United States Department of Agriculture
Forest Service
Laurentian Ranger District
318 Forestry Rd.
Aurora, MN 55705
(218) 229-3371
(218) 229-3371 (TTY)
(218) 229-3773 (FAX)

Caring for the Land and Serving People

Reply to: 1550

Date: August 22, 1995

Ing. Oscar Manuel Nunez S.
Director RBSM
Defensores de la Naturaleza
Avenida Las Americas 20-21
Zona 14
Guatemala C.A.

Dear Oscar:

Enclosed is a revision of the appendix section of my 1994 report on ecological descriptions of the Sierra de las Minas. I edited soil descriptions based on Dr. Eunice Padley's work. Please replace the originals in my 1994 document with these replacements and transfer the color pictures.

I hope you continue to find this a useful document.

Sincerely,

Robin Vora

Robin S. Vora
Assistant Ranger

cc: Drs. Dix, University Del Valle de Guatemala
Olga Valdez, University San Carlos de Guatemala
Marie Claire Paiz, Defensores de la Naturaleza
Alex Dickie, U.S. AID, Guatemala
Doris Gerdes, Hiawatha National Forest
Eunice Padley, Regional Office, Milwaukee
Scott Lampman, International Forestry
Joe Torres, Green Mountain National Forest
Paul Schmidtke, Huron Manistee National Forest
Pete Weaver, International Institute of Tropical Forestry

RECOMMENDATIONS ON MANAGEMENT OF SIERRA DE LAS MINAS BIOSPHERE RESERVE, GUATEMALA

Land Use Planning
General Management
Priorities
Program Needs
Technical Recommendations
(ecological classification, inventory, monitoring, research)
Trip Summary (January 9-25, 1994)
Names and Addresses
Ecological Descriptions

July 14, 1994

Prepared by Robin S. Vora, USDA Forest Service, 318 Forestry Road, Aurora, MN 55705. Tel. 218 229 3371. FAX 218 229 3773. DG:R09F09D01A.

In colloboration with Andreas Lehnhoff, Oscar Nunez, Estuardo Secaira, Sergio Gomez, and Marie-Claire Paiz, Defensores de la Naturaleza, Avenida Las Americas 20-21, Zona 14, Guatemala C.A. (c/o Postal Club Internacional, 7907 N.W. 53 Street Suite #445, Miami, Florida 33166). Tel. 373897-370319. FAX 682648.

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Executive Summary

Issues related to management of the Sierra de las Minas Biosphere Reserve include conservation and enhancement of biological diversity, social welfare, fire protection, soil conservation, water production, road access, logging interests, and land tenure. Management will require enforcement of laws and regulations, use of permits, land acquisition, and relocation of settlements combined with environmental education and local economic development through sustainable forestry, agriculture, and ecotourism. The objective is to stabilize and improve the welfare of people who live within the reserve so they do not have to use the forests of the core zones to meet minimum subsistence needs.

The first step of a forest inventory should be the development of an ecological classification and inventory to be used as a framework for land management related to conservation, restoration, and sustainable development. Representative remnants of all ecosystem types should be protected and restored. Changes in forest cover should be monitored annually using satellite imagery and aerial as well as on-the-ground inspections.

Watersheds should be managed uniquely to meet the needs of local communities and will require a substantial increase in on-the-ground staff during the next 5-15 years. The goal should be to get the residents of the watershed to "adopt" their watershed and conserve its natural and cultural resources, and eventually reduce the need for management oversight by Defensores de la Naturaleza. New roads, for example, should not be built unless the community or landowner will cooperate with closing or obliterating them.

Management of the reserve will require parallel and complementary programs in biological resource knowledge, migratory birds from North America, global climate change research, law enforcement (including control of hunting), ecological restoration/reforestation, fire management, environmental education, human ecology, assistance and education of women, land tenure, minor forest products, sustainable timber management, sustainable agriculture, energy forestry, and ecotourism. The report contains a preliminary needs assessment for each of these program areas. Development of programs for fire management and reforestation are the highest priority for new work. The Sister Forest Program with U.S. National Forests in the Lakes States, along with other groups, can help with long-term program institutional development.

Also contained in this report are technical recommendations regarding: ecological classification; permanent research and monitoring plots; silvicultural examination for forestry and agroforestry; timber marking, cruising scaling, logging, and monitoring; research on silvics and effects of management practices; research on watersheds and ecological restoration, including nursery development; and inventory and monitoring of plant and animal populations and habitats.

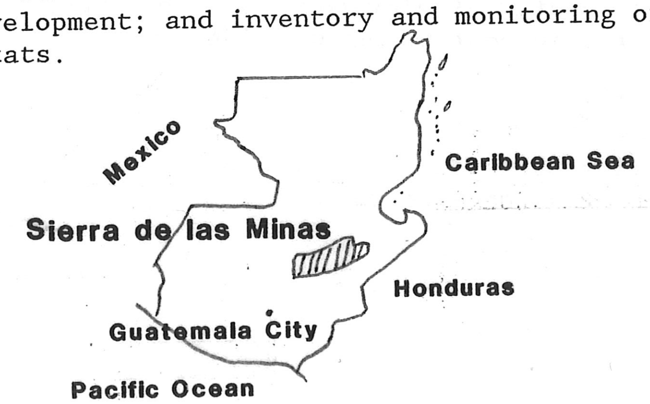


Table of Contents

I. Consultation Objectives (from Oscar Nunez and Andreas Lehnhoff, Defensores de la Naturaleza, letters March 15 and November 22, 1993 and personal communications with Jim Culbert, U.S. Forest Service International Forestry, Doris Gerdes U.S. Forest Service Region 9 Sister Forest coordinator, and Claudio Saito of U.S. AID in Guatemala City.

A. Analyze and discuss land use planning, jurisdictions, and forestry potential in the Sierra de las Minas Biosphere Reserve, Guatemala.
B. Continue a general needs assessment.
C. Design a forest inventory for the Sierra de las Minas Biosphere Reserve.
D. Assist in finding financial sources for completion of planned inventory.

II. Sierra de las Minas

A. Description

Sierra de las Minas was declared a protected area in 1990. The biosphere reserve is a mountain chain that runs east-west and is bordered on the north and south by two rivers. It is approximately 130 km long and 10-30 km wide (236,300 ha). Elevations vary between 150 m and 3015 m. Rainfalls range from 4,000 mm/year to 500 mm/year. Diverse vegetation communities include pine-oak forests, cloud forests, humid tropical forests, and dry tropical forests. These forests are known especially for their tropical conifers (6 genera, 13 species) and as important habitat for over 885 vertebrate species. It is the largest area of essential habitat for the endangered resplendent quetzal, the national bird of Guatemala. Access into the reserve core is very difficult. About 55% of the reserve is in private ownership and 60% remains in forest. The reserve includes 140 communities. Subsistence slash and burn agriculture and uncontrolled forest product extraction occur, especially on the wetter north side of the reserve. Land tenure is more established on the south side. Defensores is resolving property ownerships and has initiated a community forestry initiative. Current forest products include firewood, sawtimber (pine), medicinal plants, animals for food (subsistence hunting and trapping), and vines used for ropes, baskets, and ornaments. The reserve is an important source of water as 63 rivers run down the mountain slopes. The southern rivers provide water for agriculture, electricity, and light industry in Motagua Valley, the driest part of Guatemala. Subsistence crops such as maize, beans, and cabbage are grown with cash crops such as coffee, tobacco, tomatoes, melon, cucumber, cardamon, brocolli, sugar cane, and rice.

B. Zonation of a Biosphere Reserve

Biosphere reserves are intended to be sustainable partnerships between human societies and Nature (Gregg et al. 1989). Gregg (1991) states that the generally accepted or suggested scheme is to have a core area that is minimally disturbed. Surrounding the core is a buffer zone which may support experimental research, recreation, silviculture, low-intensity agriculture such as agroforestry, scattered small settlements, and other low intensity uses. Surrounding the buffer is a transition zone, or zone of cooperation, which is the main area for involving local people in sustainable development, forestry and agricultural extenstion, and education. It may include research and demonstration projects.

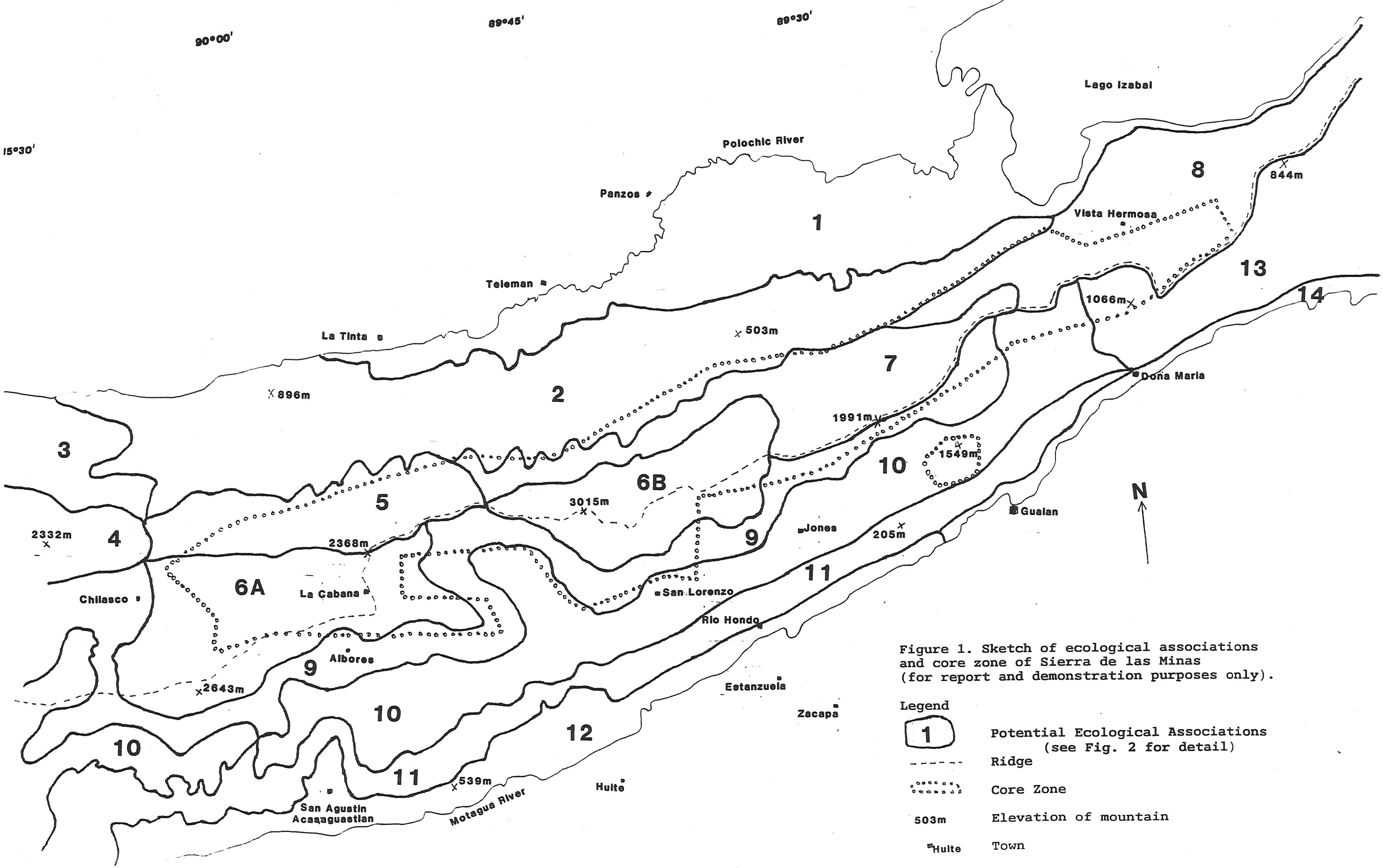


Figure 1. Sketch of ecological associations and core zone of Sierra de las Minas (for report and demonstration purposes only).

III. General Land Use Planning and Management

A. Resources

1. Natural Resources (Campbell 1982, Dix 1984, CDC-CECON 1984, various Defensores de la Naturaleza, The Nature Conservancy, and World Wildlife Fund publications).
    a. Five to seven Holdridge life zones, including cloud forest communities.
        1) Bosque humedo montano bajo (lower montane moist forest)
        2) Bosque muy humedo montano bajo (lower montane wet forest)
        3) Bosque pluvial montano bajo (lower montane rain forest)
        4) Bosque seco premontano (premontane dry forest)
        5) Bosque muy humedo premontano (premontane wet forest)
        6) Bosque pluvial premontano (premontane rain forest)
        7) Monte espinoso (thorn forest)
    b. 885 known vertebrate species (70% of mammals, birds, and reptiles that occur in Guatemala and Belize combined)
    c. Many endangered species
    d. 70 - 100 known endemic species, including 35% of plants endemic to Guatemala
    e. Close to 2,000 recorded plant species
    f. High genetic and species diversity of tropical conifers - 6 genera, 13 species
    g. High diversity of oaks - 14 species
    h. 33% of Guatemala's orchids (230 species, 25 genera?)
    i. 60% of the remaining quetzal habitat (cloud forest) in Guatemala
    j. Large block of subtropical montane forest - 102,800 ha in core, numerous remnants surrounding core, especially on upper slopes
    k. 63 rivers that are an important source of water

2. Cultural Resources
    a. Three ethnic groups
        1) Q'eqchi (Polochic drainage)
        2) Poqomchi (Matanzas - Upper Polochic drainage)
        3) Ladino
    b. Highest peaks are sacred to Q'eqchi
    c. Three pre-Columbian archaeological sites (Rio Zarquito, Tinajas, and Pueblo Viejo). San Agustin Acasaguastlan was an early colonial mission.
    d. Some agricultural systems have been developed by local people over long periods of time (e.g., fruit orchards)

B. Resource Management Issues

1. Conservation and enhancement of biological and ecological diversity in light of expanding human settlement and related advancement of the agricultural frontier.
2. Social welfare of residents of reserve.
3. Fire protection
4. Soil conservation
5. Improvement of water supply to Motagua Valley in dry season
6. Road construction or improvement that may expand human settlement
7. Logging interests of companies outside the reserve
8. Land tenure - most of the accessible land outside the core zone is

privately owned or of uncertain ownership.

C. Management goals for Sierra de las Minas (Defensores de la Naturaleza 1992):
1. Maintain the diverse ecosystems, biodiversity, genetic resources and forests (overall, all zones)
2. Protect natural water sources and watersheds for their socio-economic importance in the area surrounding the reserve
3. Promote use of sustainable natural resources for benefitting local populations.
4. Achieve community participation in the management and protection of the reserve.
5. Promote scientific study of the ecosystems and their biological and genetic wealth, for their recognition and their beneficial importance to the country and humankind alike.
6. Preserve unique scenic values.

The Master Plan for Sierra de las Minas (Defensores de la Naturaleza 1992) divides the reserve into four zones:
1. Nuclear, where the emphasis is on conservation of natural environments and limited ecotourism;
2. Multiple use and sustainable zone, where sustainable forestry is the purpose;
3. Buffer, where more intensive forestry and other community projects including agriculture may be practiced;
4. "Recovery zone", where watershed, wildlife, and forestry resource rehabilitation are the goals (Teculutan watershed).

D. Alternative approaches to accomplishing goals within the framework of the Master Plan:
1. Enforcement of laws and regulations, use of permits, land acquisition, relocation of human settlement into the buffer zone or outside the reserve.
2. Environmental education combined with local economic development through promotion of sustainable forestry, agriculture and ecotourism.
3. Combination of 1 and 2 above (preferred alternative).

The objective of the second alternative approach is to stabilize and improve the welfare of people who live within the reserve outside the core zone so they do not have to use the forests of the core zone to meet minimum subsistence needs. Development should not attract additional settlement of the reserve by people who presently live outside the reserve.

E. General Management Recommendations (excluding inventory and monitoring):
1. Core Zone
   a. Continue strict protection and law enforcement

   b. Acquire private lands (2/3s of core is owned privately)

   c. Relocate settlements (3) to mutually agreeable locations

   d. "Delimit" or blaze a red line to core area boundaries on the ground

e. Develop limited ecotourism

f. Make available as a site for non-destructive research.

g. Think big and assess biodiversity conservation needs at various scales.

2. Multiple Use, Buffer and Recovery Zones

a. Expand the reserve or create new reserves to include very dry tropical forest adjacent to Motagua River Valley, flooded tropical moist forest in the Polochic River Delta, and a connecting corridor to Cerro San Gil reserve (within Sierra de las Micos to the east of Sierra de las Minas and south of Lake Isabal).

b. Use an ecological classification as a framework for land management related to conservation, restoration, and sustainable development.

c. Maintain or restore remnants of ecosystems not represented in core - ideally 500-1,000 ha. or larger blocks linked to larger forested areas by corridors. Acquire these lands if not presently owned. Some units, 2 ha or larger, should be retained in natural forests in floodplains that have been converted otherwise to agriculture.

d. Maintain 50 m or wider corridors of natural forest on each side of perennial streams, where possible.

e. Manage each major watershed or group of small watersheds uniquely to meet the needs of local communities. The goal should be to get the residents of the watershed to "adopt" their watershed and conserve its natural and cultural resources, and eventually reduce the need for management oversight by Defensores.

To achieve this goal, substantial on-the-ground staff will be needed during the next 5-15 years. Assign watershed manager and sufficient staff to ideally have one forestry/natural resource extension agent for each 2-5 communities and one agricultural agent for each 2-5 communities. These extension agents would also do environmental education and rely on field headquarters for professional advice. Given perhaps 30 watershed management units and 140 communities, this would require at least doubling present staff. Additional funding Q. 1,150,000/year (US $200,000/year) would be needed to increase staff. See Fundacion Defensores de la Naturaleza (1993) for more details.

f. Many parts of the reserve, especially in the southside, are in need of natural forest restoration. Begin a reforestation program, using local genetic stock suited to the site, within the following areas listed by priority:

1) Areas of significant soil erosion
2) Areas where natural tree seed sources no longer remain
    a) Areas above 1500 m in the Motagua River drainage that are potential cloud forests.
    b) Other areas
3) Sparsely forested areas
    a) Above 1500 m.
    b) Other areas

g. Initiate or continue sustainable forestry and sustainable agriculture. With the possible exception of coffee which has been grown for 150 years, long-term sustainability of practices are unproven for Sierra de las Minas as well as much of the rest of the world. Forestry and agroforestry will result in simplified forests lacking the diversity of natural forests of the northside. Develop forestry and agricultural systems that also serve as habitat for native wildlife and as biological corridors connecting natural forests.

h. Do not build new roads unless the community and landowners will cooperate with closing or obliterating them. The cost of road maintenance is high and roads are the source of significant soil erosion. Roads should be maintained and new road construction should be coordinated with Caminos Rurales. A transportation system plan should be prepared prior to any major new road construction.

i. Develop a fire management plan for each watershed and for the reserve as a whole.

j. Think small and primarily in relation to the welfare of local people.

