

MESSAGE FROM THE DIRECTOR

The Tropical Resources Institute was founded in 1983 with a grant from the A.W. Mellon Foundation to provide a focus for tropical resource studies and training at Yale. There are three areas of concentration in TRI which reflect a current issue in tropical resource management. They are: natural secondary forest management, wildland protection management, and bioenergy systems. In addition to the three areas of concentration, TRI has three program areas: education and training, information management, and research.

Last year, TRI sponsored three field trips to Puerto Rico and seven masters' students internships, six of which were based in Puerto Rico and the Virgin Islands. These internships linked students with resource management organizations in the area to carry out projects ranging from an inventory of the Rio Abajo forest to a study of the Sooty tern colony on Flamenco Peninsula, Culebra, Puerto Rico.

Six Ph.D. students also received funding from TRI. Four of these students are completing work they began in 1984 and the final stages of their projects should be done by the fall of 1986. A few examples of these research topics include: The effects of environmental factors on regeneration of five tropical tree species, the influence of stand density on productivity, yield, and nutrient immobilization in albizia lebbek bio-energy plantations.

Additional news about recent activities in TRI can be found in the following pages under TRI NOTES.

This is the first issue of the TRI NEWS. Through this newsletter, we hope to inform our readers about TRI's activities as well as to establish the Institute as a center of information exchange between our cooperators. We

would welcome any articles or any information about projects or upcoming events that our readers would like to contribute. We would like to encourage readers to contact one another directly when they read of an event or project that they have an interest in.

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CONTENTS

<u>Message from the Director</u>	1
<u>Research Profiles</u>	
John A. Parrotta	2
Patricia D. Moehlman	4
<u>Cooperators</u>	6
The Department of Natural Resources, Puerto Rico	
<u>Cooperator Notes</u>	7
<u>TRI Notes</u>	8
<u>Literature</u>	10

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RESEARCH PROFILES

BIO-ENERGY RESEARCH IN PUERTO RICO

JOHN A. PARROTTA, PH.D. CANDIDATE

The problems associated with deforestation in the developing world, from the Himalayan slopes of Nepal to the African Sahel and the Brazilian Amazon, have been widely publicized in recent years and have become a principal focus of tropical resource researchers and management professionals worldwide. An important component of the tropical deforestation crisis is the loss of forest resources resulting from increased demands for fuelwood and livestock fodder in both rural areas and urban centers. Efforts to meet growing demands for fuelwood and fodder while maintaining the productive capacity of natural forests have led to the promotion of large-scale biomass plantations, farm forestry, social forestry and a wide variety of agroforestry systems. "Fuelwood forestry" has become a legitimate concern of foresters, agronomists, social scientists and rural development professionals.

Ambitious biomass plantation programs are currently under way in many fuelwood-dependent countries. These programs generally involve the cultivation of tree and shrub species capable of rapid early growth under a wide range of climatic and soil conditions in plantations managed on short rotations (3 to 10 years). Since beginning my doctoral studies at Yale, I have concerned myself with the ecological and socio-economic factors which may influence the short- and long-term success of fuelwood forestry development programs.

In 1984, with support from the Tropical Resources Institute, I conducted a three-month study of fuelwood plantation programs and associated research efforts in India and Bangladesh, both countries with serious deforestation and fuelwood

deficit problems. A number of important questions relating to plantation productivity and ecological sustainability emerged from this South Asian survey and the answers require basic research.

One such question concerns the influence of plantation stocking rate (stand density) on growth, yield and nutrient uptake. While short-rotation biomass (i.e. fuelwood and fodder) yields may be enhanced by increasing plantation stocking rates, reduction of mean tree size and changes in tree crown morphology with increasing stocking rate may be accompanied by a related increase in the weight of nutrient elements per unit of biomass removed from the plantation systems at the time of harvest. Where one or more nutrient elements are potentially limiting (as may often be the case in areas characterized by inherently poor or otherwise degraded soils), the nutrient content of harvested biomass, as affected by stand age and stocking rate, may influence site productivity through successive rotations.

In the fall of 1984, a study designed to investigate these questions was initiated in Puerto Rico with TRI support in cooperation with the Center for Energy and Environment Research (U.S. Department of Energy/University of Puerto Rico) and the U.S. Forest Service (Institute of Tropical Forestry). The species selected for this study, Albizia lebbek, is a leguminous, multi-use tree native to South Asia though naturalized in many tropical regions, including Puerto Rico and the Caribbean. It is used widely in fuelwood plantations and agroforestry systems worldwide.

The present study is designed to assess plantation development through

the first five to ten years, although intensive monitoring of biomass yields, density-influenced tree morphology parameters and nutrient uptake rates will concentrate on the establishment and early growth phases, i.e. the first two years.

Experimental plots were established in November 1984 using four-month-old seedlings planted at 0.5 m, 1.0 m, and 2.0 m square spacings, corresponding to stocking rates of 40,000, 10,000 and 2,500 trees per hectare respectively. The one-hectare coastal plantation area (located in Yoa Baja at the Center for Energy and Environment Research experimental farm) is characterized by nutrient-poor, calcereous sandy soils. Annual precipitation at the site averages 1300 mm.

