic Standard 1994). AMCAR seeks to expand into North America, especially Florida, where there is a significant Latin American population, who are also consumers of this product.

AMCAR has established two processing plants, one at Drum Hill in the concession area, and the other on the east bank of the Demerara River near Georgetown. AMCAR is also encouraging local contractors to set up five or six more canning factories in these regions to increase production capacity; AMCAR will then purchase and export the product and thus maintain its monopoly (Catholic Standard 1994). A network of AMCAR agents collect the palm cabbages from Amerindians who are the main harvesters, and deliver them, usually via river, to factories. Harvesters are paid per cabbage by agents who receive such a commission as well.

Harvesters typically cut only in relatively pure stands or "reefs" of Manicole which grows in clusters of up to 10 stems, establishing from seed as well as vegetatively from suckers (Higman 1995). When a cluster of Manicole is reached, the axeman fells the largest stems, those about 46 cm in circumference at breast height (Johnson 1994). Typically about five to seven stems out of a cluster of 10 are harvested. Stems that remain are usually immature and do not bear fruit. To ensure regeneration, however, harvesters should leave at least one mature fruit-bearing stem per cluster, since it is not known how many times a manicole can regrow vegetatively (Higman 1995).

Re-growth from coppicing may occur only once or twice before the palm becomes too old to put out suckers, and if seed-

bearing stems are not left after harvesting, the viability of future harvests from the same area may be threatened (Higman 1995). Yet AMCAR operates under the assumption that felling all large stems will lead to natural regeneration through sucker growth and will permit a second harvest within five years (Johnson 1994). It is also unknown what the effects of opening up of the reef might be. Felling of mature stems in pure stands causes significant canopy disturbance, allowing increased light to reach the forest floor. It is uncertain how the manicole reacts to this increased light and how it might compete with other shade intolerant species that may colonize the area and hinder its growth. Manicole harvesting on this scale and intensity is a new phenomenon in Guyana and effects on future regeneration and viability are unknown (Higman 1995).

Balata (*Manilkara bidentata*)

Balata is a resinous gum obtained from the latex of forest trees belonging to the family Sapotaceae. In Guyana, the balata gum is chiefly produced from the Bulletwood tree which occurs in a variety of forest types throughout the country. Most of the balata collected comes from the Rupununi region in central Guyana where the extracting company has its regional headquarters and where there is a high concentration of Bulletwood trees.

Balata is currently used in the local manufacture of handicrafts, but it was an important export in the early twentieth century. During the world war periods, balata was exported and primarily used for submarine cables and machine belting. Between 1916 and 1925, mean annual production was 554,409 kg (Guyana Forestry Commission 1985). Until the late 1970s, balata continued to be produced in significant quantities (see table). It was exported mainly to the UK for use in conveyor belts, kitchen utensils, and golf balls. However, due to the invention of cheap plastics, balata production has dropped off precipitously in the last 15 years.

BALATA PRODUCTION

Year	Quantity (Kg)
1960	259,868
1965	283,656
1970	345,690
1975	197,606
1980	107,192
1984	21,468
1994	16,000*

Source: Guyana Forestry Commission 1985

*1994 production figures are from Guyana Stores Ltd.

Guyana Stores Ltd., the only company in Guyana licensed by the government to collect balata, currently sells about 16,000 kg per year to the UK, mainly for conveyor belts. The company is currently exploring potential markets in the United States for golf



A waterfall in Guyana

balls and shoe soles; the Guyanese Institute of Applied Science and Technology is exploring possibilities for domestic manufacture of balata products. In addition, balata could be used to manufacture gloves and condoms if rubber prices become too high. If these possibilities come to pass, balata production could achieve sizeable increases.

The average Bulletwood tree matures in 8–10 years and reaches an average dbh of 60–90 cm and a height of 28–33 m. A long vertical tapping cut (about 12 mm deep) is made in the grey-brown bark and then smaller diagonal incisions are made off of this central one (Subramaniam 1988). This method directs the flow of latex to the base of the tree where it is collected in a small receptacle. A tree cannot be bled again until its bark has been healed which takes 10 to 15 years. If done correctly the tapping process is not overly dangerous as only one percent of all trees die from this process (Guyana Forestry Commission 1985). Because of balata's previous value, the felling of Bulletwood trees for timber was prohibited by the government in the early twentieth century. Given the wide distribution of trees and their ability to heal after being bled, it is possible that balata production, at a rate of about 30,000 kg per year could be ecologically viable in the future (Subramaniam 1988).

Nibi (*Heteropsis jenmani*) and Kufa (*Clusia spp.*)

The Nibi furniture industry, which utilizes two species of lianas, possesses great potential to garner large export markets.

Nibi is a flexible liana that is widely distributed throughout the country among a variety of forest types. It is used for making baskets and commercially for weaving over furniture surfaces and binding. Kufa, which is similar to the Rattan palm, is a thicker liana than Nibi and is used to construct the furniture frame. A recent survey revealed that these two lianas are widely and abundantly distributed throughout the country with almost 567,000 ha of Nibi and Kufa in the northwest region alone (Brewster 1994). Most harvested lianas come from the Pomeroon River area since

that it takes new roots about five years to reach a diameter of five cm (Brewster 1994). With an increasing demand for Kufa and Nibi and with little data on regeneration times and mechanisms, it is unclear how much longer accessible areas around the Pomeroon River can be harvested.

RECOMMENDATIONS

As markets for NTFPs expand, increased harvesting pressures will be brought to bear on accessible regions. It is clear that more information on regeneration times and mechanisms of these species is needed in order to accurately assess the viability of long-term, intense harvesting. In regards to Manicole harvesting, AMCAR should try to implement a management program in which collectors leave at least one mature stem in each cluster to ensure future regeneration from seed (Johnson 1994). In addition, a study on the physiological aspects of the palm and its growth and regeneration mechanisms needs to be undertaken in order to assess harvesting impacts. Similar ecological studies should also be done for Nibi and Kufa either through government or private channels. There also needs to be more concrete data on how much Nibi and Kufa are being extracted from the Pomeroon area. Last it should be noted that while extraction may not kill a plant, it might impair its reproduction, thus jeopardizing its viability (Peters 1994). These problems and issues need to be addressed or future availability of these resources in the accessible, intensively harvested areas may be threatened.

NIBI FURNITURE EXPORTS 1994 (ESTIMATED)

Country	Quantity (Kg)
Trinidad	15,423
Barbados	14,532
British Virgin Islands	1,030
St. Lucia	995
Suriname	559
Cayenne	430
USA	265
Antigua	210
Others	559
Total	34,003

Guyana Statistical Bureau 1995

it is close to the capital where the furniture factories are located, the river is navigable, and the Amerindian population -- heavily dependent on Kufa and Nibi harvesting for their livelihood -- provides an available workforce.

International as well as domestic markets for Nibi furniture, according to larger-scale producers, have been growing rapidly over the past 10 years and one manufacturer estimates her potential export sales at US\$3-4 million per year when full-scale factory production begins in 1996 (Dow 1995). Currently, most exports are to Caribbean markets but large-scale producers are trying to penetrate markets in the United States, particularly in Florida and New York. These producers hope to capitalize on the similar physical appearance of Nibi and Rattan furniture in order to capture a share in this multi-million dollar niche market. Some Guyanese producers have invited Southeast Asian Rattan furniture designers to train their workers in modern methods of production and design so that Nibi furniture will be competitive.

Nibi is an epiphytic plant that encircles trees with masses of aerial roots (0.6-1.25 cm in diameter) which hang down and eventually take root in the ground. Nibi is collected by simply pulling down the aerial roots and immersing them in water to keep them pliable until used. Some collectors claim that Nibi regenerates prolifically in places that were harvested (Brewster 1994). Kufa, the liana for which there are 20-30 species in Guyana, is an epiphyte whose aerial roots eventually strangle their host trees (Fanshawe 1950). The main stem of Kufa may attain a diameter of 10 cm while the aerial roots reach 15 cm. Kufa is harvested by climbing the aerial roots to where the plant is supported on the host tree and then cutting the aerial roots off at that point. Amerindians usually leave the main root intact to sustain the plant and estimate

ACKNOWLEDGMENTS

I would like to thank TRI, the Coca-Cola World Fund, and the National Science Foundation for their support. I would also like to thank my advisor, Robert Mendelsohn, and everyone in Guyana who graciously extended me assistance.

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EVALUATION OF METHODS FOR ESTIMATING PARROT POPULATIONS

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INTRODUCTION

Many neotropical parrot species are endangered as a result of widespread habitat destruction and capture for the pet trade (Collar and Juniper 1992). Possible solutions to this crisis include sustainable harvesting and international control of trade (Beissinger and Bucher 1992). These conservation approaches require reliable parrot population estimates at local and national scales. It is difficult to estimate parrot populations because parrots tend to have extensive home ranges, travel in large flocks that can be composed of several species, often inhabit forests where visibility is poor, and cryptic coloration and secretive behavior inhibit their detection when they are not in flight. The goal of this study was to compare the performance of the point transect, line transect, and mark-resighting methods and a method of my own design based on parrot roosting behavior. Performance was evaluated by testing conformity of population estimates among the methods, comparing the precision of the methods, and comparing population estimates to a reference population.

METHODS

All population surveys were conducted between June and November, 1994 at Hato Masaguaral, a working cattle ranch in the state of Guárico, Venezuela. I established a 49-ha study area that included forested and open habitat (Figure 1). I conducted 11 discrete population surveys of the green-rumped parrotlet (*Forpus passerinus*) at approximately two-week intervals using the point transect, line transect, and mark-resighting survey methods. I conducted four surveys at approximately one-month intervals using the roost survey method. I compared the population estimates to each other and to three known population parameters: the minimum population, nesting population, and number of fledging chicks. I monitored 61 artificial nest boxes that had been placed throughout the study area as part of a long-term behavioral study of the green-rumped parrotlet (Beissinger and Bucher 1992). These boxes and natural nests were monitored daily throughout the field season and these data were used to determine the total nesting population and the number of nestlings fledged during each survey period. I arrived at a minimum population size for each of the 11 survey periods from the number of nesting parrotlets and the number of non-breeding banded parrotlets that were identified during each survey period.

I conducted point transect and line transect surveys following the methodology of Buckland, *et al.* (1993). A grid consisting of eight points spaced 300 m apart was randomly placed over the study area (Fig. 1). Each of the eight points were surveyed for 10 minutes between 0730 and 1100. I repeated the process three times during each of 11 discrete surveys. Four line transects were mapped by connecting the points. I surveyed four transects between 0730 and 1100 repeating the process three times during each of the 11 surveys. I estimated populations from the point and line transect survey data using the *Distance* software (Laake, *et al.* 1994).

Parrotlets have been banded at this study site since 1988 with each parrotlet receiving a unique color combination and identification number. I used the mark-resighting methodology of Arnason, *et al.* (1991) for a closed population with an unknown number of marked individuals to estimate the population. The marked population was unknown because of band loss and mortality of birds banded in previous years. Mark-resighting surveys were limited to five days during each of the 11 discrete

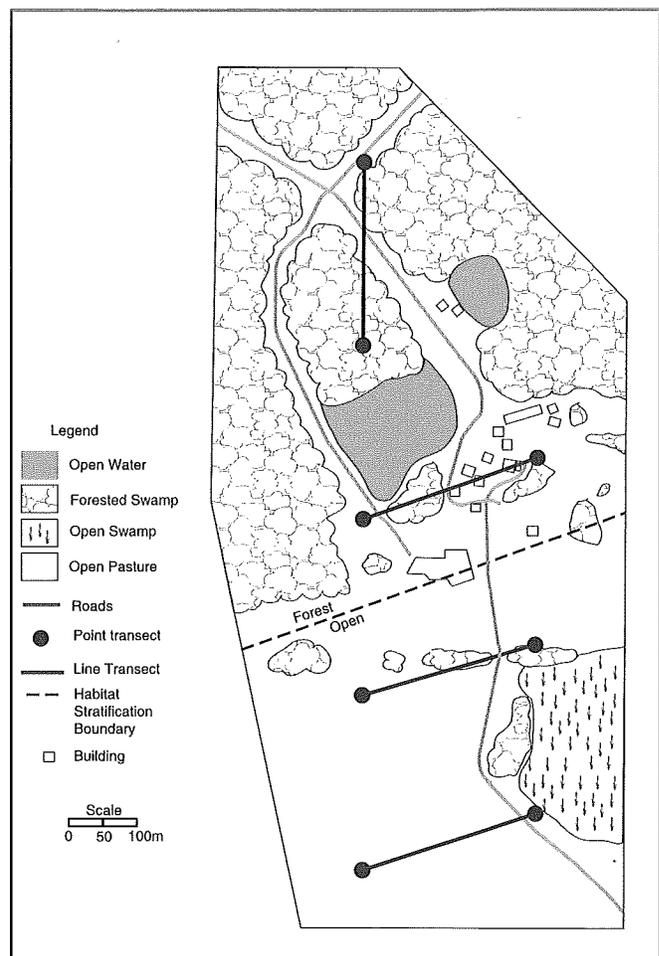


Figure 1. Map of the 49-ha study area located on Hato Masaguaral in the state of Guárico, Venezuela. The study area is stratified as forested and open habitat.

survey periods to ensure the population was closed.

I conducted four discrete roost surveys with the help of assistants. We searched for roosts beginning one hour before sunset. Each surveyor recorded the location of the roosts. These data were used to compute the average number of roosts (\bar{r}) during the survey period. The following morning two surveyors counted the parrotlets as they left one of the roosts. These data were used to estimate an average roost size (\bar{s}) during the survey period. I estimated population size for the study area by the

Table 1. Wilcoxon signed rank tests for significance of difference between population estimates for the Green-rumped parrotlet produced by three widely used survey methods.

Survey Methods	Z	p
Point transect survey - line transect survey	1.25	0.213
Point transect survey - mark resighting survey	1.07	0.286
Line transect survey - mark resighting survey	1.69	0.091

Table 2. Spearman ranked correlations between population estimates for the Green-rumped parrotlet produced by three widely used survey methods and the nesting population.

Survey Method	r	df	p
Point transect survey	0.467	10	>0.10
Line transect survey	0.169	10	>0.50
Mark resighting survey	0.187	10	>0.50

equation:

$$N_r = r \cdot s$$

where N_r = population estimate. The variance of the population estimate was computed by the equation

$$\text{var}(N_r) = \text{var}(r \cdot s)$$

and was used to compute 95%-confidence intervals.

RESULTS AND DISCUSSION

I tested for differences between the point transect, line transect, and mark-resighting population estimates using the Wilcoxon signed ranks test (Zar 1974) and found no significant difference ($\alpha = 0.05$) between population estimates (Table 1). The confidence intervals of the four methods overlapped during each survey. With the exception of the roost survey beginning 3 September, all of the population estimates exceeded the minimum population. Population estimates from all methods except the roost survey method appear to reflect peaks in fledging (Figure 2).

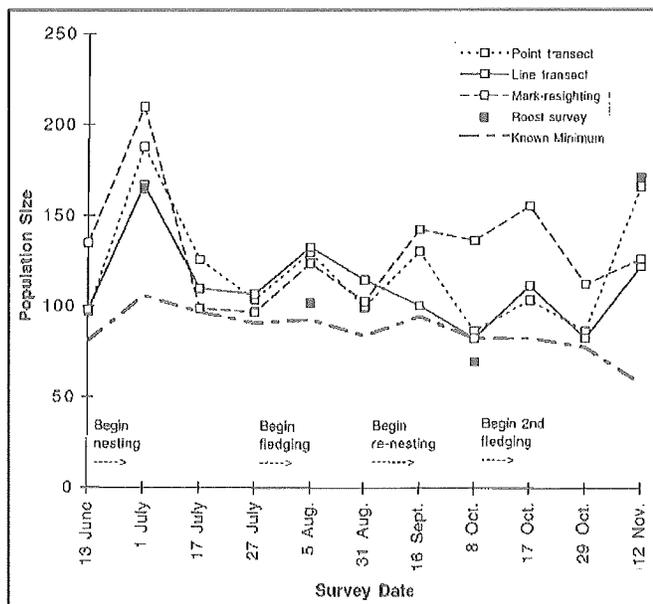


Figure 2. Survey population estimates, known minimum population, and breeding history of the Green-rumped parrotlet for the 49-ha study area during the 1994 breeding season.

The results suggest that as the breeding season progresses population estimation becomes more problematic. Population estimates produced by the point transect, line transect, and mark-resighting methods were not correlated with nesting populations ($\alpha = 0.05$, Table 2). Conformity among all four methods was greater during the first half of the breeding season than after nestlings began to fledge and parents began second nesting attempts during August (Figure 2). The roost survey estimates were lowest during the breeding season and the estimate for the roost survey beginning 3 September was below the minimum population. This is probably because many parrotlets did not roost communally while brooding. Confidence intervals for the roost survey estimates were greatest during peak breeding season due to higher variability in roost size and number of roosts per night.

Although population estimates from the point transect surveys are similar to estimates from the other methods and exceed the minimum population, three point transect population estimates for the open habitat were lower than the nesting population in the open habitat during those survey periods. It is possible that nesting parrotlets were moving from the open habitat to the forested habitat to feed during the times of survey. However, this is unlikely since most feeding occurred in large flocks in the open habitat. Many parrotlets identified in these flocks during resighting surveys were individuals known to be nesting in the forested habitat. Therefore, it is more likely that parrotlets moved from the forested habitat to the open habitat to feed. None of the line transect estimates were below the nesting populations. These results suggest that the point transect method produced underestimates of population in the open habitat and overestimates in the forested habitat while the line transect estimates more accurately reflected the actual distribution of parrotlets between habitats.