IV. PRIORITIES FOR ADDITIONAL FUNDING

A. Present primary programs and organization of Defensores de la Naturaleza (Defensores de la Naturaleza 1993)

1. Present emphasis programs
    a. Fundraising and institutional development
    b. Land acquisition and conservation easements
    c. Protection of wildlands
    d. Rapid Ecological Assessment of core zone
    e. Quetzal migration study
    f. Environmental education -- communities, decision-makers
    g. Social surveys
    h. Sustainable agriculture
    i. Sustainable forestry

2. Infrastructure
    a. 3 managers
    b. 4 technical leaders
    c. 30 field personnel (resource guards, extension agents)

d. 5 administrative personnel
e. Headquarters office in Guatemala City (computers, library)
f. Central field office and quarters in Salama
g. 4 district field offices (Jones, Chilasco, Zacapa, Teleman)
h. 4 guard shelters
i. 2 scientific stations, including quarters
j. Radio communication system (10 units)
k. 6 trucks, 6 motorcycles

B. Priorities for new program development

In addition to continuiing with present programs, the following program development priorities were identified from program needs assessments (section V) through discussions with Andreas Lehnhoff and Oscar Nunez of Defensores de la Naturaleza. Funding sources are varied and realistically Defensores will have to initiate and carry-out several parallel programs at the same time, some modified to simultaneusly meet the goals of donor organizations. See Section V Program Development Needs for more detail on the pririoties listed below.

Emphasis Programs (in addition to present work)

Develop an ecological classification and inventory to serve as a framework for management

Develop a fire management program

Develop a nursery-reforestation program

Personnel

Hire 46 additional extensionists over 3 years -- Q1,150,000/yr ($200,000/yr)

Hire 15 additional park guards -- Q375,000/yr ($65,000/yr)

Hire a nursery-reforestation coordinator -- Q75,000/yr ($12,900/yr)

Training

Extensionists in reforestation -- Q10,000/yr ($1700/yr)

Extensionists in timber management -- Q10,000/yr ($1700/yr)

Encourage a Guatemalan graduate student to complete an ecological classification for a dissertation in a U.S. University -- $30,000 for 2 yrs

Encourage 2 Guatemalans to complete the Environmental Education program at University of Idaho sponsored by U.S. AID -- $30,000

Many other formal and on-the-job training opportunities exist in Central America.

Local fire suppression -- Q10,000 ($1700/yr)

Foreign Advisors

Fire specialist from USFS or Honduran Forest Service to set-up fire management program (3 months in mid-February to mid-May) -- $25,000

Nursery-reforestation expert for 1 year assignment -- up to $150,000 (much cheaper if expert is from Central America)

Sister Forest coordination and assistance (joint activities) -- $12,000 budgeted in 1994, actual costs are higher (funded by U.S. Forest Service).

Applied Research

Research on sustainability of minor forest products (one per year by Guatemalan student -- Q10,000/yr ($1718/yr).

Ecological descriptions and elevation profiles (4-6 transects) --Q30,000($5200)

Supplies
Aerial photos (1:20,000 to 1:30,000) outside core zone in each watershed -- Q10,000 ($1700)? Plotter for GIS -- $10,000
Nursery supplies -- Q250,000/yr ($43,000/yr)

Summary of first year costs for priority assistance by program in addition to present program:

Biological resource knowledge	-- Q175,800 ($30,200)
Law enforcement	-- Q375,000 ($65,000)
Ecological restoration/reforestation	-- Q667,000-960,000 ($115,000-$165,000)
Fire management	-- Q155,500 ($27,000)
Environmental education	-- Q175,000 ($30,000)
Minor forest products	-- Q 10,000 ($1718)
Sustainable timber management, energy forestry, and sustainable agriculture	-- Q1,170,000 ($201,000)
TOTAL (excluding Sister Forest Program)	-- Q2,718,300 - 3,011,300 ($467,000 - 517,000)

See section V for additional assistance needed by program area.

C. Potential sources of funding (present support noted in paranthesis)

1. U.S. AID (small NGO grants, social analyses and developing industries, protected area studies in Lake Izabel region, updating CECON and establishing a computerized data base, policy and technical support, short- and long-term training including degree programs, farm to market roads, and planning economic growth and conservation in forestry)*
2. The Nature Conservancy (institutional development, establishment and management of the core zone, Rapid Ecological Assessment, quetzal study, social analyses)*
3. World Wildlife Fund (social analyses, developing industries, sustainable agriculture)*
4. CARE (agriculture, agroforestry, environmental education, wildland protection, social analyses)*
5. Peace Corps (2 volunteers at present, several in the past)
6. USDA Forest Service (Sister Forest program, Robin Vora's consultation)
7 RARE (quetzal project)
8. USDI National Biological Survey (Robbins and Dowell bird surveys)
9. Institute of Natural History of Chiapas (quetzal project)
10. Price-Waterhouse (computerized accounting system audits)
11. National Fish & Wildlife Foundation
12. National Wildlife Federation
13. UNDP
14. OTS (Organization for Tropical Studies)
15. Tropical study foundations in Central America
16. Minnesota DNR LCMR project
17. IUCN
18. Sweedish Children for Rainforest?
19. COSECHA, Honduras (soil conservation and agriculture)

20. Individuals and conservation groups in Guatemala, including:
21. Water users in Motagua Valley
22. Guatemalan government, CONAP (11 park or resource guards)
23. DIGEBOS or Direccion General de Bosques
24. CDC-CECON, San Carlos University (Rapid Ecological Assessment)
25. University del Valle (work of Hector Centeno and Drs. Dix)
26. FUNDEMABV or Fundacion del Medio Ambiente para Baja Verapaz (environmental education)
27. ALTERTEC (organic agriculture)
28. Becas para la Paz
29. AAB or Asociacion Amigos del Bosque
30. AGHN or Asociacion Guatemalteca de Historia Natural/Zoologica Nacional
31. Asociacion Guatemalateca Pro-defensa del Medio Ambiente
32. APROFAM or Asociacion Pro-Biensestar de la Familia
33. CONAMA or Comision Nacional del Medio Ambiente
34. CONAPEA or Comision Nacional Permanente de Educacion Ambiental
35. Comision Nacional de Adecuacion Curricular
36. INGUAT or Instituto Guatemalteco de Turismo
37. Museo Nacional de Historia Natural
38. Sociedad Audubon de Guatemala
39. Comite Departamental de Defensa del Medio Ambiente
40. Fundacion Centroamericana de Bosques Tropicales
41. Partners of the Americas

*PACA (Environmental Project for Central America or Proyecto Ambiental para Centro America) -- partnership among CARE, The Nature Conservancy, and U.S. AID to assist local communities with derivation of benefits from protected areas they live next to, while simultaneously protecting those areas from devastation.

V. PROGRAM DEVELOPMENT NEEDS

The following program development needs were identified in collaboration with Andreas Lehnhoff, Oscar Nunez, Estuardo Secaira, and Marie-Claire Paiz of Defensores de la Naturaleza. We identified objectives, current management practices, potential or recommended management practices, and assistance needed for the following program areas:

Biological resource knowledge
Migratory birds from North America
Global climate change research
Law enforcement (including hunting)
Ecological restoration/ Reforestation
Fire management
Environmental education
Human ecology
Assistance and education of women
Land tenure
Minor forest products
Sustainable timber management
Sustainable agriculture
Energy forestry
Ecotourism
Sister Forest Program

See also Defensores de la Naturaleza (1993) for an outline of a plan for 1988-2004 and Fundacion de la Naturaleza (1993).

Programs overlap. Some potential projects or assistance needs (e.g., ecological classification) are identified in more than one program area. Conservation of biological diversity is the ultimate purpose for Sierra de la las Minas Biosphere Reserve and all programs outlined in this section are designed to contribute towards that goal.

A. Biological resource knowledge

Objective: Gain a better understanding of the biological and ecological resources in order to improve conservation practices.

Current program and studies completed:
Facilities at La Cabana in pine-oak cloud forest above Albores.
Rapid Ecological Assessment (CDC, CECON of San Carlos University and Nature Conservancy assistance). Draft report January 1994.
Ecological descriptions of elevation gradient in San Lorenzo area (Drs. Michael and Margaret Dix, University del Valle). Unpublished.
Quetzal migration study (Marie-Claire Paiz and other Defensores staff in cooperation with George Powell of RARE and Nature Conservancy). Ongoing.
The biogeography of the cloud forest herptofauna of middle America, with special reference to the Sierra de las Minas of Guatemala (Jonathan Campbell, University of Kansas). Unpublished Ph.D dissertation. 1982.
Tree ferns in Reserva de Biosfera Sierra de las Minas. 1992.
Investigacion en Passalidos (Dr. Schuster).
Orchid studies (Drs. Dix)

Potential Program (see technical recommendations in section IV for detail):
1. Staff and visitors record species observations and exploitation, and and changes in vegetation.
2. Describe ecosystems using profiles -- 4 to 6 transects.
3. Develop an ecological classification and inventory to serve as a framework for management, including identification of ecosystem types not protected in core zones. Incorporate Mayan ethno-taxonomy into the classification.
4. Develop species and ecosystem catalogs.
5. Survey existing literature and ongoing research.
6. Use existing screening criteria and methods for ranking species and habitat, community, or ecosystem vulnerability.
7. Make a list of rare, endangered, and endemic species ecosystem, community/habitat types.
8. Collect population data on the highest priority rare and keystone species and habitats, communities, or ecosystems.
9. Monitor changes in forest cover annually using satellite imagery and aerial and on-the-ground inspections.
10. Monitor species groups, communities, or ecosystems as well as populations or population indices of highest priority rare and keystone species, .
11. Remeasure Rapid Ecological Assessment every 10 years (mark transects permanently in the field and record locations with GPS).
12. Establish permanent plots outside the core area to monitor long-term ecological changes (dominant plant species).
13. Publish a book on natural history of Sierra de las Minas with detailed accounts of selected life forms.

Assistance Needed:
1. Train park guards and extension agents in species identification -- Q10,000 ($1700).
2. Contract ecological descriptions using 4-6 transects -- Q30,000 ($5200).
3. Graduate student to attend U.S. university and complete ecological classification for thesis or dissertation with faculty assistance -- $30,000 for two years.
4. Hire permanent staff wildlife biologist -- Q75,000/yr ($12,900/yr).

5. Hire permanent staff botanist/ecologist -- Q75,000 ($12,900/yr).
6. Biological inventories conducted by students, volunteers -- Q30,000/yr ($5200/yr).
7. Biological research conducted by graduate students with faculty help -- Q30,000/yr ($5200/yr).
8. Plotter for GIS -- $10,000.
9. Set up weather stations in each ecological association.

B. Migratory birds that breed in North America.

Objective: Gain a better understanding of habitat relationships and population trends of migratory birds from North America.
Present program:
Some species data from Rapid Ecological Assessment.
Data from surveys by Henry Louie, Peace Corps volunteer, Chandler Robbins and Barbara Dowell (1992), USDI National Biological Survey, and others.
Background: A risk analysis by Droege and Peterjohn (1992) of North American migrants observed in Sierra de las Minas showed the following as priority species (listed in declining priority rank with highest priority first): Golden-cheeked Warbler (endangered), American Swallow-tailed Kite, Golden-winged Warbler, Peregrine Falcon (endangered), Vaux's Swift, Hermit Warbler, Blue-winged Warbler, Prothonotary Warbler, Chestnut-sided Warbler, Hepatic Tanager, Hooded Oriole, Worm-eating Warbler, Louisiana Waterthrush, Northern Waterthrush, Purple Martin, Belted Kingfisher, and Whip-poor-will. See Table 2 in the appendix for more detail.
Potential program:
1. Develop catalogs of species and habitat relationships.
2. Survey existing literature and ongoing research.
3. Use existing screening criteria and methods for ranking species and habitat, community, or ecosystem vulnerability (see "background" above).
4. Collect population data on the highest priority species and their habitats, communities, or ecosystems.
5. Monitor populations or population indices of highest priority species or species groups, and related habitats, communities, or ecosystems.

Assistance Needed:
1. Staff wildlife biologist (see previous page).
2. Equipment (mist nets) -- $1,000
3. Bird inventory and monitoring (3 people + support) -- Q75,000/yr ($12,900/yr).

C. Global Climate Change Research
Sierra de las Minas offers a good opportunity for international research into global climate change using changes in ranges of plant species as an indication of climate change. Several species (e.g., _Acer skutchii_, _Liquidamber styraciflua_, _Taxus globosus_) are at the southern edge of their range and others (e.g., _Podocarpus oleifolius_) are at their northern limits in the Sierra de las Minas (Dix 1994). Change may be noticed relatively quickly on the steep slopes of the Sierra de las Minas. Research methodology might include mapping the present edge of species distribution using GPS and GIS systems.

D. Law Enforcement.

Objectives:
Protect remaining natural forest in core areas.
Minimize illegal take of plant and animal species (Sierra de las Minas does not have surplus populations of hunted species to develop hunting programs).
Enforce laws and reserve regulations.
Resolve land tenure problems

Present program:
15 park guards, several part-time
Environmental education (see section VG)

Potential program:
Hire 15 additional park guards -- Q375,000/yr ($65,000)
Training for park guards -- Q5,000 ($900).
"Delimit" or blaze in red paint the boundaries of the core zones (ideally done cooperatively by park guards and adjacent communities).

E. Ecological restoration/reforestation

Objectives:
Restore natural forests, including stream restoration and soil conservation.
Grow more forests for sustainable timber, firewood, and other forest products.
Present management practices:
Some private farms and communities have started conifer plantations and maintained them over the past 20 years.
CAMCORE helped establish a tree seed bank in Guatemala City. One also exists in Siguatepeque, Honduras.
Proposed program:
Research on establishment of natural forests (see technical recommendations in section VI.E and F)
Need to work on all ownerships and need community commitment for protection.
Develop local seed collection provenances, collect local seed, and grow seedlings for reforestation.
Plant 3,000 ha over the next 5 years and maintain plantations. See general land use planning recommendations in section III.E.2f for priority areas for reforestation.
Develop more efficient methods of planting (present cost for 2m x 2m planting, both seedling purchase and labor, is Q5,000/ha ($350/acre).
Develop a nursery program (potential for community or cottage industry).
Assistance needed:
Regional support and funding from water users in Motagua River Valley.
Planting 600 ha/yr (present costs) -- Q3,000,000/yr ($515,500/yr).
Maintain plantations (years 1,2,3 & 6) -- Q1,920,000/yr ($330,000/yr).
Outside expert to develop nursery program -- up to $150,000 for a year (much cheaper if expert comes from Central America).
Hire in-house nursery coordinator -- Q75,000/yr ($12,900/yr).
Train extension agents in nursery/reforestation -- Q10,000/yr ($1700/yr).
Supplies for 50 small community nurseries operated by extension agents -- Q250,000/yr ($43,000/yr).

F. Fire Management

Objectives:

Reduce the number of human-caused fires

Develop a fire suppression organization with the capability of controlling fire

Present program:

Some printed fire prevention material

Training course in fire prevention

Potential program components:

1. Fire management plans for each watershed in south and west sides, and for the reserve as a whole.
2. Environmental education (fire prevention).
3. Cooperative agreements with landowners to protect investments.
4. Training and equipment.
5. Sufficient local staffing for normal fire years.
6. Contingency plans for outside assistance for major fires and especially during drought years (perhaps one in 15 years).
7. Support of local law enforcement authorities.
8. Work with ranchers to find ways to reduce burning (perhaps increase productivity of some areas to concentrate grazing).

Assistance needed:

U.S. Forest Service and Honduran Forest Service (COHDEFOR) assistance with major fires.

Outside fire management specialist to set up program (3 month assignment from mid-February to mid-May) -- $25,000.

Fire fighting tools -- $5,000 1st yr, $3,000 2nd yr, $1,000 each yr after.

Local fire suppression training -- Q10,000/yr ($1700/yr)

G. Environmental education

Objective: while addressing poverty, educate the peoples who live in the Sierra de las Minas, or influence or benefit from it, about protection and conservation of natural resources. The goal should be to get the communities in each watershed to "adopt" that watershed and eliminate the need for management by the government or outside NGOs. Also, learn from locals and modify techniques based on local experience.

Present activities:

All programs include an environmental education component.

Meetings are conducted with local decision-makers (heads of communities, military, religious leaders).

Workshops in larger cities (information, specific issues).

Formal education of local teachers (cities and rural areas).

Additional potential activities:

Workshops at local levels (information, specific issues).

Evaluation of effectiveness of current programs.

Assistance needed:

Hire two professionals (one for 2 districts) -- Q150,000/yr ($25,800/yr).

Training for extension agents -- Q10,000/yr ($1700/yr).

Materials and local radio programs -- Q100,000/yr ($17,200/yr).

2 Guatemalans complete Univ. Idaho environment education program sponsored by U.S. AID -- $30,000.

H. Human ecology

Objective: For each settlement, gain an understanding of social entities, economic systems, and current use of the land and resources.

Present evaluations:
Social diagnosis of all communities (52) in Chilasco district that included demography, health care, agriculture and forestry practices, perception and knowledge of natural resources, and social aspects of land tenure.
Social and natural resource diagnosis of five communities with an emphasis on forestry.
Social research of land and resource use in the Jones area by Guillerno Santos of San Carlos University.

Future needs:
Develop a practical method for social diagnoses that extension agents can use.
Develop methods for working with each community to achieve management objectives.
Do social diagnoses in communities outside Chilasco district.

Assistance needed:
Hire 2 social science assistants -- see section V.G, Environmental Education.
Educate staff about local ethnic groups -- Q5000 ($900).

I. Assistance to and education of women

Background: Women traditionally transfer values and knowledge to future generations. Men often leave seasonally to work on banana or coffee plantations.

Objective: Teach women appreciation of nature and rational use of natural resources.

Current program:
Primarily in indigenous areas (Polochic), environmental education conducted in conjunction with:
1. Efforts to improve living conditions.
2. Improvement of cooking to maximize nutritional values of foods.
3. Improvement of family orchards.
4. Improvement of family health by promoting hygiene and use of medicinal plants.
5. Improvement of cooking stoves by making them more efficient.

Potential program:
Expand program to entire reserve.

Assistance needed:
Hire 2 program coordinators (supervisors) and 10 women extension agents (all women) -- Q300,000/yr ($51,600).
Training of extension agents -- Q10,000 ($1700).

J. Land tenure

Objectives:
Resolve uncertain ownerships
Acquire key lands needed to achieve reserve management goals
Relocate individuals or communities when essential to achieve management goals.

Present program
Three settlements in the core zone are being relocated to mutually agreeable sites.
15,075 ha (37,300 acres) were acquired between 1991-93.

Potential program
Additional lands may be acquired to achieve reserve management goals (e.g., mini-core areas to maintain remnants of ecosystems not represented in the core).
Resolve land tenure when essential to undertake management actions.

Assistance needed:
Hire realty or land tenure specialist -- Q75,000/yr ($12,900/yr).
Funds for land acquisition and conservation easements -- ?

K. Minor forest products
Objectives: Learn methodologies and develop programs for sustainable extraction of a multitude of small miscellaneous uses of forests.

Present minor forest products:
basket materials (cash product)
medicinal plants (destructive) include Peperconia maculosa and Ciparuna nicaraguensis for headaches, Cissampelos pareira for fever, Rubus adenotrichus for dysentery, Liquidamber styracifolia for irritation and wounds, Colubrina rechinata for itch, and Clidemia sitosa for fertility (Fundacion Defensores de la Naturaleza y El Fondo Mundial para la Vida Silvestre 1989).
base of tree fern for pots (destructive)
resin from pine for starting fires (destructive)
charcoal from oaks (destructive)
edible mushrooms (local market)
coniferous seeds
ornamental plants (destructive, especially orchids)

Present program: graduate student doing research on extraction of forest products for baskets. Studies have been done also on sustainable use of tree ferns and bamboo (University del Valle).