Between November 1984 and August 1985, a number of general patterns have been observed. In all experimental plots, regardless of spacing and variations in soil nutrient status, height and stem diameter growth proceeded very slowly through the first five months following planting (see Table 1). Thereafter, growth rates increased rapidly, particularly among trees planted at wider spacings, or lower stocking rates. Differential growth rates between spacing treatments are due, in part to root competition (for available soil moisture) at higher stocking rates during low rainfall periods. Variable soil organic matter content, linked to soil moisture-holding capacity and the availability of plant nutrients, also appears to contribute to observed growth rate differences during the first nine months of plantation development.

These preliminary data indicate that competitive interactions, which are density dependent, are resulting in a reduction of mean tree size with increasing stocking rate and fairly quickly narrowing the expected differences in per-hectare biomass production between the variable stocking rate (spacing) treatments. While general conclusions regarding the optimal spacing should consider the

particular climatic and soil conditions encountered at this study site, it appears that the often-assumed productivity advantages associated with high-density plantations may not persist beyond the first year of plantation development under conditions of potential water stress and soil nutrient deficiencies.

Future work on this experiment will focus on continued assessment of growth and yield, associated patterns of nutrient uptake in above- and below-ground biomass, and the modeling of early plantation development and the partitioning of biomass and nutrients in foliage, branches, stem-wood and roots as influenced by stocking rate (competition) as well as by physical and chemical soil characteristics. It is hoped that the results of this work will contribute to our understanding of the biological aspects of bio-energy plantation development and thus provide an ecologically sound basis for the design and management of fuelwood production systems.



JACKAL BEHAVIORAL ECOLOGY AND THE EVOLUTION OF COOPERATION IN CANIDAE

PATRICIA D. MOEHLMAN, PH.D., ASSISTANT PROFESSOR IN WILDLIFE ECOLOGY

I have studied the behavioral ecology of silverbacked and golden jackals for 64 months over an eleven-year period near Lake Ndutu, Serengeti Plain, Tanzania. The two species live in adjacent but different habitats. Both species form long-term pair bonds, some for as long as six to eight years, which may effectively mean that they pair for life. The monogamous bond and exclusive mating were maintained by a high degree of affiliative behavior, food sharing, synchrony of activity, year-round maintenance of the feeding territory, cooperative hunting, and intrasexual aggression. There is a relatively large litter size. The reproductive success of a female tolerating polygyny would potentially be lower than that of a monogamous female due to the division of the male's critical paternal investment.

In both species, some male and female offspring remain on their natal territory and help to provision, protect, and socialize the next year's litter, their full brothers and sisters ($r=1/2$). They also regurgitate to their mother during her period of lactation.

In silverbacked jackals, pup survival correlated significantly with the number of adults (parent + helpers) in the family ($R_s = .89$, $P<0.01$). With more adults there was a significant increase in the feeding rate per hour and a significant increase in the percent time that the pups were guarded. Silverbacked jackals live in brush woodlands and pups are born during the dry season when the primary food resources are small rodents (60 gm) and fruit (5 gm). Foraging for abundant but scattered small food packages is energetically costly and adults generally can provision only themselves and one pup. Survival of silverbacked jackal pups is food limited and the addition of helpers to

the family correlates significantly with increased feeding rate and pup survival.

In golden jackals, pup survival also correlated significantly with the presence of helpers ($R_s = .36$, $P<0.05$), but there is more variability and the correlation is weaker. This difference appears to be related to differences in food resources and climatic conditions. Golden jackals live on the short grass plains and pups are born during the wet season when the migratory herds are in residence. Golden jackal pups are fed Thomson gazelle fawns and meat scavenged from carcasses of gazelle, wildebeast, and zebra. Golden jackal pairs provision their pups at a rate two to three times that of silverbacked pairs. Golden jackal helpers are less critical in terms of provisioning pups although both male and female helpers supply food at a rate similar to silverbacked helpers. Their contributions are simply a smaller percentage of the total feeds. Golden jackal pups are better provisioned and guarded than silverbacked pups, but fewer survive at 14 weeks of age due to density independent events, e.g. rainstorms that flood dens.

In these two sympatric species of jackal, differences in habitat, vegetation, and food resource size and availability correlates with species differences in strength of pair bond, dispersal of one-year-old jackals, pup provisioning and guarding, pup survival, and cooperative breeding.

Analyses withing Canidae on the allometry of neonate weight and litter size relative to female body weight revealed new insights to canid reproductive systems. As females get larger (1.5 - 31.1 kg, 18 species) the log-log linear regression of neonate weight versus female body weight has a slope of 0.76 ($r_s = .97$). The log-log

linear regression of litter size against female body weight yields a slope of 0.33 ($r_s = .72$). Thus, female canids have large prepartum investment and as body weight increases will require more postpartum assistance for provisioning and defending their increasingly larger litters of proportionally smaller neonates. As body weight increases both prepartum costs of raising litters are increasing.