A paired two-sample t-test (Zar 1974) of detection probabilities indicated that the likelihood of detecting a parrotlet was significantly greater for the line transect surveys than the point transect surveys in both the forested ($t = 9.18$, $df = 10$, $p < 0.001$) and open habitats ($t = 5.33$, $df = 10$, $p < 0.001$). Furthermore, the probability of detecting a parrotlet was more variable for the point transect method in both the open ($CV = 29\%$) and forested habitat ($CV = 53\%$) than for the line transect method ($CV = 20\%$ and 18% , respectively). These results indicate that the line transect survey method was more precise than the point transect method.

The mark-resighting survey method resulted in the largest confidence intervals of the four methods and required the greatest amount of time. A computer simulation experiment by Arnason, *et al.* (1991) indicated that acceptable precision requires the total number of sightings to exceed the true population. The total number of sightings I was able to acquire during each survey was never greater than or equal to the known minimum population during each survey. This low number of observations resulted in lower precision and large confidence intervals.

CONCLUSIONS

The results of this study suggest that it is more accurate to survey parrots during the non-breeding season, especially if the

roost survey method is used. The great amount of labor needed to obtain acceptable confidence intervals for the mark-resighting method renders it less applicable than the other three methods. Although the line transect method performed better than the point transect method, line transects are logistically inferior for parrots with large home ranges in difficult terrain. In those cases where the point transect method must be used, effort should be allocated equally between habitat types regardless of differences in the use of habitats for nesting. Roost surveys may be preferable for parrots with large home ranges if applied during the non-breeding season when roosts are more concentrated (Chapman *et al.* 1989).

ACKNOWLEDGMENTS

Funding for this research was provided by TRI, the National Science Foundation, and the Center for the Study of Tropical Birds. Scott Stoleson, Bret Elder, and Donna Gayer assisted with roost surveys, and Dr. Steven Beissinger provided invaluable support and guidance.

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AN ETHNOBOTANICAL SURVEY OF INSECT REPELLENTS IN BRAZIL

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INTRODUCTION

Malaria is still a major public health problem in Brazil. The use of DDT has successfully eradicated or controlled the mosquito-borne disease in some parts of Brazil; but, today it remains problematic in the Amazon where colonization occurs at a rapid pace (Sawyer and Sawyer 1988).

In an effort to explore alternative methods of malaria control, this research takes an ethnobotanical approach in search of plant materials that may serve as natural insect repellents to protect against infection of mosquito-borne disease. Given the great plant diversity in Brazil (Salomão 1988), chemical complexity (Schultes and Raffauf 1994) of tropical flora, and widespread use of that flora for medicinal and domestic purposes (e.g., Boom 1989, Brito and Brito 1993), it seems likely that there exist plants that can serve as viable insect repellents.

The literature on natural insect repellents proves very sparse. Pal, *et al.* (1989) report a few plants in a brief review of ethno-insecticides, while some general ethnobotanical surveys include insect repellents (Schultes and Raffauf 1994; Hirschmann and Arias 1990; Corrêa 1926). Several authors (Vallejo and Yépez 1994; Sawyer 1994; AAAS 1991) discuss the importance of developing alternatives to the DDT mosquito control.

METHODS AND SITE DESCRIPTION

My research was carried out in Brazil from June through August 1995 in conjunction with a CEDEPLAR¹ household



survey in Machadinho d'Oeste, a rural settlement in Rondônia, Brazil. Rondônia lies in the extreme west of the country, between 8° and 13.5° S latitude and 60° and 67° W longitude. Machadinho is located in the northeast of the state in the municipality of Ariquemes. Situated at the southern edge of the Amazon basin, this region is characterized by a wet tropical climate with a mean

Table 1. Plants used as mosquito repellent by category as mentioned in the text.

Common Name	Latin Name	Repellent Use	Reference	Use Category
Hortelã-do-campo	<i>Hyptis</i> sp. and <i>Menta</i> sp.	rub leaf on skin, burn leaves		I, II
	<i>Hesperozygis ringen</i> , <i>H. rhoddon</i>	extract	Toffoli, et al. 1991	II
Artemisa	<i>Chrysanthemum parthenium</i>	burn powder from flower		II
Citronella	<i>Cymbopogon nardus</i> (Poaceae)	extract		II
Geranium	<i>Geranium</i> sp. (Geranaceae)	rub on body		II
Lemongrass	<i>Cymbopogon citratus</i> (Poaceae)	infusion		II
Neem	<i>Azadirachta indica</i> (Meliaceae)	extract		II
Urucum	<i>Bixa orellana</i> (Bixaceae)	paint extract from aril on skin	Corrêa, 1926	II
Alfazema	<i>Lavandula</i> sp. (Lamiaceae)	extract of essential oil on skin, clothes		II, III
Erva Santa Maria	<i>Chenopodium ambrosioides</i>	bathe in infusion, plant near house		II, III
Alecrim	<i>Baccharis dracunculifolia</i>	sweep house with leaves	Hirschmann, 1990	III
Alfafa	<i>Medicago sativa</i> (Papilionaceae)	plant near house	Guerra, 1985	III
Castor	<i>Ricinus communis</i> (Euphorbiaceae)	plant near house		III
Clove	<i>Syzygium aromaticum</i> (Myrtaceae)	ground clove by head of bed		III
Garlic	<i>Allium</i> sp.	hang clove around neck		III
Orange	<i>Citrus</i> sp. (Rutaceae)	hang peel in window		III
Pau-amargo	<i>Quassi amara</i> (Simarubaceae)	bark in water repels mosquitos	Guerra, 1985	III
Eucalyptus	<i>Eucalyptus</i> sp. (Myrtaceae)			III
	<i>Hedeoma pulegioides</i> (Lamiaceae)	plant near the house	Guerra, 1985	III
Tobacco	<i>Tabacum nicotiniana</i> (Solanaceae)	extract		II

annual temperature of 25° C, greater than 2,000 mm annual rainfall with a short pronounced dry season from May through August. On Rondônia's poor agricultural soils the principle vegetation of the region is a sparse heterogeneous tropical forest with some very tall trees (<50 m) in a matrix of medium trees (25–30 m).

Three different research methods were used to gather information:

a) I searched the literature on public health, malaria, traditional medicines, and Brazilian flora in various libraries in the cities of São Paulo, Rio de Janeiro, and Cuiabá.

b) I reviewed the CEDEPLAR 1995 household questionnaire, "Malaria and Land Use," in Project Machadinho, which contained several questions relating to insect control.

c) I conducted interviews with a random selection of local people in Machadinho, scientists in academic and research institutions, plant vendors in markets, and people on the streets. Interviews for this report focused on the presence of bothersome insects, techniques and products used to kill or repel them, and the preparation and use of natural products.

RESULTS AND DISCUSSION

Residents of Machadinho provided little information on insect repellent plants, since they rarely use them. Of 27 interviews, almost all reported no personal use of insect repellents. Two male respondents said they sometimes apply a commercial chemical repellent to their clothes and skin when they go on fishing trips to the River Machadinho. When questioned about what the most bothersome insects are, the majority of respondents ranked the cockroach and *borrachudo*, a black fly, higher than the mosquito. None reported that the mosquito is problematic, even with knowledge of the malarial threat from mosquito bites.

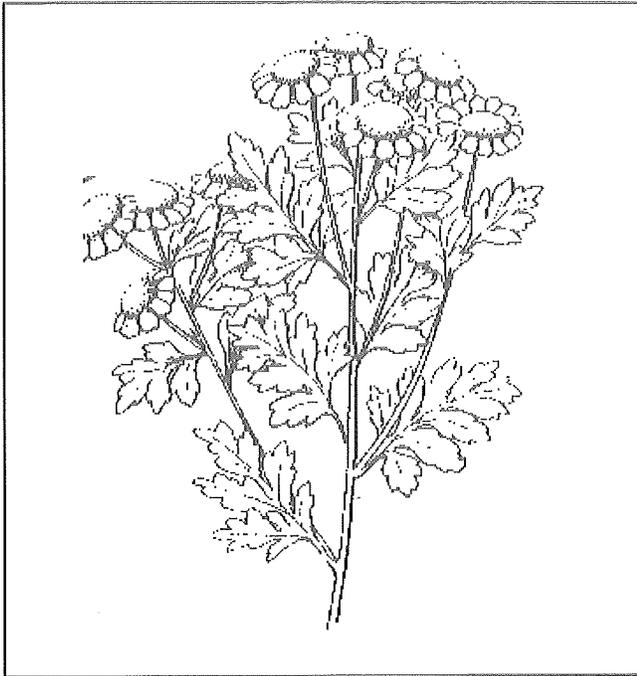
Despite the rarity of actual repellent use, the people I interviewed did respond with suggestions and anecdotes about

repellent techniques. Suggested natural products fall into three use categories. I) A plant or non-plant material is burned to produce smoke; II) a plant or its extract is used directly on the clothes or skin; and III) the live or dead presence of a plant serves to deter mosquitoes. Commercial products from natural substances are discussed as well. The plants in categories II and III are listed in Table 1.

The production of smoke to drive away mosquitoes is an age-old technique used in ancient Europe and Asia (Busvine 1966) and probably qualifies as the longest-standing method. Response from a subset (462) of the 1300+ questionnaires to the CEDEPLAR question, "Do you burn anything to frighten mosquitoes?" revealed that 26% customarily burn something, although only 6% reported that they had burned something the day before the interview. This discrepancy may be due to seasonal differences in the presence of insects or simply a lack of use. On the other hand, there were zero "yes" responses to the question, "Do you have any plant that frightens mosquitoes?" Based on the results of the survey and my interviews it seems that burning is the most common repellent method.

The CEDEPLAR survey and my interviews revealed that a variety of items are burned, including termite nests from trees, dried cow dung, trash, and dried plants, the latter being least mentioned. The two most commonly reported plant materials that are burned are the husk of the palm fruit of *Obygnia phallerata* (*babassu* or *babaçu* from the Aracaceae family), and *hortelã*, the common name of some species in the genera *Hyptis* or *Ocimum* in the Lamiaceae, or mint family. Respondents attributed the repellent effect of the latter plants to their strong aroma.

Commercial natural mosquito repellents contain volatile oils from *Eucalyptus* spp. (Myrtaceae) and *Cymbopogon nardus* (Poaceae, citronella). Both of these plants were mentioned in interviews and are used as "folk repellents." The most widespread natural compound used in insect repellents for centuries



is pyrethrum, extracted from *Tanacetum cinerariifolium* and *Chrysanthemum cinerariaefolium* (Asteraceae). Synthetic substitutes for pyrethrum are commonly used in commercial repellents.

CONCLUSION

Based on the interviews, there seems to be little custom in Machadinho of using repellents, of either natural or synthetic origin, to reduce human-insect contact. Respondents report that the hot climate makes it impractical to wear protective clothing or to apply repellent to the skin. Financial constraints, fear of intoxication, short duration of the repellent, and lack of mosquitoes are additional reasons why repellents find little use. The efficacy of the plants reported here as insect repellents is largely unknown. The category of plants that deter mosquitoes by their very presence represents an interesting potential for mosquito control, not only in and around the house, but also in cultivated areas, as their use requires little effort to process.

There is presently no compendium of ethnobotanical information on insect repellent plants of Brazil. There are many possibilities for natural repellents, only a few of which are reported here. The custom or convenience of use is not strong in Rondônia, but may be elsewhere in Brazil. Information should be systematically gathered from other regions of Brazil to complete the list of alternatives. These natural methods offer viable ways to reduce the chances of contracting malaria and other insect-borne diseases. With some focused development and education about natural products, perhaps their use can be increased.

ACKNOWLEDGMENTS

This project was supported by a grant from the Rockefeller Foundation in conjunction with the Land Use and Health in the Amazon project. In-country support was given by Donald Sawyer, president of the Institute of Society, Population, and Nature in Brazil. I would like to thank Dr. Florencia Montagnini, my advisor, and the many people in Brazil who helped facilitate this research.

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PARK-PEOPLE INTERFACE IN PARSA WILDLIFE RESERVE, NEPAL

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INTRODUCTION

Like most countries, Nepal has passed conservation laws, established institutions, and created protected areas to tackle issues of biodiversity loss. Since the passage of its first conservation act and creation of its first national park in 1973, Nepal has placed 14% of its geographical area under protected area status as of 1994. The creation of protected areas has helped slow down biodiversity loss (Mishra 1982, Basnet 1992, Mehta 1992) but also has alienated local people by denying them their traditional rights to use natural resources while forcing them to bear the cost of wildlife depreddations (Sharma 1990, Heinen 1993). Since the mid-1980s, the government has increasingly incorporated human dimensions into its biodiversity conservation philosophy to ameliorate park-people conflicts and ensure sustainable use of natural resources. This study was designed to determine the extent of park-people interface in Parsa Wildlife Reserve (PWR), Nepal and find out if the new "people-oriented" conservation policy has influenced the reserve management in any way.

Study Area

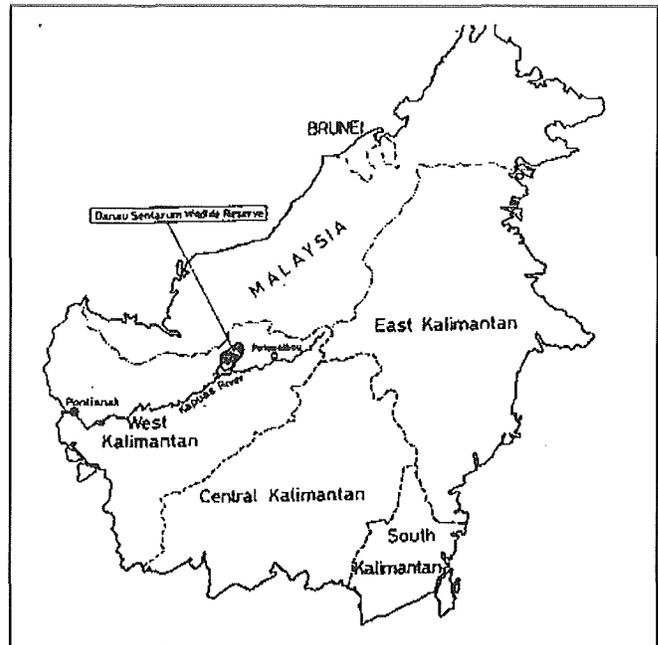
The PWR, established in 1984, is located in the subtropical zone of the central Terai (Himalayan foothills) of Nepal (Figure 1). It covers 500 km² adjoining Royal Chitwan National Park (RCNP, 932 km²). The reserve is famous for its resident populations of Indian elephant (*Elephas maximus*) and was initially established to expand the habitat for large mammals residing in the RCNP and to buffer against encroaching agricultural expansion. People living in villages, either inside or on the periphery of the reserve's boundary, depend on forest resources for firewood, grazing, timber, and minor forest products.

METHODS

The PWR was chosen as a case study for two reasons. First, there has been very little study done on any aspect of reserve management. Second, it represents a typical protected area currently administered by the government wildlife organization, Department of National Parks and Wildlife Conservation

(DNPWC). The study was conducted during summer, 1995.

Data come from various sources. Twenty randomly selected reserve staff (54% of total staff) and 100 randomly selected households from four villages (two inside the reserve and two on the boundary) were administered formal surveys along with informal interviews with individuals and groups. Four high ranking officials in the DNPWC Headquarters were interviewed to find out the department's conservation mandate regarding the management of protected areas. In addition, published and unpublished documents were reviewed.



RESULTS AND DISCUSSION

The results of this study show that, by and large, the PWR still relies on a traditional management approach regardless of the rhetoric of "people-oriented" policy at the national level. There are currently 29 game scouts (78% of the total reserve staff) who daily patrol the reserve in their respective jurisdictions. Of 12 protected areas administered by the DNPWC, all but two have deployed the army to enforce laws; the PWR has seven army posts with 246 total personnel. The existence of the armed forces shows that strict law enforcement still holds an important place in the management philosophy of the reserve.

Incidents of local people caught while illegally grazing or collecting forest products are still prevalent. A sub-

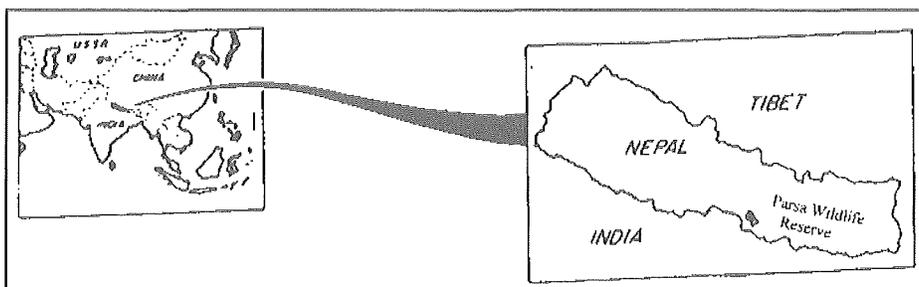


Figure 2. Location of the Parsa Wildlife Reserve

stantial number of people (38%) admitted having been fined by reserve authorities. Of these, 79% said they were fined for grazing cattle inside the reserve. By contrast, only 5% were fined for extracting forest products from the reserve. Apparently, people are more desperate about grazing their cattle than about collecting forest products. This can be attributed to the fact that most local people are subsistence farmers and cattle play an important role in their survival by providing traction for tillage and manure. Prior to the reserve's establishment, local people had been grazing their cattle in the reserve area. Since there is a shortage of grazing lands outside the reserve, people do not have any option but take the risk of grazing inside reserve boundaries.

