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AN ASSESSMENT OF BIOLOGICAL DIVERSITY

ECUADOR

AN ASSESSMENT OF BIOLOGICAL DIVERSITY AND TROPICAL FORESTS FOR ECUADOR

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for FY 1989 -1990

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FORWARD

The story of the Rio Palenque mahogany is the tale of a tree almost lost from the face of the Earth. A valuable genetic resource would have been lost, were it not for a small private research center where a few individual trees survived.

In pre-Columbian times, the Rio Palenque mahogany was much-prized by the indigenous people of the Guayas River Basin for its amazing resistance to rot. They had many uses for its strong wood, particularly as the posts on which to build their homes.

With the arrival of the Spanish, exploitation of the tree increased dramatically. It was for three centuries the most highly prized timber tree in northwestern Ecuador because of its value in cabinetry and its durability under adverse conditions. It became harder and harder to find. By 1970, everyone assumed that heavy exploitation had eliminated the tree from the basin.

During the 1970s, a group of scientists began classifying the plants in a small pocket of the remaining primary forest in the basin. One rare tree they identified as Persea, a member of the avocado family. This announcement caused a great deal of interest because many commercial members of the avocado family are susceptible to root-rot and a variety of maladies that this tree was able to resist.

In 1982, scientists discovered that the tree was not a relative of the avocado at all, but the Rio Palenque mahogany, the first known neotropical member of the Asiatic genus Caryodaphnopsis. The entire known adult population consists of twelve mature trees on the Rio Palenque Science Center property. Were it not for the Science Center, the species would have disappeared due to forest clearing, and this valuable timber germplasm would have been lost. Without the serendipitous preservation and later discovery of the identity and usefulness of the species, it would now be extinct.

How many similiar cases of unknown organisms, with potential value to man, exist in the few remaining fragments of tropical forest in Ecuador? How many have already been lost forever?

With these questions in mind, an assessment of the biological diversity and the status of the tropical forests in Ecuador has been prepared for the U.S. A.I.D. Mission in Ecuador.

The Assessment of Biological Diversity and Tropical Forest for Ecuador examines conditions and trends affecting biological resources and tropical forests in each of the three major biogeographic regions of the mainland (Western Ecuador - La Costa, the Andean Highlands - La Sierra, and the Amazon Basin - El Oriente) by identifying donor agency, NGO, and government agency development and conservation activities, and critical conservation needs.

Chapter I describes the methodology behind the assessment and provides a brief overview of Ecuador's biological diversity and the major issues surrounding its conservation. Chapter II of the assessment considers national laws, institutional policies, and individual activities which directly and indirectly affect natural resource use by analyzing development and conservation activities of government agencies, efforts by national non-governmental organizations, and those supported by international donors. Chapters III provides a regional focus of biological resources by reviewing the current knowledge concerning Ecuador's rich biolcgical diversity, its past history, and current status. Chapters VI and V review national programs, community efforts and individual attempts to manage and conserve biological diversity and tropical forests, both within and outside of the governmental sector. Chapter VI considers the economic importance of biological diversity and its contribution to the national and local economy. Chapter VII covers a broad spectrum of economic, social, and legal issues at the national level which determine land use patterns, as well as the major threats impacting biological resources and tropical forests at the regional level. Chapter VIII concludes the assessment by identifying the critical areas for conservation of biological diversity, appropriate actions for AID, and the major policy issues which need to be addressed at the national level to assure the sustainability of conservation efforts in Ecuador.

EXECUTIVE SUMMARY

The biological riches of Ecuador have been recognized since Charles Darwin's visit to the famed Galapagos Islands more than three hundred years ago. Ecuador has over 20,000 known plant species and 1,550 bird species, twice as many than the entire continental United States. Among terrestrial vertebrates, more than 300 species are found only in Ecuador, with especially high rates of endemism among reptiles (106 species) and amphibians (138 species).

Conservation of Ecuador's tropical forests are among the world's highest priorities for biological diversity. The Awa Forest Reserve was recently listed as one of the 10 global hotspots for biological diversity by the well known Ecologist, Norman Myers. The Yasuni National Park, the largest in Ecuador (6800 km2), is being considered for inclusion into the world-wide system of UNESCO's Man and the Biosphere Reserve Program.

Threatening this diverse biological diversity are many, complex factors to which there are no easy solutions. The annual deforestation rate in Ecuador is an alarming 2.3 % per year, resulting in the loss of 340,000 ha annually. This rate far exceeds that of its Andean neighbors of Colombia (1.7%) and Peru (0.4%). The central Andean highlands are practically devoid of natural forest cover. The few remaining pockets of primary forests in western Ecuador and forested areas in the Amazon are under increasing pressure from logging, agroindustry, cattle grazing and subsistence farming. Trying to provide land and food for a population growing at the rate of 2.9% per year, the Government of Ecuador has embarked on an aggressive colonization program in the Amazon basin. Indeed, of the forest cover remaining in Ecuador, we estimate that only half (700,000 km2) is relatively undisturbed by human encroachment. This diminishing core of primary tropical forest contains important habitats for plant and animal life. These areas are considered critical for the future economic development of Ecuador.

In Ecuador, as elsewhere in the tropics, the underlying causes of deforestation are poverty, inequitable land tenure, lack of non-agrarian livelihoods and accelerated population growth which lead to inappropriate land use and non-sustainable production systems. The demand for foreign exchange encourages incentives for "mining" resources from the tropical forests and their conversion into pastures and agricultural lands for export crop production.

Government policies, often incompletely informed by or insensitive to local forest dwellers and users, are also a driving force behind deforestation. For example, land titling rules under the colonization law require colonists to put 80% of their parcel into "production" within two years or risk foreclosure on the

property by the government. Current timber harvesting policy determines royalties based on the amount of wood actually removed from concessione forest tracts rather than the true harvestable volume. Such policies have had a devastating impact on tropical forests in the provinces of northwest and Amazonian Ecuador.

Destructive logging practices and the lack of incentives for sustainable forest management are also important factors contributing to deforestation in Ecuador. The adverse impacts of indiscriminate logging are magnified as associated extraction trails become roads and open the forest to landless settlers. For example, colonists who have recently settled in the Oriente have little knowledge of local sustainable-agricultural practices, and rely on their traditional methods developed in different agroecological zones such as the high Sierra or arid Costa.

However, the rural poor are hardly to blame; the majority are jobless as well as landless, with few prospects for employment in their home regions of the Andean highlands and coastal provinces. Faced with limited cash income and declining real income (the cost of basic food items rises four-to-six percent per month), they are pursuing one of two feasible options available: migrating to the urban centers of Quito and Guayaquil, or homesteading in the Oriente forests.

Although a strong political commitment for policy reform is an important variable in the ultimate resolution of these issues, the long term conservation of Ecuador's tropical forests and maintenance of its tremendous biological diversity will be impossible without the active interest and involvement of the rural poor in the planning, design and management of surrounding forested areas.

For these reasons, this assessment stresses the need for USAID/Quito to consider action at two levels.

The first is to concentrate specific conservation efforts on critical sites for biological diversity. In western Ecuador, the Awa Forest Reserve, Cotacachi-Cayapas Ecological Reserve (ER), forest fragments occurring along Quaque (in the province of Esmeraldas, south through Manabi to Guayas), and the mangrove ecosystems along coastal fringes are critical for their ecological as well as economical contribution to development activities. The area of highest priority, the western Andean slopes, due the to little primary forest remaining and the intensity of human pressure in this region, includes the forest fragments occurring between the 900 - 2400 meter elevations, Cotacachi-Cayapas ER, and the Pichincha (Maquicupuna) Forest. Along the eastern Andean slopes, the areas of La Bonita, Cerro Sumaco and surrounding area, Cayambe-Coca ER, Sanguy and Podocarpus National Parks (NP), are priority sites for conservation efforts. Critical areas in the Amazon Region are the forests occurring between the 300 - 900

meter elevations, the lower slopes of Cayambe-Coca ER, Sumaco Forest Protectorate, Sanguy NP, the Cordillera de Cutucú, the Cordillera de Guacamayo, and Yasuni NP.

Efforts to promote conservation within the national park system should ensure the adequate staffing and provide the needed logistical support of established areas at the manager and field levels through the use of PL480 funds and active local community involvement. Land titling of surrounding communities should be secured and pilot projects in land use capability utilizing agroforesty systems should be an integral part of a buffer zone management strategy to thwart the encroachment into the National Parks of Cotacachi-Cayapas, Cayambe-Coca, Sanguy, Podocarpus and Yasuni.

The Awa Forest Reserve, the largest tract of primary pluvial forest (1000 km2) remaining in western Ecuador, offers high prospects for success given the initiative of the indigenous people, Awa, to manage the reserve with the support of the national government, local NGOs, international groups and aid agencies. The transitional zone of Cerro Sumaco between the Andean Uplands and the Amazon Basin, offers high biological diversity and a unique opportunity for a coordinated regional planning effort between USAID, FAO, Ecuadorean government agencies, NGOs and the local community.

The second level of action recommended is to encourage and assist the Ecuadorean Government to enact policy that will enhance long-term conservation efforts. One such action would be to assist in the reformation of resettlement, colonization, and land titling legislation which encourages wide scale deforestation. This will be a critical determinant of how development patterns ultimately affect the large tracts of tropical forests in the Amazon Basin. Another would be to strengthen the legal distinction between forest patrimony and the general public domain open to colonization. Consideration of surface land rights over subsurface mineral rights in areas of high biological diversity would substantially increase the prospects for their sustainable conservation. Review of the current timber concessionary program could enhanced sustainable forest management through preharvest logging plans and value distinction by species and log grade.

The ongoing Tropical Forestry Action Plan for Ecuador provides USAID/Quito an unique opportunity as well as an excellent forum to dialogue in a coordinated and collaborative fashion with the Ecuadorean government, national NGOs, and other donor agencies, concerning priorities for biological diversity conservation by forming a long term strategy for forest development and conservation activities in Ecuador.

Finally, USAID/Quito should continue improving coordination between current USAID/Quito agriculture and forestry projects to enhance biodiversity conservation by promoting land use planning, environmental education at the ministerial and local levels, and support for basic research and inventory of biological resources and management systems.

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The USAID/Quito Mission was instrumental in putting this project together under difficult circumstances and time constraints. We are grateful for those in the Mission who provided us with important background information on current projects and much valued logistical support on short notice: Richard J. Peters, Robert Mowbray, Fernando Ortiz, Jane Stanley, Karen and Monica.

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BJC/

Chapter I
Introduction

1.1. Congressional Mandate

The US Congress amended the Foreign Assistance Act (FAA) in October 1986 to increase AID efforts in conserving biological diversity and tropical forests. Section 118 of the FAA specifically addresses public concern about accelerating human intervention and the resulting degradation and loss of the world's tropical forests. Section 119 addresses the increasing threat of extinction to many animal and plant species. Each USAID Mission is now required by Congress to consider the following concerns in their Country Development Strategy Statement (CDSS) or Action Plan (USAID 1987: 106,107):

- the actions necessary in that country to achieve conservation and sustainable management of tropical forests,
- the actions necessary in that country to conserve biological diversity, and
- the extent to which the actions proposed for support by the Mission meet the needs thus identified

Several works recently completed in Ecuador address these issues in some detail (Dodson and Gentry in prep.; Fundación Natura 1988; IUCN 1988; Landázuri and Jijón 1988; MAG/DINAF 1988; USAID/Quito 1988; Zapato and Fiero 1988; INCRAE 1987). This assessment relies heavily upon these and other important efforts to build a Mission strategy for biodiversity conservation and protection of tropical forests in Ecuador.

1.2. Scope, objectives, and conceptual framework

1.2.1. Scope

This activity is intended to help AID/Ecuador meet the objectives of sections 118 and 119 of the FAA by preparing a Biological Diversity and Tropical Forests Assessment. This will be appended to, or incorporated into, the Mission CDSS. The Assessment will support Mission efforts to define conservation needs in Ecuador, and identify opportunities for USAID to assist the government of Ecuador in conserving its biological resources and tropical forests.

Consistent with the statement of work for USAID/Ecuador (PIO/T no. 518-0000-3-), and in consultation with the mission staff, the team developed an approach that considers the status and management of wildlife and endangered species, forest ecosystems, protected areas, germplasm conservation, and the

conservation of economically important plant species. It also considers indigenous peoples and the impact of major development projects on biological resources, and explores major issues by region: the Costa, the Sierra, and the Oriente.

1.2.2. Objectives

- to describe the status of biological diversity and tropical forests in Ecuador.
- to identify the principal threats on the conservation of these resources.
- to identify critical information gaps that hinder biodiversity conservation and assessment.
- to propose actions for biodiversity conservation.

1.2.3. Conceptual framework

To develop a comprehensive Assessment, this document:

- covers a broad spectrum of economic, sociocultural, demographic, and policy issues at the regional and national levels that influence natural resource conservation.
- identifies the major threats to biological diversity by region.
- considers national laws, institutional policies, and individual activities which directly and indirectly affect natural resource use.

In formulating the recommendations and identifying options available to the Mission to promote conservation efforts, the assessment:

- identifies priority areas of biological diversity and the corresponding actions needed for their conservation.
- considers modifications to current AID/Quito projects or activities to enhance biodiversity conservation.
- identifies possibilities for improved coordination with other multilateral and bilateral donors, matching funds with international NGOs, or mobilization of local funds to enhance biodiversity conservation.
- proposes activities worth considering when new, additional sources of funds become available to USAID/Ecuador.

1.3. Limitations and Constraints of this Assessment

The time available (four weeks) obviously limited the depth with which we could treat each issue. For example, no discussion is included on small-scale coastal communities and their marine or land-based management systems, or on non-native highland communities.

The availability of information was another limitation. Prior to the visit, IIED/NA assembled a bibliography of working documents with abstracts. This accelerated the identification of relevant data, but could not create data where none existed.

A third constraint is inherent in the scope of work. The terms of reference directed our focus to the role that AID can and should play in the conservation of biological diversity and tropical forests. Rather than generate a "wish list" of all the modifications and adjustments that could be made in resource policy, programs, and projects, we focused on the priority items to which USAID can respond.

A final limitation is the nature of this Assessment as a separate event in the AID planning and programming process. An evaluation such as this should be an on-going process that is incorporated into all Mission activities so that updated information is regularly available. AID/W and each Mission could greatly reduce the time and resources required for each assessment by having a standard methodology and data collection process that "automatically" produce the information for assessments.

1.4. Biological Diversity of Ecuador

As defined by the Office of Technology Assessment (1986), the term biological diversity (or biodiversity) refers to the variety and variability among living organisms and among the ecological systems in which they occur. Diversity is demonstrated by the relative number of interacting ecosystems, taxa, genetic systems, and their abundance within a geographic area.

Ecuador is very rich in species. In a country the size of California there are an estimated 20,000 to 25,000 vascular plant species, far exceeding the 17,000 known for all of North America. (Harling 1987; Dodson & Gentry in prep.; and Morin, pers. comm.)

Animal diversity is equally rich with at least 1,550 bird species reported for the country (Paul Greenfield, pers. com.). Terrestrial vertebrate diversity is estimated to be 2,436 species (see Table 1.1). Invertebrate species are poorly known, but based on verbal reports of scientists collecting in the country, very numerous.

Table 1.1 Neotropical Terrestrial Diversity Profile

Country or Region	Number of Species				Total Species
	Mammals	Birds	Reptiles	Amphib.	
Ecuador	280	1453*	345	358	2436
Colombia	359	1676	383	390	2808
Peru	359	1649	298	241	2547
Brazil	394	1573	468	502	2937
Tropical Andes	569	2385	746	708	4408
Latin America and Carib.	1307	3945	2441	1864	9667
Contin. USA	234	700	263	197	1394

* Paul Greenfield now reports 1550 species of birds (Oct. 88)
Data compiled by The Nature Conservancy / Latin Amer. Div.

Although the species data are incomplete for nearly all Latin American countries, some simple comparisons are highly informative. Despite its much smaller size, Ecuador is able to hold its own in any category, in more than just total numbers, when compared with larger neighboring countries such as Brazil, Colombia and Peru. On the basis of endemic birds and mammals, Ecuador contains comparable numbers of these more mobile animals. In less mobile reptiles and amphibians, Ecuador begins to surpass its neighbors to the north and south. Only Brazil, 30 times larger than Ecuador, has a greater total number of vertebrate endemics. The spectacular biological diversity of the country is beyond doubt.

Table 1.2 Comparative Profile of Endemic Terrestrial Vertebrate Species Diversity

Country	Birds %	Mammals %	Reptiles %	Amphibians %	Total %
Ecuador	37 2.5%	26 9.3%	106 30.7%	138 38.5%	307 12.6%
Brazil	191 12.1%	68 17.3	172 36.8	294 58.6	725 2[illegible].7
Colombia	73 4.4%	22 6.1	104 27.2	141 36.2	340 12.1
Peru	89 5.4%	38 10.6	96 32.2	86 35.7	309 12.1

Compiled by The Nature Conservancy / Latin America Division

Life Zones

The country has been divided by various authors into ecological classification systems in an attempt to recognize and subdivide the ecosystems. The most universally accepted system is that of Holdridge (1967) under which Ecuador is divided into 25 broadly defined life zones based on climatological parameters (see Map 1 and Appendix 9.9). In Ecuador, further division into vegetation types within those life zones (which reflect actual community structure, edaphic conditions and biological diversity) has been only partially successful due to a lack of basic data.

1.5. Identification of Critical Information Gaps

The team interviewed knowledgeable individuals to complement the information available from a search of secondary and tertiary sources. Nevertheless, due to a constant problem of inadequate published information and limited "gray" material produced for institutional or restricted use concerning the status of biological diversity and tropical forests, this report constitutes a coarse-grained, qualitative assessment rather than the detailed, quantitative assessment we would have preferred to write about Ecuador's rich biological and human resources.

The initial step in the management and wise use of the natural resources of a region or country is to have as complete as possible an inventory of those resources. For biological resources, such an inventory is only made possible by the existence of sufficient museum collections, available for study to trained biologists. Ecuador suffers from the lack of an adequate

collection base. Furthermore, the rate of forest conversion is such that, short of a massive effort, neither the time, the funds, nor the biologists are there to inventory the biodiversity of the country adequately before it is gone forever. More taxonomists and ecologists are working on the temperate regions of the world today than have ever visited Ecuador throughout its history.

Only partial lists of the flora and fauna of the country exist. Some species lists are available, but the data are usually not linked to specific geographic locations. We are forced to assess species status indirectly, by examining the status of their habitat. Even at the habitat level, the knowledge base is incomplete. We have used the Holdridge Life Zone System as our coarse filter of biological diversity, but it is a theoretical classification system and is not designed for the detailed geographical analysis that biological diversity requires.

1.5.1. Fauna

Birds are the best-known group of the fauna, but their species count, currently 1550 (Paul Greenfield, pers. comm.), continues to grow. Their general distribution in the country is known, but we know of no existing database that can answer questions about their presence/absence in specific geographical areas below the provincial level (with the exception of lists for some protected areas).

The rest of the vertebrate fauna of Ecuador is less well known but consists of fewer total species, with mammals the best known and fish the least studied. As with the avian fauna, the exact ranges of the species are only generally known.

Table 1.3: Current Estimates of the Ecuadorean Higher Vertebrate Fauna

Birds	1550	(Greenfield, pers. comm.)
Mammals	280	(The Nature Conservancy, 1988)
Reptiles	345	(The Nature Conservancy, 1988)
Amphibians	358	(The Nature Conservancy, 1988)
	2533	Total Terrestrial Vertebrates

1.5.2. Invertebrates

Even less is known of the invertebrates of Ecuador, although the numbers are comparable to those found in neighboring countries. Smithsonian scientist Terry Erwin calculates that more

than 30,000 insects species (particularly beetles) occur in a single small block of forest in Perú.

1.5.3. Flora

The generally accepted estimates of the total number of vascular plant species that occur in Ecuador range from 20,000 to 25,000 species. Gentry (1982a) estimates 4,000 to 5,000 species, or 20% of the flora, to be endemic in the country, based on distribution patterns of local floras (see Appendix 9.10.). Many endemic species and their uses are known to indigenous groups and local foresters but have not been taxonomically described.

1.5.4. Tropical Forests

Ecuador has been described as a "forest rich" country with approximately half of its surface area claimed to be closed forest, though only 26% is primary forest and considered of importance for biological diversity. Various attempts have been made to quantify forest cover and the most current estimates range from 43% to 50%. These figures are largely derived from PRONAREG reports which give somewhat conflicting data over time within regions. For example, in PRONAREG (1987), the total number of ha (hectares) attributed to land use activities within certain quadrangle maps is greater than the surface area represented by the quadrangle. The most recent figures available from DINAF (1988b), based upon remote sensing data from CLIRSEN, describe Ecuador's forest cover as:

Table 1.4: Forest Cover in Ecuador

Land use	ha (millions)	Percent Cover
Forests	13.600*	73.53%
Forest/ Pasture/ Agriculture	2.720	14.71%
Miscellaneous	2.176	11.76%
Totals	18.496	100.00%

* includes forest plantations
Source: Ing. Sanchez, CLIRSEN
Adapted from: DINAF (1988b).

If the open forest formations which result from the transition zones between forest/agriculture/pasture are considered, then the total forest cover approaches 16.3 million ha Most of this forest cover is located in the Amazon region (70%) and about a third (30%) in the Costa, largely in the Province of Esmeraldas. The Sierra forests are largely limited to small plantations of exotic species. Some sparsely dispersed remnants of virgin forest still remain in inaccessible pockets within the Sierra and lower Costa regions. Of the approximately 13 million ha of closed forest, approximately 40 million cubic meters of wood are estimated to be exploitable on a sustained yield basis using a 30 year cutting cycle (DINAF 1988b).

Unfortunately, areas designated for timber production are not managed by concessionaires for a full rotation period of 30 years. Logging crew strip the area of the most profitable species, rarely removing trees of less than 40 cm in diameter, and quickly move on to the nest forest tract. Indeed, estimates of wood recovery from timber harvesting operations are only 25-30%. For examaple, timber harvests average only 17 m3/ha in the northwest lowland tropical forest. Logging often results in more waste and damaged trees than that which is actually harvested. And continued road construction associated with timber harvesting and oil exploration, followed by colonization, is rapidly making more forest available for exploitation.

The World Resources Report (1988-89) places the deforestation rate in Ecuador at 340,000 ha/yr. USAID/Quito (1988) estimates that more than 75,000 ha of virgin lowland forests are cleared annually. Other estimates place the deforestation rate at 200-300,000 ha per year (Bremer-Fox and Bender 1987). No matter which figures are used, the present 2.3% rate of deforestation is alarming when compared to that of its Andean neighbors of Colombia (1.7%) and Peru (0.4%).

1.5.5. Sociocultural Aspects

A systematic information base on the use of resources by indigenous and other small-scale societies is essential to identify and inventory locally-important flora and fauna, and to analyze resource management systems for their effect on biological diversity. At this time, there are no comparable baseline data on local resource management systems, ethnobiology and no longitudinal studies of changing resource practices. As a result, no reliable "benchmarks" have been established as a basis for discussing or monitoring short or long-term effects of local resource use and national programs, on either particular peoples or habitats.

Some of the information can be found in several major anthropological studies on coastal, highland, and Amazonian

cultural systems (see bibliography) and important studies of lowland resource management systems are currently underway in the Oriente and among the western Awa. Additional data on native land use are located in different public agencies. These will contribute substantively to the development of conceptual models for regional and national databases. But at present, systematic community-level information regarding local resource use is dispersed and limited, and no effective information management systems or central repositories of data on indigenous or other local systems of resource management exist.

1.6. Economic Importance of Biological Diversity

In the last few years the role of natural resources in the development of Ecuador has been recognized, though not fully understood. Most of the country's development economists and public officials no longer downplay ecological concerns. More problematic is an assessment of how much of the decline in Ecuador's rate of economic growth is due to mismanagement of its natural resources. Much of the new awareness of natural resources springs from the observation that the extractive sectors (petroleum, mining, and fisheries excluded) have lost much of their relative weight in the economy, as observed in table 1.5.

Table 1.5: Natural Resources and Gross Domestic Product (percentages of total in real terms)

	1970	1982	1986
Agricultural Crops	15.9	7.3	6.8
Livestock	7.5	5.2	5.4
Forestry *	0.9	1.1	1.1
Fishing	0.7	1.3	2.0
Petroleum and Natural Gas	(4.0)	9.7	14.4
Mining	0.3	0.3	0.7

* excluding secondary processing: wood manufacturing

Source: World Bank, 1988. Ecuador: country economic memorandum: preliminary report.

The natural resource sector (originally agriculture and later petroleum) has been crucial to the national economy. As petroleum became the leading resource of the last two decades, new national policies undermined the economic role of agriculture and forestry. Now, as petroleum reserves seem to be diminishing and international prices seem unlikely to recover in the short term,

the solution for the future seems to lie, again, in the efficient use of land and other natural resources.

There is little doubt that Ecuador's economic development would be enhanced if biodiversity were to be conserved. Economic development and biodiversity should be viewed not as mutually exclusive, but as complementary. Long term objectives must consider the nature and quantity of natural resources available and their sustainable utilization. Long-term and sustainable extraction will require appropriate national or regional policies and their uniform implementation.

The benefits to the nation of such policies are sustained employment, reduced migration to Amazonia and associated inappropriate land uses, greater availability of nutritious native products, and the potential for earning more foreign exchange.

1.7. Equity Considerations

An estimated 78 percent of Ecuador's population is described as the "popular" or lowest socioeconomic class. In the Sierra and the Oriente, this class includes populations defined ethnically as indigenous or mestizo. Some of these latter are indigenous people who have abandoned their characteristic language and dress. On the coast the group would include negros, morenos, and mulatos. The most disadvantaged are rural small landholders and landless agriculturalists (who necessarily rely on the least productive areas), followed by urban semi-skilled workers and domestics. These people have also little access to non-agricultural jobs or training and to the benefits of education, health, finance, and most other national institutions (Fundación Natura 1981).

Among the disadvantaged, probably the most economically and politically depressed populations are indigenous. They number over 2 million, mostly living in the rural highlands but with an important number in Amazonia. In both cases they exploit fragile resources. Described in terms of language and cultural systems, we find the Awà (Coaquier), Chachi (Cayapa), and Tsachila (Colorados), on the coast. Quichua-speakers, including Otavalos, Salasacas, and Saraguros occupy the highlands. Amazonia is home to other Quichua-speakers, to Shuar and Achuar (Jivaro), Huaorani (Auca), Cofan, and Siona-Secoya. Although highland peoples and their resources were incorporated into the non-native economy centuries ago, the Amazonian and some coastal people (Awà) are newcomers to that process now that tropical forest resources have become keystones of national economic development and colonization policy.

1.8. Demographic & Economic Trends and Projections

Ecuador must brace itself for a continuing demographic explosion that will double the population in less than 28 years. At the same time, the country is facing a prolonged economic crisis. Depressed oil prices, the earthquake of 1987, an enormous foreign debt burden, and low world prices for traditional and non-traditional exports are combining to limit any potential real gains in GDP per capita. In addition, non-agricultural employment remains relatively limited. The result will likely be increased pressure on forest resources: the clearing of tropical forest lands to replace degraded agricultural lands, continuing an expansion of agriculture into inappropriate areas. The precarious position of the poor and landless will undermine the success of most attempts to promote long-term programs of sustainable resource use and tropical forest conservation without the corresponding policy reform needed at the national level.

Chapter II
Legislative & Institutional Structure Affecting Biological Resources

2.1. National Laws

The absence of clear policies and an effective institutional framework for their implementation are partly a result of poor legislation on environmental matters; though having the necessary legal structure and concepts in place do not necessarily ensure their application. Ecuadorean environmental legislation is abundant and distributed throughout numerous legal mandates, regulations, and administrative decrees.

The problem in Ecuador is an inconsistent and uncoordinated application of existing environmental law. The primary constraint lies in the lack of a coherent framework to determine how different laws and government institutions relate to one another. The result is a myriad of legal conflicts brought on by conflicting jurisdictions, ill-defined policies, unclear objectives, and the failure to systematically apply even the best of environmental laws.

A recent study by Fundación Natura (1988) reviewed the legal structure of environmental controls in Ecuador and found numerous contradictions and holes among them. For example, the "Ley Forestal y de Conservación de Areas Naturales y Vida Silvestre" is a corner stone of current environmental legislation, as well as of the "Ley de Prevención y Control de la Contaminación Ambiental" with its strong bias toward sanitation), but neither can realistically cover all of Ecuador's emerging needs.

This report highlights the need to modify laws drafted for other sectors which affect forest land use practices. For example, the Agrarian Reform Law needs reform to eliminate articles which run counter to tropical forest conservation and the maintenance of biological resources. The Constitution could benefit from stronger statements regarding conservation of the - environment so that the Penal Code could impose penalties upon those responsible for environmental degradation. The basic recommendation of the report is to harmonize existing laws to eliminate contradictions rather than to draft new legislation to address current inadequacies.

2.1.1. Laws and Their Affects on Land Use Patterns

The 1964 Law of Agrarian Reform and Colonization irrevocably changed the nation's cultural and natural landscape by reducing farm size and changing the land uses of extensive highland <u>haciendas</u> (large farms). To promote more intensive use of lands perceived as under-utilized, large private holdings were subdivided (usually among prospective heirs) to create a class of

small to medium-sized landholders. The National Institute for Agrarian Reform and Colonization (IERAC) broke up large-scale agricultural enterprises, primarily those owned by the state itself, which were among the nation's finest and largest.

Indigenous laborers who had received access to marginally arable subsistence plots on the hillsides and minuscule cash wages, received titles to these plots. Concurrently, they lost free access to wood, water, and highland natural pastures (páramos), thus ending the centuries-old feudal relationship between laborers and large landholders. State haciendas were transformed from traditional latifundias into peasant cooperatives. However, large numbers of young farm workers living on the haciendas remained landless.

Subsequent revisions to the Agrarian Reform laws emphasized colonization of the Amazonian forests, which like the Sierra case, are perceived by many as under-utilized and underoccupied. Although IERAC distributes lard titles to colonists, a new agency, the National Institute for the Colonization of the Ecuadorian Amazon Region (INCRAE), was established in 1978 to: establish policies for private sector initiatives; coordinate development activities with public institutions; and to plan colonization in an effort to control spontaneous settlements. INCRAE's major objectives are the occupation of Ecuador's national borders, the reduction of population pressures in the highlands and the coastal regions ; and the promotion of market-oriented exploitation of the perceived Amazonian agricultural frontier.

2.3. National Policies

National policies on natural resources are not found explicitly in government documents. The 1980-84 Development Plan confused "natural resources policy" with "energy management" (Fundación Natura 1981b). Most natural resources were not included among the "strategic areas" for development in the 1985-1988 Development Plan. Consequently, threats to biological diversity could be addressed by the adoption of specific policies, something which AID/Quito could help the Government of Ecuador to establish.

Given the emphasis on petroleum and shrimp production to help service the heavy foreign debt burden, current development policies in Ecuador are more extractive or exploitative than conservation oriented concerning natural resources. There is little explicit regard for the country's future ability to sustain current and future development efforts, and the importance of its rich biological resources for future economic development.

Land use policies "implicit" in other sectors have had major impacts on the conservation of biological resources and tropical forests in Ecuador. For example, colonization policies are major

determinants of forest resource use, emphasizing short-term positive effects (for the colonists) and long-term negative effects for the environment(and many indigenous groups). Forest policy, particularly protection and reforestation, has received increased attention in the past 10 years as national parks and forests were created, a state-run forest corporation(EMDEFOR) was set up, and forest plantations were encouraged (Plan Bosque). Agriculture development policies seem to be largely affected by pricing and other incentives or disincentives (construction of infrastructure and irrigation, real prices, and easy credit) to foster production. However, minimal attention has been placed on the welfare of the individual farmer lacking the technical assistance, credit, and market information that could promote sustainable forms of agricultural production.

Colonization, both planned and spontaneous, originates mostly from the economically depressed and drought-stricken provinces of Loja, Bolivar, and Manabi (Fundación Natura 1987). Many colonists are forced by economic problems to leave their homes and are lured by opportunities for free land and cheap credit. A few come as land speculators and investors (Rudel 1983); others come first as construction workers and remain as subsistence farmers. Most colonists go to Napo where road networks associated with oil exploration and timber extraction have penetrated deep into the Amazon Basin.

Unregulated logging and invasions by colonists follow the road networks. These roads often penetrate indigenous lands and federally protected areas (Fundación Natura 1987). This generates not only environmental problems but also disrupts indigenous communities, especially those without legal land titles. Equally problematic are government policies that encourage deforestation by requiring colonists to put 80% of their parcel into agricultural production within two years or risk foreclosure by the government (Fundación Natura 1988).

2.3.1. Communal Policies (Indigenous)

Potential allies and partners in the conservation movements are found in agricultural cooperatives, formal community organizations, "comunas," and the political, decision-making arms of rural communities. About 1300 comunas are found in the highlands, in predominantly indigenous areas, of which approximately 250 have organized themselves into resource-managing entities in the Oriente, mostly between 1964-1984 (IERAC 1986; MAG: Dept. de Organizacion Campesinas 1988).

In the Oriente, comunas exist beside the new organizations known as "centros." The pattern of "centros", initiated in the 1960's by the Shuar and Achuar is now spreading to other indigenous groups in the Oriente and Costa regions. Characteristically, extended families move from dispersed

residences to "centros": new nuclear settlements with sports, health, educational and other facilities. This development has been accompanied by a rising political awareness, assertions of cultural autonomy, and programs to formally identify, register, protect and manage native landholdings (Uquillas 1985; Salazar 1981; Taylor Ann-Christine 1981).

The comunas and centros of tropical forest communities are decision-making bodies and landholding units that offer important localized bases for programs to protect biological diversity. To ensure success, training programs or programs to develop techniques for sustainable use have to involve local peoples as full partners in the design, implementation, and evaluation of such actions. Consideration should be given to income-generating activities that also result in protecting the habitat, such as the development of native-owned and managed parks and preserves, and native-run tourism/ventures.

2.4. Non-Governmental Organizations (NGOs)

Conservation NGOs

Unlike earlier years when there was limited public interest in environmental issues, the number of private associations (NGOs) specifically concerned with environmental issues has expanded significantly. Of the 16 organizations recently described by Fundación Natura (1988), 12 have emerged since 1978.

The majority of the NGOs surveyed in this assessment are environmentally oriented, they focus on diverse aspects of biological diversity in different geographical areas through different activities (see appendix 2.2). Some specialize in resource protection and scientific research, such as the Charles Darwin Foundation which is concerned with the Galápagos National Park. Others focus on specific regions of the country, such as Otavalo and Riobamba, or on particular communities such as Mindo (Tierra Viva-Quito). Some focus on improved utilization of natural resources such as INSOTEC. For example, INFORDE concentrates on the conservation and pragmatic use of forest resources. Others consider fauna such as the Ornithological Corporation which deals with research and conservation of birds. A few, such as the United Brethren and COMUNIDEC, focus on resource problems among particular sectors, particularly the rural poor. Several have a national scope such as Fundación Natura. Concern with low public awareness, the need for environmental data and projects, led in 1978 to the establishment of Fundación Natura, the largest and most active national-level organization in Ecuador.

NGO activities have generated an outpouring of research, publications, public information programs, and collaborative projects among local, regional, and national level organizations.

For example, the Awá, CONAIE, and Fundación Natura have entered into a joint project. In another case. the community of Mindo and the national NGO Tierra Viva de Quito successfully joined forces to secure the legal designation of "Bosques Protector" for one of the last remaining remnants of primary forest in the Andean highlands.

Collaborative efforts strengthen the position of local NGOs and communities in voicing their concerns within political areas, and establishes important linkages between community development and the national conservation movement. NGOs are invaluable from the perspective of building constituencies which support environmental concerns at the local, regional, and national levels, and among diverse socioeconomic groups. The degree to which they are mutually supportive and collaborative in pushing for policy reform when critical issues arise, and are able to link their goals and programs to international conservation organizations, will determine their long term effectiveness.

Indigenous Peoples' NGOs

Groups among local and pan-indigenous groups are potential vehicles for conservation activities , although they may not be specifically focused on environmental issues. Political mobilization to protect traditional land and life styles from external threats is especially intense in the Oriente where centros have combined into second-tier ethnic federations, and then coalesced into a pan-ethnic Amazonian federation, the CONFENIAE. Its members are the numerically powerful Quichua and Schuar federations, and the smaller Achuar, Siona-Secoya, Cofan, and recently affiliated Huaoani. These represent increasingly sophisticated organizations with firm commitments to protecting indigenous political autonomy and land rights, and to expanding ties with other organizations, national and international, public and private. (Salazar, 1981; Corry, 1985; Makas and De la Cruz, pers. comm; Borman, pers. comm; Macdonald, pers. comm.) .

CONFENIAE, a similar highland organization called ECUARUNAIAE, and a new coastal unit, are incorporated into the national umbrella organization CONAIE. The goals of CONAIE include the protection of indigenous cultures and resources; the establishment of indigenous political presence; and to participate in the national political apparatus (pers. comm. Makas and De la Cruz, and Congreso publication 1987). Although contending with strong anti-native sentiments, CONAIE has effectively represented its members and orchestrated nationally and internationally funded projects in community development, boundary establishment and land titling projects in coastal and Amazonian Ecuador.

Indigenous organizations of the western and eastern lowlands do not focus exclusively on environmental issues but consider the protection of subsistence resources among their principal goals

(Tapuy 1986). Obtaining secure communal title to indigenous lands, for each of the component groups of Schuar, Huaorani, and others, is a thrust aimed at protecting native areas against the incursions and ecologically destructive practices of newcomers while also strengthening the indigenous political status. However, success in obtaining communal titles is only an initial step towards conserving the moist forest. It needs to be supplemented by actions that effectively protect the boundaries against physical intrusions by colonists, while also encouraging continued non-destructive resource uses by indigenous people themselves.

Non-native support for native causes has contributed significantly towards the meeting of indigenous peoples' goals. Increasing national interest is evident in examples such as Fundacion Natura's support for the Shuar Federation's program to breed and reintroduce native animals which attracted funding from the Ford Foundation. Fundacion Natura's recent support for a boundary study involving the Huaorani community and CONFENIAE (El Comercio B-4, Sept, 20, 1988) is another example of this newly found support between the national conservation movement and indigenous peoples' organizations. A formal statement of concerns about Amazonia, La Region Amazonica: Realidades y Perspectivas, presented to the new government by Tierra Viva-Quito in collaboration with leading environmental groups, local agencies, regional institutions, and concerned individuals, stressed the importance of indigenous peoples involvement in Ecuador's development.

2.5. Economic Project Evaluation Process in Ecuador

Public Decree No. 659-C of August 1975 established norms to be applied in the determination of investment priorities in Ecuador. These were set down in the National System of Projects (Sistema Nacional de Proyectos) and directed by a consortium of the National Development Council (Consejo Nacional de Desarrollo - CONADE), the National Preinvestment Fund (Fondo Nacional de Preinversión - FONAPRE), the Ecuadorean Development Bank (BEDE), and other public institutions. The role of FONAPRE was to carry out appropriate preinvestment analyses before project implementation. Unfortunately, this decree has not been fully implemented and projects are still carried out independently by sectors within relevant ministries.

CONADE coordinates national planning activities which are conducted on a four-year cycle. A recent report evaluates the principal projects of the National Development Plan for 1985-1988 (CONADE 1988a, b). The evaluation made by CONADE of more than 2,000 individual projects is not sufficient in terms of rigorous economic evaluation principles. This would not be a problem if other public agencies had a process for internal review and control of the environmental impacts of their projects; or if the

public could legally (and realistically) demand such attention. Unfortunately, neither has developed to guarantee the inclusion of environmental considerations in development projects and planning, largely due to the lack of instruction and concern of these matters from traditional education systems and project implementation.

