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DEFORESTATION: PAST, PRESENT, AND FUTURE

William R. Bentley, Director

Tropical deforestation continues to attract the attention of the Western press and television. The subject is visual and vivid. Many North American and European environmental organizations have capitalized on this visual appeal by asking for funds and political support. Concerned citizens in developed nations feel they understand the basics, and they will save the tropical forests from greed and destruction.

But do they understand? I am concerned that we have simplified the problems in our mass appeals. Also, I fear most Westerners are ignoring their own historical experience with deforestation.

The problems are not simple. Deforestation is not simply the story of greedy capitalists mining a society's natural heritage. Nor is deforestation the story of poor people destroying the forest to produce subsistence livelihoods. Nor is it incompetent young governments in far away nations. Deforestation is the result of complex forces, most of which are difficult to observe or understand.

Much of northern Europe was deforested as feudal times ended and the industrial revolution began. On the North American frontiers, endless forests spawned a myth of inexhaustibility. After the American Civil War, deforestation of the Northeast, Lake States and South was obvious enough to stimulate the first conservation movement. The demise of the passenger pigeon and near extinction of the plains bison coupled with the indiscriminant timber harvests and forest fires, were grist for an effective political movement. Much like the current environmental movement, early conservationists simplified the causes and appealed to mass constituencies for support.

Some wise leaders, however, recognized that deforestation was a symptom of complex forces in a developing society. Complex problems required complex solutions. And they required insightful leaders who stayed with issues despite the waxing and waning of public interest. Pinchot, Powell, Muir, and many other pioneers created a system of public and private institutions that slowly reversed the course of destruction. The effort continues even today as we renew our debate on how the national forest, national parks, and even industrial and other private forest lands should be managed and what should be the involvement of local people and the general citizenry.

The specifics in tropical nations are not the same, but the broad issues are. Similar social processes and time periods to our own experience are required to resolve specific problems. Most of the leadership and solutions must come from people in tropical nations. Advice from outsiders will be resisted, and western money may do as much harm as good.

Conservation, at its heart, has always been an argument about equity. The obvious argument is between today's generation and future generations. The less obvious arguments are between rich and poor. Who will pay and who will benefit are central questions of conservation policy.

Our planet will be a sustainable system when local people see their advantage in conserving forests and other natural resources. Telling people how to use their resources for our benefit is a futile effort. We rarely listen when others chastise us about our consumption of oil and other non-renewable resources. Yet, helping people structure their rules and institutions to favor environmental conservation is part of development assistance in today's world. Perhaps we can benefit from some sermons.

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RESEARCH PROFILES

LION-HUMAN CONFLICTS IN THE GIR FOREST AND ADJOINING AREAS

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INTRODUCTION

Habitat destruction and intense hunting pressure have decimated most large wild mammal populations in India. Over the past 50 years, concern over these losses has led to the establishment of over 400 protected areas in the country. Increasing wild mammal populations within these areas are testimony to the effectiveness of enforced protection measures. This represents a major achievement, especially considering the growing pressures on natural resources due to a rising human population. However, the majority of these protected areas are small, under 500 square km. Extensive cultivation and an abundance of livestock exist on lands adjoining protected areas and are attractants to herbivores and carnivores. The damage caused by these animal populations is a source of antagonism to the local communities, and an increasing source of worry for the authorities (Project Tiger, 1982; Johnsingh and Panwar, 1989). A good example of such a situation lies in the Gir Wildlife Sanctuary and National Park (also referred to as Gir Forest), *ca.* 1400 square km, in Gujarat, Western India. Gir has the only surviving wild population of the Asiatic lion, *Panthera leo persica*, which consists of approximately 300 animals.

Lion predation on village cattle as well as cattle belonging to a pastoral community within the Gir Forest has been a regular occurrence in the past and continues to be so. An ongoing study indicates that cattle from these two sources contribute up to 35% of lion diet (Chellam, unpublished data). There have also been occasional reports of lion attacks that have injured or killed humans. From 1978 to 1988, 65 humans were injured and eight were killed by lions. Within the two-year period between May 1988 to May 1990, however, there were 81 human injuries and 16 human deaths due to lion attacks, and seven of the bodies were fed upon by lions (Table 1). The escalation in number of incidents over the past few years prompted a study to address the problem. I spent six months (Feb-July 1990) conducting a study for the Wildlife Institute of India during which time I attempted to determine the possible causes for the sudden increase in lion attacks on humans and management solutions to the problem.

METHODS

Interviews with villagers were conducted to reconstruct events over the past two to three years as well as to determine cattle ownership patterns across social strata. Locations of the lion attacks on humans were obtained from the Forest Department and were marked on a map of the area in an attempt to discern any existing spatial pattern. Key issues pertaining to the recent drought and the resultant differential cattle mortality suffered by the well to do and the poor locals surfaced only during data analysis. It was not possible, therefore, to quantify much of this information. Further work is needed to test certain hypotheses.

RESULTS AND DISCUSSION

Lion attacks on humans occur in distinct clumps by area. There is a major concentration of incidents along the southern border, and a smaller cluster to the north (Figure 1). These clumps could be caused, in part, by increased edge effects associated with the two distinct projections of forest into cultivated land, leading to increased lion movement from one area to the other. However, two other factors are likely to have contributed to the southern concentration of incidents.

The forest department has traditionally baited lions, using buffalo calves, to enable tourists to view lions up close. Most such lion shows took place along the southern

TABLE 1. Human injuries and deaths due to lion attacks in and around Gir Forest, India, in the years 1978-79 to 1990-91. (Source: Gujarat State Forest Department).

YEAR (1 Apr -31 Mar)	No. persons injured by lions	No. persons killed by lions	No. persons fed upon by lions
Pre Drought period (including drought)			
78-79	1	1	0
79-80	2	1	0
80-81	8	0	0
81-82	11	2	0
82-83	6	0	0
83-84	4	1	0
84-85	14	3	0
85-86	9	0	0
86-87	4	0	0
87-88	6	0	0
Post drought period			
88-89	38	6	4
89-90	33	7	2
90 (April)	10	3	1
Total	146	24	7

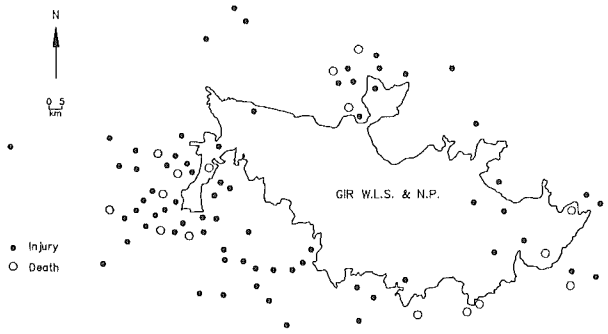


Figure 1. Locations of 70 human injuries and 16 deaths due to lion attacks in and around Gir W. L. S. and N. P. from May 1988 to May 1990 (Gujarat State Forest Department).

boundary of the park, since tourist and administrative facilities are concentrated in a village in southwestern Gir. This appears to have conditioned lion responses to humans, and the wariness towards humans associated with most wild animals appears to have been lost. In eastern Gir, where baiting is not a regular feature, lions will normally withdraw at the approach of humans. In western Gir, on the other hand, lions tolerate human approaches to within 10-15 feet and, on being pressed, will respond aggressively rather than moving away. McBride and Ruth (1988) report an increase in mountain lion attacks on humans due to a similar familiarity with humans. While the tourist show was stopped in 1987, baiting continues since it is the easiest guarantee to providing high level officials with lion sightings.