Conversely, depredations of domestic crops and animals by wild reserve animals present a big problem. The majority of respondents (75%) said they face wildlife predation problems. When asked about the kinds of predations, 72% said their crops are raided or trampled (mainly by *Elephas maximus*, *Sus scrofa*, and *Axis axis*) and livestock killed or injured by wild animals such as *Panthera tigris*, *P. pardus*, and *Canis aureus*. Twenty-four percent said they lost their crops to wild animals while three percent reported human injury. People receive no compensation for their losses.

From the staff's perspective, poaching of animals and timber by outsiders appears to be the main conservation problem. Reserve staff indicate they do not get full cooperation from local people in their efforts to stop poaching. This can be understood in light of the above results: local people have lost traditional rights to use reserve resources and suffer from wildlife loss, but receive no compensation. They do not have any stake in conservation and thus, are less likely to cooperate.

An amendment to the conservation act in 1994 has sought management of buffer zones in which local people are granted rights to use forest products on a regular basis (HMG 1994). However, regulations regarding buffer zone management have yet to be formalized. A three-year UNDP-sponsored "Parks and People Project" was implemented in 1994 in the PWR with the mandate of co-management. The project has chosen two neighboring villages as models to implement its programs. However, it is too early to detect any impact.

Prior to implementation of the "Park and People Project," there was no effort on the part of PWR management to involve people actively in management of natural resources, except for an annual meeting with local leaders. Regarding this annual event, the chairman of a VDC remarked, "... (these) meetings are a mere formality to show the outside world that the management does seek input of the local people ... we do not get anything out of these (meetings)."

The majority of respondents (69%) said reserve officials do not ask what their needs are. Seventy-two percent had never been involved in reserve management in any position, whereas 50% did not even know if someone else in their village had any involvement. Sixty-five percent of respondents had no knowledge of rules and regulations of the reserve. When asked if they would like to become involved in reserve management, 75% maintained they would. The data show how poor the outreach program of the PWR management has been.

Among people who have had any interaction with reserve

officials, 54% said they liked them while 17% did not. Respondents expressing dislike of reserve officials tended to be the ones who were fined ($i^2=12.57$; $df=1$; $p<.001$). The majority of fines (58%) occurred in a particular village ($i^2=35.75$; $df=3$; $p<.0001$) located inside the reserve and people living in this village were found to dislike management more than in any other villages inside or outside ($i^2=18.03$; $df=3$; $p<.001$). Discussions with people of this village revealed that they have had altercations with army personnel in the past for the latter's strict law enforcement and poor behavior. This situation points to the importance of public relations training when army staff are to be posted in protected areas.

CONCLUSION

The results indicate that the degree of park-people conflict in the reserve is high as evidenced by the number of fines, lack of cooperation and dissatisfaction on part of local people, and severity of wildlife loss. The national "people-oriented" conservation policy has yet to be incorporated into local management. For example, people are not actively involved in decision-making processes; they still have no legal access to reserve resources; they are not given compensation for wildlife losses even though the majority suffer from it; and they have not been provided with any alternative means of livelihood.

In addition, the PWR has neither employed local people nor carried out any economic development programs except for the recent "Park and People Project," which is still in its developmental stage. Two major inconsistencies of reserve management also stand out: its poor outreach program and excessive reliance on army protection. In the long run, however, the buffer zone management approach and the undertaking of "Park and People Project" may provide solutions to some of the above issues and may obviate the need to keep armies in the reserve.

ACKNOWLEDGMENTS

This study was made financially possible by grants from the G. Evelyn Hutchinson Prize and the Tropical Resource Institute. I wish to thank Professors S. Kellert and W. Burch for their assistance and guidance. I thank the Department of National Parks and Wildlife Conservation, Nepal for allowing me to conduct this study in the Parsa Wildlife Reserve (PWR). I am indebted to all respondents for allowing me to interview them.

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AN ATTITUDINAL SURVEY OF RESIDENT PERCEPTIONS OF CONSERVATION AT FIVE BLUES LAKE NATIONAL PARK, BELIZE

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INTRODUCTION

Belize has the lowest population of any Central American country, with approximately 200,000 inhabitants (Mallan 1993). Events in densely populated and deforested neighboring Central American countries, however, have increased immigration to peaceful and relatively pristine Belize. In particular, the Hummingbird Valley in central Belize, with its citrus industry, attracts many immigrants. Five Blues Lake National Park (Five Blues), located in this region of Belize, was established in 1991 and comprises more than 1600 hectares (Figure 1). The park headquarters is located in St. Margaret's Village (St. Margaret's), the nearest population center to Five Blues. The village center is approximately seven kilometers by dirt road from the park entrance.

I surveyed residents of St. Margaret's in order (1) to gauge the attitudes of local residents toward the park and its current and proposed programs; (2) to identify ways to prevent future land-use conflicts or pressures on park resources; and (3) to determine what environmental education and other community needs can be served by the park. In the past, local communities have often been left out of the planning and development of parks, especially in developing countries (McNeely and Pitt 1985, Wells and Brandon 1992). It is extremely important to involve local communities to help guarantee park protection and success (Groom *et al.* 1991). Based on survey results, I offer policy recommendations for the park.

SITE DESCRIPTION

Five Blues Lake National Park, with its five-hectare multi-hued namesake lake, exemplifies conservation resulting from community initiative to protect local natural resources. The Board of Directors (Board) of the Association of Friends of Five Blues (Association) advises operations and project planning for Five Blues. The Board, created through community efforts, consists of 10 members representing several ethnic groups including Garifuna, Creole, Maya, and Chinese, from both St. Margaret's and Belize conservation organizations. The Association has more than 100 members, many of whom are residents of St. Margaret's. Two park wardens -- residents of St. Margaret's and supervised by a park manager chosen by the Board -- conduct daily park operations. The village and park are accessed by a dirt road off the Hummingbird Highway, a main east-west route. Initial park infrastructure, such as a visitor center and trails, has been constructed. The visitor center is a small open thatched structure which contains basic educational exhibits and the

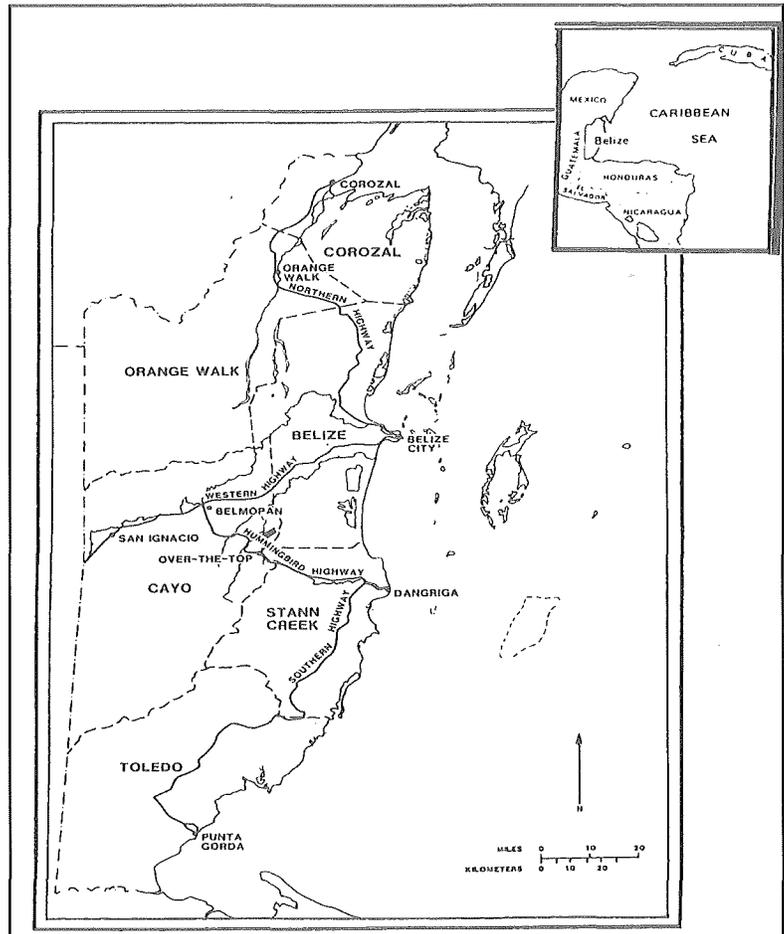


Figure 1. Five Blues Lake National Park, Central Belize

visitor registration book. A bed and breakfast association and a craft cooperative have been established in St. Margaret's, both of which receive revenue principally from tourists.

Special features of the park include its seasonal deciduous forest on limestone soils and semi-evergreen forest over alluvial soils (Furley and Newey 1979). The karst topography of the region is characterized by limestone caves, some of which contain Mayan artifacts. The park shelters more than 200 species of birds, including toucans, parrots, curassow, and tinamou. Several threatened and endangered species of wildlife live in the park, including ocelot, jaguar, howler monkeys, and Baird's tapir.

Increased pressures on the park and land use conflicts are difficulties that park staff will likely face in the near future. The population of the Five Blues area is growing rapidly, and recent immigration to the region from other Central American countries has increased land use pressures on the park. In 1980, St.

Margaret's had a population of 60 which grew to 360 in 1985, and now exceeds 600 (Day 1989, Gerlitz 1994). Although the official language of Belize is English, many residents of St. Margaret's speak other languages, primarily Spanish. Large citrus plantations located near the park draw laborers to the area. Limestone is quarried outside the park boundaries for agricultural use. The limestone kilns use large quantities of firewood which, along with demands for cooking, strain forests surrounding the park.

Illegal hunting by locals and collecting of artifacts by tourists have been problems in the park. The two unarmed wardens of Five Blues are restricted by a lack of supplies and the large area they must patrol.

Visitor activities at the park include swimming, boating, and hiking. Fishing is prohibited. There is currently no entrance fee for Five Blues, since the Belize government allows only those parks with approved management plans to charge fees. The Five Blues Lake National Park management plan has been submitted to the Government of Belize and awaits approval. Currently, to generate income, the park sells maps of the Five Blues trail system for US \$2.50.

METHODS

Seventy-nine interviews were conducted between June and August 1995 with the aid of Wendy Maldonado, the Peace Corps Volunteer at St. Margaret's, who provided Spanish translation. Since not every resident was literate, I conducted the survey verbally and recorded responses. Interviews ranged from 20 to 60 minutes. The questionnaire was initially pretested with a segment of the total village population to ensure that it addressed appropriate issues and minimized bias (Babbie 1990).

One adult (age 14 or over) each from 79 of the 120 homes in St. Margaret's was questioned. A balanced gender representation was attempted by alternating male and female interviewees. I tried to survey subjects alone to minimize influence from other family members (Deming 1960). Interviewees were encouraged to give honest responses, even if they were opposed to the park or conservation.

The attitudinal survey consisted of binomial (yes/no), categorical, and continuous (scaled) questions. The t-test was used to show differences between populations. The information gathered was analyzed using MINITAB (Ryan and Joiner 1994) and incorporated into suggested courses of action for the park, with respect to education, policy choices, ecotourism, and income generation.

RESULTS

Forty-five female and 34 male residents of St. Margaret's were interviewed. Of those surveyed, 77% spoke Spanish and 23% spoke English as their primary language. Figure 2 presents the percentage breakdown of respondents by country of origin. The mean number of years of residence in St. Margaret's is 7 (SD=4.7). The mean number of years of education of those surveyed is 4 (SD=4.2), and the median is 4. The mean number of residents per home in St. Margaret's is 5 (SD=3.0).

Members of the Association of Friends of Five Blues (27% of those surveyed) had visited the park significantly more than non-members ($t=5.99, p<0.00$). Ninety-five percent of the members, compared with only 57% of the non-members, had visited

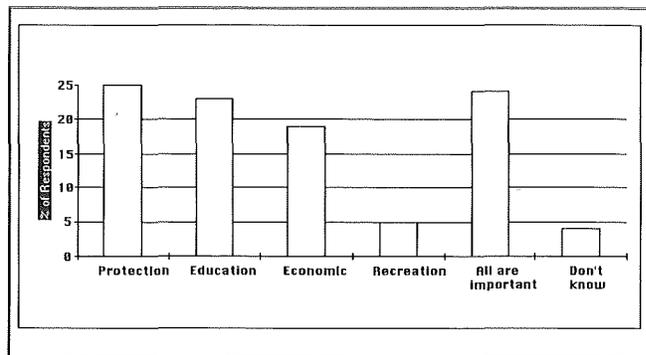
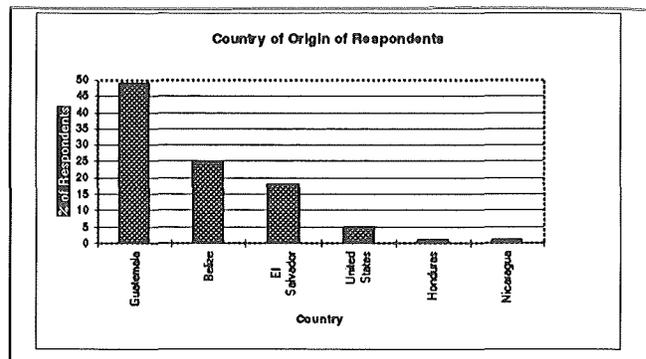


Figure 2, above. Respondents' country of origin. Figure 3. Potential park benefits.

the park. A higher percentage of surveyed males (91%) than females (56%) had visited the park ($t=1.83, p<0.07$).

There were numerous responses to the open-ended question, "Why is it important to conserve the natural resources of Five Blues?" such as "for our children/the future," "for visitors," "for the animals," "because it is beautiful," and "the plants and animals will be destroyed if not protected." In a later question, respondents were asked to prioritize four potential benefits of the park (Figure 3).

Many different suggestions were made in response to the question about potential park improvements. Table 1 presents an overview of the responses. Forty-four of the 79 survey subjects made at least one suggestion, and 26 respondents (33%) made more than one suggestion. When asked about ecotourism at Five Blues, 77% of respondents believed it is beneficial to the community, and 56% said they could personally benefit from tourism based on the park.

DISCUSSION AND RECOMMENDATIONS

The demography, ethnicity, and attitudes of residents of St. Margaret's provide insight into potential courses of action for management of Five Blues Lake National Park. The majority of residents of St. Margaret's are originally from Central American countries other than Belize. Since these residents are Spanish-speaking, it is important to offer park education programs in both Spanish and English.

Since members of the Association of Friends of Five Blues were more likely to have visited the park, publicity programs should be aimed at increasing membership and encouraging non-members to visit the park. Currently, there is minimal park publicity and village outreach. Further, females visit the park less

Suggested Park Improvements	Number of Responses
Beautification projects	20
Structural or economic amenities	18
More or improved activities	9
More protection	9
Provide transportation to park	7
Charge entrance fees	1

Table 1. Suggested Park Improvements

than males, and programs to encourage their visitation should be initiated. One possible activity suggested by four female respondents and one male respondent was to plant flowers at the park. A related initiative that might attract female visitors is to develop an interpretive trail based on orchids or medicinal plants. Eighty-seven percent of survey respondents stated they would use an interpretive trail.

In order to encourage local visitation to the park, family-oriented programs and facilities such as a shaded picnic table and overnight facilities should be developed. Currently, no lodging is available in the park, camping is prohibited, and wardens close the park at 4 pm. Five percent of respondents recommended that camping in the park be allowed. This would mean that special arrangements would have to be made to ensure both the safety of campers and of the natural and cultural resources of the park. A warden would have to be stationed overnight, a recommendation made by several respondents. A possible compromise would be for an adjacent landowner to provide space and facilities (latrines, water, cooking areas) for camping near the park. As an alternative to camping, 6% of respondents stated the need for cabanas (guest houses) or hotels. The construction of a hotel or guest facilities in the park is contradictory to the basic goals of preserving the natural area stated in the park's management plan, but again, an enterprising nearby landowner could take the initiative to provide guest services.

Another suggestion, made by 11% of respondents, was to allow vendors in the park. Although currently prohibited, allowing vendors may be a viable option with a permitting system to control volume of vendors and maintenance of a limited selling area to minimize potential environmental impacts such as littering and decreased aesthetic appeal. A permitting system whereby vendors pay for a designated space near the visitor center could work. Wardens would oversee the operations, and vendors would remove any trash resulting from their sales. A portion of profits would be used for park programs.

Currently, there is no public transportation to the park. Visitors traveling by bus along the Hummingbird Highway must walk seven kilometers to the park. People with private vehicles or bicycles use them to access the park. Many respondents cited the need for reliable transportation to Five Blues. One respondent made the suggestion that a horse-drawn cart could be available at the main road to take visitors to the park. As

transportation to the park becomes easier, visitation rates and visitor impacts should be monitored to ensure the protection of the park's natural resources.

Working with local residents will ensure that park program development is appropriate to local issues and needs and may help avoid future conflicts over use of park resources (Groom *et al.* 1991). By determining the value local residents place on protecting the park, potential conflicts over use of park resources may be avoided. Generally, the majority of respondents regarded both the park and ecotourism favorably. This is promising for the future of Five Blues and conservation activities in central Belize.