The revival of a national commission with members from key agencies and ministries in an advisory capacity in the development and planning of major public projects would increase the availability of information relevant to a specific project and help improve project design. A theoretical framework for conducting an economic analysis of biodiversity is presented in appendix 2.4.

2.6. Development Projects of International Donors, U.S.-Based PVOs, and AID

A number of international and U.S. based donors are active in development projects in Ecuador. DINAF (1988a) and FAO (1986) provide a good overviews of the major development projects supported by donors within the forestry sector of Ecuador. These projects encompass various forms of financing including foreign credit contracts and loans with USAID (12 projects), Germany (GTZ - 3 projects), Belgium (COMADERA project), IADB (reforestation project), Japan (forest inventory and aerial photography projects in the Amazon Basin), FAO-Japan (4 projects), Switzerland (Vicuña, fuel wood and soil conservation projects), FAO-Holland (Tropical Forestry Action Plan for Ecuador), ITTO (3 projects - pending), and the Inter-American Development Bank (3 projects).

The Tropical Forestry Action Plan for Ecuador (TFAP/Ecuador) provides a unique opportunity to stimulate the local government, development assistance agencies, NGOs, and private sector interests to work together to reverse deforestation by promoting sustainable forest management and conservation of tropical ecosystems in Ecuador. The TFAP/Ecuador provides a flexible framework for developing a national consensus on a forestry sector strategy to determine investment priorities and needed policy reforms and an excellent opportunity for discussion of national priorities concerning the conservation of biological diversity. It also provides a forum for AID and other donors to establish dialogue with the GOE and national NGOs concerning technical assistance needs and investment priorities for the five interrelated areas of: forestry in land use; forest-based industrial development; fuelwood and energy; tropical forest ecosystem conservation; and institutional strengthening.

The TFAP/Ecuador is being coordinated between MAG and FAO with assistance from the Netherlands, IIED and WRI. Donors which have indicated a strong interest in this exercise include British ODA and the World Bank.

The U.S. based PVOs involved in promoting conservation in conjunction with rural development include the Peace Corps (a variety of soil conservation, agroforestry, and forest conservation projects), CARE (soil conservation/reforestation), WWF (Awa Forest Reserve), IAF (Awa Forest Reserve), PADF (microenterprise assistance), IIED (Country Environmental Profile and this Biological Diversity Assessment) and IIED-WRI (Tropical Forestry Action Plan for Ecuador).

In 1988 the Inter-American Foundation (IAF) awarded several new grants with implications for natural resource issues. The recipients include the Unión de Cooperativas Agropecuarias del Norte for soil conservation and animal husbandry programs; Fundación Natura, for public information program and research on sustainable development; Comité Campesino de las Comunidades del Proyecto de Desarrollo Rural Integral for an artificial insemination program for cattle; Asociación de Indígenas Evangélicos de Napo for an agriculture program. Supplemental grants were given to Federación de Centros Shuar to continue its land titling and community organization program. An important new start for fiscal 1989 is the Awá project dealing with conservation and community development.

International attention to indigenous goals is also increasing as reflected in the support received from the US-based Cultural Survival, USAID/Quito, WWF, IAF and the Rainforest Information Centre of Australia. A September 1988 telegram to President Borja from the Canadian-based World Council of Indigenous People, seeking the cessation of road building and protection of Huaorani and other indigenous lands, marked the entry of Ecuadorian indigenous peoples' concerns into the worldwide network of native rights organizations. It is important that localized communities continue to be directly involved in this support system. Essential to this is greater sophistication about the processes of institution-building, organizational practices, and the use and innovation of political strategies on their own behalf and in coordination with others.

2.7. Selective Review of Major Development Projects Affecting Biodiversity

Biological diversity is a relatively immobile entity. Habitats cannot pack up and move to a new location. In general, a development project will have negative impact on biological diversity if it encroaches directly or indirectly on natural habitat. A project will have positive effects if it halts or reverses encroachment, or specifically augments the amount of habitat through restoration and recovery. Projects that halt encroachment may actually take place many kilometers away from the resource that receives the benefit. For example, by enhancing

agricultural productivity on existing cultivated lands, a project can contribute to the conservation of biological diversity by reducing the need for additional lands and effectively halt the clearing of primary tropical forest. In a similar fashion, projects that promote the transfer of technology concerning sustainable development techniques can reduce the demand on these natural resources. Improvements in saw log utilization, or plantings of fast-growing fuelwood species can also take pressure off native tropical forests.

Most agriculture and natural resource projects are double-edged swords. They have both positive and negative impacts. A hydroelectric project may provide electricity for homes and water for irrigation (reducing demand for firewood and allowing double-cropping), but it does so at the cost of destroying the native forest that is now beneath the waters of the reservoir and possibly increasing erosion, or salinization, through inappropriate use of irrigation waters.

Development projects can have positive, negative, or neutral impacts on biological diversity. Among the many currently being implemented in Ecuador, the following were selected for economic assessment based upon given time constraints to conduct an analysis and the availability of adequate data. A complete list of development projects receiving international assistance within the agricultural and natural resource management sectors is present in Appendix 2.3.

2.7.1. Hollin - Loreto - Coca Highway

The highway between Hollin-Loreto-Coca was completed to solve economic and social problems created by the 1987 earthquake by resettling displaced families and restoring transportation access. A socio-economic analysis done by Southgate (1988a) stated the difficulty of quantifying the cost and benefits of this project, emphasized the importance of economic analysis to justify such development projects.

2.7.2. Watershed Development

There exists a possible linkage between the magnitude of soil movement caused by the 1987 earthquake and land use practices in the Quijos watershed. A socio-economic evaluation by Southgate (1988b) points to the decreased stability of soils due to deforestation and the possible linkage to the increased risk of floods and landslides. He identifies in general terms the costs associated with deforestation and subsequent farming by colonists. Development decisions by government agencies and colonists clearly ignore the negative externalities associated with deforestation and do not provide solutions to the problem of poverty.

The Instituto para el Desarrollo de Estrategias Agropecuarias (IDEA) analyzed several major watersheds in Ecuador, such as the Aguarico and Quijos, the Pastaza, and the Napo (IDEA 1987, 1988a,b) describing the physical characteristics of the watersheds, but failing to provide quantitative information that could serve in economic analyses. Potential land uses of various parts of the watersheds are, however, identified and can serve as a guide to land use planners. Several of these studies strongly recommend more detailed studies and analyses and the creation of an inter-institutional presidential commission for the evaluation of management activities in watersheds. An Interamerican Development Bank study on the Peripa hydroelectric dam, while providing technical information on construction and operation costs, provides no quantitative assessment on the cost and benefits of watershed protection.

2.7.3. Daule-Peripa Dam

The Dirección General del Medio Ambiente (1986) analyzed the major risks to the shrimp industry posed by the future Daule-Peripa dam and related irrigation projects, and the utilization of pesticides in the areas to be irrigated. About 17,000 ha of cultivated land in the lower part of the Daule river will be irrigated. As in many other studies, this report fails to develop any quantitative estimates of the potential impacts on the shrimp fisheries, but is useful in identifying those pesticides which pose a potential threat and need to be monitored.

2.7.4. Forestry Sector Development Project

Economic analyses of the contribution of the forest sector of Ecuador were done for the USAID Forestry Sector Development Project (USAID/Quito 1982b). From the point of view of demand, the outlook for the forestry sector is good. However, the current rate of reforestation is inadequate to replenish the harvested acreage. The Project Paper contains a number of financial/economic analyses of field demonstration projects which are summarized in Table 2.1 (in all cases, a real discount rate of 10 percent was used).

These analyses do not include additional benefits that natural forests or forestry plantations could have in protecting economically important watersheds. For the Poza Honda dam project, a conservation program consisting of protecting forest on 870 ha of the watershed, planting trees on 505 ha, with conservation measures on 2,805 ha of grazing land, terracing 320 ha for cultivation, would cost 45 million sucres. This investment could reduce the sedimentation rate from 4 to 2 percent, which would double the life of the dam from 25 to 50 years. The benefits are estimated to be 770 million sucres in terms of present net worth. Preliminary estimates for the Paute watershed indicated that an investment of $10 million in conservation would generate an annual savings of 4.5 million in present value.

2.7.5. Soil Conservation

A general review of soil and conservation problems in Ecuador (Maldonado 1980) makes a strong argument for soil and water conservation projects, and identifies high priority areas for soil conservation.

Table 2.1: Economic Return on Agriculture and Forestry

	Net Present Value (sucres/ha)	Internal Rate of Return (%)	Benefit/Cost
Pine plantations in highland Ecuador	4,457	12.4	1.38
Pine plantations with potato intercropping	58,972	>50.0	1.92
Eucalyptus plantations	606	10.6	1.05
Agroforestry plantations in humid tropics:			
-Laurel and bananas	36,595		1.62
-Laurel and coffee	28,595		1.54
-Cedar and bananas	59,969		1.96
-Pachaco with rice, corn and pasture	17,316		1.30
-Teak with rice, corn and beans	22,033		1.29
-Balsa with rice and corn	58,699		1.96
-Pachaco without previous thinning	6,996		1.37
-Laurel with thinning	11,010		1.49

Chapter III
Status and Protection of Species at Risk

3.0. Introduction

An assessment of the status of species and habitats in Ecuador is a formidable task because the list of species is incomplete and habitat preferences are not well known. Nevertheless, a first approximation can be made on the basis of broad habitat types using the Holdridge Life Zone approach. Life Zones are units of a classification system based on biophysical characteristics that are useful indicators of ecological communities or a species presence. In the absence of detailed information that allows us to pinpoint the locations of specific populations and their ranges, we can make relatively certain statements about the status of ecological life zones and thereby extrapolate this information to the species level.

Considering the relatively small area of the country under protected status (and the dubious validity of that status) at least 50%, nearly 3,000 plant species, are at extreme risk of becoming extinct before the turn of the century. Given this situation, an even greater number of invertebrate and vertebrate animals are at extreme risk.

Much caution must be exercised in referring to published data on biodiversity and the extent of forest remaining in Ecuador. The definition of biodiversity refers to the kinds and abundance of living organisms within an ecosystem and their interactions between one another. For example, biodiversity is drastically reduced when a square kilometer of primary forest containing more than a thousand species of vascular plants, many more insects, kinds of forest-dependent birds, and mammals, is converted to second growth after logging, or is left fallow after being clear-cut. Second growth forest are extremely limited in their number of species when compared to primary tropical forests; and regeneration of primary forest species takes a long time in tropical moist forests.

A recent study by Dodson & Gentry (in prep.) on biological extinction in western Ecuador found primary forest cover remaining on less than 6% of the region. The recent Plan de Accion Forestal para el Ecuador (DINAF 1988b) - reports that 24% of western Ecuador is still covered by tropical forest. The difference between the two reports depends on two factors: the Dodson & Gentry report is based on field visits throughout the region during 1987-88 whereas DINAF (1988b) report is based on a map published by PRONAREG (1977). The Dodson & Gentry report focuses exclusively on exclusively undisturbed or minimally disturbed primary forest while DINAF (1988b) considers all areas of forest cover with no distinction between primary forest, recent second growth forest, or agricultural systems which utilize tree cover for shade crops.

An official category of forested area considered by DINAF (1988b) is "Bosque Protector" which refers to forests located in areas not apt for agricultural exploitation but not necessarily clothed in forest cover. This category provides protection for lands that do not qualify for protection as national parks or forest reserves. It also provides shelter from expropriation for privately owned lands which retain forests that qualify for protection. Unfortunately, the term "Bosque Protector" does not necessarily refer to lands with extant forest. For example, in western Ecuador, DINAF (1988b) cites 670,245 hectares of Bosque Protector, while Dodson and Gentry were able to verify that primary forests exist on less than 300,000 ha. in the region. The Daule-Peripa Watershed (220,853 ha.) has no primary forest cover yet it is classified as a Bosque Protector. Therefore, the total of 1,352,039 ha. (13,520 sq. km.) of Bosque Protector cited by DINAF (1988b) may be misleading in terms of conservation of biological diversity. We estimate that there are approximately 700,000 ha. of primary tropical forest remaining in Ecuador which are important for maintaining biological diversity.

3.1. Life Zones of Ecuador and their Status

According to the most recent study (Cañadas, 1983), twenty-five Life Zones occurring in Ecuador (Map 3.1). Experience from many years of collecting and traveling throughout Ecuador suggests that ecological maps of Ecuador are quite generalized, and that life zones are more fragmented than is indicated by the Cañadas (1983) map.

In Appendix 3.1, we present an extensive discussion of the geography, climate, soils, and Life Zones of Ecuador on a regional basis, e.g., western Ecuador (about 80,000 km2), the Andean Highlands (Sierra, about 112,000 km2), and the Amazon Region (Oriente, about 81,000 km2). For this discussion, we will briefly review the major ecosystems and their present conservation status. Maps in appendix 3 illustrate the changes in forest cover for the country as a whole from 1958 to 1988.

Table 3.1. presents data concerning original, aboriginal, and recent forest cover by region and forest category with estimates of number of species of vascular plants, (and number of endemic plants) in each, respectively.

Table 3.1: Area (1000 Km2) of forest cover in Ecuador with estimated numbers of total and endemic species

Forest Categories	Original Km2	Original %	Aborig. Km2	Aborig. %	1958 Km2	1958 %	1988 Km2	1988 %	Estimated Species Total	Estimated Species Endemic	Estimated Species %
Western Ecuador:											
Dry	20	25	15	70	12	60	0.2	1	1,000	190	19
Moist	40	50	30	70	24	60	1.5	<4	1,000	140	15
Wet	12	15	10	80	7	58	<.1	<0.8	1,700	340	20
Pluvial	8	10	8	>90	6	75	3.2	>50	2,300	590	>25
Subtotal	80	100	68	77	49	63	<5	<8	6,300	1,260	20
The Sierra:											
Flanks	61	60	45	73	40	66	18	30	8,500	2,125	25
Highlands	40	40	12	30	10	25	8	20	2,000	500	25
Subtotal	102	100	57	56	50	49	26	25	10,500	2,625	25
The Oriente:											
Base of Andes	39	48	39	100	35	90	11.7	30	6,000	1,000	17
Amazon Basin	42	52	42	100	41	97	30	70	2,200	230	10
Subtotal	81	100	81	100	76	94	41.7	51	8,200	1,230	15
Totals	263	100	206	78	175	67	72	26	25	5,115	20

3.1.1. Western Ecuador (La Costa)

We have separated Western Ecuador into 4 categories of forest: dry, moist, wet, and pluvial. These categories may each include several Holdridge Life Zones. The dry forest in western Ecuador encompasses tropical desert scrub, tropical desert, tropical thorn scrub, premontane thorn scrub, very dry tropical forest and premontane dry forest according to the Holdridge system. All of these Life Zones have been severely altered by humans and their domestic animals. We estimate that about 25% (20,000 km2) of western Ecuador consisted of dry forest in aboriginal times. Probably much less than 1 % (about 200 km2) of this category now remains in an undisturbed condition.

The moist forest category, which encompasses tropical moist forest and premontane moist forest in the Holdridge system, was once the most extensive forest cover in western Ecuador. Since the soils of western Ecuador are generally quite rich, particularly when compared with the Oriente, the moist forests were extremely attractive for agricultural development. The

forests were converted to cacao, coffee, pasture and short-cycle crops such as rice, soy beans, corn and yucca. They also have a rain-free period of at least 4 months, allowing for easy access. We estimate that nearly 50 % (40,000 km2) of western Ecuador was covered with a fairly homogeneous moist forest in aboriginal times. Less than 4% (about 1,500 km2) now remains. Regeneration of moist forest is probably very slow, and in this case, most of this forest was clear cut, burned, plowed, and thus, permanently altered.

The wet forest category, encompassing tropical wet forest and premontane wet forest in the Holdridge system, was originally a band extending from the Colombian to the Peruvian borders. The band was about 20 km wide at the northern extreme, and very narrow and broken to the south. The soils are very rich and the forests have been mostly converted to banana, African oil palm and rubber cultivation. We estimate that about 15 % (12,000 km2) of Western Ecuador was covered by this type of forest and that now less than 0.1 % (90 km2) survives.

Pluvial forest, encompassing premontane pluvial forest and lower montane pluvial forest, forms the only substantial surviving forest category. Conversion of this forest has been mostly for subsistence agriculture, and is the home of most of the surviving western lowland indigenous cultures. We estimate that about 10% (8,000 km2) of western Ecuador was covered by this forest category and that about 4% (3,200 km2) remains. The persistence of these forests is probably attributable to the notoriously poor, highly leached soils, inaccessibility due to high year-round rainfall (which destroys unpaved roads), and the precipitously broken nature of the terrain. These forests are of particular interest because they probably contain the highest biological diversity in western Ecuador, comprising part of the Chocó region which allegedly contains the most diverse forests on the face of the earth (Gentry 1986). Though most of the remaining forest lands have been declared National Ecological Reserves, they are also the only large extensions of forest left in Western Ecuador in an increasingly land and timber starved era.

In total, less than 6%, or 5,000 km2 of Western Ecuador (80,000 km2) is still covered by primary forest.

3.1.2. The Sierra (Andean Highlands)

We consider the Sierra region to consist of the areas above the 900 m contour on the east and west sides of the Andes. A band of forest existed on each outer flank of the two slopes between the 900 and 3000 m elevational range. These forests are extremely diverse biologically due to adaptations to plethora and destructive microhabitats by plants and animals. The forests and páramos above the 3,000 m contour were less diverse, and though extensive forests once existed on the inner flanks and in the interandean valleys, they were heavily converted by the indigenous populations prior to the Spanish conquest.

The eight forest life zones present on the Andean flanks ranged from extremely dry to very wet, and consist of premontane thorn forest, premontane dry forest, premontane moist forest, premontane wet forest, premontane pluvial forest, montane moist forest, montane wet forest, and montane pluvial forest. They covered about 24% of the country as a whole. With the construction of numerous roads from the Sierra to western Ecuador and the Oriente, as well as secondary roads which followed, the forests have been largely converted to pasture, citrus and naranjilla production. We estimate that less than 30% (19,000 km2) of the Andean flank primary forests now remain of the original 61,000 km2.

The region from the 3,000 m contour to snow line at about 5,200 m, has twelve life zones: montane thorn steppe, montane dry forest, montane humid forest, montane wet forest, montane pluvial forest, subpáramo steppe, subpáramo humid, subpáramo wet, subpáramo pluvial, subalpine humid, subalpine wet, and subalpine pluvial. This region covers about 40,000 km2, or about 40% of the Sierra. Much of the lower areas of the region have been converted to the production of potato, oca, garlic, etc., while the intermediate levels are used as pasture. We estimate that approximately 80% of the upper Sierra has been converted to agriculture in one form or another, leaving about 8,000 km2. in a relatively natural state.

Only about 9.3%, or 25,468 km2 of the total area of the Sierra (112,000 km2) are still covered by natural vegetation.

3.1.3. The Amazon Region (El Oriente)

We consider the Oriente region to consist of those lands below the 900 m contour extending to the Peruvian - Colombian borders. This area covers approximately 81,000 km2 and includes 7 life zones, of which 6 occur only at the base of the eastern Andean slope. The majority of the region was clothed in forests of one life zone, the tropical moist forest, lying below the 300 m contour. This region covers about 42,000 km2. It is a reasonably

flat region with meandering rivers, many of which are quite large. Biodiversity is lower in this region than on the flanks of the Sierra or on the lower slopes, and the flora has many species in common with the rest of the Amazon Basin.

It is only with the recent advent of oil exploration and exploitation that the forests of this region have suffered significant alteration. The easy access granted by the road networks associated with petroleum activities and a massive governmental colonization effort have resulted in a significant reduction of forest cover. We estimate that about 30% of the forests have been converted to other uses, leaving about 30,000 km2 still in primary forest.

The region at the base of the Andes, with premontane dry, humid, wet, and pluvial forests, and lower montane humid and pluvial forests are extremely biologically diverse. This area of approximately 39,000 km2 has been heavily converted to agriculture, mostly pasture and coffee. We estimate that about 30% (11,700 km2) of these forests remain undisturbed.

About 51%, or 41,700 km2 of the total Oriente region (81,000 km2) remains forested, of which a large portion is relatively homogenous lowland forest with lower biodiversity than the forests of the Andean slopes.

Nationwide (273,000 km2), we estimate that only 26%, or (72,000 km2) is still clothed in primary forest, with more than half (41,700 km2) occurring in the lowlands of the Oriente.

3.2. Definition of "Species at Risk"

Various international treaties (e.g. CITES) offer definitions for different classifications of endangerment: rare, threatened, endangered, etc. We have chosen the broader label "Species at Risk" to cover all of these categories, including rare, threatened, endangered, reduced population and endemic, that signal a need for special attention. In this way, we can focus on the problem of endangerment even though the information base does not allow us to determine the exact category for a particular species or population.

Under this system, a species is at risk when its habitat is under threat. We consider any species endemic to Ecuador to be subject to at least moderate risk of extinction considering the current protection status of primary natural forests. Obviously, an indeterminate number of species have already gone extinct since only 26% of the original forest cover is still extant. Other reasons that contribute to the endangerment of particular species are over-hunting, natural pathological epidemics and disease spreading from domestic animals.

3.2.1. Analysis of Species at Risk Following a Regional Focus

In Appendix 3.2, we present a discussion of biological endemism in Ecuador. Based on numbers generated in the discussion of Appendix 3.1, we are able to estimate the risk situation for vascular plants in the three regions of Ecuador. Animal species, dependent on the presence of undisturbed vegetation, can be expected to suffer the same risk factors.

Western Ecuador.

In Tables 3.2 and 3.3, we present accumulated data (Dodson & Gentry, in prep.) concerning the species of vascular plants at risk at four intensively studied sites in western Ecuador (Rio Palenque Science Center, Jauneche, Capeira, and Centinela). Extrapolation from these data indicates that, of the 6,300 species estimated to occur in western Ecuador, 1,260 (20%) are at risk.

Andean Highlands.

Extrapolation based on data in Appendices 3.1 and 3.2 indicates that about 10,500 species of vascular plants occur in the Sierra and that 2,625 of those species (25%) are endemic and therefore at risk.

Amazon Region.

Similar extrapolation indicates that about 8,200 species of vascular plants occur in the Oriente and, of those, 1,230 species (15%) are endemic and at risk.

Galápagos Islands.

The Galápagos have a native flora of 702 species of which 228 are considered to be endemic (Wiggins and Porter, 1971). Thus 32.5% of the plant species are endemic vs. 20% in mainland Ecuador. The basic difference between the risk situation on the Galápagos Islands and that of mainland Ecuador is an international awareness (partially due to ecotourism) of the precarious situation of the Galápagos. This awareness has resulted in the application of far stronger control measures that, along with the distance from the mainland, lead to more effective conservation measures. Similar awareness of the risk situation on the mainland must be developed if the alarming rate of biodiversity loss is to be thwarted.

Table 3.2: Comparison of the status of vascular plant species at four sites in Western Ecuador.

	RPSC	Jauneche	Capeira	Centinela
Vascular plant species reported:	1289	728	772	1164
Cultivated plant species:	215	136	141	177
Native plants:	1074	592	631	987
Species now extirpated at site:	25		1	84
Remaining native plants:	1049	592	630	903

Table 3.3: Risk situation at 4 sites in western Ecuador (Species at extreme risk due to small populations)

	RPSC	Jauneche	Capeira	Centinela
Endemic to site	18	5	0	± 84
Found at other sites in region. .	49	12	18	17
Species of broad distribution . .	39	33	63	?
Species with short-term sustainable populations at site	942	542	559	?
Species at risk on a long term basis	312	73	187	?
Species not at risk, primarily due to wide distribution . . .	670	469	372	300

Chapter IV
Status & Management of Protected Areas

The National Park System of Ecuador began more than fifty years ago when a "Reserve National Parks for the Fauna and Flora" was set aside in the Galápagos Islands in 1936 (Decreto 31, Registro Oficial 189, 14 May 1936). Since then, the system has grown to include a wider variety of designated protected areas. In this report, we expand the scope of view further by including information on other types of protected and managed landscapes in Ecuador as well.

An important concept in wildland planning is the idea of "coverage" -- how well the biological diversity of a country is "covered" or included in the wildland system. In this report we attempt to assess the coverage based on park locations and general life zone data. This provides, at best, only a rough estimate because the diversity within an individual life zone may be extreme. A single park or equivalent reserve for a geographically-broad and biologically-diverse life zone would clearly not be adequate.

4.1. Wildlands and Protected Areas

Wildlands are areas where natural capital predominates. We can categorize all landscapes according to their relative naturalness. Wildlands are landscapes which show more "naturalness" and less evidence of human intervention. Protected areas are places on the landscape that receive some significant level of protection from invasion, disturbance, or conversion, that could alter (physically or biologically) the natural ecosystems. Not all wildlands are protected areas, but an adequately protected area should be able to remain wild.

4.1.0. National Wildland System in Ecuador

The National Wildland System in Ecuador consists of several subsystems. The Department for the Administration of Natural Areas and Wild Resources (DANRS) of the Forestry Directorate (DINAF) of the Ministry of Agriculture and Livestock (MAG), is responsible for the sub-system of "National Parks and Reserves." DINAF itself is responsible for the main portion of the "National Forests" sub-system. Private landowners and other institutions and organizations are responsible for a major portion of the sub-system of "Protection Forests and Vegetation."

4.1.1. The National Park Sub-system

Ecuadorean Law #74 (Ley Forestal y de Conservación de Areas Naturales y Vida Silvestre, 1981) established seven categories for the National Park Sub-system: National Parks, Ecological Reserves, Wildlife Refuges, Biological Reserves, National Recreation Areas, Faunal Production Reserves, and Hunting and Fishing Areas. In practice, the system uses five categories: National Parks, Ecological Reserves (plus a subset, the Geobotanical Reserve), Biological Reserves, Faunal Production Reserves, and National Recreation Areas.

4.1.2. The National Forest Sub-system

The same Ley Forestal cited above establishes different categories for the Forest Sub-system. The basic categories are Production Forests, Protection Forests, and Forest Reserves. Timber companies can acquire concessions for harvesting in Production Forest blocks. Protection Forests are areas set aside as "Bosque y Vegetación Protectores" to conserve soil and water resources. Forest Reserves are areas set aside for future use and therefore not available for current consumption.

4.1.3. The Non-governmental Sub-system

The alarming rate of deforestation throughout the tropics called the attention of the Private-sector conservation community (non-governmental) to the existence of vestigial forests and wildlands that are not part of the recognized national system. Many of these smaller sites are simply the forest remnants that private land owners have chosen not to cut. Others are connected with research projects. A new but growing group are private reserves set aside specifically to conserve and protect the biological resources within their borders -- private sector conservation actions.

In Ecuador, there exist examples of all three types: national parks, national forests, and privately protected areas. The research stations of the universities often have small forest patches within their borders. Several private individuals have worked hard to maintain private forest patches for research and ecotourism. The agricultural research stations in various regions of the country also conserve forest remnants. Although small (usually fewer than 5,000 ha and often fewer than 200 ha), these areas can protect certain communities or assemblages of species. A continuing problem is the protection of these private and institutional forests from the threat of agrarian reform. One strategy is to seek official designation of the sites via Ministerial decree as "Protection Forests."

4.2. Inventory, Use and Assessment of Management Activities

In this section we provide an overview of the individual units in the protected area system, highlighting the specific threats to their integrity vis a vis conservation of biological diversity.

4.2.1. Designated Protected Areas

The designated protected areas of Ecuador are the 11 units in the National Park System. Authorities recently reviewed the system (MAG/DINAF 1988 and FN 1988) and those reports form the basis of this summary.

Table 4.1: Designated Protected Areas of Ecuador (1988)

National Parks (NP):	Cotopaxi NP Galápagos NP Machalilla NP Podocarpus NP Sangay NP Yasuni NP
Ecological Reserves (ER):	Cayambe-Coca ER Cotacachi-Cayapas ER Manglares-Churute ER
Geobotanical Reserve (GR):	Pululahua GR
Fauna Production Reserve (PR):	Cuyabeno Fauna PR
Biological Reserve (BR):	Limoncocha BR
National Recreation Areas (RA):	Cajas National RA El Boliche National RA

Cotopaxi National Park

Cotopaxi National Park covers a range of elevations from 3,300 - 5,897 meters, including Cotopaxi Volcano. The park suffers from clandestine hunting and fishing, as well as off-road motorized vehicle use in the páramo areas.

Galápagos National Park

Galápagos is the flag-ship of the Ecuadorean National Park System due to its international fame. The park is 1,000 km. to the west of the mainland. The significant distance, and the overwhelming international attention focused on the park, make the

unit almost an independent part of the system. Visitor use in 1987 was officially 32,000 but unofficial counts put the number at 64,000 -- even though the carrying capacity for the park was set at 25,000.

Machalilla National Park

Machalilla is Ecuador's primary coastal park. The area includes beautiful beaches, bays, cliffs, and inlets. Park boundaries extend 2 nautical miles into the marine environment. Land claims are a continuing problem. IERAC distributed some titles to land within the park. Subsistence wood extraction continues. Goats are a detriment to the native vegetation. Illegal hunting continues for deer, peccary, and armadillo.

Podocarpus National Park

The newest national park, Podocarpus conserves a mountainous region of the southern part of Ecuador with populations of the native Podocarpus spp. Two and possibly three species are endemic to the Ecuadorean Andes. Visitation is limited at the moment, given the newness of the park and resulting lack of facilities. Colonists have settled within the park boundaries at several points.

Sangay National Park

Sangay National Park includes the world's most continuously active volcano. In 1987 there were 1,438 visitors reported. Specific problems were not reported.

Yasuni National Park

The largest of the Ecuadorean continental parks, Yasuni conserves a large section of the Amazonian Tropical Moist Forest. Its extreme distance from population centers and difficult access limit annual visitation. Petroleum exploration is under way in the park. Impending exploitation will require road construction and will almost certainly open new areas to colonization.

Cayambe-Coca Ecological Reserve

Cayambe-Coca is one of the wildland areas closest to Quito. Its borders are accessible from several roads. Hunting and fishing, timber harvest, colonization, and road projects threaten its integrity. 9,000 visitors were reported for 1987.

Cotacachi-Cayapas Ecological Reserve

Cotacachi-Cayapas ranges from 300 (?) to 4,939 meters -- one of the broadest ranges in any protected area. The park is home to the "Chachis" (a local indigenous community) as well as some 5,000

colonists. In 1987, 95,000 persons visited the reserve. Timber exploitation is the primary threat.

Manglares-Churute Ecological Reserve

Manglares-Churute protects an arm of the Gulf of Guayaquil. Mangroves, salt ponds, coastal scrub vegetation, and upland ridges are the major features. Firewood and charcoal production, conversion to shrimp ponds, road building, and colonization are major threats.

Pululahua Geobotanical Reserve

The Pululahua Reserve was set aside to protect some of the fascinating species and communities in life zones on the western slope of the Andes in the immediate vicinity of Quito. The reserve ranges from 1,800 to 3,550 meters. In spite of its closeness to Quito, much of the reserve is very inaccessible. Visitation in 1987 was only 3,380 persons.

Cuyabeno Fauna Production Reserve

An innovative unit of the Ecuadorean Wildland System, Cuyabeno is a reserve for subsistence harvesting of fauna and forest products by local peoples. An oil exploration and exploitation road cuts across the middle of the reserve. Colonization is the major result of the road, but it also allows a large number of visitors to see a cross-section of the reserve.

Limoncocha Biological Reserve

Limoncocha is a small reserve (4,613 ha) rich in aquatic systems. Despite the small size, it harbors an enormous number of water birds and other aquatic life. In 1987 there were 2,676 visitors to the reserve.

Cajas National Recreation Area

Only 18 km from the city of Cuenca, Cajas is a heavily used recreation area. Elevations range from 3,500 to 4,550 meters. Major threats are grazing, hunting, firewood cutting, and road building. Hiking and fishing are major attractions. In 1987, more than 25,000 people visited the area.

El Boliche National Recreation Area

El Boliche is a recreation area adjacent to Cotopaxi National Park, ranging from 3,000 to 3,600 meters. Monterey pine (*Pinus radiata*) is a major part of the landscape. Camping and hiking are major attractions. Hunting and fire are the major threats.

4.3 Constraints of The Ecuadorean National Park System

The Ecuadorean system of protected areas suffers a series of moderate-to-severe limitations: lack of political support from higher levels, lack of staff and training, lack of operating funds, lack of public support, shortage of equipment, etc. The problems are not unique to Ecuador, but rather reflect a general disregard for the role of protected areas in the national culture and economy of many countries.

The staffing levels and resulting ratio of staff per unit area are typical of and contribute to the types of problems mentioned above. The worst case is probably Yasuni, where each ranger is responsible for an average of 200,000 ha (maybe as "few" as 100,000 ha per employee, since staff is reported to be 5 instead of 3).

4.3.1. Finances of the National Park System

The operations budget for national parks in Ecuador amounted to 50.8 million sucres in 1984, that is, some 250,000 dollars. This represents an investment of only US$.09 per hectare. The operations budget of the park system comes from two main sources: budget appropriations from the central government and revenues generated by the park units themselves (fees and other charges). For the five-year period from 1980 - 1984, internally-generated revenues accounted for almost two-thirds of the budget.

Table 4.2: Annual Operations Budget of the Park Program (in millions of current sucres)

	1980	1981	1982	1983	1984	Total
From entry fees	2.5	2.0	3.0	11.4	27.6	46.5
From licenses	5.2	3.0	3.4	7.7	14.9	34.2
Charges to boats & travel agencies	5.6	3.2	3.5	4.4	0.3	17.0
Subtotal	13.3	8.2	10.0	23.6	43.6	97.7
From operations	13.3	8.2	10.0	23.6	43.6	98.7
From government	--	12.7	7.1	17.1	7.2	44.1
Total	13.3	20.9	17.1	40.7	50.8	142.8

Source: Fundación Natura. 1985. "Alternativas de manejo y administración para el sistema de parques nacionales en el Ecuador." Quito, Ecuador.

(It is troubling to note that revenues reported from Galápagos boat-operator and travel agency fees are declining even though visitation -- shown by visitor fees -- is rising sharply).

Table 4.3: Staffing Levels for Existing Protected Areas

Protected Areas and Reserve Name	Personnel							Total Size of Area (ha.)	Staff Relation Area per Employee (ha/emp)
	Technical			Rangers		Admn	Totl for Area		
	Supt	Intp	Cons	Perm	Seas				
Cotopaxi	1		1	8	5	1	16	33,393	2,226
Galápagos*	1	1	4	46	9	2	65	693,700	11,011
Machalilla	1			5	8	1	15	46,683	3,335
Podocarpus	1		1	2	3		7	146,280	20,897
Sangay	1		3	11	8		23	271,925	11,823
Yasuni	1				2		3	679,730	226,577
Limoncocha	1		1		2		4	4,613	1,153
Cayambe-Coca	1		2	9	5		17	403,103	23,712
Cotacachi-Cayapas	1		2	6	5		14	204,420	14,601
Manglares-Churute	1		1		7		9	35,042	3,894
Pululahua	1			1	2		4	3,383	846
Cuyabeno	1			2	3		6	254,760	42,460
El Boliche	1			7	4		12	1,077	90
Cajas	1		1	7	7		16	28,808	1,801
National Total	14	1	16	104	70	4	211	2,806,917	13,560

Notes: Supt=Superintendent, Intp=Interpretive, Cons=Conservation, Perm=Permanent, Seas=Seasonal, Admn=Administration
*Has 2 motorboat patrols.
Source: DINAF (1988b): Tropical Forestry Action Plan for Ecuador.

4.4. Indigenous Communities and Protected Areas

Ideally, outside experts could collaborate with indigenous communities in the planning and management of protected areas that adjoin or incorporate traditional native lands. Despite differences in their agendas, resource protection agencies and NGOs concerned with meeting subsistence needs share the common goal of ensuring sustainable habitats. The potential for alliances between national and local interest groups, based on common goals, is relative limited in the Andean highlands, where, except for scattered communal holdings, indigenous peoples usually manage fragmented individualized plots. Greater potential for such collaboration exists in the western and Amazonian Ecuador where indigenous groups have been managing relatively extensive areas of lowland tropical forest and, in many cases, have been receiving communal titles to them from IERAC.

A legislative basis does exist for cooperation, if not actual alliances, with indigenous communities. The Ley Forestal, as amended 1985, recognizes the exclusive right of aboriginal communities to use their customary resources, including forest products and wildlife in accord with government regulations. Although wood can be taken for household use, commercial exploitation of timber is prohibited (Coello pers. comm). The Law further directs MAG to establish the boundaries of the areas claimed by indigenous communities in order to guarantee aboriginal community rights and in effect withdraw these lands from the public domain (and threat of colonization or commercial exploitation). The law states that the areas delimited will permit the maintenance of an adequate standard of living in accord with ethical and religious values, and other customs (Ley #74, as amended 1985, Art 102 and 103).

Under current Ecuadorean law, there appears to be no regular legal process in place for recognizing the land claims of the indigenous communities once protected areas have been designated in their traditional use zones. Control over lands set aside by MAG resides with the national government ("patrimonio forestal") as recently occurred with the Awa Reserve, whether the areas include traditional indigenous holdings or not (José Vallejo, pers. comm).

In the Costa, the Forest Reserve and Awa Communal Seat recently established in the coastal province of Esmeraldas (13 September 1988) to protect both the tropical forest and the Awà culture provides a structure for effective collaboration between indigenous peoples and the Ministry (Villareal, 1987; DINAF-IERAC-INERHI 1988). Here, the Awa themselves are taking an active interest in the issue of conservation management. Yet in the Oriente, where native peoples are associated with Ecological Reserves, and reserves are associated with rich oil and timber

resources, application of the protective provisions of the Ley Forestal is weak. Establishment of the Cuyabeno Faunal Production Reserve, for example, gave the Siona-Secoya hunting and fishing rights, but non-native outsiders continue their poaching activities unabated (Fundación Natura 1988; Timm, Albuja V., and Clauson 1986). More serious was the loss of native lands to the politically more powerful colonists who used oil company roads to penetrate into the area, and then successfully claimed indigenous lands by obtaining legal title from IERAC (Borman, pers. comm; Coello, pers. comm.).

A current threat to native claims comes from colonists who are likely to use a planned oil company road into Yasuni National Park to overrun the Huaorani territory in and near the park (Nations 1988; McMeekin, pers. comm). It has also been suggested that in some areas park personnel have not consistently acknowledged indigenous hunting and fishing rights (Corry 1987; Pesillo Indians. pers. comm.).

Despite the potential benefits, collaboration between national agencies and local communities has been limited. To some extent this can be attributed to institutional under-staffing and budgetary constraints that limit coordination and programs, and to ineffective inter-agency cooperation, for example, between the Ministry of Agriculture and the Ministry of Social Welfare, which is responsible for comuna organization. In addition, institutional mechanisms for establishing partnerships with indigenous peoples to plan and manage conservation units, and for training native allies, need to be developed.

4.5. Proposed Protected Areas

A protected area system is never really "complete" because new information continues to surface. Inventories of selected areas reveal new endemics; remote sensing reveals unstudied refugia; a new water project requires a comprehensive watershed management plan including a protected area. Ecuador is no exception. A project to enlarge the national park system in 1976 received technical support from FAO. Several organizations and institutions have proposed other additions and modifications.