Among Canidae (37 species) the basic mating system is long-term monogamy, a system that is rare among mammals. A review of the continuum, of small to large canids reveals persistent trends in feeding ecology, sex ratio, dispersal, mating systems, and neonate rearing systems. Small canids (<6.0 kg) are monogamous with a tendency towards polygyny, an adult sex ratio skewed towards females, female helpers, and dispersal biased towards males. Allometric analyses correlate in that smaller canid females which produce smaller litters of more developed neonates will require less postpartum male investment. As predicted by theory on parental investment and sexual selection there will be less competition by females for males, a tendency towards male dispersal, a polygynous mating system, and females that help and nurse communally. Medium-sized canids (6.0-13.0 kg, e.g. jackals) have equal sex ratios, equivalent sexual emigration, equal sex ratio of helpers, and observations at present indicate that they are strictly monogamous. Paternal investment is critical to pup survival and females do not share that investment. Large-sized canids (>13 kg) are monogamous with indications of polyandry, have sex ratios skewed towards males at birth, females emigrate, and most helpers are male. Large females require a lot of investment in their large litters of relatively altricial offspring. A female cannot afford dilution of these contributions by sharing them with other females. Competition for males can be intense and infanticide of subordinate females' litters has been observed.

Ecological parameters, in particular food resources, can affect feeding ecology, breeding strategies, and reproductive success. Although sex ratios and sex biases in helping vs. dispersing correlate with the body scaling trend, resource availability and feeding ecology also correlate with home range/territory size, group size, and litter size. Small canids are typically solitary foragers. Medium-sized canids are facultative cooperative hunters, and large canids are usually obligatory cooperative hunters. Exceptions to the allometric relationships observed in Canidae (e.g. arctic foxes, maned wolves) correlate strongly with type and availability of food resources and the energetics of foraging.

Within Canidae, the allometry of neonate weight and litter size vs. maternal body weight imposes critical requirements for the successful rearing of young in terms of postpartum investment by adults in addition to the mother.

Allometry can provide important insights to the origins of social organization and cooperative breeding in Canidae. However, the availability of food and the potential for nutritive input to the mother and pups can have dramatic effects on this equation.

The main objectives of continued jackal research are to examine 1) developmental behavior of littermates, their social interactions with peers, older siblings, and parents and the correlations of these data and ecological factors with who stays and who disperses, 2) relative success in dispersal of one versus two-year-old jackals, and 3) the energetic roles of type, size, spatial, and temporal availability of food in feeding, spacing, mating, and cooperative breeding systems. In order to further investigate the role of diet and feeding ecology in social behavior and organization the research will be expanded to include a third sympatric species of jackal (Canis adustus) whose diet is primarily insects.

COOPERATORS

THE DEPARTMENT OF NATURAL RESOURCES OF PUERTO RICO

MONA ISLAND CENTER FOR ENVIRONMENTAL EDUCATION AND RESEARCH

In 1973, the Department of Natural Resources (DNR) of Puerto Rico was entrusted with the administration of Mona Island, a remote island off the west coast of Puerto Rico. Whales, coral reefs, giant rock iguanas, sea turtles, precolumbian artifacts and many endemic plant species make Mona a valuable place for research and environmental education programs. Seven animal species that live or nest on the island are protected by the U.S. Endangered Species Act. Three of these species are not found anywhere else in the world.

DNR hopes to establish a Center on Mona for environmental education and research. The Center will combine the efforts and expertise of DNR with that of the University of Puerto Rico to make the island accessible to the local and international scientific community. The Center will serve three primary functions: promoting scientific research, making Mona known to citizens through conservation education programs, and fostering community service and outreach activities.

Mona Island is one of the few islands of its size in the Caribbean to have no permanent settlements. The vegetation, which belongs to the subtropical dry life zone, is comprised of 9 natural plant associations yet 80 percent of the plateau is dominated by dense short woodland. Six species of plants are endemic to Mona, one of the most interesting being the spidery tree cactus Harrissia portoricensis.

There is a small landlocked red and white mangrove stand covering less than 1 hectare on the western coastal terrace. Near the abandoned lighthouse on the east coast, tree cacti of two species have developed into a dense forest nearly 6 meters high.

Terrestrial vertebrates on Mona include the endemic coqui, 10 species of reptiles, 9 of which are endemic and 4 of which are considered endangered, roughly 100 bird species and 9 mammal species. The rock iguana, Cyclura stejnegeri, which is now protected by the U.S. Endangered Species Act, is found all over the island. Its total population is estimated at between 2000 and 4000 individuals. Other reptiles include the Mona boa and the endangered Monito gecko whose total population numbers only a few dozen.

Seabirds, fishing bats and introduced mammals such as pigs, goats and cats also populate the island.

Off Mona's coast, coral reefs of elkhorn and brain corals as well as seagrass beds can be found. Mona's beaches are designated critical habitat for the hawksbill turtle. The island supports one of the largest nesting and feeding populations of these animals in the Caribbean.

DNR is promoting the use of Mona Island for research and education by both local and international institutions. Research on oceanography, marine pollution, sea turtle population dynamics, coral reef ecology, ecology of dry forests and plant succession studies are just a few of the topics of projects which have been carried out by various institutions from both Puerto Rico and the mainland United States.

Additional information about Mona Island and research possibilities there can be obtained by writing Jose Vivaldi, Department of Natural Resources, P.O. Box 5887, Puerta de Tierra, Puerto Rico 00906.

