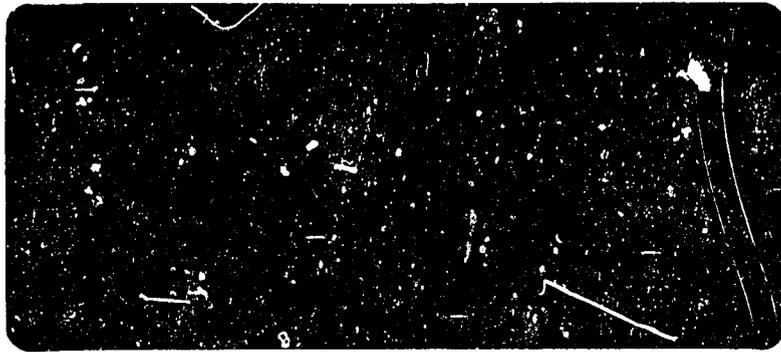


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International Science and Technology Institute, Inc.





PANAMA  
COUNTRY ENVIRONMENTAL PROFILE

PANAMA: STATE OF THE ENVIRONMENT AND NATURAL RESOURCES

FIELD RECONNAISSANCE STUDY FINAL REPORT

Contract No. AID/SOD/PDC-C-0251

International Science and Technology Institute, Inc.  
2033 M Street, N.W., Suite 300  
Washington, D.C.

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PANAMA: STATE OF THE ENVIRONMENT AND NATURAL RESOURCES  
A FIELD RECONNAISSANCE STUDY EXECUTIVE SUMMARY

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August 1980

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## PREFACE

This environmental profile of Panama is one of a series commissioned by the Agency for International Development (AID) for countries receiving United States assistance. This report describes the results of a field study conducted by seven-person multidisciplinary team over a total of five weeks.

The scope of work for this field study was prepared in a cooperative effort between the AID/Panama mission and Ministry of Planning of the Government of Panama. Five areas were selected for broad examination by the environmental team. The team received additional guidance from the staff members of the Ministry of Planning and the Technical Advisory Committee which helped to develop the scope of work (members are listed in Appendix A). This profile was prepared by the following persons:

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# PANAMA: STATE OF THE ENVIRONMENT AND NATURAL RESOURCES

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## SUMMARY AND RECOMMENDATIONS

### SUMMARY

#### Methods and Objectives

During a five-week period in April and May, 1980 a multidisciplinary team of seven experts in environmental and renewable natural resources undertook a general review in Panama of the following topics: deforestation and soil erosion; loss of wildlife and their habitat; contamination of air and water resources; solid waste disposal; noise pollution; and impacts upon the environment from hydroelectric, industrial, and agricultural projects. Individual reports by team members were compiled and edited into the present document. The principal objectives of the review were to: assess the status of the environment and natural resources of Panama; identify major resource and environmental management needs; recommend measures to avoid or minimize adverse impacts on the environment as a result of development plans, strategies, and projects; and provide information on the environment and natural resources of Panama that can be used in the planning and establishment of priorities for development. These objectives were established jointly by the Government of Panama and the AID/Panama Mission to help guide future development assistance efforts in Panama.

#### THE MOST CRITICAL ENVIRONMENTAL AND RENEWABLE NATURAL RESOURCE PROBLEMS IN PANAMA

The following were identified by the team as the most critical environmental and renewable natural resource problems facing Panama at present:

Spontaneous Colonization. The destruction of previously undisturbed wetland forests along the Atlantic seaboard and in the central part of Darién province by agrarian peasants migrating from the provinces of Los Santos, Herrera, and Chiriquí is one of the most critical environmental problems in Panama. These peasants destroy vast areas of forest by slash and burn agriculture and by clearing land for cattle ranching. Colonization of wetland forests is part of the natural development strategy and is seen as a necessary "conquest"; undisturbed forests are seen as non-productive economically. Colonization is fostered directly or indirectly by government agencies: spontaneous colonization follows the building of roads into previously inaccessible areas, while in some provinces government agencies actually provide easy credit to cattle ranchers wishing to expand their pasture acreage. There is no overall plan for orderly colonization in frontier areas and as a result land is cleared that is unsuitable for agriculture. Little attention has been given to alternatives such as timber management which could provide an economic return while maintaining a forest cover.

Deforestation. Current estimates of Panama's actual forest cover range from 38 to 45% of the total land area (29,000-35,000 square kilometers). Destruction of forests is primarily the results of agricultural expansion into forested areas; approximately 2.7% of the country's land area is cleared for agriculture

yearly. Even at an intermediate rate of 1.5% per year, it is estimated that Panama will lose an additional 10,000 km<sup>2</sup> or one-third of its existing forest reserves in the next 25 years. At present, deforestation is taking place at a rate of 50,000 hectares per year. Although most of the deforestation is the result of land clearing for agriculture, other factors contribute to the destruction. These factors include: a poorly conceived and executed timber/forest concession system; complete absence of silviculture and forest management practices and information; estimates of lands suitable for agriculture based on inappropriate classification systems; poor timber utilization; and degradation of soils as a result of erosion and compaction. Although the Dirección de Recursos Naturales Renovables (RENARE), the agency responsible for all aspects of renewable natural resources, has adequate legal authority to enforce sound forest management practices, it has proven to be relatively ineffective. The Dirección does have a small reforestation program but projections allow for reforestation of only 38,500 hectares over a five-year period.

Soil Erosion and Rangeland Deterioration. The widespread loss of forest cover as a result of agricultural expansion into forested areas is causing major changes in the hydrologic cycles of major watersheds and contributing to the loss of an estimated 1600 to 2000 metric tons of soil per hectare per year in Panama. High intensity rainfall, easily eroded soils, and lack of knowledge of basic soil conservation measures on the part of small farmers all are factors in the erosion of soil and deterioration of rangeland. Grazing of livestock on moderate to steep slopes combines destruction of the vegetative cover of pasture lands with compaction of soil; again, heavy rainfall erodes unprotected soils. Within a few years, soil fertility is exhausted and the farmers move on to clear more land. This destructive cycle continues as agriculture expands into fragile wetland forest areas where soils are poor, unsuited to agriculture, and easily eroded once the forest cover is removed. Other impacts of denuded watershed areas, soil erosion, and sedimentation are sharp fluctuations in stream flows causing flooding and droughts, heavy siltation in hydroelectric and water supply reservoirs, and the loss of freshwater and marine fishery habitats due to excessive siltation in important breeding areas such as mangrove swamps. Soil erosion is a common problem throughout the agricultural zone of the country, with the highland volcanic soils of Chiriquí Province most seriously affected.

#### Destruction and Contamination of Marine Fishery Habitats.

Panama's marine fishery resources represent an important domestic food source as well as a principal export commodity. Critical to the long-term productivity of these marine resources is the protection and conservation of the country's extensive coastal mudflats and mangrove forests. These areas are being adversely affected by dredging operations, indiscriminant use of pesticides and defoliants, industrial pollution, construction of recreational development and commercial shrimp ponds, and extraction of red mangrove bark for the tanning industry. Panama's littoral zones, including coastal wetlands, marshes, mangrove forests, and mudflats, must be carefully developed to ensure continued production of important commercial species of fish, shrimp and shellfish.

## CONSTRAINTS TO EFFECTIVE NATURAL RESOURCE MANAGEMENT AND ENVIRONMENTAL PROTECTION

The major obstacles to effective natural resource management and environmental protection in Panama are:

Lack of Public Awareness and Understanding of the Environment. A very limited number of Panama's people live in a relative state of balance with the environment. The most notable exceptions are certain indigenous groups who have evolved stable subsistence patterns of existence. The population as a whole does not regard environmental protection a strong priority. Public awareness and understanding of the fundamental problems and conflicts that are and will be arising over natural resources management and use are equally minimal. The urban population's perception of the environment centers around aesthetic issues such as noise, odors, and open spaces, while rural campesinos regard their environment with a "conquista" (conquering) attitude as seen in indiscriminant burning of forest resources that could be harvested for other uses.