Program development:
Do an ethnobiological survey of uses of plants and animals by local peoples.
Determine long-term sustainability of use of each product, especially baskets.
Determine uses of potential medicinal plants for local people to heal themselves.
Use an ecological classification to identify potential and suitable sites for resource extraction.

Assistance needed:
Research on sustainability of each product by Guatemalan licenciatura -- Q10,000/yr ($1718/yr).
Program coordinator (forester or ecologist with MFP background) -- Q75,000/yr ($12,900).
Contract with Qeqchi medicine man for one year training of staff -- Q40,000 ($6900).

L. Sustainable Timber Management
Objectives:
Reduce or eliminate pressure on forest resources in the core zone by developing a sustainable community-based forestry program outside the core zone to contribute to the welfare of local peoples. Forest management should contribute significantly to conservation of biological diversity by maintaining many components of natural forests.

Present practices:
Local people have been cutting trees for centuries
DIGEBOS has approved many previous management plans (last in 1993).
Defensores and CONAP have approved two new management plans (one operational at present).
Private farms have done inventories and reforestation.
Hired a field forester in 1994.
Did stand inventories in Uaxinlan cooperative (750 ha)

Program development (see technical recommendations)
Use an ecological classification and land-use planning process to identify suitable sites.
Manage each watershed uniquely to meet local needs while protecting biological resources.
Defer timber management in areas that would require construction of major collector roads or where new local roads could not be closed or be obliterated after timber harvest.
Work within the confines of land tenure.
Map all existing forestry plantations.
Develop local markets for high valued wood products that don't require extensive forests (e.g., furniture?)
See technical recommendations regarding inventory, logging plans, monitoring, and research.

Assistance Needed:
Two more professional foresters -- Q150,000/yr ($25,800).
10 more forestry extension agents -- Q250,000/yr ($43,000/yr).
Training extension agents -- Q10,000/yr ($1700/yr).
Aerial photos for each watershed outside the core zone -- Q10,000 ($1700)?
Orthophotos for each watershed --
Research on natural forest management -- Q25,000/yr ($4300/yr).
Outside expert to assist with development of a combined and integrated program for collection, storage, and processing of data (1 month) -- $10,000.

M. Sustainable Agriculture

Background: 140 communities within the reserve. Much of the area outside the the core zone is owned privately and land tenure on the upper slopes of the north side is uncertain.

Objectives:
Soil Conservation.
Improve agricultural productivity in converted sites near or in villages to alleviate pressure on forests and control expansion of the agricultural frontier.

Current Management Practices:
Contour planting
Minimum tillage -- till half (uphill) of rows and incorporate organic matter and "green manure" (legumes, e.g., velvet bean an exotic, and scarlet runner bean at higher elevations).
Living and stone barriers to control erosion on slopes
Organic practices such as liquid fertilizer (extracted from fermentation of of some plants), botanical insecticides (e.g., garlic, hot peppers, marigolds), and composting.
Coffee has been grown for 130 years using an agroforestry approach. Madre de cacoa (Gliricidia) and chalum (Inga) are often used for shade trees. Some organic coffee plantations (certified by OSCIA) in the upper Polochic Valley obtain cash prices that are 25% higher.
Use of permanent crops such as cardoman (sometimes planted with trees).
Use of nitrogen-fixers in living fences.
Family orchards (knowledge of use of local fruit trees has been passed down over the centuries).

Present field staff: field manager and 18 extension agents.

Potential Management Practices (see Manolis 1992)
Use an ecological classification and land use planning to identify suitable sites.
Develop agroforestry techniques with a long-term forestry component (e.g., taungya -- seasonal crops grown with initial stages of tree plantations).
Alley cropping -- combined food crops and nitrogen-fixing trees (living barriers are an example).
Pasture with nitrogen-fixing trees.

Assistance needed:
36 more extension agents -- Q900,000 ($155,000).
Training by local institutions (ALTERTEC in organic agriculture, CARE in agroforestry, COSECHA in Honduras in soil conservation and extension) -- Q10,000-30,000/yr ($1700-5000/yr).
Orthophotos for each watershed --

N. Energy Forestry
Objective: Reduce pressure on natural forests by growing firewood in or near settlements.
Current management practices:
Living fences
Re-growth of fallow sites
Firewood plantations

Program development:
Use an ecological classification to determine suitable sites
Do more of current management practices

Assistance needed:
Extension agents (see sustainable timber management and agriculture)
Research on reforestation and natural forest management (see technical recommendations)
Outside expert to develop program and train staff in social forestry (1 year) -- up to $150,000.
Staff specialist in social forestry -- Q75,000 ($12,900).
Orthophotos for each watershed --

O. Ecotourism
Objective: Develop a small-scale community-based program to bring income from outside into local communities thereby making local peoples less dependent on extraction of forest products or agriculture, and also enable them to view the forest as an economic asset. The program should complement, not compromise biodiversity objectives.
Potential pitfalls: Much of the land surrounding the core is in private ownership. Excessive development could harm natural forests and increase immigration of people from outside the reserve. Tour agencies from outside the reserve would take profits away from local people. Tourism will introduce social and cultural change in indigenous peoples.
Present facilities:
Don Carlos and family maintain an unadvertised hotel at Albores.
Difficult access limits use.
Potential program development:
Specialized ecotour groups such as birders or orchid societies (no collection).
In addition to Albores-La Cabana, small-scale developments may be profitable at Vista Hermosa, Jones, San Lorenzo, Chilasco, and perhaps La Tinta or Teleman (operated by coffee growers across the river?). The Polochic River Valley may be more intriguing to foreign visitors because of Mayan culture and more tropical-like forests, but difficult access presents a problem. Any hotels should be small and located in villages rather than in the core.
Develop products for sale in tourist markets elsewhere in Guatemala. A graduate student from University del Valle is presently studying this in association with baskets from Chilasco.
Assistance needed:
Hire staff to develop program -- Q75,000yr ($12,900/yr).
Develop products for tourist sale elsewhere.
Make connections with proper tour groups in U.S. and Europe that will be sensitive to local needs and cultures -- $10,000 travel funds.
Information exchange with other countries where ecotourism is more developed (e.g., Costa Rica, Mexico) -- $5,000 travel funds.

P. Sister Forest Program

Objectives (from 2 Feb. 1994 Sister Forest meeting)
Committment to a long-term relationship among partners and their institutional development.
Conservation of natural resources from a global perspective.

Potential Program (Robin Vora's recommendations based on his site visit and earlier discussions, not from 2 Feb. 1994 Sister Forest meeting or April 1994 field visit)

1. Information exchange
   a. Maintain library.
   b. Each partner send copies of publications of interest to other.
2. Promotional materials.
3. Assistance with preparation of proposals.
4. Assistance with finding sources of supplies.
   a. Forestry field equipment (I gave them a water-proof field notebook, loggers tape, diameter tape, and 2 BAF prism (all metric).
   b. Printer for GIS.
   c. Aerial photos, including orthophotos.
   d. Nursery supplies.
   e. Fire management supplies.
5. Assistance with coordination and accomplishment of training.
   a. Ecological classification -- graduate study in U.S.
   b. Environmental education -- University of Idaho (funded by U.S. AID).
   c. Forest management -- U.S. Forest Service class in Michigan.
      1)Andreas Lehnhoff, Oscar Nunez.
   d. Provide Oscar Nunez the opportunity to become fluent in English (live with U.S. families to improve English).
      1)Forest management class (see above), or
      2)Enroll for a quarter at a U.S. university, or
      3)One to three month assignment on a Lakes States National Forest.
   e. Provide Defensores managers the opportunity to gain additional insights and ideas on management by observing management of a U.S. National Forest. Offer Andreas a one-month Deputy Forest Supervisor assignment and the others a one-month Assistant Ranger assignment on a Lakes States National Forest.
6. Assistance with coordination of land use planning and program or project accomplishment.
   a. Jointly develop prototype management plans for one or more watersheds.
   b. Fund Jerry Bauer for 10 or more days to serve as a liason in Guatemala, perhaps using U.S. AID PASA funds.
7. Technical assistance through site visits, including temporary assignments.
   a. Fire management program development (3 months in Sierra de las Minas).
   b. Nursery-reforestation program development (1 year in Sierra de las Minas).
   c. Sister Forest team visits (see below).
   d. Robin Vora return for one week to the Polochic River drainage to complete preliminary recommendations for land use planning, assessment of management needs and priorities, and recommendations for inventory, monitoring, and research.
8. Sponsor small annual international workshops with the location alternating between the Lakes States and Guatemala.
   1) 8 Guatemalan participants (four from Defensores).

    2) 8 U.S. participants (including NGOs).
9. Assistance with fundraising.
    1) Assist Defensores with setting up an endowment to ensure long-term management and institutionalization of programs.

I participated in the February 1-2, 1994 Sister Forest Steering Committee meeting in Milwaukee and made verbal and written recommendations regarding program development, including a 1 1/2 week visit to Guatemala by 3 U.S. members in April and a 1-2 week visit by Guatemalans in the summer, 1994.

Table 2 in the appendix lists bird species observed in Sierra de las Minas that also breed in the northern Great Lakes, and provides information on habitat where seen and population risk status. Highest priority migrants to the northern Great Lakes appear to be (listed in declining priority rank with highest priority first): Peregrine Falcon, Golden-winged Warbler, Chestnut-sided Warbler, Belted Kingfisher, Whip-poor-will, and Wood Thrush. See Table 2 in the appendix for more detail.

VI. Technical Recommendations related to Program Development

A forest inventory should begin with an ecological classification and inventory and a mapping from satellite imagery of existing land use (forest, farm, pasture, residential, town).

A. Hierarchical multi-factor ecological classification
1. Objective: develop an ecological classification system and inventory that is used as a framework for land management related to conservation, restoration, and sustainable development. The system should be practical and not academic in orientation.

2. General approach
For management purposes it is useful to be able to describe landscape ecosystems or communities as discrete units and define them on maps and aerial photographs. At the lowest level of landscape scales (site), an ecosystem is a unit or area of land with a distinct combination of natural physical, biological, and chemical properties that causes it to respond in a predictable and relatively uniform manner to specified actions or stimuli applied by nature or humans. In a hierarchical classification the lower (more specific) units fit within separate units described by the next higher (less specific) level in that system. This permits aggregation of data at different levels of resolution for analyses. Such a classification organizes knowledge about these systems, depicts capabilities, and provides the potential for estimating or anticipating effects of management. It should enable one to map land areas, at various scales, that have common attributes and might respond in similar ways to conditions and activities. Common methods of description include: classification of recurring assemblages of topography, soil, and vegetation; ordination of vegetation along ecological gradients; and landscape profiles and maps showing spatial relationships (Mueller-Dombois and Ellenberg 1974).

Ecological classifications provide a framework for managing all biological resources (timber, minor forest products, grazing, wildlife, crops) (Barnes et al. 1982). Needed is a system that predicts present and future vegetation structure, composition, and dynamics of secondary succession, natural and human-caused disturbance, and alternate management prescriptions. A given existing canopy cover type may have a different successional pathway on different ecosystem types, and therefore may react differently to the same treatment. Landscapes should be classified first on an ecological basis (resource neutral) and then management interpretations made. Such a classification system will facilitate area analyses, planning of land allocations, and development of silvicultural prescriptions consistent with maintaining sustainable ecosystems, including site productivity and biodiversity. Lund (1986) presents a framework for integrating inventories.

Develop an ecological classification that integrates climatic zones, physiography, soils, and vegetation into a hierarchy of native landscape ecosystem types. Start with regional ecosystems and subdivide them into ecosystems at smaller scales. Use known information and extensive reconnaissance at larger scales and more intensive ecological classifications and stand mapping in buffer and transition zones where commodity production is to be emphasized. Learn and use features of local Mayan descriptions and classifications.

The following constraints should be put on methodologies to facilitate adoption by field managers:

1. It must be understood easily by managers;
2. Managers outside the demonstration area must be able to reproduce it easily and quickly;
3. It will take advantage of existing classifications, inventories, and methods already in use and understood by managers.
4. It must fit into current work mandates and charge.

3. Identification of regional ecosytems

a. Obtain forest cover type and density maps for Central America being completed at present by the U.S. Forest Service, Southern Forest Experimental Station (contact Susan Eggen-McIntosh, 601 338 3131). This will include mapping of four broad cover types at a resolution of 1 km^2. Types include temperate hardwood forest, conifer forest, tropical moist forest (trees > 15 m), and dry tropical forest (vegetation 5-15 m). This work should be completed by the end of 1994. These maps will permit coarse scale analyses across Central America and Mexico. Sierra de las Minas is in path 20, row 49, SW quarter scene (SW Guatemala).

b. Nations et al. (1989) describe four physiographic regions in Guatemala: Pacific Coast plains, Pacific Coast volcanoes, Central Highlands, and the Peten.

c. Sierra de las Minas is one of the east-west extensions of the Central Highlands. Donley's (19 ?) map of physiographic regions show the range at the juncture of sedimentary (north) and metamorphic (south) geologic formations with the Depression de Izabal to the north (Polochic) and Motagua to the south. These depressions correspond with major faults. Dix (1994) states that in the northern part of the biosphere reserve, palaezoic or older rock formations include schists and gneisses. These grade into tertiary metamorphosed amphibolites and marbles to the south, with belts of serpentine along the north western margin and the southern side of the range. Campbell (1982) provides a more detailed account of geology of Sierra de las Minas.

d. Holdridge's life zone maps for Guatemala and Central America provide a climatic overlay and also permit coarse scale analyses across Central America. The Holdridge system (Holdridge 1947, 1964) assumes a direct relationship between patterns of climate (primarily temperature and rainfall) and vegetation, with topographic, biotic, and edaphic factors having secondary influence. See section III.A.1 General Land Use Planning for a listing of Holdridge life zones in the Sierra de las Minas.

e. Using existing landsat imagery, geology, soils, topographic, rainfall, Holdridge life zone, and vegetation cover type maps, subdivide the broad regional ecosystems that include Sierra de las Minas into smaller ecosystems at lower scales in the hierarchy. For example, the north-facing slopes might be separated from the south facing slopes. Continue to subdivide and delineate ecosystems at hierarchical scales until sufficient resolution is reached to meet coarse-scale information needs for conservation of biological diversity. These ecosystems will generally be thousands of hectares in size and for convenience I will use the term ecological association to describe this level of the ecological hierarchy. References on classification of regional ecosystems include Albert et al. (1986) and Miller and Golden (1991). For demonstration only, I have included sketches of regional classification to the ecological association level (Fig. 1, 2). These need to be refined and mapped accurately with field verification.

4. Identification of local ecosystems.

a. The Rapid Ecological Assessment done by The Nature Conservancy and Centro de Datos para la Conservacion de Guatemala (CDC-CECON 1994) provides vegetation and related ecological information for four areas (each 1 km x 100m) in the core zone.

b. Conduct additional extensive reconnaissance of the reserve to: describe and map changes in vegetation with respect to elevation, aspect, slope, and soil; verify and refine ecological associations drawn from existing maps; identify potential ecosystem types at the site level; and begin a list of common plants by potential ecosystem types (association and site levels of hierarchy). Using existing roads and trails where possible, do 4-6 walking transects with a GPS unit Potential transect locations include:

Garcia-Vista Hermosa-Lake Izabal
Las Delicias-Jones-Panzos
Ojo de Agua-San Lorenzo-crest and Teleman to base of cliffs on north side
Magdelena-San Augustin A.-Albores-La Tinta
Morazan-Chilasco-Tucuru

Draw gradient profiles to more fully describe and depict biological and ecological conditions. References on extensive inventory include Mueller-Dombois and Ellenberg (1974) and Spies and Barnes (1985a). See the appendix for some ocular data we collected quickly at roadside points.

c. Establish weather stations in each ecological association. A station with automatic recording equipment that would be checked once a week could be installed for perhaps $1500 (each). Given the objective to provide local employment, it would perhaps be preferable to have just a max-min thermometer and rain gage checked once a day. Additional weather-related data that should be collected during the dry season for fire management should include wind-speed (anemometer), fuel moisture (fuel sticks and scale), and humidity (sling-psychrometer 3 times a day).

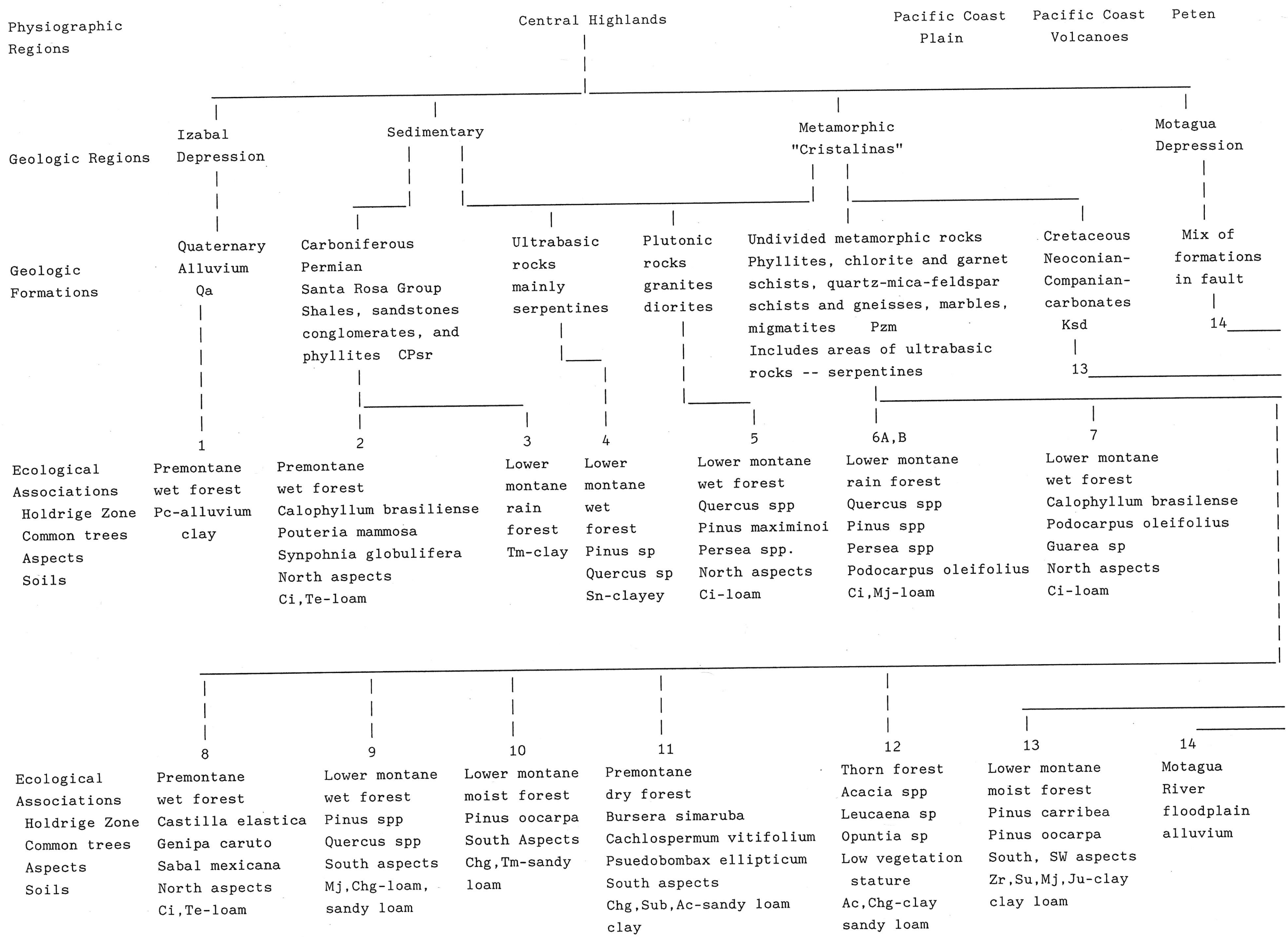


Figure 2. Schematic diagram of regional ecosystems (for demonstration purposes only, see Fig. 1 for map).

d. Conduct intensive inventory to verify and map ecosystem sites in ecological associations where watershed restoration or sustainable development is planned.