ACKNOWLEDGMENTS

This project would not have been possible without the help of several people and organizations. I thank the Tropical Resources Institute and Robert Horwich of Community Conservation Consultants/Howlers Forever for their financial support. In addition, I am indebted to Wendy Maldonado for her constant help and energy throughout my study. Finally, I thank the members of the Board of Directors of Five Blues and the people of St. Margaret's for welcoming me into their village and homes.

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RECONCILING WILDLIFE CONSERVATION AND LOCAL PERCEPTIONS OF A PARAGUAYAN FOREST RESERVE

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INTRODUCTION

"Since the reserve was created, there are many more jaguars (*Panthera onca*) coming into our farms to steal our pigs and chickens." As I listened to a farmer who had settled in northeastern Paraguay 30 years ago, long before a protected area existed in the region, I wondered whether the conservation organizations responsible for the creation of the Mbaracayú Forest Reserve had ever anticipated such a problem. This farmer's concerns, while certainly valid, could be interpreted as a sign of success from the perspective of wildlife conservation. Park guards who periodically catch groups of poachers in the reserve, however, find it difficult to share this optimism.

Despite indisputable evidence that poachers still frequent the reserve, according to a Mbaracayú Forest Reserve Guard, there is a great deal of disgruntlement among reserve neighbors over the prohibition of hunting in the Mbaracayú Reserve. Hunters claim that game constitutes an important food source for local communities; they have been joined in complaints against the reserve's existence by groups dissatisfied with the community development efforts of conservation organizations. In light of increasing population pressures on the reserve's natural resources (Fundacion Moises Bertoni 1993), waning community support for conservation activities poses an acute threat to the reserve's sustainability. Conservationists have attempted to address this situation through community development activities. However, these efforts have blurred the image of conservation organizations in the eyes of local communities and have raised communities' expectations beyond that which is feasible for conservation organizations to provide. No longer satisfied with agricultural cooperatives whose goals are to promote self-sufficiency and to wean reserve neighbors from the resources they used to extract from the reserve, such as yerba mate (*Ilex paraguayensis*), local leaders have complained that conservation organizations will not pay for landing strips, paved roads, churches, and new schools, said a Ñandurocai resident.

In order to secure community support, conservation organizations need to understand root causes of misunderstandings between conservationists and local people. This requires extensive dialogue between the parties involved, including those living in remote areas farthest from social centers but closest to the resources being degraded. The purpose of my study was to reach these people primarily to survey their knowledge of and attitudes towards the Mbaracayú

Forest Reserve and, secondarily, to get a sense of the extent of current poaching levels within the reserve.

BACKGROUND

Located in the headwaters of the Jejuí mí River, on Paraguay's eastern border with Brazil, the Mbaracayú Forest is the southwestern extension of Brazil's Atlantic Forest. It is the largest tract of undisturbed forest in eastern Paraguay and contains approximately 90% of Paraguay's rare and endangered species (Fundacion Moises Bertoni 1993). Seventy-eight species of mammals have been observed (Hill *et al.* 1996), and over 400 bird species have been recorded in the reserve in the past two years (Madrono and Esquivel 1995). The reserve encompasses 65,000 ha which, after changing hands between numerous absentee landowners, was acquired by the International Finance Corporation of the World Bank as a result of a defaulted loan. In 1992, with the assistance of the Nature Conservancy, the Fundación Moisés Bertoni acquired the tract. During the previous year, the Foundation had successfully lobbied for a protected areas law establishing Mbaracayú as a permanent forest reserve and prohibiting hunting, logging, and resource extraction from national parks and protected areas. An important exception to Law 112/92 was made, however through Article 13. As a concession to land's to which they currently hold title being too small to support their hunting and gathering lifestyle (Kaplan and Kopischke 1992) and to the fact that meat contributes 60% of the calories in their diet (Hill *et al.* 1984), Aché Indians were allowed to hunt within the boundaries of the Mbaracayú Reserve as long as they used traditional weapons only (Fundación Moisés Bertoni 1993).



Children living near Mbaracayú Natural Forest Reserve, Paraguay

That the Aché were allowed to hunt and the Paraguayans were not quickly became a point of contention between conservation entities and local communities. During World Bank years, when the territory was virtually unmanaged, nearby inhabitants had grown accustomed to using the land for hunting and light timber extraction. When, in 1992, local communities were suddenly prohibited from hunting in the reserve while the Aché continued to do so, tensions between the local communities and reserve managers arose, resulting in resentment and frustration. In the last two years, arrests and confiscation of weapons by park guards from those caught poaching in the reserve have exacerbated the tenuous relationship.

METHODS

In order to gather information on poaching activity and local attitudes towards the reserve, I conducted semi-structured interviews with 78 residents of María Auxiliadora, Ñandurocai, 11 de Septiembre, and Tendal, four settlements bordering the reserve. Interviews included questions on agricultural operations, nutrition, demographics, hunting activity (inside and outside the reserve), and personal attitudes toward the reserve (Silva and Strahl 1991). In order to gain greater access to people's homes, a young woman from each community accompanied me to the interviews in her community and introduced me as a North American university student, making it clear that I was not an employee of the conservation organizations operating in the area. Interviewees were chosen at random, and most had small farms (20 ha or less) but lacked title to the land they farmed. Because the communities do not have formal governing bodies, I chose to interview school teachers and store owners as surrogates for local political figures, since they are among the most visible and educated members of the community.

In addition to community members, I interviewed members of Fundación Moisés Bertoni staff as well as agricultural extensionists and park guards hired by the Foundation to work in and around the reserve. I also interviewed two North American anthropologists who work with the Aché and Guaraní indigenous communities located near the reserve and who have been working in the area for more than 20 years; last, I spoke with the leader of the Arroyo Bandera Aché community about relations between conservation officials and the local, non-indigenous Paraguayan communities.

RESULTS

The results of my study indicate that there is indeed significant subsistence hunting and some local market hunting (Redford and Robinson 1991) taking place both inside and outside the reserve. Numerous respondents admitted they had hunted in the reserve when it belonged to the World Bank but denied having done so since the Fundación Moisés Bertoni acquired the land. Of the 78 respondents, 38% did acknowledge that other people from their community or from neighboring communities were hunting in the reserve, while 35% of the interviewees mentioned that it is still possible to buy meat of hunted animals from individuals in the community. Contrary to empirical results obtained in other parts of South America (Redford and Robinson 1991), game sold in the communities surrounding the reserve is at least as expensive if not more

expensive than beef. According to 40% of those interviewed, most hunting is done by small groups of men, at night, on average once per month. The three most frequently hunted animals were deer (*Mazama* spp.), armadillo (*Dasypodidae* spp.), and paca (*Agouti paca*); tapirs (*Tapirus terrestris*) and capybaras (*Hydrochaeris hydrochaeris*) were also mentioned by 23% and 4% of interviewees, respectively.

As expected, the responses to the attitudinal questions were more mixed, as many interviewees took the interview as an opportunity to express their frustration with the reserve and those managing it. When asked what they thought of the reserve, 62% of those interviewed responded that its creation had been a positive change, and 16% said they did not know whether it had been good or bad for the area. Subsequent questions revealed that most of the indifferent respondents knew little or nothing about the reserve and were thus unable to discuss it, while many of those who had initially felt that the creation of the reserve was a good idea, later in the interview expressed very negative opinions of it. These opinions emerged with questions about who benefitted most from the reserve. Forty-three percent of those interviewed felt that the reserve benefitted its employees, foreigners, and people from Paraguay's capital, Asunción, much more than it benefitted local communities. Six respondents also mentioned that the reserve was most valuable to foreigners because they were the ones who owned it and visited it most often. While, in fact, the Foundation owns the reserve, visits from foreigners give local communities the impression that it belongs to North Americans or Europeans.

Three respondents said the reserve had been good for the area because conservation organizations had brought electricity to many homes. When asked what they thought the purpose of the reserve was, 30% said that they did not know, while 13% said that it had no use or that it had been created for foreign visitors. Finally, when asked whether they thought the forest would still exist if the reserve had not been created, the majority of respondents (38%) said yes, explaining that the forest was so large that it was never going to disappear.

DISCUSSION AND CONCLUSION

My interviews revealed that inhabitants of communities surrounding Mbaracayú have numerous misconceptions about the reserve, its purpose, and the mission of conservation organizations operating in the area. Many respondents, while familiar with the reserve's location, fauna, and history, were misinformed about its purpose and objectives. Many of the reserve's neighbors had not gone into the reserve since its creation four years ago and viewed it as a forbidden zone where only foreigners, park guards, and a few privileged locals were allowed to enter. As a result of strict access policies, both Mbaracayú and the Foundation have been enshrouded in a cloud of mystery, rumor, and misinformation. Local communities have come to resent the Foundation for placing limitations on their hunting activities which appear to benefit only wealthy foreigners (Shaw 1991). Such an atmosphere has fostered resentment and ill will among reserve neighbors and will surely lead to further erosion of community support. In order to reverse this trend, conservation organizations will need to devote more resources and effort to environmental education and community outreach programs.

Paraguay has had a long tradition of totalitarian rule whose effects on protected areas management are clearly evident even after the overthrow of General Alfredo Stroessner in 1989. Local populations tend to view hunting prohibitions as another oppressive form of top-down control of the poor by the rich. Absence of a physical buffer zone separating the reserve and its natural resources from adjacent human settlements only aggravates this problem. The abrupt boundary that exists between the reserve and the lands used by local communities for farming and grazing has been the scene of numerous confrontations between the Foundation and reserve neighbors.

Unlike monocultures incapable of sustaining wildlife populations, a buffer zone comprised of small-scale, diverse farms, limited timber harvest zones, and low intensity grazing areas could potentially bear regulated hunting by neighboring communities. Local people might then view the buffer zone and, by extension, the reserve as a protected breeding ground for animals they could profit from, albeit in a regulated fashion (Shaw 1991). Having a stake in the long-term sustainability of animal populations could provide local communities with an incentive to abstain from overhunting and to monitor each other's hunting levels. The opportunity for winning back local support by allowing limiting hunting activity within the reserve's buffer zone would also be politically appealing to the Foundation.

ACKNOWLEDGMENTS

This project was made possible by a grant from the Tropical Resources Institute. I wish to thank the Fundación Moisés Bertoni, Jon Padwe, and Kim Hill for their assistance both in the field and in the preparation of this manuscript.

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ENRICHMENT PLANTING OF CALAMANDER IN SRI LANKA

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INTRODUCTION

Over the past century Sri Lanka's closed-canopy natural forest cover has dropped from around 80% to 24% of total area. In the southwestern quarter of the island known as the wet zone, the island's only rainforests face degradation and deforestation (Forestry Planning Unit 1995). Land clearing for agriculture, particularly for tea and rubber, has reduced wet zone forest cover to roughly 9% of total area. Remaining forests exist in small, fragmented tracts surrounded by human settlement (Gunatilleke and Gunatilleke 1985).

Rainforests of southwest Sri Lanka serve as refugia for flora unique to South and Southeast Asia. Seventy-seven percent of rainforest tree species are endemic to Sri Lanka (Gunatilleke and Gunatilleke 1981) and thus these forests have high conservation value throughout Asia and the island. Lowland rainforests are the most species-diverse forests in Sri Lanka and boast a high percentage of species endemic to the wet zone.

To protect the last vestiges of wet zone forests, the Sri Lankan government has maintained a logging moratorium in the wet zone since 1990. This moratorium has reduced commercial logging, but forests still suffer timber and fuelwood poaching (IUCN 1990). Realizing economic dependency on the forest resource, a recent Forest Sector Master Plan recommends that the wet zone logging ban be lifted to allow low-yield timber management compatible with conservation goals. Enrichment planting is offered as one means of enhancing timber yield within these forests (Forestry Planning Unit 1995).

Enrichment planting increases a species population to levels greater than natural densities, yet well below plantation densities. This process enhances ecological and economic value while maintaining biological and structural integrity in the forest (Schulze *et al.* 1994, Ashton *et al.* 1993). Enrichment planting of high-value timber species may offer a higher return on investment and maximize harvesting revenue under a low-volume timber management regime. In Sri Lankan rainforests, enrichment planting species such as calamander (*Diospyros quaesita*) may restore endangered flora while meeting economic needs of timber extraction.

Long before wet zone forests became threatened, calamander was exploited. This heavy wood has distinct brown stripes throughout the black heartwood and is one of few Sri Lankan ebonies that reaches dimensions suitable for timber (Wright 1904). Presently calamander is a "super-luxury" timber and commands one of the highest prices for saw logs (State Timber Corporation 1993).

In addition to its high economic value, calamander is an optimal candidate for enrichment planting since the species may not recover given its low population and forest fragmentation. Overexploitation compounded calamander's natural rarity within the rainforest. Calamander grows throughout the rainforest at

low population densities in a yet undiscernible pattern. Flowering and fruiting are aseasonal and may occur at random, multi-year intervals. The trees are dioecious, and require an animal pollinator. Unlike many species in this forest, calamander does not grow in clumps, thus increasing the distance across which pollinators must travel (Kostermans 1981, Wright 1904). Forest fragmentation may reduce the likelihood of successful pollination as the distance between forest stands increases.

Calamander exhibits physiological characteristics that may inhibit rapid population recovery. During initial seedling development, the hypocotyl and epicotyledonary leaves often separate from the nutrient-rich cotyledons and endosperm to grow through the rigid testa. Seedlings beneath the canopy have a high mortality rate, since this light-poor environment does not allow adequate photosynthesis for nourishment. The tree may be slow-growing, since slow growth characterizes other species within the genus, but this hypothesis has yet to be tested (Kostermans 1981, Wright 1904).

This study attempts to determine optimal site conditions for growing calamander within the lowland rainforests of southwest Sri Lanka. Silvicultural prescriptions to encourage establishment and growth of calamander will be based on this study. Successful establishment and management of this species within the forest matrix should decrease the likelihood of calamander's extinction and add economic value to the forest.

Regeneration in the Sri Lankan Rainforest

Species of the family Dipterocarpaceae dominate the canopy of this forest type; thus this floristic association is commonly known as the "mixed-dipterocarp rainforest" (Whitmore 1984). While dipterocarps indeed dominate, diversity within the forest nonetheless is extremely high (Gunatilleke and Gunatilleke 1985). Regeneration of this forest type requires canopy gaps to release advance regeneration of canopy species (Holmes 1956). Gap size, frequency, and type play an important role in regeneration composition, vigor, and abundance. In extremely large gaps (one hectare or larger), tree regeneration is poor. Grasses, ferns, and shrubs occupy such sites for indeterminate periods (Gunatilleke and Gunatilleke 1983). Tree regeneration establishes in smaller canopy gap disturbances caused by drought, lightning, or blowdowns (Ashton 1992b). Calamander is believed to be a late successional species that germinates in shade and responds to increased light from medium canopy gaps (Ashton *et al.* 1993).

Forest floor microclimate within gaps can differ greatly from that beneath a closed canopy. For example, diurnal temperature ranges and sunlight are greater in gaps than in the understory. Gaps appear to have lower surface soilwater than adjacent forest understories (Spurr and Barnes 1992). Forest floor microclimate also varies across gap sizes. Larger gaps receive more light with

a higher percentage of direct sunlight than smaller gaps (Ashton 1992a). Within the wet zone rainforests of Sri Lanka, gap size follows an elevational gradient with the largest gaps in valleys and the smallest gaps along ridgetops. This gradient is a function of soil water and soil thickness. In valleys, trees blow down during rainstorms when deep soils become saturated and trees lose their rooting. At ridgetops, tree roots pass through thin soil and attach to bedrock. Ridgetop trees are less susceptible to blowdown, but more susceptible to drought. Trees die standing, leaving small gap as the branches and stem fall through the canopy (Ashton 1992b).

EXPERIMENTAL DESIGN

This study measures the microclimatic conditions of naturally occurring forest gaps and growth of calamander seedlings planted in the center of these gaps. Response of calamander seedlings to different gap conditions should not only provide insight into the species' ecology, but also assist in writing enrichment planting guidelines. Gaps were chosen along mid-slopes and in valleys since calamander has been observed at these elevations and is conspicuously absent from ridgetop floristic associations (Ashton 1994). Gaps ranging from roughly 400 m² to 40 m² represent the various gap sizes found within the forest.

The 400 m² gaps represent multiple blowdowns, gaps of 200 m² represent single treefalls, and gaps of 100 m² or smaller represent individual tree mortality (Ashton 1992a, b).

Stems and crowns surrounding each gap were mapped to make horizontal crown maps and vertical profile diagrams (Figure 1). Structural measurements of height, height to base of crown, crown projection area, and stem location were measured using forest mensuration tools. Light regime characteristics were determined using daily photon photosynthetic flux density sensors positioned 30 cm above each plot center with observations taken throughout one sunny day from 6:00 a.m. to 6:00 p.m. A data logger collected light measurements in micromoles/second/meter² at 10-second intervals and recorded these data as a 10-minute average. These averages are used to determine a daily photon photosynthetic flux density (DPPFD) for each site.

The soils in this region were classified as tropical ultisols (USDA 1975). To provide a comparison of nutrient availability, samples of the top 10 cm of soil were taken from four locations per plot from the understory and gap plots at each site. The measurement of nutrient availability may be used to explain differences in seedling growth, but more likely will only provide general parameters for nutrient availability in soils of the study sites.