Current Development Strategies. Major commitments have been made by the Government of Panama to develop the natural resource reserves in the provinces of Chiriquí, Bocas del Toro, Darién and the Comarca de San Blas. Intensive development programs have been initiated in these areas to exploit the natural resources as part of a solution to Panama's immediate economic problems of high unemployment, spiraling inflation and interest rates, heavy dependence on foreign imports, and an outflow of capital to pay for development investments. Such development strategies reflect a willingness on the Government's part to accept adverse impacts of development activities upon the environment. Given the lack of broad public support for environmental issues, national priorities are unlikely to change until environmental degradation begins to affect the productivity of the natural resources being exploited.

Lack of Centralized Authority for Resource Management and Environmental Protection. The responsibility for natural resource management and environmental protection in Panama is distributed among a host of ministries and semiautonomous institutions. There is no central agency responsible for a continuing, comprehensive and integrated natural resources and environmental quality planning and programming effort. Competition for scarce financial resources is intense, and the Government's priorities have favored those ministries and institutions most directly involved in agricultural, industrial, and commercial production operations as well as the provision of services such as public health, education and other social services. At present, internal budget allocations within Panama's ministries favor traditional development projects as opposed to activities geared towards long-term sustained productivity of the country's renewable resources.

Lack of Technically Qualified Personnel. Panama's educational institutions offer limited training in the natural sciences and no training in either interdisciplinary or specialized environmental and natural resource management fields. The feasibility of establishing and maintaining an effective environmental and natural resource planning and management program in Panama will be hampered by a lack of sufficient numbers of well-trained administrators and technicians in the appropriate fields. Ensuring the availability of such professionals requires two simultaneous developments: institutions of higher

techniques that emphasizes practical field experience; and senior level decisionmakers in the ministries will need to broaden their understanding of the managerial and multidisciplinary skills required for effective planning and implementation of programs for the long-term protection and productivity of Panama's natural resources. These developments do not appear likely in the near future.

Lack of Accurate Environmental and Natural Resources Data. Environmental protection and natural resources management programs in Panama are hampered by a lack of accurate, up-to-date information on the extent and current utilization of natural resources. The availability and accuracy of the baseline data for natural resources in Panama is generally poor and unreliable. This is exacerbated by the lack of a central agency responsible for natural resources data collection and analysis. Until more accurate information becomes available, environmental and natural resource planning in Panama will have to rely upon limited and questionable data currently available.

## RECOMMENDATIONS

The following recommendations are presented in greater detail in the corresponding chapters.

### LAND SETTLEMENT AND RESOURCE DEVELOPMENT

- Establish a policy towards colonization that regulates settlement and determines the manner in which the wet forests will be used in the future, based upon ecological principles and guidelines, which will be followed by all development agencies;
- Review and modify the present road building program of the Ministry of Public Works to prevent or minimize impacts on the environment;
- Provide technical assistance to development agencies in preparing appropriate environmental strategies and resource management plans;
- Take corrective measures in the severely deforested areas of Colón province;
- Discourage extensive ranching in Donoso and Santa Isabel by suspending credit for ranching activities and prohibiting conversion of forested areas to pasture;
- Encourage planting of permanent crops such as cacao and coffee, and improve management of existing tropical tree species;
- Secure and protect the land rights of minority groups inhabiting areas of wet tropical forests which are subject to colonization and deforestation.

### FOREST RESOURCES

- Establish national and community forests with effective administration, technical management, and enforcement capabilities;
- Initiate experimental forest management projects for cativo, red mangrove, oréy, and cuipo and mixed wet forests, emphasizing multiple uses of forest resources;
- Implement silvicultural programs for cativo and red mangrove forests;
- Initiate intensive research programs to evaluate and develop innovative uses of Panama's forest products, such as using partially hydrolyzed cuipo wood as cattle fodder;
- Promote plantation forestry and agroforestry projects in areas with degraded soils;
- Evaluate Panama's forestry concession system, examining conflicts between short-term exploitation and the maintenance of long-term productivity of the forest resources;

- Establish and maintain up-to-date forestry statistics;
- Inventory forest areas threatened by agricultural expansion and develop rational land use plans based upon soil capability analyses.

#### AQUATIC RESOURCES

- Divert part of Panama's fishing fleet, both public and private, to exploitation of underexploited species by offering economic incentives and other appropriate means;
- Adopt and enforce regulations governing minimum size of harvest for selected species such as lobster;
- Utilize existing fishery resources more effectively, for example marketing fish caught by shrimp or purse seiners or exploring alternative uses of shrimp heads;
- Develop capabilities to collect and monitor environmental quality of critical habitat and biological communities;
- Maintain more complete statistical data on utilization of marine resources by establishing a permanent office at Vacamonte and providing required financial resources and technical personnel;
- Establish a Coastal Zone Management Committee, composed of distinguished public, private and academic experts, to administer coastal zone affairs. Grant Committee powers of consent over all projects or activities that could significantly affect coastal zone ecological systems;
- Initiate a comprehensive inventory and characterization study of Panama's coastal zone to establish current baseline conditions, including type of resource, extent, characteristics, ownership and present utilization;
- Formulate and adopt a coastal classification system consisting of different categories or levels of protection reflecting environmental sensitivity, resource abundance, uniqueness and ability to sustain long-term yields;
- Strengthen coordination and cooperation among different ministries regarding areas of jurisdiction, development strategies, programs and policies;
- Evaluate the potential effects of exotic species introduction programs, perhaps by an existing or expanded multidisciplinary committee to include representatives of RENARE, DINAAC, Dirección de Recursos Marinos and the University of Panama;
- Undertake research on feasibility of culturing native Macrobrachium species or utilizing sterile hybrids for pond culture rather than introduced species;

- Investigate raising and marketing of alternative marine stocks such as conch, turtles, and mangrove oysters.

#### WILDLIFE RESOURCES AND NATIONAL PARKS

- Establish a national wildlife and protected areas development plan, supported by a set of clear and comprehensive objectives;
- Design a synecological and applied research program, listing research projects in order of priority, in accordance with the proposed development plan;
- Review and evaluate national parks and wildlife legislation to determine applicability in view of proposed national wildlife and protected areas development plan. Incorporate means for active public participation in management and enforcement of development plan in the existing or newly-created legislation.
- Review existing and proposed national parks and their classification system, and adopt, where appropriate, new protection classifications such as biological reserves, wildlife sanctuaries, and ecological reserves which better reflect characteristics and needs of each area;
- Initiate series of pilot projects with multiple land use emphasis, including commercial exploitation of wildlife species such as turtle breeding, crocodile farming, and exotic tropical bird management;
- Establish within RENARE an Outdoor Recreation section to promote and develop tourism in national parks and public involvement in natural resource conservation.

#### SOIL AND WATER RESOURCES

- Plan, design, and implement national resource management projects by using an integrated multidisciplinary approach based upon watershed units;
- Conduct a comprehensive nation-wide survey of Panama's watersheds to identify critical problems, resource potentials, and current utilization in order to establish basic priorities of land use capabilities and development needs;
- Protect watersheds that serve as municipal water supply and hydroelectric power sources;
- Undertake practical research and development of pilot projects on soil and water conservation. Provide necessary financial, technical, and administrative support to institutions such as RENARE and IDIAP to ensure development and maintenance of such projects.
- Initiate integrated multiple-use watershed development projects where agriculture, forestry, road construction, and other land uses are combined according to land use capabilities;

- Develop within Panama's university and primary/secondary school systems an environmental awareness and technical capability to deal with natural resource and environmental protection problems;
- Establish and implement educational curricula and field extension services to meet needs of natural resource management and environmental protection.