COOPERATOR NOTES

A Sweet Potato Working Group, coordinated by Frank Martin of the USDA-ARS Tropical Agriculture Research Station and sponsored by the American Association for Horticultural Science, Tropical Region, has been formed to exchange information about and study the potential of the sweet potato. The group consists of a group of individuals from the Caribbean Islands, northern South America, Central America and the southern United States who have an interest in breeding and in improving the culture or care and the uses and processing of this vegetable. To receive information about the working group or to become a member, contact Frank Martin, USDA-ARS, Tropical Agriculture Research Station, Box 70, Mayaguez, PR 00709.

In Puerto Rico, construction is beginning on the Department of Natural Resources' field center at Rio Abajo. Two houses, a garage, a nursery and an aviary will be the first buildings to go up. In February, DNR was the principal sponsor of a conference on "The Use of Mass Communications for Environmental Protection in the Caribbean Region." Coordinated by Victoria Dompka (MF '83), the conference and workshop brought in speakers from various governmental and non-profit organizations in the Caribbean. Country representatives from Costa Rica, Honduras, Haiti, Jamaica, the Dominican Republic, Barbados and Trinidad were on hand to give presentations on environmental media projects in their country. The proceedings from this conference will be published by TRI.

The Coast Guard just gave the Conservation Trust of Puerto Rico, the lighthouse in Fajardo, Puerto Rico. The Trust plans to restore the lighthouse to its original condition, adding a lab for marine research. The lighthouse is located on Cape San Juan where sea turtles nest and the adjacent lagoon supports a rich variety of bird life. The Trust also is in the process of restoring an 1880

coffee mill in Ponce. They plan to plant 84 acres with the plant varieties which were used at the original mill. The mill should be open to the public in about a year and it will be used as both an historic site and as an interpretive and training center.

In the summer of 1985, Cornell University initiated an inter-departmental program in agroforestry. This program aims to direct existing University expertise in the biological, physical and social sciences to facilitate increased interdisciplinary research, develop graduate level course instruction and thesis research advising capabilities in the area of agroforestry and to disseminate research findings through Cooperative Extension and development programs both in New York State and internationally. Anyone interested in additional information about this program should write: Dr. James P. Lassoie, Department of Natural Resources, Fernow Hall, Cornell University, Ithaca, N.Y., 14853.

We would welcome any news about programs or research projects that readers would like to send in. In each issue of TRI NEWS, there will be a "cooperator notes" section to share this sort of information. TRI has formal cooperative agreements with many institutions both within the U.S. and abroad. At present, these include: The Department of Natural Resources in Puerto Rico, The Institute of Tropical Forestry, the Center for Energy and Environment Research (both in Puerto Rico), Purdue University, Cornell University, The New York Botanical Garden, Centro Agronomico de Investigacion de Tropical Ensenanza (CATIE), Universidad Nacional Agraria - La Molina, Lima, Peru, and the Northeastern Forestry University in Harbin, China. Informal agreements exist with many institutions in the U.S., the Caribbean, Asia and Latin America.

TRI NOTES

TRI Director, William R. Burch, Jr., visited Costa Rica this fall to work out the arrangements of a grant that TRI, CATIE and the Universidad Nacional Agraria - La Molina in Peru received from the Tinker Foundation. The grant will initiate a program of Latin American natural resource education involving student, faculty and information exchange between these three institutions. In addition, Dr. Burch recently returned from Thailand where he journeyed during the semester break to serve as a consultant for FAO. His assignment was to advise in the development of a social forestry curriculum at Kasetsart University in Bangkok.

In December, Peggy Rasmussen, Assistant Director, and several School students, attended the Conference on Tropical Forest Conservation sponsored by the Smithsonian Institution, Friends of the National Zoo and the World Wildlife Fund. Sixty experts presented their papers. Topics of discussion at the conference ranged from reserve systems and cultural parks to indigenous agriculture and forestry practices. Seven masters' students and six recent School graduates also attended the conference.

In the first week of February, Peggy Rasmussen and Katherine Snyder, Assistant to the Director, attended the conference on the "Use of Mass Communications and Environmental Protection in the Caribbean Region" in Puerto Rico. They also visited TRI cooperators in the both Puerto Rico and the Virgin Islands.

The TRI advisory group held its first meeting at the School this year on March 3 and 4. Advisors who attended were: Dr. Mason Carter, Head of the department of forestry and natural resources at Purdue University; David A. Harcharik, Director of International Forestry with the U.S.D.A. Forest Service; Robert O. Blake, Senior Fellow with the International

Institute for Environment and Development; Hilda Diaz-Soltero, former Secretary for the Department of Natural Resources of Puerto Rico; Ghilleen T. Prance, Senior Vice President for Science at the New York Botanical Garden; and Gregor Wolf a 1984 graduate of the School and representative from CARE. Mr. Wolf stood in for John Michael Kramer, Program Coordinator for CARE. During the two days of meetings, discussions focused on the education and research program, communications and the sustainability of the Institute. Other members of the TRI advisory group are: Gerardo Budowski formerly of CATIE, Jefferey Burley of the Commonwealth Forestry Institute, David Challinor from the Smithsonian Institution, Marc Dourojeanni from Universidad Nacional Agraria, La Molina - Lima, Peru, Victor Gonzalez from Celta Agencies, Inc., Peter Huxley from ICRAF, Thomas E. Lovejoy from World Wildlife Fund, Ariel Lugo from the Institute of Tropical Forestry and John Sullivan from AID.