Six-month old, container-grown seedlings obtained from the Sri Lanka Forest Department were planted after measuring height from shoot tip to root collar and number of leaves. Twenty-five seedlings were planted in 1-m² plots within forest gaps of varying size and in adjacent forest understory. Seedlings were planted 20 cm apart in a 5-by-5 arrangement. Field technicians at the Sinharaja Field Station took quarterly measurements of seedling shoot growth, leaf number per seedling and mortality. At the end of the first year, seedlings from each plot were randomly selected, dried, and weighed to determine proportional carbon allocation to roots, stems, and leaves. Shoot growth, leaf number per seedling and mortality will continue to be measured quarterly, whereas dry weight will be measured again after two years of growth.

RESULTS AND DISCUSSION

Gap conditions varied with light and soil nutrients (Table). At all sites, understory plots received less light than gap plots. At the smallest gap site, the understory received roughly half as much DPPFD as the gap site. At the largest gap site, the understory plot received roughly 4% as much as the gap site. Light differed across gaps as well.

Seedlings of calamander grown in gap centers showed higher survival than understory seedlings at each site. In both

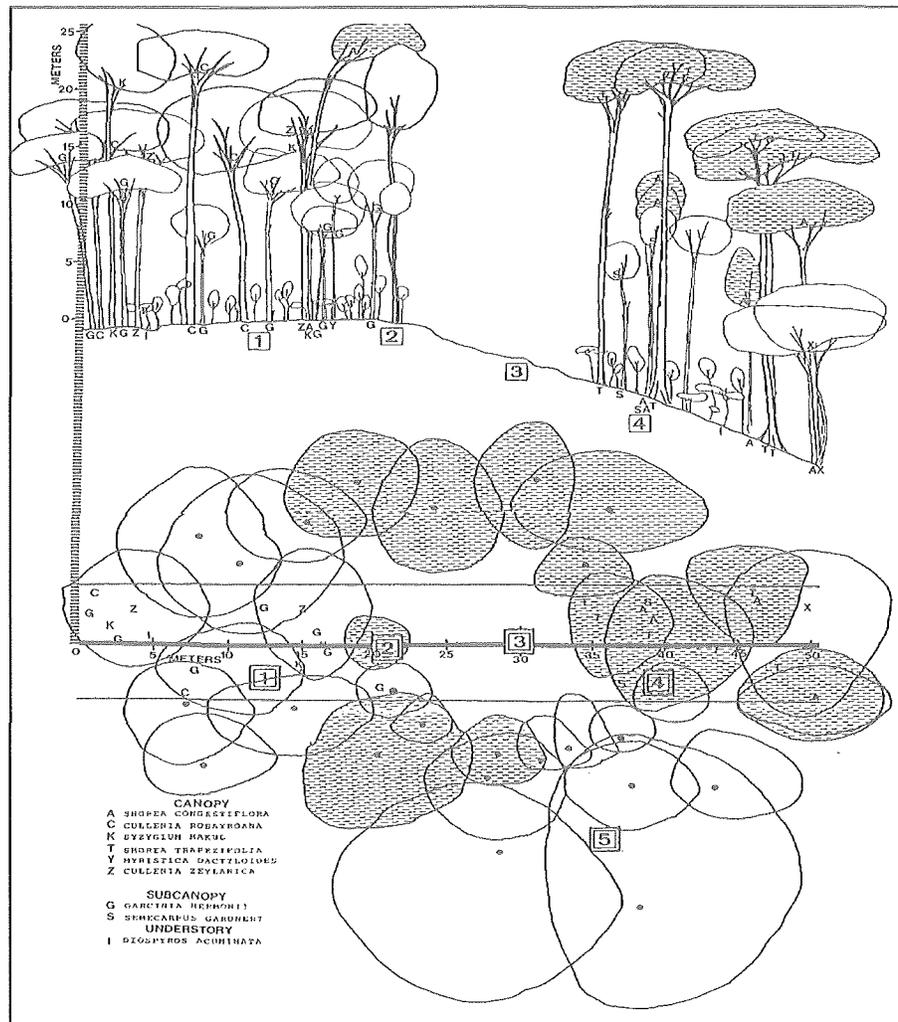


Figure 1: Midslope Gap

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	Gap	Understory	Gap	Understory	Gap	Understory	Gap	Understory	Gap	Understory	Gap	Understory
Daily Photon Photosynthetic Flux Density, mols/m ² /day	1.208	0.223	1.793	0.407	3.413	0.512	3.628	0.146	13.917	0.324	18.732	0.681
pH	4.01	3.91	4.17	3.84	4.09	4.02	4.2	4.01	4.63	4.03	4.73	4.16
Nutrients, ug/g												
Al	148	281	41	126	101	120	45	130	16	170	65	83
K	27	36	18	26	24	30	12	44	15	36	10	43
P	14	13	5	12	9	8	7	12	3	9	7	10
Mg	18	23	21	25	27	36	11	51	24	41	14	41
Ca	47	48	46	48	110	103	35	95	111	147	160	88
Seedling Mortality (%)	16	44	28	44	44	60	16	52	20	36	52	60
Mean Seedling Height in cm (standard deviation)	2.7 (1.8)	1.1 (2.3)	3.4 (1.8)	0.7 (1.2)	4.4 (1.4)	1.6 (2.0)	7.1 (4.7)	1.0 (2.0)	7.6 (6.3)	1.1 (1.4)	3.3 (1.6)	1.5 (1.1)
Mean Change in Leaf Number (standard deviation)	1.0 (2.0)	-1.4 (1.3)	0.8 (3.0)	-1.2 (1.3)	-2.5 (2.9)	-0.6 (0.5)	2.0 (4.1)	1.9 (2.8)	1.9 (2.8)	-1.1 (1.5)	1.0 (4.9)	-0.6 (1.3)
Significant Difference in Growth												
Gap vs. Understory	No		No		No		Yes (p<.001)		Yes (p<.001)		No	
Gap vs. Gap	No		No		No		No		No		No	

gap and understory at sites 1 and 5 seedlings died from herbivory, but the percentage of loss attributed to this factor was not recorded. Lower seedling mortality in gaps comes as little surprise, since seedlings in gap centers are better able to produce carbohydrates necessary for survival and growth. Seedling response to gap conditions is expected from a mature phase canopy tree like calamander.

When grouped across sites, seedlings planted in gaps showed significantly higher growth ($p < .0001$) than seedlings planted beneath the forest understory. However, sites 4 ($p < .001$) and 5 ($p < .01$) were the only sites in which gap seedlings showed significantly higher growth than understory seedlings. Both of these sites are medium gaps, although site 5 receives four times more light than site 4. However, site 3 receives roughly the same DPPFD as site 4, yet the mean growth rate was nearly 3 cm less. It is too early to speculate why two similar sites show such differences in growth. Both sites 4 and 5 showed a significant growth increase shortly before the 12-month measurement. Seedlings in other sites may soon show this initial growth spurt and have two-year growth rates comparable to sites 4 and 5.

The gap seedlings in sites 2 ($p < .01$), 3 ($p < .001$) and 6 ($p < .001$), showed significantly more leaves than the adjacent understory seedlings. None of these sites showed significant height growth compared to the understory plots. Conversely, gap seedlings in sites 4 and 5 did not have significantly more leaves than the adjacent understory. Once again, it is too early to draw meaningful conclusions from one year's data. After two years, dry-weight measurement of root, shoot, and leaves will provide insight into seedling carbon allocation and possible plant stresses affecting seedling growth.

This study will continue for at least one more year, if not

longer, to better understand the establishment of calamander. One year's data provide too little information to accurately suggest optimal site conditions for enrichment planting. However, it is not too early to make procedural recommendations for future studies of seedling establishment. Future studies should record the percentage of seedling mortality due to herbivory. This may provide an estimate of wild seedling loss to herbivory, as well as allow better site comparisons of mortality from seedling stress or nutrient deficiency.

During the planning process, considerable effort should be devoted to finding a wide size range for gap sites. Preliminary light measurements at gap centers would allow gaps to be chosen based not only on size of canopy opening, but also on total or direct sunlight. While other factors contribute to seedling microclimate conditions, better representation of light regimes based on DPPFD may provide a clearer understanding of seedling response to a key gap condition.

CONCLUSION

After one year, this study has begun to show growth differences across gaps for calamander seedlings. Higher growth at intermediate light levels may indicate that calamander establishes best in medium size gaps. Calamander's establishment in intermediate light suggests that the tree may be a part of the mid-slope forest in which gaps tend to be of moderate size. However, it is too early to reach meaningful conclusions. While the information provided thus far may be useful, further monitoring over the next few years will provide a better understanding of optimal conditions for calamander seedling establishment. This methodology seems an appropriate means by which to reach the final goal of enrichment planting guidelines. Enrichment plant-

ing can be a valuable tool by which to restore species or enhance the natural productivity within a forest. In the rainforests of Sri Lanka, enrichment planting may be an effective method for addressing the complex demands placed upon forest resources.

ACKNOWLEDGMENTS

I would like to express gratitude to the following people for assistance with this project: Dr. Mark Ashton of the Yale School of Forestry and Environmental Studies, Drs. C.V.S. Gunatilleke and I.A.U.N. Gunatilleke of the University of Peradeniya, Dr. B.M.P. Singhakumara of the University of Sri Jayewardenepura, the field staff of Sinharaja Research Station and the Forest Department of Sri Lanka.

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SOCIOCULTURAL CONSTRAINTS TO LAND MANAGEMENT DECISIONS: THE CASE OF *BOFEDAL* RESTORATION IN BOLIVIA

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INTRODUCTION

Land rehabilitation and ecosystem restoration have been proposed as a necessary part of sustainable development and biodiversity conservation strategies in the tropics (Janzen 1988, Brown and Lugo 1994). While it is recognized that restoration requires consideration of both ecological and social factors, much of the literature is concerned with the ecological constraints to restoration. However, managing for alternate endpoints in a restoration project requires choosing between management regimes requiring different levels of time, resources, and money, as well as in feasibility within local social, cultural and, political contexts (Brown and Lugo 1994). Socioeconomic

constraints may therefore ultimately define restoration potential, especially in rural areas of the tropics where land use pressure is high, social problems may be intractable, and project funds are limited.

In past decades, a body of theory has developed for grassroots social and cultural approaches to participatory rural development; more recently, the participatory approach has been applied to conservation projects (Western *et al.* 1994, Alpert 1995). The following conservation and development issues have been shown to be important to project success: local participation and empowerment; land tenancy; economic incentives and disincentives; administrative structure and local enforcement of conservation agreements; and short-term vs. long-

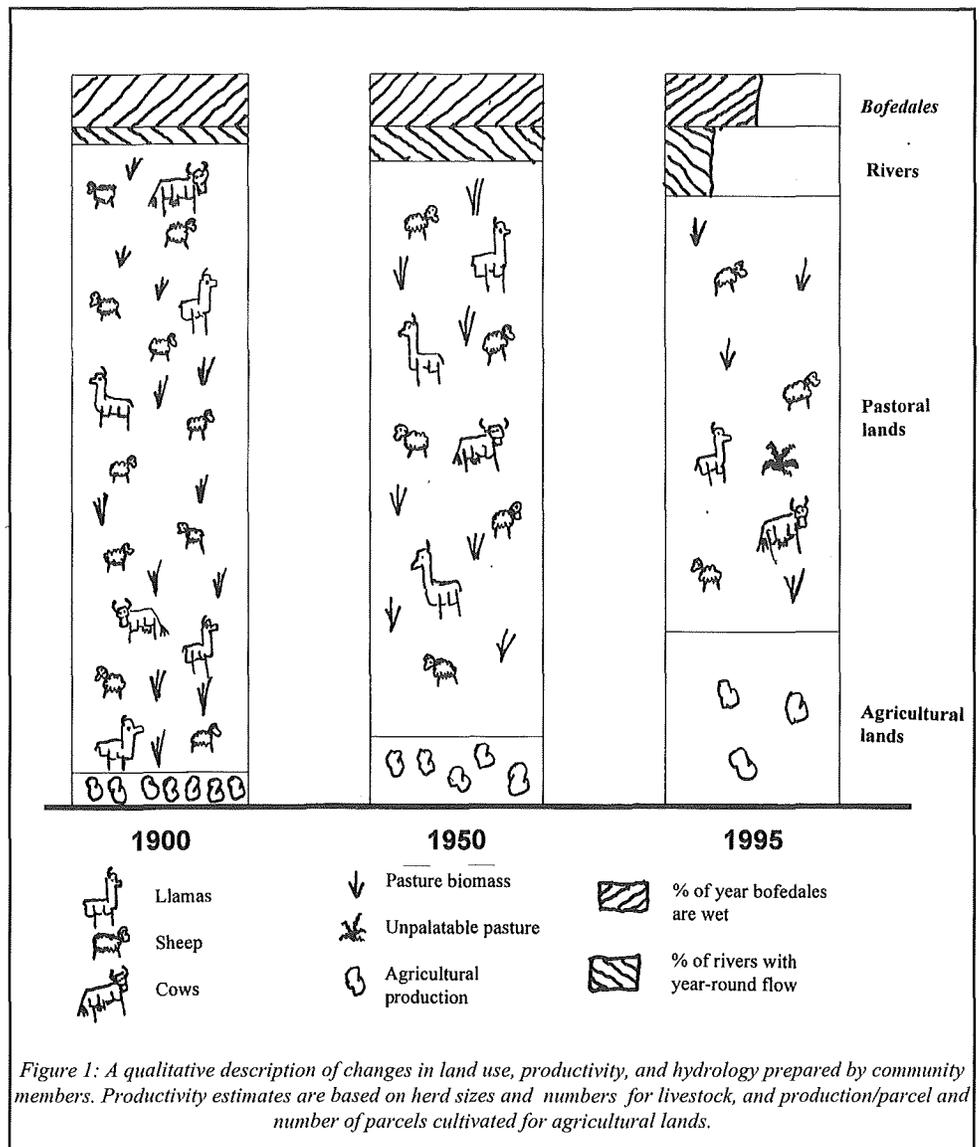
term approaches. Little information is available as to how these factors influence the success of restoration activities (e.g. Karki 1991). This paper uses *Bofedal* restoration in the Puna region of the central Andes to discuss social constraints to restoration efforts. Special attention will be given to the role of local worldviews in shaping land management decisions affecting restoration success.

BACKGROUND

The Puna region of central Bolivia is one of the most densely populated areas of the Andes. Historically high levels of resource use have degraded the Puna ecosystem in several ways, including destruction of *Polylepis* woodlands (Ellenberg 1979, Kessler 1993), soil erosion leading to alterations in hydrologic cycles, and a reduction of the productive capacity of agricultural and pastoral lands (Ruiz and Morales 1992). Land degradation has been a factor in maintaining some of the lowest standards of living in Latin America and causing human migrations to the lowland tropics. In recent years, much of the migration has been to coca-growing (*Erythroxylem coca*) areas such as the Chapare region, leading to environmental and social problems.

Land rehabilitation and ecological restoration strategies are needed to restore agricultural and pastoral productivity, conserve Andean biodiversity, and help stem further migrations. To identify restoration needs and priorities from the local perspective, I undertook a study from June-December of 1995 in the project site of a local non-government organization (Centro de Estudios Ambientales Dorothy Baker CEADB). Located in the Province of Tapacari on the eastern *cordillera* (3,800 m-4,600 m), vegetation is characterized by steppe and scrubland of the dry Puna type, rainfall is less than 500 mm/yr. with an extended dry season, and night frosts are common (Molina and Little 1981).

The region was colonized by Aymara *llameros* roughly 200 years ago. Although their ancestors were seen as benefiting from fertile soils, gentle rains, and abundant crops, local perceptions of resource degradation in the last century indicates a trend of decreasing productivity and alterations in the hydrologic regime (Figure 1). Current evidence of degradation includes gully erosion in up to 20% of the land surface, destruction of agricultural land in the valleys due to ravine formation and destruction of high elevation pasture lands due to expansion of agricultural activity to marginal slopes above 4,300 m. To



address these problems the CEADB began a watershed rehabilitation project in 1993.

I used the family of tools and approaches of Participatory Rural Appraisal (Chambers 1994) for the study. After a literature review and several introductory visits, a five-day workshop was convened in Pasto Grande, with 27 participants from seven central communities, three CEADB personnel, a communications for development specialist, a sociology student, and myself. Resource degradation problems, cultural and socioeconomic factors, and restoration needs were discussed using visual tools such as participant mapping, time lines, trend lines, and analytic diagrams, as well as focus group discussions. The results of the workshop were triangulated through comparison with reports from other NGOs in the region, key informant interviews, and a participant check when the conclusions were discussed with each community. Some issues such as the role of the local worldview in shaping land management decisions, problems due to the long-term nature of restoration, and land tenancy needed further investigation. This was done through interviews with community members and key informants, and community meetings.

RESULTS

A total of four restoration projects, three economic development projects, and a series of community development and environmental education training needs were identified (Table 1). Of the highest priority was erosion control and *bofedal* restoration. *Bofedales* are flat or undulating areas where the water table remains at or below the surface for much of the year, forming intermittent or permanent wetlands. Vegetation is mainly soft-leaved rosettes and graminaceous plants forming a flat cover, as opposed to the wetter *Distichia* bogs that form deep peat layers (Siebert 1994). *Bofedales* are an important community resource as they provide forage and watering holes during the dry season. They are especially important to sheep which cannot graze on the tough bunch grasses and depend on the more tender low-growing grasses and forbs (Pfister *et al.* 1989).