#### WATER, AIR AND SOLID WASTE POLLUTION

- Conduct review of existing environmental legislation and administrative authority among different government institutions and revise to clearly delegate responsibilities;
- Establish a stream or water classification system to regulate use of Panama's water resources and adopt appropriate standards to ensure water quality within each classification category;
- Institute a permitting system to regulate withdrawals and discharges into all bodies of water. Promulgate practical regulations and guidelines and provide needed financial resources and technical personnel to enforce them;
- Initiate environmental monitoring and enforcement in areas where population and pollution source concentrations are highest and pose the greatest environmental risks;
- Prepare an environmental impact statement on the Cerro Colorado project, giving special consideration to the unique climatic, hydrologic and biologic characteristics of the sites and surrounding region, and details of proposed control measures and their anticipated ability to mitigate the potential negative effects of the project;
- Strengthen interagency and intra-agency coordination and communication among public, private and semi-autonomous agencies to ensure effective protection and utilization of Panama's natural resources;
- Establish a centralized data bank for the collection and retrieval of environmental information. Provide through this data bank access to international, regional, and domestic environmental information sources such as scientific journals, conference papers, theses, and legislation;
- Promote public awareness of the need for resources conservation through a variety of educational media including radio, television, newspaper articles, technical seminars, and other appropriate means.

MINERAL AND ENERGY RESOURCES

- Require environmental assessments and/or impact statements for mineral exploration projects such as Cerro Colorado;
- Sponsor an interagency investigation into potential land-use issues resulting from current patterns of mineral exploration and extraction, and the concession-granting process;
- Initiate an active monitoring program on the potential environmental hazards associated with the handling of petroleum products at both the Colón oil refinery and the petroleum port at Charco Azul in Chiriquí;
- Encourage the shift from petroleum-based energy sources towards renewable sources including geothermal, hydroelectric and biomass by active participation in regional energy development programs;
- Evaluate the effectiveness of watershed management components of existing hydroelectrical power projects;
- Support the development of rural decentralized non-commercial biomass energy sources, on a sustained production basis, through a combination of direct incentives and coordination of technical assistance provided by national, binational and international agencies.

## RECOMMENDATIONS TO AID/PANAMA

The following recommendations are consistent with AID's environmental policy (Regulation 16: PD-63) and with congressional authorizations under the Foreign Assistance Act (Sections 102, 103, 118, 119) relating to assistance in institutional strengthening as well as direct assistance in environmental and natural resources management. These recommendations are of the highest priority if the critically important natural resources in Panama are to be conserved and managed for long-term productivity.

- ° Increase staff capabilities in the environmental and natural resource areas by adding a full-time Environmental Officer with appropriate training in one or more of the environmental sciences, practical experience with impact assessment methodologies and procedures, and communication skills. Assist the government of Panama in establishing a technical capability to evaluate the potential effects of proposed development strategies and projects and select and implement environmental protection measures.
- ° Use this report as the basis for formulation of a strategy within the AID/Panama mission to include awareness of environmental and natural resources issues in all development programs funded by AID. Educate AID personnel to incorporate practical environmental safeguards in planning and design stages of development programs, and inform personnel of points of conflict and misuse of renewable natural resources, environmentally sound management practices, and the interrelationships of ecological systems.
- ° Institute a more careful review of potential Government of Panama development projects to be funded by AID and supervise more closely planning, design and implementation of potentially sensitive projects such as dams, roads, irrigation structures, and utilization of fishery resources. Indicate in project papers and loan agreements how environmental review, selection and supervision will be carried out, and what technical assistance is needed to ensure that potentially significant impacts are avoided or minimized;
- ° Undertake with the appropriate agencies, both governmental and non-governmental, a broad range of environmental education programs for senior and junior level personnel including seminars, workshops, short courses, and programs of applied research, field data collection, laboratory analysis, and environmental monitoring. Request the participation of qualified host country ecologists and environmental specialists to assist in the preparation of initial environmental examinations and environmental assessments of proposed development projects.

## POTENTIAL AREAS FOR PROJECT DEVELOPMENT

The following recommendations outline areas of potential project development for AID and/or the Government of Panama.

- ° Develop a Government of Panama National Commission for Environmental

Protection within the Office of the President. The Commission should have a strong mandate for action from the President and legislative authority. The Commission should have these functions: recommend and assist the President in formulating policies; evaluate programs and project activities of ministries, semi-autonomous agencies and private groups and assess the effect of their actions upon the environment; make findings available to the President, Legislature, and the public; serve as the coordinating body for interministerial activities relating to the environment; and provide technical assistance to provincial and local governments on environmental problems. Day-to-day technical and administrative operations would be carried out by a Technical Secretariat representing a cross-section of Panamanian experts. The Secretariat would be composed of professional, full-time personnel selected from the relevant disciplines.

- Initiate new programs in addition to institution building programs such as providing technical assistance in the following areas:
  - environmental inventory, analysis and use of different classification systems for forests, marine fisheries/coastal zone areas, streams and rivers, wildlife and national park areas, etc.;
  - environmental monitoring techniques, giving high priority to physical-chemical properties of air, land, and water;
  - impact analysis techniques;
  - integration of environmental studies into public policy formulation, development strategies and regional/watershed planning; and
  - management principles, criteria for selection, and action plans for the establishment and maintenance of protected areas, particularly the National Parks and wildlife reserve system, and potential biological and ecological reserves.
- Develop and implement specific environmental education programs for the public. Successful efforts to conserve Panama's natural resources and manage the environment will depend upon strong public support and understanding of the potential effects of development activities upon those resources. The AID/Panama Mission can help to generate an environmental consciousness by supporting and developing such programs.
- Update forestry inventory and deforestation assessment in Panama. Accurate and up-to-date information on Panama's forests is essential to the planning and implementation of realistic programs for the short-and-long term protection, management and utilization of forest resources. Review the status of Panama's forests and current rates of deforestation, based upon interpretative analyses of satellite imagery and conventional aerial photography with strong emphasis on field verification. Detailed data should be obtained on special forest types that have existing or potential commercial importance such as cativo, mangrove, and orey. Prepare maps of remaining forests and summarize data on the basis of the regional development framework used by MPPE. This study should be done in collaboration with RENARE and IGN, and should be directed and supervised by a tropical forest ecologist.

- Redirect colonization activities away from traditional slash and burn to a more rational use of forested areas based on their land use capabilities. Support a five-year forest colonization pilot project based on a "forest farming" concept. Forest colonization would be based on management of natural resources for sustained yield of timber; production forest could be owned and managed by colonist families separately or cooperatively. This project should be located in virgin tropical wet forests because of high timber stocking and rapid natural regeneration. Selection of pilot area and development of colonization plans must be based on detailed forest inventory, land use capability classification and forest management plans. This effort will require technical assistance in tropical forest management, silviculture, sociology and integrated rural development. The proposed pilot project could become a successful model for rationalizing land use by slash and burn colonists.
- Support specific projects which would promote the utilization of Panama's aquatic resources on a sustainable basis. Emphasize increased local employment generation capacity and effective production system organization. USAID/Panama can provide technical assistance in the form of production and processing technologies, credit mechanisms, and marketing channels as necessary for the following projects:
  - a pilot research project to identify alternative markets and determine the economic feasibility of non- and under-utilized resources such as shrimp heads and shrimp by-catch;
  - continued involvement in small-scale freshwater pond aquaculture projects with more thorough examination of the environmental implications of species introduction.

CHAPTER I. GENERAL ENVIRONMENTAL AND ECONOMIC CONDITIONS AND TRENDS

- A. Summary
- B. Environmental Conditions
- C. Demographic, Social and Economic Conditions
- D. National and Regional Development Strategies and Plans
- E. Agriculture and the Economy
- F. Livestock and Grazing
- G. Land Tenure

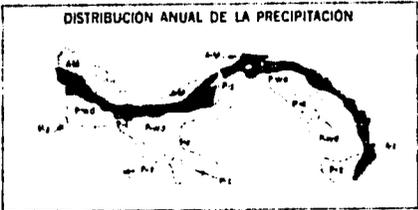
A. Summary

The Republic of Panama is located at the southeastern extremity of Central America and covers a total surface area of 75,616 square kilometers. It forms the narrowest and lowest part of the Isthmus that links North and South America. Panama is bordered by Costa Rica to the west, Colombia to the east, the Caribbean Sea to the north and the Pacific Ocean on the south. The country is divided roughly at its midpoint by the Panama Canal which transverses the Isthmus and connects the Caribbean Sea and Pacific Ocean.