The second factor contributing to the southern concentration of incidents is the feeding of aging and wounded lions. The forest department is known to provide food to aging and wounded animals. The latter are actually captured, on occasion, to treat wounds. Such assistance from outside the normal system results in the continued survival of animals unable to deal with the normal environment. Such animals may often become cattle lifters, since killing cattle is easier than killing wild ungulates. Lion dependency on cattle as food may ensue, leading to an increased probability of lion-human conflict.

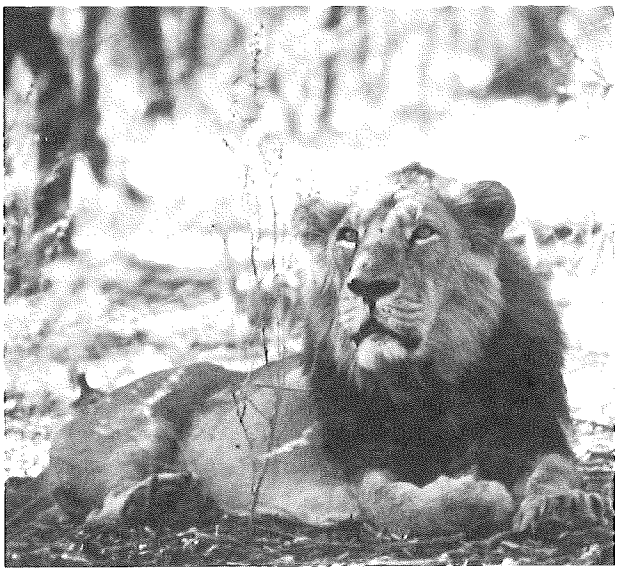
It is suggested that these two factors have led, over time, to the Gir lion population becoming both familiar with humans and, to some extent, dependent on livestock in adjoining villages. However, such conditions existed prior to 1988. It is necessary, then, to establish the factor(s) responsible for triggering the sudden increase in lion attacks on humans.

Interviews with villagers suggested that prior to 1986 the wealthier sections of the village community housed cattle inside cow-sheds, while the poor managed, at best, a thorn enclosure as protection against lion attacks. In addition, poor communities are often segregated and forced to live on the outskirts of the village. This, combined with the inadequate protection provided to the cattle, suggests that maximal cattle losses were suffered by the poor because lion-human interaction is most likely limited to the less densely populated village outskirts.

Interviews with villagers reveal that during a severe drought that affected this part of the country during 1986 and 1987, the poor, unable to buy cattle feed, suffered up to 90% cattle mortality. The drought broke in 1988 and surviving cattle, in the case of the poor, were moved into the house at night in an attempt to provide the maximum protection possible. As a consequence, there was a virtual disappearance of cattle as potential prey for lions. The drop in availability of prey, it is hypothesized, resulted in lions taking more desperate measures to secure prey: moving through more congested parts of the village; jumping 10-12 foot walls to get into compounds that housed cattle; jumping onto roofs; removing tiles and then jumping into a room with cattle. In two extreme cases, lions actually entered houses and carried away and fed on two young children.

MANAGEMENT SUGGESTIONS

Although reports indicate a decrease in incidents over the past 6-7 months, one should bear in mind that the lion population is growing. Gir already supports a lion population density higher than most parts of East Africa (Schaller, 1972; Hanby and Bygott, 1987; Van Orsdol et al., 1985). The events witnessed in 1989 and 1990, triggered in this case by the drought, could well be a precursor to similar events in the future — a consequence of a rising lion population.



A male Asiatic Lion finds comfort under the shade in Gujarat, India.

All forms of baiting and feeding/treating wounded or aging animals need to be banned immediately. In addition, I see a need to initiate a lion culling program at Gir. This would serve two purposes. First, the lion population would be maintained below an identified threshold level, which is essential in reducing the number of lion attacks on humans. Second, a hunted animal population can be expected to exercise far greater levels of caution in dealing with humans. This, too, is essential considering the lack of any boundary separating lion habitat from human habitation.

One can expect similar problems to confront management authorities in other parts of south Asia, as animal populations increase within the tiny protected areas typical of the region. Far more intensive management of these highly unnatural ecosystems, including regular culling of certain species, may be required to minimize the costs borne by local communities.

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PROTECTING THE COSTA RICAN BIOLOGICAL RESERVE: FOREST GUARDS OF MONTEVERDE

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INTRODUCTION

Identifying ecologically valuable areas that need protection, and establishing national parks and preserves, are among the most common and important tasks of the natural resource manager. Protecting the natural resources after they are placed within the legal boundary of a national park or preserve is a difficult, little publicized, and extremely important aspect of a successful natural resource management program.

For my Tropical Resources Institute internship, I spent June to August 1990 studying the protection system of the 10,000 hectares that make up the Monteverde Cloud Forest Reserve and surrounding conservation lands in the Tileran Mountains of Central Costa Rica. This is a region considered by many to be the best managed and most successfully protected reserve in Latin America. The intent of my study was to assess the ability of the guard system to deter such threats to the integrity of the Reserve as hunting, squatting, and timber cutting, and to make recommendations for improving protection of the Reserve. I communicated my results and recommendations, and exchanged ideas with local resource managers. I also attempted to share this knowledge and experience with the Yale School of Forestry and Environmental Studies community and with other resource managers through TRI Working Paper #46, published under the guidance of

Yale F&ES Professors Garry Brewer, Bill Burch, and Bill Bentley.

BACKGROUND

Protection of this unique cloud forest ecosystem began in 1951, when 19 North American Quaker families from Alabama settled in Monteverde, Costa Rica and purchased land in an effort to protect their watershed. Today, the cloud forest and surrounding lands they bought and protected are home to a wealth of species diversity including 400 species of birds, 490 species of butterflies, 500 tree species, 300 species of orchids and 200 species of ferns. Some of the more spectacular residents include the resplendent quetzal (*Pharomachrus mocinno*), the bare-necked umbrella bird (*Cephlopterus glabricollis*), and the golden toad (*Bufo periglenes*). Larger mammals include the tapir (*Tapirus bairdii*) and jaguar (*Panthera onca*).

The Reserve is now part of a larger conservation unit, which also consists of two government forest reserves, a national park, and the private Children's Rainforest (a reserve funded by contributions from schoolchildren from Europe and North America). The Tropical Science Center, a non-profit environmental group based in San Jose, manages the Reserve. It was this Center that provided me with the opportunity to participate in the internship. Another major institutional manager is the Monteverde Conservation League, a grass roots conservation group consisting of local farmers and biologists. This group buys and manages land for conservation, and is involved in local environmental education and reforestation. The Costa Rican government is the third participant, managing two adjoining forest reserves and the recently established Arenal National Park.