The symposium on "Utilization without Conversion: Natural Management of Tropical Moist Forests" which was scheduled for March 7 and 8 has been postponed and is tentatively rescheduled for the fall of 1987. The papers will be published in a book that will be available before the symposium.

On April 21, the International Natural Resources Group and TRI sponsored a symposium on "Development Aid and the Environment: Issues and Perspectives" sponsored by the International Natural Resource Group and the Tropical Resources Institute. The symposium addressed issues surrounding the influence of development aid on the environment and natural resources of developing countries. Speakers included Michael Curtin from the Inter-American Development Bank, Jeremy Warford of World Bank, Barbara Bramble of the National Wildlife Federation, Gus Tillman from Associates

for Rural Development and David Runnalls from the International Institute for Environment and Development.

Under a recently signed cooperative agreement between the School and the Northeastern Forestry University in Harbin, China, four professors from the University traveled to the School this fall to meet with faculty and to visit the Hubbard Brook Ecosystem Center in New Hampshire. Other visitors to the School included the Vice Chancellor of Tamil Nadu Agricultural University in India, Dr. Gerardo Budowski from CATIE who gave two lectures on agroforestry and met with students and faculty, Dr. Gill Shepherd from the Overseas Development Institute in London, and Dr. Peter A. Huxley from the International Council for Research on Agroforestry (ICRAF). Dr. Huxley held an open discussion on ICRAF and current research trends in agroforestry. In addition, Dr. Huxley gave a demonstration of a micro computer model which predicts the productivity and sustainability of tree/crop associations.

This year, Dr. Thomas Siccama took three field trips to Puerto Rico to study the variety of ecosystems on the island. These trips are 10 days long and take place over Thanksgiving and Spring Break.

This semester, Dr. Ramachandra Guha from the Centre for Studies in Social Sciences in Calcutta is a visiting lecturer at the School. He is teaching a course on the social aspects of forestry in developing countries with a focus on India. Dr. Guha received a B.A. from Delhi University and a Ph.D. from the Indian Institute of Management and has had his research published in such journals as the Economic and Political Weekly, the South Asian Anthropologist, and The Statesman. Currently, Dr. Guha is serving as a consultant on the United Nations University - World Institute of Development Economics Research pro-

ject on "Technology Transfer: Alternate Approaches." Also at the School this semester as a visiting fellow is Dr. Harry Blair, head of the Political Science Department at Bucknell University. Dr. Blair, who has served as a consultant to U.S.A.I.D., FAO and the Ford Foundation, just returned from a six-month stay in India and Bangladesh where he was doing research on social forestry. In April, TRI hosted Dr. K.G. Tejwani from the International Centre for Integrated Mountain Development in Nepal. Dr. Guha, Dr. Blair and Dr. Tejwani gave presentations in a panel discussion on Forestry and Environmental Issues in India and South Asia. Also in April, TRI hosted Dr. J. Bandyopadhyay from the Indian Institute of Management in Bangalore. Dr. Bandyopadhyay gave a talk on "Dynamics of Forest Degradation in the Himalayas."

The Seminar on Energy and Rural Development Strategies which is sponsored in part by the Conoco, Inc. and the A.W. Mellon Foundation has brought in speakers from a wide range of academic disciplines and from the government and the private sector to explore problems relating to energy and society. Topics in the seminar this semester have ranged from "Productive Community Settings for Sustainable Society" to "Hydro Power Transfer Between Quebec and the Northeastern and Midwestern United States."

TRI received a grant from the Tinker Foundation to establish a Latin American program of natural resource education with CATIE and Universidad Nacional Agraria in Peru. The first steps in this program will occur this summer when TRI will send two students to CATIE for internships. This fall a student from CATIE will enroll in the Ph.D. program at the School.

The masters' students who interned in Puerto Rico and the Virgin Islands this summer currently are finishing reports on their work. These reports

will be published as TRI working papers. Steve Miller and Susan Pilling spent a month in Puerto Rico accumulating information for the Tropical Ecosystems Ecology course offered each fall and spring semester. They visited new and previously visited sites for potential use as examples of the island's geology, hydrology, life zones, forestry, agriculture and land use. Information packets made from this information will be used as supplements in the field.

Edgardo Gonzalez worked with the Department of Natural Resources Forest Service on completing an inventory of the Rio Abajo forest which contains a large quantity of quality hardwood plantations. The inventory will be used to develop a comprehensive management plan for a sustainable yield of forest products. Edgardo helped develop a computer program to analyze the general inventory data generated from this study.

Betsy McGean and Ken Andrasko spent the summer in Puerto Rico and the U.S. Virgin Islands evaluating the current

status and progress of three UNESCO Biosphere Reserves. This study was a comparative analysis of the three reserves as they were operated by three different agencies: the Virgin Islands National Park, the U.S. Caribbean National Forest and Puerto Rico's Guanica State Forest.

Mark Dillenbeck, in conjunction with the Department of Natural Resources Forest Service conducted an economic analysis of line planting of mahogany in the Luquillo National Forest. In addition, he evaluated the economic feasibility of line planting of mahogany for private individuals and for public and private concerns in other countries as well.

Lisa Hilli worked with the U.S. Fish and Wildlife Service on a study of the Sooty Tern colony on Flamenco Peninsula, Culebra, Puerto Rico. She took a census of the colony three times during the breeding season in 1985 to determine the habits of these birds and the reasons for the decline in their population.