Table 4.4: Areas Proposed for Ecuadorean System

National Parks	
Galápagos #	Cotopaxi *
Machalilla *	Sangay *
Yasuni *	Pichincha
Ecological Reserves	
Conambo-Pindoyacu-Curaray ●	Cayambe-Coca *
Cotacachi-Cayapas *	Manglares-Churute *
Lagarto Cocha	Chongon-Colonche
Sumaco	Limoncocha
Bosques de Cinchona	Podocarpus *
Archipelago de Jambeli	Padmi
Cazaderos	Arenilla
Cordillera de Chilla	Tahuin
Ilinizas	Sade
Isla de la Plata (now Machalilla)	Palmira
	El Angel ●
Zucarqui	Aves Marinas de Limones
Isla Santa Clara	Puyango ●
Paquishapa	Garganta de Pastaza
Tundo y Jajal	Bosque de Arrayan
Gualguama	Bosque de Palma Cera
Faunal Production Reserve	
Cuyabeno *	Cordillera de Cutucú
Antisana ●	Rio Tigueno
Shushufindi	Rio Eho
Rio Hoja Blanca	
National Recreation Areas	
Cajas *	El Boliche *
Laguna de Mojanda	Cerro Azul

Note: # indicates existing unit
* indicates area added following 1976 report.
● indicates area under study (DINAF 1988b)

4.5.1. FAO 1976 Study

The FAO study (Putney 1979) to develop a park system strategy began with a mapping of populated areas. By excluding these areas from consideration, the team hoped to avoid conflicts over land uses. The methodology sought to integrate life zones, known forest cover, and available information about species and habitats. The report proposed several new areas, setting

priorities in each management category (National Park, Ecological Reserve, etc.) (Table 4.3.).

The FAO (1976) study still provides valid arguments for completing the Ecuadorean Park System by designating the remaining recommended units. Although some resistance has come from people who claim that Ecuador has already met the goal of protecting 10% of its land, there is ample justification for additional units, particularly in light of the enormous biological diversity found in this small country.

The most active proposal for a new unit in the national park system is the area surrounding Sumaco Volcano. A second proposal is an enlargement of Cuyabeno in light of the severe impacts by colonists along the access road that bisects the existing park. A third proposal is an enlargement of Yasuni National Park from 600.000 to roughly 800,000 ha.

4.5.2. Other Designated Areas

The National Forest System is another potential source of protection for biological diversity. Unfortunately the forest production mandate is focused mainly on timber extraction. Little attention is given to identifying pristine forest sites and protecting them for their diversity. The policy is still single-use (wood/fiber) rather than the more widely promoted multiple-use concept.

A comprehensive treatment of the National Forest System is contained in the Tropical Forest Action Plan for Ecuador (DINAF 1988b) and will not be repeated here. Appendix 3.1 includes a list of Protection Forests (Bosques Protectores).

4.5.3. Other Protected Areas

Several de facto protected areas exist in Ecuador. In this section we initiate a preliminary list of these sites.

Table 4.5: De Facto Protected Areas in Ecuador (Preliminary List)

Research-Oriented Centers

Rio Palenque Science Center (Private)
Maquipucuna Science Center (Fund. Maquipucuna)
Capeira Science Center (Fund. Natura)
Jauneche Science Center (Univ Guayaquil)
Payamino Forest (INIAP)
San Carlos Forest (INIAP)
Jatun Sacha Reserve (Fund. Jatun Sacha)

Non-Governmental Education Centers

Although these areas have no legal guarantee for protection of their biological diversity, most are energetically protected from encroachment by their various owners. This ensures protection of the biotic resources during the life-time of the owner or institution. Many also serve important educational roles and thereby broaden the base of their support in the general public, as well as increasing public awareness of some of the issues about conserving biological diversity.

4.7. Assessment of Coverage

Throughout the world, it is fairly well accepted that a major objective of protected areas is the conservation of the national heritage of flora and fauna. In Ecuador, the park system is still in its formative stages, but an assessment of the current system reveals serious gaps in "coverage" -- the desire to have at least one representative site for each major habitat and community in the country.

Based on Cañadas' life zone map (1983) and our approximations of locations of units in the park system, we can make the following observations about the wildland system:

National Basis

The data available do not allow a complete assessment of coverage of the national park system. A recently published map (IGM 1987) of the road system and tourist attractions does not agree with the individual park maps on the location or size of the units. In a similar fashion, the life zone map (Cañadas 1983) has not been updated with more recent meteorological data nor sub-divided to reflect associations and communities at a smaller scale. Both activities are much needed and should be a priority for Ecuador and the international scientific community.

The Costa

The Costa is the least represented of all the regions in Ecuador. A simple visual comparison of the map of national parks with the map of life zones reveals the situation. Although there are at least 11 broad life zones in the Costa, there are only three units from the National Park Sub-system found there. Although the number of separate life zones in the Costa is not as great as in the Sierra, each life zone can have great variation over the length of the coastal area.

The Sierra

The Sierra contains the most striking pattern of life zone diversity in Ecuador. The abrupt topography, towering Andean cordilleras, wide range of rainfalls, and relative isolation of small landscape units has produced a highly compartmentalized or interrupted mosaic of life zones. Although the Sierra contains the largest number of protected area units, they still do not do justice to the life zone variability there.

The Oriente

The Oriente as defined in this report extends from the 900 meter line on the eastern flank of the Andes out to the eastern boundary of Ecuador. East of the 77 degree longitude line, the life zone is uniform (Tropical Moist Forest sensu Holdridge). This tends to obscure the great diversity found in the Oriente, and underlines the coarseness of using life zones as the filter or categorization technique. Unfortunately we do not have a geographically-referenced database for Ecuador to supply finer detail.

Given the locations of biological diversity cited in Chapter III, in particular the importance of the flanks of the Andes, it is clear that a more detailed assessment is needed. The existing protected area system makes a good start at including areas of diversity, but serious gaps remain. Since native forest cover is the best single indicator of biological diversity, a good point of departure would be a mapping of primary and minimally-disturbed forests on a national level.

4.8. Assessment of Protected Areas' Fulfillment of Objectives related to Biological Diversity

Given the incomplete coverage of sites of natural diversity by established protection mechanisms (primarily the National Park System), we can only conclude that diversity is at risk in Ecuador. The system is incomplete, coverage is inadequate, and the protection units themselves do not receive the budgetary resources required to provide protection.

Even if we include the Forest Sub-System and the small but growing private sector sub-subsystem, the number, size, location, and management of the total wildland system is inadequate. Since all three sub-systems (Parks, Forests, and Private-Sector) have important roles to play and are able to complement each other's weaknesses, we recommend projects to reinforce all three sub-systems.

4.9 Ecotourism

Ecotourism -- also called ecological tourism, nature tourism, adventure travel, or scientific tourism -- is a non-consumptive use of natural resources. In some regions of the world, it yields

greater social and economic benefits than consumptive uses. For Ecuador, the financial benefits of ecotourism are not precisely known, but it is clearly one of the alternatives Ecuador should consider, for example, in the management of the forests in the Oriente. At the moment, fees from the Galápagos Islands generate roughly 30% of the revenues that go into the operating budget for the park system as a whole.

Ecotourism can have both positive and negative impacts. A massive influx of relatively well-to-do visitors can overwhelm the social fabric, customs, and traditions of the host culture. Tourist dollars can cause significant distortions in the local economy. Visitor impacts can also be physical. In the Galápagos Islands, problems are already occurring with vegetation trampling, disturbance of nesting fauna, soil compaction, solid waste disposal, water shortages, water pollution, and other concerns more commonly associated with urban growth than national parks.

A recent inventory of tourism and its principal activities in Ecuador ranked nature study and adventure travel among the top attractions. According to the survey, tourists preferred natural areas (mountains, lakes, beaches, wildlife observation sites, forests, etc.) for these activities -- all of which could be offered in a comprehensive system of protected areas.

The Government of Ecuador has made only very limited investments (political or financial) to provide protection for natural areas with importance as tourist attractions. With a few exceptions, the major tourist promoters have not come on board the ecotourism bandwagon, in spite of the significant benefits that this type of "smoke-less" industry offers. National policies have also failed to embrace this non-destructive use of natural resources fully.

A related problem is the lack of training opportunities for guides and tour organizers regarding the natural history of Ecuador, the requirements for ecotourism activities, and aspects of the entrepreneurial side of the business. Only Galápagos Park has a periodic training program for park guides.

Parks can be managed to produce significant revenues (the case of Galápagos is an excellent example), but primary objectives of conserving biological resources should not be lost from sight. Ecotourism is an important part of the solution to park financing, but must not be allowed to endanger the park resources. A strong campaign is needed to redirect some of the Galápagos travel load to sites on the continental side which have greater species diversity, more endemic species, and easier access than the Islands. Galápagos National Park has the international reputation, but is not the only site of biological interest in the country.

Chapter V
In-Situ and Ex-Situ Conservation Outside of Protected Areas

5.1. In-Situ Conservation

5.1.1. Traditional Land Use Patterns

In the past, traditional systems of resource management in both the highland and lowland areas had been relatively successful in reducing the long-term adverse effects on the habitat. The factors that contributed to success included the availability of arable land and hunting and fishing grounds, and use of low-energy technology. These enabled sparse populations to meet their localized food needs and periodically relocate or send new families into unoccupied areas.

These conditions no longer exist in the highlands where the increasing dependence on the market economy for food staples, coupled with the factors of population growth, inequitable land distribution, fragmented small-scale landholdings, and individualized tenure, have long reduced the opportunities for indigenous or other villagers to manage resources without threatening the habitats that support biological diversity. At the same time, the cultural features such as family patterns and forms of authority that developed with the traditional management systems, were important in regulating the access to and use of resources have likewise changed.

Indigenous managers of Ecuador's northwestern and eastern tropical forests continue to be relatively low-density populations who use traditional resource management regimes. Contemporary pressures are inducing market orientations, new cash needs, nucleated rather than dispersed settlement types, and other changes, but indigenous groups continue to use their sophisticated environmental knowledge and low-energy technology to an important extent. Kinship systems and authority patterns that regulate access to subsistence resources and the effective imposition of quotas or bans on certain resource uses, remain intact among many groups. Long-term empirical studies are needed for better understanding of native resource management regimes and the possible transfer of technology to modern day systems. It is generally argued that, except for temporary openings created by new swidden plots, the forest canopy in areas of indigenous occupation is left relatively undisturbed. Although plant composition changes, the forests regenerate (Whitten, ed. 1981). Clearing of garden plots does not involve uprooting large trees, major disturbance of soil, or intensive cultivation. Under-exploiting rather than maximizing production has been the rule (Descola 1981; Rainforest Information Center 1987).

Although often viewed as having homogeneous cultural systems, including resource management sub-systems, indigenous lowland groups actually occupy diverse habitats. These range in altitude from about 600 m in the Puyo or Canelos Quichua area to between 400 and 250 m in the Achuar territory (the great hylea amazonica or true Amazonian biotype), and from the periodically flooded rich riverine to less fertile interfluvial areas. Correspondingly specific resource management systems vary between groups and sometimes among them as well. Where available land has been abundant, as for example among the Achuar, pioneering slash-and-burn cultivation replaces the common cycle of clearing, planting, fallowing, and reclearing a plot. While burning felled trees is frequent among some groups, others such as the Awà or Cofan who occupy high-moisture areas necessarily leave the felled vegetation to decompose (Rainforest Information Center 1987; Descola 1981; Villareal pers. comm; Borman pers. comm).

Dispersed families manage several small plots at a time. They sometimes open a new one each year. This system gives households access to plots in different stages of productivity, crops with different growing cycles, and different arrays of intercropped species that may number as many as 15 or 20, including nitrogen-fixing food crops and fruit trees that contribute to forest regeneration. Each plot usually exhibits different degrees of forest regeneration, and provides a variety of habitats for wildlife. For those groups who rotate their gardens, fallowing periods may start after 3-5 years and last from 10-30 years. The effectiveness of shifting cultivation generally depends on access to abundant land but is also regulated by such factors as soil type. Game and fish provide important protein sources for family consumption, and are customarily taken with the use of traditional traps, blowguns, and fishing gear. Poisons are crucial features of fishing technology. Additional dietary variety and nutrients come from collecting forest plant products (Vickers 1981, Descola, 1981). Wildlife harvest by relatively small groups whose traditional labor-intensive techniques, limited storage and processing possibilities,has resulted in limited takes and probably poses insignificant long-term effects on the animal population. In addition, these groups impose explicit conservation measures such as hunting quotas or bans on their members when reductions in wildlife populations are noted (Timm, Albuja V., Clauson 1986).

5.1.2. Contemporary Threats to Traditional Land Use Patterns

Whether natives of tropical forests will be able to maintain their customary resource uses and associated livelihood is questionable now that their resource base is shrinking, due partly to natural increase among indigenous populations. More threatening perhaps is the planned and spontaneous colonization of their traditional lands by colonists from the coast and highlands.

Colonists precede and follow the construction of roads, built by petroleum companies, and other local contractors, that penetrate indigenous zones, many of which are supposedly protected by law as native reserves and ecological reserves (Nations 1988; Coello pers. comm., Borman, pers. comm). Such non-native encroachment is quickly legitimized by the distribution of land titles by IERAC to newly settled colonists. This, in turn, generates serious problems for indigenous communities because distribution of their land titles lags far behind that of the colonists, and makes their traditional territories vulnerable to continued, uncontrolled colonization (see Table 5.1).

Table 5.1: Land Adjudications in the Amazon Region, 1964-1982.

	Hectares	%	Number of Families	%
Amazon Region	874,741	100.0	17,181	100.0
Colonos and Private Industry	529,064	60.5	12,838	74.7
Indigenous Communities	345,677	39.5	4,343	25.3

Source: Elaborated from data in IERAC (n.d.). in Uquillas, Jorge. 1985.

African oil palm and cacao plantations, cattle ranches, and subsistence farming by colonists significantly reduce the forest land area available to native peoples to carry out their traditional livelihood (Vickers 1981; Borman, pers. comm, McMeekin, pers. comm). These outside pressures are encouraging reduced fallow periods, forcing indigenous people to seek new, more fragile lands located further away from colonist and or other native settlements (Whitten, 1976; (Descola 1981, Yost 1981).

Increasing needs by native peoples for cash or manufactured goods are also stimulating adaptations to the market economy with implications for lowland resources. To meet demands by the non-native market for hides and meat, and to satisfy their own increasing needs for cash or manufactured goods, some native peoples are intensifying their hunting (Yost, 1981). In some communities cash crops such as maize are driving native cultigens from the garden. Some people may be abandoning traditional settlements and subsistence pursuits altogether for cattle ranching or beginning to pursue market-oriented activities such as panning for gold (Macdonald 1981).

Other impacts on wildlife derive from the demand for animal protein by settlers and the military, which is encouraging commercial hunters and fishermen to increase their take in order to feed the newcomers. Hunting grounds are being depleted and some game, manatee for example, is undergoing severe decline (Timm, Albuja V., Clauson 1986).

Government and missionary pressures to nationalize native groups and resources, and change indigenous cultural systems, partly by introducing a commercial cattle industry and encouraging nucleated settlements, is reducing the cultural diversity of native groups so that they begin to approximate a generalized model of national culture. Native groups also are moving into nucleated settlements. The use of adjacent horticultural resources is intensifying as fallow periods are being reduced. In some cases the introduction of cattle has resulted in the near elimination of fallowing periods and the conversion of gardens to pastures (Descola 1981). Diseases are spreading, partly because of the close proximity of families but also as a result of diseases that colonists and tourists might be introducing (Yost 1983).

As indigenous cultural systems, including resource management regimes, continue to be resilient and responsive to features of their regional, national, and international contexts, traditional ways will yield to new demographic and market demands. To avoid the culturally and ecologically destructive changes that transformed the indigenous livelihoods and resources of the highlands, and many western lowland areas, Ecuador's national planning and development agencies will need to forge more effective partnerships with native peoples. Conservation programs that respect indigenous cultures and resources, development programs that recognize new economic needs and more effective land titling programs, need to be considered.

5.2. Ex-situ Conservation

5.2.1. Botanical Gardens and Zoos

Ecuador has not had a strong tradition of expenditure on Botanical Gardens and Zoos as is true in other Latin American countries. Perhaps that is because the country as a whole was a first rate botanical garden and zoo without making a major issue. Unfortunately, those times have passed and left the country with very few accessible natural areas and a lack of major facilities for ex-situ conservation. Several efforts during the last 30 years have been made in this direction by concerned persons, to the degree that lands have been designated for the purpose in some of the major cities, but funds have not been available for their development. In Guayaquil the lands set aside for the botanical garden were invaded for urban housing.

In Quito, the parks department maintains a facility called a botanical garden, which in fact does qualify as such, but it is not open to the public. In Guayaquil, the Sociedad Ecuatoriana de Orquideologia, maintains a garden of about 7 ha, primarily oriented toward protection and display of orchid species native to the coastal region. In Cuenca, a new botanical garden has been established at Ushupud in the Paute valley. It is privately owned and supported in association with a tourist facility and holds great promise of developing into an excellent garden displaying upland native plants. In Loja, the oldest botanical garden in Ecuador was developed by the University of Loja but suffers from lack of support.

Captive breeding programs for tortoises and iguanas on the Galápagos Islands, under the direction of the Charles darwin Research Station, have been quite successful.

A government supported project by PREDESUR at Vilcabamba in southern Ecuador maintains an orchid collection, primarily for display purposes, along with a zoological park oriented toward commercial adaptation of native species.

5.2.2. Herbaria and Museums

Several herbaria and zoological collections exist in the country. Federally supported is the Ecuadorean Museum of Natural History in Quito, which has a small but developing herbarium and zoological collections. The Pontifica Universidad Católica in Quito, has the strongest biological training program in the country, with a rapidly growing herbarium, housed in excellent facilities. The Polytechnic University in Quito has a developing zoological collection which compliments the botanical strength of the Catholic University. The oldest university, the Universidad Central, has a small herbarium, but with some important historical collections, and has hope of the development of adequate facilities to house them.

Chapter VI
Conservation of Economically Important Native Species and Germplasm

Determining the value of Ecuador's native resources on the domestic or world markets, and establishing programs to develop those resources in a sustainable manner, have been limited without a comprehensive database on native species and germplasm. Despite these limitations, the country's native genetic resources have already proven their economic potential by contributing to the improvement of crops and domesticated animals, especially to increased yields and enhanced qualities such as nutritional value and resistance to particular diseases and adverse weather conditions.

6.1. Important species from a commercial perspective

Material from Ecuador's wild tomatoes, Lycopersicon esculentum cerasiforme and L. hirsutum, have improved the domesticated crop by increasing its vitamin C content and amount of soluble solids. Materials from the wild Lycopersicon esculentum cerasiforme have also helped extend the range of domesticated tomatoes to the ordinarily unfavorable growing conditions of the wet tropics. Some forms of L. cheesmanii which are endemic to the Galapagos have been found to tolerate high salinity levels and could further extend the range of the domesticated plant. Materials from the wild also helped add vigor to the domesticated pineapple when plant breeders crossed wild species, including Ecuador's Pseudananas sagenarius, with the principal cultivar, "Cayenne," to develop stronger root systems and longer life (R. and C. Prescott-Allen 1986).

6.1.1. The Forest Resource

Natural Forests

Since 1967, approximately 10.7x106 ha of natural forest have been inventoried for timber in the provinces of Esmeraldas, Napo, Pastaza, Morona Santiago, and Zamora-Chinchipe. These timber inventories have largely concentrated on the humid tropical forests. Both MAG (1988a) and Landázuri and Jijón (1988) provide estimates on average volume per hectare, total volumes, and merchantable volumes. Average volume per hectare ranges from a low of 22.6 m3/ha for dry tropical forests to a high of 130 m3/ha for moist tropical forests in Esmeraldas. Estimates of merchantable volume range from 31 - 56% of total volume. However the commercial value of wood products from the forest will naturally increase over time with the availability of new resources, advances in wood processing, and changes in market preferences. As forests continue to be depleted of perferred timber species and the total forest area declines, we can expect

to see more substitution and diversified utilization within wood markets.

Due to the lack of standardization between the various institutions which conducted these inventories and the time span between them (1967-84), it is difficult to estimate the standing volume and value of timber in Ecuador's forests. As described above, there have been drastic reductions in forest cover in the Esmeraldas region since inventories were initiated. For example, mangrove forests have been heavily affected by the expansion of shrimp ponds along the coast. Regardless of these problems, MAG/DINAF (1988a) estimates that the total standing volume in the country, is 15-18 x 10^8 m^3, with 72-86 x 10^7 m^3 distributed within the dbh classes of 40 cm or larger, and 78-95 x 10^7 m^3 within the dbh classes of 10 -30 cm.

Forest Plantations

Forest plantations of exotic species harbor little biological diversity when compared to natural forests. They can provide certain environmental benefits, but even this has been contested in cases of inappropriate site and species selection (Morris 1985). Plantations can be considered beneficial to biological diversity if they are established through reforestation and divert pressure natural forests.

Landázuri and Jijón (1988) estimate that plantations occupy 111,416 ha of the total forest cover in Ecuador, with 79% of the plantation area in the Sierra, 19% in the western region and 2% in the Oriente. Unfortunately, regional reforestation rates are inversely proportional to harvesting rates. At the present pace of reforestation, it will take 200 years to reforest the Sierra and 300 years in western Ecuador. Reforestation efforts are lowest within the Oriente but, as a whole, this region still contains a substantial forested area.

With the establishment of small nurseries and demonstration plantations, DINAF established 63,544 ha of plantations, between 1964-1986. These are largely located in the Sierra. Other public and private institutions involved in reforestation efforts on the remaining estimated 48,000 ha are CREA, CRM, INCRAE, ENDDESA, PREDESUR, Provincial governments and the "Juan Manuel Durini" Forest Corporation. Present national nursery production and capacity is totally inadequate to meet reforestation needs.

Even though the forest industry is largely dependent upon native hardwood species from the tropical lowlands, reforestation is oriented towards *Pinus* and *Eucalyptus* plantings in the Sierra. According to DINAF nursery production records, reforestation is mostly with exotic pines (*Pinus radiata*, *P. spatula*) and eucalypti (*Eucalyptus globulus*, *E. salun*, *E. rostrata*) across the Sierra. Increased emphasis is being placed on the use of native species

(e.g. Alnus sp.) in reforestation projects, but this has not been carried out except in isolated cases. The potential for their incorporation into agricultural schemes appears much more promising. A recent study of the wood supply for a major furniture manufacturing operation in Cuenca found that 80% of the wood consumed came from private lands under agricultural production in the coastal province of Los Rios (Mussack 1988). The potential for developing extension programs using native hardwood species through programs between the wood processing industry and private landowners could significantly relieve the pressure on natural forests and help to conserve biological diversity.

Tropical broadleaf species such as Teca (Tectona grandis), Balsa (Ochroma pyramidale) Roble, Terminalia Amazónica, Fernàn Sànchez, Leucaena sp, Acacia sp, cedro (Cedrela odorata) are used in western Ecuador for reforestation. A number of other native species such as algarrobo, pachaco, and guachpeli are also interplanted with agricultural crops. Incorporation of timber species into national agricultural programs (e.g. coffee and cacao) for use by the forest products industry could help to reduce the pressure on remaining natural forests.

Forest Based Industry

The forestry sector (timber production, primary and secondary manufacturing) contributed 3.5% to the 1986 Gross National Product according to the 1987 Memorias del Banco Central del Ecuador. Direct employment in primary and secondary manufacturing for 1987 was estimated by CENDES to be 9,242. USAID/LAC (1982) estimated that over 75,000 jobs were directly or indirectly dependent upon the forestry sector. Direct employment in 1980 was reported by Bremer-Fox and Bender (1987) as 25,000 people, and total employment including logging operations was around 50,000. In 1979, CENDES estimated total direct employment to be 28,000. By national accounting methods, the forestry sector has not contributed significantly to the economy, providing only 2.5-3.5% of the GNP from 1974-68, and current figures point to a decline in the forest industry as an active sector of the national economy.

The forest industry consumes 2.3 million m3/year of which 60,000 m3 is exported and the remainder supports some 446 major sawmills, 90 furniture plants, 37 secondary processing mills, 18 balsa processors, 6 plywood plants, 5 veneer mills, 3 particleboard plants and 5 wood treatment plants (Laso 1987, Escobar per. com.). Importation of paper, paper waste and pulp account for Ecuador's unfavorable balance of trade in the forest industry. The recent Forestry Action Plan for Ecuador proposes the establishment of a pulp mill to counter this situation but current wood supplies and availability to support such an investment are questionable.

A recent study conducted by INFORDE identified some 4000 small private sawmills operating independently in rural areas. However, an undetermined amount of chainsaw operators are also an important sector of this industry but their production has yet to be quantified. Proper wood utilization is a common problem throughout the industry and perhaps felt hardest in the cases of small private sawmills and chainsaw operators. Technical assistance programs directed towards these sectors to improve efficiency could help lessen the pressure on the remaining virgin forests. Indeed, estimates by AIMA show that only 30% of the timber harvested is recovered by the wood industry due to extreme inefficiency and lack of quality control in primary and secondary processing.

The forest industry wood supply comes 40% equally from the Costa and Oriente, with the remaining 20% from the Sierra (Bremer-Fox and Bender 1987). These numbers will change dramatically as the forests become depleted in the Esmeraldas province, hauling distances become greater in the Oriente, and plantations become more mature in the Sierra. Currently, royalties to the government are based on the volume of wood actually harvested, not on standing volume, and monitored through road checks by an understaffed division of government inspectors. Log prices paid at the mill site make no differentiation for hauling distance. As a result of these practices, there are few incentives for careful logging practices to minimize residual stand damage and long term management programs.

6.1.2. Cultivated Food Crops

The economic importance of cultivated crops germplasm can be an elusive concept. It can mean species to be consumed by humans, or it can involve a myriad of other uses which have direct or indirect benefits in the economy, such as providing biomass for energy, raw materials for industries, conserving agriculture soils, or the exports of raw materials (BID 1983).

The issue of "consumption" in Ecuador leads to consider the use of those species which are basic to the survival of its population. Ecuadoreans pay very little, and sometimes nothing, for the use of valuable and scarce raw materials and energy. The national accounts do not deduct for the loss of capital from exploitation of resources, or for the costs of environmental pollution.

These patterns of consumption of natural resources have led to destruction of many of the forests and other resources, to occupy with human settlements the most productive soils, and to make extensive use of scarce resources for the benefit of a small minority of the population. (Fundación Natura; 1981, T-7). Moreover, deforestation has caused the loss of some species in the Coast and the Oriente, suggesting that these forest resources will

be totally lost, in the coastal provinces, in the 1990s, and in the Oriente in the first decades of the next century (Fundación Natura; 1981, A2).

An empirical observation in the decline in farming of some major products that are economically important (Table 6.2).

Table 6.1: Changes in cultivated areas of selected important crops

PRODUCTS	NUMBER OF HECTARES IN FARMING 1973-1975	1980-1982	1986-1987
COTTON	27,723	20,301	24,700
RICE	105,155	129,868	227,600
FLINT CORN	156,000	169,000	261,300
SOYA	4,166	22,456	39,300
POTATOES	66,287	31,602	38,100
FLOWER CORN	114,049	60,017	60,395
BARLEY	75,193	29,671	64,200
WHEAT	59,666	34,115	41,100
BEANS	65,024	50,886	42,200
Total	673,263	547,916	798,895
Increase:		-18.62%	45.81%

Source: Ministerio de Agricultura, Information from SIGMA ONE CORPORATION

Considering potential increases in yield per hectare, having less potatoes, corn, wheat, barley and beans indicates the critical situation of domestic production of basic food items. The impact is largely felt in lower income groups.

Similarly, fish products were always a cheap source of protein for the Ecuadorean population, and food consumption was the limit of their economic importance. It is now estimated that some 80% of the marine fisheries catch is used for fishmeal, yielding substantially less in direct food input for national consumption than similar products.

Shrimp farming, due to the prices received for shrimp in international markets, has stopped being a generally used food in Ecuador but other fish species still have a great deal of local value on the basis of their consumption by lower income groups. Yet, shrimp and other species such as tuna have now gained economic importance, and, in the last two decades, have become the second highest source of foreign exchange from exports in

Ecuador.

6.2. Species with Economic Significance at the Local Level

Characteristically, indigenous residents of the tropical forest manage the forests' terrestrial and riverain features so that a wide array of cultivated, semi-domesticated, and wild plants can be obtained on a sustained basis. These serve diverse household and community economic needs for foods and medicines, construction materials, fuel, and subsistence technology. We need to point out here that "economic" refers not to market exchanges alone but also to the substantive economic exchanges of goods and services that occur without cash payments among kin and within and between communities. Conservation of genetic materials that are economically important in this sense result from both deliberative and informal practices that include manipulating the location of crops, protecting certain wild species from fire, selectively clearing new gardens by leaving certain plants uncut, and selectively transplanting wild species. The approximately 30 species cultivated by the Awa of Esmeraldas and lowland Carchi in northwestern Ecuador, for example, include valued wild plants such as Citris aurantifolia ("limon") and Bixa orellana ("achiote") which are naturalized in regrowth areas. The Cofan, along with other eastern lowland peoples selectively transplant clusters of semi-domesticated flowering crops close to their house sites.

Ethnobotanical studies are needed to tap the experience-based knowledge that has traditionally guided uses of the local habitats and the domesticated and wild species they support. Such studies are likely to yield insights into promising medicinal, agricultural, and other genetic materials, possibly including some with pesticide application, and into varieties of plant life with previously unsuspected commercial potential (David Neil, pers. comm.). Even if studies do not always reveal new economic uses, researchers will find that native familiarity with the local habitat assists them in identifying the full spectrum of plant life. Just the trees that the Awa people recently helped researchers inventory in their northwestern homeland, for example, yielded the names of some 50 families with 189 varieties, according to data reported by the Rainforest Information Centre (1987).

6.2.1. Fish and Game

The importance of fish protein to the diet is not known quantitatively. Communities with access to lakes, rivers, or coastline (and more recently man-made reservoirs), provide a considerable part of their animal protein from fish, particularly during certain seasons of the year.

Fishing with cast nets or throw-nets along the Coast during the dry season is widespread. The reduced river flow concentrates

the fish and even strands many in large pools in the riverbed. In the Oriente, the seasonal fluctuations for many streams are not as pronounced. Fishing with dynamite or "barbasco" (fish poisons made from Amazonian plants) is common.

Wildlife harvesting for meat is a significant source of animal protein in the diets of many rural Ecuadoreans. Although the data are incomplete and very sketchy, a number of studies have shown the importance of wild game for the colonists on the agricultural frontier and for indigenous communities.

Many of the wildlife species that once served as sources of protein have been virtually eliminated in the Sierra and in the western Ecuador by agricultural and urban expansion. The larger mammals and fowl are the most prized species, and their populations are under severe pressure because land conversion has removed their basic habitat. Only in the Oriente do populations seem relatively affected except near high-density colonization areas.

Mountain tapir and speckled bear are the largest hunted species in the Sierra, but have been reduced in numbers throughout their ranges. In the Oriente, collared peccary and deer are heavily pursued. Among the indigenous communities, the smaller mammals are consumed in great numbers.

6.2.2. Native plants with potential in floral trade

Most of the floral trade in Ecuador is based on a cottage industry approach. House plants are commonly propagated on a small scale and peddled on the streets of the major cities. No large wholesale nurseries exist and retail sales tend to be restricted to supermarkets and florist shops. Nearly all of the trade is based on exotic plants, mostly introduced long ago, primarily those which have a rapid turnover and are easily propagated. A market exists for native plants, but the tendency to "buy foreign", suggests that native plants should be given common names like "Irish leather-plant" rather than "Anturio" for sales appeal.

A successful retail nursery in Santo Domingo specializes in indoor house plants but among it's stock of several hundred cultivars, only 2 are native Ecuadorean plants, *Anthurium andreanum* and *Zamia lindenii*.

A few professional collectors of native Ecuadorean orchids still operate in the country. Since enforcement of CITES regulations their business has been much reduced but their prices have risen to compensate. Most sell their wild-collected plants to orchid enthusiasts in Guayaquil, Cuenca, or Loja but a few "arrange" export permits, mostly by smuggling high-value plants to Colombia, Peru, or Europe.

Chapter VII
Major Issues in Biological Diversity and Tropical Forest Conservation

7.1. Major Issues at the National Level

The annual deforestation rate in Ecuador is an alarming 2.3 % per year, resulting in the loss of 340,000 ha annually. This rate far exceeds that of its Andean neighbors of Colombia (1.7%) and Peru (0.4%) (World Resources Report 1988-89). The central "Sierra" (Andean highlands) of Ecuador is practically devoid of natural forest cover. The few remaining pockets of primary forests in western Ecuador and forested areas in the Amazon are under increasing pressure from logging, agroindustry, cattle grazing and subsistence farming. Trying to provide land and food for a population growing at the rate of 2.9% per year (Landázuri and Jijon 1988), the Government of Ecuador has embarked on an aggressive colonization program in the Amazon basin. Indeed, of the forest cover remaining in Ecuador, we estimate that only half (700,000 km2) is relatively undisturbed by human encroachment. This diminishing core of primary tropical forest contains important habitats for plant and animal life. These areas are considered critical for the future economic development of Ecuador.

The loss of tropical forests in Ecuador are attributable to similar root causes of deforestation identified throughout the tropics: poverty, inequitable land tenure, lack of non-agrarian livelihoods and accelerated population growth which lead to inappropriate land use patterns; the demand for foreign exchange (vital for servicing the external debt), which provides incentives for "mining" resources from the tropical forests and their conversion into pastures and agricultural lands for export crop production.

Government policies which stimulate deforestation are also a driving force behind deforestation (Repetto 1988). For example, land titling rules under the colonization law require colonists to put 80% of their parcel into "production" within two years or risk foreclosure on the property by the government. Current timber harvesting policy determines royalties based on the amount of wood actually removed from concessione forest tracts rather than the true harvestable volume. Such policies have had a devastating impact on tropical forests in the provinces of northwest and Amazonian Ecuador. Destructive logging practices and the lack of incentives for sustainable forest management are also important factors contributing to deforestation in Ecuador. The adverse impacts of indiscriminate logging are magnified as associated extraction trails become roads and open the forest to landless settlers.

For example, colonists who have recently settled in the Oriente have little knowledge of local sustainable-agricultural practices, and rely on their traditional methods developed in different agroecological zones such as the high Sierra or arid Costa. This is a leading threat to biological diversity and tropical forest conservation, as these colonists continually require more and more land to carry out environmentally degrading practices.

However, the rural poor are hardly to blame; the majority are jobless as well as landless, with few prospects for employment in their home regions of the Andean highlands and coastal provinces. Faced with limited cash income and declining real income (the cost of basic food items rises four-to-six percent per month), they are pursuing one of two feasible options available: migrating to the urban centers of Quito and Guayaquil, or homesteading in the Oriente forests.

Many of these issues have been previously identified and discussed by Fundación Natura (1981), Fundación Natura (1988), Landázuri and Jijón (1988), USAID/Quito (1988), countless texts, intra-institutional studies, internal memos and numerous consultant reports. Our assessment supports all of these findings and attempts to provide an overview of the fundamental causes threatening the conservation of biological diversity and tropical forests in Ecuador by focussing on:

* Limited non-agricultural subsistence alternatives.

* Inappropriate land use practices.

* Political and Institutional constraints.

* Economic pressures (e.g., external debt burden).

* Accelerated population growth.

* Inadequate information base for decision making concerning biological diversity.

Although a strong political commitment for policy reform is an important variable in the ultimate resolution of these issues, the long term conservation of Ecuador's tropical forests and maintenance of its tremendous biological diversity will be impossible without the active interest and involvement of the rural poor in the planning, design and management of surrounding forested areas.

7.1.1. Limited non-agricultural subsistence alternatives.

Serious problems for the rural poor became apparent as the cost of rural labor rose at the same time that mechanized

agriculture became widespread on the larger farms and larger organized peasant cooperatives. The resulting decrease in demand for labor left landless farm workers without opportunities to earn wages.

Population growth within the context of limited agricultural resources and non-agricultural subsistence options, stimulates peasant migration to urban centers in the highlands and the coast, or to colonization schemes in the Oriente forests. Using data from the 1974 agricultural census, Handleman (1980) argued that agrarian reforms failed to produce a substantial class of small land holders with economically viable units of at least 5 hectares.

Today, these smallholdings are undergoing increasing fragmentation and intensive cultivation. Even though substantial returns are unlikely, more hillside Sierra land is being put into agricultural production. Recently, cooperatives that repaid IERAC financing of hacienda lands have converted their holdings into individual parcels, a step likely to encourage further fragmentation, more intensified cultivation (Catucuamba, pers com), which will lead to greater soil erosion, reduced productivity and increased unemployment.

While social programs to reduce growth rates are part of the solution, consideration needs to be given to providing economic options that do not depend on agriculture, particularly in newly colonized areas; and housing options that do not require converting forested areas into new communities. Training and educational programs will be crucial in order to equip the large number of landless rural poor to take advantage of jobs in the non-agrarian sector.

7.1.2. Inappropriate land use patterns

Although agriculture is a declining activity nationally, colonists are converting Oriente forests into farms and ranches at an alarming rate in areas without agricultural capabilities. Poor rural populations in the Sierra are pressing eroded and fragmented hillside plots into production without even meeting their own household food needs. Coastal groups are invading the holdings of others. Meanwhile, expanding urban populations are encroaching upon arable and forested lands for living space and roadways, and are taxing sanitary and other municipal services beyond their capacity (Landázuri and Jijon 1988).

In 1986, the total number of hectares under agricultural use were slightly over 2 million ha. Although both actual and potential land use data are questionable, official figures reflect that:

1. Land use in farming has increased substantially (60%) in the last decade.

   This is particularly true in the Costa, where it has more than doubled, largely reflecting land conversions from forests into farming.

2. The area under cultivation in the Sierra has decreased by close to 40%.

3. The number of hectares under farming in the Oriente has more than doubled.

   Many GOE officials interviewed during this assessment indicated that the Amazon region's full agricultural "potential" has yet to be reached; though one has to question if this potential is at the expense of more appropriate land uses such as protective forests or forest reserves based on true land use capability.

The problem of non-sustainable agriculture is rooted in the inappropriate use of lands in the Sierra, the over-utilization of fragile soils which are not of an agricultural aptitude in the Oriente, and the under-utilization of agricultural lands in the Costa. This condition is complicated by limited access to productive soils, dependence on inadequate agricultural technology, ill-use of soils for the type of products farmed, absence of clear policies, inefficient soil conservation practices, and indiscriminate use of inputs. Combined, these land use practices result in low production yields.

The sustainable agriculture in Ecuador should be based on increasing yields rather than on expanding the agricultural frontier (for example, in the Oriente) because of the social costs, limited benefits, and degradation of environmental systems necessary to support long term agricultural activities that the latter option involves. Technological advances and management practices should be placed as principal objectives in any national agriculture programs. While agricultural production will generally decrease with the overuse or misuse of the resource base, increased production is possible utilizing irrigation technology, improved production methods and germplasm. This will require more reliable sources of water, of which supplies are severely threatened by deforestation. Thus, sustainable development will force land use planners to remove areas currently in traditional agricultural production. These areas are largely unsuitable for intensive agricultural production and, according to their land use classification, should never have been converted from forest cover. The resultant loss of production will be traded off for the other outputs and services that a protected forest can provide such as dependable, quality water supplies and reduced soil erosion.

7.1.3. Institutional Limitations.

Almost all public agencies, and many private groups, need to go beyond expressions of concern to developing institutional processes that will enable them to adopt specific actions to control the use of the environment and coordinate activities with one another. The low levels of technical expertise, research and the exchange of information on development and conservation matters are constraints that need to be resolved. An evaluation should be conducted of the priority assigned to the work of the few existing departments within relevant ministries, and their capacity to enforce existing regulations, as the first step in this reform.

The institutional capacity of the country to evaluate, implement, coordinate and monitor development projects is currently inadequate. The impact of key factors of non-sustainability should be carefully evaluated before analyzing and recommending economic alternatives and strategic action plans. In terms of economic planning at the national level, all current land uses need to be analyzed, region by region, in terms of sustainability indicators or land use capability assessments.

The Ecuadorian National Congress drafted a Law in 1988 which has yet to be approved, creating the Ecuadorean Institute for Environmental Conservation (INECA) to plan, coordinate, and implement all actions dealing with the environment. The creation of a central environmental agency was first suggested by Fundación Natura as an Environmental Secretariat Office linked directly to the President, supported by a Superior Council for the Environment. Unfortunately, INECA will conflict with at least fourteen other public agencies given their present roles and functions on environmental matters. While INECA would be an important first step nationally, other forms of institutional adjustments will be necessary in existing ministries and agencies to ensure the adequate incorporation of conservation concerns at the regional and local levels.