METHODS

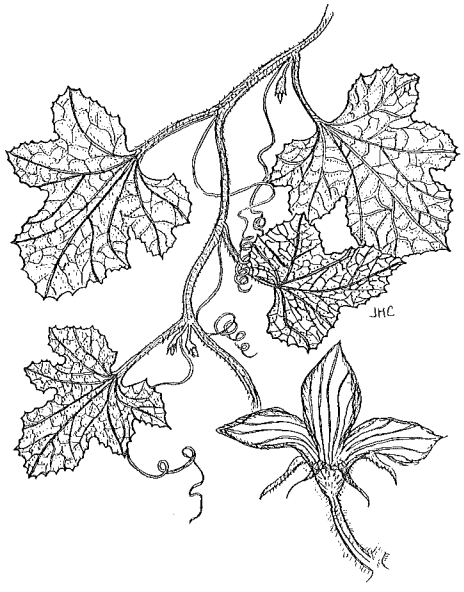
My study consisted of both formal and informal interviews with people from local communities, managing institutions, and the forest guards. It also consisted of a field component designed to determine the protection problems that the Reserve faces, why these problems are occurring, and how they might best be solved. The latter entailed my spending much of the summer walking through the rainforest with the guards, meeting local farmers, patrolling trails and looking for signs of squatters, hunters, and tree fellers. In addition, I reviewed relevant scientific, sociologic, and conservation literature.

RESULTS

One finding of my study was that the guard system is effective despite the incredibly large area covered by only eight guards, the difficult field conditions (4000 - 5000 mm / year of rain), and the inability of a guard system to address socio-economic problems. The guard system does serve to discourage hunting, squatting, and tree cutting. Its particular strengths include its leadership, its flexibility to adapt to changing jurisdictional boundaries, and its coverage of regions on the basis of biological and not just artificial boundaries. For example, one motivation for the establishment of the Reserve was to protect the habitat of the resplendent quetzal. Research by scientists including Carlos Guindon (DF Candidate, Yale School of F&ES) have shown that although the quetzal breeds in the cloud forest, it is an altitudinal migrant, leaving the Reserve twice a year to live in unprotected forest. The guards recognize this and encourage farmers owning land in these unprotected areas to protect the bird.

A second finding was that the guards perform a wider range of functions than was commonly recognized. Beside their "main" job of patrolling, the guards participate in environmental education of farmers, assist scientists in their studies, assist visitors who need directions, help clean trails, look for medicinal plants for local use, assist in a recycling program, communicate forest conditions to managers, and disseminate Reserve goals to the local population.

A third result was the discovery that community views towards the Reserve, particularly those of local farmers who are most likely to participate in hunting, squatting, and tree felling, differ widely. While some farmers recognize the benefits of the Reserve, a small segment of the local community is opposed to the idea of a reserve and many could not identify any benefits they gain from it.



Cucumis melo

DISCUSSION

The above results have important implications for reserve management. Recognition by managers that the guards are the "eyes, ears, and voice" of the Reserve will hopefully lead to their being used more to achieve wider management goals such as communication with local residents.

An understanding of some of the negative community attitudes towards the Reserve suggests that the protection program should stress the communication of environmental benefits from the Reserve, such as watershed protection. In addition, it suggests that economic benefits from the Reserve should be allocated among individuals living nearby so that they would develop an interest in the Reserve's continued protection. For example, some of the entrance fees could be used to develop community projects. Incorporating the protection system of the Reserve with the lives of the local people is crucial if the integrity of the Reserve is to be maintained. Though recognizably difficult to achieve, the idea that the community becomes the protectors or "forest guards" is a powerful one for conservation efforts.

My recommendations for improving the forest guard system include more orientation towards environmental education; involvement of the community in protection; increasing the professionalism of the guards; enhancing the image of the guards in the local communities; improving communication among involved institutions; strengthening the financial footing of the program; and recognizing what a guard system can and cannot do.

The protection system involving forest guards at Monteverde Cloud Forest Reserve is a good example of a system which is successfully protecting the integrity of a biological reserve. As such, it is valuable for other environmental managers as an effective technique for reserve protection.

Editor's Note: In keeping with the Tropical Resource Institute's efforts to establish long term relationships with regions and institutions, Doug was the fifth Yale FES student to spend an internship at Monteverde. His work was intended to complement the other four studies conducted from 1987 to 1989 which studied the role of ecotourism, community water resources, management of formerly settled lands, and the relationship between the town of Monteverde and the Reserve.

USING NITROGEN-FIXING TREE PRODUCTS FOR HUMAN CONSUMPTION

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INTRODUCTION

Nitrogen-fixing trees (NFTs) play an important, if limited, role in ensuring adequate human nutrition in rural areas around the world. In addition to the more highly touted attributes of NFTs — nitrogen fixing capability, fast growth rates, ease of propagation, tolerance of environmental extremes, potential for rapid genetic improvement, and provision of multiple end products and services — NFTs are valued for their edible young shoots, leaves, flowers, pods, and seeds.

Documented uses of NFTs for human consumption have been recorded for over 200 species representing 20 genera. The major NFTs used as food are listed below (Table 1). While in most cases the edible products of NFTs do not increase human caloric intake to any marked degree (the most important facet of nutrition for the world's hungry), they do provide many vitamins and micro-nutrients essential for good health. Several species are a source of emergency food during droughts, crop failures, and seasonal food shortages.

A number of NFTs have potential to benefit regions other than those in which they have been traditionally used. Selected species described in the following sections have long been cultivated by farmers or harvested in their native habitat by nomadic tribes. They are some of the most promising candidates for extension into new areas and deserve consideration in rural development efforts.

TABLE 1. The major nitrogen fixing trees and shrubs used for food by ecological zone.
Sesbania grandiflora

ARID AND SEMI-ARID TROPICS	HUMID TROPICS	HIGHLAND TROPICS	TEMPERATE
	Acacia pennata (ssp suavis)	*Erythrina edulis*	*Elaeagnus spp.*
Acacia aneura	*Cajanus cajun*	*Inga edulis*	*Hippophae rhamnoides*
Acacia holosericea	*Enterlobium cyclocarpum*	*Inga feuillei**	*Robinia pseudoacacia*
Acacia nilotica	*Inga vera*	*Myrica esculenta*	*Shepherdia argentea*
Acacia senegal	*Inga edulis*		
Cajanus cajun	*Leucaena leucocephala*		
Cordeauxia edulis	*Parkia filicoidea*		
Geoffroea decorticans	*Parkia javanica*		
Inga vera	*Parkia speciosa*		
Olneya tesota	*Pentaclethra macrophylla**		
Pithecellobium dulce	*Pithecellobium dulce*		
Prosopis cineraria	*Sesbania grandiflora*		
Prosopis juliflora/pallida			

* No record of nodulation.
Source: NFTA NEWS (11) December 1990.

HUMID TROPICS

From community gardens in Honolulu to multi-storied Javanese home gardens, *Sesbania grandiflora* is commonly planted as a "tree vegetable." It is well suited as a component of the overstory because light easily penetrates the tree's airy crown. The tree's main importance is the nutritive value and dietary variety that its leaves, pods, and flowers supply.

Sesbania leaves can provide riboflavin that is often deficient in diets that include only small quantities of animal proteins. The vitamin A content of the leaves surpasses that of many vegetables while supplying significant amounts of protein, calcium, phosphorus, potassium, iron, and vitamin C. The leaves, young shoots, and green pods are steamed or stir-fried and eaten alone or mixed into curries, salads, soups, and vegetable dishes. The flowers are not nutritionally important but provide variety to the diet by virtue of their sweet flavor. The long (4-10 cm) creamy white blossoms are eaten raw, steamed, boiled in soups, or dipped in batter and fried in oil or butter. Excessive ingestion of grandiflora, however, is cautioned against because of its high saponin content. Frequency of traditional use ranges from once a week to once every two weeks.