Oral histories and 15 years of observation by the CEADB personnel has indicated a trend of *Bofedal* degradation over the last 40 years: many *bofedales* that were once wet year round are now wet only in the rainy season (four to six months), or have been converted to steppe vegetation characteristic of drier sites. Three causes of this altered hydrology of *bofedales* were identified: 1) increased runoff and erosion and decreased infiltration, leading to decreased recharge during the dry season, 2) an increase in outflow, often caused by the formation of gullies in the *Bofedal* and a breach in natural dikes, and 3) a drought that

Table 1: Project ideas identified in the Participatory Rural Appraisal workshop and number of times each project was chosen as first priority (Projects were classified as 1st, 2nd, or 3rd priority by each community)

<i>Bofedal</i> restoration	4
Erosion control (terracing, cover crops, check dams)	4
Agroforestry for frost protection	2
Small animal husbandry (e.g. <i>cuis</i>)	2
Reforestation (only two communities below treeline)	1
Greenhouses	0
Artisanry workshop	0

has affected the area for the past six years. Prescriptions for *bofedal* restoration include erosion control in the catchment area (terracing, planting cover crops, and check dams in gullies) and restoring slow-seepage outflow within the *bofedal* using dams.

Social impediments to bofedal restoration

The lack of terracing traditional in neighboring areas, lack of cover crops, intensive grazing of fallowed fields, and expansion of agricultural lands to steep, marginal areas above 4,300 m are causes of erosion in the study area. Erosion control and gully rehabilitation, although progressing, have been hindered by two factors. The first is a lack of understanding of why erosion occurs and how to prevent it, and a misunderstanding of the effect of erosion on key hydrologic processes such as *bofedal* recharge and river flow during the dry season. Education is therefore needed.

The second constraint is related to the system of land tenancy. Under the *Ayllu* (local) system, individuals or communities own land and plant in *Ayanokas*, which are intracommunal planting areas found throughout the *Ayllu* territory (Lispergue *et al.* 1989). Thus, land tenancy is individual, communal, and intracommunal. Within the catchment of a *bofedal* are non-*Ayanoka* lands above 4,300 m and *ayanoka* lands below that elevation. A community cannot implement erosion control in the *ayanokas* for fear of entering into conflict with other communities who have rights to parcels; for example, check dams have only been built in the non-*ayanoka* land. Implementing erosion control at the level of the *ayanoka* would require new practices, such as terrace building and planting of cover crops, to be incorporated into the agricultural cycles, implying new administrative roles for the *ayllu*. The possibility of negotiating solutions to some of the land tenancy problems and creating new roles and authority for the *ayllu* generated enthusiasm among community members and is an ongoing process.

A third alternative to *bofedal* restoration was creating lagoons by constructing dams in rock-bottomed gullies. This was largely seen as a quicker solution where most of the costs in terms of materials were borne by CEADB, whereas *bofedal* restoration was seen as more labor intensive. As restoration may require long-term investments in time, resources, and labor for an uncertain return, short-term solutions to resource needs may be far more attractive to local people. In addition, migration is an alternative in this area, and community members with plans to migrate had little enthusiasm to undertake long-term projects in land rehabilitation. Two strategies were discussed. One was to implement complementary projects such as lagoon construction and greenhouses to meet short term resource needs. The second was to make the investment in *bofedal* restoration more manageable to local communities through a long-term commitment to labor-saving activities such as transportation of rock for dams.

Land rehabilitation within the Andean worldview

To better understand the human factors defining restoration decisions, we must understand how processes of land degradation and rehabilitation are perceived within the Andean worldview. Figure 2 shows a simplified model of the Andean worldview made up of three interacting forces, the extra-human (supernatural) society, the human society, and nature (Van den Berg 1990). Each domain has internal relations and cycles as well as relations with other sectors. Harmonious relations within this system leads to equilibrium, the result of which is abundant production and well-being for the human society. Disequilibrium, which occurs when cycles or relations are disrupted, results in decreased production and well-being for the human society.

Figure 3 shows a scenario of land degradation according to the Andean worldview. Disequilibrium can occur with three types of errors. Error 1 implies a misuse of natural resources, either through overuse or through use disharmonious with natural processes. Locals expressed the concern that population levels have risen and that they are using the land too much. Others commented that the younger generation no longer has the wisdom of grandfathers, because they do not "listen to the earth" and understand its indications or complaints, and there-

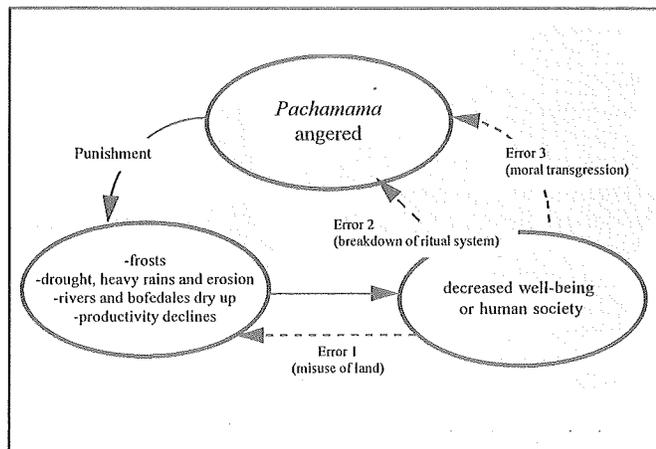
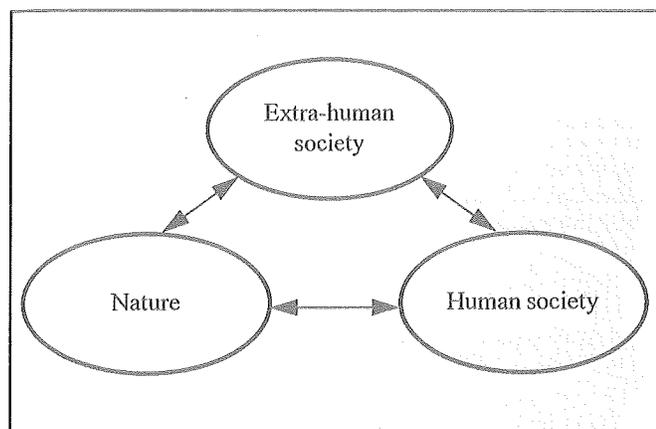


Figure 2 (above): A simplified model of the Andean worldview.

Figure 3: The sources and results of disequilibrium that cause land degradation and decreased well-being within the Andean worldview.

fore do not cultivate with natural rhythms (e.g. they no longer use some traditional weather forecasting techniques). The extra-human society, angered by a disrespectful misuse of resources, punishes them with poor crops, frosts, heavy rains, droughts, and other natural disasters.

Disequilibrium can also be caused by failings in the relationship between the human society and the extra-human society (error 2). Two laws govern life in the Andean worldview, procreation and reciprocity. In compliance with these laws the human society must perform a series of prayers and rites that serve to stimulate the *Pachamama* towards abundant production (procreation) and provide retribution for the use of land (reciprocity). The system of rites has degraded over time, and many are no longer practiced, practiced less frequently, or with the participation of fewer community members. A common lament, especially from the elders, is that all of the *desgracias* (natural tragedies) that have occurred are due to a lack of respect shown by the younger generation that no longer performs rites.

The third source of disequilibrium (error 3) is caused by failings in human relationships. For example, a moral transgression can lead to punishment by the extra-human society. Rules governing society are a mix of Andean cosmology (procreation and reciprocity) and the western concept of sin, and punishment may come from either the *Pachamama* or the Christian God.

In all cases, land degradation is seen as punishment for the actions of human society, and is fully reversible by improving land-use, ritual practices, or human relations, and asking for-

giveness of the extra-human society. However, land rehabilitation was often perceived as requiring changes in ritual practice and human relations rather than changes in land management. It is very common to hear community members blame their degradation problems on errors 2 and 3, only rarely on 1. Inappropriate management practices such as lack of erosion control are not considered misuse of land in this region, as they are "planting the same as [their] grandfathers have always planted." Although conservation practices are mandated within the Andean worldview (e.g. they must respect the carrying capacity of the land and plant within natural rhythms), once these practices are lost and degradation has occurred the local culture has few mechanisms for ecological restoration: they lack both the empirical knowledge and the belief that the human society can rehabilitate the land through earthworks and changes in agricultural and pastoral practices. *Bofedal* restoration through manipulation of hydrologic flows has been met with skepticism, as within their worldview it is the extra-human society that "heals" the *bofedales* and not the domain of human society.

Skepticism about the land management approach to *bofedal* restoration has a synergistic effect with social impediments to erosion control, the high investment in time, labor, and resources required for successful restoration, as well as the possibility of migration being an attractive alternative: if there is an uncertain outcome to restoration efforts due to their belief system, there is less incentive to overcome these constraints. Also, land use prescriptions not understood within the local worldview are met with decreased participation due to lack of understanding of their need. Therefore, for project activities to proceed in this region, restoration management prescriptions will have to be incorporated into local worldview, either empirically through environmental education or through contextualizing restoration ideas within myth and rite systems.

CONCLUSIONS

Restoration is widely seen as an investment that requires consideration of ecological and social factors in complex management regimes. As in the case of the broader field of conservation and rural development, issues at the level of human society and nature such as environmental education needs, land tenancy, long and short-term investments, and potential migration have played a large role in the present study. However, this analysis is incomplete within the Andean world, which is made up of interactions between ecological, social, and additional supernatural elements. This worldview plays a role in defining local views about how degradation and restoration occur, social structures such as land tenancy systems that constrain land management, decisions about whether high long-term investments in restoration are feasible or worthwhile, and what management practices are acceptable and understandable.

In rural societies where traditional worldviews play an important role in shaping land management decisions, a psychological approach to myth analysis (such as in the field of communications for development; Hartman in press) should be combined with the functionalist approach of conceptual models of social ecology (Burch 1995). The psychological approach considers the role of myth and rite in identifying key local

attitudes that may inhibit successful communication between locals and outside professionals. In this case study, different idealizations about the process of land degradation and restoration (Western versus Andean) lead to lack of communication on key issues of project development. Local participation may be diminished due to lack of relevance of project activities to traditional agricultural cycles and rite systems, and thus may not be sustained if future effort does not address this problem. Also, new administrative roles proposed for the *Ayllu* system may have decreased social relevance and influence if not backed up by the myth system.

The role of myth in success of restoration and conservation projects is underexplored. Myth has been recognized as an important factor in rural development (e.g. Freire 1973), although few approaches have analyzed myth explicitly in project planning and the development of educational materials. Further research in this area could improve the success of restoration efforts in the tropics.

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GENDER AND CASTE: INTERSECTING VARIABLES IN FORESTRY

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INTRODUCTION

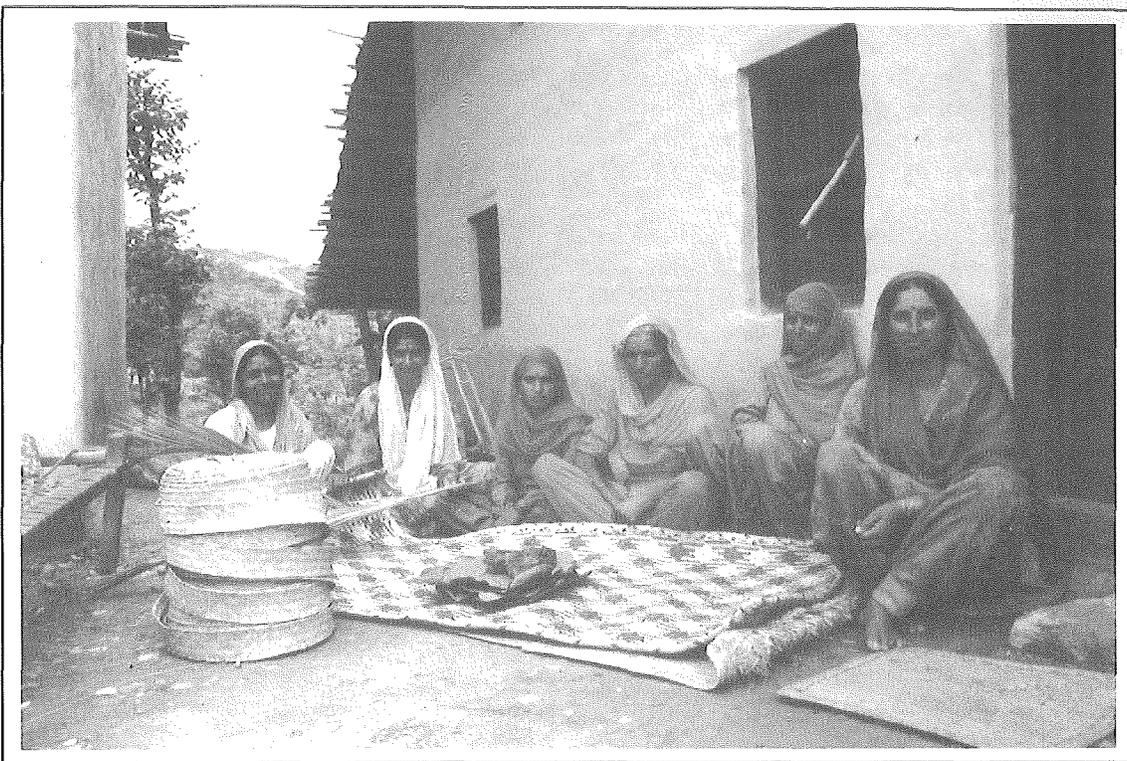
The impacts of forestry projects on women are often assumed rather than measured (Molnar 1991). Women are increasingly being recognized as primary users of forests in developing countries (Acharya and Bennet 1982, Cecelski 1985, FAO and SIDA 1987, Kaur 1988, DeBeer and McDermott 1989, World Bank 1990, Sarin 1990). Division of labor by gender in societies of most developing countries makes women responsible for the collection of fuelwood, fodder, and other non-timber forest products. Today, participation of women in forestry projects is a recognized imperative for forest conservation; understanding the needs of women becomes crucial for its success. However, amidst the euphoric discovery of gender as a variable in forestry, differential access to and use of resources by women of different classes or castes is often ignored.

This paper argues that women of different castes use forests differently, and have differential access to forests and forestry projects. Treating gender as an independent analytical category overlooks these differences and could lead to poor project design, biased species selection in plantations, and in general, failure of the broader participatory objective. This discussion is based on the results of a study conducted in three Himalayan villages in India over the summer of 1995 to understand the differences between women of different castes in access to and use of forests.

STUDY SITE

Himachal Pradesh is a mountainous state in the western Himalayan region of India. Kangra is one of the most densely populated and well forested districts of this state. The study site lies in the lower, drier Changar (unirrigated) region of

Kangra district. A striking characteristic of this region is the absence of young men in the villages. Men migrate to industrial towns in search of jobs, join the military, or find work with contractors extracting pine resin. Women are the permanent village residents. They manage agricultural lands, tend cattle, raise children, and make daily decisions affecting the household. Thus they constitute a principal target group for any forestry or development project.



Women with mats, plates, and cups made from non-timber forest products in Kangra, Himachal Pradesh, India

Caste, a form of hereditary hierarchical system common in Hindu societies, is a significant form of stratification in this region. Villages are generally segregated by caste. The upper castes in Kangra include *Rajputs* (warrior) and *Brahmins* (priest), and the lower castes include *Lohars* (Blacksmiths), *Chamars* (leather workers), and *Kolis* (agricultural laborers). Subsistence agriculture forms the major occupation of women of all castes in this region. An upper-caste village, a lower-caste village, and a mixed-caste village were selected for study.

METHODS

Participatory mapping and other rapid rural appraisal techniques (Khon Kaen 1987) were first used to build rapport with the villagers and also to map households and resources. Socio-economic mapping was particularly useful in identifying family size, and land and cattle distribution in the villages. I triangulated these techniques by walking several transects across the village with different groups of women, and verifying the number of plots used by each household. All women in the villages (30 in the upper-caste village, 25 in the lower-caste village, and 26 in the mixed-caste village) participated in interviews, and in either the transects or mapping process. Women were asked exactly how, and how often, they use nearby forests, how they rank different uses of forests, and what tree species they consider important. They were also asked how many times in the last year they had met any forest department official, in what context, and for what purpose. Interviews were conducted in Hindi and Pahari (a local dialect of Hindi), and the interviews were recorded only when women felt comfortable with the procedure (usually only in group meetings).

The data on land owned by women were collected through

individual interviews, but triangulated through observation of the number of plots of land cultivated by each household. The average data converted to hectares is presented in this paper. Species and use ranking was done with groups of women. The data on collection and use of non-timber forest products reflect women's attitudes, rather than actual use, as collection and use could not be verified throughout the year. During the time I was in these villages, none of the upper-caste women collected any non-timber forest products. They purchased them from lower-caste women and from the local market. Statements of women about the forest department should be taken only as perception since the anecdotes could not be verified with the department.

RESULTS AND DISCUSSION

The data reveal that women of different castes use forests for different reasons and in different ways. Caste and economic status were highly correlated in the villages studied. Agricultural labor was an important source of income for lower-caste women. Upper-caste women did not engage in wage labor and the men in their households usually had permanent, particularly governmental, jobs. The differences in land and cattle owned by women of the same caste was not significant in any of the villages studied. Responses of women in the mixed-caste village were also polarized according to caste. Women of higher castes generally had more land and lived in better and larger houses. "They [women from richer households] can feed their cattle from their land. We don't have enough for ourselves." This statement by a *Koli* woman sums up my first conclusion. The average land holding in the upper-caste village was 4.5 ha, and the cattle to land ratio was less than one per ha. In contrast, average landholding in the lower-caste village was less than 1 ha, and the cattle

to land ratio more than doubled. Land and cattle holding in the mixed caste village varied by caste. The average lower caste land holding was 1.1 ha while that of the upper caste was 4.3 ha. Higher-caste women are able to meet all or most (nine months in a year) of their fodder requirements from agricultural waste. Lower-caste women mentioned having to buy fodder frequently from the local market or from *Rajput* women.