Governmental support for the protection of natural resources might follow the models existing in other Latin American countries or consider approaches taken in the U.S., where 2 federal agencies are responsible for monitoring compliance with environmental legislation. One agency, the Council on Environmental Quality, formulates national environmental policy and oversees the execution of the National Environmental Policy Act (NEPA) by federal agencies. The other federal agency, the Environmental Protection Agency, works closely with state and local governments to ensure compliance within their jurisdictions with legislation for air and water quality, toxic substances, pesticide use, and waste disposal. Each federal agency establishes its own environmental compliance office, consistent with legislation; an

arrangement that helps reduce inter-agency competitiveness and territoriality while promoting the development of agency-specific procedures.

7.1.4 Economic Pressures

Ecuador's external debt1 is expected to fall between US $10 - 11 billion for 1988. Table 7.1 shows the growth of the total external debt from 1980 to 1988. In 1987, it represented 74% of GNP or roughly US $9,000 for every man, woman and child in Ecuador. Dwindling reserves of foreign currency, critical to the servicing of the external debt, are currently running a negative balance (US -$350 million) and estimated to increase to only US $70 million by the close of 1988 (Paredes Lucio 1988).

Table 7.1: Growth of the external debt in Ecuador (1980 - 1988)

Total External Debt in US $ millions			
1980	1983	1986	1988 (estimated)
5,997	7,543	8954	10,100

Sources: Data for 1980-86, World Resources Report 88-89
Data for 1988, "Perpectiva Economica", Ago. 88

Internal statistics on the national economy are equally bleak: the national budget deficit for 1988 will be in excess of s/. 250 billion sucres, a 73.5% increase over 1987. Given current economic trends, inflation is expected to top 75% by the end of 1988. The average Ecuadorean felt the economic crunch as the purchasing power of their minimum salary (s/. 14,000 sucres/month) declined 17% in real terms from 1987 to 1988 (Paredes Lucio 1988).

Faced with climbing inflation and declining revenues due to the softening of world prices for export commodities and decreased petroleum production capacity stemming from damages suffered during the March 1987 earthquake, the GOE enacted austeric measures in September 1988 in an attempt to bring the national economy under control. These measures were outlined in the GOE Plan de Emergencia unveiled on August 31, 1988. Ambitious as the plan is, it is doubtful that the GOE will be able to meet its goals given current economic patterns.

Unfortunately, the natural resources base of Ecuador, mainly its tropical forests and the petroleum, timber and perceived agriculture frontier which it harbors, will be increasingly turned to for valuable foreign exchange and as a "safety value" for

society's demographic pressures, further eroding the possibilities for Ecuador's future economic development.

7.1.5. Population Growth

The problem of population growth must be considered within the context of shrinking average farm sizes and limited non-agricultural employment opportunities. Combined, these factors represent the largest obstacle to protecting and managing the biological diversity and tropical forests of Ecuador. Resolving these issues will require more intensive, rather than extensive, agricultural practices, coupled with a reduction in population growth and the creation of non agrarian employment and income opportunities.

Unchecked population growth within the context of limited subsistence and housing alternatives, especially for the nations's rural poor, presents major challenges. According to Landàzuri and Jijon (1988), Ecuador's population is growing at 2.9 percent (see table 7.2) and will double in 27 years.

Table 7.2: Population growth rates in Ecuador

Total Population				Between Censuses		
1962	1974	1982	1986	62-74	74-82	82-86
TOTAL POPULATION:						
1,447,200	6,829,467	8,606,116	9,093,987	3.2%	2.9%	2.9%
URBAN AREAS:						
1,447,200	2,797,800	4,226,000	5,093,987	5.6%	5.3%	4.8%
RURAL AREAS:						
3,248,605	4,031,667	4,380,116	4,553,120	1.8%	1.0%	1.0%
COSTA-GALAPAGOS:						
2,119,300	3,527,700	4,804,300	5,567,700	4.3%	3.9%	3.8%
SIERRA-ORIENTE:						
2,576,500	3,301,800	3,801,800	4,079,400	2.1%	1.8%	1.8%

Sources: 1 - Población Total: INEC, Resumen de los Censos Nacionales 1962, 1974, 1982, 1986: Estimación por Tasas de Crecimiento.
2 - Urban and Rural Population: Estimates from the World Bank

However, growth rates differ regionally, with 2.2 percent suggested for the Sierra and 2.5 percent for the Costa. In the Oriente, which has seen a major influx of young colonists, the estimated growth rate for the period 1974-1982 was 4.9% which,

unlike the national rate, has shown no evidence of decline (Fundación Natura 1988). The national growth rate will likely continue to increase over the next several years. More than declining birth rates among the young population, this trend reflects a declining death rate, decreasing infant mortality and result of health care delivery systems reaching more remote populations.

Evidence indicates declining fertility rates in urban areas, especially in Quito and Guayaquil, among women of higher socioeconomic levels (CONADE 1987). This pattern is similar to other developing countries in which better educated and more economically secure urban women delay the birth of their first child and limit the total number of offspring.

Environmental Consequences of Uncontrolled Population Growth

The linkage between deforestation and population growth becomes clear when one examines the root causes of deforestation. Colonization, with concomitant conversion of forests to agricultural land and utilization for fuelwood consumption, is the principle cause of deforestation in Ecuador.

Erosion problems go hand in hand with deforestation and are most prevalent in areas of high population densities and highly intensive land cultivation practices. Other key factors contributing to erosion are the inadequate practices used in annual crop production on steep slopes, the lack of appropriate land conservation practices, and the susceptibility of certain soils to erosion. Approximately 25% of the country is affected by moderate to severe soil erosion resulting in the loss of 12 -240 tons topsoil/ha/yr (USAID/Quito 1988), but a considerable portion can be attributed to natural geomorphological processes (Landázuri and Jijón 1988).

Deforestation and soil erosion lead to decreased water availability, increased flooding potential, siltation and reduced water quality. Reduced water production capacities impact directly on irrigation and hydroelectric power production potentials. Decreased water quality negatively impacts human health as well as the number and variety of downstream aquatic life, many which serve as an important protein source for local populations.

7.1.6. Need for an Information Base Regarding Biological Diversity

A major obstacle to conserving biological diversity in Ecuador is our limited knowledge of existing species and their relative importance for conservation. At best, current information only scratches the surface concerning the vast variety of species, their status, habitat, and interactions which make up Ecuador's biological diversity. Proper decision-making requires adequate information and appropriate analysis. Although there is a wide variety of information available in Ecuador, it is not treatment equally in all subject areas and regions of the country. The resulting imbalance makes priority-setting difficult.

Collecting, assembling, and organizing the available data into a coherent and easily-accessed whole would be a major contribution to research and analysis. For the natural resource data in particular, a Conservation Data Center would be a major step forward. Individual researchers and several institutions (museums, government offices, universities) have informally expressed their interest in a cooperative information project. The remaining obstacles are identifying the lead institution as a home for the data bases and developing a financial plan for its support.

7.2. Review of Regional Threats to Biodiversity Conservation

7.2.1. La Costa (Western Ecuador)

Ecuador's coastal region, when defined to include the provinces that encompass the lowlands between the ocean and the Andes, has emerged as the stronghold of progress and development for the country. Ecuador's future economic development in large measure depends upon how its coastal ecosystems are utilized and managed. The recent boom in shrimp mariculture along the Costa has made this the largest private sector activity in the country, second only to petroleum in the value of goods exported. Ecuador's coastal ecosystems contain the nation's best farmland and produce virtually all of the nation's agricultural exports. Population growth is most rapid in coastal cities where birth rates are the highest in the nation. Guayaquil, the nation's largest and fastest growing city, is the center for banking and industry and a thriving sea port.

The Costa region's soils are the most fertile in Ecuador. Proper agricultural techniques would allow for more intensive use of these soils and thus partially relieve the pressure of inappropriate land use in the Sierra and Oriente. According to (MAG:1985) the region's two dominant agricultural land uses are for coffee and cocoa production. These two "traditional export crops" require periodic renewal their of plant stock with improved germplasm to thwart diseases and improve productivity and thus,

are intimately dependent upon their wild relatives found in tropical forests.

Today, both the opportunities and problems posed by how the Costa is managed has reached a critical juncture. Once-luxuriant forests that supported an important shipbuilding and lumber export trade a century ago have virtually all been replaced by low yielding, erosion prone, banana plantations and pastures. The construction of over 120,000 hectares of shrimp ponds has brought the almost complete eradication of mangroves in many estuaries. The shrimp industry continues to threaten this critically important habitat that, among many other benefits, is of vital importance to sustaining the wild shrimp populations that produce the larvae used to stock shrimp ponds. Similarly, declining water quality is a threat to public health, the ability of estuarine habitats to support fisheries, and the mariculturists who require large quantities of high quality water for their shrimp farms. Both estuarine habitats and water quality will be under increasing pressure in the years ahead as upstream dams are built and as cities and their associated industries expand.

Conflicts among incompatible activities -- such as fish processing facilities and tourism -- give rise to poor site selection for physical structures and ill-conceived development activities which are abundant along Ecuador's coastline. Not only are such mistakes expensive and avoidable, they threaten to undermine the potential for tourism that is beginning to capitalize on the sandy beaches and scenic bays of Ecuador's extraordinarily diverse coastline. The situation is further complicated by new major development activities such as the search for petroleum and the production of natural gas in the Gulf of Guayaquil and along the offshore continental shelf.

Marine Resources

Prior to 1970, mangrove ecosystems were considered unproductive and under-utilized, however, this view has changed and there is now great interest in conserving and maintaining mangrove forests as significantly productive systems. Ecuador's mangrove forests are now recognized as being economically and ecologically important for several reasons. They provide a refuge for numerous species of marine vertebrates and invertebrates, as well as roosting and resting sites for birds. Mangrove forests are enormous producers of organic matter in the form of leaf litter and form the base of a food web which includes a number of commercially important crustacean, molluscan, and fish species. Mangrove estuaries provide critical habitat for fish and shellfish populations that support several hundred thousand artisanal fishermen who produce a critically important source of protein for the region's rapidly growing population. Several valuable forest products are also derived from mangroves: including construction

materials for houses; bridge and dock pilings; firewood and charcoal for domestic use; and tannins for leather.

The geographical distribution of mangrove forests, salt flats and commercial shrimp ponds was recently mapped by CLIRSEN using remote sensing, and are described in table 7.3.

Table 7.3 Extent of mangrove forests, salt flats and shrimp ponds in western Ecuador, 1969- 1987 (1000 hectares).

Province	Mangroves			Salt Flats			Shrimp Ponds	
Year	1969	1984	1987	1969	1984	1987	1984	1987
Guayas	125.5	119.6	113	41	17.4	10	52.6	70
El Oro	33.7	24.5	23	9.7	2.5	2.5	26.5	30
Manabi	12.4	8	6	1.1	0.8	0.2	8.4	10
Esmerl	32	30.1	28	-	-	-	1.6	3.5
Totals	203.6	187.2	170	51.8	20.7	12.7	89.1	113.5

Source: Preliminary data by CLIRSEN

Industrial fisheries initiated in the 1950s have modernized and diversified in recent years. In the last 20 years, annual catches have increased 16 fold from 55,000 to 901,000 metrics tons (mt/yr) and are estimated to soon reach 1 million mt/yr. The recent boom in shrimp farming has made it the second largest private sector activity next to petroleum in the value of goods exported. There is no indication that the industry's growth is slowing. Between 1980 and 1987, annual income from the export of shrimp rose from 56.9 to 383.1 million dollars. However, the continued expansion of shrimp farming has been accompanied by a reduction in the extent of mangrove and salt flat ecosystems. This has had an impact on the plant and animal communities along the entire coastal zone. An even greater impact has been felt in the socio-economic development of human settlements in the area.

Uncontrolled larval fishing has had a major impact on coastal fisheries resources through the catch of non-shrimp larvae killed accidentally in the fine-mesh nets used for capturing shrimp larvae. This particularly affects artisanal fisheries, liquidating schools of baitfish necessary for line fishing and stocks of economically or otherwise important species of both fish and aquatic invertebrates. This problem is exacerbated by unregulated near-shore trawling with fine-mesh nets by both foreign and national industrial fleets which, in turn, results in population reductions of their target species. There is growing concern that over-exploitation of immature stocks combined with a

25% loss of valuable mangrove habitat due to shrimp pond expansion, will severely hinder the sustainability of shrimp populations.

Other activities in the middle and upper watersheds of the inland provinces which have negative impacts on the sustainable development of mangrove ecosystems are: agricultural practices and livestock overgrazing which lead to soil erosion; urban development and associated ill-placed road building, drainage works, water impoundments, waste disposal, and port construction; transportation, use and spillage of petroleum products; and mine tailing discharges.

In 1986, a Coastal Zone Resources Management Project was initiated by agreement between the Government of Ecuador and the U.S. Agency for International Development. The "Dirección General de Medio Ambiente" (DIGEMA), of the "Ministerio de Energia y Minas del Ecuador" and the Coastal Resources Management Program of the University of Rhode Island are now working to develop management strategies for Ecuador's Costal region, including its mangrove forests and associated ecosystems.

The mangrove management strategy is oriented toward sustained yield of the mangrove forest ecosystems and protection of the resource base. This will require the protection of the remaining riparian forests in the coastal watersheds to prevent the irreversible deterioration of the coastal fisheries. Likewise, it will be necessary to control the construction of roads and port facilities, waste disposal, land drainage, and other infrastructure projects in the riparian zone. The maintenance of natural patterns of water flow in the coastal river systems and circulation in the estuaries is essential to the health of mangrove ecosystems. Contingency plans to avoid pollution of the water and soil by petroleum products or other chemicals are also needed.

These measures will permit the controlled development of various activities in the mangrove forests, including silviculture, bee keeping, tourism, fishing, and harvesting of mollusks and crustaceans, while maintaining ecosystem equilibrium which is essential to the life cycles of many marine organisms of commercial importance. The implementation of the mangrove ecosystem management strategy demands the coordinated action of several government ministries and the interpretation of various laws, regulations and ministerial decrees.

Proposed Road into Cotacachi-Cayapas / Awa Reserve

Perhaps the most serious and immediate threat to biodiversity conservation in western Ecuador is the proposed road from La Concordia in the province of Pichincha to Tobar Donoso in the Province of Esmeraldas, located on the Colombian border. The road

is currently in the planning stage at the Ministry of Public Works, (MOP). The initial phase of construction from La Concordia to the Rio Guayallabamba is already completed. The road will cut through the middle of both the Cotacachi-Cayapas and Awa reserves. Coupled with lumber concessions and colonization, this project will effectively destroy the last remaining large area of undisturbed pluvial primary-forest in western Ecuador. This area, the southern extension of the famed Choco region, houses the greatest biodiversity in the region and has been identified by Norman Meyers as one of the 10 global hotspots for biological diversity conservation.

Water Resource Development

The Costa has long been a major agricultural region for Ecuador. Soils are fertile, deep, and many are well-drained. The dry season allows soils to dry out so that preparation and harvesting can be mechanized. The limiting factor in many cases is simply the availability of water. Water resource development projects in the Costa focus, therefore, on the agricultural aspects of irrigation, flood control, minimum flow, etc. Hydropower is a component, but not the overriding concern (in part because vertical drops are not as great). Potable water supplies become a subset of the control of minimum flows.

For the Guayas River Basin, the largest watershed on the Pacific side of all of Latin America, some twenty major and minor waterworks have been proposed. One of the largest and most recent is the Daule-Peripa dam and reservoir, also known as the "Jaime Roldos Aguilera" project. The JRA project also includes phase II and phase III activities, but the main component of phase I is the Daule-Peripa dam, now completed.

Water Pollution

The major threat to biological diversity from water pollution are the results of human modification of the natural water regimes in both water quality and water quantity. Water quantity is perhaps the less worrisome of the two, although changes in quantity will affect quality. Major water works are under construction to modify the flow regimes of the river systems, particularly the Guayas Basin. Through flood control and maintenance of minimum flows, CEDEGE and INERHI hope to reduce the peak fluctuations in stream levels, thereby reducing flood damage to urban and rural lands as well as ensuring sufficient supplies of water for municipal use, navigation, and irrigation throughput the year. By reducing peak flows, however, these dams and retention reservoirs will reduce the nutrients that flood waters contribute to flood plains. Riparian habitats that depend on these annual inputs of fertile silt from upstream will be placed at risk.

Water quality is a more serious concern. It affects urban and rural communities and can have severe impacts on aquatic ecosystems. The major threats to water quality come from agricultural, industrial, and urban sources. The same hydrological projects that provide water for irrigation are also creating water quality problems because the return water from the irrigated fields is carrying fertilizers, pesticides, and salts leached from the soils.

Industrial wastes include the complex salts and heavy metals as well as solvents and cleaning fluids. Although not heavily industrialized by global standards, the Costa is undergoing a relatively rapid expansion in small and medium industries. Urban wastes represent a less hazardous and less toxic problem, but one that is perhaps more difficult to control given the enormous number of individual sources that produce these large-volume wastes.

The effects of water pollution and sediment loads on aquatic ecosystems are tragic. Benthic communities are simply smothered by silt and other sediments. Toxic chemicals, even when not fatal to the aquatic plants and filter feeders, may be concentrated in the body tissue of bioaccumulators, posing a hazard higher up the food chain to predatory species, and causing concern in human consumption. Alarmingly high pesticide levels have already been linked to die-offs in the shrimp-farming business, where enormous amounts of estuary water are pumped into the ponds each day.

Pesticides and Other Toxic Substances

Pesticide use and abuse in Ecuador has been amply discussed in Sevilla & Perez de Sevilla (1985) and Perez de Sevilla (1987). It is clear that pesticides have been improperly used to the disadvantage of the human population and need for control of their use is urgent. It is also true that wholesale ban on importation can have a deleterious effect on cultivation of some crops in tropical regions. For example, the use of Mirex is banned in the US for fire ant control but it is the only effective pesticide for control of leaf cutter ants, one of the most destructive pests in tropical regions. Use of Mirex for leaf cutter control is very local, only affecting the specific nest area whereas in the US it was broadcast over pastures from crop-dusters at several pounds per acre.

7.2.2. La Sierra (Andean Highlands)

Andean Agriculture

Sierra farm lands are mostly used for domestic production where, as a result of inappropriate land use patterns, the flatlands are used primarily for livestock pasture. This forces small farmers to the steeper slopes to carry out intensive agriculture. This land use pattern should be reversed, but is driven by land costs and the more attractive rates of returns from livestock raising verses traditional agricultural. Increasing populations and the inequitable concentration of the land in a few hands forces small Sierra farmers to continuously divide up smaller and smaller parcels of land between their children. This ultimately leads to migration to the cities or colonization areas.

Watershed Management and Pollution

Much of the concern over water resources in the Sierra involves erosion control or water pollution control. The steep slopes, intensive land use, low capital and technology levels, small plots, and a host of social and political factors combine to create serious soil erosion problems. Loss of native vegetation (usually forest, at the lower elevations) exposes soils to wind and rain. Deforestation, whether for urban, industrial, or agricultural expansion, leads to increases in soil erosion in the tops of the watershed and increases in sedimentation in the lower parts.

7.2.3. El Oriente (The Amazon)

Agriculture in the Amazon

Agriculture occupies over one million ha, of which close to 120,000 ha are in farming, with the remainder in pastures and other "productive" forms (Fundación Natura 1988). Its contribution to the Gross Domestic Product (GDP) is very small -- except for African oil palm -- due to low yields associated with the inadequate use of modern and traditional technologies. Most subsistence products are farmed under systems which lead to rapid soil erosion, forcing lands to be abandoned or degraded after only a few years. With the help of international donors (USAID) efforts are being made to identify agro-silvo-pastoral systems that conserve and improve soil fertility while providing sustainable harvests for rural farmers.

Large expanses of tropical forests have been cleared for African oil palm plantations. In 1984, conversion of tropical forests for African oil palm plantations accounted for 9500 ha. In the Napo Province there are reportedly 20,300 ha of concessions for companies to farm African oil palm. Processing plants for the new industry are located near riparian courses and are serious

point sources of pollution, dumping their effluent directing into the waterways.

Roads and Petroleum

Roads in the Oriente are not necessarily built to open new areas to colonization. Timber harvesting and land occupation are often by-products of petroleum exploration and exploitation policies and processes. The petroleum activities demand manpower for the construction of roads and for other exploration and exploitation actions. It opens up forested areas previously inaccessible, generates commercial activities, creates land tenure conflicts and as a result, it deteriorates the environment through unregulated timber harvesting, ill-planned colonization in dispersed and disorganized human conglomerates, creating negative impacts upon protected areas and established native communities in the Oriente.

Unfortunately, petroleum exploration areas often conflict with important areas of tropical forest habitat in the Oriente, such as the Cuyabeno Faunal Reserve and Yasuni National Park (Nations 1988). Airport facilities in Santa Cecilia, Lago Agrio, Puerto Francisco de Orellana, Limoncocha and Tarapoa, and their associated road system have contributed to an unguided occupation of these areas. Such is the case in the development of Lago Agrio-Coca, Lago Agrio-Tarapoa, and with the oil exploration grids in Fanny, Marian, Parahuaco, Atacapi, Tetetes, Shuaras, Sansahuari, and Shushifindi.

The first roads into the Oriente were in associated with the development of haciendas in the Pastaza Province, following the Ambato-Baños-Puyo highway. Later, highways were built in the provinces of Pastaza (from Palora to Mera), Napo (from Mera to Puyo), and Morona Santiago (from Puyo to Tena), opening the way for individual farmers to settle into these areas. In all these cases, farming was preceded by deforestation, of which only a small portion (30%) of the wood was utilized through the sale of individual logs to intermediaries who then resold the logs to larger producers. (Fundación Natura 1987).

The largest impact of roads on biodiversity in the Oriente is observed in the province of Napo, upon the construction of the Baeza-Lago Agrio road, and then with the roads from Santa Rosa de Quijos to the Due and Cofane rivers. Up to 1980, some 6,000 title-holding colonizers had followed the Baeza-Lago Agrio route, and occupied almost all of the productive lands along it, in a land use pattern known as "respaldos"[1]

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[1] "Respaldos" are layers of landholdings developed parallel to a road. Farmers occupy the first layer as the road is opened, sell them, and then move to another layer further back, away from the road. This process can continue up to six or seven "respaldos" (Fundacion Natura; 1987).

Colonization

Colonization of the Oriente by settlers has increased substantially over the last two decades, largely following new roads associated with oil exploration activities through government sponsored colonization schemes. These immigrants pose a serious threat with their lack of knowledge of forest cultivation methods. Indeed, two of the root causes of deforestation are land clearance for colonization and the production of charcoal and fuelwood, which between them account for the use of 2,300,000 m3/yr of timber (IUCN 1988). Land reform laws encouraged deforestation by stipulating that homesteaders had to clear 80 percent of their land within 2 years of settlement to qualify for ownership. Although this law has been repealed, the damage to the forests has already occurred and many new colonists are still conscious of this requirement.

In spite of the relatively small number of people settled in the Oriente, it is now being developed for some entrepreneurial ventures, such as oil extraction. Commercial african oil palm plantations and cattle ranching are encroaching into the newly accessible areas of the Amazon forests.

Reforestation efforts are not generally undertaken by the colonists as GOE programs may have difficult requirements (plats or land survey - "planos") for the small land owner to meet. Many colonist, unconvinced on the returns from forestry investments, are unwilling to assume the risk of plantation failure and have to pay back the loans offered through these programs. Special funds created from oil revenues through Plan Bosque to encourage tree planting have doubled the reforestation rate, which accounted for some 29,000 ha in 1986, but has been crippled by the economic crunch and allegations of corruption (Escobar, pers. comm.). Pilot agroforestry projects such as that of Coca, are more promising alternatives to promote wiser land use practices among the rural poor. The consequences without more emphasis on such programs are then those of deforestation followed by over-utilization, both processes which, if continued via the opening of new roads, will eventually affect all of the forests in the Oriente.

Should Ecuador continue with the intention of building the Oriente Highway connecting Venezuela, Colombia and Perú, the ecological impacts will be disastrous even if measures are taken to reduce them as the process of colonization that follows will be difficult to control given current policies and procedures.

Impacts of Colonization on Indigenous Peoples

Steps by the central government to incorporate the native people and natural resources of the Oriente into the national political, economic, and sociocultural systems are not only directly threatening the tropical forest. They are also putting the cultural diversity of native peoples at risk and, as a result, undermining the traditional resource management systems that have contributed importantly to the maintenance of the tropical forests.

As colonists convert forests into croplands or pastures they invade the actual or potential subsistence grounds of native peoples. This generates hostilities between natives and non-natives, the displacement of native communities from customary areas, and the potential for hostilities among native communities in competition for resources. The establishment of concentrated settlements and military outposts are also creating an escalating demand for protein, resulting in a decline in preferred local game species. For example, fishing practices (over which there is little control) now include the use of dynamite and barbasco to capture fish, such as the bagre, which are a traditional source of protein for many indigenous groups.

Demographic increases among indigenous peoples, coupled with the tendency among some groups to become less migratory and more dependent on nucleated settlements for schools, markets, and other services, is prompting change or abandonment of traditional farming systems. Although native population densities remain relatively low, and agricultural practices still include extended fallow periods, the characteristically non-destructive systems are being transformed in some areas as cultivation is intensifying.

More frequent interactions between indigenous and non-native communities is increasing the indigenous population's reliance on manufactured or other market goods, and bringing associated new needs for cash incomes. A related trend is replacement of the subsistence production of diverse native crops with the production of limited varieties of non-native crops with cash or market value.

7.2.4. Galápagos Islands

The Galápagos Islands are a United Nations World Heritage Site and a cornerstone in the conservation of biological diversity because it was on these islands that Charles Darwin made many of the observations about natural selection and evolution for which he is famous.

The major issues affecting the Galápagos are settlement and tourism. Ecuador has a strong national policy to establish

"living frontiers" or settlements along national boundaries. Although particularly directed toward the Peruvian and Colombian borders, this de facto policy produces announcements in the national legislature and local newspapers for the reclaiming of the Galápagos from foreign incursion. Organized tourism of the islands is heavily skewed toward foreign visitors who can afford the considerable prices (although there is a two-tiered pricing system to encourage Ecuadorean visitors). The basic question is how much human settlement and alteration of the islands, whether for agriculture or tourism, is desirable.

Resource use by local inhabitants of the islands is a growing problem. The islands have very limited potable water supplies, dependent upon recharge from an annual rainfall of less than 200 mm/year in many areas. Agriculture on the islands is difficult at best. Fishing is more attractive but very difficult to regulate and ensure sustainable harvests.

The Galápagos Islands attract an international tourism that staggers the imagination. The islands are 1000 km west of the continent, yet annual visitation is reported to be above 65,000 persons/yr. With a carrying capacity estimated to be 25,000 persons/yr, the result is a growing stress on both physical infrastructure and the natural system. The detrimental impacts of congested tourism include the trampling of fragile vegetation, soil compaction, garbage and sewage disposal, and coral reef alteration from anchor damage and over-collecting of marine life. However, tourism is also largely responsible for the success of the Galápagos as an officially protected area. Were it not for the tourism, funds from international sources would not have been available to support the Charles Darwin Research Station and the National Park. In accepting international funding, Ecuador also exposed itself to international pressure and intervention in the management and protection of the islands.

The clearest lesson from the Galápagos is that world attention can play a significant if not determinant role in ensuring the protection of a world-class example of biological diversity. The question arises: Why not the mainland, too? Continental Ecuador contains more biological diversity and in many areas more species per unit area than the Galápagos. Continental Ecuador has more endemic species per unit area and offers a wider array of tropical ecosystems. Redirecting international attention from the well-known to the even-more-superlative mainland sites should be a high priority focus in the conservation of biological diversity and tropical forests in Ecuador.

Chapter VIII
Recommendations for Proposed Actions

8.1. Priority areas for biodiversity conservation

Based upon precipitation data, elevation and the occurrence of remaining primary tropical forest, the team identified the following priority areas for the conservation of biological diversity and tropical forests in Ecuador:

Western Ecuador (La Costa)

- o Awa Reserve
- o Cotacachi-Cayapas
- o forest fragments occurring along Quaque (Esmeraldas), south through Manabi to Guayas.
- o Mangrove ecosystems (along coastal fringes)

Western Andean slopes (La Sierra)

Considered as the zone of highest risk due the to (1) few remaining areas of high biological diversity (pockets of intact primary forest) and (2) the intensity of human pressure in this region.

- o forest fragments occurring between 900 - 2400 meter elevations.
- o Cotacachi-Cayapas
- o Pichincha (Maquicupuna)

Eastern Andean slopes (La Sierra)

- o La Bonita
- o Cerro Sumaco and surrounding area
- o Cayambe-Coca
- o Sanguy
- o Podocarpus

Amazon Region (El Oriente)

- o forests occurring between 300 - 900 meter elevations
- o lower slopes of Cayambe-Coca, Sumaco, Sanguy
- o Cordillera de Cutucú
- o Cordillera de Guacamayo

8.2. Current opportunities for biodiversity conservation

8.2.1. Priority conservation actions for USAID/Quito

USAID/Quito efforts to conserve biological diversity and tropical forests should concentrate on the priority areas identified in section 8.1 with special attention to western Ecuador. Based upon available data, this region contains the highest level of biological diversity (number of species per unit area) in the country. Western Ecuador contains the least amount of primary tropical forests (5000 km2) of the three major geophysical regions and faces the most intense pressures from human activities. Of particular importance is the Awa Forest Reserve (1000 km2), the largest remaining tract of primary pluvial forest in western Ecuador. The initiative of the Awa nation to actively manage the Reserve and their collaboration with growing international support, provide encouraging signs for successful conservation of what has been described as one of the 10 global hotspots for biodiversity conservation.

In the eastern Sierra - Oriente region, the transitional forest zone of Cerro Sumaco is another area of high biological diversity which offers an unique opportunity for donor coordination between USAID and FAO following the events of the 1987 earthquake and consequent road construction and resettlement program. The likelihood of significant local community involvement is excellent through coordination with the indigenous peoples group, FOIN. This area could serve as a model for a coordinated, regional planning effort which incorporates conservation concerns through the protected area -- buffer zone approach with management activity conducted by local community members.

Current attention on Yasuni National Park (6800 km2), the largest national park in Ecuador, concerning recent research findings confirming its biological diversity, oil exploration activities and proposed road construction, and growing concern about the Hoarani indigenous people (Coello per com., McMeekin per. com, Nations 1988) make this a high priority area for tropical forest conservation. USAID should support the proposed biological research station currently being endorsed by CONOCO and controlled colonization through the enactment of the Policia Forestal proposed by the Ecuadorian Armed Forces as prerequisites to road building into the western portion of Yasuni NP (see recommendations by Miller, 1988).

Other areas which merit consideration are those that have suffered from human encroachment but still maintain biological resources which are of economical, cultural as well as ecological importance. These areas include mangrove forests and their associated ecosystems of the coastal provinces of Gauyas and El

Oro; and forests slated for timber harvesting in the provinces of Esmeraldas and Napo. Conservation activities should promote intensified shrimp larvae nursery practices through the Coastal Resources Management Project; and projects in improved wood utilization and preharvest logging plans promoted through INFORDE with private enterprise (see DeBonis 1988).

Current trends and potential hopes for the future in conserving biological diversity indicates that working with local communities as the primary beneficiaries in management schemes is essential for successful, long term results. Several national NGOs promoting conservation, community development, and indigenous peoples have demonstrated a strong ability to mobilize local support by promoting traditional resource management systems in the successful conservation of biological diversity and tropical forests. For example, actions of the community of Mindo and Tierra Viva-Quito resulted in the declaration of the Mindo-Nabillo Forest Protectorate (190 km2). Likewise, initiatives by the Awa community with the assistance of CONAIE secured international attention concerning the Awa Forest Reserve (1000 km2). These efforts have proven to be very effective and are testaments to the ability of NGOs and local communities to successfully conserve forested areas in the face of increasing pressures on natural resources.

In sum, a comprehensive effort by USAID to assist the GOE in conserving biological diversity and tropical forests will require a flexible approach, one which focusses on needed policy reform and can also respond to specific instances and special areas as the opportunities arise.

8.2.2. Priority areas for policy reforms[1]

Focusing conservation activities on these priority areas in itself will not ensure the long term maintenance of these ecosystems unless the fundamental issues confronting biological diversity are concurrently addressed at the public and political level as well. This will require a two tiered approach, focusing on high profile projects which cut across the spectrum of issues at the community level and identify policy reform needed at the national level to ensure the sustainability of local conservation efforts.

The Tropical Forestry Action Plan for Ecuador provides an excellent chance to identify policy reform needed at the national level (see chapter VII) to ensure the long term sustainablity of conservation efforts in Ecuador. Secondly, the TFAP offers USAID an opportunity to dialogue with the GOE, other donors, and

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1 An indepth discussion of suggested legislative reforms is provided in Fundación Natura (1988).

national NGOs, concerning investment priorities for biodiversity conservation, training, and to promote the sustainable development of forest resources in a coordinated and collaborative fashion (see in chapter II).

An important area for policy reform is the strengthening of the legal distinction between "patrimonio forestal y áreas naturales" and the general public domain, "baldios". Current Ecuadorean law, particularly the colonization and agrarian reform measures, makes inadequate differentiation between lands withdrawn from the public domain for environmental reasons (patrimonio forestal) and those lands still in the public domain and open to colonization (baldios).

Development of a legal framework for conflict resolution between protected areas and mineral extraction interests is another high priority for policy reform. Legislation regarding subsurface mineral right supercedes that of surface rights and results in the consistent, lawful encroachment into protected areas by petroleum related activities.

Concessioner agreements between timber companies and the GOE assess royalties paid to the government on the amount of wood actually harvested at a flat rate fee. This practice encourages poor utilization of forest stand through removal of only a few trees per hectare and results in a high incident of damage to the residual trees. DINAF (1988b) estimates that although commercial volume reaches 130 m3/ha in the province of Napo, on the average only 17 m3/ha is harvested. Current arrangements with third party, independent logging contractors create a loophole for noncompliance with reforestation requirements, discouraging efforts to develop long-term sustainable silvicultural systems. GOE revenues could be enhanced and improved harvesting practices promoted by implementing a royalty system based upon the merchantable volume of concessioner forest tracts, or that values the harvested volume by log grade and species (DeBonis 1988, Repetto 1988). Reforestation requirement should recognize natural forest regeneration systems as viable options.

8.3. Enhancement of selected USAID projects for biodiversity conservation

8.3.1. Promotion of land use planning

<u>Forestry project for Ecuador (USAID/Quito 1982b)</u>

The forestry project for Ecuador (USAID/Quito 1982b) attempts to strengthen the institutional capabilities of the National Forestry Directorate (DINAF) of the Ministry of Agriculture and Livestock. DINAF has a pivotal role in coordinating conservation efforts in protected areas and implementing forestry projects in Ecuador. It is the central agency within the GOE to promote the

conservation of biological diversity and tropical forests. Focus should be placed on the National Park Service of DINAF and concentrate on buffer zone management activities (agroforestry and local resource management projects), adequate staffing and the necessary logistical support through PL-480 funds in the existing National Parks of Cotacachi-Cayapas, Cayambe-Coca, Sanguy, Podocarpus and Yasuni.

Forestry Sector Development Project (1982)

Expand the Forestry Sector Development Project (518-0023) model to include land use capability planning and mapping. The critical step is moving from a descriptive system to a prescriptive system where land use regulation actually occurs. The "bosques y vegetación protectores" legislation (Ley #74) creates the power to regulate land use, but has not been widely implemented. There is a unique opportunity in the Oriente to establish land use regulation based on actual capability and thereby encourage appropriate resource development. The QUMAT project in Bolivia provides a good model which could be adapted to the Oriente region. The program must include a "carrot" such as credits and incentives as well as a "stick" to encourage sustainable land use practices.

Agricultural Policy Analysis Unit

Broaden the scope of the Policy Unit to include micro-economic case studies of land use capability versus actual land use, particularly in the Oriente. Establish a monitoring program to track land use in a longitudinal study, both in the Oriente and in the Sierra. Initiate studies which demonstrate the linkages between forested areas and agricultural systems by quantifying the environmental services provided in economic terms (opportunity costs and the nonsustainability of alternative uses). Conduct sociocultural studies of small scale resource users in the Oriente, Sierra and the Costa to demonstrate the importance of secondary forest products to local economies and establish a baseline for planning and project development.

Agricultural Sector Reorientation Project (518-0051)

Tie colonization, titling, and agricultural extension activities to appropriate land use in accordance with land use assessments and classifications developed in other USAID supported projects.

Land Titling Project (518-0059)

Ensure that land titling support focuses on the areas most appropriate for agricultural uses and the high priority areas for biological diversity conservation identified above in section 1 and other areas of high biological diversity which have been

sustained over time through tradition management practices by local communities (e.g. Awa Reserve).

EDUNAT III

Encourage Fundación Natura to expand the scope of EDUNAT III to include seminars and policy discussions of land use capability assessments and policy reform needed to ensure sustainable land use practices. Sustainable development models could be the first area of studies and presentations to initiate dialogue with GOE officials. Promotion of local workshops conducted in native languages at the community level should also be an important component of this project.

Fundación IDEA

Add seminars for GOE decision makers on land use capability and assessment with an emphasis towards reform of conflicting laws and policies identified in Fundación Natura (1988), Fundación Natura and FONAPRE (1988), and chapter II of this assessment.

Coastal Resources Management Project

Continue support and expand the Costal Resources Management Project (CRM) concerning:

- The identification of life cycles of mangrove dependent fisheries species of subsistence, commercial, or biological importance.

- Coastal and near-shore ecosystem linkages to upland watershed sectors (agriculture, forestry, rural and industrial development practices, etc) that have downstream impacts on the coast.

These efforts can be incorporated as part of the proposed CRM activities for the Special Area Management Zones identified in each of the four coastal provinces coupled with intensive education/training programs on the above topics.

8.3.2. Improved coordination among USAID projects

The linkages between various AID projects need to be closely examined. For example, there should be a close and natural linkage between the forestry project and the Rural Technology Transfer System Project (USAID/Quito 1982a) because of the latter's objective of technology transfer to small farmers. Trees, both fruit and timber species, naturally play an important role in such systems for soil conservation, windbreaks, fuelwood, fodder, and other products. There is also a natural link between this project and the USAID Land Titling Project for Ecuador (USAID/Quito 1985b), which seeks to establish institutional

mechanisms for the efficient and effective provision of secure land tenure in rural Ecuador.

The USAID agricultural sector reorientation project for Ecuador (USAID/Quito 1985) deals with an important aspect of any development project: information systems. The project monitoring and evaluation phase of the USAID-funded CARE Small Farmer Irrigation Project should be linked with the information collection activities in the agricultural sector reorientation project.

Opportunities exist to develop the economic assessment capacity of Fundación Natura as part of the USAID funding of project EDUNAT III. This project should provide increased awareness of environmental issues and serve as a forum to evaluate the complex economic aspects of development alternatives.

Training and evaluation activities of the USAID Research, Extension, and Education Project (USAID/Quito 1988b) should be integrated whenever possible with other existing projects described above.

An office should be set up to track projects listed in appendix 2.3 as well as those in other sectors like industry, transportation and communications, and education, where direct and indirect impacts affect natural resources.

8.3.3. Research

The Flora of Ecuador Project

USAID/Quito supports the MBG project in inventory of trees of the north Oriente and the preparation of a manual for identification of those trees. This program could be expanded to provide identification manuals of specific groups of animals and plants, such as: invertebrates of the coastal waters (associated with problems in the shrimp industry), fresh water and marine fish, a treatment of the Lauraceae of Ecuador (one of the most poorly known families, in which a large number of valuable timber species is known to occur), etc. Contracts could be arranged with specific taxonomic authorities for preparation of identification manuals.