LITERATURE

Each issue of TRI NEWS will contain a list of recent tropical publications, received or noted by the Forestry and Environmental Studies Library. The publications selected will emphasize those aspects of tropical resources that TRI has chosen to specialize in -- secondary forest management, natural reserves, and bioenergy.

The bibliographic citations used to prepare the lists are maintained in a TRI microcomputer database in the Library. Presently, this database supports the School's TRI program, but we envision a wider role for it within the international tropical community. To achieve that goal, we wish to build

into the database the most comprehensive record of current technical reports and in-house documents of tropically oriented agencies and institutions. These kinds of publications are often difficult to locate, and TRI NEWS can serve as a clearinghouse for the listing, indexing, and, eventually, the dissemination of such documents. We are asking, therefore, that readers of TRI NEWS send us copies of their reports and in-house documents to be incorporated into the database. Each issue of the Literature section in TRI NEWS will contain a listing of documents received, together with a brief annotation. Searches and printouts of the database will be available to our cooperators and readers upon request.

Agricultural compendium for rural development in the tropics and subtropics. Elsevier Scientific Publishers. 1983. 739 pp.

Agroforestry; a lesson from the third world. Woods, F. W. ; Ostermeier, D. *The Futurist*, 19:24-26, 1985.

Agroforestry as an aid to rational rural development in Vanuatu. Neil, P.E. ; Jacovelli, P.A. *Commonwealth forestry review*, 64:259-266, 1985.

Amazon; limnology and landscape ecology of a mighty tropical river and its basin. Sioli, H. ; ed. Dr W. Junk B V Publishers, *Monographiae biologicae*, 56, 1984. 763 pp. Available from Kluwer-Boston.

The appraisal of rural water supplies. McNeill, D. *World development*, 13:1985. Includes comment by G. B. Baldwin.

Assessment of forestry management problems and issues; a Delphi approach. Ministry of Natural Resources, Philippines, Natural Resources Management Center, 1980. 59 pp.

Basic procedures for agroeconomic research. International Rice Research Institute, 1984. 229 pp.

Bibliography of forestry in Puerto Rico. Mosquera, M. ; Fehelley, J., eds. Forest Service, General technical report SO-51, 1984. 196 pp.

Los bosques de Puerto Rico. Lugo, A. E. ; ed. Institute of Tropical Forestry, Forest Service, USDA ; Departamento de Recursos Naturales, Puerto Rico, 1983.

Bush fire and agricultural development in Ghana. Korem, A. Ghana publishing corporation, 1985. 220 pp.

Can technology save the tropical forest? *Bioscience*, 34(6):350-352, 1984.

Central-America's tropical rain forests; positive steps for survival. *Ambio*, 12(5): 232-238, 1983.

Changes in shifting cultivation in Africa. Forestry Department. FAO. FAO forestry paper 50, 1984. 59 pp.

Coconut wood; processing and use. Haas, A. ; Wilson, L. ; eds. FAO forestry paper 57, 1985. 57 pp.

Coffee rust in the Americas. Fulton, R. H. ; ed. American Phytopathological Society, Symposium book, 2, 1984. 120 pp.

Community forestry for revitalising rural ecosystems--a case study. Singh, A.K. ; and others. *Forest ecology and management*, 10:209-232, 1985.

Compensatory recruitment, growth and mortality as factors maintaining rain forest tree diversity. *Ecological monographs*, 54(2):141-164, 1984.

Computerized bibliography of the energy for rural development reference collection. Santerre, M. East-West Center, Resource Systems Institute, 1982, 423 pp.

Costa Rican natural history. Janzen, D. H. ; ed. University of Chicago Press, 1983.

Delivery systems for rural development in India; a field view of institutional linkages. Ray, A. *Public administration and development*, 5:353-362, 1985.

Ecology of the Lake Manyara elephants. Weyerhaeuser, Rick. Yale School of Forestry and Environmental Studies, 1982, 270 pp.

Economics of agricultural development in tropical Africa. La-anyane, S. John Wiley & Sons, 1985. 153 pp.

The effect of soil nutrients and light on the tree growth and interactions during tropical forest succession; experiments in Costa Rica. Muston, M. A. University Microfilms International, 1984. 276 pp.

Effects of human activities on Zambia's Kafue flats ecosystems. Sheppe, W.A. Environmentalist, 12:49-57, 1985.

Environmentally sound small-scale forestry projects; guidelines for planning. Ffolliott, P. F. CODEL/VITA, 1983. 109 pp.

The environment, public health and human ecology; considerations for economic development. World Bank, 1985. 294 pp.

Farm and community forestry. Foley, G. ; Barnard, G. International Institute for Environment and Development, Technical report 3, 1984. 236 pp.

Field guide to Uganda forest trees. Hamilton, Alan. Makerere University, Kampala, 1981, 279 pp.

Food and fruit-bearing forest species. 1: Examples from Eastern Africa. FAO forestry paper 44/1, 1983. 171 pp.

Food and fruit-bearing forest species; examples from Southeastern Asia. FAO forestry paper 44/2, 1984. 167 pp.

Forest farming. Douglas, J. S. ; and others. Intermediate Technology Publications, 1985. 207 pp.