Cultivated widely in many Asian and Southeast Asian countries, *grandiflora* is now distributed pantropically. Wild populations are not known. Easily propagated from seed, the tree is tolerant of saline soils and waterlogging and can reach a height of 15 meters. *Sesbania* grows best in the lowland humid tropics with rainfall of 2,000-4,000 mm, although it has been grown successfully in areas with only 800 mm of rain per year. In addition to its use as human food, *grandiflora* is much valued as a source of nutritious ruminant fodder, green manure, and medicines. Service functions include partial shade for nurseries, windbreaks for fruit orchards, and support for pepper vines.

TROPICAL HIGHLANDS

In the tropical highlands, *Erythrina edulis* is a promising candidate for use as a "tree bean" in home gardens and in boundary plantings as a living fence. The 8-10 meter tall tree bears bi-annual seed crops of up to 200 kg/tree/year. Its fast growth, sturdy nature, and spiny bole make for a substantial living fence.

Erythrina seeds provide much needed protein during seasonal food deficits in the Andean regions where it is grown. Borne in greenish purple pods 20-30 cm long, the seeds contain about 20% protein and have an amino acid balance that is equivalent to that of other legumes. The large seeds (2.5-3.5 cm in diameter) are usually boiled in salted water and served with corn, potatoes, bread or other starchy foods.

Native to the Andes from western Venezuela to southern Bolivia, *erythrina* has been grown at an altitude between 1,100-2,700 m in rainfall regimes

that range from 450-1800 mm. Easily propagated by seed and stem cuttings, this fast growing pioneer species is not known to be very widely cultivated outside of this region. One reason for this is that the seeds are recalcitrant, losing viability after only a few weeks. In addition to its centuries-old use as a protein source during times of scarcity, *erythrina* provides forage for animals, leaf mulch for crops, and fuelwood.

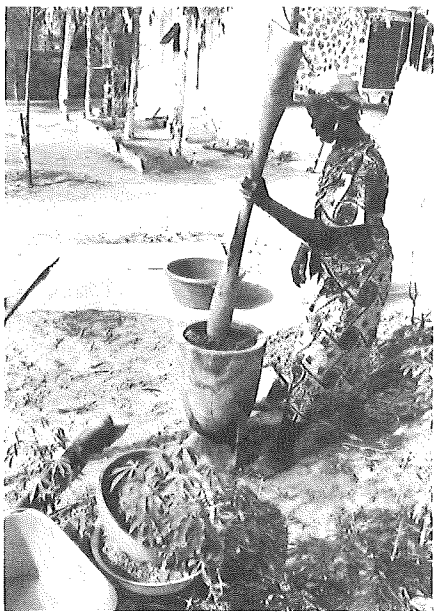
ARID AND SEMI-ARID TROPICS

Approximately 27% of the tropics is classified as arid or semi-arid. Inadequate, unreliable, and variable rainfall as well as saline and infertile soils render the majority of these lands unsuitable for dependable annual production of grain crops and livestock. Seasonal food shortages are common occurrences due to poor yields and extended droughts.

Nitrogen fixing trees and shrubs have their greatest potential to be used as human food in these dry climates because of their tolerance to the adverse growing conditions of these regions. Historically, residents of arid and semi-arid lands have long relied on nitrogen-fixing trees and shrubs for food during times of hardship.

The Australian *Acacias* spp. may hold the greatest promise as a nutritious tree food source for arid regions. *Acacias* can bear prolific seed crops in nutrient poor soils and under the harsh environmental conditions that characterize arid lands. The Australian Aborigines used the seeds of some 20 species of *Acacias* as a staple food. The seeds were ground into a coarse flour which was then mixed with water. The "seedcakes" were then baked in the ashes of a fire or on hot stones. Protein, fat, and carbohydrate values of the ripe seeds of acacias are higher than that of wheat or rice and contain 17-25% protein, 5-16% fat, and 30-40% carbohydrates.

Australian forester Lex Thomson believes that the Australian *Acacias* have considerable potential for human food production in the drier parts of Africa. The successful introduction by the Maradi Integrated Development Project of *Acacia holosericea* seed as a food source to farmers in Niger lends credence to his claim. In April and May of 1990, farmers processed *Acacia holosericea* seeds collected from two-year old trees using the same methods normally employed to process millet. Various traditional dishes were prepared using this seed flour as the sole component of a dish or blended



Threshing *Acacia holosericea* seeds.

with other grains or pulses. Both adults and children who ate the various dishes found them palatable and a number of farmers are now planting the trees as a backup food source on non-arable land that would otherwise go unused.

Further research may be needed to assess possible toxic side effects from long term ingestion of the seeds as would occur during times of crop failure and drought. In addition, the potential exists for the tree to become excessively weedy and to replace native vegetation of importance. The Australian *Acacias* are also precocious seeders. Caution must be exercised when introducing such a plant into new environments.

These necessary and serious cautions notwithstanding, the use of *Acacias* as a human food source merits consideration due to the outstanding nutritional status of *Acacias* seeds, their tolerance of harsh environmental conditions, and their ability to bear pods within a year after planting.

SUMMARY

The NFTs discussed here are representative examples of an important but underappreciated food resource. Although far from being a panacea for food shortages and nutritional deficiencies, nitrogen fixing trees can supply vitamins and serve as a reliable source of emergency food during famines caused by crop failures and seasonal food shortages. The use of NFTs as a food source should not be ignored during the course of species selection. More

After threshing, arils are removed from *A. holosericea* seeds before winnowing and grinding to produce flour.

extensive research is needed, however, before the full potential of NFTs for human nutrition will be realized.

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Editor's Note: The author is writing a manual on the use of NFTs for food. If you have knowledge of the use of NFTs for food please write: Mark Zimsky, Yale University, School of Forestry and Environmental Studies, 205 Prospect Street, New Haven, CT 06511.

This article first appeared in the December, 1990 (Number 11) newsletter of the Nitrogen Fixing Tree Association, P. O. Box 680, Waimanalo, Hawaii, 96795.

SECONDARY FOREST REGENERATES HOPE FOR THE ENDANGERED BIRD FAUNA OF BRAZIL'S ATLANTIC FOREST

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INTRODUCTION

People the world over are keenly aware of the tragedy of tropical deforestation, habitat fragmentation, and its associated loss of biodiversity. The media has successfully promoted the need for conservation of tropical forests but images of exposed tropical soils hardening to cement have distracted attention from the utility of secondary forests for conservation.

Secondary forest, defined as forest that regenerates after human disturbance, now occupies about 31% of the tropical closed forest biome (Brown and Lugo, 1990). While restoration of the primary tropical forest community may take 1,000 years, secondary forest attains a closed canopy and heights approximating those of a primary forest within a few decades (Uhl et al., 1988).

Communities and managers are looking more to secondary forest as a hope for the future. Conservation of tropical forest biodiversity may depend on secondary forests as a means to defray the need for local wood

products. I propose that secondary forests may also be managed to increase the viability of fragmented primary forest reserves. Linking tropical forest fragments with corridors of secondary forest may encourage movement of organisms between fragments and permit genetic mixing between otherwise isolated populations, thus increasing species capabilities in the face of a changing environment.