PL 480 Funds

Expand the use of PL 480 monies to finance and provide logistical support to host-country scientists conducting research on natural resource, particularly the aspects related to conservation of biological diversity (basic inventories, population dynamics, traditional and potential uses and management schemes, etc.). A major component should be land use capability assessments and applied agroforestry systems research.

8.4. Comments on USAID/Quito Action Plan: Natural Resources

USAID/Quito (1988b) recognizes the threat posed to Ecuador's long-term economic development by the continued degradation of the country's biological resources. It addresses existing institutional, social, and economic constraints and would improve project evaluation with respect to environmental and sustainability questions. The four major strategies identified were:

1) To ensure that natural resources are taken into account in the formulation and implementation of national government policies.

2) To broaden and strengthen support for the preservation and management of natural resources by the Ecuadorean public.

3) To develop a stable institutional system for planning, supporting, publicizing, and using high quality research on natural resource problems.

4) To design and implement natural resource field activities that provide solutions to natural resource deterioration and to provide successful demonstrations:

The following activities represent some of AID/Ecuador's present and proposed future efforts in this area:

- o public environmental education (EDUNAT I & II), specifically make environmental education a necessary and integral part of all natural resources projects within the agricultural office; put emphasis of mission-supported environmental education programs on public education; base environmental education programs on Ecuadorean experiences; design field activities with research and education objectives in mind; and provide long-term training for Ecuadorean students in the United States.

- o Addressing technical problems at the field level and strengthen institutions of the forestry sector (Forestry Sector Development Project) and continue support to private, non-profit environmental groups.

- o The highly successful approach for addressing policy issues and conflict resolution of coastal resource management (Coastal Resources Management Project).

- o Recognizing the need to work with local farmers to improve current agricultural practices, reduce soil erosion and intensify production (Community Land Use and Small Farm Irrigation Projects) and broaden support to cover local

environmental problems and decentralize activities to allow for appropriate responses to the ecological and cultural variability of the country.

- Improve the coordination among projects and agencies through linkages between the agricultural and natural resource projects of the Mission, the initiation of a policy dialogue with the government of Ecuador, and the review of projects financed by bi- and multilateral aid agencies.

- Development of better baseline data for economic analysis through the establishment of natural resources research units within universities and supporting research within the context of appropriate Mission projects.

Many other U.S. agencies and organizations are active in promoting the rational management of Ecuador's natural resources. The Mission is supporting many of these efforts and can take advantage of its good position to coordinate these interests to confront common problems. Projects of this type include:

- working with AID/S&T to support the private wood processing industry (INFORDE).

- Inventories to generate base-line data on biological resources (Missouri Botanical Garden, New York Botanical Garden, the Smithsonian Institution).

- Incorporation of indigenous peoples as an integral part of biological resource conservation and management (Cultural Survival).

- Training of local personnel, protection and nature study of natural areas (the Nature Conservancy, World Wildlife Fund, Western Foundation of Vertebrate Zoology).

Through these activities, the Mission has done a good job of supporting local non-government organizations (NGOs) who are playing a key role in monitoring development activities and influencing national policy formulation. However, some friction has developed between GOE institutions and national NGOs due to unclear jurisdiction among well entrenched government agencies over certain biological resources to which a particular NGO develops affinity. While this may hinder coordination in the short term, these NGOs are playing an important role in maintaining the issue of biological diversity and its relation to economic development at the front of the political agenda.

The Mission has attained substantial understanding of the economic limitations imposed by the continued degradation of Ecuador's biological resources. This has been successfully conveyed to the GOE in the case of the Coastal Resource Management

Project. The Mission should continue its cross-sectoral approach to dealing with biological diversity and tropical forest conservation and management issues. It should coordinate activities such that all mission projects and activities address the importance of maintaining biological diversity.

In sum, the basic Mission framework for conserving biological diversity and tropical forests should focus on:

- o Promoting support by the Ecuadorean public for the conservation and rational management of biological resources.
- o Funding of projects specifically designed to conserve biological diversity and tropical forests through support of traditional resource management systems among indigenous and other small scale communities.
- o Encouraging impact assessments of GOE policies by the GOE on the conservation of biological resources and tropical forests through implementation of the DINAF-INHERI-IERAC planning body which resulted in the declaration of the Awa Forest Reserve. Foster the participation of NGOs in this process.
- o Identifying development projects supported by other donors which promote the misuse of biological resources.

While the integration of the Mission's agricultural and natural resource activities are now joined together in a single program, stronger integration is needed at the project level. Projects should be linked together under a common strategy which specifically addresses the conservation of biological diversity. In line with this strategy, all Mission projects and activities should emphasize:

- o Sustainable production.
- o Maintenance or restoration of natural ecosystems.
- o Meeting human needs of local communities associated with USAID/Quito projects through the improvement of environmental quality.

8.5. Project proposals for the conservation of biological diversity

8.5.1. National Conservation Data Center

One of the limitations on assessing biological diversity in Ecuador is the lack of a centralized information center where available data on flora, fauna, ecosystems, protected areas, and development projects can be found under one roof. The Conservation Data Center (CDC) methodology developed and supported

by The Nature Conservancy could provide the basis for such a center. An appropriate host institution and start-up funding is needed to get the Center moving.

The goal of the CDC is to provide biodiversity information as a service to development and conservation organizations in the governmental and non-governmental sectors. By making biodiversity data available in an organized, geographically-oriented fashion, appropriate development projects can be encouraged and activities which threaten biodiversity can be readily identified and potentially avoided or mitigated.

A wide variety of researchers and scientists consulted during this assessment expressed willingness to cooperate in data exchanges. In this way, a CDC could be created with a minimum staff and rely heavily on data generated by cooperating researchers

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Lead Agency: MAG/DINAF, MEM/DIGEMA, or CONADE with assistance from the Nature Conservancy International.

Funding: $500,000 (start up costs)

8.5.2. Basic Research Support

The status of herbaria and museums in Ecuador is inadequate to proceed with biodiversity inventories, maintenance of present collections, maintenance and housing of accumulating collections, staff competence, etc. USAID/Quito could make a major contribution by:

1. Support of upgrading of competence of existing Ecuadorean scientists through training programs available in the US and other Latin American countries.

2. Support of advanced students through similar training programs to upgrade capability to do biodiversity work.

3. A major, one-shot, effort to upgrade facilities at the existing universities and museums.

For example, the Museo Ecuatoriano de Ciencias Naturales, is the one institution in the country that is federally supported and expressly dedicated to housing and curating specimens and doing research on Ecuadorean flora and fauna. It has never been adequately supported but could make a major contribution if the facilities were upgraded with necessary materials such as cabinets, microscopes, curation materials, etc. Staff competence could be upgraded with training programs as mentioned above.

Lead Agency: The Universidad Catolica has good facilities but could use help. The Universidad Central has poor facilities. The

Universidad Politecnica, the University of Guayaquil and the University of Loja all have programs in the field and desperately need help.

Funding: $50 - 100,000.00 each for a total of $300 - 600,000.00

8.5.3. Community Owned and Managed Parks

Ecuador's western and eastern lowlands contain relatively undisturbed tropical forests that fall outside designated parks or other protected areas but are within the legal boundaries of communal indigenous holdings. The proposed project, which requires the involvement of indigenous tropical forest peoples, will enhance the protection of biological diversity by establishing community-owned and managed conservation areas. Some of these areas will adjoin existing parks or preserves and thus function as buffer zones around them. Concurrently, the boundaries of indigenous communities will gain additional protection against penetration by potential colonists. In addition, community members will find opportunities to continue customary resource practices while the cash incomes earned from tourism offset the shortfall between subsistence production and the cash needed for market exchanges.

The National Park Service staff, including indigenous employees, will collaborate with indigenous communities and organizations (CONFENIAE), government agencies, and environmental NGOs such as Fundacion Natura, to provide planning assistance and training programs for park managers and interpreters. Additional training will come from CIDE. Members of Kuna Yala in Panama are an important source of indigenous trainers with park experience. The Inter-American Foundation or Cultural Survival would be expected to work with local anthropologists and indigenous communities to develop anthropological feasibility studies and make their findings and recommendations available to other involved agencies.

This project requires close working relationships with lowland Quichua groups near Sumaco and Huaorani peoples near Yasuni in the eastern lowlands, and with the Tsachala of the western lowlands, once anthropological studies indicate local feasibility, natural resource studies indicate suitability, and communities have legally secure communal titles.

Lead Agency: U.S. National Park Service. National Institutions: Ministry of Energy and Mines, Fundacion Natura, Confeniae, Kuna Yala, Panama, Center for International Development and Environment, Inter-American Foundation or Cultural Survival.

Funding: $150,000 per annum; duration 5 years.

8.5.4. Workshop on Community-Based Conservation

This workshop will consider the constraints and opportunities associated with the establishment of preserves or other conservation units on community lands and under community management. Emphasis is on indigenous and other small scale communities. Participants will include individuals with experience in managing natural resources that are open to the public and those with resources that will be managed for conservation and public use. The agenda will include panel discussions, case studies, and mini-training programs on resource management, museums and interpretation, tourism, law enforcement, and techniques for collaborating with public (GOE), private, and international agencies.

National Park Service staff will coordinate the project in collaboration with community representatives, CONFENIAE, and selected environmental NGOs. Trainers will include indigenous NPS staff, staff from the Navajo and Pacific Northwest Tribal parks, and from Kuna Yala. Workshop products will include draft management plans or approaches for Ecuadorean community parks, strategies for developing museum programs on natural and cultural resources, including ethnobiology and oral history programs.

Leading Agency: National Park Service. Other collaborators: Center for International Development and Environment, Kuna Yala, Panama; Confeniae, selected environmental NGOs, community park representatives.

Funding: $40,000

8.5.5. Traditional Resource Management Data Bank

This project will develop a comparative database on the marine and land-based resource uses of indigenous and other small scale communities. Traditional resource management systems will be considered in their broad anthropological sense, including technologies; traditional bodies of knowledge about resource capabilities and varieties of flora and fauna (ethnobiology), and their uses; maps of past and present subsistence areas; resource use histories; labor systems. The information base will be dynamic, reflecting contemporary changes in resource use. Among other results, the database will provide cultural benchmarks for (1) tracking environmental effects of resource management systems, population densities, and settlement patterns and (2) tracking effects of national programs on small scale communities, resources, and resource management systems.

The information will reflect the needs of user groups in Ecuador's planning and environmental agencies, and international donors, and also facilitate the design of resource protection

programs that are consistent with local practices and goals. The information base will be housed in the existing anthropological archive system of the Museum of the Banco Central, Quito.

The initial steps include the identification and evaluation of available information on small scale resource users found in sociocultural studies, and public and private agency files and publications, and the development of data categories in consultation with potential user groups.

Lead Agency: Museum, Banco Central. Other collaborators: Ecuadorean Anthropologists in private and public agencies, user groups in the Ministries of Agriculture and Social Welfare, Cultural Survival.

Funding: $200,000

Bibliography

AID/Washington, 1988. "Progress in conserving tropical forests and biological diversity in developing countries". (The annual report to Congress on the implementation of sections 118 and 119 of the Foreign Assistance Act, as amended) US AID, Washington, DC. 140 p.

AID/Washington, 1987. "AID Manual for Project Economic Analysis. Bureau for Program and Policy Coordination". AID/ Washington, D.C. 207 p.

Alvarez, A., B. Vasconez & L. Guerrero. 1984. Multi-temporal study of mangrove, shrimp farm and salt flat areas in the coastal zone of Ecuador through information provided by remote sensors. DIGEMA-URI-USAID. Fundación Pedro Vicente Maldonaldo. Guayaquil, Ecuador.

Anon. 1988. "Natura apoya delimitación en Territorio Huaorani", El Comercio, 20 September 1988, Section B-4.

Anon. 1980. Information handbook of the Republic of Ecuador, Vol. 1-3. E. Romero Palacio, ed.

Anon. 1987. Inventario de la red vial nacional. Ministerio de Obras Publicas. Quito, Ecuador.

Anon. 1985. US strategy on the conservation of biological diversity. An Interagency Task Force Report to Congress. USAID, Washington. 54 p.

Anon. 1973. Area handbook for Ecuador. US Department of State. Washington, DC.

Aviles, Yanez. 1985. El Proceso de Colonizacion en el Ecuador. Instituto Ecuatoriano de Reforma Agraria y Colonizacion. Quito, Ecuador

Banco Central del Ecuador. 1986. Información estadistica mensual, No. 1616. (Agosto 15, 1988).

BID. 1984. Informe de proyecto, Ecuador. Financiamiento adicional primer etapa programa de desarrollo múltiple Daule-Peripa. Banco Interamericano para el Desarrollo (BID), Washington, D.C.

Bremer-Fox, J. and W.L. Bender. 1987. The Forestry Private Enterprise Initiative in Ecuador: An Assessment of INFORDE's First Eighteen Months. Washington, D.C. 111p.

Burns-Balogh, and P. Bernhardt 1988. "Floral evolution and

phylogeny in the tribe Thelymitreae (Orchidaceae: Neottioideae). Plant Syst. Evolution. 159:19-47.

Cañadas, Luis. 1983. El mapa bioclimàtico y ecològico del Ecuador. Editores Asociados, Quito, Ecuador.

Cañadas, Luis, y W. Estrada, 1978. Ecuador: mapa ecològico. PRONAREG, Ministerio de Agricultura y Ganaderia - el Instituto Geogràfico Militar, Quito, Ecuador.

CEDEGE. 1983a. Plan de conservaciòn ambiental del proyecto de propòsito mùltiple "Jaime Roldòs Aguilera". Departamento Tècnico, Unidad de Estudios Agroecològicos, CEDEGE, Guayaquil, Ecuador. 395 p.

CEDEGE. 1983b. Proyecto para el establecimiento y manejo de la faja forestal de proteccion del embalse. Direcciòn de Desarrollo Agricola y Reasentamiento, CEDEGE, Guayaquil, Ecuador. 73 p. et seq.

CLIRSEN. 1986. Estudio multitemporal de manglares, camaroneras, y àreas salinas de la costa ecuatoriana mediante informaciòn de sensores remotos 1969-1984. IGM, Quito, Ecuador.

Coe, Edward y Chuck Gee. 1986. Plan estratègico de comercializaciòn del turismo en el Ecuador. USAID, Quito, Ecuador.

CONADE. 1988a. Informe del presidente del Consejo Nacional de Desarrollo al honorable Congreso Nacional. Quito, Ecuador. 275 p.

CONADE. 1988b. Informe del presidente del Consejo Nacional de Desarrollo al honorable Congreso Nacional - anexo. Quito, Ecuador. 114 p.

Corry, Stephen. 1985. "Ecuadorian Amazonia: The 'Naked', the 'Noble', and the 'Tamed'" An End to Laughter? Tribal Peoples and Economic Development. Survival International, Cambridge, MA, pp. 43-73.

Dàvalos N., Lupe, y Washington Estrada A.. 1981. Catàlogo provisional de la flora ecuatoriana: Vol I. MAG/PRONAREG (Programa Nacional de Regionalizaciòn Agraria). Convenio MAG-ORSTOM (Office de la recherce scientifique et technique outre-mar), Francia. Quito, Ecuador. 45 p.

Davis, E.W. and J.A. Yost. 1983. "The Ethnomedicine of the Waorani of Amazonian Ecuador", Journal of Ethnopharmacology 9:(2-3), pp. 273-298.

DeBonis, J.N. 1986. "Harvesting tropical forests in Ecuador", Journal of Forestry, April, pp 43-46.

Department of State. 1982. Proceedings of the U.S. Strategy Conference on Biological Diversity. Nov. 6-18, 1981. Washington, D.C. 126 p.

DIGEMA/PRMC. 1988a. Plan de acción para el manejo de los ecosistemas de manglar, como parte de los recursos costeros ecuatorianos. Min. de Energia y Minas, Quito, Ecuador.

DIGEMA/PRMC. 1988b. Grupo trabajo manglares. Programa de manejo de los ecosistemas de manglar en el Ecuador. Min. de Energia y Minas, Quito, Ecuador.

DIGEMA. 1986. Anàlisis proyecto manejo recursos costeros. Min. de Energia y Minas, Quito, Ecuador.

DINAF. 1988a. Plan de acción forestal para el Ecuador: Resumen Ejecutivo. Direccion National Forestal, Ministeria de Agricultura y Ganaderia, Quito, Ecuador.

DINAF. 1988b. Plan de acción forestal para el Ecuador: Diagnostico del Sector Forestal. Direccion National Forestal, Ministeria de Agricultura y Ganaderia, Quito, Ecuador.

Dituris 1983. Plan maestro del desarrollo turistico del Ecuador 1983-1987. Quito, Ecuador.

Dodson, Calaway M. y Alwyn H. Gentry. 1978. "Flora of the Rio Palenque Science Center, Los Rios Province, Ecuador". Selbyana: The Journal of the Marie Selby Botanical Gardens, 4:(1-6) 628 p. Sarasota, Florida.

Dodson, Calaway M., Alwyn H. Gentry and F. M. Valverde. 1986. "Flora of Jauneche". Selbyana, The Journal of the Marie Selby Botanical Gardens, 8: 1-512, Sarasota, FL.

Dodson, Calaway H.; Gentry, Alwyn H.; y Sarmiento, Fausto. (in prep). Biological extinction in western Ecuador. 43 p.

Encalada Reyes, M. A. 1983. Medio ambiente y desarrollo en el Ecuador. Fundación Natura, Salvat Editores Ecuatoriana, S.A. Quito. 125p.

FAO. 1988. Potencialidades del desarrollo agricola y rural, anexo IV, recursos naturales y medio ambiente. FAO, Rome. 111p.

FAO. 1986. Compendium outlining multilateral and bilateral grant and loan assistance to the forestry sector in developing

countries. From the TFAP 3rd meeting of the Forestry Advisors Group, held 18 April 86 in Rome, Italy. pp. 52-54.

FONAPRE. 1984. Memoria. 89p.

Fundación Natura. 1988. Actualización del diagnóstico del medio ambiente en el Ecuador. Fundación Ecuatoriana para la Conservación de la Naturaleza, Quito, Ecuador. (Versión Preliminar: Septiembre 1988). sin pag.

Fundación Natura. 1987. Estudio para el establecimiento de una fundación para la conservación de los recursos bióticos de la Amazonia: Diagnóstico. Quito, Ecuador. 511p.

Fundacion Natura. 1981. Diagnóstico del medio ambiente en el Ecuador. Quito, Ecuador.

Fundación Natura. 1981a. Diagnóstico de la situación del medio ambiente en el Ecuador, Tomo I. Quito, Ecuador.

Fundación Natura. 1981b. Diagnóstico de la situación del medio ambiente en el Ecuador, Tomo II. Quito, Ecuador.

Fundación Natura and FONAPRE. 1988. Development Policy Issues for Ecuador's Amazonia (Ecuador: Amazonian Policy). 110 p. (plus appendices and maps), Quito Ecuador.

Gentry, Alwyn H. 1988b. Species richness and floristic composition of the Choco region plant communities. Caldasia 15:71-79. Academia de Ciencias Fiscicas, Exactas, y Naturales. Bogotá, Colombia.

Gentry, Alwyn H. and Calaway H. Dodson. 1987a. Contribution of non-trees to species richness of tropical rain forest. Biotropica 19: 149-156.

Gentry, Alwyn H. and Calaway H. Dodson. 1987b. Diversity and biogeography of neotropical vascular epiphytes. Ann. Missouri Botanical Garden. 74:205-233.

Gentry, Alwyn H. 1986. Endemism in tropical versus temperate plant communities. in M. E. Soule, (ed.) Conservation biology. Sinauer Associates; Sunderland, Massachusetts. pp. 153-181.

Gentry, Alwyn H. 1982a. Patterns of Neotropical plant species diversity. Evolutionary biology 15:1-84.

Gentry, Alwyn H. 1982b. Phytogeographic patterns in northwest South America and southern Central America as evidence for a Choco Refugium. In G. Prance, (ed.) Biological

diversification in the tropics. Columbia Univ. Press pp. 112-136.

Gentry, Alwyn H. 1982c. Neotropical floristic diversity: phytogeographical connections between Central and South America, Pleistocene climatic fluctuations, or an accident of the Andean orogeny. Ann. Missouri Botanical Garden. 69:556-593.

Gentry, Alwyn H. 1979. Extinction and conservation of plant species in tropical America: a phytogeographical perspective. in: I. Hedberg ed. Systematic botany, plant utilization, and biosphere conservation. Almquist & Wiksell, Stockholm. pp. 100-126.

Government of Peru-OAS-UNEP. 1987. Minimum conflict: guidelines for planning the use of American humid tropic environments. OAS, Executive Secretariat for Economic and Social Affairs, Department of Regional Development, Washington, DC. 198 p.

Gow, David, Kate Clark, John Earhart, Marti Fujita, Jan Laarman, and Greg Miller. 1987. Peru: an assessment of biological diversity. A Report to USAID by Development Alternatives, Inc., Washington, D.C. 61 p.

Gregersen, Hans M. 1979. Economic analysis of forestry projects. FAO Paper 17. Rome.

Gregersen, Hans M., and A. Contreras. 1975. U.S. investment in the forest-based sector in Latin America: problems and potentials. Johns Hopkins University Press, Baltimore.

Gregersen, Hans M., S. Draper, and D. Elz, eds. (in prep.) People and trees: the role of social forestry in sustainable development. World Bank Economic Development Institute, Washington, D.C.

Handelman, H. 1980. Ecuadorian Agrarian Reform: The Politics of Limited Change. American Universities Field Staff. Hanover, New Hampshire.

Harling, G. 1987. (Ecuadorian flora estimate)

Hassaurek, F. 1967. Four years among the Ecuadorians (1861-1866). in C. H. Gardiner. (ed.) Southern Illinois Univ., Carbondale & Edwardsville, Illinois.

Hazlewood, P. 1988. Expanding the role of non-governmental organizations in national forestry programs. The report of three regional workshops in Africa, Asia and Latin America. The World Resources Institute and the Environmental Liaison Center. WRI, Washington, D.C. 44 p.

Hecht, S. B. and Susan Schwartzman. 1988. The good, the bad, and the ugly: extraction, colonist agriculture and livestock in comparative economic perspective. Environmental Defense Fund, Washington, D.C. 20 p.

Holdridge, Leslie R. 1967. Life zone ecology. Tropical Science Center, San José, Costa Rica.

IBRD. 1985. World debt tables: external debt of developing countries, 1984-85 edition. The World Bank, Washington DC, 303 p (ISBN O-8213-0507-7).

IDEA. 1988a. Politicas de manejo de suelos y aguas en tierras agricolas de la cuenca del rio Pastaza, conclusiones y recomendaciones del seminario y estudio técnico. Documento técnico 7. Instituto para el Desarrollo de Estrategias Agropecuarias, Quito, Ecuador. 154 p. (plus appendices)

IDEA. 1988b. Riesgos naturales en la cuenca hidrográfica del rio Napo. Documento técnico No. 10. Instituto para el Desarrollo de Estrategias Agropecuarias, Quito, Ecuador. 127 p. (plus appendices)

IDEA. 1987. Estudio de riesgos naturales de las cuencas hidrográficas de los rios Aguarico y Quijos. Documento técnico No. 5. Instituto para el Desarrollo de Estrategias Agropecuarias, Quito, Ecuador. 102 p. (plus appendices)

INCRAE. 1987. Prediagnostico de la Region Amazonica Ecuatoriana. Instituto Nacional de Colonización de la Region Amazonica Ecuatoriana, Quito, Ecuador.

IUCN. 1988. Ecuador (with emphasis on Western Ecuador): Conservation of Biological Diversity and Forest Ecosystems. A brief document prepared by IUCN Tropical Forest Porgramme, Doc. No:103IJ. International Union for the Conservation of Nature, Cambridge, U.K. 10p.

IUCN-UNEP-WWF. 1980. World conservation strategy: living resource conservation for sustainable development. International Union for the Conservation of Nature, Gland, Switzerland. 72 p.

Klima, Edward. 1986. Estudio sobre la industria de pesca de camarones en el Ecuador y sugerencias para su administración e investigaciones.

Kress, N. J. 1986. The systematic distribution of vascular epiphytes: an update. Selbyana 9:2-22.

Laarman, Jan. 1987. Nature-oriented tourism in Costa Rica and Ecuador: diagnosis of research needs and project opportunities. Forestry Private Enterprise Initiative Working Paper No. 6. Research Triangle Park, North Carolina. 18 p.

Laarman, Jan, y Luis Maldonado. 1988. Turismo en áreas silvestres: oportunidades y problemas. Iniciativa Forestal para el Desarrollo (INFORDE), Quito, Ecuador. 16 p.

Landázuri, Helena, y Carolina Jijón. 1988. El medio ambiente en el Ecuador. Instituto Latinoamericano de Investigaciones Sociales (ILDIS). Quito, Ecuador. 226 p.

Lucio-Paredes, P. 1988. "El Plan de Emergencia". Perspectiva Economica, No. 34: Agosto 1988. CETERIS, Quito, Ecuador. 31 p.

Lugo, Ariel E.; John J. Ewel, Susanna B. Hecht, Peter G. Murphy, Cristina Padoch, Marianne C. Schmink, and Donald Stone, (eds.) 1987. People and the tropical forest: a research report from the US Man and the Biosphere Program. US Department of State, Washington, DC. US GPO NTIS PB 87-115580. 75 p.

MacArthur, R. and E.O. Wilson. 1967. The theory of island biogeography. Princeton Univ. Press, Princeton, NJ.

Macdonald J.W. Theodore. 1981. Indigenous Response to an Expanding Frontier: Jungle Quichuan Economic Conversion to Cattle Ranching. pp. 356-383.

MacKinnon, John; Kathy MacKinnon, Graham Child, and Jim Thorsell, (compilers) 1986. Managing protected areas in the tropics. Based on the workshops on Managing protected areas in the tropics, World Congress on National Parks, Bali, Indonesia, October, 1982. IUCN, Gland, Switzerland. 295 p.

MAG (INERHI-DINAF-IERAC). 1988. Informe técnico previo a la declaratoria de la Reserva Forestal de Asentamiento Comunal Awá. Junio 1988. Ministerio de Agricultura y Ganaderia, Quito, Ecuador.

MAG-CRM 1980. Diagnóstico regional de Manabí. Ministerio de Agricultura y Ganaderia, Quito, Ecuador.

Maldonado, Fausto. 1980. Forest and soil conservation in Ecuador. A report prepared for USAID/Quito, Ecuador. 107 p.

Man Ging, Felix, y Roger Macías. (1988 - en imprenta) Aves de la Presa de Daule-Peripa. en Estudio limnológico del Embalse

Daule-Peripa. Facultad de Ciencias Naturales (eds.). Universidad de Guayaquil, Guayaquil, Ecuador.

Matuszeski, W., E. Pérez, S. Olsen, L. Arreaga. 1988. Structure and objetives of a Coastal Resources Management Program for Ecuador. AID/DIGEMA/PRMG project paper. Quito, Ecuador.

McGaughey, S. E. and Hans M. Gregersen. 1988. Investment policies and financing mechanisms available for sustainable forestry development. Interamerican Development Bank. Washington, D.C. 126 p.

McPadden, Charles. 1986. Pesca de red Ecuatoriana del camarón 1974-1985.

Miller, Gregory A. 1988. "Ecuador trip report and recommendations", 28 February - 13 March 1988 (AID/LAC, Washington DC) 11 p.

Myers, Norman. 1986. Mass extinction of species: a great creative challenge. Albright Lecture in Conservation, Berkeley, California.

Myers, Norman. 1987. The Extinction Spasm Impending: Synergisms at Work. Conservation biology 1:14-21.

Mussack, M. 1988. Diagnóstico socio-económico de los sistemas agroforestales de cacao, café y arboles de sombra utilizados en la producción de madera en la costa de Ecuador. North Carolina State University, Raleigh, North Carolina. 98 p.

Nations, James 1988. Road Construction and Oil Production in Ecuador's Yasuni National Park. Miami, Florida. unpublished MS

Neill, David. 1988. Oil wells, indians and rainforests of the upper Amazon. Missouri Botanical Garden Bulletin. 76:5-7.

Office of Technology Assessment. 1986. Staff paper on the role of US development assistance in maintaining biological diversity in developing countries. Prepared by the Food and Renewable Resources Program. US Congress/OTA, Washington, DC. 33 p.

Patzelt, E. 1978. Fauna de Ecuador. Imprenta Ecropin Cia., Ltda., Quito, Ecuador.

Paucar, Angel. 1986. Plan de emergencia para la Reserva Ecológica Manglares de Churute. MAG/DINAF, Quito, Ecuador.

Prescott-Allen, Robert, and Christine Prescott-Allen. 1983. Genes from the wild: using wild genetic resources for food and raw materials. An Earthscan Paperback. International

Institute for Environment and Development, London, U.K. 101 p.

Prescott-Allen, Robert, and Christine Prescott-Allen. 1982. What's wildlife worth? economic contributions of wild plants and animals to developing countries. An Earthscan Paperback. International Institute for Environment and Development, London, U.K. 92 p.

Proyecto de Manejo de Recursos Costeros. 1987. Sintesis de información sobre los recursos costeros. Fundación Pedro Vicente Maldonado, Guayaquil, Ecuador.

Putney, Allen D. 1979. Estrategia preliminar para la conservación de áreas silvestres sobresalientes del Ecuador. Ministerio de Agricultura y Ganaderia, Quito, Ecuador. 47 p.

Rainforest Information Centre. 1987. Description of the Tobar Donoso Project. A report on the Awa Forest Reserve.

Repetto, R. 1988. The forest for the trees? government policies and the misuse of forest resources. World Resources Institute, Washington, D.C. 105 p. (ISBN 0-915825-25-2)

Rose, D. W. 1988. Economic assessment of biodiversity and tropical forests. Report Submitted to USAID Guatemala, International Institute for Environment and Development, Washington, DC, 93 p.

Rudel, Thomas K. 1983. Roads, Speculators, and Colonization in the Ecuadorian Amazon. Human Ecology Vol. II. 4, pp 385-403

Serrano, V. 1987. Economia y ecologia. Corporación de Estudios para el Desarrollo. 196 p.

Salazar, Ernesto 1981. The Federation Shuar and the Colonization Frontier. pp. 589-613

Simberloff, D.S. 1986. Are we on the verge of a mass extinction in tropical rain forests? in: Elliot, D.K. (ed.) Dynamics of extinction. Wiley & Sons, New York. pp 165-180.

Simberloff, D.S. & L.G. Able. 1976. Island biology theory and conservation practice. Science 191:285-286.

Snedaker, Sam; Josh Dickinson, M. Brown, and E. Lahmann. 1986. Ubicación de piscinas camaroneras y alternativas de manejo de ecosistemas de manglares en el Ecuador.

Southgate, D. 1988a. Comentarios sobre los impactos socioeconomicos de la carretera Hollin-Loreto-Coca. Instituto

para el Desarrollo de Strategias Agropecuarias, Quito, Ecuador. 6 p.

Southgate, D. 1988b. Aspectos socioeconomicos de la cuenca del rio Quijos. Instituto para el Desarrollo de Strategias Agropecuarias, Quito, Ecuador. 9p.

Svenson, H. K., 1946. Vegetation of the coast of Ecuador and Peru and its relation to the Galapagos Islands. American Journal of Botany 33:394-498.

Taylor, Anne-Christine. 1981. La riqueza de Dias: los Achuar y las misiones (pp. 115-144), in Norman E. Whitten, Jr. Amazonia Ecuatoriana: la otra cara del progreso. Ed. Mundo Shuar, Quito, Ecuador.

Tapuy, Cristobal. 1986. Interview: Presidente de CONFENAIE. Colibri, Revista de la Fundación Natura, Vol 1:61-64.

Terborg, J. & B. Winter, 1982. Evolutionary circumstances of species with small ranges. In: G. Prance, ed: Biological diversification in the tropics. Columbia Univ. Press. pp. 587-600.

Timm, Robert M., Luis Albuja U., and Barbara L. Clauson. 1986. Ecology, Distribution, Harvest and Conservation of the Amazonian Manatee. Trichechus inunguis in Ecuador. Biotopica 18 (2).

Ugalde, Luis; and Dietmar W. Rose. 1988. A management information system for tropical forestry research. Journal of Forestry. (in press, October 1988 issue).

UNDP. 1988. Cooperación para el desarrollo Ecuador, informe 1987. United Nations Development Program, Quito. 101 p.

University of Rhode Island/Coastal Resources Management Project. 1988. Structure and objectives of a coastal resources management program for Ecuador (draft concept paper - June 1988). 38 p.

Uquillas, Jorge E., 1985. Indian Land Rights and Natural Resource Management in the Ecuadorian Amazon. Theodore Macdonald ed. Native Peoples and Economic Development. Cultural Survival Inc., Cambridge, MA.

USAID/Quito. 1988a. Annex: Mission strategy for the management and preservation of natural resources. (Part of the Mission Action Plan, FY 89 and FY 90) Quito, Ecuador. 13 p.

USAID/Quito. 1988b. Research, Extension, and Education Project Project Paper. AID/LAC. Quito, Ecuador.

USAID/Quito. 1985a. Agricultural Sector Reorientation. AID/LAC/P-252. Quito, Ecuador.

USAID/Quito. 1985b. Land Titling Project Project Paper. AID/LAC/P-274. Quito, Ecuador.

USAID/Quito. 1982a. Amendment to Rural Technology Transfer System Project Paper. AID/LAC/P-055/1. Quito, Ecuador.

USAID/Quito. 1982b. Forestry Sector Development Project Paper. AID/LAC/P-097. Quito, Ecuador.

Valverde, F. M., G. de Tazan, and C. Garcia R. 1979. Cubierta vegetal de la peninsula de Santa Elena. Facultad Ciencias Naturales, Publication 2:1-236.

Valverde, Flor Maria. 1986. Manglares del Golfo de Guayaquil.

Vickers, William 1981. _____ as Adaptation Traditional Belief and Modern Intervention in Siona-Secoya Religion. pp. 705-727. Norman E. Whitten ed.

Wetterberg, Gary. 1982. "Trip report - Ecuador" (January 24-February 19, 1982). Report presented to the Chief, International Affairs Branch, National Park Service, US Department of the Interior. Washington, DC. 105 p.

Whitten, Norman E. Jr., ed. 1981. Cultural Transformations and Ethnicity in Modern Ecuador. University of Illinois Press, Urbana, Illinois.

Wiggins, I. L. & D. M. Porter. 1971. Flora of the Galapagos Islands. Stanford University Press, Stanford, CA.

Wilson, M. 1987. Nature-oriented tourism in Ecuador: assessment of industry structure and development needs. Raleigh, North Carolina. 37 p.

World Bank. 1988. "Ecuador: country economic memorandum". Preliminary report. Washington DC.

World Bank. 1974. Environmental health, and human ecologic considerations in economic development projects. Washington, D.C. 142 p.

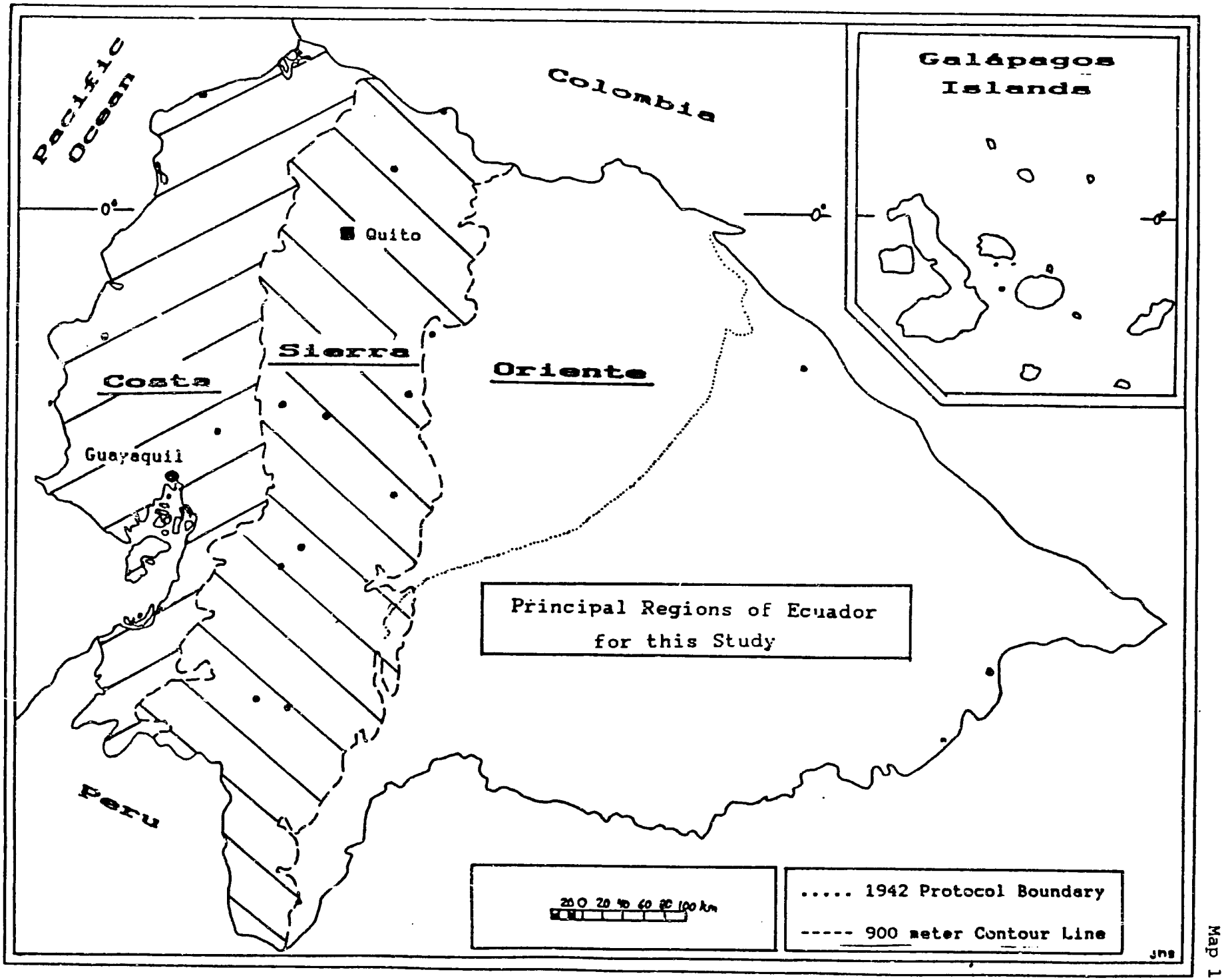
World Wildlife Fund. 1987. Ecuador program. Internal planning document. Washington, DC. 35 p.

WRI-IIED-UNDP. 1988. World Resources 1988-89. An assessment of

the resource base that supports the global economy. Basic Books Inc., NY. 372 p. (ISBN 0-465-09240-3)

Yost, James A. 1981. Twenty Years of Contact: The Mechanisms of Change in Wao ("Aura"). Culture pp. 677-704.