Panama's narrow land mass is bisected in an east-west direction by a series of rugged mountains (cordilleras) and coastal ranges. These mountain ranges, which reach a maximum elevation of 3,593 meters (Volcan Barú) near the Costa Rican border, create distinct Pacific and Atlantic climate regimes as well as a unique diversity of ecological conditions expressed in different life zones. The climate is warm tropical, except for the cooler conditions which prevail in the western and eastern highlands. However, climate differences between regions are attributed primarily to varying levels of precipitation rather than temperature. Regional rainfall variations may range from less than 50 inches to approximately 200 inches or more per year. Seasonal variability in precipitation results in a distinct alteration between wet and dry seasons.

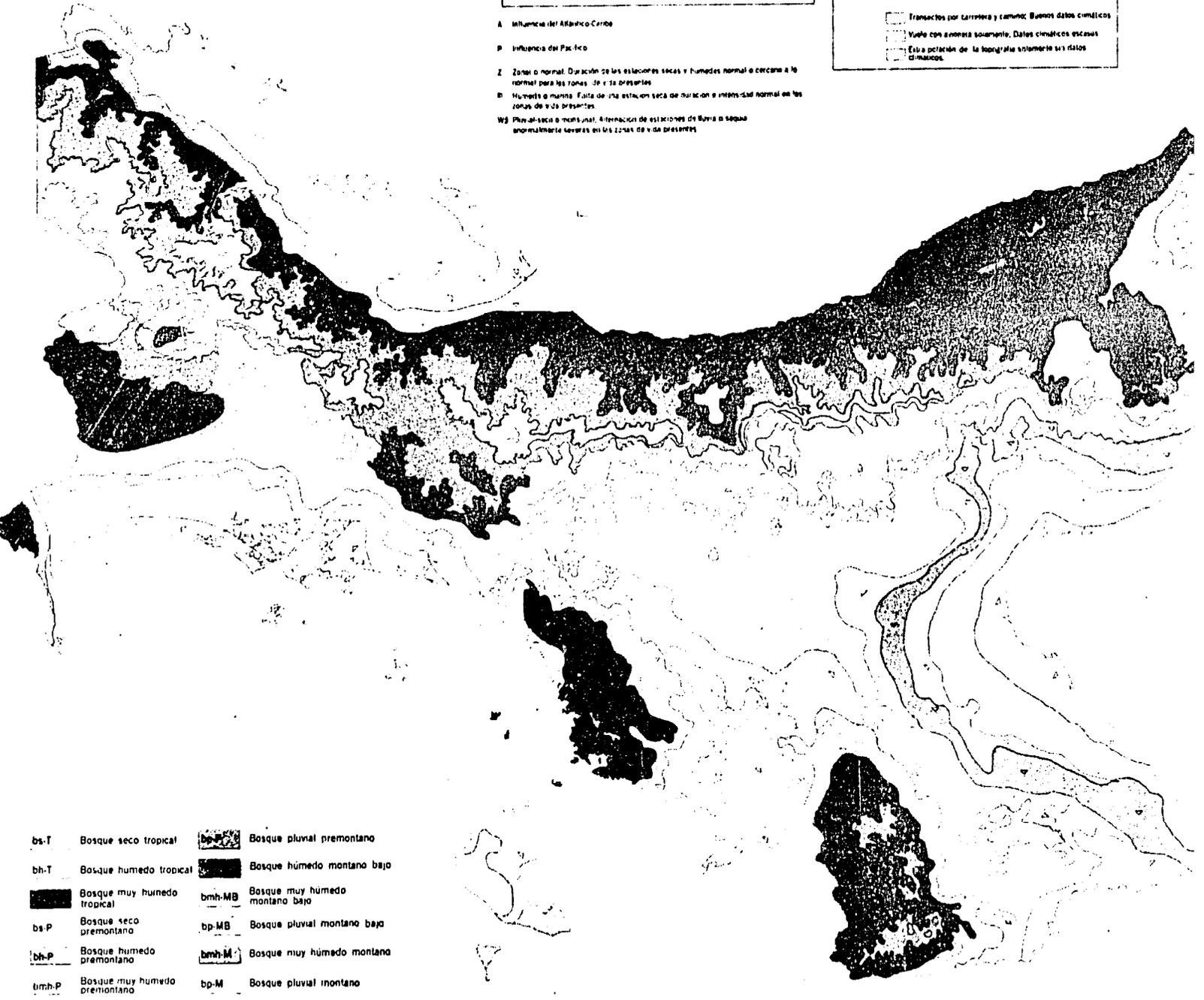
The wet season usually extends over a seven to nine month period beginning in April and ending in December. Heaviest annual accumulations of rainfall are found in three primary areas: (1) the Caribbean coastal plain west of Colón to Rio Calovebora; (2) the Pacific rain shield along the central and western Cordilleras; and (3) a small area located in the Serrania de San Blas. In contrast to these areas, the eastern part of the Azuero Peninsula along the Bahia de Parrita (Las Tablas, Chitre and Los Santos) experiences severe droughts and shows signs of desertification.

The country's primary renewable natural resources of significant importance are its limited but rich agricultural soils found largely in Chiriquí, Chanquinola, Chepo and the Chucunaque lowlands east of the Gulf of San Miguel; its extensive tropical forests which comprise over 300 different species of trees of potential commercial value; the highland watersheds of the Cordilleras which have potentials for hydroelectric power generation; and the extensive coastline (490 miles on the Atlantic and 870 miles on the Pacific) and associated marine resources which represent an important food source for domestic consumption as well as for export.



- A Influencia del Atlantico-Caribe
- B Influencia del Pacifico
- Z Zonas o normal. Direccion de las estaciones secas y humedas normal o cercano a lo normal para las zonas de vida presentes
- H Humedas o monta. Falta de una estacion seca de duracion e intensidad normal en las zonas de vida presentes
- MB Pluvial-seca o montana. Alteracion de estaciones de lluvia o sequia anormalmente severas en las zonas de vida presentes