Conservation of viable bird communities is important in maintaining the integrity of an ecosystem as they serve an important function in the reproduction and regeneration of tropical forests. Birds, as well as bats and insects, are mobile links that pollinate and disperse many unrelated plants (Gilbert, 1980). Loss of these mobile links will hasten the decline of a forest, but the colonization of secondary forest may enhance restoration. Birds moving between primary and secondary forest may disperse forest tree species into disturbed areas.

Support from the Tropical Resources Institute and the Council for Latin American Studies allowed me to conduct a study to examine the potential of secondary forest to aid in the conservation of birds of the Atlantic Forest region of Brazil. Dr. Sergio da Vinha of the Cacao Research Institute of Brasil (CEPEC) provided guidance and logistical support for a study of secondary forest birds at the forest reserve Estação Ecológica Pau Brasil (EPB). My study objectives were to characterize forest birds that co-occur in secondary forest and to identify seeds dispersed by birds into secondary growth.

THE ATLANTIC FOREST

The Atlantic Forest region of southeastern Brazil contains a large number of endemic plants and animals. Eighteen percent of the bird species found in the region are endemic to the Atlantic Forest ecosystem. This area also contains a large percentage of Brazil's human population. Southeastern Brazil was the area first settled by the Portuguese and thus has a long history of human use. The Atlantic Forest, which once covered a coastal strip from Rio Grande do Norte to Rio Grande do Sul, has been reduced to approximately 1% of its original distribution (Fonseca, 1985). The remaining 99% lies under development, agriculture, or capoeira (secondary forest). Preservation of the unique fauna and flora associated with the Atlantic Forest may depend on the connection of the remaining fragments of forest lying in reserves or private ownership.

EPB, an 800 ha reserve in Southern Bahia that is managed by CEPEC, is a center for silvicultural and ecological research. The reserve is adjacent to 6,000 ha of forest managed by another Brazilian institute. A mosaic of young and old secondary forest and primary forest allowed me to examine the propensity of certain primary forest birds to enter secondary forest.

METHODS

Birds were censused with mist nets during the summer of 1990. A "wall" of nets, 100 meters long and 8 meters high was placed in primary forest, tall secondary forest, and short secondary forest. Only the lower portion of primary forest and tall secondary forest, which have heights of 20-25 meters, were censused completely. Mist nets, set to the height of the short secondary forest, should have resulted in a complete census of birds from the ground to the canopy. It is assumed that all birds flying or walking through this 100 meter section of short secondary growth fell into our nets. Captures along these 100 meter sections were then compared between habitats.

In this analysis, I compare only bird species whose habitat is classified as secondary forest and/or primary forest. Species that inhabit unforested areas but also use forested areas were not taken into consideration. Feces were collected from all birds that consume fruit. The seeds were compared to collections at CEPEC and the New York Botanical Gardens to characterize plants dispersed into the secondary forest.

BIRDS OF ESTAÇÃO PAU BRASIL

A total of 716 captures were recorded during the study. Seventy species of birds fell into the nets, 14 of which are

endemic to the Atlantic Forest region. Two endemic cotingas captured in secondary forest at EPB are listed in the International Council for Bird Preservation (ICBP) Red Data Book (1981). *Cotinga maculata* and *Xipholena atropurpurea*, frugivores of the primary forest, are listed as vulnerable. Another frugivorous cotinga captured during the study, *Carpornis melanocephalus*, is listed in the ICBP checklist of threatened birds (Collar and Andrew, 1988). Clearly these three species would benefit from an increase in secondary forest cover.

Some general patterns emerged from preliminary analysis of birds of secondary and primary forest at EPB. One half of the forest understory species occurred in both short and tall secondary forest. Birds that join understory mixed-species flocks were particularly widespread with seven species being captured in both secondary forest habitats and only two being more restricted. A woodcreeper (*Xiphorhynchus guttatus*) occurred only in primary forest and a single woodpecker (*Piculus flavigula*) was captured in tall secondary forest.

Three understory frugivores were common in all habitats at EPB. Less common understory frugivores were more restricted. The two threatened cotingas were absent from tall secondary growth. In contrast, a manakin (*Chiroxiphia pareola*), an Euphonia (*Euphonia xanthogaster*), and a terrestrial dove (*Geotrygon montana*) were absent from short secondary forest.

Many of the more restricted understory species are insectivores that forage alone or in mated pairs. Two such antbirds, *Formicarius colma* and *Dysithamnus mentalis*, were caught only in primary forest. Five other understory insectivores, three of which are endemic to the Atlantic Forest, were caught in the tall, but not the short, secondary forest.

Birds that feed in the canopy were caught primarily in short secondary forest. This is likely a consequence of the mist nets not sampling the canopy of the taller forests, but it is still interesting to note which canopy species forage outside the primary forest. Two species that form mono-specific canopy flocks were captured at EPB. Omnivorous species that form canopy mixed-species flocks were fairly common in the captures of short secondary forest with six species, including two endemic tanagers, present. Five other canopy species, including the two vulnerable cotingas, were captured in short secondary forest. Two endemic insectivores that forage on the bark of trees, *Heliobletus contaminatus* and *Veniliornis maculifrons*, were also captured only in short secondary forest.

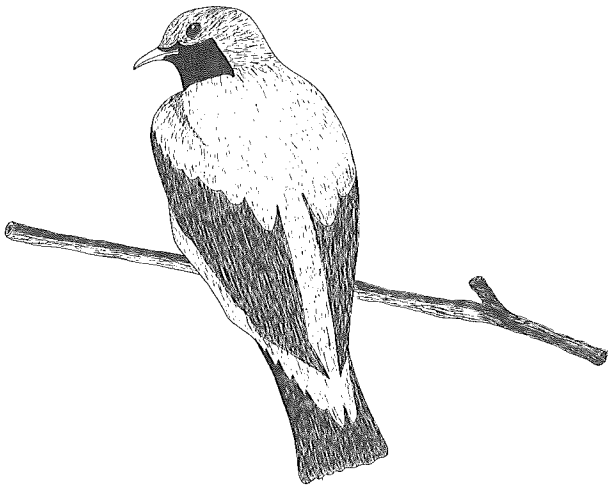
SEED DISPERSAL

Eighty-three feces samples containing seeds were collected from 21 bird species. By far the most common fruit eaten was *Miconia mirabilis* (Melastomataceae). Eighty-one percent of the samples contained *M. mirabilis* and 18 bird species consumed the fruit during the study. The seeds of this forest treelet (5-6 m) were widely distributed in all the habitats studied. Five different palms and two species of Malpighiaceae (*Byrsonima* spp.) were dispersed into all secondary forest sites. Two Solanaceae (*Solanum* spp.), were dispersed by forest cotingas into short secondary forest. Nineteen seeds have not yet been identified.

PRELIMINARY CONCLUSIONS

The large number of forest bird species, particularly endemic species, co-occurring in primary and secondary forest gives promise to the idea of using secondary forest to conserve Atlantic Forest birds. Certain understory insectivores appear to require more developed secondary forest. Further analysis into the characteristics of co-occurring species may tease out the subtle differences in bird species' use of secondary forest and provide management strategies for conservation of the unique bird fauna of Brazil's Atlantic Forest.