1). Evaluate suitability of existing aerial photographs. If necessary, contract for aerial photographs or videos (with GPS) at 1:20,000 to 1:30,000 scale for these ecological associations.

2). Derive relationships between aerial or satellite photos or videos and on-the-ground observations (extensive reconnaissance).

3). Stratify based on extensive reconnaisance and locate at least 5-10 plots (releves) within each potential ecosystem type. Record plot locations on maps (GIS) with a GPS. Minimum sample area should be estimated using nested plots to determine releve plot size. Collect data on vegetation (structure and composition), key wildlife habitat elements, soil, and landscape position. Possibly use a data-loader for computer input. Use Mueller-Dombois and Ellenberg (1974) and Spies and Barnes (1985b) as references. Analyze data and complete classification using state-of-the-art computer programs such as CANOCO (canonical correlation analysis) which allows inclusion of environmental as well as floristic relationships to describe ecological units. Report results.

The vegetation along the road from Ojo de Agua to above San Lorenzo, for example, offers a view of the diversity of ecosystem types at the site level including thorn forest of low stature with cactus and legumes, a narrow gallery forest, at least two types of premontane dry forest, alternating bands of forests dominated by *Pinus oocarpa* or oaks, marble outcrops with epiphyte-laden oak containing endemic agaves and epiphytic cacti, cliffs, mixed pine forests, and cloud forests of oaks with conifer groves (Campbell 1982, Dix 1994).

5. Identify and map ecosystems, especially high quality representatives, not presently protected in core areas. Evaluate designation of additional core areas to protect unrepresented ecosystems.

6. Identify ecosystems suitable for sustainable development (e.g., forestry, agriculture) and develop a range of management prescriptions with local involvement. These prescriptions could also predict resource production potential (e.g., site growth and yield of timber).

B. Permanent research and monitoring plots.

Research and long-term monitoring may be needed to provide information needed for conservation of biological diversity, management of resources on a sustainable basis, and public education. The Rapid Ecological Assessment classified broad vegetation types from satellite imagery. Four transect clusters were located in core zone of the reserve. In each cluster, plants were sampled using ten transects 4 m x 100 m coming off at right angles to a line one km long. Data were collected also on passalid beetles (Coleoptera), bats, rodents, butterflies, and birds and a report prepared (CDC-CECON 1994). I recommended marking the transects with permanent stakes and recording locations with a GPS as soon as possible, thereby making the plots permanent and facilitating long-term research and monitoring. Transects should probably be sampled again in 10 years. It took 12-15 days to sample each transect.

Additional permanent plots are not recommended until objectives of research or monitoring are well-defined. I recommend a committee of scientists and managers hold a workshop to define long-term research and monitoring objectives.

To accomplish such objectives, permanent sample plots may be needed in each ecosystem type in addition to the Rapid Ecological Assessment transects in the core. Releves used for ecological classification could be marked permanently in the field and locations recorded with a GPS. Many methodologies are available and the choice is dependent on objectives. See Lund et al. (1993) for a state-of-the-art review of methods. Plot design should take advantage of work done for Rapid Ecological Assessement or ecological classification. Plots should be remeasured at least every 10 years to estimate resource condition and trends.

To monitor timber growth and yield, for example, Alder and Synnott (1992) recommend between 50 and 1,000 stratified random plots depending on variation, with at least one plot per 1,000 ha. They recommend plots 100 m x 100m, subdivided into 25 20 m x 20 m quadrats. If this methodology is too intensive given resources available for management, Birdsey and Jimenez (1985) and Birdsey et al. (1986) demonstrated a simpler procedure using a cluster of three permanent sample plots to represent about 28 ha previously stratified by forest classes determined by aerial photography. The tables in their reports are good examples of data application. U.S. Forest Service forest inventories or monitoring of trends (FIA, Birdsey and Schreuder 1992) use double sampling for stratification. A large number of sample points are located on aerial or satellite photographs and a subset proportional to stratum size is sampled on-the-ground using permanent plots. Sample plots are post-stratified for analysis and screening and examples of classifications are ownership, forest type, stand-size class, and stand age.

One of the original primary reasons for this consultation was to design a comprehensive reserve-wide forest inventory with an emphasis on assessing the timber resource, perhaps something similar to the U.S. Forest Service's Forest Inventory Analysis (FIA) on a smaller scale. I do not recommend this as a high priority at the present time for the following reasons:

1. The management objective outside the core zone is to improve the welfare of local peoples living within the reserve, and thereby only indirectly support the regional or national economy. The reserve does not have to provide a sustained timber yield. Publication of inventory results will result in pressure from outside groups to timber exploitation.
2. Land-use planning, and ideally an ecological classification, are needed first to identify lands suitable for sustainable timber management.
3. Much of the land is unsuitable because of lack of access, steep slopes, or recommended stream buffers.
4. Much of the suitable land has already had its larger trees removed, and in many areas converted to agriculture and settlements or left treeless (Teculutan watershed).
5. Much of the land outside the core zone is in private or uncertain ownership and any management will have to meet the goals of the landowner.
6. Road construction for logging will expand human settlement unless roads can be closed or obliterated.
7. Long-term sustainability of timber management and its ecological effects are

unknown. Application of results of research and monitoring of ecological effects may further reduce the land base available for timber management.

8. The costs of a comprehensive forest inventory would be high because of poor access and highly diverse ecosystems. If not contracted, the project would consume considerable staff time that would be better spent on higher priority management. For example, it took a consultant two months to do an inventory of the forests of the Uaxilan cooperative (781 ha).

C. Silvicultural examination for forestry and agroforestry.

As mentioned, the first step is to use a land use planning process within each watershed, combined ideally with an ecological classification to identify areas best suited for sustainable forestry and agroforestry. For example, generally do not consider sites on poor rocky soils, greater than 40% slope, or within 50 m of a perennial stream. Carefully evaluate a transportation system of local and collector roads and its social and environmental consequences. It would be worthwhile to map and keep records of existing plantations because these areas will probably be managed again for timber. Social assessments should document what trees are being used for what purpose and where they are cut. An index of species abundance in relation to distance from the community could be noted. Consult with landowners, or potential landowners in the case of uncertain ownership, to determine interest in forest management. Resolve land ownership boundaries. Work with landowners to establish short and long-term objectives, including availability of the forest for timber harvest and management.

A silvicultural examination is conducted of available and suitable forests to determine and schedule appropriate forest management. These procedures can be used also to monitor changes in timber resources on five "farms" where Defensores would like to stop or control logging (in core?). Methodology varies from a determination from aerial photographs to a simple walk-through by trained personnel to intensive sampling to assist in preparation of a management prescription. Large forest areas with recurring forest types may be stratified using aerial photography and an ecological classification, and sampling is then done by stratum instead of stand to reduce sampling costs. The level of precision should be sufficient to determine if logging would be profitable to the landowner or community and if it can be carried out within silvicultural guides for sustainable forest management.

On maps and aerial photos of lands suitable for forest management, delineate stands (management units perhaps 2 to 100 ha) using ecological boundaries and roads. If quantitative data is needed to prepare a management prescription, use variable or fixed plot sampling to collect that data (timber volume, growth, forest structure, insect and disease risk). See Deusen and Boyle (1991) for a reference. Fixed area plots are best when interest lies in estimating the number of stems per hectare or another variable that is unrelated to tree size, or when understory vegetation precludes use of variable plots as on the north slopes. I support continued use of 1/10 ha plots which appear to be the standard in Guatemala. Field personnel have found it easier to use 20 m x 50 m plots, with the longer distance up the slope, than circular plots (plot boundaries are marked first). Variable points are best for estimating tree attributes that are proportional to tree basal area (e.g., volume). They are quicker than fixed plots but variation among plots is often greater than fixed plots. I recommend their use in the more open pine forests of the south and west. A plot should include an average of 5-12 trees and it appeared that a 2 BAF (metric) prism should work. Variable strip plots provide an intermediate plot design. Groups of plots (clusters) used in stratified sampling can reduce travel time. Sample numbers are dependent on variability. Pilot samples may be needed to determine coefficients of variation. A minimum of at least 20 samples should be taken and perhaps a sample of 1% of the total forest of interest might be adequate for large tracts (>1,000 ha). Seedlings may be sampled also using fixed plots if data are needed on advanced regeneration. Data are also needed on practical aspects such as number of trees or percent of area that will actually survive logging. As mentioned, in many cases, simple visual inventories are done by experienced technicians, especially when forest products are of low economic value. Lund and Thomas (1989) outline the range of options available and costs to: sample within mapped entities, use mapped polygons as sampling units, and generate maps and inventory statistics from sample data. Lund et al. (1993) provide a state-of-the-art review of stand inventory technology. The USDA Forest Service can provide training in the U.S. and abroad on remote sensing, videography, and other technical methods, and excellent facilities are available in Salt Lake City and Starkville, Mississippi.

D. Timber marking, cruising, scaling, logging supervision, and monitoring.

The silvicultural prescription prepared after completing stand examination procedures described above provides guidelines for marking trees for cutting and preparation of a logging plan. Most timber management in Guatemala is done using selection cutting today. The general rule is to cut between 20-40% of the volume (they typically don't work with basal area), except in the case of a commercial thinning when stocking is reduced based on age and tree density. Cutting cycles are typically 20-25 years. Trees cut are generally between 40 and 80 cm diameter at 1.4 m (dbh). The standard practice in Guatemala is to mark trees that are to be left or not cut. Tree marking paint should be visible on tree stumps to verify that only unmarked trees were cut. It may be preferable to mark trees to be cut when only a few trees are to be removed. The logging plan should identify log landing sites, skid trails, and restrict logging to the dry season. Heavy equipment should be restricted to designated (flagged) skid trails in wet or highly erodable areas or on the north slopes where heavy damage to the residual vegetation can be expected. These concerns and recommended restrictions are obviously reduced when trees or boards are carried out of the forest manually or by livestock on trails.

Timber marked for cutting should be "cruised" (sampled) if an estimate is needed prior to logging (e.g., for a contract). Cruising can be done in conjunction with tree marking or as a separate follow-up procedure. Sampling precision (standard error) for commercial forestry is generally 10% of volume in pine and 15% of volume by species in other forest types in Guatemala. It may be preferable to estimate standard error on the basis of value instead of volume when there are high-valued species (e.g., caoba or mahagony (Swietenia macrophyla), Cedrela mexicana, Dahlbergia or rosewood, Voychisia or San Juan).

On the other hand, with low valued species, landowners are sometimes just paid by the tree and therefore volume or grade determination is unnecessary.

Some landowners in the Sierra de las Minas have apparently had problems with loggers taking more trees than were designated for retention or more trees than for which they paid. Cut trees and stumps should be checked and counted before leaving the property. In addition, they should be "scaled" (measured) when tree volume or value is high. Dilworth (1988) and Wenger (1984) are good handbooks on log scaling and timber cruising.

Timber harvest units should be checked during and immediately after logging for compliance. They should also be monitored to evaluate the effectiveness of silvicultural prescriptions and harvest plans.

E. Research on silvics and effects of management practices.

1. For the most important commercial species, or for commercial species whose biology and ecology are poorly known, initiate research on (Putz 1993):
a. Plant reproductive systems and pollinators;
b. Phenology;
c. Seed production;
d. Seed dispersal, predation, and germination;
e. Light and nutrient requirements;
f. Responses to competition;
g. Population biology, harvesting schedules, and yield estimates;
h. Damping-off and other seedling pathogen problems;
i. Susceptibility to and consequences of mechanical damage caused by logging;
j. Effects of cataclysmic disturbances.

2. Initiate research on the long-term consequences of natural forest management (Putz 1993) and alternatives (conversion to pastures, plantations, or agricultural fields) on ecosystem functions (e.g., watersheds and nutrient cycles), wildlife populations, and biological diversity.

F. Research on watershed and ecological restoration, including nursery planting practices.

Bratton (1992) states that most attempts at restoring natural ecosystems used either an agricultural or a climax community model emphasizing productivity and stability as indicators of ecosystem health. Common are tree plantations of one or two species with seedlings closely spaced. New restoration efforts emphasize community structure or ecosystem function models favoring biotic diversity, presence of rare or unique elements, system complexity, and maintenance of natural processes. Any vegetation management within the core zone should emphasize ecosystem restoration, while some combination of ecological restoration and reforestation for timber or fuelwood management should occur outside the core zone.

Research is needed to develop community structure and ecosystem function models. Research is also needed on species genetics, seed collection and processing, plant propagation, natural forest recovery, and artificial seedling establishment, especially on arid and steep south-facing slopes. Water-capture in cloud forest should be studied and recommendations made for management through reforestation. Streamflow should be monitored at several points within and below the reserve if not done already.

G. Assessing ecosystem health, including inventory and monitoring of plant and animal populations and habitats

An ecosystem is healthy if it is stable and sustainable -- that is, if it is active and maintains its organization and autonomy over time and is resilient to stress (Haskell et al. 1992). Costanza (1992) suggest an ecosystem health index that is a product of indices of vigor (system activity, metabolism, primary productivity), system organization (includes diversity and connectivity), and system resilience. Rapport et al. (1985) and Odum (1985) list symptoms of ecosystem distress and characteristic responses of ecosystems to stress. Symptoms of ecosystem stress include: reduced primary production (except euthrophicated aquatic systems); loss of nutrient capital; loss of species diversity; dominance by short-lived, opportunistic, and often exotic species; increased fluctuations in key populations; retrogression in biotic structure (opportunistic species replace specialists); and increase incidence of disease (Rapport 1992). Relevant indicators, endpoints, parameters, and scales to assess ecosystem health are needed for quick diagnostic tests to detect stress early and recommend remedial action (Haskell et al. 1992).

To monitor biodiversity, Noss (1990) recommends a top-down hierarchical approach beginning with a coarse-scale inventory of landscape pattern, vegetation, habitat structure, and species distribution, then overlaying data on stress levels to identify biologically significant areas at high risk of impoverishment. He recommends monitoring indicators which are components of ecological composition, structure, and function at four levels: regional landscape, community-ecosystem, population-species, and genetic. Much has been written about monitoring indicators of ecosystem health, including plant and animal species and habitats, and some other useful references include Mueller-Dombois and Ellenberg (1974), Bell and Atterbury (1983), Conant et al. (1983), Cooperrider et al. (1986), Landres et al. (1988), Williams and Marcot (1991), and Lund et al. (1993).

The first step should be to transcribe the latest satellite imagery (1993), already prepared for Sierra de las Minas by The Nature Conservancy, into a GIS data base (Defensores has the software but not a plotter). Maps should be plotted showing overlays of management zones and ecosystem types. These maps will serve as a baseline for monitoring changes in natural forest distribution. We can assume a correlation between plant and animal presence and forest type as long as patch sizes are large enough to sustain viable populations and have not been significantly degraded, or species have not been extirpated by hunting. Habitat needs to maintain viable populations and thresholds for habitat degradation are unknown.

The process thereafter should be to develop species and habitat (ecosystem) catalogs, survey existing literature and ongoing research, and use existing screening criteria and methods for ranking species and habitat (ecosystem) vulnerability. Identify high priority species or species groups, including ecological indicators, and conduct inventories to estimate populations and available habitat, or population and habitat trends. Emphasize elements of diversity thought to be most vulnerable to extirpation and sensitive to human-made disturbances or to be "keystone" species likely to have cascading effects on other elements of diversity.

Salwasser et al. (1983) state that inventory will often encompass measurement of many things. Monitoring should be specific to plan or program objectives and major assumptions used in planning. Additional monitoring should not be carried out until objectives have been stated clearly (often in the form of a question), and scope (scale) and needed data reliability (statistical power and precision) defined. Evaluation of monitoring results should assess and communicate the effectiveness of reserve management practices.

The Rapid Ecological Assessment of the core zone (CDC-CECON 1984) and the transects recommended in section VI.A4b (identification of local ecosystems) will provide a species list by ecosystem, community, and habitat type. The Rapid Ecological Assessment also provides data on passalid beetles (Coleoptera), bats, rodents, butterflies, and birds in the core zone. Periodic remeasurement of these transects or sample sites provide an opportunity for long-term monitoring. Other studies (e.g., Campbell 1982, Dix and Dix 1990, and Dix 1994) provide species lists and habitat relationships. CDC-CECON (1984), for example, identified eight communities in the core zone: coniferous cloud forest, three other types of cloud forest, "asociacion Pino-Encino-Liquidambar," a high elevation scrub forest, tropical forest, tropical forest with Sabal-Cecropia. Campbell (1982) identified four major animal habitats in the higher elevations of Sierra de las Minas in his study of herptofauna: upper subtropical wet forest, hardwood cloud forest, Liquidambar forest, and humid pine-oak forest. Special habitat features or elements include cliffs, epiphytes, riparian vegetation or gallery forests, snags and live trees with cavities, fruit-bearing trees, and various aquatic elements such as springs, fast-moving streams, flooded forest, and lakeshore.

Difficult access, multi-layered forests, and the nocturnal nature of many species will limit practically what can be accomplished. The quetzal project is presently studying migration of two birds and hopes to eventually have a sample of eight birds. The following vertebrate species or species groups were identified as indicators for monitoring from a practical standpoint in discussions with Drs. Margaret and Michael Dix of University del Valle, Ron Savage of CARE, and Marie-Claire Paiz of Defensores de la Naturaleza: howler monkey species, gallinaceous birds (cracids), white-tailed deer (indicator of illegal hunting), and frogs (in spring). Reptiles are an important group in dry forests but sampling must be at night and would be destructive to habitats. Inventory and monitoring of jaguar may have value as an indicator of the effectiveness of the size of core zone, but from a practical standpoint would be very difficult. CDC-CECON (1994) recommended monitoring raptors, especially the endangered harpy eagle (Harpia harpyja). See sections V.B and V.P, and Table 2 in the appendix, for lists of priority North American migratory birds. Plants or plant communities are probably the best practical monitoring indicators (e.g., exotic species, some epiphytes, or fruit-bearing trees important to many animal species; quetzals, for example, use trees of the Lauraceae family). An ecological classification and further ecological studies are necessary to identify the best monitoring indicators or "vital signs" of ecosystem health.