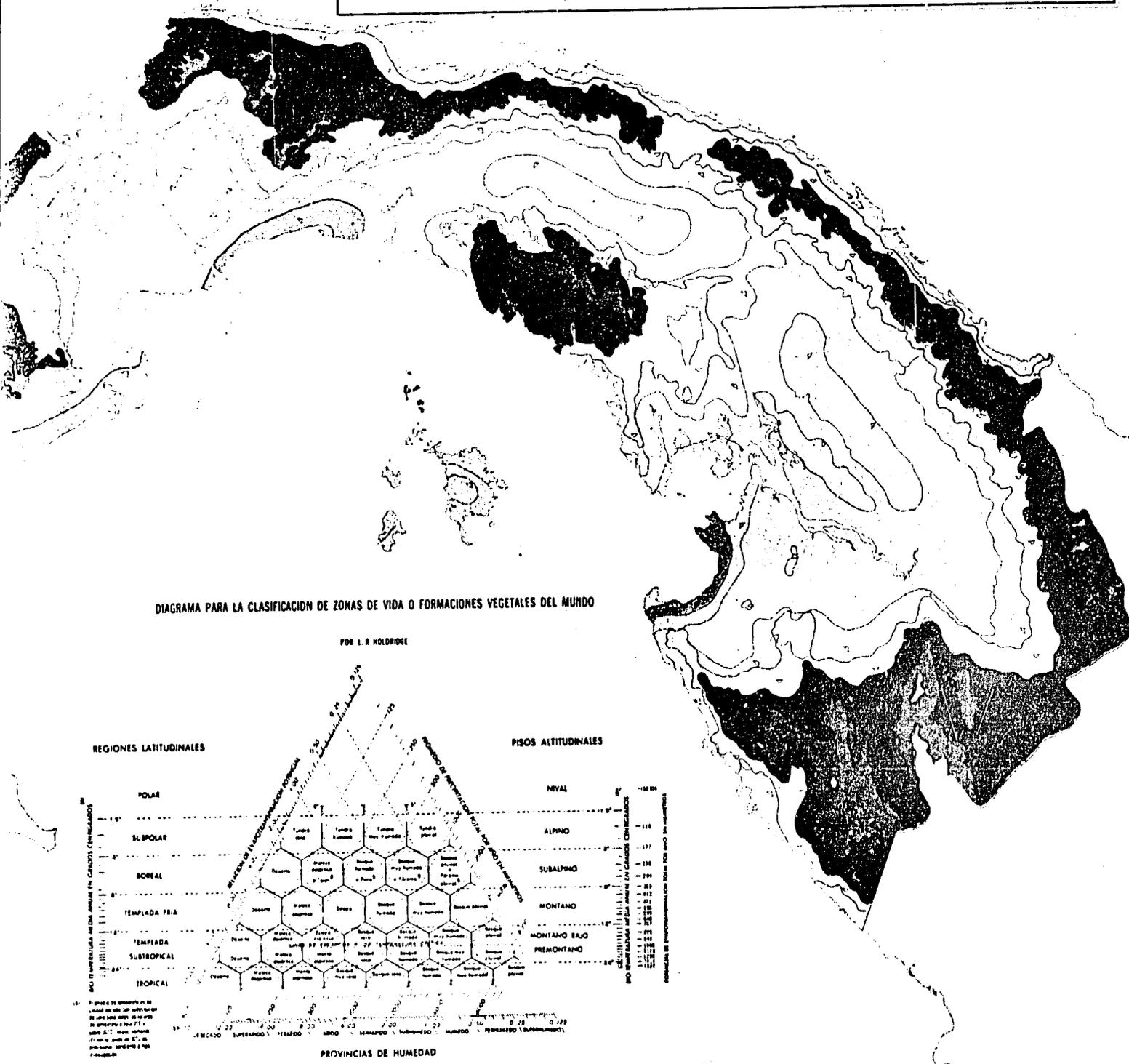
- Transectos por carretera y camino. Buenos datos climaticos
- Vuelo con avioneta solamente. Datos climaticos escasos
- Falta de cobertura de la topografia solamente. Sin datos climaticos.



- |       |                              |        |                                |
|-------|------------------------------|--------|--------------------------------|
| bs-T  | Bosque seco tropical         | bp-M   | Bosque pluvial premontano      |
| bh-T  | Bosque humedo tropical       | bmh-MB | Bosque muy humedo montano bajo |
| bs-P  | Bosque seco premontano       | bp-MB  | Bosque pluvial montano bajo    |
| bh-P  | Bosque humedo premontano     | bmh-M  | Bosque muy humedo montano      |
| bmh-P | Bosque muy humedo premontano | bp-M   | Bosque pluvial montano         |

(transición Fresco)  
 (transición Cálido)  
 (transición Seca)  
 (transición Húmeda)  
 Límites de Zonas de Vida  
 Límite de Transición

# FIGURE 7 ECOLOGICAL LIFE ZONES OF PANAMA



15A



MAR

BOCAS DEL TORO

LAGUNA DE CHIPPON

COTACOS LOS MOSQUITOS

CORDILERA DE TALAMANCA

CORDILERA

CENTRAL

CORDILERA

CENTRAL

SERANHA DEL TABASARA

DAVID

CHIRIQUI

SANTIAGO

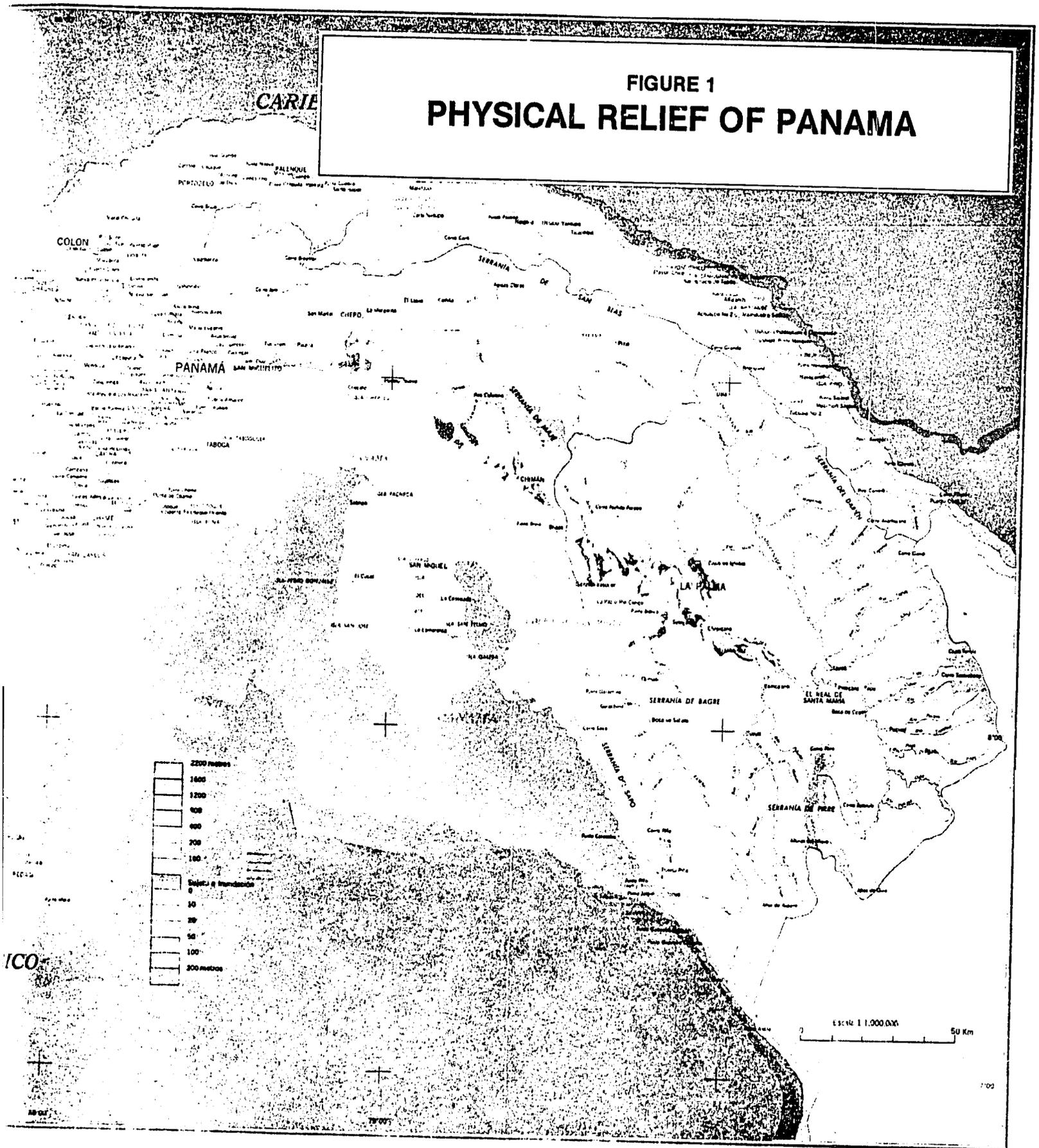
CHILRE

LAS TABLAS

OCEANO

PACIFICO

**FIGURE 1**  
**PHYSICAL RELIEF OF PANAMA**



## B. Environmental Conditions

The physical and biological characteristics of Panama are best understood in the context of its different vegetative life zones. (Figure 2) This Life Zone System, developed by Holdridge, has been widely used throughout tropical America and is useful for showing the diversity and complexity of Panama's environmental conditions. Broadly interpreted, these vegetative life zones can be classified into four categories:

1. Tropical Rain Forests
2. Forested Uplands and Adjacent Foothills
3. Savanna Hills and Lowlands
4. Coastal Mangroves and Tidal Mudflats

Due to a wide range of developmental pressures, Panama's resource base is being subjected to increased pressures. One of the most serious problems is the deforestation of the country's tropical forests. The rate of loss or destruction of tropical forests in Panama is estimated to be between 40,000 and 60,000 hectares per year. The majority of the forest clearing is occurring in the tropical rain forest and forested uplands/ foothills in the Darién, Colón, northern Chiriquí and Veraguas provinces. Widespread deforestation threatens serious soil loss of rich agricultural soils, flooding and depletion of water resources for domestic and industrial-commercial uses.