The second aspect surveyed was fuelwood needs. Since upper-caste women had larger tracts of land, they had space to plant trees along the borders of their lands. Lower-caste women had insufficient land even to meet their food needs, and the few trees on their own lands could not meet their fuelwood requirements. They had to buy both staple foods and fuelwood. Over half the *Rajput* houses also had a kerosene stove to supplement a fuelwood stove, while none of the lower-caste households could afford this option. Ninety eight percent of lower-caste women mentioned fuelwood scarcity as a serious problem while this was not a major concern for upper-caste women. Lower-caste women consistently ranked species that provided fuelwood and fodder higher than species that provided only poles or timber. Lower-caste women strongly favored planting fuelwood and fodder trees, compared to upper-caste women who preferred trees for poles and timber, which they could use in house construction or sell.

There is also a distinct caste bias regarding collection of non-timber forest products. Upper-caste women vehemently declared they do not collect "herbs and gums." They consider it a lower-caste pursuit and look down on such activities. "It is only lower-caste women who would climb trees for such things," a *Rajput* woman exclaimed. For lower-caste women, however, it is a minor income supplement. They make articles such as plates, cups, mats, and baskets. Apart from using these articles in the household, they may also make larger quantities for sale on advance demand. Women from upper-caste villages buy these articles from lower-caste women, but demand is seasonal and infrequent. Although lower-caste women expressed a keen interest in developing this craft as a steady and reliable source of income, the price of these products in the villages did not make it a profitable option. A basket made with Rupees (Rs.) 5 worth of bamboo, and at least a whole day's work sold for Rs. 15, while wage labor earns Rs. 20 or more per day.

The Forest Department was viewed by lower-caste women as a source of sporadic household income, although only men from this village had been employed by the Forest Department. Women from the lower-caste village had not met with any Department personnel in the last year and were unaware of any Department programs. Accounts of previous contact with the department were restricted to meeting the forest guard when collecting fuelwood.

Women in the lower-caste village recounted two instances in the past five years when they had encountered a forest guard while they collected fuelwood. They recounted with much excitement how they had seen him approaching, dropped their axes, and ran away. They said they had "escaped" him both times. Women also claimed they were only collecting non-timber forest products, which is not illegal. When asked why they had fled when they were not doing anything illegal, women said they felt the forest guard would arrest them anyway. A few

women did admit to lopping green branches for fuel occasionally, but all vehemently stated they would be blamed for cutting green wood regardless of whether they were actually doing it. They also said that if their axes were confiscated, they would not retrieve them since they cannot afford fines. In individual interviews, all except three women mentioned the same two encounters, but exact details of how many women were present varied.

In contrast, forest officials at the range officer level (intermediate management) had visited the upper-caste village 3 to 10 times both to inform villagers of forest schemes that could benefit them, and to visit friends and relatives in the village. No Forest Department official had visited the mixed-caste village, but the village women of any caste did not express fear or any negative feelings toward the department, although they also occasionally collected fuelwood from the forest.

CONCLUSION

The three villages studied lie close to each other and are administered by the same forest department personnel but have very different uses for the forest and very different perceptions of the forest department depending on caste. Forestry projects that cater to fuelwood and fodder needs are likely to be well received by lower-caste women, while upper-caste women are more interested in income-generating plantations. Perceptions of fear and distrust of the forest department by lower-caste women will also have to be addressed if participation is to be fruitful. Therefore, different strategies are required to meet the needs of women of different castes. Recognizing the intersection between gender and caste as variables that affect forest use is a crucial first step in designing participatory forestry projects. Ensuring involvement of all women, and a more equitable distribution of the benefits of such projects is a much bigger challenge.

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SOCIOLOGICAL DIMENSIONS OF COMMUNITY FORESTRY IN RURAL WESTERN ZIMBABWE

Andrea S. Lee, MFS Candidate

Yale School of Forestry and Environmental Studies

INTRODUCTION

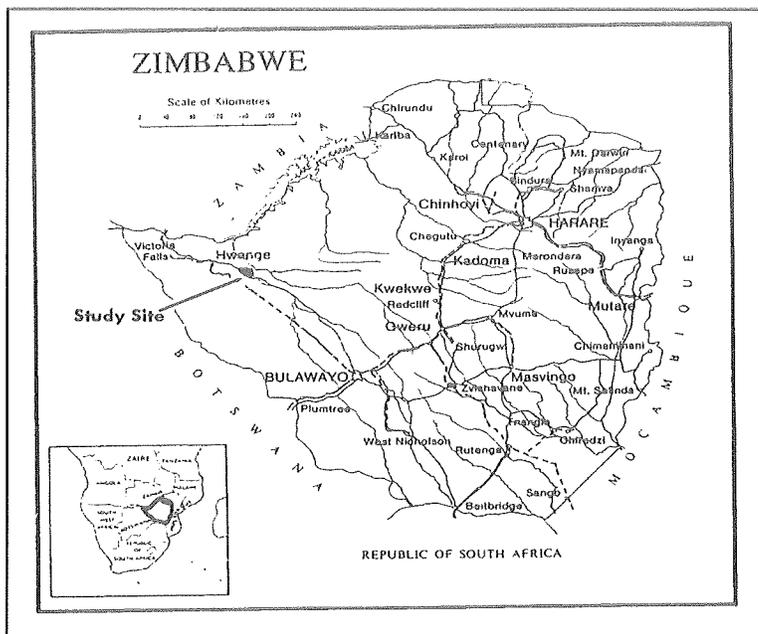
Zimbabwe is afflicted with a variety of ecological and socio-economic problems. The economic hardships local people face compromise the integrity of the natural environment by increasing social demands placed on forest, water, and other natural resources (ENDA *et al.* 1992). Community forestry is one way of resolving localized environmental and economic problems. The *community* element demands that foresters incorporate the roles local people play in the valuation and management of forests (Lee *et al.* 1990) and recognize their need for forest resources. *Forestry*, meanwhile, generates information to build a greater understanding of forest system functions and outputs and promotes management plans for sustainably increasing forest product outputs, helping practitioners to balance ecological and human production limits. A clear understanding of ecological and human problems, however, is essential to developing sensible resolutions.

According to key informants in this study, farmers feel vulnerable to national and international pressures that reduce availability of financial resources (capital investment, subsidies). These constraints affect the ability of local people to afford even the barest necessities. Rural Zimbabweans increasingly find themselves caught between tradition and modernity (Sylvester 1991); bread and butter, cooking oil, tea and coffee, sugar, tennis shoes, radios, and many other non-traditional items require cash. These items add diversity to the rural lifestyle, and have increasingly become part of local socio-economic expectations. Residents are anxious to find answers to the causative economic and environmental problems making their expectations so difficult to fulfill.

This community forestry project is located in rural Western Zimbabwe. Two hundred local people were surveyed to find out more about local needs concerning forest products. I was also able to determine levels of interest in a reforestation-afforestation program. The project also included soil sampling and phytosociological analysis of 45 plots for woody species' health and diversity. A comparison of effects of communal and private land management strategies was also conducted. The sociological aspects of this project will be discussed here.

SITE DESCRIPTION

Gwayi Zimbabwe is 250 km northwest of the nearest city, Bulawayo. Most residents are self-employed farmers or farmer-herders. There exists a major trend among young adults to emigrate to cities to find work paying cash. According to local



sources, most return periodically to visit family, work a plot of land, and participate in traditional rites of passage (marriage, childbirth, death).

The Mabale Communal Area (MCA) consists of two villages with several hamlets in each village, for a total population of approximately 3,500 families. Government statistics for this area were not available, but information about the current population was obtained from the Mabale chief, the local headmen, clinic workers, and the rural district counselor. This information was tabulated with the help of one village headman, and is presented in Table 1. The chart shows demographic distribution by age and gender.

The entire area is about 120 km², and consists of three ecologically distinct geological areas: upland, lowland, and watershed. Most people live on the edges of the forest (upland) or the vlei (lowland). About one-fifth also live along the watershed network. Many families are now clearing land for agriculture along the southwestern edge of the MCA forest. These forest soils are initially more robust than those along the vlei (higher levels of available plant nutrients), but soil fertility lasts only a few years of mixed cropping (traditional agrosilvopastoral system). Due to overall low soil fertility in both forest and vlei areas, people use shifting agriculture.

The lack of forest cover makes the vlei an output-oriented system in decline. Additionally, forested uplands are rapidly eroding, exhibiting soil loss and increasingly rapid rock decomposition. The forfeiture of forest cover from agricultural expansion contributes to this decline in the health of the forest ecosystem. Further study of forest productivity is needed to

confirm these hypotheses. However, reduction in overall agricultural productivity may be an indicator of a declining system's capacity.

METHODS

Sociological information was obtained through a review of recent literature and collection of data from a variety of field informants. Fifty youth, 50 adult females, 50 adult males, and 50 elders were surveyed (mostly in the local language, with the help of a field assistant). Semi-structured interviews were conducted with key informants (Mabale chief, district counselor, and headmen). Informal interviews were also conducted with other key community members (clinic nurses, shop owners). Participation in community-oriented projects helped supplement information possibly missed in the surveys.

Villagers were randomly chosen to be interviewed. Interviewing occurred over six days; each day a different direction was chosen to survey people from a base in the village compound. Varying parts of each day were spent at sites where people congregate. Point destinations included the local shop, grinding mill, bore-hole, and clinic.

PRELIMINARY RESULTS

A major environmental threat to the local forest is habitat fragmentation. These mixed forests, made up of 30 or more species, are known as Miombo Woodland. They are normally a resilient source of fuelwood, medicine, food, timber, and other products for local people, when they are not being used as agricultural lands. According to the chief, there are rules protecting the kind and amount of wood allowed for removal by his people. One study of indigenous forestry practices in Zimbabwe shows that there are traditional rules concerning which and how many trees people can cut (Clarke 1994). Stronger rules and more effective enforcement would better regulate encroachment into native forest.

All adults surveyed were asked if they thought changing management methods would provide more wood to fulfill their needs. Without exception, people said they would like to see a change in the way local forests are managed. Interference levels of a new management style would, however, have to be identified. It is likely that different hamlets will approve varying amounts of interference from Extension Forestry Agritex, agricultural extension workers paid by the government to link

TABLE 1 APPROXIMATE PERCENT OF TOTAL POPULATION BY AGE AND GENDER

Elder (> 50 years)		Adult (marriage to 50)		Youth (unmarried, generally < 16)	
Male	Female	Male	Female	Male	Female
11%	9%	15%	17%	22%	26%

source: anecdotal, n=12,000

TABLE 2 WHERE RESPONDENTS WANT TREES TO BE PLANTED

	Home	River	School	Someplace Else
Youth	34	4	50	24
Adult Male	90	4	6	2
Adult Female	96	2	2	2
Elders	86	6	4	0

(in percent, n=200)

TABLE 3. KINDS OF TREES RESPONDENTS WANT PLANTED

	Gum	Mopane	Wild Medler	Fruit/Food/Fodder
Adult Male	40	22	24	34
Adult Female	58	36	24	64
Youth	0	0.5	0	96

(in percent, n=150)

rural people with current trends in agricultural improvement, and others.

Of the 200 people surveyed, all but one said they would like to see more trees, and that they would be willing to help maintain them with at least half an hour a day labor, such as carrying water, fencing, and pruning. Table 2 shows the locations at which people want trees planted. The variety of places cited illustrates the needs of differing social groups. These differences must be taken into account when actual placement of afforestation project sites are decided. Encouraging stewardship will facilitate successful maintenance of trees; however, individual's limits of time and energy must be recognized and acknowledged in planning and implementing projects.

Most respondents said they want fruit trees (Table 2). The majority of people surveyed also responded that they want gum trees (*Eucalyptus* species). This exotic tree has a straight bole, making it excellent for construction, a low ash content (<1.5%), burns steadily, and is easily cut by hand. Table 3 shows the top four kinds of trees respondents mentioned. Such a clear breakdown by type once again falls into socially defined groups of age and gender. This information also must be integrated into decisions concerning tree species chosen for afforestation.

The primary reasons respondents said they feel trees should be planted are shown in Table 4. People gave a variety of reasons for wanting trees. This data shows the importance of trees in the lives of local people. Many respondents (98% elders, 68% adult females, 86% adult males) said they want trees in part because there are fewer now than in the recent past. This desire may be a result of NGO efforts to educate local people about the deforestation problem occurring locally as well as nationally.

TABLE 4 WHY RESPONDENTS FEEL TREES SHOULD BE PLANTED

	Shade	Fuel	Windbreak	Erosion	Fencing	Fruit/Fodder	Medicine	Carving	Building
Adult Male	32	14	16	12	14	24	0	12	28
Adult Female	40	98	30	56	8	32	0	4	20
Youth	8	82	0	0	56	12	8	22	72
Elders	2	48	2	0	2	2	28	22	76

(in percent n=200)

CONCLUSIONS AND RECOMMENDATIONS

Solutions to some of the most critical socio-economic and ecological crises in this area will come from a two-pronged approach: 1) afforestation of socially determined tree species in locally designated areas and 2) reforestation, with indigenous species of trees, of areas currently being cleared for agricultural use. Resolution of the deforestation problem must include slowing clearing of indigenous forest for agriculture. The Zimbabwean government should support this effort, as it is an investment in the future of the country's natural resources and heritage.

Since many indigenous trees grow slowly, reforestation plans incorporating them must be long-term. Growing multiple-purpose trees, as well as trees catering to specific needs, will be the optimal path for socially and ecologically sustainable growth and maintenance of a productive forest ecosystem (FAO 1990). Prevention of continued soil erosion must occur to keep the current erosion problem from escalating, and to address related ecological problems, such as erosion pit reclamation (NRC 1993).

Forestry projects that measure the effectiveness of reforestation of indigenous species, afforestation of socially preferred species, and erosion prevention exercises are needed. These will help determine the extent of ecological problems and provide invaluable information toward improving similar problems facing communities across the southern African region.

ACKNOWLEDGMENTS

This project was funded by the Tropical Resources Institute and Coca Cola World Fund. Very special thanks to the entire de Vries/du Bois clan; Maa and Paa McLoughlin; the Mabale people, especially the Dingani family; and Tom Siccama, Dan Vogt, and Joel Tilley at Greeley Memorial Laboratory. In the field, Mr. Felix Banda of the Zimbabwe Department of National Parks and Wildlife Management, Mr. Ncube of the Zimbabwe Historical Museum in Bulawayo and Sergeant K. in Gwayi were indispensable for their help in identifying plants. Thanks always to my family for keeping the faith.

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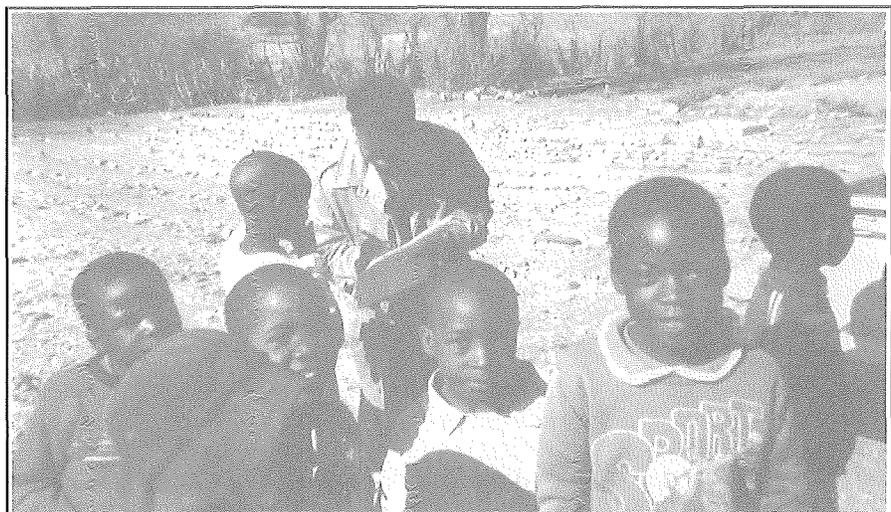
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School teacher helps to survey primary school children

conservation areas -- Holy Hills where hunting, gathering, and tree felling were prohibited -- but also to live in harmony with their forested environment as a whole.

During the 1960s and 1970s, the social and political turmoil of the Cultural Revolution took its toll on the Dai's sacred land. Bo was only a child when his village's temple was sacked in a nationwide campaign to weed out "spiritual pollution" and when Holy Hills that had been preserved for centuries were pillaged. Despite the damage that Holy Hills sustained during the Cultural Revolution, these forests remain a visible part of the landscape in Xishuang-banna today. In the vocabulary of the new economic gospel, Holy Hills are called Scenery Forests.

Scenery Forests are managed by local village foresters, who are appointed by a township forestry station. A forester is paid about \$3.50 a month for his part-time work, which includes, among other duties, protecting Scenery Forests against encroachment. Village foresters, however, have told me that they are noticing a lack of regeneration of certain species. They suspect that this lack of regeneration results from villagers' collection of the trees and branches that fall to the ground naturally. According to the regulations for management of Scenery Forests, villagers may salvage any wood lying on the ground, and so, as trees gradually mature and die, the nutrients stored in the standing biomass of the rain forests are removed from the ecosystem. This nutrient loss is probably hindering the growth of new trees.