VII. Appendix.

A. Trip summary.

January 8-9, 1994: travelled to Guatemala City. I was met by Oscar Nunez at the airport. Northwest Airlines lost my suitcase which we did not recover till the next evening. I checked into the Hotel Casa Grande. Oscar gave me a quick tour of downtown in the evening and we shared a snack at a restaurant.

January 10-12, 1994: met the staff of Defensores de la Naturaleza. Andreas Lehnhoff, Executive Director, gave me an overview of the organization. Oscar briefed me on the Master Plan for Sierra de las Minas Biosphere Reserve and he described social assessments and forest inventories. Luis Movil, President of the Board of Directors, joined us for lunch. Oscar and I held meetings over two days with U.S. AID (Claudio Saito, Henry Tschinkel, Abraham Guillen, and Edgar Pineda), CDC-CECON of San Carlos University (Olga Valdez and Jose-Maria Aguilar), University del Valle (Margaret and Michael Dix and Hector Centano, the latter also past President of the Board of Defensores), CONAP (Emmy Diaz and Erick Arellano), DIGEBOS (Francisco Moscoso), Ron Savage of CARE, and Jerry Bauer of the U.S. Forest Service on assignment to the Caminos Rurales project. We collected ideas, perspectives, maps, and other information.

January 12 (evening) to January 19, 1994: visited Sierra de las Minas. Spent a day and a night with Sergio Gomez of Defensores travelling to and visiting Vista Hermosa and surrounding forests. We met with Don Emilio, president of the Uaxilan cooperative. We stopped periodically and took notes of various ecosystems throughout the trip. Oscar joined us the second day in the field for the rest of field trip and Sergio remained with us the entire trip. We travelled in a Suzuki jeep. The field roads were a challenge. Cornelia, a member of Defensores staff working with women in villages in the Polochic Valley, and her companion, Peace Corp volunteer Laura Nolan, joined us for two days. We visited Jones and some of the surrounding pine forest and took the drive up through San Agustin Acasaguastlan up to Albores to Don Carlos's house (3 of the family are staff members of Defensores). Don Carlos's wife is an incredible cook. We were joined there by Marie-Claire Paiz, Juan Skinner, and others of the quetzal project. We walked up to La Cabana, a Defensores facility in the core zone. We viewed various cloud forest communities and found ourselves trapped at sundown in a quagmire of fallen large trees cut by an angry logger. Fortunately several individuals had flashlights and Juan was familiar with the area and found a way out. We enjoyed the spectacular view from Angel Rock the next morning before heading down to the Motagua Valley and northwest to Salama, field headquarters for Defensores. I organized my notes and ideas one morning while the Defensores staff held an annual work planning meetng. I took a brief trip to Chilasco with Don Carlos, Jr. and Peace Corps volunteer Tim Harper. Oscar, Sergio, and I drove one day down the Polochic River Valley, including an excursion to a ridge overlooking the Matanzas River and another to a coffee plantation across the river from Teleman. We did not have time to get into the relatively inaccessible forests of the upper north slopes in the Polochic drainage (most of the lower slopes have been cleared). I enjoyed seeing the Mayan peoples in the Polochic Valley. Estuardo Secaira, who met us earlier in Guatemala City and Salama, joined us for our last day in the field, a drive up to and beyond San Lorenzo. We viewed a variety of forest types from dry thorn forest to dry pine-oak forest to more mesic pine forests to oak-conifer cloud forest. I demonstrated use of forestry field equipment and gave Oscar a 65 m loggers tape, 5 m diameter tape, a 2 BAF prism (metric), and an all-weather metric field notebook. I throughly enjoyed the field trip, including the diversity of forests and peoples, and greatly appreciated the time, hospitality, and transportation provided by the staff of Defensores de la Naturaleza.

January 20, 21, 24, 25, 1994: Estuardo, Sergio, and I took an morning flight over the south and west slopes of Sierra de las Minas giving us a good overall perspective by viewing many areas we could not visit on the ground and seeing how the several areas we visited fit together. Clouds, unfortunately, prevented us from viewing the north side of the reserve and the slopes above Lake Izabal. Back in Guatemala City, I collected additional information I needed for this report. I gave Oscar a box full of technical publications, including many of the references in this report, and briefly discussed the contents of each publication and their application. I met with Andreas, Oscar, Estuardo, and Marie-Claire to continue the needs assessment. I spent an evening with Drs. Dix to collect more ecological information and discuss related ideas. Andreas, Oscar and I had dinner another evening with Brian Houseal, Kathy Moser, and Richard Devine of The Nature Conservancy. I gave "close-out" presentations to Luis Movil and the staff of Defensores and to U.S. AID (Claudio Saito, Abraham Guillen, Edgar Pineda, and Wayne Williams) and Jerry Bauer. Jerry and I had dinner at his house where he described his work in Guatemala and he stated he would like to assist with the Sister Forest program.
We took off the weekend of January 22-23 and I took annual leave January 26-29.

January 30-31, 1994: Travelled back to the United States and home.

February 1-2, 1994: Participated in the Sister Forest Steering Committee meeting in Milwaukee. I assisted later with preparation for the site visit in April 1994 and with preparation and display of a poster on the Sister Forest Program that was displayed at the Great Lakes Ecosystem Management Conference in Duluth, Minnesota in May 1994.

B. Contacts

Technical contacts in Guatemala (Tel. 011-502-2-)

Oscar Nunez (Manager, Forester), Defensores de la Naturaleza, Avenida Las Americas 20-21, Zona 14, Guatemala C.A. (c/o Postal Club Internacional, 7907 N.W. 53 Street Suite #445, Miami, Florida 33166). Tel. 373897-370319. FAX 682648.

Andreas Lehnhoff (Executive Director), Defensores de la Naturaleza.

Estuardo Secaira (Field Manager), Defensores de la Naturaleza

Luis Movil (President), Defensores de la Naturaleza

Hector Centeno (Presidente Honorario of Defensores and President of University del Valle),

Marie-Claire Paiz, Defensores de la Naturaleza

Jerry Bauer (Forester, U.S. Forest Service), USAID/UNIT 3323, APO AA 34024. Tel. 720059, 721135, 341880(home), FAX 311151.

Henry Tschinkel (Regional Forestry Adviser), U.S. AID, la Calle 7-66, Zona 9, Guatemala. Tel. 320322. FAX 320523. Mail: US AID/ONARM, Unit 3323, APO AA 34024.

Abraham Guillen (Forester), U.S. AID

Claudio Saito (Forester), U.S. AID. Tel. 721135, 372875 (home)

Edgar Pineda (Forester), U.S. AID

Wayne Williams (Environmental Officer), U.S. AID

Margaret Dix (botanist, ecologist),University del Valle, Tel.3803 36-40,x166.

Michael Dix (vertebrate zoologist), University del Valle, Postal 82, 01901 Guatemala. Tel. 690791 al 5, 692563, ext. 166. FAX 380212. Location -- 11 Calle 0-00, Zona 15, Vista Hermosa 3 in Guatemala City.

Olga Valdez (coordinator), Centro de Datos para la Conservacion (CDC-CECON), Universidad de San Carlos, Avenida de la Reforma 0-63, Zona 10, Guatemala, C.A. Tel. 347662, 346064, 310904. FAX 347664.

Jose-Maria Aguilar, CECON

Claudio Mendez (zoologist), CECON.

Herbert Droege (botanist), CECON.

Ana Rosalito Barrios (ecologist), CECON

Enrique Coranando, CECON.

Ron Savage (Agroforestry and Environmental Education, Herpetologist), CARE Apartado Postal 1211, Guatemala, C.A. (15 Avenida 3-66, Zona 13, 01013). Tel. 345625,27,28, 317833. FAX: 318167.

Hilda Rivera, CARE (Proyecto PACA)

Emmy Diaz, CONAP

Erick Arellano, CONAP

Fransisco Moscoso (Sub-Director General), DIGEBOS, 7a Av. 6080, Zona 13, Guatemala. Tel. 735207-09. FAX 735211,14,15.

Carlos Gooddey, IUCN (number from Ron Savage)

Chuck Veiman, UNEPED, 8a Avenida 2-92, Zona 2, Santa Ellena, Flores, El Peten, Guatemala. 502-9-500197.

Jorge Cabrera, CCAD, 7a Av. 31/01 Zona 9, Edificio La Cupola, 2a Nivel, Guatemala. Tel. 32 06 84 or 85.

U.S. Peace Corps (agroforestry, environmental education) -- Dasilio Estrada

Potential pilot for aerial photography or video: Captain Oscar Alvarado Lara, Jerente General Services Areos Nacionales, Aeropuerto International La Aurora, Avenida Hiencopie y 18 Calle, Zona 13, Guatemala. Tel. 317479.

Pilot for charter flight (4-5 passengers): Ernesto Flores, Vuelos Privados, Guatamala City. Tel. 0821206, 761567.

Pilot for charter flight (4 passengers): Guillermo Rivera, Guatemala. Tel. 357959, 300003.

U.S. Embassy Security: tel. 323347.

Spanish-English translators (muchas gracias!)

Frances Sosadeeter, U.S. Forest Service, 1498 W. US-2, St. Ignace, MI 49781. Tel. 906-643-7900. FAX 906-643-7611. DG:R09F10D05A.

Dave Hernandez, U.S. Forest Service, 118 S. 4th Avenue East, Ely, MN 55731. Tel. 218-365-7680. FAX 218-365-7665. DG:R09F09D05A.

Technical Contacts in U.S. (thank you!)

Jim Culbert, International Forestry, USDA Forest Service, P.O. Box 96090, Washington, D.C. 20090-6090. Tel. 703-235-1676. FAX 703-235-3732. DG: W01C.

Scott Lampman, International Forestry, USDA Forest Service, Washington, D.C. Tel. 703-235-9461. FAX 703-235-9441. DG:W01C.

Doris Gerdes, U.S. Forest Service, 8181 U.S. Hwy 2, Rapid River, MI 49878. Tel. 906-474-6442. FAX 906-474-6570. DG:R09F10D01A.

Burton Barnes, Univ. Michigan, School of Natural Resources, Dana Bldg., 430 E. University, Ann Arbor, MI 48109-1115. Tel. 313-764-1407.

Pete Weaver, International Institute of Tropical Forestry, Rio Piedras, Puerto Rico 00928-2500. Tel. 809-766-5335. DG:R08F16A.

Frank Miller, Forestry Dept. P.O. Box 9681, Mississippi State Univ., MS 39762. Tel. 601-325-3279 or 2796.

Susan Eggen, U.S. Forest Service, Forestry Sciences Lab, Box 906, Starkville, MS 39759. Tel. 601-338-3133. FAX & front desk tel.601-324-1611. DG:S30L01A.

Laurie Hunter, The Nature Conservancy, 1815 Lynn St., Arlington, VA 22209. Tel. 703-841-4870.

Kathy Moser, The Nature Conservancy. Tel. 703-247-3731.

Andrea Cristofani, The Nature Conservancy. Tel. 703-841-4214.

Shirley Keel, The Nature Conservancy. Tel. 703-841-2714.

Peg Kohring, 10 E. 67th St., Richfield, MN 55423. Tel. 612-338-8494/869-7034(H)

Matt Perl, World Wildlife Fund, 1250 24th St. NW, Washington, D.C. 20037. Tel. 202-778-9705.

Tom Spies, P.O. Box 68, Harvard Forest, Petersham, MA 01366. Tel. 508-724-3302.

Rich Birdsey, U.S. Forest Service, 5 Radnor Corporate Center, Suite 200, 100 Matsonford Rd., Radnor, PA 19087-4585.

Gyde Lund, USDA Forest Service, FIERR, 1st Floor, S.W., Auditors Bldg., 14th & Independence Ave., S.W., P.O. Box 96090, Washington, D.C. 20090-6090. Tel. 202-205-1147. FAX 202-205-1087. DG:W01C.

Jack Putz, Dept. Botany, Univ. Florida, Gainsville, Florida 32611-2009. Tel. 904-392-1486. FAX 904-392-3993.

Chandler Robbins, USDI, Patuxent Wildlife Research Center, 11410 American Holly Dr., Laurel, MD 20708-4015. Tel. 301-497-5641.

Henry Louie, 11420 Bedfordshire Ave., Potomac, MD 20554. Tel. 703-276-0677.

Jim Manolis, Dept. Fisheries & Wildlife, 200 Hodson Hall, 1980 Folwell Avenue, St. Paul, MN 55108. 612-624-3421. 612-624-3785 (home).

Joe Peters, 5301 Lake Wheeler Rd., Raleigh, NC 27603. Tel. 919-779-8722. FAX 919-515-7231.

Bruce Marcot, U.S. Forest Service, P.O. Box 3890, Portland, OR. 97208. Tel. 503-326-4952. DG:R06A.

John Lehmkuhl, U.S. Forest Service, 3625 93rd Avenue, SW, Olympia, WA 98512. Tel. 206-956-2345. DG:S26L09A.

Joe Torres, U.S. Forest Service, RD#4, Box 1260, Middlebury, VT 05753. Tel. 802-388-4362/6688. DG:R09F20D01A.

Paul Schimdtke, U.S. Forest Service, 401 Court St., Mio, MI 49647. Tel. 517-826-3252. DG:R09F04D05A.

Bob Spivey, 1219 N. Jackson,#105, Milwaukee,WI 53202. Tel.414-273-0552.DG:R09A.

U.S. Forest Service personnel from Region 9 "Sister Forests."

Table 1. Conifers of Sierra de las Minas (by Dr. Michael Dix, University del Valle, Guatemala City).

Species	Where found[1]
CUPRESSACEAE	
Cupressus lusitanica	cloud forest above 1,700 m
Juniperus comitana	primarily cloud forest, above 1,200 m
Juniperus standleyi	cloud forest, highest elevations
PINACEAE	
Abies guatemalensis	cloud forest, above 2,600 m
Pinus ayacahuite	cloud forest, above 2,000 m
Pinus oocarpa	south-southwest slope & cloud forest,500-2,750 m
Pinus psuedostrobus	upper south slopes & cloud forest, above 1,600 m
Pinus maximinoi or *tenuifolia*	south slopes and cloud forest, 1,100-2,400 m
Pinus carribea	western edge below 800 m
Pinus tecunumanii	south-southwest slopes, above 1500 m
PODOCARPACEAE	
Podocarpus guatemalensis	north slopes and cloud forest, 1,200-2,600m
Podocarpus oleifolius	cloud forest above 2,000-2,700 m
TAXACEAE	
Taxus globosa	cloud forest above 2,200 m

[1]See also Veblen (1978) and Dix (1984).

Table 2. Habitat and risk status of migratory birds that nest in the northern Lakes States and overwinter in the Sierra de las Minas (preliminary list).

Common name[1]	Habitat[2] Sierra de las Minas	Habitat[2] Great Lakes	Risk Status[3] U.S. Midwest	Risk Status[3] North America
Great Blue Heron	wetlands	wetlands		
Cattle Egret	cultivation	pastures		
Green Heron	wetlands	wetlands		
Sharp-shinned Hawk	forest,edge	cont.conif.forest		7-?
Cooper's Hawk	forest,edge	cont. decid. forest		7-?
Osprey	(in flight)	water		
Turkey Vulture	all areas	frag./disturbed		8-pos.increase
Peregrine falcon	wetlands	open country		3-endangered
Whip-poor-Will	cult.,conifer	contiguous forest	3.29	7-pos. decline*
Ruby-thr. Hummingbird	cultivation	forest	2.57	8-pos.increase
Belted Kingfisher	stream,ponds	streams, ponds		7-pos. decline
Great Crested Flycatch.	forest	frag./dist. forest	3.29	8-pos.increase*
Yellow-bellied Flycat.	forest	cont. conif. forest	3.00	8-sig. increas*
Least Flycatcher	second growth	cont. decid. forest	2.71	8-pos. decline
N. Rough-winged Swallow	pasture	open country	2.14	8-pos.increase
Gray Catbird	scrub forest	frag./dist. forest	2.86	8-pos. decline
Wood Thrush	forest	cont. decid. forest	3.57	8-sig. decline*
Swainson's Thrush	cloud forest	cont. decid. forest	2.57	8-pos.increase*
Cedar Waxwing	cultivation	frag./dist. forest		8-sig.increase
Philadephia Vireo	forest,scrub	cont. decid. forest	3.43	8-pos.increase*
Yellow-throated Vireo	forest	cont. decid. forest	3.00	8-pos. decline*
Solitary Vireo	cloud forest	cont. conif. forest	2.57	8-sig.increase*
Warbling Vireo	cult.,conifer	frag./dist. forest	2.57	8-sig.increase
Black-and-white Warbler	all areas	cont. decid. forest	2.43	8-pos.increase*
Golden-winged Warbler	cloud forest	old field	4.1	4-sig. decline*
Tennessee Warbler	cult,cloud f.	cont. conif. forest	3.0	8-? *
Yellow Warbler	cultivation	wet scrub	1.57	8-sig.increase
Magnolia Warbler	cultivation	cont. conif. forest	3.0	8-sig.increase*
Myrtle Warbler	cultivation	cont. conif. forest		8-sig.increase
Black-thr.Green Warbler	all areas	cont. conif. forest	3.0	8-pos. decline*
Chestnut-sided warbler	cultivation	cont. decid. forest	3.57	6-pos. decline*
Ovenbird	forest	cont. decid. forest	3.14	8-pos.increase*
Northern Waterthrush	wetland,forest	cont. decid. forest	2.57	6-pos.increase*
Common Yellowthroat	cultivation	wet scrub, marsh	2.29	8-pos. decline
Wilson's Warbler	all areas	cont. conif. forest	2.86	8-pos.increase
Northern Oriole	cultivation	frag./dist. forest	2.86	8-pos.increase*
Indigo Bunting	cultivation	frag./dist. forest	2.86	8-pos. decline
Rose-breasted Grosbeak	cult,cloud f.	cont. decid. forest	3.14	8-pos.increase
Red Crossbill	pine	cont. conif. forest		?

[1] List is based on: "List of birds observed 1991-1993, Sierra de las Minas, sector Chilasco" by Henry Louie; Robbins and Dowell (1992); CDC-CECON (1994), and observations in the general area by Chandler Robbins and Barbara Dowell (1994). Peterson (1980) is a source for scientific names.

Table 2 cont.

[2]Habitat in Sierra de las Minas is based on above-listed references, cloud f.=cloud forest, cult.=cultivation (includes fallow fields and hedge rows), trop. f. =tropical forest. Habitat in the northern Great Lakes is based on a landscape classification by primary habitat affinity (Green 1991) and Peterson (1980), cont.=contiguous, decid.=deciduous, conif.=coniferous, frag.=fragmented, dist.=disturbed.

[3]Mean scores to rank management concern in the U.S. Midwest (5-highest, 1-lowest) are from Thompson et al. (1992). Listed under North America are ranks and population trends for species suggested as high priority for monitoring by Droege and Peterjohn (1992). Those noted with an asterik were listed as "migrants in jeopardy" by Erlich et al. (1986).