Much of the original forest cover in the savanna hills and lowlands have been replaced by secondary or later growths stemming from repeated clearing and burning of the land for shifting agricultural use or intensive cattle grazing. Because of the long-term effects of these practices, the land's capability to remain productive is being deleted rapidly in areas such as the Azuero Peninsula, Veraguas, and Colón provinces.

The coastal wetlands and intertidal estuaries of Panama are enormously rich in marine life producing numerous commercially valuable fish, shrimp and shellfish species. Conflicting land uses in these environmentally sensitive areas pose significant risks to the continued biological functioning and productivity of the essential life support systems found here. Particularly important is the protection and conservation of the mangrove forests.

## C. Demographic, Social and Economic Conditions

The size of Panama's population was estimated in 1978 to be approximately 1.8 million inhabitants. While official preliminary 1980 Census estimates of the national population have not been released yet, it is believed that the current population figure is slightly less than 2.0 million persons. Historically, Panama's rate of population growth (average) between 1930-1970 has equalled 2.8 per cent. This sustained high rate of increase since the 1930's has resulted in the country's population doubling since 1945 (Fox and Haguet).

The geographic distribution of Panama's population is roughly split 50-50 between urban and rural places. The total population of the country's nine urbanized areas (5,000 persons or more) was 738,680, which presents 51.7 percent of the national total. Of these only three had over 25,000 inhabitants in 1970: Panama City (520,000); Colón (103,000) and David (41,000). The dominance of the metropolitan region is clearly evident with Panama City and Colón located at either end of the canal waterway. However, it should be noted that David, Santiago and Chitré-Los Santos perform vital roles as regional economic centers in their respective geographic areas. The rapid growth of the metropolitan region in the 1950's, 1960's and early 1970's was in part attributed to the net outmigration from the Central Region and in particular the Azuero Peninsula.

The sharp contrasts between urban and rural standards of living, employment stability, accessibility to social and cultural opportunities plus the environmental deterioration of the Central region's natural resource base have been a complex set of "push and pull" factors that have dramatically changed Panama's social and economic scene. However, the material dreams of the country's rural-to-urban migrants have suffered serious setbacks since the mid-1970's. The national economy is severely strained by urban unemployment and underemployment (35%) and a rural economy that is stagnant. Recovery has been extremely difficult because of high interest rates, burden of servicing large international loans, and general lack of private sector confidence and willingness to invest in new growth.

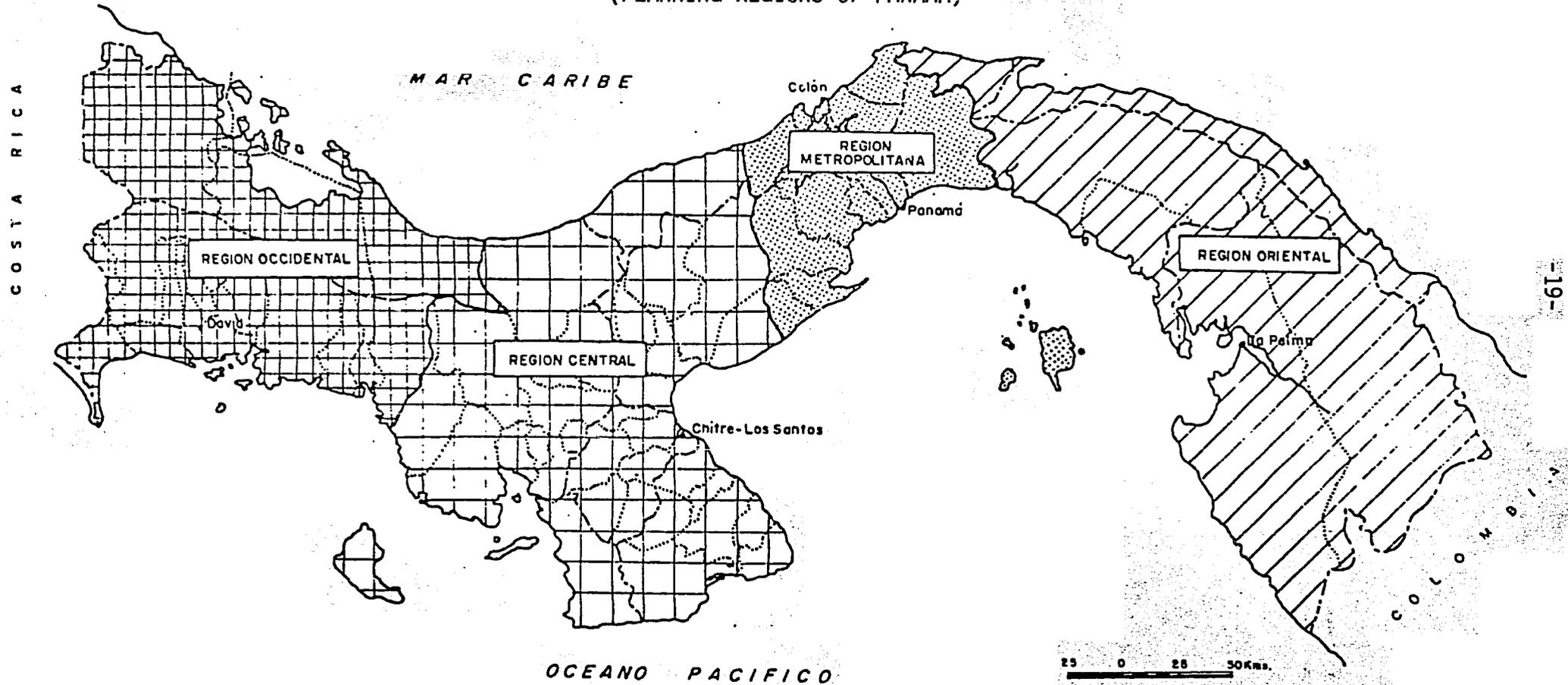
#### D. National and Regional Development Strategies and Plans

In an attempt to counter the prevailing economic and social conditions in Panama, the GOP initiated an overall development program in the mid-1970's entitled its National Development Plan for 1976-1980 and currently in draft form is the National Strategy for Regional Development 1980-1990. The primary objectives of these national planning efforts are to: (1) accelerate economic growth and improved distribution of economic benefits; (2) reduce foreign dependencies and vulnerability to international economic fluctuations; (3) increase diversification of Panama's economy and higher level of employment; (4) improve the capacity of public sector institutions; (5) increase public participation with decision-making process; and (6) improve standards of living for the least favored segments of the population.

##### 1. National/Regional Development Strategies

The accomplishment of the GOP's development objectives are tied to the adoption of a national/regional strategy consisting of two major thrusts. First, the disequilibrium of the Panama Canal and the metropolitan region are to be controlled to avoid the excessive concentration of public and private investments and economic benefits that have historically accrued here to the detriment of the remainder of the country. Secondly, the Panamanian economy is to be substantially diversified and modified towards producing goods and services to satisfy the country's internal market demands, discouraging use of competitive imported products and promoting of agricultural and industrial production for export purposes.

Figure 3  
**REGIONES DE PLANIFICACION DE PANAMA**  
 (PLANNING REGIONS OF PANAMA)



Concrete actions of the GOP to implement its national economic policies are embodied in a series of conceptual development plans prepared for the four (4) planning regions of Panama -- Oriental, Metropolitan, Central and Occidental (Figure 3).