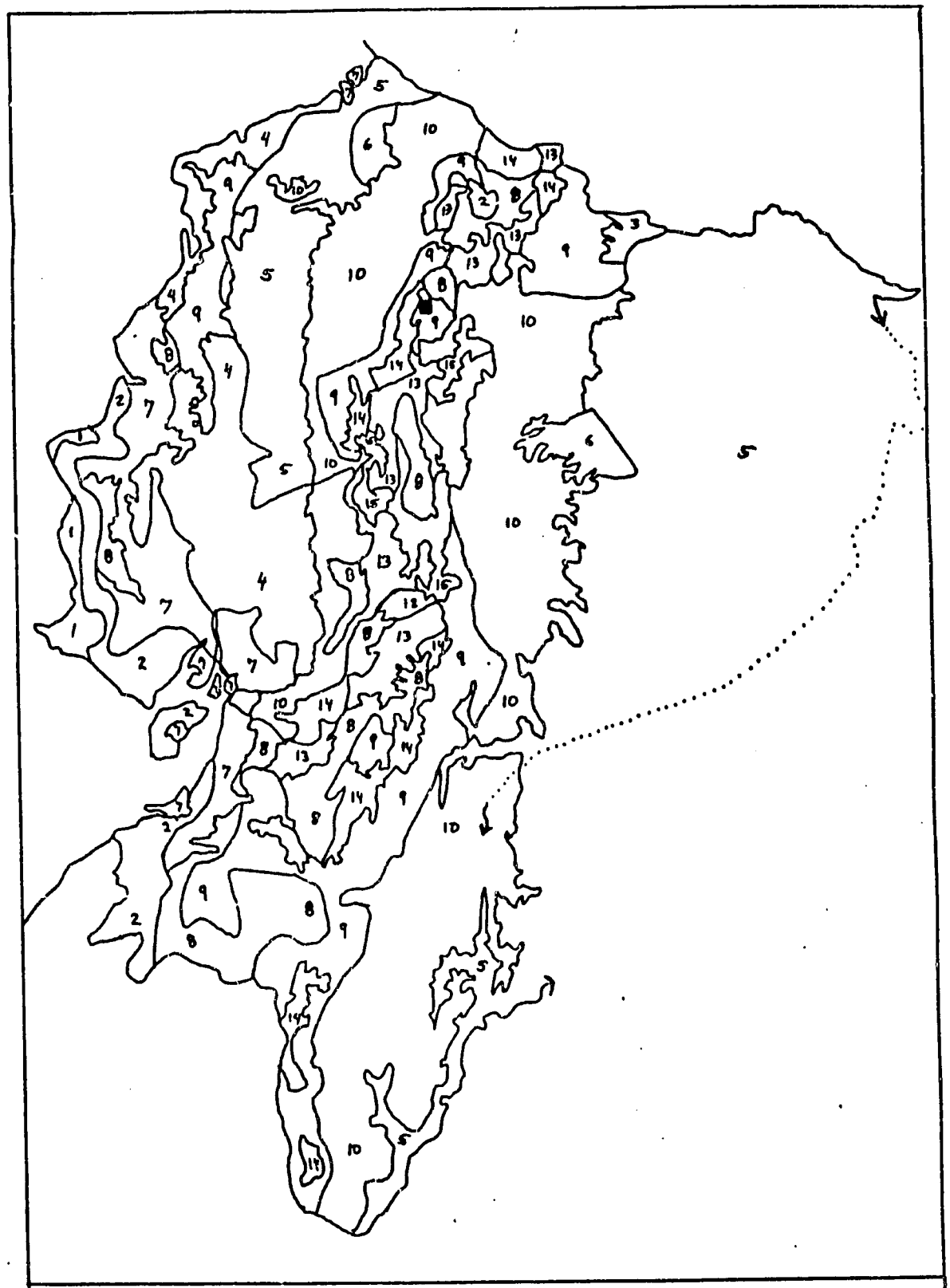
Zapata, B. and M. Fierro. 1988. "Diagnóstico del sector pesquero y camaronero", serie informes numero 1: mayo 1988. Proyecto de manejo de recursos costeros, DIGEMA-URI-USAID, Fundación Pedro Vicente Maldonaldo, Guayaquil Ecuador. pp. 35-81.



Map 1

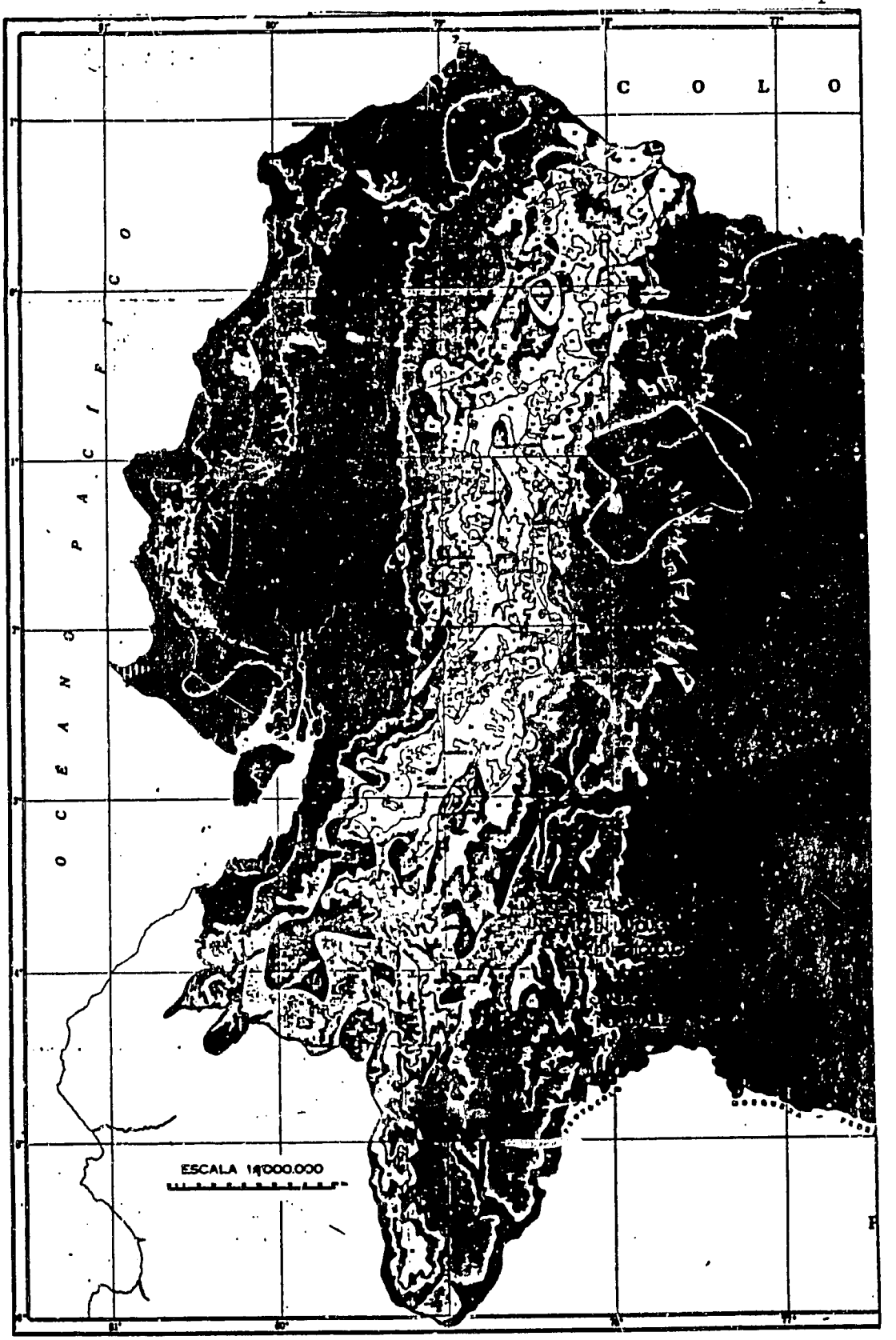
ECUADOR

Map 2



Generalized Distribution of the Life Zones of Ecuador

Map 3



Distribution of the Life Zones of Ecuador

MINISTERIO DE AGRICULTURA Y GANADERIA
PROGRAMA NACIONAL DE
REGIONALIZACIÓN AGRARIA
PRONAREG - ECUADOR
(1978)

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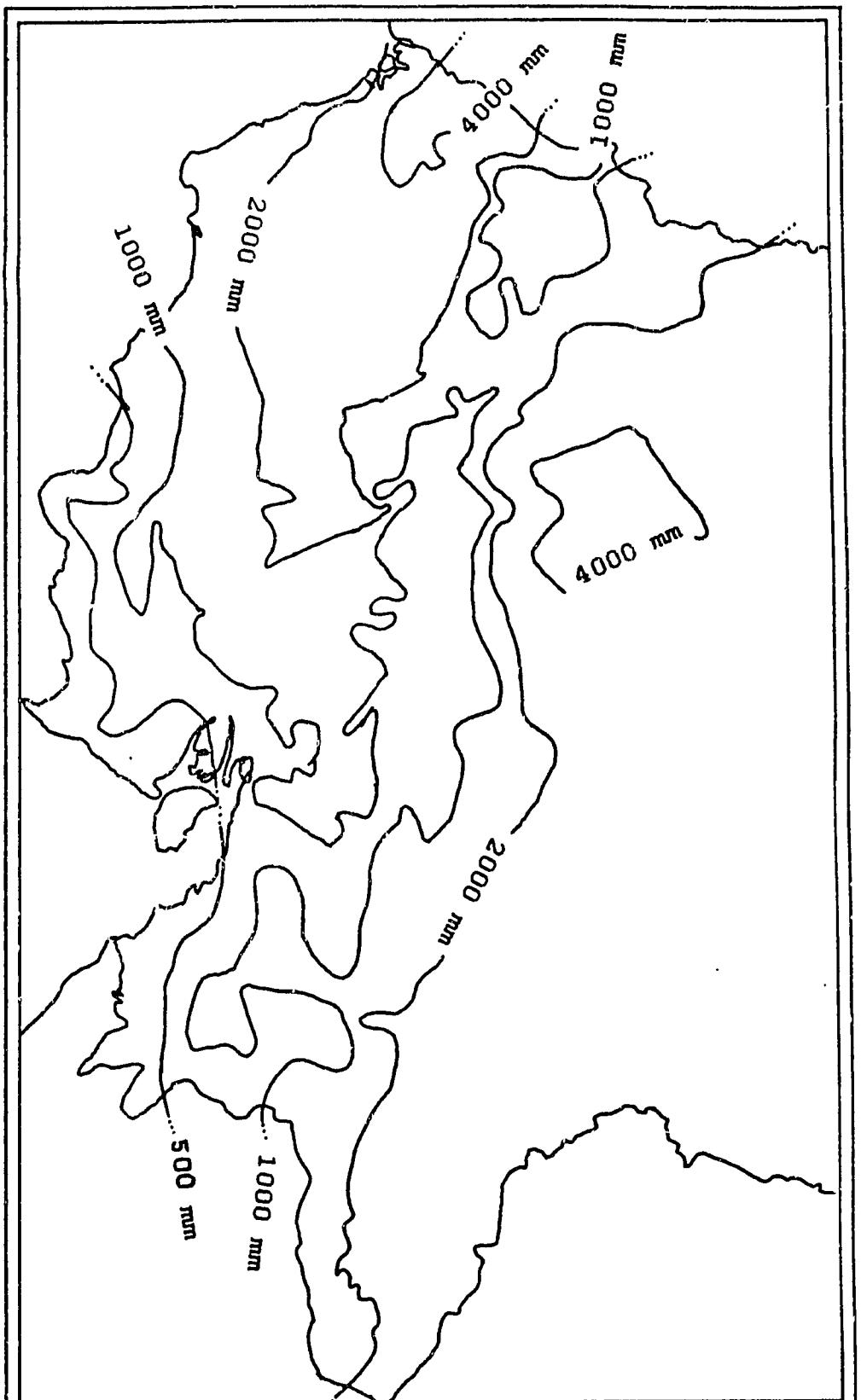
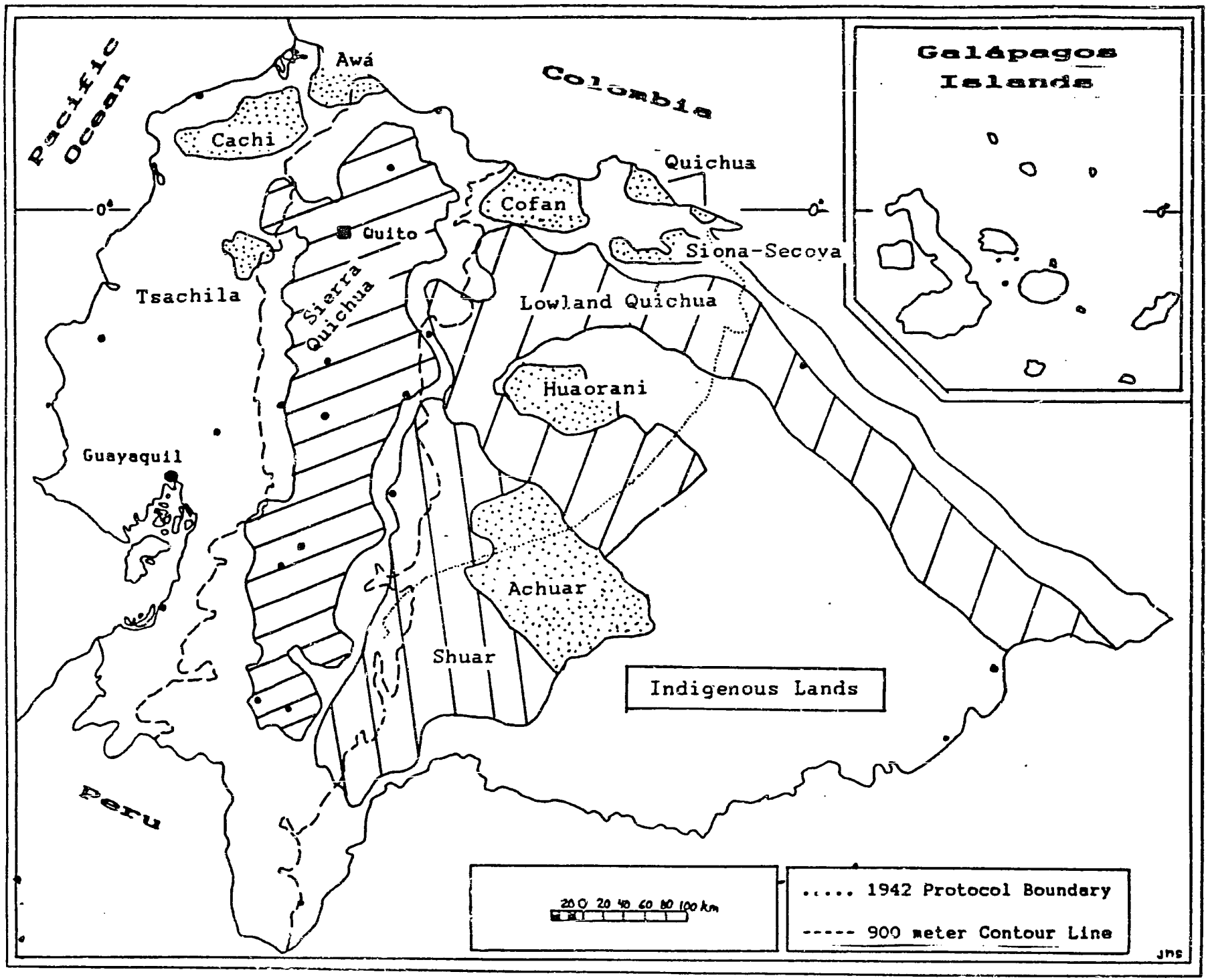
Map 4

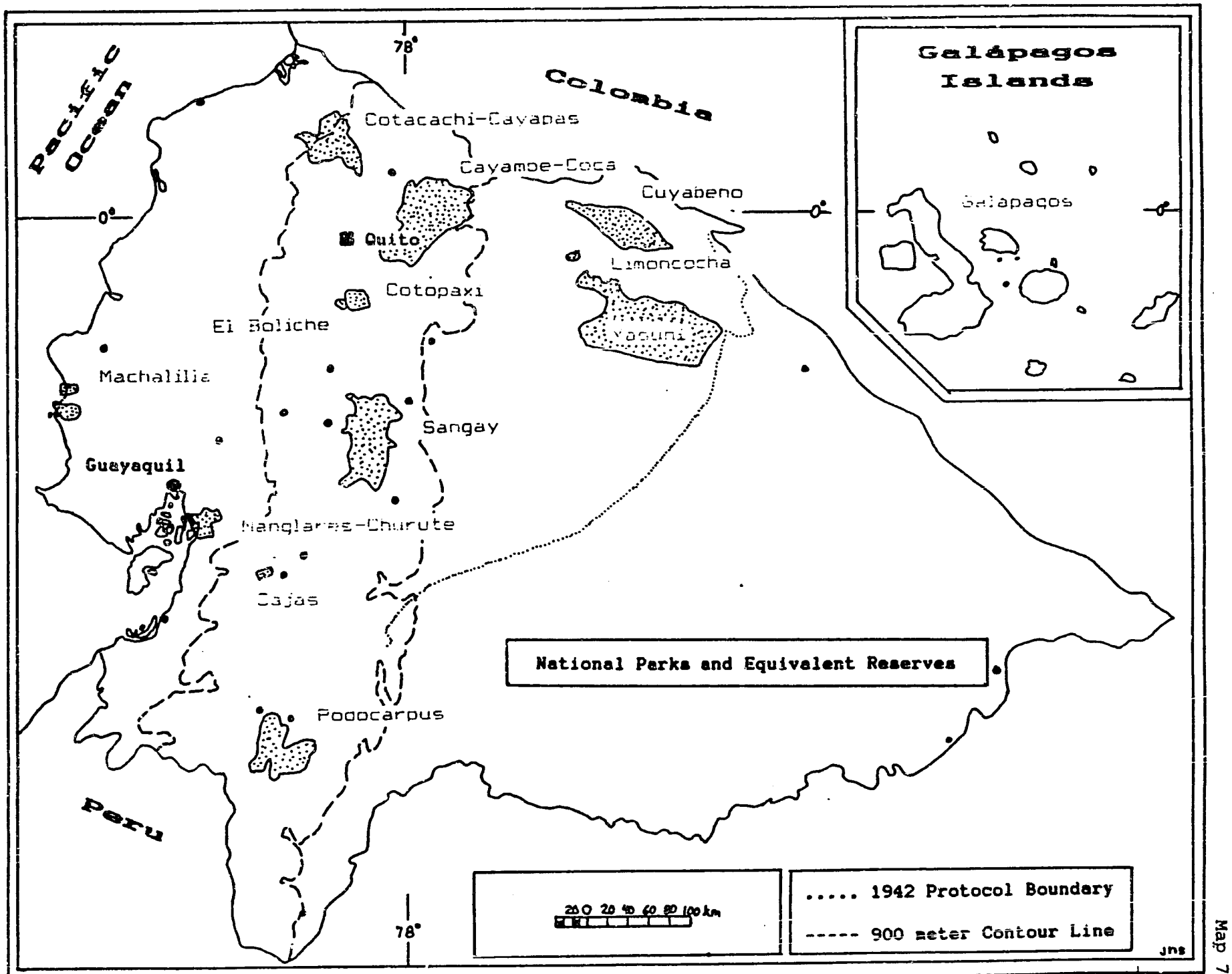


Rainfall Isolines



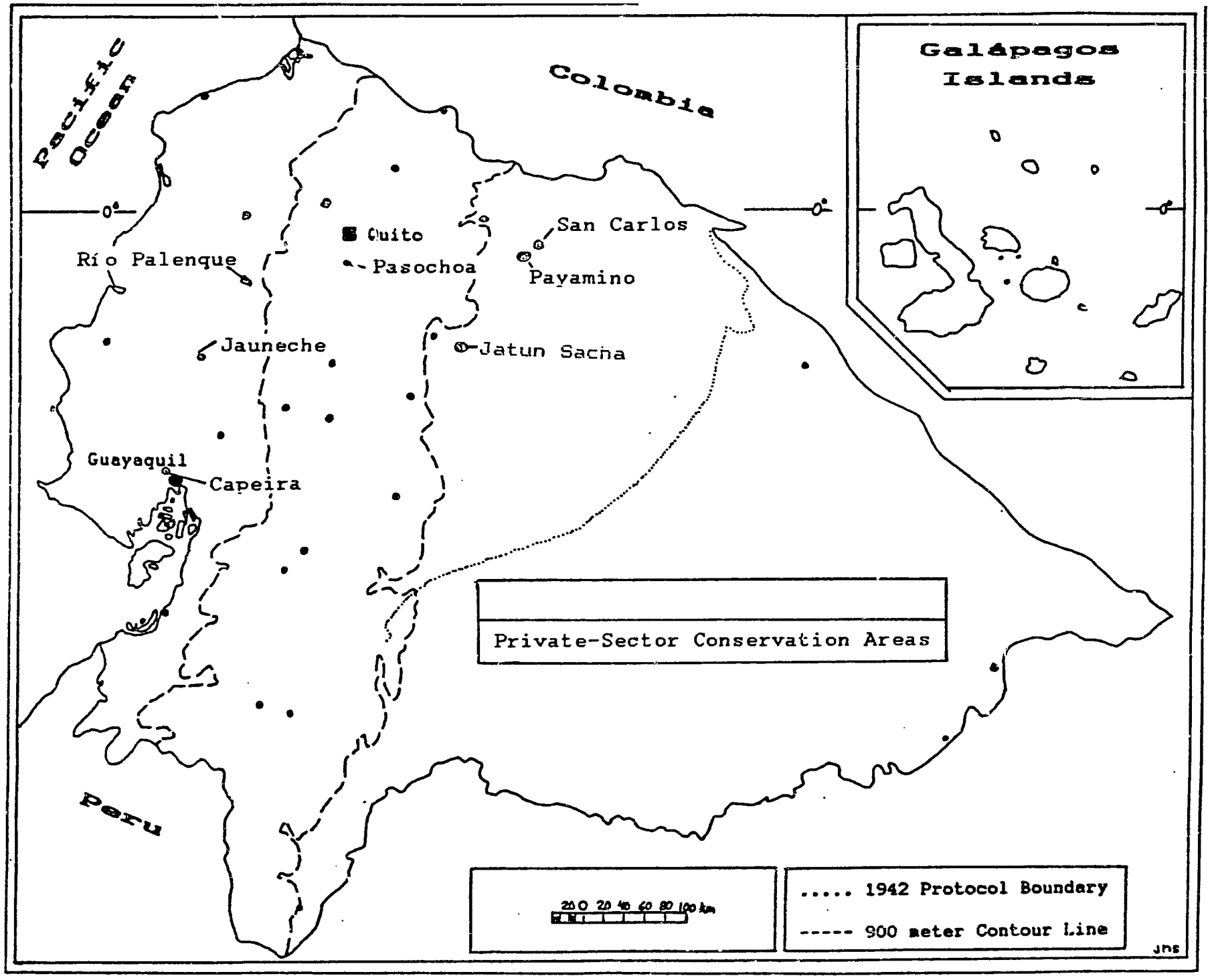
Map 5

ECUADOR



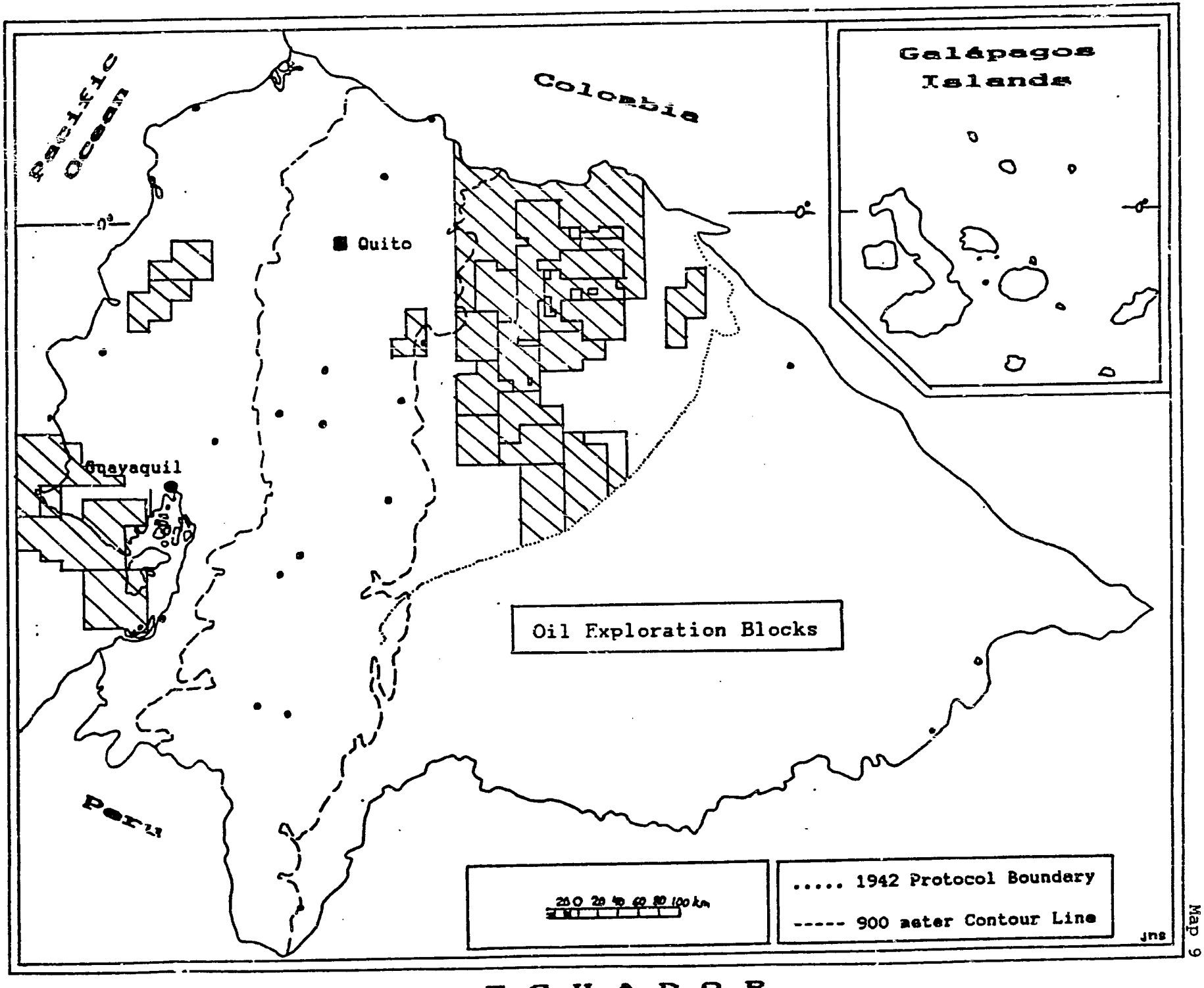
Map 7

E C U A D O R



ECUADOR

Map 8



Map 9

ECUADOR

PN-ABX-251

Ecuador : Appendices

AN ASSESSMENT OF BIOLOGICAL DIVERSITY AND TROPICAL FORESTS FOR ECUADOR

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Appendix 1.1: Team Members and Persons Interviewed

IIED Team Members

Bruce Cabarle	WRI/CIDE/Team leader
Muriel Crespi	US National Park Service
Calaway Dodson	Missouri Botanical Garden
Carlos Luzuriaga	Independent Consultant
Dietmar Rose	U. Minnesota
John Shores	The Nature Conservancy/Latin America Division

Ad Honorem Team Members

Howard Clark	AID/LAC/REMS
Nora Berwick	AID/S&T/FENR
Maria Magdalena del Pozo	MEM/DIGEMA
Kate Clark	Independent Consultant/Editor

Interviews

Alberto Andrade	Aeromapa, Ltda.
Richard Peters	USAID/Quito/Agric and Natural Resources
Fernando Ortiz	USAID/Quito/Agric and Natural Resources
Jane Stanley	USAID/Quito/Contracts Officer
Henry Alderfer	USAID/Quito/Food for Peace
Robert Mowbry	USAID/Quito/Forestry Development Officer
Fausto Maldonado	USAID/Quito/Program Specialist
Patricio Maldonado	USAID/Quito/PVO Officer
Molly Kux	AID/S&T/FENR
M. Lou Higgins	AID/S&T/FENR
Dan Deely	AID/S&T/FENR
Marti Fujita	AID/S&T/FENR
Jorge Barba	AIMA
Maria Del Carmen Molestina	Banco Central/Museo
Sonia Acosta	CEPE
Fabian Sandoval	CEPE
Roberto Sanchez	CLIRSEN
Luis Makas	CONAIE
Rodrigo de la Cruz	CONAIE
Doug McMeekin	CONOCO/Environmental Advisor
Mecias Catucuamba	Cooperativa Atahualpa, Pesillo
Nancy Hilgert de Benavides	Corp. Ornitológica del Ecuador
Ted MacDonald	Cultural Survival
David Gow	Development Alternatives, Inc.
Galo Tobar	DINAF
Edgard Vasguez	DINAF
Sergio Figueroa	DINAF/DANRS
Flavio Coello	DINAF/DANRS
Gustavo Hinojoso	DINAF/DANRS

Alba Salvatierra M.	DINAF/Patrimonio Forestal
José V. Vallejos	DINAF/Patrimonio Forestal
Guy Chapond	FAO/Quito
Jeff Tschirley	FAO/Rome
Angel Alvarado	FOIN/Botany Trainee
Verna Pauchi	FOIN/Zoology Trainee
Raymond Offenhiser	Ford Foundation/Lima
Jorge Uquillas	Fund. Desarrollo Agropecuario
Rodrigo Ostaneda	Fundación Maquipucuna
Ivan Cornejo	Fundación Maquipucuna
Yolanda Kakabadse	Fundación Natura/Quito
Lilian Benitez	Fundación Natura/Quito
Gonzalo Oviedo	Fundación Natura/Quito
Kari Keppi	IDB
Steve Magaughy	IDB
Afranio Basso	IDB/Electrificatin Specialist
Jorge Soria Vasco	IDEA
Jorge Armendariz	IERAC/Amazonia
Nels Johnson	CIDE/WRI
Peter Bayley	Illinois Natural History Survey
Peter Arnold	Independent Consultant
Jessice Ehlers	Independent Consultant
Enrique Laso	INFORDE
Vincente Molinos	INFORDE
Amèrica Celez	MAG/Organizaciones Agrícolas
Natalia Arellana	MAG/Organizaciones Agrícolas
Luis Cañadas	MAG/Unidad de Anàlisis de Politicas
David Neill	Missouri Botanical Garden
Fernando Hurtado	Missouri Botanical Garden
Patricio Mena	Missouri Botanical Garden
Brian Riley	Peace Corps/Ecuador
Julie Schwantes	Peace Corps/Ecuador
Michael Junio	Peace Corps/Ecuador
Chuck Crimmins	Peace Corps/Ecuador
Tom Larson	Peace Corps/Ecuador
Francisco Garcès	Peace Corps/Associate Director
M.B. & Bobby Borman	Residents
Greg Miller	The Nature Conservancy
Bernardo Leòn	Tierra Viva-Quito
Fernando Hidalgo	Tierra Viva-Quito
Ana Maria Varea	Tierra Viva-Quito
Vicente Pòlit	Tierra Viva-Quito
Peggy Stern	UC-Davis/Researcher
Dan Tunstal	CIDE/WRI
Arvelio Garcia	Unesco/Education
Jaime Jaramillo	Univ. Catòlica/Botany
Mark Schaeffer	US Fish and Wildlife Service
Carlos Villareal	UTEPA
Stuart Strahl	Wildlife Conservation International/NYZS
Jim Hicks	World Bank
Liz Boo	World Wildlife Fund - US

Appendix 1.2: Acronyms and Abbreviations

AECONA	Asociación Ecuatoriana de Defensa de la Naturaleza
AID	Agency for International Development
AID/W	AID/Washington
AIEN	Asociación Indígena Evangélica del Napo
AIEPRA	Asociación Indígena Evangélica de Pastaza Region Amazónica
AIMA	Asociación de Industriales Madereros
AIPSE	Asociación Independiente del Pueblo Shuar del Ecuador
ANR	Agriculture and Natural Resources
BID	Banco Interamericano de Desarrollo (IDB)
BR	Biosphere Reserve
BRUNARI	Bolivar Runacunap Riccharimui
BM	Banco Mundial (World Bank - IBRD)
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CCA	Coordinadora Campesina de Azuay
CCRP	Centro Científico Río Palenque
CDC	Conservation Data Center (Centro de Datos para la Conservación)
CDSS	Country Development Strategy Statement
CEDEGE	Comisión de Estudios para el Desarrollo de la Cuenca del Río Guayas
CEDIG	Centro Ecuatoriana de Investigación Geográfica
CEPE	Corporación Estatal Petrolera Ecuatoriana
CENDES	Centro de Desarrollo Industrial de Ecuador
CEPAL	Comisión Económica para América Latina
CEPAR	Centro de Estudios de Población y Paternidad Responable
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
CLIRSEN	Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos
COE	Corporación Ornitológica del Ecuador
CONACYT	Consejo Nacional de Ciencia y Tecnología
CONADE	Consejo Nacional de Desarrollo
CONAIE	Confederación de Nacionalidades Indígenas del Ecuador
CONFENIAE	Confederación de Nacionalidades Indígenas de la Amazonía Ecuatoriana
CONOCO	Continental Oil Company
CR	Chimborazo Riccharimui
CS	Cultural Survival
DANRS	Departamento de Areas Naturales y Recursos Silvestres
DGP	Dirección General de Pesca
DIGEMA	Dirección General del Medio Ambiente
DINAF	Dirección Nacional Forestal
DITURIS	Dirección Nacional de Turismo
DRI	Desarrollo Rural Integrado

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ECUARUNARI	Ecuador Runacunap Riccharimui (Regional Confederation for the Sierra)
ESPOL	Escuela Superior Politécnica del Litoral
FA	Federación Awa
FAO	Food and Agriculture Organization of the UN
FC	Federación Chachi
FCN	Facultad de Ciencias Naturales/Guayaquil
FCUNAE	Federación Comunas Unión de Nativos de la Amazonia Ecuatoriana
FEINE	Federación de Indígenas Evangélicas del Ecuador
FOCIN	Federation of Indian Organizations of Napo
FICI	Federación Indígena y Campesina de Imbabura
FIIS	Federación Interprovincial de Indígenas Saraguros
FFF	Fundación Fauna y Flora
FJS	Fundación Jatun Sacha
FM	Fundación Maquipucuna
FN	Fundación Natura (Ecuador)
FOIN	Federación Organización de Indígenas del Napo
FONAPRE	Fondo Nacional de Preinversión
FUNDAGRO	Fundación para el Desarrollo Agropecuario
FY	Fundación Yachanahuari
GIS	Geographic Information System
GT	Gobernación Tsachila
IBRD	International Bank for Reconstruction and Development (World Bank)
IDB	Interamerican Development Bank (BID)
IDEA	Instituto para el Desarrollo de Estrategias Agropecuarias
IERAC	Instituto Ecuatoriano de Reforma Agraria y Colonización
IGM	Instituto Geográfico Militar
IIED/NA	International Institute for Environment and Development/North America
ILPES	Instituto Latinoamericano de Planificación Económica y Social
INAMHI	Instituto Nacional de Hidrología y Meteorología
INCRAE	Instituto de Colonización .. Región Amazónica Ecuatoriana
INE	Instituto Nacional de Electrificación
INEC	Instituto Nacional de Estadísticas y Censos
INECEL	Instituto Ecuatoriano de Electricidad
INEMIN	Instituto Nacional de Minas
INERHI	Instituto Ecuatoriano de Recursos Hidráulicos
INFORDE	Iniciativa Forestal Privada para el Desarrollo[AID/FPEI]
INIAP	Instituto Nacional de Investigación Agropecuaria
INP	Instituto Nacional de Pesca
IUCN	International Union for Conservation Nature and Natural Resources

JCA	Federación Jatum Comuna Aguarico
MAB	Man and the Biosphere (Unesco program)
MAG	Ministerio de Agricultura y Ganaderia
MBG	Missouri Botanical Garden
MECN	Museo Ecuatoriano de Ciencias Naturales
MEM	Ministerio de Energia y Minas
MIC	Movimiento Indigena de Cotopaxi
MICH	Movimiento Indigena de Chimborazo
MICIP	Ministerio de Industria, Comercio, Integración y Pesca
MIT	Movimiento Indigena de Tunguragua
NC	Nacionalidad Cofán
NH	Nacionalidad Huaorani
NPS	National Park Service (US)
NS	Nacionalidad Siona
OISE	Organización Indigena Secoya del Ecuador
OPIP	Organización de Pueblos Indigenas de Pastaza
ONU	Organización de las Naciones Unidas
ORSTOM	Institut Francais de Recherche Scientifique pour le Dévelopment en Cooperation
PC	Peace Corps (Cuerpo de Paz)
PID	Project Identification Document
PP	Project Paper
PR	Pichincha Ricccharimui
PREDESOR	Programa .. Desarrollo Oriente ??
PREDESUR	Programa de Desarrollo del Sur del Ecuador
PROFOGAN	Programa de Fomento Ganadero
PRONACOS	Programa Nacional de Conservación de Suelos
PRONAF	Programa Nacional Forestal (now DINAF)
PRONAREG	Programa Nacional de Regionalización Agraria
RPSC	Rio Palenque Science Center
RAE	Región Amazónica Ecuatoriana
SEDRI	Secretaria de Desarrollo Rural Integrado
SHUAR	Federación de Centros Shuar
SODENA	Sociedad de Defensa de la Naturaleza
SOPROMA	Sociedad Protectora del Medio Ambiente
TNC	The Nature Conservancy
TV-Cuenca	Tierra Viva Grupo Ecológico-Cuenca
TV-Quito	Tierra Viva Grupo Ecológico-Quito
UCIC	Unión Comunas Indigenas de Calderon
UNAE	Unión Nativa de la Amazonia Ecuatoriana
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
Unesco	United Nations Education Science and Culture Organization
UNINCA	Unión de Indigenas y Campesinos del Azuay

UOCE	Unión de Organizaciones Campesinas de Esmeraldas
UPCCC	Unión Provincial de Cooperativas y Comunas del Cañar
USAID/Quito	US Agency for International Development/Quito Mission
UTEPA	Unidad Técnica Ecuatoriana del Plan de Ordenamiento y Desarrollo de la Reserva Etnica y Forestal Awá
WB	World Bank
WHC	World Heritage Convention
WHS	World Heritage Site
WRI	World Resources Institute
WWF	World Wildlife Fund

Appendix 1.3: Definitions related to the Conservation of Biological Diversity

Biological diversity, both genetic and ecological, encompasses all species and ecosystems. It is determined by the numbers and varieties of species in an ecosystem, their genetic makeup, and the distribution of the various organisms up and down the food chain. (US Strategy on the Conservation of Biological Diversity 1985). Biological diversity encompasses variation at several different levels, from complete ecosystems down to the molecular basis of heredity. (OTA 1986)

Ecological diversity refers to the variation among ecosystems, such as across life zones. (*)

Ex situ (off site) conservation means protecting activities that involve removing the species from its natural location and applying some sort of artificial preservation (botanical gardens, seed banks, sperm banks, etc).

In situ (on site) conservation means protecting the species/community/habitat in its natural location through management and protection activities.

Genetic resources are actually or potentially useful characteristics of plants, animals, or other organisms, that are transmitted genetically. (Prescott-Allen 1983)

Species diversity means the variety of different species.

Genetic diversity means the variety of genes. Genetic diversity is normally used to cover diversity within species, while species diversity is the term for diversity among species. (Prescott-Allen 1983)

Protected areas are those geographical regions of the landscape that receive some significant level of protection in the sense of preserving their biological resources. There are two types of protected areas: de jure -- established in law, and de facto -- existing in fact. A National Park is usually a good example of the de jure protected area. They are also called designated protected areas. An example of a de facto protected area might be a particularly inaccessible mountain range, whether designated or not. (*)

Wildlands are areas where natural capital predominates. They are the areas of the landscape where human intervention is minimal or non-existent, or where the indigenous communities have evolved unobtrusive resource exploitation schemes and the ecosystems have long ago adapted to their presence. (*)

(*) Definitions developed by the authors.