The avian frugivores are instrumental in effectively dispersing one forest treelet. Until more seeds have been identified to species it is difficult to evaluate the impor-



Cotinga Maculata

tance of birds as seed vectors for regeneration of disturbed areas at EPB. The short duration of this study limits wide-ranging conclusions. It is interesting to note the prominence of one plant species during the study. The percentage of tree species that are fruiting varies from approximately 5% in June, to 12% in July, and to 15% in August (Vinha and Lobão, 1989). *Miconia* remained abundant in the feces samples throughout the study. This indicates that the avian frugivores may depend on *Miconia* for part of the year or that they preferentially consume this species.

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RECLAIMING INDONESIA'S DEGRADED LANDS THROUGH RESEARCH AND EDUCATION

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INTRODUCTION

Many tropical countries rely heavily on their rain forest resources for long-term economic security and environmental quality. The destruction and degradation of tropical forests has become a major topic of concern and research within these countries and around the world. Current land use practices on nutrient poor tropical soils, if continued, will result in dramatic increases in the extent of degraded lands and losses of needed forest resources.

Indonesia, containing 62% of the closed forest in Southeast Asia, is experiencing deforestation rates as high as 700,000 hectares (ha) annually (Repetto and Gillis, 1988). Grasslands presently cover 16 to 20 million ha. The dominant grass, *Imperata cylindrica,* is spreading at a rate of 100,000 to 200,000 hectares annually, choking out regeneration and retarding natural forest succession (Donner, 1987). Over 40 million ha of Indonesia's land is in need of reclamation (Soedjarwo, 1985; FAO, 1981).

Across Indonesia, shifting cultivation results in the clearing of 400,000 to 500,000 ha of forested land annually (Repetto and Gillis, 1988). In Kalimantan, the Indonesian portion of the island of Borneo, highly weathered infertile soils generally prevail and shifting agriculture can only sustain human communities at low population densities compared to other islands of the archipelago. Yet, expanding indigenous communities and immigration from the crowded island of Java threaten to exert pressure on protected forest areas in Kalimantan to the detriment of its wildlife and water quality and Indonesia's vast biological diversity.

Current rates of deforestation will only increase the extent of degraded land and secondary forests. Forest management practices to encourage regeneration have met with minimal success. New silvicultural methods and the capacity to implement them need to be developed in order to bring Indonesia's degraded lands back into productivity.

One silvicultural method to enrich degraded lands is to reforest with native trees and lianas to increase their

Measuring wildling growth, Cabang Panti Research Site, Western Kalimantan, Indonesia.

economic value. Increasing the long-term output of marketable forest products (non-timber and timber products) could potentially increase the income of local farmers above that obtained from shifting cultivation. However, forest enrichment is a complex task requiring long-term commitments to the gathering and transferring of technical knowledge at the local, regional and national levels. This will involve working with rural people to assess markets and needs as well as educating Indonesian students to apply these practices and solve future forest problems as they arise. There is also a need to catalyze policy changes at the regional and national level to provide incentives for the implementation of sustainable land management practices.

RESEARCH STUDY

The purpose of my research was to contribute to existing knowledge on the regeneration strategies of valuable hardwood species (*dipterocarpaceae*), and to train Indonesian students in forestry and rain forest ecology. This project was conducted from June 1990 to November 1990, with support from TRI, the Conservation, Food and Health Foundation, Inc., and the Cabang Panti Research Project.

The project was conducted at the Cabang Panti Research Site located within the 100,000 ha of Gunung Palung National Park, West Kalimantan, Indonesia. The 15 square km Cabang Panti site was established in 1985 by Dr. Mark Leighton of Harvard University to examine the interactions between vertebrates and plants in different forest formations through a comprehensive, long-term research program. The Gunung Palung National Park contains intact native fauna and flora which have experienced minimal human disturbance.

The research aspect of my project involved studying the seedling ecology of four *Shorea* species by measuring their survival and growth rate in forest gaps. The family of trees that encompasses the *Shorea* genus, the *Dipterocarpaceae*, dominates lowland forests of the region. This important timber tree family supplies 25% of the raw materials for the world's hardwood market. The *Shorea* spp. alone accounted for more than 50% of Indonesia's total log output in 1973 (FAO, 1981). The dipterocarps and many other tree families in Southeast Asia are well-known for their habit of gregarious flowering or masting (Ashton, 1980). Masting events occur at intervals of two to five years or up to ten years (Noraini et al., 1987). The year 1987 was a mast fruiting year for the region and dipterocarp seeds flooded tree-fall gaps that had been created in the park by hand-logging five to ten years prior to the masting event. Natural factors — climate, light levels, herbivores and pathogens — not readily replicated in field trials had been at work for three years, affecting *Shorea* seedling survival. The situation provided an excellent opportunity to determine how *Shorea* spp. utilize forest gaps in their natural regeneration strategies.

I first located and described the man-made gaps in the lowland sandstone habitat of the study site. Gaps that had opened beneath or beside mature *Shorea* trees and received seed input during the 1987 mast were visited and the seedlings in the gap and adjacent understory were measured. Correlations between seedling densities, heights, and other measured parameters are currently being analyzed to determine each species' light micro-site preference and the effect of competition on seedling growth and survival.

To determine each species' potential for use in enrichment planting, I transplanted 680 wildlings (seedlings growing naturally in the understory) of 6 *Shorea* species in gap and understory light conditions. Wildlings were used because of the unavailability of *Shorea* seeds due to the masting nature of *Dipterocarpaceae*. The transplant experiment was designed to determine each species' response to transplanting in the two different light micro-sites. Current planting techniques do not account for the environmental heterogeneity created in selectively logged forests that are converted to a mosaic of open and shaded areas. Understanding a species' light micro-site preference will enable foresters to make appropriate site selections when transplanting wildlings, giving them a better chance for survival.

EDUCATION

The educational aspect of my project involved teaching six Indonesian students the principles of forestry and

tropical ecology while assisting them in the completion of research projects on various topics in rain forest ecology. I incorporated my own research into this task, using it as a teaching tool during the project's development and implementation. The students, from Sumatra, Java, and Kalimantan, were part of an ongoing student fellowship program at the research site. Three of the students were still working toward their undergraduate degrees while the other three were recent graduates. I assisted the students with data collection, documentation and analysis. This was accomplished through field and classroom discussions, critiques of written reports, and assistance with computer data analysis. Three of the students culminated their fellowships by presenting results at the International Conference on Forest Biology and Conservation in Borneo, July 30, 1990 in Sabah, Malaysia. I submitted a formal report to sponsoring Indonesian and international funding agencies evaluating the program with recommendations for future groups.

SUMMARY

The transplant experiment continues to be monitored. Survival and growth data from these plantings are collected monthly. I am currently analyzing data from this experiment as well as the data collected from the gap study. Results of this research will provide baseline data for future projects assessing the potential of indigenous forest species for enriching degraded lands.

Basic research and the education of Indonesian students in forestry and ecology are the types of steps needed to address the complex and expanding problem of degraded lands in Indonesia. The proper management of land still in production or recently disturbed is likely to be far easier and cheaper than rehabilitation of severely degraded lands. If the productive potential of degraded lands can be restored, then more forest resources will become available to meet the needs of the Indonesian people, and the pressure on remaining intact forest ecosystems will ultimately decrease.