The major development thrusts of the regional plans of action are summarized below by region:

#### Oriental Region

- Extension of the Panamerican Highway to the Colombian border;
- Construction of regional/local highway network to link Garachine, Boca de Sabolo and La Palma to the Panamerican Highway;
- Establishment of 3 areas for intensive agricultural use;
- Exploitation of forestry resources in the Serrania de San Blas and Serrania de Maje areas;
- Development of a new center of tourism in the Golfo de San Blas; and
- Provision for a National Park along the Colombian border.

#### Metropolitan Region

- Construction of a new highway from Penonomé to Colón and a direct connection from La Chorrera to the new highway to better integrate the 3 regional centers -- Panama City, Colón and La Chorrera;
- Construction of access roads to improve integration along the Atlantic coast from Colón to Nuevo Chagres and Miguel de la Borda and from Colón to Portobelo and Santa Isabel;
- Construction of a coastal access road parrall to Bahia de Panama from Chepo to Chiman;
- Protection of the Panama Canal watershed through reforestation and establishment of national parks;
- Establishment of intensive agricultural use areas in the vicinity of Chepo; and
- Development of a new center of tourism in the Golfo de San Blas.

#### Central Region

- Improvements to the urban structure of Chitré-Los Santos such as an industrial park, transportation terminal, etc.;

- Protection of the hydrologic resources (reforestation and national park) in the vicinity of Tonosí;
- Extensive reforestation in an arc-shaped area extending from Río Caté on the coast to Las Palmas, Canazas and Calobre; and
- Construction and/or improvement of rural access roads to improve economic and social integration of the region.

#### Occidental Region

- Development of a regional transportation terminal and expansion of the industrial park complex in David;
- Expansion of David's urban services;
- Construction and operation of the Cerro Colorado copper mine and associated support facilities and services; and
- Development of the hydroelectric potentials in the head waters of the Río Teribe and Changuinola.

#### E. Agriculture and the Economy

In the mid 1970's agricultural production accounted for almost one-fifth of the gross national product, employed about 30% of the labor force and generated nearly one-half of the country's exports. Many of the country's most important industries and trade and commercial operations depend directly on processing and marketing farm products. The production of food and fiber is one of Panama's most important economic activities and will continue to be in the foreseeable future. Panama's most important agricultural export crops in 1977 (according to World Bank information) were bananas (\$66.5 million), sugar (\$21.9 million), coffee (\$5.5 million) cacao (\$2.1 million), and red meat (\$1.5 million). These, when added to shrimp (\$30 million) and fish meal (\$10.5 million) exports, constituted approximately 80% of total national exports for 1977.

Domestic crops, similar to export crops, have since the 1960's been affected by a series of factors including political and economic uncertainties, droughts and virtual neglect by the Ministry of Agriculture (MIDA). Since the early 1970's, MIDA's credit, technical assistance and other services have been channeled principally to government organized farming communities called "asentamientos." A recent World Bank study identifies another reason, i.e., the growing scarcity of good readily accessible agricultural land, particularly on the Pacific slope which has historically supported most of Panama's agricultural expansion. Not only is the limit of the agricultural frontier being quickly reached, but also, degradation of already developed lands from over-use and ignorance of soil and water conservation principles (AID, 1979) is

reducing existing potentials. As an indicator of this general phenomena, land in crops actually declined in the 1960-1970 decade while pasture land increased.

With the assistance of international lending institutions and short-term borrowing from private banks, the GOP more than tripled the availability of farm credit during the the 1968-1975 period. Unfortunately, much of this credit has not been controlled and adequately directed to promote higher production in accord with proper land use. For example, of the 1977 total agricultural credit amounting to over \$160 million (almost 50% of the value of agriculture production in that year), 40% was invested in livestock. It is clearly evident that much of this credit went to financing, directly or indirectly, the deforestation of production or protection lands. In the future marginal grazing lands to the already 1,200,000 hectares of degraded and badly eroding lands of the Republic.

Most official agricultural credit is provided through the Banco de Desarrollo Agropecuario (BDA), and since 1973 a major portion of BDA credit has been invested in the government's collective farming ("asentamiento") operations. Many of these loans, however, fell into arrears because of poor management and inefficiencies of the "asentamientos." There appears to be no shortage of loanable funds for agriculture with external assistance from IDB, IBRD and AID, along with funds available from the private banking system. Credit distribution and "direction" remain a problem, however, especially for those small producers unable to offer title for loan collateral or to whom credit is not attractive under current lending terms.

#### F. Livestock and Grazing

Most of the 1,120,000 has. of pasture in Panama are located along the Pacific slope south of the Continental Divide where the majority of the country's rural population is concentrated. Most of these pastures (80 to 85%) are in "faragua" grass, *Hyparrhenia rufa*, under traditional extensive management practices. Since the late 1940's Panamanian credit institutions sometimes supported by international and bi-national agricultural assistance programs, have loaned money to encourage the planting of "faragua" and range extension, with generally no covenants nor control mechanisms with respect to where and how these land use changes were to be carried out.

Under current agricultural practices, the "colono" or slash and burn farmer is the first to enter new areas. He fells and burns the forest to provide a site for his crops, frequently using a mixed cropping system. The fertility is quickly depleted by erosion and oxidation of organic matter so that he must change his crop area to a new clearing. He often sows faragua grass on the old site and eventually sells the (untilled) land to larger livestock operators.

Faragua, by natural growth habit, is a bunch grass which grows in clumps and spreads by seeding rather than shooting out runners. Conse-

quently, even during the rainy season, a faragua pasture is 40-50% bare ground and is constituted by a series of grass clumps circumnavigated by muddy cattle trails. Exposed soil surfaces occupy an extremely high percent of total surface areas in faragua pastures due to overgrazing and burning, trampling, compaction and the growth characteristics of faragua grass.

Faragua grass is characterized by a low protein content. This situation is often aggravated during the dry season when the grass goes to seed and protein formerly available to cattle located in the seeds. In addition, the grass quickly loses its moisture content and palatability in the beginning of the dry season.

The principal grazing animals in Panama are beef and dairy cattle. Since cattle are less agile than sheep and goats and less inclined to climb steep slopes, they have a tendency to first graze the flat lands and the moderate slopes, and to graze the steeper slopes only when driven by hunger. The maximum slope gradient which cattle will graze under normal circumstances varies according to a number of factors, but is usually in the 20-40% slope category. Given the characteristics of faragua pastures, however, the cattle tend to quickly overgraze available pastures with moderate slopes and are forced to graze more steeply sloped pastures to avoid starvation during the dry season (six months or more in some parts of the country). The consequent development of cattle trails and terraces, which lack vegetative cover and become unstable and subject to sliding and accelerated erosion, is a common phenomenon.

Most pasture improvement and management efforts in Panama, including the Canal Watershed Management Pilot Project in its soil conservation-pasture improvement component, is directed toward changing traditionally managed faragua pastures over to more intensive management schemes using stoloniferous grasses that have a sod-forming growth pattern spread by rooting at the roots or nodes. The principal species of these new "wonder grasses" are tanner grass, Brachiaria radicans; signal grass, B. decumbens; pangola grass, Digitaria decumbens; star grass, Cynodon plectostachy; hermarthria, Hermarthria altissima; and aleman grass, Echinochloa polystachys.

While these new grass varieties are less subject to erosion, generally more "conservative" of the soil and offer the benefit of concentrating the same amount of cattle on less land, a serious doubt arises as to the cultural acceptance of this new grass and availability of all of the technological package that goes with it. Establishment costs are generally high (\$300/Ha.) and maintenance practices required are much more rigorous. The question arises as to the "appropriateness" of this technology in the context of the small farmer or rancher.

#### G. Land Tenure

The present land tenure situation is a serious impediment to rational natural resource management and conservation. A large percentage of rural holdings (an estimated 50%) are untitled and there is a concen-

tration of the best scarce agricultural lands of the country in the hands of a relatively few powerful large landholders. The predominant pattern is that of small subsistence farmers.