Broad-winged Hawk, Olive-sided Flycatcher, Purple Martin, Barn Swallow, Cliff Swallow, Bank Swallow, Tree Swallow, Eastern Kingbird, Veery, Red-eyed Vireo, Blackburnian Warbler, Cerulean Warbler, Canada Warbler, Nashville Warbler, Bobolink, and Scarlet Tananger are probaby just migrants through Sierra de las Minas.

Individuals of the following species are probably not from the Great Lakes: Red-tailed Hawk, American Kestrel, Great Horned Owl, Hairy Woodpecker, and Eastern Bluebird.

E. Ecological descriptions of roadside points in Sierra de las Minas based on quick visual inventories by Oscar Nunez, Sergio Gomez, and Robin Vora. See Figure 1 for locations.

"muy rapido ecological assessment"

1. 5.9 km on road from Garcia to Uaxinlan.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 12
Parent material (1970 geology maps): cretaceous, Neacomian-Campanian carbonates
Holdrige Life Zone: lower montane moist forest
Forest cover type: pine forest **Topographic position:** midslope
Elevation: 250-600 m **Aspect:** S **Slope:** 10-50%
Distance to surface water and type: ephemeral, 5 km to Motagua River
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Zr
Soil texture observed (top 30 cm): shallow, gravelly silt loam
Dominant overstory species: Pinus carribea?
height: 12-18 m **diameter:** 20-40 cm dbh **canopy cover:** 5-20%
Lianas and vines: none **Epiphytes:** few
Mid-story species: oaks **height:** 2-4 m **canopy cover:** 5-10%
Dominant understory species: exotic grass **Total understory cover:** 90%
Diagnostic plant group: Pinus carribea?
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: Rano berlanderia, Saurus vulgaris, Tinamus major
Timber potential: good for pine, potential to grow trees 50 cm dbh and 20 m
Minor forest products: firewood, resin from pine to start fires
Grazing potential: good
Stand history and disturbance: area logged 30-40 years past
Remarks: private land, potential for reforestation if control fire, grazing
Phases: flats have deeper soils and larger trees (e.g., 7.2 km from Garcia)
Stages: various stages of degradation because of logging, grazing, and fire.

Degraded pine forest 5.9 km from Los Garcia to Uaxinlan, Sierra de las Minas. Photo by R. Vora, 13 January 1994.

2. 8.6 km on road from Garcia to Uaxinlan.

Ecosystem Type:

Ecological Association (Fig. 1, 2): 12

Parent material (1970 geology maps): cretaceous, Neacomian-Campanian carbonates

Holdrige Life Zone: lower montane moist forest

Forest cover type: pine forest

Topographic position (valley, midslope, etc.): upper slope

Elevation: 600-800 m **Aspect:** S **Slope:** 5-70%

Distance to surface water and type: ephemeral, 8 km to Motagua River

Water table (depth or shallow, deep, etc.): deep

Soil classification (Simmons 1959): Zr, Ju

Soil texture observed (top 30 cm): shallow, gravelly silt loam

Dominant overstory species: Pinus carribea? and Pinus oocarpa
height: 12-20 m **diameter:** 20-40 cm dbh **canopy cover:** 5-20%

Lianas and vines: none

Epiphytes: few

Mid-story species: oaks **height:** 1-4 m **canopy cover:** 0-10%

Dominant understory species: exotic grass **Total understory cover:** 90%

Diagnostic plant group: Pinus carribea? and Pinus oocarpa

Special wildlife plants (fruits, seeds, browse): oaks

Den trees: few **Snags:** few **Down logs:** few

Common animals: Rano berlanderia, Saurus vulgaris, Tinamus major
Biscatatus sp., Sceloporus squamosus

Timber potential: good for pine, potential to grow trees 50 cm dbh and 20 m

Minor forest products: firewood, resin from pine to start fires

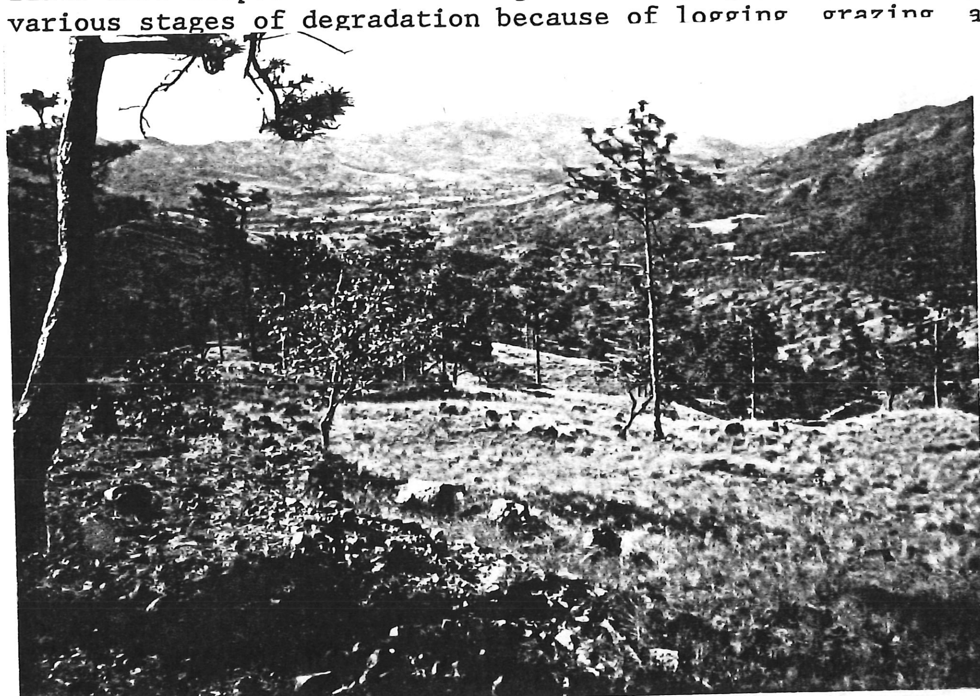
Grazing potential: fair, some steep slopes

Stand history and disturbance: area logged 30-40 years past

Remarks: private ownership, potential for reforestation if control fire, grazing. Some natural regeneration of pines.

Phases: flats have deeper soils and larger trees (e.g., 7.2 km from Garcia)

Stages: various stages of degradation because of logging, grazing, and fire.



Degraded pine forest 8.6 km from Los Garcia to Uaxinlan, Sierra de las Minas.
Photo by R. Vora, 13 January 1994.

3. 8.6 km on road from Garcia to Uaxinlan.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 12
Parent material (1970 geology maps): cretaceous, Neacomian-Campanian carbonates
Holdrige Life Zone: lower montane moist forest
Forest cover type: pine-broadleaf forest
Topographic position (valley, midslope, etc.): upper slope
Elevation: 650-750 m **Aspect:** S **Slope:** 0-35%
Distance to surface water and type: headwaters
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): Ju, Sub
Soil texture observed (top 30 cm): brown silt loam > 50 cm
Dominant overstory species: Pinus carribea?, Pinus oocarpa, Pithecellobium arboseum, Pouteria sp. -
height: 12-20 m **diameter:** 20-40 cm dbh **canopy cover:** 15-25%
Lianas and vines: few **Epiphytes:** some
Mid-story: oaks, Beaucarnea guatamelensis **height:** 1-5 m **canopy cover:** 70-90%
Dominant understory species: exotic grass, Chenopodium ambrosnoides
Total understory cover: 5-20%
Diagnostic plant group: Liquidamber styraciflua, Pouteria sp., Pinus oocarpa, Pinus carribea?
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: Spilogale angustifrons, Tayassu tajuca
Timber potential: pine, Castaneo
Minor forest products: firewood, resin from pine to start fires
Grazing potential: poor
Stand history and disturbance: area logged 30-40 years past
Remarks: private ownership. Agroforestry potential for maize, coffee, sugar cane, and cardamon
Stages: various stages of degradation because of logging, grazing, fire, and agriculture.

Mixed pine-broadleaf forest on upper slopes 9.9 km from Los Garcia to Uaxinlan, Sierra de las Minas. Photo by R. Vora, 13 January 1994.

4. 12.0 km on road from Garcia (Vista Hermosa).
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 8
Parent material (1970 geology maps): carboniferous Permian
Holdrige Life Zone: premontane wet forest
Forest cover type: tropical forest
Topographic position (valley, midslope, etc.): upper slope
Elevation: 450-780 m **Aspect:** NE **Slope:** 10-80%
Distance to surface water and type: headwaters
Water table (depth or shallow, deep, etc.): 12-15 m, shallow
Soil classification (Simmons 1959): Ci, Te
Soil texture observed (top 30 cm): silt loam and silty clay loam; reddish brown on ridges, brown in draws
Dominant overstory species: Dialum guianensis, Pithecellobium arboseum, Pouteria sp., Quercus spp., Swartzia cubensis
height: 12-20 m **diameter:** 20-125 cm dbh **canopy cover:** 60-80%
Lianas and vines: some **Epiphytes:** some
Mid-story species: Cupia sp., Annona sp., Rheedia edules
height: 5-15 m **canopy cover:** 30-40%
Dominant understory species: Astronium sp., Apeiba sp. **Cover:** 40-60%
Diagnostic plant group: Callophyllum brasiliense, Podocarpus sp., Guarea sp.
Special wildlife plants (fruits, seeds, browse): Chamaedorea sp.
Den trees: many **Snags:** many **Down logs:** many
Common animals: Dasypractus punctata, Tapirus bairdii
Timber potential: Callophyllum, Podocarpus, Guarea, Virola guatemalensis, Hieronymus alchorneoides, Cedrella mexicana, Karwinskia caldeconii
Minor forest products: firewood **Grazing potential:** poor
Stand history and disturbance: area around Vista Hermosa cleared since 1976
Remarks: Agroforestry potential for maize, coffee, sugar cane, cardamon, bananas, rice. Orchids collected.
Phases: drainages, ridges
Stages: various stages of degradation because of logging and agriculture.

Tropical forests around Vista Hermosa, 12.0 km from Los Garcia, Sierra de las Minas. Photo by R. Vora, 13 January 1994.

Rainforest near Vista Hermosa. Ecological association #8.
Site description by Dr. Eunice Padley (14 May 1995).

Soil description (auger sample):
0-7" Silt loam with very high organic matter content. 7.5YR2.5/2
7-12" Clay loam with high silt content. 5YR4/4. Iron oxide staining. Soil hard to rewet after drying. pH about 6.
12-18" Silty clay loam. 5YR4/3. pH 6-6.5.
Many rocks below 18"; couldn't auger further.

Vegetation described on previous page.

Comments: This site was visited quickly just before dark, so it was difficult to observe much of the area. Coffee and maize cultivation was occuring on cleared lands near the rainforest site, and these areas appeared to be productive. Further analysis of these soils may be warranted to determine the amount of free iron oxide and the degree of resistance to rewetting. If these soils are subject to irreversible drying, recommendations for agroforestry programs would include practices that maintain vegetative cover.

5. Slopes below Vista Hermosa (Uaxinlan cooperative).
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 8
Parent material (1970 geology maps): carboniferous Permian
Holdrige Life Zone: premontane wet forest
Forest cover type: tropical forest
Topographic position (valley, midslope, etc.): mid- lower slopes
Elevation: 50-550 m **Aspect:** NE **Slope:** 20-80%
Distance to surface water and type: many streams
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): Te
Soil texture observed (top 30 cm): deep loam and clay loam
Dominant overstory species: Blighia sapida, Bucida sp., Esteralia mexicana, Synphonia globulifera, Vochysia hondurensis, Belotia campbelli
height: 12-35 m **diameter:** 40-125 cm dbh **canopy cover:** 60-80%
Lianas and vines: many **Epiphytes:** many
Mid-story species: **canopy cover:** 30-40%
Dominant understory species: Manihot esculenta (exotic), Philodendron sp. Xanthosoma robustum **Total understory cover:** 40-60%
Diagnostic plant group: Philodendron sp., Colcasia esculenta, Carludovia palmata
Special wildlife plants (fruits, seeds, browse): Miconia sp. (fruits)
Den trees: many **Snags:** many **Down logs:** many
Common animals: Cuniculos paca, Mustela frenata, Didelphis marsupiales
Timber potential: Bucida, Esterculia, Synphonia, Vochysia, Dalbergia sp.
Minor forest products: firewood **Grazing potential:** poor
Stand history and disturbance: clearings since 1976
Remarks: Agroforestry potential for maize, coffee, sugar cane, cardamon, bananas, rice. Trees cut to collect orchids.
Phases: drainages, ridges
Stages: shifting cultivation

Tropical forests below Vista Hermosa, Uaxinlan Cooperative, Sierra de las Minas. Photo by R. Vora, 13 January 1994.

6. 1.7 km from Jones.
Ecosystem Type: Ecological Association (Fig. 1, 2): 10
Parent material (1970 geology maps): Jones formation, dominantly phylite and shcist, minor greens, amphibolite, and marble; some bands of serpetine
Holdrige Life Zone: lower montane moist forest
Forest cover type: pine forest
Topographic position (valley, midslope, etc.): mid slopes
Elevation: 600-1000m Aspect:various slope: 20-80%
Distance to surface water and type: stream in canyon bottom
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Zr, Chg
Soil texture observed (top 45 cm): silty loam with crumbly rock below 7.5 cm
Dominant overstory species: Pinus oocarpa
height: 15-20 m diameter: 20-30 cm dbh canopy cover: 20-30%
Lianas and vines: none Epiphytes: few
Mid-story species: Acacia spp, Quercus spp., Dirsonima crasifolia
height: 3-5 m canopy cover: 10-15%
Dominant understory species: grass, Mimosa, cullindor, Pinus oocarpa
Total understory cover: 70%
Diagnostic plant group: Pinus oocarpa
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few Snags: few Down logs: few
Common animals: Sceloporus squamous, Trimorophada biscatatus
Timber potential: good
Minor forest products: firewood, pine resin for starting fires
Grazing potential: good
Stand history and disturbance: cut 1940s
Remarks: degraded by cutting and frequent fires
Phases: drainages, ridges
Stages: degraded near Jones

Degraded pine forests 1.7 km from Jones, Sierra de las Minas. Photo by R. Vora, 14 January 1994.

Pine forest west of Jones. Ecological association #10.
Site description by Dr. Eunice Padley (14 May 1995).

Soil description (from auger sample):
0-3" Silt loam, slightly moist. Color 10YR5/4. pH 6-6.5.
3-18" Silt loam with crumbling rock in matrix. 5YR5/6.
18-24" Clay loam, still with a lot of silt in the matrix. 5YR5/8. pH about 6.
24-30" Clay loam with fine high chroma mottles, indicative of wetting-drying cycles. 7.5YR5/6.
30-48" Clay loam. 10YR5/6.
48-50" Clay loam. 10YR6/6. pH about 7.
50" Possibly bedrock, or large rock.

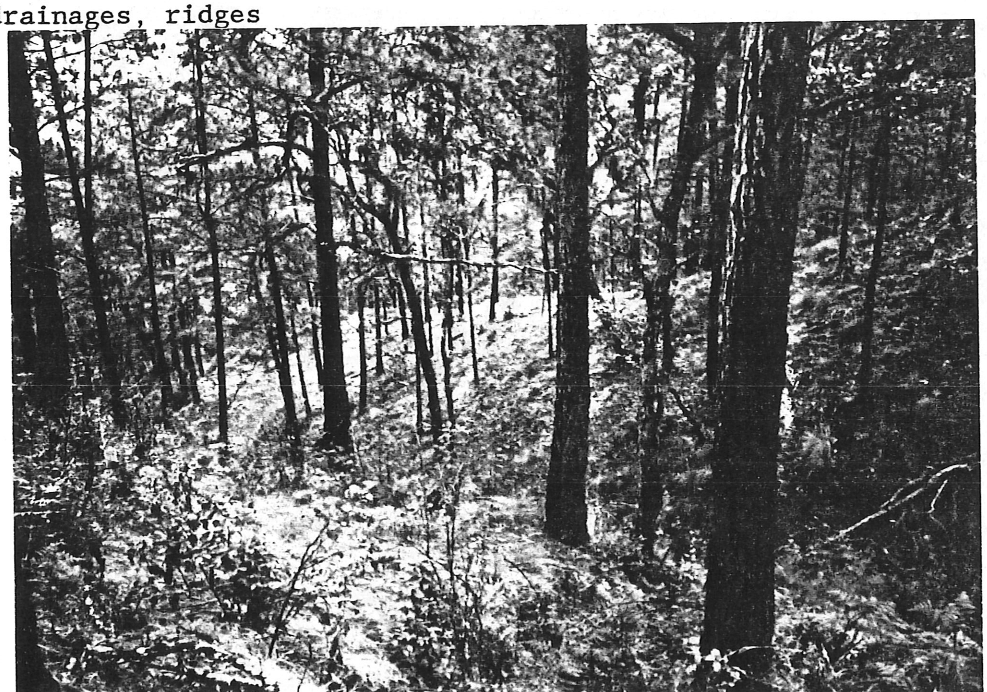
Vegetation description:
Overstory: Pinus oocarpa, 30% canopy cover, 15-18 meters high, 20-40 cm d.b.h., age 40-50 yrs. A few epiphytes present.
Midstory: Quercus sp., Dirsonima crasifolia, 10% canopy cover, 5-10 meters.
Understory: Mimosa, grasses, Cullindor, P. oocarpa seedlings. 30% cover.
Litter: Pine, 25% cover. Scattered surface rock, 5-15% cover.

Physiography: slope 30%, East aspect, elevation 925 m, deep water table.

Comments: Similar soils in the vicinity are being deforested and utilized for agriculture. Based on the texture, color, and reaction of the soils, they appear to be productive for agriculture and forest vegetation, and apparently the indigenous people are aware of their productive potential. In most of the places we visited, there appeared to be a correlation with extent of forest clearing and productive potential of the soils. Concerns are that the pine forest could be largely cleared for agriculture and that this cover type could be reduced to a few isolated stands. Also, because of the silt content of the soil, erodibility could reduce agricultural productivity if row crops are commonly used. It was interesting to compare the Sierra de las Minas to the National Forests in the Lake States: here in the north central United States, pine forests typically occur on sites that are less productive for agricultural crops, but in Guatemala, pine forests seemed to occur on the "better" sites, from a production perspective.