Forest tree improvement. FAO forestry paper 20, 1985. 271 pp.

Forestry in land use policy for Indonesia. Ross, M. S. University of Oxford, Ph.D. Thesis, 1984. 266 pp.

Forestry in the Himalayas--how to avert an environmental disaster. Nautiyal, J.C. Interdisciplinary science reviews, 10:27-41, 1985.

Fuelwood and charcoal use in developing countries. Sathaye, J. ; Meyers, S. Annual review of energy, 10:407-430, 1985.

Fuelwood in Kenya; crisis and opportunities. O'Keefe, P. ; Raskin, P. Ambio, a journal of human environment, research and management, 14:220-224, 1985.

Genetics and conservation; a reference for managing wild animal and plant populations. Schonewald-Cox, C. M. ; and others, eds. Benjamin/Cummings Publishing Company, 1983.

Guia de los parques nacionales de Costa Rica. Boza, M. A. Fundacion de Parques Nacionales, 1984. 128 pp.

Handbook for mangrove area management. Hamilton, L. S. ; Snedaker, S. C. ; eds. East-West Center, Environment and Policy Institute, 1984. 123 pp.

Handbook of tropical food crops. Martin, F. W. ; ed. CRC Press, 1984. 296 pp.

Improved woodburning cookstoves; signs of success. Baldwin, S. ; and others. Ambio, 14: 1985.

India's action plan for wildlife conservation and the role of voluntary bodies. Singh, S. Environmentalist, 5:31-38, 1985.

Indigenous construction materials programmes--lessons from Ghana's experience. Ofiri, G. Habitat international, 9:71-80, 1985.

Issues in population pressure, land resettlement, and development; the case of Nepal. Shrestha, N.R. ; and D. Conway. Studies in comparative international development, 20:55-82, 1985.

IUCN directory of neotropical protected areas. Commission on National Parks and Protected Areas. Tycooly International Publishing Ltd, 1982. 436 pp.

Jari revisited--changes and outlook for sustainability in Amazonia's largest silvicultural estate. Fearnside, P.M. ; Rankin, J.M. *Interciencia*, 10:121-129, 1985.

Loss of productive soil in India. Jalees, K. *International journal of environmental studies*, 24:245-250, 1985.

Management of large mammals in African conservation areas. Owen-Smith, R. N. HAUM Educational Publishers, Pretoria, 1983. 297 pp. Proceedings of a symposium held in Pretoria, South Africa, 29-30 April 1982.

Managing elephant depredation in agricultural and forestry projects. Seidensticker, J. World Bank, 1984. 33 pp.

Man-made vegetation changes: an example from Botswana's savanna. Van Vegten, J.A. National Institute of Development and Cultural Research Documentation Unit, University College of Botswana, Working paper no. 40, 1981, 81 pp.

Natural systems for development: what planners need to know. Carpenter, Richard A. ; ed. Macmillan Publishing Company, 1983. 485 pp.

A new technique for monitoring bacteriological quality of water in relation to water-borne diseases. Gopal, R. ; and others. *Annals of the arid zone*, 23:229-234, 1984.

Non-conventional water resources. 1. economics and experiences in developing countries. M. R. Brewster, M.R. ; Buros, O.K. *Natural resources forum*, 9:65-76, 1985.

Opportunities and constraints for organizations to help sustain tropical forest resources. Hyman, E.L. *Environmental management*, 10:11-20, 1985.

Patterns of indigenous timber extraction from Moluccan rain forest fringes. Ellen, R.F. *Journal of biogeography*, 12:1985.

People's participation in farm forestry; a case study in West Bengal. Sen, D. ; and others. *Journal of rural development*, 4:441-481, 1985.

People's participation in watershed management; a case study of DVC. Jaiswal, N. K. ; and others. *Journal of rural development*, 4:409-440, 1985.

Physiological ecology of plants of the wet tropics. Dr. W. Junk Publishers, Tasks for vegetation science 12, 1984. 254 pp. Proceedings of an international symposium held in Oxatepec and Los Tuxtlas, Mexico, June 29-July 6, 1983.

Planning and environmental risk in Kenyan drylands. Bernard, F.E. *Geographical review*, 75:58-70, 1985.

The Planning and management of integrated rural development in drylands-- early lessons from Kenya's arid and semi-arid lands programmes. Wiggins, S. *Public administration and development*, 5:91-108, 1985.

Rainfall, agriculture, livestock and human density in the dry regions of Kenya. Kalff, J. ; and others. *Journal of arid environments*, 9:1985.

A re-appraisal of forestry development in developing countries. Douglas, J. J. Martinus Nijhoff/Dr. W. Junk Publishers, *Forestry sciences*, v. 8, 1983.

Research policy and review 5. biomass energy problems and policies in Asia. Soussan, J. ; O'Keefe, P. Environment & planning, section A, 17:1293-1302, 1985.

Review of the possibilities for integrating cattle and tree crop production systems in the tropics. Payne, W.J.A. Forest ecology and management, 12:1-36, 1985.

Satellite remote sensing of total herbaceous biomass production in the Senegalese Sahel, 1980-1984. Tucker, C.J. ; and others. Remote sensing of the environment, 17:233-250, 1985.

Second Bangladesh National Conference on Forestry; proceedings, Dacca, January 21-26, 1982. Bangladesh Forest Department, 1982, 604 pp.