NEW ECONOMIC GOSPEL

Followers of the new economic gospel seem to worship rubber, rather than old, sacred tree species, such as fig. Rubber and two thousand Mandarin-speaking Chinese sent from distant inland provinces to Xishuangbanna to run a massive state-owned rubber tree farm brought the greatest changes to the region. In the 1950s, these Chinese came across the country to set up rubber tree farms covering tens of thousands of acres in order to produce the latex that Beijing's economic planners deemed necessary to build a modern country. Conversion of rain forest to rubber tree plantations brought about rapid declines in the area covered by natural flora, which dropped from nearly 70 percent in 1950 to only 20 percent in 1980. Even the Chinese state-run newspaper the *People's Daily* has warned that this loss of natural forests has led to potentially disastrous soil erosion and floods, and has also nearly extinguished valuable, rare plants.

Through the late 1970s, latex production was confined to state-owned plantations by China's rigid economic system. But



The landscape displays rice paddies and upland rice cultivation in the foreground and old growth rainforests in the background

in the 1980s when Deng Xiaoping proclaimed his new economic gospel -- "To get rich is glorious!" -- the entrepreneurial spirit of the Dai people was unleashed. Villagers quickly learned techniques for growing and tapping rubber trees from their new Chinese neighbors, who acted as missionaries of the new economic gospel. Dai people are now planting rubber on any available tract of land as they day dream of buying watches, color television sets, stereos, refrigerators, motorcycles, and their own cars.

The landscape of Bo's typical lowland Dai village, home to almost 450 people and covering 8,000 acres, has been altered dramatically since the introduction of latex and the advent of the new economic gospel. In addition to converting rainforests to rubber plantations, villagers have severely depleted their community's forests in the process of building their dream homes -- spacious, heavy-timbered structures bigger than those of their former feudal lords. Once villagers were prohibited from build-

ing such homes, because they would have been considered an affront to the authority of the Dai lords. Older villagers say they did not even own an iron axe or any other tool that would have enabled them to fell a massive hardwood tree and use it to build a house. Today the inside of some of these new houses are lavish, too. One villager has a red vinyl modular sofa set and wall unit complete with a color television.

As deforestation accelerated in the era of the new economic gospel, the state government began to pay more attention to forest protection and re-designed the reserve management bureaucracy to address the dual goals of preservation and economic development. The laws regarding the administration of the reserves are specifically designed with many loopholes to allow profit-making activities and even to promote local entrepreneurial activities. Moreover, national market reforms and fiscal decentralization have forced local governments and work units, like the Nature Reserve Management Bureau, to become commercially self-sufficient.

The new economic gospel encourages nature reserve managers to ignore villagers' quasi-illegal use of reserve land, because the reserve managers and their work units depend on and profit from local economic development linked to these activities. About one-third of the paddy land that Bo's village has used for decades is located inside the reserve. The reserve management not only recognizes the village's historic claims to the land but also turns a blind eye to the villagers' opening up a little more paddy land every year. Today the paddy land goes a couple of kilometers deeper into the reserve than it ever did. The reserve managers have also permitted villagers to plant corn on



A woman plants a rubber tree

30 meters of land adjacent to their paddies. Moreover, the villagers now spend so much time in the reserve planting rice and harvesting corn that they have built grass huts in the reserve.

In 1989, Bo received permission from reserve managers to build a road into the reserve to give the villagers better access to their rice paddies. The funds to build this road came from the second-to-last timber sale from the village's community forest and the road has had great impact on land use in the reserve. Almost everyday, when villagers ride their tractors home from the reserve they bring with them cloth bags and rattan baskets filled with mushrooms, edible fungus, and wild vegetables.

Some tractors are piled high with timber. The villagers pay reserve managers about \$50 a cubic meter for what are commonly referred to as "windblown" trees — trees that are probably blown over by economic incentive. Reserve managers are permitted to sell trees that fall to the ground naturally for about \$25 per cubic meter and are required to share half of the profits with the local government, the managers directly pocket an extra \$25 for every cubic meter of wood they sell, and thus feel strong incentive to allow villagers to cut both windblown and live trees. All activities promoted by the new economic gospel have severe negative impacts on the reserve's forests.

REMNANTS OF AN OLD SPIRITUAL GOSPEL IN THE NEW ERA

In spite of the tremendous changes ushered in by China's new economic gospel, the Dai have not completely rejected their old spiritual gospel. While they convert their diverse rain forests into uniformly spaced rubber plantations stretching across the land, the monotony is broken by a few large and impressive fig trees still held sacred by the Dai.

One afternoon last summer, as we were sitting in Bo's house and looking out across the village, Bo told me a story about one sacred tree that made me realize how strongly the Dai still cling dearly to some of their old beliefs in sacred animals and plants, even as they strive to modernize. Bo started by recalling the day when, walking through the forest, he saw hanging from a tree a strange human shape. As he walked closer, he could tell what he saw: it was the ghost of his brother-in-law.

Bo's eyes were filled with faith as he told his agonizing story, which began when his brother-in-law wanted to plant rubber trees on a hillside where a majestic fig tree still stood. Many villagers warned him not to cut down the fig tree, but his brother-in-law insisted anyway. He declared that he no longer believed in the spirits of big old trees, but the villagers knew that cutting down a fig tree is like killing a Buddha.

Bo never explained to me how his brother-in-law died, he ended the story shaking his head and sighing as if to say: the moral of the story is never cut down a sacred tree because you will suffer the consequences in the end. Later, as I pondered Bo's story and what it revealed about the immense power that the old spiritual gospel still wields today, I became convinced that the old spiritual gospel offers the Chinese government an opportunity to achieve its goals of preserving the rain forests without hindering economic growth.

The Director of the Xishuangbanna Nature Reserve has already begun to experiment with an efficacious combination of old and new gospel. Even though the cultivation of herbs is prohibited by nature reserve management guidelines, the Director recently made the decision to allow villagers to cultivate a medicinal herb. Cultivation of this herb, which is a highly valued commodity throughout South and Southeast Asia, taps into the power of the new economic gospel by giving villagers real economic incentives to protect the trees in the nature reserve.

Because the herb thrives in the low light of the rain forest's understory, it gives villagers an economic incentive to protect the unique environment created by the old growth trees. Simultaneously, cultivation of this medicinal herb, which is called Chinese cardamon and has been used by both the Chinese and the Dai as a stomach remedy for hundreds of years, taps into the power of the old spiritual gospel. Cultivating Chinese cardamon and other indigenous Dai customs such as protecting Holy Hills and sacred trees provide rays of hope for creating biologically and economically sustainable reserve management plans.

While incorporating the old spiritual gospel into the reserves of the new economic era could improve the success of China's efforts to conserve some of the nation's last remaining rain forests and the unique culture of the Dai, the future of Xishuangbanna is precarious at best. A couple of days before I left Xishuangbanna last summer, a group of Hong Kong businessmen took Bo and several other village leaders out to a banquet to discuss purchasing Bo's village rice paddy land. The businessmen planned to use the land to build a landing pad for helicopters that would bring China's new economic elite directly to the reserve and businessmen assured Bo that helicopters would also bring great commercial opportunities to his village.

Bo stood firm in his refusal to sell the village paddy land, but he agreed to sell the village fuel wood forests. These fuel wood forests have been cultivated by the Dai for centuries as their heat source for cooking. I asked Bo where he and the other villagers would get their cooking fuel once the forests were sold. He answered with his now familiar grin of a clever child that they would go into the nature reserve at night and steal the wood that they needed. And, Bo exclaimed, it would not really be stealing because the reserve's forests had once belonged to villagers anyway.

NEPAL RESEARCH ABSTRACTS

DETERMINATION OF GROWING STOCK OF BANPALE FOREST AND ITS MANAGEMENT PRESCRIPTION

Tanka Acharya and Achyut Gyawali

Banpale forest is that forest within the boundary of the Institute of Forestry, Pokhara. This research intended to obtain information about the growing stock (GS), forest density, species composition, and to provide tentative management prescriptions for the whole forest.

A systematic line plot method of sampling was used. Ten percent of the actual forest area was sampled. Total height and diameter at breast height (dbh) within each sample plot were measured. Regeneration status was studied in 4 m x 4 m quadrants. Four such quadrants within each sample plot were laid and the regeneration count was done by species.

The total GS per hectare is 7.45 m³ with standard error (SE) of 3.90 m³. For *Castanopsis indica*, the GS per hectare is 4.33 m³ with SE of 2.12 m³ and for *Schima wallichii*, is 2.26 m³ with SE of 1.32 m³. Comparison in the similar situation is not available yet.

The results show that regeneration is coming up well through coppicing. Most of the regeneration is below five cm dbh, and the GS is low. Therefore, silvicultural treatments are recommended to increase GS and enhance growth and development of the forest. In some places, thinning is necessary. Most of the mature trees are diseased and should be removed.

As the forest is rich in flora and fauna and close to the Institute, this forest should be converted into a recreation area with research and demonstration plots for students and faculty at the IOF.

Tanka Acharya and Achyut Gyawali were exchange students from Nepal at the School of Forestry and Environmental Studies in 1995.

PEOPLE'S ATTITUDE TOWARDS KHAIRANITAR RESEARCH CENTER, POKHARA, NEPAL

Achyut Gyawali

The Khairanitar Research Center of the Institute of Forestry, lies near to central campus in Pokhara, Nepal. The climate is sub-tropical, dominated by the Scheima-Castanopsis forest type. The soil is very poor due to limestone conglomerates. Farming techniques outside the research center are somewhat advanced thanks to the agriculture farm. Most people in the area are literate and their occupations include agriculture.

The villagers near the research center reap the benefits from the research center, including surface grass, leaf litter, and dead twigs of the planted Sisoo (*Delbergia sisoo*) and Khair (*Acacia catechu*) trees. There are also conflicts, including villagers grazing cattle inside the research center, cutting natural Khair trees along the Seti River, and using research center's land as a cattle path.

Rapid Rural Appraisal (RRA) and various tools of Participatory Appraisal (PRA) were used in this study. Various solutions are proposed to alleviate the growing conflicts in the area. Possible solutions include villager participation in research, provision of job opportunities, distribution of multi-purpose tree seedlings to villagers at subsidized prices, and permanent wall construction along the cattle path inside the research center.

ISTF REPORT

The Yale Chapter of the International Society of Tropical Foresters brought together 250 leaders and future leaders in ecotourism for a conference entitled, "The Ecotourism Equation: Measuring the Impacts," 12-14 April 1996. Through interactive working groups, participants examined ecotourism's socio-economic and ecological impacts, discussed management and planning techniques, and proposed parameters for success.

Ecotourism is still in its early stages of development and suffers from a scattered and unanalyzed mass of information and experiences. This international conference focused on identifying information that currently exists, determining what we can learn from past experience, and what options are available in planning and management.

A list of concluding statements served as an immediate product of the conference.

Conference Proceedings will be published in the *Yale Forestry and Environmental Studies Bulletin Series*.

For more information write:

ISTF Ecotourism Conference

Yale School of Forestry and Environmental Studies

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**THE ECOTOURISM
EQUATION**

BOOKS RECEIVED

Forest Litter Insect Communities: Biology and Chemical Ecology, T.N. Ananthakrishnan, 1995, Science Publishers, Inc. This work synthesizes available knowledge of litter ecosystems in tropical forests, from the viewpoint of the entomological resource sustainability at various levels, laying stress on their biological diversity with emphasis on their functional diversity. Trophic systems in forest litter communities and chemical ecological studies of litter involving primary and secondary metabolites, as well as leaf volatiles now known to play an important role in the structure of litter communities, have been discussed at length. The author is Director of the Entomology Research Institute, Loyola College, Madras, India.

Soil and Water Management Systems, Glenn O. Schwab, Delmar D. Fangmeier, William J. Elliot, 1996, John Wiley & Sons, Inc. This book presents up-to-date information in a simplified form that will be useful to the beginning student. It emphasizes the engineering phases of soil and water conservation in agriculture with the realization that all aspects must be considered, including agronomic, economic, environmental, biological, and others. Vocational agriculture teachers, instructors for continuing education, engineers, county extension directors, contractors, developers, farm managers, farmers, and others who face rural and urban engineering problems may find this information valuable.

Casuarinas, N.S. Subbarao and C. Rodriguez-Barrueco, 1995. Science Publishers, Inc. This book includes all aspects of the

biology, taxonomy, management, cultivation practices, uses and economics of the tree species with major emphasis on microbial associations (*Frankia* and mycorrhizae) that render *Casuarinas* self dependent in nutrient requirements. The book will prove useful to students of agrobiolgy, forestry, and agroforestry besides serving as excellent resource material for research workers. It also serves as a guide to technocrats and administrators whose mission is to grow plants in problem soils.

Tropical Ecosystems: A Synthesis of Tropical Ecology and Conservation, M. Baladrishnan, R. Borgstrom, S. Bie, eds. 1994. Science Publishers, Inc. The major motivation behind this edited volume on tropical ecosystems is overall coverage of subject areas from most of the regions of the developing tropics, so as to serve as a ready reference-cum-advanced textbook in natural resources management and sustainable development in the tropics.

Sun and Small Energy Needs, S.S.R. Prasad, ed., Oxford and IBH Publishing Co. PVT. Ltd. 1995. This book discusses developments in the field of solar photovoltaic technology and their applications particularly in developing countries. It shows how these developments are already on a significant scale improving the quality of life of the people in these countries. Discussions on the economics, social and environmental advantages of solar photovoltaic technology make the book particularly interesting. The author is a member of the faculty at the Center for Energy, Environment and Technology at the College of India, Hyderabad.

COOPERATORS' NOTES

Call for Papers for *Desarrollo Agroforestal y Comunidad Campesina: en Comunidades Rurales del Noroeste Argentino*

For 1996 this Spanish journal would like submissions of 6-7 pages on disk in WordPerfect format. Articles should have a light tone and invite readers to debate the issues. The next edition will be about Management and Use of Native Forests and Peasant/Indigenous Communities. For more information contact Chris van Dam, España 2076, Casilla de Correo 559, (4400) Salta, Argentina. Te/fax (54) 087-311354; email: gtz@ciunsa.edu.ar

Ninth Conference of the International Soil Conservation Organization (ISCO) 26-30 August 1996 in Bonn, Germany

Rapid degradation of soil fertility and non-sustainable land use are a worldwide challenge. The 1996 ISCO Conference will have a practical slant under the motto, "Towards Sustainable Land Use - Promoting Cooperation between People and Institutions." Scientists and representatives of agencies and organizations from all over the world involved in development cooperation and natural resource management are invited to share their experience in their search for answers to this challenge. The conference will look at five topics:

1. Soil conservation and sustainable land use: various responses to erosion and desertification

2. Other forms of soil degradation: assessment, rehabilitation, and prevention

3. Demographic, socio-economic, and cultural factors in sustainable land use

4. Soil conservation and sustainable land use, innovative approaches, technologies, and methods

5. Promoting cooperation between people and institutions

The conference will consist of four main components: plenary sessions with presentation of technical and scientific papers, working groups for in-depth discussions on specific topics, dare-to-share fair with booths and displays to exchange experience, and excursions. There will be a limited number of sponsorships for conference participants from developing countries, Eastern Europe and CIS countries.

For further information contact:

A. Klein; Federal Environmental Agency

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INTERNSHIP PROGRAM EXPANSION

The Tropical Resources Institute (TRI) is currently expanding its Internship Program database in order to increase the number of internship opportunities available to students of the Yale School of Forestry and Environmental Studies.

Each summer approximately 20 students receive funding for internships based upon a faculty committee's review of proposals. Among the requirements for funding is that the student have a collaborator with whom the project will be conducted. Only research-oriented proposals are accepted, and collaborations where a student will be contributing to ongoing projects are highly encouraged.

Proposals are reviewed for funding in January/February of each year by the Tropical Studies Committee; most students therefore establish firm contacts by December for the following summer's work.

The Internship Program is designed to promote research in a broad range of disciplines concerned with the social and ecological aspects of tropical ecosystems. Articles in this journal are the preliminary results of TRI Internship projects.

If you are interested in working with a TRI intern, please detach and complete the form below. Please indicate types of research opportunities which might exist within your organization.

If you have a specific project that might be appropriate for an internship, TRI will advertise this information in the School's internal newsletter so that interested students may contact you for more details.

Please contact the Projects Coordinator, at the address below if you have any questions.

INTERNSHIP PROGRAM, *Expression of Interest*

Contact Name(s)

United States:

Foreign:

Name and address of Institution:

Telephone:

FAX:

e-mail:

Please return this form to:

The Tropical Resources Institute
Yale School of Forestry
& Environmental Studies
205 Prospect Street
New Haven, CT 06511 USA
email: trinews@yale.edu

Description of institution's work, including site description, scope of project, number of years of project operation, and potential for future continuation. Please attach a separate sheet if necessary and enclose any relevant brochures or literature.

Proposed internship project. Please include any preferred qualifications or language requirements.

Provisions (e.g. in-country room/board, air ticket, in-country transportation, etc.) that you/your institution could possibly provide.

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The Tropical Resources Institute sponsors research projects in tropical studies concerning the sustained management, restoration, and conservation of tropical ecosystems. TRINews articles are produced by masters and doctoral students of the Yale School of Forestry and Environmental Studies based on their research. Opinions expressed in these papers represent the views of authors only and not necessarily those of Yale University or TRI.

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