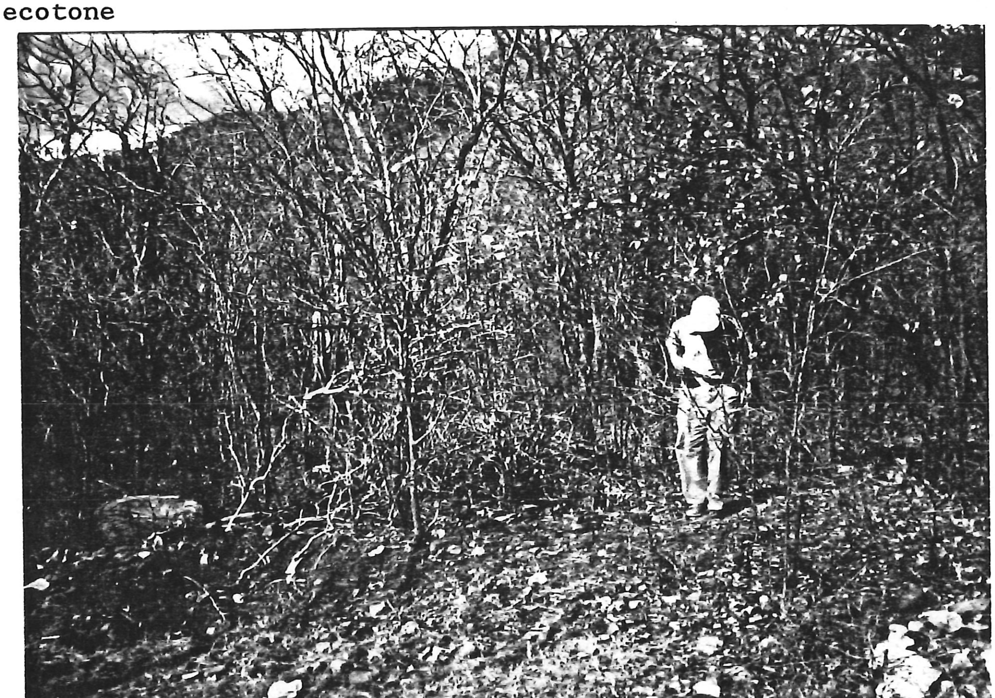
Soil and site characteristics appeared to be strongly related to bedrock characteristics. Bedrock near this observation point included serpentine, quartz, mica, and marble. Vegetative characteristics differed depending on bedrock type.

7. Four to 9 km from Jones.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 9
Parent material (1970 geology maps): Jones formation, dominantly phylite and shcist, minor greens, amphibolite, and marble; some bands of serpetine
Holdrige Life Zone: lower montane wet forest
Forest cover type: pine forest
Topographic position (valley, midslope, etc.): mid slopes
Elevation: 900-1700m **Aspect:**various **slope:** 10-70%
Distance to surface water and type: stream in canyon bottom 0.5 km
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Mj, Chg
Soil texture observed (top 30 cm): reddish brown -light brown silt loam
Dominant overstory species: Pinus oocarpa, Pinus maximinoi
height: 15-25 m **diameter:** 20-40 cm dbh **canopy cover:** 50-70%
Lianas and vines: none
Epiphytes: few
Mid-story species: Oaks, Liquidamber
height: 3-10 m **canopy cover:** 15%
Dominant understory species: grass
Total understory cover: 60-70%
Diagnostic plant group: Pinus oocarpa, Pinus maximinoi
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: Sceloporus squamous, Trimorophada biscatatus
Timber potential: very good
Minor forest products: firewood, pine resin for starting fires
Grazing potential: good
Stand history and disturbance: cut 1940s
Remarks: degraded by cutting and frequent fires
Phases: drainages, ridges
Stages:



Pine forests 4-9 km from Jones, Sierra de las Minas. Photo by R. Vora, 14 January 1994.

8. One km from Ojo de Agua.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 11-12
Parent material (1970 geology maps): Subinal formation; red shale and sandstone; some conglomerate with limestone and serpetine cobbles
Holdrige Life Zone: premontane dry forest-thorn forest
Forest cover type: Acacia
Topographic position (valley, midslope, etc.): lower slope
Elevation: 300-500 m **Aspect:** S **slope:** 0-40%
Distance to surface water and type: valley bottom
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Chg
Soil texture observed (top 30 cm): light, rocky, coarse, clay loam
Dominant overstory species: Busera simaruba, Acacia farnesiania, Guiacum sanctum, Leucaena guatemalensis, Cochlospermun vitifolium
height: 5-10 m **diameter:** 5-15 cm dbh **canopy cover:** 30%
Lianas and vines: none **Epiphytes:** few
Mid-story species:
height: **canopy cover:**
Dominant understory species: Dyckia guatamalensis, Opuntia sp.
Total understory cover: 5%
Diagnostic plant group: Legumes, cactus
Special wildlife plants (fruits, seeds, browse):
Den trees: few **Snags:** few **Down logs:** few
Common animals: reptiles including iguana, gila monster, Ctensaures similis, roadrunner, raptors
Timber potential: very good
Minor forest products: firewood
Grazing potential: poor
Stand history and disturbance: grazing, burning
Remarks: ecotone



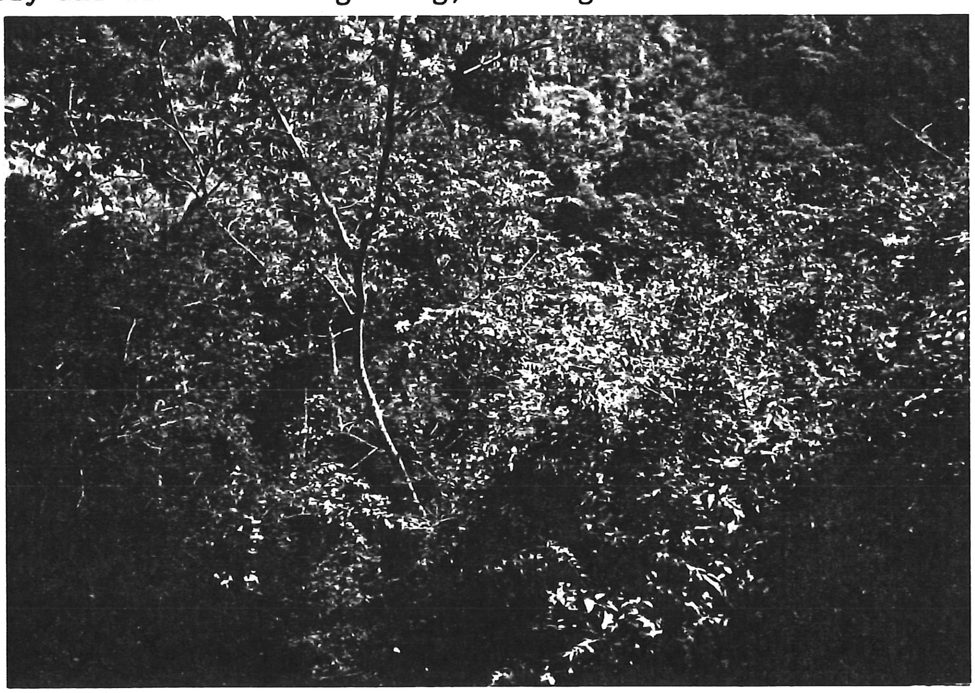
Estuardo Secaira in dry forest 1 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

Site descriptions by Dr. Eunice Padley (15 and 16 May 1995).

Thorn forest near Rio Hondo, up the road to San Lorenzo. Ecological association #12.
Soil (described from auger sample taken in roadcut. Soil was too dry to sample by augering directly into the ground.):
0-5" A horizon. Sandy clay loam. 25% gravel. 7.5YR3/2. pH 6-6.5.
5-15" B horizon. Clay loam. 7.5YR4.4. pH about 8.
15-24" BC horizon. Silty clay loam. 10YR5/3. pH about 8.
Vegetation:
Low overstory: Guyacon, Chrysanthea, Hematoxicillan, Acacia.
Low canopy: Guyacon, Acacia, Hematoxicillan, Chrysanthea, Cephalosaries.
Ground vegetation: Cactus species, including Opuntia, and grasses.
Comments: Much of the thorn forest area has been degraded by grazing, and apparently there are no preserved areas within this type.

Dry forest 13 km south of San Lorenzo (3.3 km from Ojo de Agua). Ecological association #11.
Soil (sampled from a roadcut after dark; may not represent site):
0-3". Ar horizon (mixed with weathering bedrock). Silt loam. 7.5YR2.5/2. pH about 6. Micaceous pebbles comprise about 75% of this layer.
3"+ Bedrock.
Comments: This ecological association appears to be shallow to bedrock or boulders all along the road. There appears to be a strong association between vegetation (dry forest), soils (very shallow to bedrock), and land use (mostly grazed, no cultivation).

9. 5.8 km from Ojo de Agua.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 11
Parent material (1970 geology maps): San Agustin formation--cataclastic granitic gneiss and migmaite
Holdrige Life Zone: premontane dry forest
Forest cover type: legumes and compositae
Topographic position (valley, midslope, etc.): lower slopes
Elevation: 600-1000 m **Aspect:** S **slope:** 20-60%
Distance to surface water and type: valley bottom
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Chg
Soil texture observed (top 8 cm): silt loam, shallow to bedrock
Dominant overstory species: Busera simaruba, Pseudobombax ellipticum, Cochlospermun vitifolium
height: 5-10 m **diameter:** 5-20 cm dbh **canopy cover:** 60%
Lianas and vines: none **Epiphytes:** few
Mid-story species: Ceiba aesutifolia, Acacia spp., Psuedobombax ellipticum
height: 2-5 m **canopy cover:** 30%
Dominant understory species:
Total understory cover: 10%
Diagnostic plant group: Legumes, taller overstory than dry forest, also mid-story
Special wildlife plants (fruits, seeds, browse):
Den trees: few **Snags:** few **Down logs:** few
Common animals: Crotalus durissus, grey fox, roadrunner, raptors
Timber potential: no
Minor forest products: firewood
Grazing potential: poor
Stand history and disturbance: grazing, burning



Dry forest 5.8 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

Site descriptions by Dr. Eunice Padley (15 May 1995).

Transition forest area between oak-pine forest and dry forest, 9.5 km south of San Lorenzo (6.8 km from Ojo de Agua). Ecological association transition between #10 and #11. May be a separate ecological association.
Soil (sampled from a roadcut after dark; may not represent site):
B1 horizon. Sandy clay loam. 7.5YR5/6. pH about 5.5.
B2 horizon. Sandy clay loam. 5YR5/6. pH 6-6.5.
Comments: This soil is quite different from that of the following site, which represents Ecological Association #10, but additional investigation is needed to identify typical conditions and decide whether this area should be a separate Ecological Association.

Oak-pine forest 5 km south of San Lorenzo (11 km from Ojo de Agua). Ecological association #10.
Soil (sampled from a roadcut after dark; may not represent site):
A horizon. Silty clay loam. 7.5YR2.5/2. pH about 8.
B horizon. Clay loam. 7.5YR3/3. pH about 8.
Comments: High pH's of these soils may be partly due to inputs of lime dust from marble transport along the road.

10. 8.5 km from Ojo de Agua.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 10-11
Parent material (1970 geology maps): San Agustin formation--cataclastic granitic gneiss and migmaite
Holdrige Life Zone: lower montane moist forest -- premontane dry forest
Forest cover type: Mixed oak - pine
Topographic position (valley, midslope, etc.): lower mid-slopes
Elevation: 600-1000 m **Aspect:** S **slope:** 20-60%
Distance to surface water and type: canyon bottom
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Chg
Soil texture observed (top 30 cm): rock outcrops, shallow, silty clay loam
Dominant overstory species: Quercus spp., Pinus oocarpa
height: 10-20 m **diameter:** 15-40 cm dbh **canopy cover:** 40%
Lianas and vines: none
Epiphytes: Spanish moss
Mid-story species: Quercus spp., Pinus oocarpa
height: 5-10 m **canopy cover:** 10%
Dominant understory species: grass, shrubs
Total understory cover: 20%
Diagnostic plant group: Oak dominanace
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: Sceloprus spp., Norops spp., raccoons
Timber potential: no
Minor forest products: firewood
Grazing potential: poor
Stand history and disturbance: grazing, burning (every year)
Remarks: fire killing oak seedlings
Phases: some cliffs
Stages:

Oak forest 8.5 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

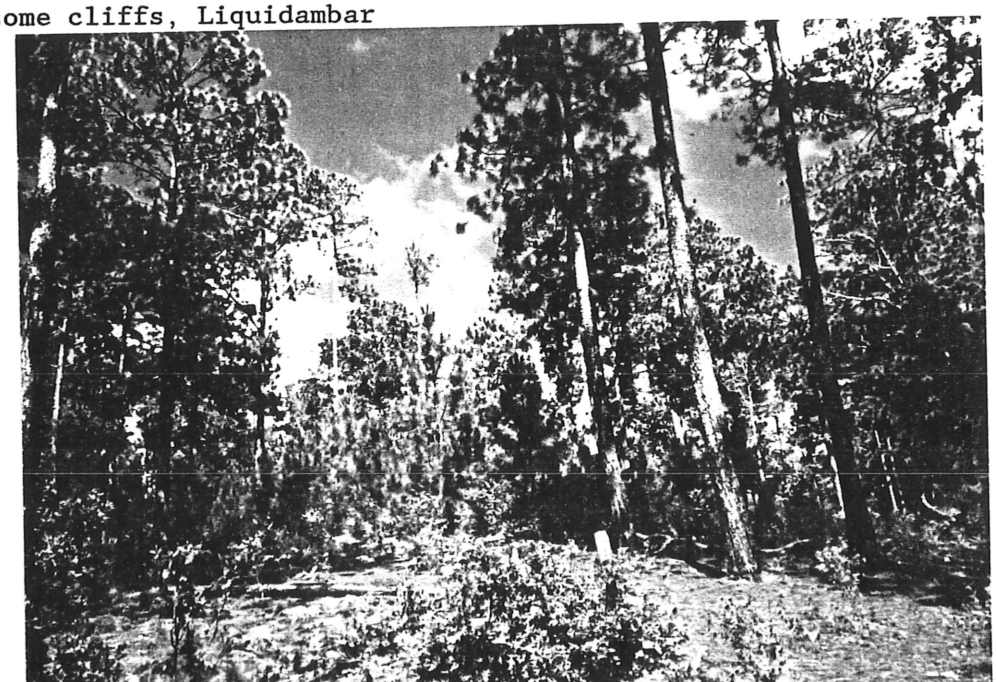
11. 12.6 km from Ojo de Agua.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 10
Parent material (1970 geology maps): San Agustin formation--cataclastic granitic gneiss and migmaite
Holdrige Life Zone: lower montane moist forest
Forest cover type: Pine forest
Topographic position (valley, midslope, etc.): mid-slopes
Elevation: 1300-1600 m **Aspect:** S **slope:** 10-40%
Distance to surface water and type: canyon bottom
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Chg
Soil texture observed (top 30 cm): rock outcrops, shallow, stoney silt loam
Dominant overstory species: Quercus spp., Pinus oocarpa
height: 30-40 m **diameter:** 20-50 cm dbh **canopy cover:** 40%
Lianas and vines: none
Epiphytes: few
Mid-story species: Quercus spp., Psidium guava
height: 5-10 m **canopy cover:** 20%
Dominant understory species: grass, forbs, Agave sp.
Total understory cover: 20%
Diagnostic plant group: Pinus oocarpa dominant with some oak
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: grey fox, raccoons, squirrel, oppossum
Timber potential: good
Minor forest products: firewood, resin from pine
Grazing potential: fair
Stand history and disturbance: grazing, burning (every year)
Remarks: fire killing oak seedlings
Phases:
Stages:

Pine forest 12.6 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

12. 14.0 km from Ojo de Agua.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 10
Parent material (1970 geology maps): Jones formation-dominantly phylite and mica schist, minor greens, amphibolite, and marble
Holdrige Life Zone: lower montane moist forest
Forest cover type: Oak
Topographic position (valley, midslope, etc.): mid-slopes
Elevation: 1500-1800 m **Aspect:** S **slope:** 0-50%
Distance to surface water and type: canyon bottom
Water table (depth or shallow, deep, etc.): moderate
Soil classification (Simmons 1959): Chg
Soil texture observed (top 30 cm): rock outcrops, dark brown silt loam
Dominant overstory species: Quercus spp., Pinus oocarpa, Pinus maximinoi, Pinus tecunumanii
height: 10-20 m **diameter:** 10-40 cm dbh **canopy cover:** 60%
Lianas and vines: some
Epiphytes: many, Spanish moss
Mid-story species: Quercus spp., few palms
height: 3-10 m **canopy cover:** 10-30%
Dominant understory species: shrubs, Agave sp.
Total understory cover: 20%
Diagnostic plant group: Oaks, epiphytes, agaves, palms
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: some **Snags:** some **Down logs:** some
Common animals: grey fox, raccoons, squirrel, oppossum
Timber potential: good
Minor forest products: firewood
Grazing potential: poor
Stand history and disturbance: some cutting, grazing
Remarks: fire killing oak seedlings, oaks cut so cows can eat epiphytes
Phases: some cliffs
Stages:

Oak-epiphyte-palm-agave forest 14.0 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

13. 16.3 km from Ojo de Agua.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 10
Parent material (1970 geology maps): San Agustin formation-cataclastic granitic gneiss, some Jones formation around San Lorenzo marble quarry
Holdrige Life Zone: lower montane moist forest
Forest cover type: Pine
Topographic position (valley, midslope, etc.): mid-slopes
Elevation: 1800-2000 m **Aspect:** S **slope:** 0-30%
Distance to surface water and type: few streams
Water table (depth or shallow, deep, etc.): moderate
Soil classification (Simmons 1959): Chg
Soil texture observed (top 50 cm): silt loam
Dominant overstory species: Pinus oocarpa, Pinus maximinoi, Pinus tecunumanii, Acer skutch
height: 20-40 m **diameter:** 20-50 cm dbh **canopy cover:** 30%
Lianas and vines: few **Epiphytes:** many
Mid-story species: Quercus spp., pines
height: 3-10 m **canopy cover:** 10-30%
Dominant understory species: shrubs, ferns, blackberry
Total understory cover: 10%
Diagnostic plant group: Pines mixed with oaks
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: some **Snags:** some **Down logs:** some
Common animals: Abronia (lizard), Elapha (rat snake), Bufo marinus
Timber potential: good
Minor forest products: firewood, resin from pine for fires
Grazing potential: fair
Stand history and disturbance: some cutting, grazing; disturbed around San Lorenzo
Remarks: Acer reduced by fire. Marble mining.
Phases: some cliffs, Liquidambar



Mixed pine forest 16.3 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

In San Lorenzo. Ecological association #10.
Site description by Dr. Eunice Padley (15 May 1995).

Soil was sampled from an exposed roadcut in town, and may have different properties than surrounding undisturbed soils due to drying and the effect of lime dust from marble transport through town.

0-4" Silt loam. 10YR5/6 (dry), 10YR4/3 (wet). pH 7.5-8.
4-20" Silt loam, very oxidized appearance. 7.5YR5/6 (dry), 7.5YR5/8 (wet). pH 5-5.5. Dry soil had very firm consistence, angular blocky structure, but rewet easily.

Comments: Marble in the area had strong effervescence with HCl, indicating that it contains much free calcium carbonate. Vegetative diversity is often very high in areas with high lime content; marble cliffs would be likely places to survey for unusual species and communities. It may be advisable to consider acquisition and preservation of some marble cliffs in the area.

14. 24.4 km from Ojo de Agua.
Ecosystem Type:
Ecological Association (Fig. 1, 2): 9
Parent material (1970 geology maps): San Agustin formation-cataclastic granitic gneiss
Holdrige Life Zone: lower montane wet forest
Forest cover type: Oak
Topographic position (valley, midslope, etc.): upper slopes
Elevation: >2200 m **Aspect:** all **slope:** 10-60%
Distance to surface water and type: headwaters, canyon bottoms
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): Chg, Mj
Soil texture observed (top 30 cm): sandy clay loam
Dominant overstory species: Quercus spp., Podocarpus sp., few pines
height: 20-50 m **diameter:** 20-80 cm dbh **canopy cover:** 80%
Lianas and vines: many
Epiphytes: many
Mid-story species: Quercus spp., tree ferns
height: 5-10 m **canopy cover:** 30%
Dominant understory species: shrubs, ferns, blackberry
Total understory cover: 30%
Diagnostic plant group: Podocarpus, Oaks with epiphytes
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: some **Snags:** some **Down logs:** some
Common animals: quetzal, white-tailed deer, Penelope nigra
Timber potential: poor
Minor forest products: firewood
Grazing potential: no
Stand history and disturbance:
Remarks: Core zone. Erosion from road should be corrected.
Phases:
Stages:

Oak cloud forest 24.4 km from Ojo de Agua, Sierra de las Minas. Photo by R. Vora, 19 January 1994.