Seminar proceedings; current and planned research in relation to reafforestation, woodlot and firewood. Tietema, T. ; ed. National Institute of Development Research and Documentation, Gaborne, Botswana, 1984. 37 pp.

Soil erosion and sediment transport research in tropical Africa. Lal, R. Hydrological sciences journal, 30:239-256, 1985.

Soil erosion from tropical arable lands and its control. Lal, R. Advances in agronomy, 37:183-248. 1984.

Soil management for optimized productivity under rainfed conditions in the semi-arid tropics. Elswaify, S ; and others. Advances in soil science, 1: 1-65, 1985.

A soil suitability guide for different tillage systems in the tropics. Lal, R. Soil and tillage research, 5:179-196, 1985.

Sundarbans wildlife management plan; conservation in the Bangladesh coastal zone. Seidensticker, J. ; Hai, M. A. International Union for the Conservation of Nature and Natural Resources, 1983. 120 pp.

Survey of conservation priorities in the Lesser Antilles, preliminary data atlases: Aruba, Barbuda, Bonaire, Curacao, Grenada, Martinique, Montserrat, Nevis, St. Kitts, St. Lucia, St. Vincent, Saint Martin/Sint Maarten, Anguilla, Antigua, Guadeloupe, Saba, St. Eustasius. Eastern Caribbean Natural Area Management Program. Caribbean Conservation Association, University of Michigan School of Natural Resources, and the United Nations Environment Programme, 1980.

Technical notes on comparative costs of solar, wind and diesel pumping at village sites in Nigeria and Somalia. Lovejoy, D. Natural resources forum, 9:77-80, 1985.

Tropical rain forest; ecology and management. Sutton, S. L. ; Whitmore T.C. ; Chadwick, A. C. ; eds. Blackwell Scientific, Special publication 2, British Ecological Society, 1983. 491 pp.

Tropical rainforest; the Leeds Symposium. Chadwick, A. C. ; Sutton, S. L. ; eds. Leeds Philosophical and Literary Society, Central Museum, Leeds, U. K. 1984. 335 pp. Companion volume to Tropical rain forest; ecology and management, Special publication no. 2, British Ecological Society, 1983.

Tropical silviculture: principles and techniques. Nwoboshi, Louis C. Ibadan University Press, 1982, 333 pp.

The Village that fought back. Cross, M. New scientist, 105:1985. Success story of Minigo, Tanzania.

Water quality in hydroelectric projects; considerations for planning in tropical forest regions. Garzon, C. E. World Bank technical paper number 20, 1984. 33 pp.

Watershed forest influences in the tropics and subtropics; a selected, annotated bibliography. Williams, J. ; Hamilton, L. S. East-West Center, Environment and Policy Institute, 1982. 217 pp.

Wood energy and preservation of woodlands in semi-arid developing countries; the case of Dodoma region, Tanzania. Allen, J.C. Journal of development economics, 19:59-84, 1985.

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Avifaunal reflections of historical landscape ecology in Puerto Rico. Brash, A. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, paper no. 3, 1985. 20pp.

Composition and structure of a subtropical moist secondary forest in the limestone region of central Puerto Rico. Ashton, P.M.S. ; Lowe, J.S. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no 4, 1985. 27 pp.

Computer geographic information systems to manage biogeographic data for the design of habitat reserves; a study for the Puerto Rico Conservation Data Center. Backus, E. H. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 5, 1985. 49 pp.

The demand for non-wood softwood products in Puerto Rico. Boething, H. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 6, 1985. 32 pp.

Descending from the upper reaches: a chemical analysis of a rain forest stream. Ceraso, J. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 7, 1985. 23 pp.

Diaz sin escarcha; Yale's Tropical Resources Institute in Puerto Rico. McConnell, C. ; Ceraso, J. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 8, 1985. 50 pp.

An interpretation of discussion at a workshop on: the human factors affecting forestry/fuelwood projects: an agenda for research and development. Burch, W. R. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 1, 1985. 98 pp.

Interpreter's handbook for hacienda la esperanza. Gagnon, D. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 9, 1985. 90 pp.

Land use changes in rural Puerto Rico and attitudes toward reforestation. Clausi, R.E. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 10, 1985. 55 pp.

Orchids, coquis, and scorpions; natural history collections and environmental education in Puerto Rico. Rasmussen, P. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 11, 1985. 87 pp.

Population characteristics of the Hawksbill turtle (*Eretmochelys imbricata*); a case study of the Endangered Species Act. Olson, M. H. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 12, 1985. 7 pp.

Selecting sites for reforestation in Puerto Rico. Friday, J.B. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 13, 1985. 47 pp.

Site index curves of teak (*Tectona grandis* L.) in the Limestone Hill region of Puerto Rico. Friday, K. S. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 14, 1985. 47 pp.

Thinning guideline for teak (*Tectona grandis* L.) Larson, B. ; Zaman, M.N. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 2, 1985. 20 pp.

The underground feral goats of Mona Island. Haaser, J. Tropical Resources Institute, School of Forestry and Environmental Studies, Yale University, Working paper no. 15, 1985. 32 pp.

Forester's field guide to the trees and shrubs of Puerto Rico. Ashton, P.M.S. Tropical Resources Institute, 1985.

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