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NEVIS, AN ISLAND MICROCOSM: THE UNIQUE ENVIRONMENTAL CONCERNS OF SMALL ISLANDS

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In recent years, large international aid agencies and regional environmental groups have recognized the vital role that local non-governmental organizations (NGOs) play in balancing environmental and economic concerns. The Island Resources Foundation (IRF), a private, non-profit environmental organization focusing on Caribbean issues launched an ambitious NGO institution-building campaign in 1989 with a five year matching grant from the U.S. Agency for International Development (USAID). The program aims to strengthen the NGOs' organizational management skills, improve the planning and implementation of major projects (including grant writing, budget preparation, evaluation and monitoring) and increase the NGOs' capacity for collecting, archiving and distributing information. As part of this program, IRF places natural resource graduate students in selected NGOs throughout the Caribbean. With a matching grant from the Mukti Fund, I travelled to the island of Nevis in the Eastern

Caribbean in the summer of 1990 to work for the Nevis Historical and Conservation Society (NHCS).

Nevis, the smaller of the two islands that constitute the Federation of St. Kitts-Nevis, lies just northwest of Antigua, at the same latitude as Belize in Central America. A cloud-shrouded, 1075 m (3,000 foot) volcanic peak dominates the 93 sq. km. (36 sq. mile) island which is fringed by long coral beaches and occasional rocky headlands. Census takers estimate the population of Nevis at just under 10,000, the majority of whom are descendants of African slaves. Like many of the Caribbean islands, Nevis was colonized by European sugar planters in the early 1600s. The British and French vied for control of the island, with the British retaining final hegemony. St. Kitts-Nevis remained a Crown colony of Great Britain until 1983 when residents successfully fought for independence.

Several prominent Nevisians founded the NHCS in 1980, primarily to preserve the historical heritage of the island. In the mid-1980s the Society's constituents and Board recognized the need to add environmental conservation to its agenda and adopted a dual natural and cultural conservation mission. Two former Peace Corps volunteers and one Nevisian currently administer the society as curators. Like similar Caribbean organizations, the NHCS must take special care to balance the concerns of its native Nevisian and expatriate constituents. The NHCS operates the two museums on the island and works actively with a group of talented primary and secondary school teachers to promote environmental education in the public school system and through programs at the public library.

While Nevis' economy was agriculturally based for three and a half centuries, in recent years it has shifted to tourist-related service industries. Touted as the unspoiled "Queen of the Caribbees", the island has catered to a more upscale clientele, most of whom stay in former sugar cane plantations which have since been converted into inns. The beginning of this year marked the opening of a 200 room luxury hotel operated by the Four Seasons chain and an adjacent 18-hole championship golf course — both firsts for the small island. The Four Seasons hotel is built on a three mile stretch of undeveloped beach that is among the most beautiful in the Caribbean. The Nevis Island Administration has plans for another hotel and residential development on the beachfront contiguous to the Four Seasons hotel. My original project was to evaluate the development plan and establish a baseline environmental monitoring system for the site. As often happens in small, active NGOs, however, another more pressing project arose.

USAID must develop Country Environmental Profiles (CEPs), a "state of the environment" report, for all recipients of USAID funds. The profiles help the agency prioritize projects for funding and provide a comprehensive but succinct review of environmental issues for the local governments. The Agency contracted with the Caribbean Conservation Association (CCA) to produce the CEPs for six Caribbean islands, and the CCA in turn hired IRF as the technical research and writing team for the project. IRF, recognizing this as an excellent opportunity for its NGO strengthening program, selected a local NGO on each island to serve as research and documentation centers for the project. The NGOs benefitted in three ways: they broadened their understanding of the environmental issues on their islands; they strengthened their relationships with the government agencies that provided much of the information; and they remained permanent repositories of the collected materials. IRF chose the Nevis Historical and Conservation Society to be the documentation center for the Nevis CEP. Unlike other NGOs, people under the NHCS umbrella actually wrote the CEP. This was an affirmation of the quality of the NHCS's work as IRF hired off-island consultants to write the Environmental Profiles for other islands. It also gave the NHCS an excellent opportunity to involve members of the island community in the project.

The CEP for Nevis attempted to cover several central themes. It described the natural resource base of the island including flora, fauna, water, mineral, cultural and historic resources. The discussion then centered on issues related to pollution, environmental health, land use planning and development control in relation to these resources. All of this information was placed within the context of Nevis' institutional framework. Writers identified problems in each area and proposed recommendations for mitigation and solution. My role was to research and write the chapters on water resources, agriculture, forestry and watershed protection, as well as pollution and environmental health. I also edited and contributed to several other chapters. The water resources chapter included water supply and demand projections as well as a discussion of catchment area and wellhead protection measures, water pollution problems and water management and legislation. Solid waste, sewage and liquid waste, oil pollution as well as mosquito control programs were among the topics covered in the pollution and environmental health chapter. The agriculture section contained discussions of land classification and capability, land use patterns and farming systems, land tenure, soil erosion and agro-chemical use. The extent and condition of forests and major watersheds and forest product utilization were described in the section on forest resources.

Because of time constraints and the objectives of the

project, the research involved extensive review of existing information, rather than collection of new field data. I studied the reports of a seemingly endless parade of consultants and extracted the important and consistent information. My most difficult task, however, was integrating this information with the perceptions and concerns of the Nevisians working in the various sectors. To this end I conducted personal interviews with the heads of the Water, Agriculture and Public Health departments as well as officials in the Planning, Electricity and Customs offices and private industry representatives.

Over the years the NHCS has built a cooperative working relationship with the government of Nevis. The Island Administration now solicits the Society's review of development projects for environmental and historical impacts. The CEP project, by highlighting environmental problems, had the potential to seriously strain this relationship. The challenge for me was to work closely with the department heads to identify and define the environmental problems facing the island without losing the objectivity of an outside observer. This challenge was confounded by the problem that the department heads reported to elected ministers who did not always share their views.

Edward Towle, the president of IRF, wrote an intriguing paper in 1985 ("The Island Microcosm") in which he outlined the issues and institutional arrangements characteristic of small island systems. Nevis' environmental problems and opportunities are greatly influenced by this "island effect." Nevis developed as an export-destined monocrop plantation. Every inch of the island to within 300 m (1,000 feet) of its central peak produced sugarcane. A few vegetables were grown to support the population, but most food and commodities were imported. Three centuries later, after periods of high agricultural exports, the island has once again become a net importer of food items, and today is only self-sufficient in eggs. Years of sugarcane and cotton production along with livestock overgrazing have eroded much of the topsoil. Opportunities in the construction and service sector have also wooed Nevisians away from agricultural labor. Small islands like Nevis are caught between the need to maintain an equitable balance of exports and imports, and the rapidity with which their very limited and spatially bounded resource bases can be overtaxed. Islands, like small towns, feel the exaggerated effects of the boom-bust cycles which often result from this tension.

The natural resource base of Nevis remains largely unstudied and unquantified. Science education in the public school system does not inspire or prepare students for work in this field, and opportunities are extremely limited. Due to its size, Nevis has not attracted many foreign scientists to its shores and forests although interest is increasing. With so little known about the biophysical characteristics of the island, management decisions are difficult to make. On the other hand, Nevis is fortunate that it has not yet experienced some of the serious pollution problems facing many of its neighboring islands. Cash monocrops like sugarcane and bananas usually require high fertilizer and biocide inputs. Since sugarcane and cotton became unprofitable on Nevis long before many of the other Caribbean islands, the agricultural sector diversified and Nevisian farmers now use comparatively low amounts of these substances.