Appendix 2.1:Non-governmental and Indigenous Organizations (NGOs)

Environmental and Development NGOs

Fundación "Charles Darwin" para las Islas Galápagos
Fundación "Instituto de Estrategias Agropecuarias"
Sociedad Ecuatoriana "Francisco Campos" de amigos de la naturaleza
Corporación Ornitológica del Ecuador
Fundación "Maquipucuna"
SODENA - Sociedad de Defensa de la Naturaleza "Pachamamata Camaccuna". Subproyecto Acción Ecológica
CESA - Programa de Conservación de Recursos Naturales de la Central Ecuatoriana de Servicios Agricolas
Fundación "Brethren y Unida"
Grupo Ecológico "Tierra Viva" - Quito
Grupo Ecológico "Tierra Viva" -Cuenca
Fundación "Fauna y Flora" - Guayaquil
Fundación "Pedro Vicente Maldonado" - Guayaquil
Comité Ecológico de la Escuela Politécnica del Litoral
CECAV - Comité Ecológico "Camino Verde"
Grupo "Amigos de la Naturaleza" de Otavalo
Fundación Natura - Comité Ecuatoriano para la Defensa de la Naturaleza
INFORDE - Iniciativa Forestal Privada para el Desarrollo.

2. Indigenous Peoples' Organizations

AIEN - Asociacion Indigena Evangelica del Napo
AIEPRA - Asociacion Indigena Evangelica de Pastaza, Region Amazonica
AIPSE - Asociación Independiente del Pueblo Shuar del Ecuador
CONFENAIE - Confederación de Nacionalidades Indigenas de la Amazonia Ecuatoriana
Federación Shuar.
FEINE - Federacion de Indigenas Evangelicas del Ecuador
FOCIN - Federation of Indian Organizations of Napo
FOIN - Federación Organización de Indigenas del Napo
J.C.A'rico- Federación Jatum Comuna Aguarico
OPIP - Organización de Pueblos Indigenas de Pastaza
UNAE - Union Nativa de la Amazonia Ecuatoriana
CONAIE - Confederación de Nacionalidades Indigenas del Ecuador

Appendix 2.2: Directory of Conservation and Development NGOs in Ecuador concerned with Biodiversity.

FUNDACION CHARLES DARWIN

Address: Av. Colón 535 y 6 de Diciembre (6th floor)
P.O. Box: Casilla 3891-2E, Quito
Tel. 527-912
Contact: Mr. Juan Black, Secretary General

Objective: The conservation of soil, flora, fauna, wildlife, terrestrial and marine environment of Galápagos Islands. FCD manages the Charles Darwin Station, promotes scientific research in Galapagos as well as in other parts of Ecuador and abroad. FCD conducts educational campaigns on the importance of the archipelago and its preservation. FCD produces various scientific publications, and has many documents on related topics.

Funding: FCD receives support from the Government of Ecuador, conservation groups and individuals.

FUNDACION NATURA (The Nature Foundation)

Address: Av. 6 de Diciembre 5043 y El Comercio
P.O. Box: Casilla 253, Quito
Tel. 249-780, 434-449
Contact: Ms. Yolanda Kakabadse, Executive Director

Objective: The protection of nature (particularly from destructive human activity) to guarantee the survival of all kinds of life. FN promotes scientific research, campaigns, seminars and conferences to support conservation of the environment, and works with public and private agencies.

Funding: FN works in Ecuador and abroad. It receives funds from the Government of Ecuador and international agencies.

SOCIEDAD ECUATORIANA FRANCISCO CAMPOS DE AMIGOS DE LA NATURALEZA

Address: Tamayo 516 y Carrión, Quito
Tel. 233-871

Objective: To identify, collect, classify, and research native species of Ecuador. SEFCAN organizes seminars, conferences, expositions and distributes information on the natural sciences and the preservation of endangered species.
SEFCAN works with Museo Ecuatoriano de Ciencias Naturales which is a public institution.

FONDO ECUATORIANA POPULORUM PROGRESSIO (FEPP)

Address: Mallorca 427, P.O. Box: Casilla 5202, Quito
Contact: Mr. Jose Tonello F., Director

Objective: To provide technical and social assistance to rural communities in agriculture and forestry. FEPP has forestry projects promoting the noncommercial use of exotic species for soil protection. FEPP teaches people about forest development, management and conservation.

Funding: FEPP works in different provinces of Ecuador supported through private funding and some international assistance.

FUNDACION BRETHREN Y UNIDA (Brethren and Unity Foundation)

Address: Av. América 2137 y Sosaya, Quito
Tel. 541-303, 541-235
Contact: Dr. Germán Salazar, Executive Director
Mr. Wagner Molina, Deputy Director

Objective: Development for the rural poor. The foundation's main activities are education campaigns and participatory research. It produces audiovisual and teaching materials for popular education. It also maintains records of research on socio-organizational aspects and popular agricultural technologies, successful traditional Andean technologies for preservation of the environment. Maintains a tree nursery with more than 40 native species, and promotes agricultural activities with organic, non-chemical materials. Its methodology includes participatory research, dialogue with rural people, and training through audio-visual booklets.

Funding: financed with its own funds. Formerly received funds from religious organizations in the U.S. and Europe.

FUNDACION MAQUIPUCUNA

Address: Tamayo 516 y Carrión, Quito
Tel. 233-871
Contact: Mr. Iván Cornejo

Objective: To protect wild fauna, flora and endangered species, working together with other organizations through research, improving scientific knowledge and supporting campaigns to preserve specific species.

SOCIEDAD ECUATORIANA DE CIENCIAS DEL SUELO (SECS)

Address: P.O. Box 9012 Quito
Tel. no phone
Contact: Dr. Fausto Maldonado, President (at AID 521-100)
Ing. Patricio Solis, 521-259, 230-817

Objective: To protect the environment, particularly concerning the conservation and research of soil resources. This professional association of soil scientists conducts scientific research on the identification of soil types and land use capability. The society is concerned with preventing erosion and deforestation. One of its strategies is to train experts to promote soil conservation in their different instititutions and activities.

Funding: Funding is provided through members' contributions.

ACCION ECOLOGICA (AE)

Address: Av. 12 de Octubre 344 y Fray Vicente Solano.
P.O. Box: 246-C, Quito
Tel. 231-234
Contact: Ms. Esperanza Martinez, Coordinator

Objective: To find solutions to Ecuador's environmental problems. It manages ecological zones of high risk, by focussing on social problems by promoting the use of alternative or traditional technologies. AE conducts workshops, collects field data, provides advisory services, and works with the poor rural communities.

Funding: AE receives funding from international organizations (Pan para el Mundo, and MISERIOR) and some local government funding for specific projects.

SOCIEDAD DEFENSA NATURALEZA (SODENA)

Address: Pasaje San Luis 104 y Santa Prisca (Edificio Recalde Of. 401) P.O. Box: 246-C, Quito
Tel. 570-443
Contact: Ms. Esperanza Martinez, President

Objective: SODENA promotes preservation of the environment. It conducts educational campaigns about environmental problems in poor sectors bordering protected areas. It works with scientists and is the main sponsor of the Ecological Action Project.

Funding: Membership dues.

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CENTRAL ECUATORIANA DE SERVICOS AGRICOLAS (CESA)

Address: Inglaterra 532, P.O. Box: Casilla 160179-CEQ, Quito
Tel. 524-830
Contact: Ing. Luis Rodriques P., Director

Objective: The conservation of natural resources in poor rural areas through the participation and organization of the local communities. CESA's Natural Resources Preservation Program works with special agricultural techniques and promotes native tree species for soil conservation. It has forest nurseries in many provinces and would like to extend into others.

Funding: International organizations finance specific projects.

CORPORACION ORNITOLOGICA DEL ECUADOR/ CONSEJO ECUATORIANO DE CONSERVACION INVESTIGACION (CECIA)

Address: Shyris y Rusia (Mundo Juvenil)
P.O. Box: 9068 S-7, Quito
Tel. 244-314

Objective: To research, conserve and teach about natural habitats. Its main program is the Conservation of Birds and Habitats National Plan. CECIA's work methodology is a process of problem identifications, site selection, and research development. Its research focusses on genetic resources (biodiversity). CECIA works with children and adults through ornithological workshops, seminars and conferences. It has the best ornithological library open for public use.

Funding: Receives funding from international conservation organizations and from membership dues.

FUNCADION CIENCIA/INSTITUTO PARA EL DESARROLLO DE ESTRATEGIAS AGROPECUARIAS (IDEA)

Address: Bossano 617 y 6 de Diciembre
Tel. 245-344
Contact: Ing. Nèptali Bonifaz, Executive Director
or Dr. Jorge Soria, Deputy Director

Objective: IDEA is a private foundation which promotes scientific research about the most salient problems related to agriculture, farming and forestry. Its priority areas are food production and storage, export products (traditional and non-traditional, the management and conservation of soil and forest resources, tropical agricultural systems, and socio-economic studies of the rural sector.

IDEA conducts seminars with members of the private and public sector to generate recommendations on strategies and policies for the benefit of the private sector. Based on these recommendations, IDEA proposes specific projects.

Funding: IDEA receives funds from PL 480-USAID, and other international agencies, particularly CIDA.

CONFEDERACION DE NACIONALIDADES INDIGENAS DE LA AMAZONIA (CONFENIAE)

Address: Av. 6 de Diciembre 159 y Pazmiño (Edificio Parlamento).
Tel: 543-973
Contact: Ampam Karákras, President

Objective: CONFENIAE is a confederation of Indian nations of the Ecuadorian Amazon region. It promotes the recognition and value of indigenous cultures and territories, and assists in the organization of ethnic groups. CONFENIAE works in projects related to the survival, progress and welfare of its members, especially in maintaining the integrity of their traditional territories.

Funding: Receives some international and national funding.

COMUNIDEC/FUNDACION INTERAMERICANA

Address: La Niña 145 y 6 de Diciembre
Tel. 526-598
Contact: Ms. Colombia Vivas, Director

Objective: COMUNIDEC is an international organization which promotes development for rural communities and provides project grants for community development projects. Many of these activities are to promote the conservation of natural resources.

Funding: Receives funds from the InterAmerican Foundation (U.S. Congressional funds) and other international agencies.

INSITUTO DE INVESTIGACIONES SOCIO ECONOMICAS Y TECHNOLOGICAS (INSOTEC)

Address: Juan Leòn Mera 920 y Wilson (Edificio Wilson)
Tel. 543-260, 550-527
Contact: Dr. José Lanusse, Executive Director
or Ing. Miguel Andrade, Technical Director

Objective: INSOTEC's primary goal is to support small industries through institutional strengthening of small producer guilds. It analyzes policies and designs strategies for these groups. INSOTEC also conducts applied research related to small industries at the macro and micro economic levels. INSOTEC works particularly

with small forest industries, food processing and community development. Its main interest is to link community development/small producer concerns with environmental quality and sustainable use of natural resources.

Funding: INSOTEC receives funds from international agencies including CIDA, USAID to finance specific projects or credit programs for small industries.

FUNDACION PARA EL DESARROLLO AGROPECUARIO (FUNDAGRO)

Address: Av. de los Shyris y esquina Rio Coca (Edificio Eurocentro) P.O.: Casilla 219 Sucursal 16 Centro de Exposiciones, Quito.
Tel. 455-850, 451-125, 451-122
Contact: Dr. Jorge Chang, Executive Director or Ing. Tomás Dousdebes, Assistant to the Director

Objective: FUNDAGRO promotes activities and technologies to increase agricultural production for local consumption and export. Its programs focus on scientific research, development of new technologies and community education. Other research projects relate to the study of tropical forests.

Funding: FUNDAGRO receives funds from PL 480 (USAID); CIDA.

FEDERACION NACIONAL DE CAMARAS DE PEQUENOS INDUSTIALES (FENAPI)

Address: Av. Colón 1643 y 9 de Octubre.
Tel. 236-036, 554-111
Contact: Mr. Bruno Frixone

Objective: FENAPI is an organization of small industries in Ecuador interested in the rational use of renewable and non-renewable resources as factors of production. This organization does not have any conservation projects but is sensitive to the industry's dependence upon natural resources and the need for sustainable management.

Funding: FENAPI works with its own resources and some grants.

FUNDACION ECUATORIANA DE DESARROLLO (FED)

Address: Guayaquil 1494 y Oriente
Tel. 512-447, 570-904
Contact: Mr. César Alarcón, Executive Director or Mr. Diego Tamayo, Program Director

Objective: FED supports small producers of the informal sector through organization strengthening, technical assistance and minimum credit assistance for production activities. FED provides services by sponsoring workshops on basic manufacturing,

machining. carpentry, locksmithing, and blacksmithing. FED does not have any projects directly related to the conservation of natural resources.

Funding: The project designed by FED are funded by specific agreements with InterAmerican Development Bank.

COMITE ECUATORIANO DEFENSA NATURALEZA Y MEDIO AMBIENTE (CEDENMA)

Address:

Objective: This informal network promotes the conservation of nature. The commitee assembles environmental organizations, government agencies, scientists and other persons or institions concerned with the environment. CEDENMA considers environmental problems from the social aspect. CEDENMA is a policy/lobby organization. Responsibilities for activities are shared by member organizations.

Funding: CEDENME is financed through contributions from member organizations.

FUNDACION PEDRO VICENTE MALDONADO PARA LAS CIENCIAS DEL HOMBRE Y LA TIERRA

Address: Orellana 211 y Panama (Office 401), Guayaquil
P.O. Box: Casilla 10904, Guayaquil
Contact: Mr. Emilio Ochoa, Executive Director

Objective: The rational utilization of coastal resources. This foundation focusses on conflict resolution between alternative uses of coastal resources to avoid over-exploitation. It carries out research projects in the natural sciences. The organization manages the USAID-DIGEMA-URI Coastal Resources Management Project jointly with the Escuela Politecnica del Literas (ESPOL) which has an environmental research and conservation curriculum.

COMITE ECOLOGICO CAMINO VERDE (CECAV)

City: Riobamba

Objective: To identify and monitor environmental problems of Riobamba, proposing alternative aimed at enlisting the participation of the people affected. With advise from students of "Escuela Politecnica del Chimborazo" and "Sociedad de Defensa de la Naturaleza" (SODENA), CECAV has submitted to the Municipal Council of Riobamba a program for solid waste management and waste water treatment.

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GRUPO "AMIGOS DE LA NATURALEZA DE OTAVALO"

City: Otavalo

Objective: To identify and monitor local environmental problems and develop solutions. To date, the group has taken some steps to find a solution to the problem of solid waste produced at the Fabrica de Cemento Selvalegre. The group collaborates with INERHI to deal with problems of water pollution.

FUNDACION FAUNA Y FLORA (FFF)

Address: Ministerio de Agricultura, 10th floor, Departamento de Forestación. P.O. Box: Casilla 15149, Guayaquil
Tel. 330-950, 397-730

Objective: FFF promotes scientific research on the native fauna and flora of Ecuador, the conservation of nature, and seeks to serve the entire community. The organization conducts educational campaigns, seminars and conferences on nature conservation. Its manages an important mangrove forestry project.

Funding: The foundation is supported through membership dues.

GRUPO ECOLOGICO TIERRA VIVA - Cuenca

Address: Sucre 5-60, 3 Piso, Cuenca
P.O. Box Casilla 1891, Cuenca
Tel. 824-621
Contact: Noelia Montesinos

Objective: To protect all forms of life. TV-Quito places special emphasis on reaching an ecological equilibrium with nature and the improvement in the quality of life for all social groups in Ecuador. The group conducts campaigns and seminars. TV-Cuenca works with individuals or institutions with similar objectives.

Funding: The group receives funds from membership dues, and GTZ (German aid)

GRUPO ECOLOGICO TIERRA VIVA - Quito

Address: Manuel Larrea 1117 y Santiago, Quito
Tel. 233-757
Contact: Juán Pablo Pólit, Presidente

Objective: To protect all forms of life. TV-Quito places special emphasis on reaching an ecological equilibrium with nature and the improvement in the quality of life for all social groups in Ecuador. Its principal areas of focus are environmental education, organic agriculture and conservation. TV-Quito

operates as an independent entity from TV-Cuenca. Works with local communities to secure legal protection and develop management strategies for community forests.

Funding: Membership dues; received a small grant from CIDE/WRI through the TFAP/Ecuador effort.

SOCIEDAD ECUATORIANA BIOLOGIA

Address: Universidad Técnica de Ambato, Ambato
Contact: Dra. Laura Arcos Terán, Departmento de Biologia, Universidad Católica del Ecuador (PUCE). Casilla 2184 Quito.

Objective: This organizations seeks to coordinate research activities in the biological sciences. Its members include professionals from the disciplines of biology, agriculture, veterinary and medical sciences.

Funding: Supported by membership dues.

CENTRO DE INGENIERIA PARA TECNOLOGIA ADECUADA (CITA)

Address: Hurtado de Mendoza 10-412, Cuenca
Tel. 800-085
Contact: Ms. Estela de Rossmarin, Executive Director

Objective: To develop appropriate technologies to meet the basic needs of rural people and other disenfranchised groups. Publishes reports on seminars and relevant issues. They also work with organic agriculture.

Funding: receives international assistance.

Appendix 2.3: Major Economic Development Projects

Project Name	Source of Funding	Duration	Total Support in US$
1. Natural Resources			
Management and Conservation of the Rio Paute watershed	FAO	1987-88	125,000
Consolidation of infrastructures for irrigation and drainage	Belgium	1987-89	1,401,500
Study of the national plan for electrification	Belgium	1985-88	2,916,700
Soil conservation and sprinkler irrigation	USAID/CARE	1987-90	850,000
Geodynamics of tertiary water-sheds in the Andes	France/CATER	1987-89	800,000
Ecology of the Amazon region	France/CATER	1983-88	2,200,000
Technical and economic evaluation of Carbonifera de Malacatos watershed	OLADE	1987-88	18,500
2. Agriculture, Forestry and Fisheries			
Rural Development Phase II	PNUD/FAO	1987-88	280,366
Assistance to National Bank	PNUD/FAO	1980-88	2,260,206
Development of social component of rural development project Cañar and Nazón	UNICEF	1986-89	369,300
Rural infrastructure	PMA	1984-89	15,250,000
Chemicals and agricultural residues	OIEA	1985-89	300,000
Basic agricultural techniques	OIEA	1985-88	251,000
Forestry program	GTZ	1983-91	8,649,000
Forestry development project Palmira	Belgium	1982-89	2,555,556
Agriculture promotion in the Loja province	Belgium		
Production of yuca and corn	25% ONG	1986-88	366,667
Substitution for sugar cane	CIID/Canada	1987-91	99,900
Rural integrated development in Santa Isabel and Cañar	CIID/Canada	1987-91	219,800
Forestry and environment	ICI/Spain	1987-89	500,000
Support of Ecuador forestry sector	ICI/Spain	1987-89	100,000
Reorientation project of agricultural sector	USAID/Ecuador	1982-90	1,487,000
Land titling program	USAID/Ecuador	1985-90	7,100,000
Agricultural education	USAID/Ecuador	1985-90	2,000,000
Reforestation	CARE	1983-89	680,000
			830,000

Project Name	Source of Funding	Duration	Total Support in US$
2. Agriculture, Forestry and Fisheries (cont.)			
Agriculture and fisheries prod.	France	1981-88	980,000
Aid to rural farm communities	France	1985-88	23,550
Erosion and soil conservation studies	France/ORSTOM	1983-90	4,200,000
National irrigation plan	France/ORSTOM	1987-89	2,500,000
Reforestation	Switzerland	1987-89	1,100,000
Horticulture	Switzerland	1986-89	1,139,000
Irrigation in Pungal Chungazo	Switzerland	1987-90	379,000
Irrigation in Mocha, Quero, and Ladrillos	Switzerland	1986-88	57,000
Commercialization of agricultural products	CIM	1985-89	169,800
Evaluation of tropical pasture	CIID/IICA	1984-88	65,376
Administration support of the central unit Protega	BID/IICA	1987-92	250,000
Rural integrated development in Puerto Ila, Chone, Quinindé	BIRF/IICA	1983-88	576,170
Rural integrated development Guamote	CAF/IICA	1987-89	132,034
Technical alternatives to substitute for sugar cane in the Gunguilla valley	IICA/CIID BID/IICA Ecuador Bolivia Colombia Peru Venezuela	1987-90	126,398
Cooperative program for agric. investigation in the subandean region		1987-90	3,800,000

Appendix 2.4: Theoretical Framework for the Economic Analysis of Biodiversity

To make choices among competing uses of limited natural resources of a country, a careful assessment of the trade-offs associated with using resources is required (U.S. AID 1987). Economics deals with the allocation of scarce resources among competing alternatives. As a first major step, these alternatives need to be carefully analyzed with respect to questions of sustainability. Non-sustainable alternatives need to be replaced as soon as possible with sustainable alternatives, the premise being that non-sustainable alternatives are not economically desirable in the long term. Sustainable alternatives need to be subjected to careful economic analysis based on an as complete as possible accounting of costs and benefits. Additionally, it is necessary to identify other potential alternatives designed to meet specific goals of society.

Economic analysis provides a systematic and organized procedure for comparing these competing uses. Many complex questions need to be addressed in such analyses. The economic project analysis manual (U.S. AID 1987) provides valuable insights and examples of how to tackle specific problems of valuation. Another valuable guide to project analysis was published by FAO (Gregersen and Contreras 1975).

Some guidelines for the incorporation of environmental, health, and ecologic considerations in economic development projects are provided by the World Bank (World Bank 1974), which provides another framework for developing integrated project designs. Additional general criteria for development projects, with special reference to environmental considerations, and questions of sustainability, are contained in FAO (1988).

Assessment of Alternatives

Economic analysis of biodiversity protection has two aspects. One is to assess the economic value of protecting biological diversity and tropical forests in general, the second is to identify the best alternatives for protecting selected areas once the need and the feasibility for such an action is established.

Economic Value of Protection

In order to compare the economic returns from two different development projects, one with and one without protection, it is necessary to identify the costs and benefits of the two scenarios. This approach follows the project analysis "with and without" concept in order to clearly separate out the costs and benefits due to protection of resources. Because in many cases external pressures from growing populations on the proposed protected areas exist that would threaten the protected status, project analysis

cannot be seen in isolation, but needs to be seen in the context of a whole region. For the economic analysis, this implies that costs and benefits need to be identified and wherever possible be quantified for the whole region affected by the proposed protected area. A simple framework for identifying key impact categories is shown in Table 1. For each feasible management alternative, the filling out of this table will help guide the process of identifying the major impact categories and trace them to measurable impacts on outputs.

Table 2.4.1. Framework for Identifying Major Impact Categories of Regional Development - With and Without Protection of Biodiversity and Tropical Forests

	Without Protection	With Protection
<u>Physical Attributes Affected</u>:		
Soils		
Water quantity		
Water quality		
Vegetative cover		
Species diversity		
Aesthetics		
<u>Output Categories Affected</u>:		
Agriculture		
Forestry		
Livestock		
Fisheries		
Wildlife		
Germplasm		
Tourism		
Recreation		
Production costs		
Income		
Employment		
Health		
Education		
Standard of living		
<u>Development Climate</u>:		
Employment opportunities		
Development options		
Stability		
Planning flexibility		
Education		

Environmental impacts are wide ranging and difficult to track. There is a limit in the ability to trace the impact of deforestation to a reduced ability to learn new agricultural techniques because the increased poverty has reduced the time that children can attend school. The most obvious impacts should,

however, be traced looking for productivity changes that can be measured using market prices. Increased erosion in itself cannot be included easily into the economic analysis unless its impact is traced to a reduction in agricultural productivity which can be quantified in terms of products and value of products. Thus each of the physical factors that is impacted by development needs to be traced to a measurable output change that is caused by the change in this factor. A few general examples of this tracing of the impact transmission mechanism are provided in Table 2. The descriptions of these transmission chains are not complete and are listed only to describe the general process. It should be noted also that deforestation might have water quantity and aesthetics impacts even before erosion increases significantly.

In the project analysis, care should be exercised not to double count some of the impacts. For example, the inclusion of the impacts of erosion on land values and soil productivity in the analysis could lead to double counting since land value already reflects production potential (U.S. AID 1987).

Table 2.4.2. Examples of the Impact Transmission Mechanism

```
Deforestation causes:
  ->Erosion which impacts on:
        ->land values
        ->agricultural productivity
        ->livestock productivity
        ->forestry productivity
        ->water quantity which impacts on:
              ->irrigated area which impacts
                    ->agricultural productivity
        ->occurrence of floods causes:
              ->loss of property and lives
        ->sedimentation rates impact:
              ->hydroelectric power production
              ->recreation potential of bodies of water
        ->water quality impacts on:
              ->health measured in higher health costs
              ->education and technology transfer which can lead
                                    to:
                    ->use of better production techniques which
                                    impact:
                          ->land use productivity
              ->aesthetics which determine
                    ->recreation potential of body of water
        ->fisheries productivity
 ->Loss in species diversity reduces
        ->genetic variability which can lead to
              ->costly disease and insect outbreaks with
                    ->reductions in land productivity
              ->lost abilities to develop new products
 ->water quantity which impacts on
        ->irrigated area which impacts
              ->agricultural productivity
 ->occurrence of floods causes
        ->loss of property and lives
 ->aesthetics which determine
        ->real estate value
```

Benefits of Protecting Forest Resources

IUCN (1986) lists 16 general categories of potential benefits arising from protecting forest lands:

1) Stabilization of hydrologic functions
2) Protection of soils
3) Stability of climate
4) Conservation of renewable harvestable resources
5) Protection of genetic resources
6) Preservation of breeding stocks, population reservoirs and biological diversity
7) Promotion of tourism
8) Provision of recreational facilities
9) Creation of employment opportunities
10) Provision of research and monitoring facilities
11) Provision of education facilities
12) Maintenance of a quality living environment
13) Advantages of special treatment
14) Preservation of traditional and cultural values
15) Natural balance of environment
16) Regional pride and heritage value

Specific benefits that typically are related to conservation and natural resource protection efforts that should be analyzed for supporting economic analyses are:

- Tourism Benefits

Greater environmental awareness especially in the US and Europe and increasing interest in non-traditional tourist activities such as bird watching, tropical nature hikes, and white water rafting, combined with sightseeing of archeological sites have increased the potential benefits associated with environmental protection.

- Recreation Benefits

Not to be forgotten in an analysis of the benefits from protecting tropical forests are recreational benefits that accrue to local populations.

- Water Production

Availability of water in sufficient quantity and quality has important economic benefits for the country. The cost of not protecting this water production potential because of deforestation and non-sustainable land use practices can be estimated by the value of lost electric production capacity due to sedimentation and decreases in agricultural production. Additional costs are related to health costs associated with

poorer water quality and decreases in coastal and inland fisheries production and lost recreation and tourism potential.

- Biological Diversity and Ecological Services

This is the category of benefits of forest protection that is the most difficult to assess. A few studies have attempted to quantify the value of products extracted from tropical forests on a sustainable basis(see Hecht and Schwartzman 1988, Rose 1988). Use of the cost of restoring disturbed tropical habitat to a plantation as an estimate of the value of lost biodiversity (see Hecht and Schwartzman 1988) is extremely conservative and should wherever possible be replaced with on site monitoring of products and values removed in sustainable extraction systems. This naturally does not measure the contribution of potentially utilizable products.

Comparing Protection Alternatives

The identification of alternatives for achieving project objectives is a key step in project analysis. The key objective of the current study is to propose and compare alternatives for protecting biodiversity and tropical forests. The following guidelines for the identification of alternatives are offered:

1. Non-sustainable human activities, involving the natural resources of the country, can also be considered activities that reduce biodiversity.

When identifying production alternatives to achieve specific development objectives, alternatives that can achieve these objectives and that maintain biodiversity at the same cost as other alternatives that lead to a reduction in biodiversity, should be favored. The selection process becomes more difficult when alternatives that maintain biodiversity are also substantially less cost-effective, assuming of course that all costs of not maintaining biodiversity in alternative projects were properly accounted for.

In the purest sense, project selection could be done on the basis of accepted measures of project performance such as discounted net present value, but reliance on these measures alone is not recommended because it will generally be impossible to adequately account for all costs and benefits of development projects that might lead to the destruction of individual species and a reduction of biodiversity. As a general rule, it would appear unwise to accept apparently more cost effective, but non-sustainable, production alternatives over sustainable production alternatives. It should certainly call into immediate attention the need for additional data collection.

Non-sustainable production alternatives eventually do have small or negative net benefits, and the net benefits of sustained production, no matter how small, will eventually outweigh those of non-sustainable production. Production alternatives that are not sustainable should not be accepted by planning agencies. The key task for planners is to identify beforehand what makes a development project sustainable or non-sustainable. Key indicators of non-sustainability of proposed projects for protection of biodiversity are described in table 2.4.2.

2. Only alternatives that coincide with the identified potential uses of land based on the productive capacity of soils, terrain features, and climatic conditions should be selected.

Lands classified as forest sites need to stay under forest cover. If current land uses in an area are non-sustainable, they should be replaced quickly with sustainable production alternatives. Such sustainable alternatives need to be identified and compared using project analysis. Local populations need to receive the financial and technical support to switch to the recommended alternative without jeopardizing their short-term livelihood.

The major alternatives fitting within the objective of conserving biological biodiversity include:

1) Total Protection
2) Protection with sustainable extraction activities.
3) Partial protection with integrated land uses including agriculture, livestock and forestry.

Some of these alternatives can be combined in regional development projects with other activities such as tourism and recreation and would be fully compatible, e.g., establishment of parks and tourism development. One important observation is that the "conservation alternative" with its specific costs and benefits is only one of many alternatives for resource "use" including economic development alternatives. The task will be to identify among the economic development alternatives those that are the most cost-effective as well as sustainable while meeting specific objectives of development. In some cases, outright protection of the resource will be the most efficient action. Table 3 below provides a framework for some of the information categories for adequately describing any given alternative.

Table 2.4.3. Key Information for Describing Production Alternatives

- Producers
  - -private objectives
  - -laws and regulations
  - -public objectives
- Products
- Production Costs
  - -direct
  - -indirect, opportunity costs estimating opportunities foregone
  - -short-term
  - -long-term, recuperation costs of reclaiming degraded resources
  - -distribution
- Consumers
- Private household consumption
- Market Values
  - -local
  - -regional
  - -national
  - -international
- Production Benefits
  - -direct
  - -indirect
  - -short-term
  - -long-term
  - -distribution
- Sustainability Indicators
- Indicators of Non-sustainability
- Development Barriers
  - -economic
  - -institutional
  - -political
  - -cultural
  - -technical
  - -financial
  - -infrastructure
- Development Mechanisms
  - -regulation (laws, taxes)
  - -incentives (subsidies)
  - -infrastructure
  - -education
  - -market development

Selecting the Best Protection Alternatives

It was not possible in the available time to compare alternative protection alternatives using project analysis procedures. Whatever alternatives are eventually selected, it will be essential to recognize that their successful implementation will depend on the success of conserving the areas under consideration. This will require that certain factors of non-sustainability are recognized and dealt with. To assess in general the potential for success of development alternatives that would conserve biological diversity and tropical forests, it is essential to analyze biological, physical, institutional, political, and socio-economic indicators of non-sustainability. These are indicators that would provide development planners signals of potential and/or existing factors that could lead to the failure of proposed development projects.

Appendix 3.1: History and Status of Forests in Ecuador

Ecuador is commonly divided into three regions: Western Ecuador (or the Coast), the Sierra and the Oriente. Sources discussing the limits of the three regions vary widely, some taking the 300 m contour, some the 500 m contour, and others the 1,000 m contour. Most geographers tend to use the 900 m contour line as a convenient dividing point between the three regions. We follow the latter approach because it seems to make sense biologically. Thus defined, the three regions are approximately equal in size, i.e., Western Ecuador with 80,000 sq. km, the Sierra with 102,000 sq. km, and the Oriente with 81,000 sq. km.

As a means of comparing historical vs present situations in reference to man's activities in Ecuador, we present several maps. Map 1 shows the river system navigable by launch or canoe, the principal means of inland transport prior to roads. Map 2 shows the road and railroad system existing in the 1940s. Since extensive deforestation seldom occurs more than 5 km on either side of a road or river bank, a combined map of roads, railroads and river systems provides a tentative indication of where relatively undisturbed forest existed in Ecuador prior to 1945 (Map 5). At that time, we estimate that at least 75% of Ecuador was probably still forested. By 1957, substantial forest conversion to banana plantations already had occurred, particularly along the new post-World War II roads (Map 3); however, we estimate that approximately 63% of the surface of Western Ecuador still retained forest cover (Map 6).

All available evidence suggests that substantial deforestation, particularly in Western Ecuador, did not begin until after World War II when road construction was accelerated. Between 1957 and 1988 several factors played important roles in the deforestation of Ecuador. Demographically, the population of Ecuador increased from less than 4 million to 10.2 million. Land reform programs, initiated in the early 1960s, effectively promoted colonization of government-owned forested lands. Petroleum export provided more than 60% of the national income as Ecuador became a member of the Organization of Petroleum Exporting Countries (OPEC), selling oil at more than 35 dollars a barrel, and thereby insuring abundant new funds for development. Major sums were invested in road construction to provide communication and transport for the new colonists to cities and markets. Bananas, oil palm, soy beans, rice, corn, and shrimp farming, as well as the traditional cacao and coffee, became sizable export crops, providing substantial agroindustrial income. Constructed and maintained by the Ministry of Public Works, an extensive network of primary and secondary roads was developed throughout most of Ecuador (Map 4). Primary roads provide communication between major cities; secondary roads connect smaller communities to the primary roads. In 1957 about 13,000 km of primary and secondary roads existed in the country (Inventario de la Red Vial

Nacional, M.O.P., 1987). In 1982 (the most recent available information), there were 19,341 km of primary road and 16,276 km of secondary road for a total of 35,617 km in the Republic of Ecuador, triple the 1957 total. Estimates by Ing. Fausto Lafebre, Director of Technical Programming of the M.O.P., (pers. comm.) indicate that as of 1987 there are more than 50,000 km of primary and secondary roads in the country.

In addition, many penetration roads (or neighborhood roads as they are often called) were constructed, either by private enterprise or by 10 to 12 largely uncoordinated governmental agencies, which were programmed to help in development of agricultural colonies and cooperatives. Most of the penetration roads were constructed during the land reform efforts between 1965 and 1975 when a plan was implemented to develop and put into production all "nonproductive" lands, including all forested lands, in Western Ecuador. Many of the penetration roads are not maintained by the M.O.P. and in many cases the Ministry is not even aware of their existence. No estimates are available as to the total kilometers of these roads, but personal experience indicates that they are now very extensive and form a dense network that provides easy access during the dry season to all forested areas. Such easy access has had a devastating effect on the forests.

The three regions tend to have distinctive biological integrity, with relatively few species in common on both sides of the Andes, and even fewer between the Andean Region and either contiguous region. Therefore, we will discuss the geography, climate, soils and life zones of Ecuador on a regional basis, i.e., Western Ecuador, Sierra, and Oriente.

3.1.1. Western Ecuador

3.1.1.1. Geography

The boundaries of Western Ecuador have been established as the Pacific Ocean to the west, the Colombian border to the north, the Peruvian border to the south, and the 900 m contour line on the Andean mountains to the east. With this definition, Western Ecuador has a land area of approximately 80,000 sq. km, about a third of the total 263,000 sq. km. of continental Ecuador. As thus defined, Western Ecuador is about the size of the State of North Carolina, while the Republic of Ecuador is similar in size to the State of California. The majority of Western Ecuador consists of a series of peneplains extending westward from the base of the abruptly rising Western Cordillera of the Andes. There is also a low range of coastal hills seldom exceeding 800 m in elevation.

3.1.1.2. Climate

The cold Humboldt Current moves northward along the coast and collides, near the equator, with a branch of the warm Panama Current moving southward. Both then move westward toward the Galápagos Islands. The earth's seasonal oscillation produces annual north and southward shifts in the currents, which affect the climate of Western Ecuador. The southern half, with less than 1,000 mm of annual rainfall, has a rainless period exceeding eight months (early May through early January), although a persistent cloud cover during the dry season ameliorates the temperature and dryness. Near the ocean, night fogs provide substantial atmospheric humidity, especially on the crests of the low coastal mountains. The northern half, beginning about one degree south of the equator, becomes increasingly humid northward, varying from an annual rainfall of 2,000 mm with a minimum of 10 mm of rainfall each month south of the equator to annual rainfall of 8,800 mm and at least 100 mm of rain each month in the north near the Colombian border.

3.1.1.3. Soils

The soils of the Western peneplains are alluvial and volcanic in origin. Since aboriginal, agriculture times has sustained large populations and much of the region is under intensive agroindustrial use at the present time. The soils of Western Ecuador are much richer than those of other tropical lowland areas. Associated high productivity and turnover rates of the native forest may be in part responsible for the dynamic speciation that seems to have occurred. However, it must be remembered that those rich soils make conservation in Western Ecuador very different from that in most tropical regions. Instead of the common outcome of a few years of crops followed by abandonment, in Western Ecuador the result of forest conversion is often productive and sustainable agriculture. This situation is somewhat analogous to that of midwestern North America in the middle of the last century where cultivation of rich soils nearly eliminated the native prairie flora.

3.1.1.4. Major Ecosystems

Of the twelve life zones reported in Western Ecuador, 10 have been studied with varying degrees of intensity. Five have been intensively sampled by using the florula approach (see Dodson & Gentry, 1978). These include the Flora of Rio Palenque (1978) in tropical wet forest, the Flora of Jauneche (1985) in tropical moist forest, the Flora of Capeira (in press) in tropical dry forest, the Flora of Centinela (in preparation) in premontane pluvial forest, and the Flora of Tenefuerte in premontane wet forest. The Santa Elena Peninsula, with three very dry life zones (tropical desert, tropical desert scrub, and tropical thorn scrub) was studied by Svenson (1946) and Valverde (1979). Valverde has continued with studies of the Cerros de Colonche with preparation of a flora in progress. This region of the dry coastal mountains

has tropical thorn scrub, premontane thorn scrub, tropical dry forest, very dry tropical forest, premontane dry forest, and tropical moist forest.

Accurate estimates of the number of species of vascular plants in Western Ecuador are not possible at this time, especially since two of the life zones richest in species have not been extensively sampled, (premontane humid and pluvial forest). However, extrapolations of species numbers can be made based on the data generated in florula preparation and from the relatively thoroughly sampled Western Ecuadorean orchid flora. The 5 sites studied by Dodson and Gentry have a combined total of about 2,500 species. The number of orchid species found in the five florula sites is 253, closely approximating the 10% suggested for tropical floras worldwide (Kress, 1986). We have 2,568 orchid species cataloged for all of Ecuador, and this is also remarkably close to 10 % of the estimated 20,000 to 25,000 vascular plant species projected by Harling (1987) and Dodson & Gentry (in prep.). Since we have catalogued 632 orchid species for lowland Western Ecuador, and assuming the 10% rule, we might therefore expect about 6,300 vascular plant species in the region.

Overall figures for the fauna are not available but data on birds show a very similar pattern, with more than 1,550 species now known for the country, 605 of these in Western Ecuador (of the 1,550, 1475 are documented from the mainland, 50 are restricted to the Galápagos and more than 25 have been reported, but not documented, from the mainland, Ridgley & Greenfield, pers. comm.). Note that the highest bird endemism in the entire world is probably in the Ecuador/Colombia Western slope border area (Terborg & Winter, 1982).

The prolonged dry season in the south and west results in desert, desert scrub, tropical thorn scrub, and a cover of very dry to dry tropical forest on the plains progressively inland and away from the cold waters along the coast. The coastal hills are clothed with thorn scrub at the base, premontane dry forest on the slopes and moist or wet forest on the higher crests. The original forest cover of the central plains changed from tropical dry forest to tropical moist forest at about two degrees south latitude (near Babahoyo) and gradually changed from tropical moist forest to tropical wet forest north of one degree south latitude (near Quevedo). Near Santo Domingo, this changed to premontane pluvial forest. An extensive system of savannas, swamps and gallery forests once existed along the large rivers that drain the Guayas basin south of one degree south latitude. Only the Santa Elena Peninsula at the Western extreme of Ecuador immediately adjacent to the cold Humboldt Current had true desert conditions (lacking forest cover) similar to those of coastal Peru.