Site descriptions by Dr. Eunice Padley (15 May 1995).

Pine forest 5 km west of San Lorenzo. Ecological association #9.
Soil (sampled from a roadcut at dusk):
Very thick B horizon exposed. Sandy clay loam. 10YR5/8. pH about 5.5.

Cloud forest near road at beginning of trail to REA transect. Ecological association #6B.
Soil (described from small pit about 18" deep):
O and A horizons present, not sampled.
E horizon. Silt loam. 7.5YR4/2. pH about 4.
B horizon. Silt loam. 7.5YR5/6. pH about 4
Soil was similar to other sites along REA transect. There may have been more broad-leaved philodendron at this site. Evidence of cow trampling was present in some places. An old windthrow near the pit had exposed soil underneath which had color of 7.5YR6/8 and was heavily mottled.

Comments on sites along REA transect in cloud forest:
These sites are on soils shallow to bedrock, with evidence of considerable leaching due to the humid environment. They are very acid soils, extremely different from those in other ecological associations we observed. They are not suitable for cultivation.

Cloud forest at south end and center of REA transect. Ecological association #6B.
Soil (described from 1" soil probe):
Very thick organic layer at surface, on steep west-facing slope.
0-1" A horizon.
1-4" E horizon.
4"+ B horizon.
All colors, textures, and pH values similar to next site described. Horizons thinner, likely due to the steepness of the slope.
Vegetation:
Overstory: <u>Quercus</u> spp., 60% cover, 35 meters, 50-80 cm d.b.h.
Epiphytes: ferns, bromeliads, orchids, Mofer, Piperaceae.
Midstory: tree ferns, less than 30% cover. Locust sp.?
Vines: Moraceae
Litter: complete ground cover.
Physiography: 35% slope, West aspect.

Cloud forest at REA base camp. Ecological association #6B.
Soil description (described from 1" soil probe and from a pit dug for the REA):
0-3" A horizon. Organic material.
3-11" E horizon (indicates strong leaching). Sandy clay loam. 7.5YR4/2. pH about 4.
11"-24"+ B horizon. Sandy clay loam, with high silt content. 10YR5/8. pH about 4. Sand grains are from weathered quartz.
Vegetation:
Overstory: <u>Quercus</u> spp, 60% cover, 30 meters, 80 cm d.b.h.
Epiphytes: many bromeliads, mosses, orchids, ferns.

Midstory: Podocarpus, Quercus, tree ferns less than 15 meters, 4-15 cm d.b.h.
Vine: Moracene
Understory: ferns, Smilacina or Streptopus
Litter: complete ground cover, including epiphytic bromeliads, ferns and orchids that had fallen.
Physiography: 10-30% slope.

Dwarf forest above treeline near REA transect. Ecological association #6B.
Soil (described from 1" diameter soil probe): highly decomposed organic material formed into large hummocks. 5YR3/1.
Vegetation:
Overstory: Pinus sp., less than 1% canopy cover, 7-8 meters, 15 cm d.b.h.
No midstory.
Understory: 4-5 spp. Ericaceous shrubs, 30-40% cover. Agave, 15% cover.
Mosses, Cladonia sp., rushes, 2-3 fern spp.

15. One km south of San Agustin Acasaguastlan
Ecosystem Type:
Ecological Association (Fig. 1, 2): 12
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rokcs. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites; and ultrabasic rocks, mainly serpentines.
Holdrige Life Zone: thorn forest
Forest cover type: Dry forest
Topographic position (valley, midslope, etc.): lower slopes
Elevation: 200-400 m **Aspect:** S **slope:** 0-60%
Distance to surface water and type: rivers from mountains
Water table (depth or shallow, deep, etc.): deep, except in floodplain
Soil classification (Simmons 1959): Ac
Soil texture observed (top 30 cm): shallow, rocky, light, sandy clay loam
Dominant overstory species: Legumes, cactus
height: 2-5 m **diameter:** 2-10 cm dbh **canopy cover:** 40%
Lianas and vines: no
Epiphytes: no
Mid-story species: none
height: **canopy cover:**
Dominant understory species: bare soil, rock, herbaceous
Total understory cover: 10%
Diagnostic plant group: low forest of legumes, cactus
Special wildlife plants (fruits, seeds, browse):
Den trees: few **Snags:** few **Down logs:** few
Common animals: reptiles
Timber potential: no
Minor forest products: firewood
Grazing potential: very poor
Stand history and disturbance: grazing, cutting, fire
Remarks: Outside reserve
Phases: Gallery forest
Stages:

Thorn forest near San Agustin Acasaguastlan, Sierra de las Minas. Photo by R. Vora, 16 January 1994.

16. North of San Agustin Acasaguastlan
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 11-12
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rokcs. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites; and ultrabasic rocks, mainly serpentines.
Holdrige Life Zone: thorn forest-premontane dry forest
Forest cover type: Acacia
Topographic position (valley, midslope, etc.): lower slopes
Elevation: 300-700 m **Aspect:** S **slope:** 10-70%
Distance to surface water and type: rivers from mountains
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Ac
Soil texture observed (top 30 cm): shallow light-grey sandy clay loam
Dominant overstory species: Acacias, Crescentia alata
 height: 5-10 m **diameter:** 10-20 cm dbh **canopy cover:** 40%
Lianas and vines: no **Epiphytes:** no
Mid-story species: Acacias, cactus
 height: 1-3 m **canopy cover:** 30%
Dominant understory species: bare soil, rock, herbaceous
 Total understory cover: 20%
Diagnostic plant group: legumes, cactus
Special wildlife plants (fruits, seeds, browse):
Den trees: few **Snags:** few **Down logs:** few
Common animals: reptiles, scorpions, geckos, amblypygis (arachnids)
Timber potential: no
Minor forest products: firewood **Grazing potential:** poor
Stand history and disturbance: grazing, cutting, fire
Remarks: Outside reserve
Phases: Gallery forest (have Morpho-blue butterflies)

Dry forest near San Agustin Acasaguastlan, Sierra de las Minas. Photo by R. Vora, 16 January 1994.

17. One km above Albores.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 9
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rocks. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites.
Holdrige Life Zone: lower montane wet forest
Forest cover type: Conifer forest
Topographic position (valley, midslope, etc.): upper slopes
Elevation: 1500-2300 m **Aspect:** S **slope:** 10-45%
Distance to surface water and type: many small streams
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): not mapped
Soil texture observed (top 30 cm): reddish-brown silt loam
Dominant overstory species: Pinus maximinoi, Pinus tecunumanii, Cupressus lusitanica, broadleafs
height: 20-40 m **diameter:** 15-80 cm dbh **canopy cover:** 80%
Lianas and vines: few **Epiphytes:** many (Bromeliads)
Mid-story species: oaks **height:** 5-10 m **canopy cover:** 10-20%
Dominant understory species: some pines, lots of ferns
Total understory cover: 20%
Diagnostic plant group: Pinus maximinoi, Pinus tecunumanii
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals:
Timber potential: good
Minor forest products: firewood, resin from pine to start fire (ocote)
Grazing potential: poor
Stand history and disturbance: grazing, cutting, fire
Remarks: pine dominates in disturbed areas
Phases: Gallery forest (have Morpho-blue butterflies)

Pine forest above Albores, Sierra de las Minas. Photo by R. Vora, 15 January 1994.

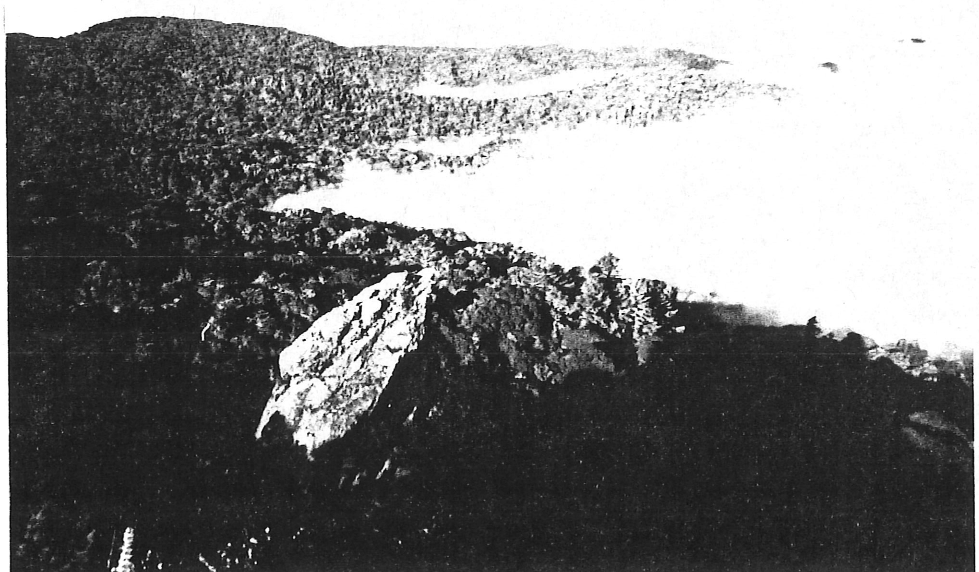
18. 2.5 km above Albores.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 6A
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rocks. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites.
Holdrige Life Zone: lower montane rain forest
Forest cover type: Broadleaf
Topographic position (valley, midslope, etc.): upper slopes
Elevation: 2300-3000 m **Aspect:** all **slope:** 0-40%
Distance to surface water and type: many small streams
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): not mapped
Soil texture observed (top 30 cm): reddish-brown silt loam
Dominant overstory species: Quercus spp., Pinus maximinoi, Pinus ayacahuite, Abies guatemalensis, Taxus globosa
height: 40-50 m **diameter:** 20-120 cm dbh **canopy cover:** 70-80%
Lianas and vines: few **Epiphytes:** many (bromeliads, cactus, orchids)
Mid-story species: oaks **height:** 2-20 m **canopy cover:** 10%
Dominant understory species: little bamboo, lots of ferns **Cover:** 80%
Diagnostic plant group: Oaks, few large pines
Special wildlife plants (fruits, seeds, browse): oaks, Persea (quetzal)
Den trees: few **Snags:** few **Down logs:** few
Common animals: quetzal, tapir, cats, white-tailed deer, wild pig
Timber potential: none because in core
Minor forest products: firewood, resin from pine to start fire (ocote)
Grazing potential: none
Stand history and disturbance: minor grazing, cutting, fire
Remarks: pine dominates in disturbed areas
See CDC-CECON (1994) Rapid Ecological Assessment for more accurate and detailed data
Phases: dwarf forest above 2400 m where windy

Oak-pine cloud forest above Albores, Sierra de las Minas. Photo by R. Vora, 15 January 1994.

19. 2 km above La Cabana.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 6A
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rocks. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites.
Holdrige Life Zone: lower montane rain forest **Forest cover type:** Conifer
Topographic position (valley, midslope, etc.): upper slopes
Elevation: 2600-3000 m **Aspect:** all **slope:** 0-15%
Distance to surface water and type: many small streams
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): not mapped
Soil texture observed (top 30 cm): shallow stoney silt loam
Dominant overstory species: Pinus maximinoi, Pinus ayacahuite, Abies guatemalensis, Taxus globosa
height: 30-40 m **diameter:** 70-100 cm dbh **canopy cover:** 70-80%
Lianas and vines: few
Epiphytes: many (bromeliads, cactus, orchids), lots of lichens, mosses
Mid-story species: oaks, Taxus globosa, some pines, Prunus, alder
height: 2-10 m **canopy cover:** 10-30%
Dominant understory species: dense shrubs, grasses, spaghnum **Cover:** 70-80%
Diagnostic plant group: Pines and other conifers
Special wildlife plants (fruits, seeds, browse): oaks, Persea (quetzal)
Den trees: few **Snags:** many **Down logs:** many
Common animals: howler monkey **Timber potential:** none because in core
Minor forest products: firewood, resin from pine to start fire (ocote) mushrooms **Grazing potential:** none
Stand history and disturbance: minor grazing, cutting, fire
Remarks: pine dominates in disturbed areas
See CDC-CECON (1994) Rapid Ecological Assessment for more accurate and detailed data **Phases:** dwarf forest above 2400 m where windy

Conifer cloud forest above La Cabana, Sierra de las Minas. Photo by R. Vora, 15 January 1994.

20. 2 km+ above La Cabana.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 6A
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rocks. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites.
Holdrige Life Zone: lower montane rain forest **Forest cover type:** Broadleaf
Topographic position (valley, midslope, etc.): upper slopes
Elevation: 2500-2800 m **Aspect:** all **slope:** 0-20%
Distance to surface water and type: many small streams
Water table (depth or shallow, deep, etc.): shallow
Soil classification (Simmons 1959): not mapped
Soil texture observed (top 30 cm): silty clay loam, deep, lot of organic matter
Dominant overstory species: oaks, few pines in groves, Abies guatemalensis,
height: 50-60 m **diameter:** 100-150 cm dbh **canopy cover:** 80-90%
Lianas and vines: few
Epiphytes: many (bromeliads, cactus, orchids), lots of lichens, mosses
Mid-story species: oaks, Taxus globosa, tree ferns, Lauraceae family, Taxus
height: 3-30 m **canopy cover:** 20%
Dominant understory species: ferns, bamboo, dogwood **Cover:** 30%
Diagnostic plant group: Oaks, Lauraceae
Special wildlife plants (fruits, seeds, browse): oaks, Persea (quetzal)
Den trees: many **Snags:** many **Down logs:** many
Common animals: howler monkey, quetzal, cats, squirrels, cracids, peccary,
Timber potential: none because in core
Minor forest products: firewood, base of tree fern for flower pot, mushrooms, grass and palms for baskets **Grazing potential:** none
Stand history and disturbance: minor **Remarks:** lot of water production. See CDC-CECON(1994) Rapid Ecological Assessment for more accurate and detailed data
Phases: dwarf forest above 2400 m where windy
Cupressus lusitanica with tall shrubs



Broadleaf cloud forest above La Cabana, Sierra de las Minas. Photo by R. Vora, 15 January 1994.

21. 5 km west of Chilasco.
Ecosystem Type: **Ecological Association (Fig. 1, 2):** 9
Parent material (1970 geology maps): Mix of paleozoic--undivided metamorphic rocks. Phyllites,chlorite and garnet schists, quartz-mica-fledspar schists and gneisses, marbles, and migmatites.
Holdrige Life Zone: lower montane wet forest **Forest cover type:** Pine
Topographic position (valley, midslope, etc.): mid-slopes
Elevation: 1200-1700 m **Aspect:** several **slope:** 10-60%
Distance to surface water and type: in canyons
Water table (depth or shallow, deep, etc.): deep
Soil classification (Simmons 1959): Cr
Soil texture observed (top 60 cm): brown, reddish-brown silt loam
Dominant overstory species: Pinus maximinoi, Pinus oocarpa, Pinus tecunumanii, Pinus pseudostrobus, Alnus jorullensis
height: 20-50 m **diameter:** 15-50 cm dbh **canopy cover:** 50%
Lianas and vines: few **Epiphytes:** few
Mid-story species: oaks, pines, Liquidambar **height:** 2-5 m **canopy cover:** 10-20%
Dominant understory species: ferns, grass **Total understory cover:** 10-20%
Diagnostic plant group: Mixed pines
Special wildlife plants (fruits, seeds, browse): oaks
Den trees: few **Snags:** few **Down logs:** few
Common animals: squirrels **Timber potential:** excellent
Minor forest products: firewood, resin from pine for starting fires
Grazing potential: none **Stand history and disturbance:** secondary forest
Remarks: grasses are the result of disturbance
Phases: Magnolia guatemalensis along streams
Cupressus lusitanica with tall shrubs

Mixed pine forest 5 km west of Chilasco, Sierra de las Minas. Photo by R. Vora, 17 January 1994.

Site descriptions by Dr. Eunice Padley (16 May 1995).

Pine forest on road to Chilasco. Ecological association #9.
Soil (described from roadcut and auger sample):
0-4" A horizon. Silt loam. 10YR2.5/1. pH 6-6.5.
4-12' AE horizon.
12-24" E horizon. Silt loam. 10YR6/3 (moist), 10YR7/2 (dry). pH about 6.5.
24-48" B horizon. Sandy clay loam. 10YR7/3. pH about 6.5.
Vegetation:
Overstory: Pinus maximinoi, Pinus oocarpa, Liquidamber, Staracyflua, Quercus spp., Myrica cerifera. 70% canopy cover, 25 meters tall, 50-80 cm d.b.h.
Midstory: Quercus spp., liquidamber, Pinus spp. 10-20% cover, 5-10 meters.
Epiphytes: some bromeliads.
Understory: Callianda, mimosa, Quercus spp., liquidamber, oja de queso, grasses. 80% coverage.
Physiography: 10-20% slope, south aspect.
Comments: Much of this area has been cleared for agriculture, similarly to pine forests on the south side of the Sierra de las Minas, and conservation concerns are similar to those noted for the pine forest near Jones.

The bedrock mineralogy of the unit appeared to be mixed, although different from mineralogy observed in pine forests on the south side of the Sierra de las Minas. We observed some reddish-colored roadcuts with apparent oxidation of iron, and some light-colored material that appeared to be cemented pumice. A sample of the light-colored material had a pH of 5.5 to 6.0 before wetting, but when crushed and wet, the pH dropped to 4.5 to 5.0 and the sample had the odor of sulfuric acid; apparently there are sulfates in the cementing material.

Low cloud forest at Biotopo Quetzal on the northwest side of the Sierra de las Minas. Ecological association #5.
Soil (described from exposure around cabin):
0-6" A horizon. Silty clay loam. 7.5YR2.5/2. pH about 5.5.
6-12" AB horizon. Sandy clay loam, containing nodules that will not rewet. 10 YR 4/6. pH about 6.
12-18" B1 horizon. Silty clay loam. 10YR5/6. pH about 6.
18-36" B2 horizon. Silt with organic matter accumulation; thixotropic. 10YR5/8. pH about 6.
36-54" B3 horizon. Silty clay loam. 7.5YR5/6. pH about 6.
54-66" BC horizon. Sandy loam (although sand size particles may be cemented concretions of smaller soil separates). Duripan layer. 10YR6/6 (moist), 10YR8/4 (dry). pH 6.5-7.0, slight effervescence.
Vegetation:
Overstory: Quercus, Scheflera, Cecropia.
Midstory: Heliconia, tree ferns.
Understory: bromeliads, Moraceace, Lilaceae, Chamaedorea, ferns, mosses.
Vines also present.
Oropendula present; indicative of cloud forest habitat, but not found at very high elevations.
Elevation: 1600 meters.

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