Industrial pollution is not a serious threat as there is no heavy industry and very little light industry on the island. The effects of what little pollution does exist are not carefully monitored so potential problems could easily go undetected. A growing problem is the disposal of solid and liquid wastes, particularly automotive parts, waste oil and derelict vehicles. Space and money for proper land disposal is limited so open burning and ocean dumping are commonly practiced. Treatment or proper disposal of waste oil on-island is often prohibited by economies of scale, yet high transportation costs constrain the development of a regional facility to serve all the Caribbean islands.

The problems mentioned above are not atypical of those found in many parts of the world today. Small size, however, has a marked and confounding effect on the biological and physical functioning of island ecosystems. Watersheds are much shorter so that any contaminants are likely to reach coastal waters in less time and in more concentrated form than on larger land bodies. Tolerances to biocides can develop more rapidly in the smaller target populations found on islands. Nevisian farmers already note a sharp decline in the effectiveness of a pesticide brought into wide use only a decade ago.

Equally profound are the effects of size on the socio-economic and political institutions of islands. A population of fewer than 10,000 within a 93 square km area leads to a peculiar brand of politics characterized by "intense face-to-face personalism and kinship ties that reduce objective decision-making, inhibit confronting serious (polarizing) issues, and reinforce the status quo" (McElroy et. al., 1987). Leaders often wear many hats and travel in convergent professional and social circles. Bureaucracies become disproportionately large. Boom-bust cycles spawn parallel cycles of emigration and immigration. The Caribbean islands have a long history of inter-island migration and Nevis is no exception. Well-educated, ambitious Nevisians continue to emigrate to the United States, Canada and Great Britain and send money

and consumer goods back to relatives on Nevis. These remittances constitute a major portion of the island's economy, but their exact contribution is next to impossible to quantify. Construction and farm laborers from other Caribbean islands immigrate and fill jobs on Nevis creating cultural tensions.

The CEP project confirmed many of these previously held beliefs about the social, political and environmental milieu of islands in general, and Nevis in particular. It also served to point out discrepancies between the accepted opinions and recommendations of consultants and realities on Nevis. For example, consultants recommended that Nevis operate one sanitary landfill, but the topography of the island limits transportation to a ring road encircling the central peak. Safety and logistical problems probably make two or three small facilities a better option. Similarly, several agricultural assessments of Nevis identify land tenure as a major constraint when in fact an extremely high proportion of the population owns enough land to provide for their family, but not enough for commercial production. The CEP also identified gaps in government record keeping such as biocide imports, the amount of charcoal produced from the forests, and basic health statistics. Other environmental factors such as the amount of waste oil improperly disposed of from the two generator plants (3,000 gallons a year) were quantified for the first time.

Islands may have simple, undisputed borders, but patterns of social interaction, institutional structure and resource dependence are very complex. Natural resource managers must be sensitive to these patterns and to the ways in which they differ from continental societies. Incremental changes can have an exaggerated effect on the social and natural environments of small islands. Fortunately, local NGOs are forming throughout the Caribbean, with the support of active regional groups like IRF, and are working towards positive changes in the quality of life and the quality of the environment for Caribbean islanders.

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Nevis, the smaller of the two islands that constitute the Federation of St. Kitts-Nevis.

TRI NOTES

ISTF Conference

The Yale Chapter of the International Society of Tropical Foresters held a conference, "Planning for Amazonia: Incorporating Indigenous Peoples' Knowledge Into Land Use," on April 20-21, 1991 at Yale University. The conference was sponsored by the Yale School of Forestry and Environmental Studies, TRI, The Institute for Social and Policy Studies, the graduate program in International Relations and the Peabody Museum of Natural History.

The conference brought together students and professionals to address the risks and benefits of incorporating indigenous people's knowledge into land use planning in the Amazon. Issues presented included establishing better communications with indigenous peoples, creating markets for forest products, and implementing policies that encourage these methods.

Working group papers will be available in the fall of 1991. For further information contact Toral J. Patel at the Yale School of Forestry and Environmental Studies, 205 Prospect Street, New Haven, CT 06511.

TRI Summer Internships

A number of students were awarded TRI grants to conduct research in the various countries in the tropics during the summer of 1991. The individual research topics covers a wide range of subjects. Working papers will be published and made available through TRI upon completion in the following year.

Fernando Allegretti.....Brazil
Gary Helseth.....Pakistan/Afghanistan
Mark Jen.....China
Teunchai Lakhaviwattanakul.....Thailand
Kate Lance.....Guyana
Lisa Lumbao.....Indonesia
Chuck Meyers.....Brazil
Aliza Mizrahi.....Mexico
Nuria Muniz-Miret.....Argentina
Adisorn Noochdumrong.....Thailand
Toral Patel.....India
Laura Peterson.....Costa Rica

COOPERATOR NOTES

Tropical Forest Management Newsletter

The International Tropical Timber Organization (ITTO) is funding a project to promote the development of human resources with the purpose of achieving conservation and sustainable management of tropical forests in the Asia-Pacific region. A newsletter, "ITTO Tropical Forest Management Update", is being published to address issues related to tropical forest management innovations, approaches to tropical forest conservation, and training opportunities for forest managers. The project is being coordinated by ANUTECH, the consulting arm of the Australian National University in Canberra, Australia.

Contributions by organizations and individuals on topics related to the above are encouraged. Please direct any inquiries to:

ITTO Topical Forest Management Update
ANUTECH
GPO Box 4
Canberra A.C.T. 2601
Australia

Tel: +616 249 5861
Fax: +616 249 5875

Short Course Cancellation

The short course, "Production and use of nitrogen fixing trees in small-scale farming", cosponsored by the Nitrogen Fixing Tree Association (NFTA), University of Hawaii and NIFTAL, has been cancelled due to insufficient participant response. It was originally scheduled for July, 1991.

International Plant Nutrition Conference

The "XIIth International Plant Nutrition Colloquium and Field Trip 1993" as well as an "International Symposium on Zinc in Plants and Soils" will be held in Perth, Australia in September 1993. For additional information contact:

Plant Nutrition Secretariat
The Conference Office
University of Western Australia
Nedlands
Western Australia 6009

TRI WORKING PAPERS
(1986 - 1990)

No. 16.
A Curriculum Guide for a Course on "Gender Roles in the Community Approach to Forestry". Nancy Sheehan. Tropical Resources Institute, 1986, 82 pp. $8.25

No. 17.
Approaches Toward Biosphere Reserve Assessment: Case Studies in the Caribbean. Betsy A. McGean. Tropical Resources Institute, 1986, 84 pp. $8.50

No. 17a.
Appendices for Report on Approaches Toward Biosphere Reserve Assessment: Case Studies in the Caribbean. Betsy A. McGean. Tropical Resources Institute, 1986, 73 pp. $7.50

The Biosphere Reserve paper and appendices can be purchased together for $15.00.

No. 18.
DNA Content Polymorphism and Tissue Culture Regeneration in Caribbean Pine. G. P. Berlyn, A. O. Anorou , R. C. Beck and J. Cheng. Tropical Resources Institute, 1986, 50 pp. $5.75

No. 19.
Economic Analysis of Mahogany Plantations in Puerto Rico. Mark Dillenbeck. Tropical Resources Institute, 1986, 76 pp. $8.00

No. 20.
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