Finally, a narrow strip of perhumid cloud forest on the lowermost Andean slopes is included in Western Ecuador as here

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defined. This region is an extension of the Colombian Chocó pluvial forests, generally characterized by extremely high annual rainfall. These conditions extend southward in increasingly narrow elevational bands along the flanks of the Andes. Pluvial forest with 8,800 mm of annual rainfall reaches south only to Tobar Donoso, at the Colombian border, (about one degree north latitude). However, premontane pluvial forest reaches nearly to the Peruvian border, where it is reduced to a strip only a few hundred meters wide near the 900 m contour. In general, the moist vegetation types form broad extensions near the Colombian border but are reduced to narrow bands between the 300 and 900 m elevational lines near the Peruvian border.

3.1.1.5. Historical perspective and present status

During the centuries preceding the Spanish conquest in the early 1500's, Western Ecuador apparently supported a large population of native peoples. The quantity of artifacts and ceremonial mounds scattered across the plains is so large that it could only have been produced by a large population over a prolonged period of time. Towns that apparently had 10,000 or more inhabitants when the conquistadors arrived, have been discovered recently in Manabi, and it has been suggested that the rural population of Western Ecuador may have been greater at that time than it is today (P. Norton, pers. comm.). European diseases are presumably the agent that drastically reduced the native population.

During the colonial period, most farming and forest conversion was restricted to the Guayas river system, the Sta. Elena Peninsula (then much more humid than now, according to historical records), and the seasonally dry coastal region of Manabi. The lucid descriptions of Hassaurek (1967), United States Ambassador to Ecuador from 1861 to 1866, of the Guayaquil and Babahoyo regions indicate that the population was still very sparse at that time. For example, Guayaquil had an estimated population of 20,000 in 1861 vs 1.7 million today. According to Hassaurek, most of the region from Babahoyo to the high country, even flanking the main trail to the Sierra, was still unbroken forest.

Figures 2 and 3 illustrate the changes in forest cover that we have observed in Western Ecuador from 1958 to 1988 in four categories of forest: dry, moist, wet and pluvial. These categories may each include several life zones. For example, the comparative maps of dry forest in figure 2 encompass tropical desert scrub, tropical desert, tropical thorn scrub, premontane thorn scrub, very dry tropical forest and premontane dry forest in the Holdridge (1967) system. All of these life zones have been severely altered by man and his domestic animals. We estimate that about 25 % (20,000 sq. km) of Western Ecuador consisted of dry forest in aboriginal times. Probably much less than 1 %

(about 200 sq. km) of this category remains in an undisturbed condition.

The moist forest category, which encompasses tropical moist forest and premontane moist forest in the Holdridge system, was once the most extensive forest cover in Western Ecuador. Since the soils of Western Ecuador are generally quite rich, particularly when compared with Amazonia, the moist forests were extremely attractive for agricultural development. They also have a rain-free period of at least 4 months, allowing for easy access. We estimate that nearly 50 % (40,000 sq. km) of Western Ecuador was covered with moist forest in aboriginal times. Surely less than 4% (about 1,500 sq. km) remains. Regeneration of moist forest is probably very slow, and in this case, most of the forest was clear cut, burned, plowed and permanently altered.

The wet forest category (fig. 3), encompassing tropical wet forest and premontane wet forest in the Holdridge system, was originally a band extending from the Colombian to the Peruvian borders. The band was about 20 km wide at the northern extreme and very narrow and broken to the south. The soils are very rich and the forests mostly converted to banana, African palm and rubber cultivation. We estimate that about 15 % (12,000 sq. km) of Western Ecuador was covered by this type of forest and that now less than 0.1 % (90 sq. km) survives.

Pluvial forest, encompassing premontane pluvial forest and probably lower montane pluvial forest, forms the only substantial surviving forest category. We estimate that about 10% (8,000 sq. km) of Western Ecuador was covered by forests of this category and that about 50 % (4,000 sq. km) remains. The reasons for the persistence of this forest are the notoriously poor, highly leached soils, inaccessibility due to high rainfall throughout the year (which destroys roads that are not all-weather), and the precipitously broken nature of the terrain. These forests are of particular interest because they probably contain the highest biological diversity in Western Ecuador, comprising part of the Chocó region (Gentry 1982) which contains the most diverse forests on the face of the earth (Gentry 1986). Though most of the still-forested lands have been declared National Ecological Reserves they are also the only large extensions of forest left in Western Ecuador in an increasingly land- and timber-starved era.

As indicated above, Western Ecuador has an extremely diverse flora, with more than 6,300 species in an area of 80,000 sq. km. A substantial portion of the floral diversity found in Western Ecuador is probably a result of the general syndrome of explosive speciation in the northern Andes (Gentry, 1982; Gentry & Dodson, 1987). The causal mechanisms for that explosive speciation are not well understood, but surely one of the factors is the plethora of microhabitats in the region. Not only are there a large number of microhabitats in Western Ecuador but they are spatially

isolated due to the natural fragmentation of many of the life zones. Of the twelve life zones cited by Cañadas (1983), eight to ten often were represented, even originally, by small to very small, noncontiguous patches of forest strung out linearly either along the tops of the coastal mountains or along the lower slopes of the Andes. It is in those natural fragments that speciation was presumably most rapid, judging by today's exceptionally high endemism.

The forest fragments that now remain, tend to be in the most inaccessible areas. They often are located near the summits of the coastal mountains or along the steep flanks of the Andes. These are generally humid to wet forests, with high species diversity and high natural endemism.

We suspect that much of the flora of Western Ecuador may operate on a different set of parameters than do the large expanses of relatively homogeneous tropical zone habitats. Those include extremely rapid speciation, adaptation to survival with very low population densities, adaptation to small habitat patches, and concomitant rapid extinction rates. Thus we would submit that conservation of even the tiny habitat fragments that remain in Western Ecuador might well reserve a substantial portion of the estimated original complement of nearly 1500 species endemic to the area, despite the tremendous deforestation that has taken place. Any such effort must be undertaken very soon, however, since many of these species will surely be lost if the few tiny forest patches that remain today are destroyed.

Map __ displays the extent of relatively undisturbed forest known to remain in Western Ecuador today. The only two substantial tracts left are in the Provinces of Esmeraldas, Carchi and Imbabura, in the extreme north, where high year round rainfall has impeded road access. These two tracts are the Awá Ethnobotanical Reserve (101,000 ha and the Cotacache-Cayapas Ecological Reserve (204,420 ha). We know from personal experience that an undetermined but increasing proportion of both reserves has already been converted by colonists and lumber interests. Moreover, the government is currently planning an all-weather highway that will pass through the middle of both reserves.

Much of the dry forest reserve of the Machalilla National Park near Manta (46,683 has.) has been seriously disturbed by colonists and their goats, and is now second growth. South of Guayaquil, the Churute Forest Reserve (35,000 has.) had a fairly substantial cover of mangrove (much of which now has been converted to shrimp farms), but also ranged to disturbed dry forest on the protruding hills.

Only one of the protected areas in Western Ecuador is a national park: Machalilla National Park. Ecological Reserve status is applied to Manglares-Churute, and Cotacachi-Cayapas. The

Awå is an Ethnic Reserve that apparently does not benefit by the same status as an Ecological Reserve. A third governmental category is that of "Bosque Protector" which, in reality, refers more to soil conservation and watershed protection than to forest protection. For example, the Daule-Peripa Hydroelectric Project watershed of 220,853 has. is a "bosque protector" with essentially no significant remaining blocks of forest. A few small privately-owned reserves, that benefit from "bosque protector" status, exist in Western Ecuador, oriented toward forest conservation. These include Capeira (10 ha) in dry forest near Guayaquil, Jauneche (130 ha) in tropical moist forest south of Quevedo, the Rio Palenque Science Center (100 ha) in tropical wet forest between Quevedo and Santo Domingo, and the La Perla (50 ha) in premontane wet forest north of Santo Domingo near La Concordia.

Extensive mangrove forest once covered the coastal regions that did not directly face the open sea. The advent of mariculture (on a scale which yields the largest shrimp export of any country worldwide) had reduced, by 1984, the mangroves by 10.6%, from 2,036 sq. km to less than 1,881 sq. km (Alvarez, et al, 1984). Considerable further conversion has taken place since 1984.

We estimate that approximately 100,000 ha of undisturbed forest remains outside of protected areas, principally surrounding the Cotacachi-Cayapas and Awå reserves and in the Cojimes and Coaque mountains of northern Manabi and Esmeraldas Provinces.

In total, we estimate that less than 5,000 sq. km of reasonably undisturbed forest remain in Western Ecuador; that is, less than 6% of the land surface is presently covered by primary vegetation. The Plan de Accion Forestal (1988) cites 19,699 sq. km as natural forest coverage, but the source of that estimate was the Atlas Geografico del Ecuador, 1977, whose data was based on previous studies. The only two relatively large remaining forest tracts are in danger of disappearing rapidly, and construction of a new allweather road through them will accelerate this process.

3.1.2. The Sierra

The Sierra consists of about 102,000 sq. km., all of which lie above 900 m elevation.

3.1.2.1. Geography

Ecuador is split north and south by the Andes mountains (the Sierra) that constitute its main geographical structure. Two chains are generally recognized, while both to the north and south of Ecuador the Andes are composed of 3 chains. Some geographers consider the relatively low ranges to the east, such as, the Cordillera de Guacamayo, the Cordillera de Cutucu and the Cordillera del Condor to represent a 3rd range. Others include

the low coastal mountains as a 4th range. In Ecuador, the Andes resemble a ladder with the Western range forming one side while the eastern range forms the other. Between the ranges are interandean valleys separated by rungs or "nodes". Each valley is an average 2,500 m in elevation and 60 to 70 km wide with a river that exits either to the west or east. Those valleys with westward flowing rivers tend to be drier. A series of high, mostly snow-capped volcanos characterize the two parallel ranges; many are still active.

The Andes were formed of tectonic plates uplifting, tilting and sliding under one another from west to east. Thus, the western face of each plate is shear while the eastern face has a gentler slope. The fracture lines tend to be the location of volcanos which have contributed substantially to the height and substance of the ranges. The highest volcano is Chimborazo, over 6,300 m.

The northern half of the Ecuadorean Andes are mainly formed of material from Quaternary volcanic eruptions acted upon by Pleistocene glaciers. The last glaciation ended only 6,000 years ago (A. Hirtz, pers. comm.). The southern half of the country is composed of folded Meiocene sedimentary strata covered by lava and volcanic ash from the Pleistocene to the present.

1.2.2. Climate

Considering the diversity of terrain, elevation, and effects on rainfall, most of the climatic regimes that occur on the face of the earth are to be found in the Sierra of Ecuador. The mountains are follow the general rule, that for each 1,000 m increase in elevation, mean annual temperature is reduced by __ Therefore, as one ascends either flank of the Sierra, from the 900 m contour line to the ridge, temperatures decrease until the actual snow line is reached at about 5,000 m on the protruding volcanos.

On the shear Western slope, the lower elevations are directly affected by the same weather phenomena as discussed above for Northern Ecuador, with the more southern sectors tending to be much drier while the northern regions are usually wet. Rain falls throughout the entire region from January through May, but near the Peruvian border it is dry from May to December, while near the Colombian border rain falls throughout the year. As mentioned above, those interandean valleys with large rivers draining to the west tend to be dry, particularly so from the 900 m contour lands. The upper elevations, from 3,000 to 5,000 m, tend to be wet throughout the year, with a decreasing rainfall gradient to the south near the Peruvian border.

The climatology of the more gentle eastern slope depends on nearly constant east to west winds bringing rain-bearing

; from the Amazon basin. From north to south there is
:ve homogeneity, perhaps due to the absence of the dry river
:s which occur on the Western side, broken by a few pockets
:remely humid areas such as Tena and Mera. The same
:ional effects occur as on the Western slope in reference to
:ature gradients.

.ocal climatalogical effects depend on many factors, such as
:ion, mean annual temperature, seasonal temperature, rainfall
:bution, steepness of the slope, direction of slope face,
encroachment, etc. Therefore, a multitude of microhabitats
each with its peculiar set of climatalogical parameters,
:duplicated over extensive land areas.

3. Soils

e soils of the Sierra are principally volcanic in origin in
:rthern half of the country and uplifted sedimentary in the
:rn half.

4. Major ecosystems

he Holdridge system (see the Cañadas map in the text)
s the vegetation formations occurring between the 900 m and
00 m contours into an extensive series of life zones
ped in bands that are often narrow due to the abruptness of
opes. These bands are: lower montane and premontane dry
, lower montane and premontane moist forest, lower montane
emontane wet forest, and lower montane and premontane
forest. Above the 3,000 m contour, the life zones are
dry, montane humid, montane wet, montane pluvial,
ne dry tundra, subalpine humid tundra, subalpine pluvial
alpine pluvial tundra and, finally, the perpetual snow

e major portion of the biodiversity occurring in the Sierra
tween the 900 m and 2,400 m contours where many distinctive
bitats are found. In this band, relatively few species are
n common on each side of the Andes. From the 2,400 m
to snow line species tend to be similar, within life
throughout the region.

estimate that more than 950 orchid species, of the 1,050
restricted to the Sierra as a whole, are found only in the
,400 m zone. We have few data compiled in this zone, but
rom the Mera region, on the eastern slope between the 1,000
500 contours, are illustrative. We have compiled a list of
hid species collected at the Mera site, in approximately 15
Of those, 79 have not been found elsewhere in Ecuador.
species at the Mera site were found in the area of Tena,
0 km to the north. The Tena site, however, is in the
region below the 900 m contour.

.5. Historical perspective and present status

'he interandean valleys have been occupied since man came to America. The rich soils, amiable climates, and relative ty from invading tribes lent the valleys to extensive :tion expansion, cultural development and agricultural use. nly much of the region was occupied when the Incas arrived nortly thereafter, the Spanish. Extensive forests still d on the inner flanks of the mountains. The outer flanks ne 900 m contour upward were still little exploited as late '.

nly five roads, and two railroads provided access from n Ecuador to the Sierra, and one road led to Puyo in the e in 1957. An extensive series of paths, called "Caminos de ura", led from the coast or the Oriente to the Sierra, but oduced relatively few settlements on the flanks, and most of nad populations of less than 1,000 persons.

'e present day situation in the Sierra is similar to that of n Ecuador. The native flora of the interandean valleys has early eradicated. A few patches of native forest, on the flanks of the mountains, still exist in remote areas. The s of the outer flanks of the Andes have also been seriously ed (see Maps __ & __). What was a nearly solid band of urbed forest in 1958, broken only along the few access roads ound the few settlements along the paths, has been converted to pasture land. This has resulted from an intense network ghborhood roads on both flanks of the Andes, but especially western flank.

:rtunately, a series of National Parks and Ecological ts have been established in the Sierra, mostly in what were mote areas. These may act to slow the conversion process. north, the Cotacachi-Cayapas Reserve (204,420 ha) spills om western Ecuador into the region above Ibarra and . On the other side of the valley the Cayambe-Coca 3 ha) Ecological Reserve crosses the summit of the eastern f the Andes and nearly reaches the basin in the Oriente. west of Quito, the Pululahua Geobotanic Reserve (3,383 ha) es the crest of the western range. Farther south, the i National Park (33,393 ha) surrounds the volcano from t derives its name. East of Riobamba, in Central Ecuador, gay National Park (271,925 ha) straddles the eastern range rly reaches the Oriente. To the west of Cuenca, the Cajas l Recreation Area (28,808 has.), covers an extensive area o with spectacular high mountain lakes, mostly at ons of more than 3,500 m. South and east of Loja, in n Ecuador is the Podocarpus National Park (146,280 ha), in high country above 3,500 m.

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y the Cotacachi-Cayapas Ecological Reserve and a few protectores" (principally on the western slopes of Mt. ha) lie on the western flank. The Cotacachi-Cayapas is only 10 km wide in places between the 900 m and 3,000 m s. The western flank is 650 km long and the protection of three strips 10 to 20 km wide, would only save a few of imated 800 species of endemic vascular plants. nately, there is very little forest remaining on the flank it could be preserved. Two nongovernment preserves, the cuna, west of the Pululahua Reserve and Guajalito, in the ga region, add 3,000 to 4,000 ha. located south of ni-Cayapas and will help save several species.

e two large reserves, the Cayambe-Coca and the Sangay l Park on the eastern flank, protect about 150 km of the long strip that we estimate contains about 1,100 endemic of vascular plants. Therefore, many more species are ed than on the western flank.

The Oriente

e Oriente, as here defined, occupies about one third of the (about 81,000 sq. km.) below and east of the 900 m contour Andes.

. Geography

oroximately half (40,000 sq. km.) of the Oriente lies on er eastern slopes of the Andes from the 900 to the 300 m . This region is heavily broken but tends to slope ly to the east. Most of the area is very wet and forms the ers of very large rivers (e.g., the Napo, the Pastaza, the , etc.) which feed into the Amazon to the east. The three ridges, the Guacamayo, the Cutucu and the Condor, form the ge of the Andes, as mentioned above, and tend to emerge base of the eastern slope. All three reach a little more 00 m elevation.

Amazon lowlands, as here defined, begins at the 300 m and extends to the Colombian and Peruvian borders. This about 40,000 sq. km. is roughly half of the Oriente and have meandering rivers, ox-bow lakes, relatively flat nd poor soils.

. Climate

climate of the region is primarily affected by the east winds carrying moisture laden clouds from the Amazon Basin America. Rainfall is continuous throughout the year with tical decrease in August, September and October, though it heavily, day after day at season. In the upper regions, ase of the Andes, much more rain falls and the

:ures are cooler due to elevational effects and abundant
ɔver.

: lower, flatter, eastern areas tend to be hot during the
do not cool appreciably at night. Thunderclouds tend to
'ule with heavy local showers interspersed with bright
:. From June through September, the area is subject to
:al cold waves coming in from Brazil which drop the
:ure drastically and the region becomes surprisingly cool.

. Soils

'ls on the lower slopes of the eastern range of the Andes
:rally rich as a result of continuing deposition of
's eroded from the mountains to the west. The soils of the
:asin in Ecuador are also alluvial, but many of the
: are ancient and have been heavily leached and are
:to sustained agriculture. Soils along the major rivers
be rich as a result of frequent flooding and silt deposit.

. Major ecosystems

:Cañadas map lists relatively few Holdridge life zones in
nte region as here defined. A substantial majority of the
'rom the 300 m contour line eastward lies within the
'moist forest life zone, while the area close to the base
ndes has broken bands of premontane moist forest,
ne wet forest, and premontane pluvial forest. Within each
'ife zones, a substantial number of forest types occur
'differences in soils, inundation periods, rainfall, cloud
n, slope facing, etc.

have little complete data concerning the flora of the
but have compiled a list of 821 orchid species restricted
'iente below the 900 m contour. We have collected 205
pecies in the region of Tena between the 900 m and 400 m
:. Of those 205, 36 were in common with the Mera site, for
alty index of only 10%.

· Historical perspective and present status

'pre-Columbian times, the Oriente was occupied by native
'imarily dispersed along the numerous rivers. With the
of the Spanish many of the natives were enslaved as a
rce for gold exploitation along the rivers and in the
:at the base of the Andes. In the 17th century, the
'evolted and threw the Spanish out. In addition, a
:al number of people, indigenous to the Sierra migrated to
nte to escape the slavery practices of the Spanish
on the large haciendas in the interandean valleys.

ıs of 1958, only the road from Ambato to Puyo permitted
ılar access to the Oriente. In 1963, the road from Loja to
: was completed and continued on to Bomboiza and Gualaquiza.
y thereafter, a road from Cuenca to Macas was completed and
: with the Gualaquiza road only in 1982. The Ambato-Puyo
ıas extended in the late 1960's from Puyo to Tena and
:ted to the Quito-Baeza-Lago Agrio road in the late 1970's.
nnection between Baeza and Quito was completed in 1972. Oil
ation in northern Napo Province and the completion of the
ndean pipeline in 1971 caused an explosive expansion of the
ıtion of the north Oriente, with colonists following the
constructed for petroleum exploration and exploitation.
to petroleum exploitation in the early 1970's, little major
ıstation had occurred in the Oriente. With the opening of
ıad from Baeza to Lago Agrio, the resettlement after the Loja
ıuake, and the opening of petroleum exploration roads, a
of colonists entered the northern portion of the Oriente.

he establishment of the large Yasuni National Park (679,000
n the extreme eastern portion of the region, could be
ed to preserve the majority of the biodiversity in the
ds of eastern Ecuador. However, recent petroleum discoveries
region and the roads planned to service the wells will open
rk to colonization and consequent reduction of
ersity. The Cuyabeno Faunistic Production Reserve (254,760
northern Napo province is bisected by petroleum roads and
en seriously threatened by consequent colonization. The
Protector Cerro Sumaco y Cuenca Alta del Rio Suno (100,045
threatened on its southern flank by colonization by
ıs from the March 1987 Earthquake in northern Napo
te. Its northern flank is better protected by absolute
ssibility at the present time.

* * * * * * * * *

3.1.1. Comparison of the status of vascular plant species at four sites in Western Ecuador.

	RPSC	Jauneche	Capeira	Centinela
'ar plant species reported.	1289	728	772	1164
ıated plant species	215	136	141	177
: plants	1074	592	631	987
ıs now extirpated at site -	25		1	84
ıing native plants	1049	592	630	903

* * * * * * * * * * *

Table 3.1.2. Risk situation at 4 sites in Western Ecuador.

ıs at extreme risk due to 'l populations:	RPSC	Jauneche	Capeira	Centinela
ıc to site	18	5	0	± 84
at other sites in region	49	12	18	17
ıs of broad distribution	39	33	63	?
ıs with short-term ıainable populations at site.	942	542	559	?
ıs at risk on a long term ıis	312	73	187	?
ıs not at risk, primarily to wide distribution	670	469	372	300

ble 3.1.3. Data on reasonably well known species from which extrapolations concerning the diversity of the flora using the 10% factor suggested in Kress (1986) were derived.

stimates of Orchid genera and species for South American untries

Dodson (unpubl.) has recently prepared a list of the chids which have been reported from South America. After moving synonyms, and updating nomenclature, the list ntains 7,415 species which are recognized as valid. mparison of this recently prepared list with those of evious similar efforts is as follows:

stimated untry	Schlechter (1919/1924) Gen./Sp.	Dressler (1981) Sp.	Dodson (Unpubl.) Gen/Sp.	Dodson Gen/ Sp.
rgentina		200	102	120
olivia	78/323	750?	99/ 871	119/1100
razil		3000	2211	2500
ayenne			125	200
hile		50	49	60
olombia	146/1490	3000	196/2725	208/3000
cuador	93/746	2500	203/2568	214/3000
uayana			212	400
raguay			124	200
eru	111/838	2000	144/1433	165/2000
urinam			347	375
ruguay			29	40
enezuela	103/635	1500	169/1186	170/1300
exico & C.A.				2400
orth America		153		153

3.1.4. Regional status of forests and species at risk.

	Forest Cover Original (1000 km2).	Present	%	# of species	Species at risk
n Ecuador	80	5	6	6,300	1,260
forest	20	0.2	>1	1,000	190
it forest	40	1.5	4	1,000	140
forest	12	<.1	<0.1	1,700	340
ial forest	8	3.2	40	2,300	590
erra	102	26	25	10,500	2,625
Flanks	61	18	30	8,500	2,125
High Sierra	40	8	20	2,000	500
iente	81	41.7	51	8,200	1,230
of Andes	39	11.7	30	6,000	1,000
on Basin	42	30	70	2,200	230
	263km2	72 km2	27%	25,000	5,115

* * * * * * * * *

Table 3.1.5. Federally-protected Areas.

National Parks	Area
Cotopaxi	33.393
Galapagos	693.700
Machalilla	46,683
Podocarpus	146,280
Sangay	271,925
Yasuni	679,730
Biological Reserves.	
Limoncocha	4,613
Ecological Reserves.	
Cayambe-Coca	403,103
Cotacachi-Cayapas	204,420
Churute	35,042
Geobotanic Reserves.	
Pululahua	3,383
Ecological and Ethnic Reserves	
Awà	101,000
Faunistic Production Reserves	
Cuyabeno	254,760
Chimborazo	58,560
National Recreacion Areas	
Boliche	1,077
Cajas	28,808
16 Areas	2,966,477

* * * * * * * * *

3.1.6. Protective Forests or "Bosques Protectores"

ective forests are defined as forests located in areas not apt for cultural exploitation. Their function is to conserve water, soil, , and fauna. Many are privately owned.

ince	Name	Type	Area in Ha
as, El Oro, aldas, Manabi.	Mangroves	Mangrove	362,742
as	Loma Alta.....	Desert and dry forest.....	1,854
as, Manabi, Rios, incha	Daule-Peripa.....	Hydroelect. watershed...	220,853
as	Ramal del estero		16
as	Isla Puna.....	Mangrove and dry forest..	84,400
as	Cord. Molleturo..	Upland Forest.....	28,100
incha	Hda. Sta. Rosa & Yasquel		2,597
incha	Hda. Caracha		260
incha	Hda. San Carlos de Yanahurco		645
incha	Hda. La Perla		250
incha	La Paz y San Jose de Quijos		399
incha-Cotopaxi	Toachi-Pilaton-Pujili		212,000
incha	Hda. Piganta		927
incha	Hda. Pilopata, Pasochoa		319
incha	Eastern Flank of Volcan Pichincha		10,016
incha	Predio Zarapullo		21,585
incha	El Beaterio		18
incha	Km 76, Chiriboga-Sto		100
incha	Mojanda Grande		712
incha	Hda. Florida Blanca		7,493

3.1.6. (cont.) Protective Forests or "Bosques Protectores"

incha	El Carmelo	6,538
incha	Toaza	1,264
incha	Mindo-Nabillo	19,200
var	Hda. San Pablo	170
var	Cerro Samama y Guineales	3,101
var	Hda. Schishimbe	1,064
rahua	Cerro Casigana	180
y	Predio Jeco	2,324
y	B. de Quinoa Miguir	265
y-Canar	Paute	195,161
y	Sunsun, Yanasacha	
y	Hda. Totorillas	656
y	Mazan	2,430
r	Pamplona	34
r	Sta. Martha, Chical	4,512
r	Cubilan-San Camilo	902
r	Rio Burgay	36,700
ro	Bosque Petrificado de Puyango	2,658
	Cerro Sumaco y cuenca alta del Rio Suno	100,045
Rios	Aguatal de Arriba (Jauneche).....Tropical Moist Forest....130	
	Ingenio Sta. Rosa	12,410
bura	La Floresta	3,121
l Hectares Bosques Protectores		1,352,039

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ndix 3.2: Biological Diversity and Endemism in Ecuador

Endemism can occur at many different levels, from a single etop to a continent. Gentry (1986) used the term "locally mic" for species that have total distributions of up to 75,000 km. Thus any species restricted to the 80,000 sq. km of ern Ecuador as here defined should be considered as locally mic. In reality most species endemic to Ecuador are much more lized, occurring in only one or two ecologically appropriate st types, with original distributional areas of less than 00 sq. km.

.1. Western Ecuador

As a region, geographically isolated Western Ecuador is well n to harbor a large component of endemic species. We estimate t about 20% of the flora of the region is endemic. This imate is the same as that of Gentry (1982a) for wet forest nts based on distributional patterns of the Rio Palenque plant cies. For the 870 naturally occurring Rio Palenque species n known distributions, 20% (172) are endemic to Western Ecuador another 6% to Western Ecuador plus adjacent Colombia.

Similar analyses of the distributional patterns of the plant cies of the Capeira dry forest flora show that 19% are endemic the dry area of Western Ecuador (here taken to include the togeographically similar adjacent northwesternmost corner of u). Thus endemism of the dry forest species is essentially as h as that of wet forest ones. Dry forest plants differ in ing only 5 species (1% vs. 6% of the Rio Palenque flora) more ely endemic to coastal Ecuador plus adjacent Colombia. Moist est species tend to be less prone to endemism than those of her dry or wet forest in Western Ecuador. Nevertheless, lysis of the 553 species of the moist forest Jauneche florula dson et al., 1986) for which we have complete identifications distributional data indicate that a significant 15% are emic to Western Ecuador, with an additional 2% endemic to tern Ecuador plus southwest Colombia. Identifications are as too incomplete for our cloud forest florula sites to attempt ilar analyses, but all indications are that they have even her rates of endemism.

We conclude from these data that if lowland Western Ecuador 6,300 naturally occurring vascular plant species (see above), ut 20% of them (over 1,500 species) are probably endemic to the ion. Interestingly, even though moist and dry forest florulas e a higher percentage of widespread species (respectively 47% 50%) than does wet forest Rio Palenque (31%), the endemism e remains similar due to reductions in such intermediate egories as Central America-to-western Ecuador (8% at Capeira 12% at Jauneche vs. 18% at Rio Palenque). A taxonomic

akdown of endemism figures is also of interest. At Rio enque there are a disproportionate number of monocots among the emic species (28% vs. only 19% of the dicots) but at both eira and Jauneche endemism of monocots and dicots is similar. all three sites, fern endemism is much lower (6 to 9%), and hid endemism unusually high (24% at Jauneche, 50% at Capeira, 28% at Rio Palenque). Much of the excess monocot endemism at Palenque is due to better representation of speciation-prone hids. In view of their unusually rapid speciation (Gentry & son, 1987; Balough & Bernhart, 1988), an estimate of endemism ed on orchids might be expected to be on the high side, even ugh orchids are also famous for long distance dispersal of ir minute seeds. Orchids have been relatively intensively veyed in Western Ecuador and 68 (27% of the region's 250 known cies) are endemic. Again, this would seem to concord with our imate of around 20% endemism for the flora as a whole.

The preceding discussion addressed endemism at a regional el. However, within Ecuador there are loci of much narrower emism, especially on isolated ridge tops. Some of these ches of high local endemism may consist of habitat islands no e than 0.5-10 sq. km, such as that of Centinela, a ridgeline ching 600 m elevation 12 km east of Rio Palenque. That such reme local endemism is typical of certain tropical forests has y recently been realized (Gentry, 1982c & 1986).

Unfortunately our floristic knowledge is far too meager to luate how many isolated ridge tops shelter large numbers of emic species. It is certainly possible that many of them do did before being deforested). For example, preliminary ervations at Lita, a high rainfall region in Esmeraldas near Colombian border, suggest a very distinctive flora with many cies new to Ecuador and presumably to science; however, several the putative Centinela endemics have also been discovered re. Many new and apparently endemic species are also being covered at La Planada, just across the Colombian border on a 0 m ridge that extends from the main Andean Cordillera navides & Gentry, in prep.), at Tenefuerte, another local rula site east of Quevedo at 1000 m, and at Cerro Azul, a 400 m vation ridge dominated by cloud forest just north of Guayaquil.

How many such species exist and how many of them will turn to be extreme local endemics (e.g., Centinela endemics) can y be determined with far more extensive floristic data than rently available.

.2. The Sierra

Concrete data concerning endemism in the Sierra region is xing. Reverting to data accumulated on distribution of orchid cies we estimate that 1,050 species are limited to the Sierra ve the 900 m contour. If so, and the 10% rule holds, then

ɔut 10,500 species of vascular plants should occur in the ɟion. Due to the extreme number of microhabitats and the ɜcies adapted to live exclusively in them, we estimate that ɔut 25% of the species are endemic. Consequently, about 2,625 ɜcies might be expected to be endemic to the Sierra of Ecuador.

ʔ.3. The Oriente

Again concrete data is lacking, but substantial endemism ɔld be expected to occur only from the 900 m contour to about ɜ 300 m contour with the succeeding plains being much more ɔogeneous and extending well into Amazonia. Therefore, our ɜimate of endemism in the Oriente is set at about 15%. We ɜimate that about 821 orchid species are found exclusively below ɜ 900 m contour and more than half of those are restricted to ɜvations above 300 m. Using the 10% rule of orchids vs total ɜcular flora, then about 8,200 species of vascular plants should ɜur in the Oriente. Of those 8,200 species, 15% should be ɟemic for a total of 1,230 species.

The total number of vascular plant species endemic to Ecuador, the projection from reasonably sound data on orchid species in ɜ country is valid, should be about 5,215 species. These ɔstitute about 20% of the approximately 25,000 species expected occur in the country.

ble 3.2.1 Areas of forest categories in Ecuador with estimated numbers of species endemic to them.

rest tegories	Original Km2	Original %	Aborig. Km2	Aborig. %	1958 Km2	1958 %	1988 Km2	1988 %	Estimated Species Total	Estimated Species Endemic	Estimated Species %
stern Ecuador:											
y	20	25	15	70	12	60	0.2	1	1,000	190	19
ist	40	50	30	70	24	60	1.5	<4	1,000	140	15
t	12	15	10	80	7	58	<.1	<0.8	1,700	340	20
uvial	8	10	8	>90	6	75	3.2	>50	2,300	590	>25
btotal	80	100	68	77	49	63	<5	<8	6,300	1,260	20
e Sierra:											
anks	61	60	45	73	40	66	18	30	8,500	2,125	25
ghlands	40	40	12	30	10	25	8	20	2,000	500	25
btotal	102	100	57	56	50	49	26	25	10,500	2,625	25
e Oriente:											
se of ndes	39	48	39	100	35	90	11.7	30	6,000	1,000	17
azon asin	42	52	42	100	41	97	30	70	2,200	230	10
btotal	81	100	81	100	76	94	41.7	51	8,200	1,230	15
tals	263	100	206	78	175	67	72	26	25	5,115	20

ppendix 4: Biodata Sketches of Team Members

ruce Cabarle — Team Leader.
Forestry Program Associate / Latin America
The Center for International Development and Environment of the World Resources Institute

r. Bruce Cabarle, a Forestry Specialist, is an Asociate of the orestry and Land Use Program the Center for International evelopment and Development, a center within the World Resources nstitute of Washington, DC.

s the coordinator for the Center's forestry related activities in atin America, Mr. Cabarle has been part of an international ission working with national counterparts in providing periodic ssistance to the Government of Ecuador during 1988 to develop the AO coordinated, Tropical Forest Action Plan for Ecuador.

rior to joining the Center in 1988, Mr. Cabarle worked with a rivate engineering firm in Puerto Rico as field supervisor of a rototype, forage-grass farm, testing land applications of unicipal sludge. From 1984 to 1987, he held various positions ith the Forestry Bureau of the Department of Natural Resources of uerto Rico as Cheif Forester, Resource Forester and Inventory orester. Mr. Cabarle also held various seasonal positions from 980 - 83 with the US Forest Service in Idaho in the areas of imber sale administration, forest inventory, reforestation and ire suppression.

n 1983, Mr. Cabarle received a Master of Forestry Degree from the ale School of Forestry and Environmental Studies, New Haven, onnecticut. He is also a 1981 graduate of the Natural Resource anagement Program of Cook College, Rutgers University, New ersey.

alaway Dodson — Curator
Missouri Botanical Garden

r. Calaway Dodson is a Curator with the Missouri Botanical Garden n St. Louis, Missouri, and Director Ad Honorem of the Museo cuatoriana de Ciencias Naturales in Quito. In addition, he is a o-founder and owner of the Rio Palenque Science Center near uevedo, Ecuador.

e is resident in Ecuador where he continues with research rojects begun 31 years ago as a staff member of the Missouri otanical Garden. Those projects include a taxonomic treatment of he 2,568 orchid species now known to occur in the country. He lso collaborates with Dr. Alwyn Gentry, also of the Missouri otanical Garden, on floristic projects in which representative

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lots, usually 100 ha from each life zone, are analyzed for pecies content as well as compared with the floras of similar lots in other life zones. Fully illustrated Florulas of two of ne plots, Rio Palenque (wet forest) and Jauneche (moist forest), ave been published while a third, Capeira (dry forest) is in ress.

r. Dodson was Professor and Founding Director of the Institute of otany at the University of Guayaquil, Professor of Botany and urator of the herbarium at the University of Miami, and Founding irector of the Marie Selby Botanical Gardens.

uriel Crespi — Senior Anthropologist
US National Park Service

r. Muriel Crespi is Senior Anthropologist in the Washington ffice of the U.S. National Park Service. The country's major esource protection agency, the U.S. National Park Service is esponsible for parks and preserves that conserve exemplary or ndangered habitats with their dependent wildlife. It also is esponsible for preserving important cultural sites, structures, nd objects in the public domain. Frequently, the cultural urvival of contemporary Native Americans and other small-scale ommunities is contingent on access to these same natural and ultural resources.

s a cultural anthropologist, Dr. Crespi is concerned with eveloping policies, guidelines, and programs dealing with elationships between parks and indigenous or other communities raditionally associated with them. She also reviews planning and nvironmental impact documents, monitors programs, and works with ark staff and planners to define and resolve issues involving local communities.

rior to joining the U.S. National Park Service, Dr. Crespi worked s an independent consultant on projects that included evaluating ulti-cultural educational programs, developing training materials n women in agricultural development (for the U.S. Department of griculture). She has been on the faculty at Hunter College, of the City University of New York, and the University of Wisconsin t Madison.

etween 1962 and 1980, Muriel conducted field research in Ecuador, eld a Fulbright to teach at Universidad Católica, Quito, lectured t the Casa De Cultura in Quito and in Riobamba, and published on rural communities and peasant federations. Her special interests include small-scale communities and their resource uses, and the roles of local communities within regional and national systems.

arlos Luzuriaga — Independent Economics Consultant Associate: "Soluciones Económicas y Sociales, Cia. Ltda." Profesor: Central University of Ecuador, Catholic College, University of Ecuador, Army Polytechnical, Universidad San Francisco de Quito.

Dr. Luzuriaga recently completed several studies on the conomics of Ecuador's natural resources, including a paper for undación Natura and the World Bank on the economic aspects of evelopment in the Amazon entitled " Development policy issues for cuador's Amazonia". He is also a lecturer and participant in nternational seminars on this topic.

His interest in national resource economics evolves from an xtensive experience in economic development matters, and from dvisory roles in Ecuador and abroad, as a staff member and onsultant for the Organization of American States, the World ank, the United Nations Development Program and the U.S. Agency or International Development. Until recently, Dr. Luzuriaga was personal advisor to the Minister of Agriculture of Ecuador.

Doctor Luzuriaga has written several books on the economic evelopment of Latin America, lectured as visiting professor in wo US universities, and participated in missions or advisory roups on economic development matters in all but two of the Latin merica countries.

ietmar Rose — Resource Economist
University of Minnesota

r. Dietmar Rose was unable to leave a biodata sketch.

ohn Shores — Technical Advisor and Country Program Director
The Nature Conservancy/Latin America Division

r. John Shores is Senior Technical Advisor in The Nature onservancy's Latin America Division. The Nature Conservancy is n international conservation organization dedicated to the dentification and in situ protection of representative samples of he biological diversity of the earth. He is called on to provide echnical assistance in wildland management and conservation of iological diversity in countries where the Conservancy co-ponsors projects or where host-country organizations have equested assistance in identifying potential projects and ctivities.

s Country Program Director for Colombia and Ecuador, Mr. Shores s responsible for the planning, technical assistance, and

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onitoring of Conservancy-supported projects and programs in these
o countries.

r. Shores is a graduate of the Strategic Wildland Management
rogram at The University of Michigan's School of Natural
esources, where he was awarded the Master of Science degree in
983. His preparatory work was also at Michigan where he was
warded the Bachelor of Science degree in 1972 in the area of
atural Resource Planning.

ince 1972, Mr. Shores has focused his academic studies and
rofessional attention on the resource management issues in Latin
merica. He dedicated six years to the US Peace Corps, working as
n advisor with the national park systems of Colombia and the
ominican Republic. Since leaving the Peace Corps in 1978, He has
een a project advisor, project director, senior investigator, and
ndependent consultant with RARE, World Wildlife Fund, US Peace
orps, and USAID, as well as a computer consultant and programmer
or commercial and non-profit organizations.

is areas of special interest are wildland planning and
anagement, plus the application of computerized information
ystems to natural resource decision-making.