Watershed protection and soil conservation efforts affect both public and private lands and the public interest. Because of inadequate Forest Service personnel and infrastructure, enforcement is in many areas inoperative and/or ineffective. Squatting is a common practice frequently taken advantage of or promoted for personal and/or political motives on both private and public lands. The current written legal body in general favors squatting and makes it difficult for the state or the individual to maintain land in an "unimproved" forest cover.

Private lands are traditionally not subject to government controls, even for the protection of public interests. The attitude of land owners makes it difficult to require proper land use under existing policy. Expropriation is very infrequently used in natural resource management. Past world experiences in watershed management projects oriented toward the correction of the land use of small landowners indicate that economic incentives or strong disincentives will have to be used to accomplish land use changes.

## CHAPTER II: LAND SETTLEMENT AND RESOURCE DEVELOPMENT

- A. Summary
- B. Colonization - Its Causes and Effects
  - 1. The Causes of Colonization
  - 2. Critical Colonization Fronts
  - 3. Small Farmers and Colonization
  - 4. Inter-Ethnic Relationships
  - 5. Road Construction
- C. Panama's Development Strategy
- D. Assessment of Panama's Awareness and Commitment to the Environment
  - 1. General Public Understanding
  - 2. GOP Commitment
  - 3. Actions Facilitating Uncontrolled Settlement
  - 4. Conclusions
- E. Recommendations

## A. Summary

Panama's most critical environmental problem today arises out of the process of uncontrolled colonization. Social and cultural conditions in Panama are leading to the widespread destruction of the country's largest reserves of wet tropical forests. The tropical forest reserves are located along the Caribbean seaboard region, consisting of the provinces of Colón, Veraguas and Bocas del Toro and in the Oriental region, which comprises the eastern half of the Panama province and all of Darién province.

The process of colonization is based on extensive cattle grazing by the peasants from "the interior", Panama's densely inhabited western plains on the Pacific side of the Isthmus. These peasants or "campesinos" are originally from the provinces of Herrera, Los Santos, and Chiriquí. The most dynamic of all these groups of peasant settlers are the "Santenos" from the province of Los Santos in the Azuero Peninsula (Heckadon, 1979).

Two sets of interrelated problems arise out of the on-going massive settlement of 'interiorano' families in the distant frontiers. The first set of problems, identified several years ago by Heckadon and Herrera (1972), is based on relationships between the interior peasants, who transplant their distinctive cultural patterns and extensive grazing system, and the minority groups such as Indians (Cuna, Guaymí, Bogota) and Blacks (Darienitas and Costenos) who already inhabit the wet tropical forests of the Caribbean and the Darién. The second set of problems is the serious ecological and economic constraints inherent in the productive system of the interior peasant, which is based on extensive slash and burn agriculture (Heckadon 1978). Extensive grazing is done by expanding horizontally into the wet tropical forest areas. If present trends of converting forests into pastureland continue unabated, it is highly probable that by the end of this century, this natural resource will have largely disappeared from the Isthmus.

One major cause of colonization is the extensive road construction program carried out by the Government of Panama. Because government policy is directed toward raising the living standards of the rural poor, secondary and tertiary roads are built to provide access to marketing and service centers. Such roads also provide access to undeveloped forested areas and encourage colonization. Future road construction projects are essentially for penetration roads into these undeveloped areas.

At present, there is little public awareness of environmental deterioration in Panama. There still exists an attitude in Panama that views tropical forests as symbols of underdevelopment and as resources which in their natural state do not render any economic benefits to the country. The issues of environmental quality and conservation of scarce resources are not supported nor even perceived by the general public, and national development plans reflect this. Most development strategies are focused on fulfilling the social needs for employment, education, and food production.

## B. Colonization - its Causes and Effects

### 1. The Causes of Colonization

The causes behind the process of peasant colonization are very complex. As McKay (1971) has pointed out, colonization is the other side of the coin of the rural exodus to Panama's large urban centers. These migratory movements originate in the deep transformations sustained by the Panamanian agrarian society during the 20th century. Both are due to the increased penetration of national institutions into the countryside (health, education, etc.) and the formation of an internal market, particularly for beef (Heckadon, 1979).

The demographical revolution that has taken place in the hinterlands since the 1920's has been another contributing factor in migration since population has tended to double every twenty years. Rising population densities have meant increased pressure on natural resources, which in turn has led to a drop in the resource base. The ecological deterioration that has taken place in the Central and Occidental regions of Panama has taken place within the context of an unequal agrarian structure that has also functioned as an expulsive factor.

The contemporary process of colonization is largely a phenomenon that began after the conclusion of the Second World War, as Panama's economy sharply declined after the boom years. "Interiorano" peasants began to settle in the Metropolitan and Oriental regions during the early 1960's and in the Caribbean seaboard area since the 1970's (McKay, 1975). The population exodus from Panama's traditional rural heartland and has been particularly strong from the Los Santos province, which lost 30% of its population between 1940 and 1960 (C.G.R., 1965).

There is a new practice connected with colonization that includes the selling of newly opened lands. A particular strata of the peasantry called "rastrojeros" are penetrating unsettled or partially settled forested areas, enclosing tracts of land and then selling the cleared land to migrants arriving later. They are described as "a traditional peasantry only in the sense that they employ traditional rudimentary subsistence techniques, but their attitude toward the land is that it is a commodity to be acquired cheaply and sold shortly afterwards. This is a new form of conduct among the peasantry that did not exist a generation ago." (Heckadon, 1979).

### 2. Critical Colonization Fronts

One of the major environmental concerns involving the expansions of the cattle fronts is the rapid rate of tropical forest area being settled with a concomitant increase in the demands being placed on these forest ecosystems by both people and cattle. In the case of the district of Tonosí, there is an area of 1,300 km<sup>2</sup> that was

colonized between 1950 and 1970. Within this twenty-year period the population increased from 4,000 to over 10,000 inhabitants (12% increase), while the number of cattle rose from 12,000 to 65,000 thousand (442% increase). A general rule of thumb is that it takes one hectare of cleared forest to sustain one head of cattle, after it has been improved with pastures. In 1950, the country had 570,000 hectares in pastures (C.G.R. 1957). By 1970, the number of cattle had risen to 1.2 million and areas under pasture to 1.1 million hectares (C.G.R. 1975).

#### Eastern Section of the Caribbean

One of the most seriously threatened areas of tropical forests is located in the eastern sector of the Colón province known as "La Costa de Arriva." It is formed by two districts-Portobelo and Santa Isabel. Colonization is rapidly expanding into this sector particularly in the Portobelo area. This is due mainly to the building of the coastal road in the early 1970's that linked the city of Colon with the ancient Spanish town of Portobelo. The road has facilitated the penetration of 'interiorano' campesinos, mostly from Los Santos, into the area. Many of the people had been driven out of the district of Tonosí in Los Santos province as a result of the lowland forests having been already destroyed and transformed into pasture lands. A few forested areas still exist in the more difficult mountainous sections. However, these lands have been subdivided and it will only be a matter of a few years before these forests will be cleared. To illustrate the intensity of the colonization movement in the region, a 10,000 hectare forest park, created by the Panamanian Institute of Tourism (IPAT) around Portobelo for environmental and tourism reasons, has been almost totally deforested and the park exists in name only.

Within the 'Costa de Arriva' area only the district of Santa Isabel remains unaffected from colonization. However, the planned construction of the road between Portobelo, Nombre de Dios and Cuango will make this area vulnerable to settlement pressures. Already Agrarian Reform, part of the Ministry of Agriculture, is granting land tracts to colonists wanting to go and settle there. In addition, the Banco de Desarrollo Agropecuario (Bank of Agricultural Development) is extending credit to settlers so they can expand their herds.

#### Western Section of the Caribbean

The "Costa de Abajo" section is formed by the districts of Chagres and Santa Isabel. The district of Chagres has been almost totally deforested and the land transformed into grasslands. Only two small forested sectors remain intact. One is a small strip of forest in the vicinity of the Canal and the other along Rio Indio where the New Amsterdam Company still retains about 1,500 hectares in forest. Most of the colonists are now migrating in a pincer-like movement. Along the coast, the colonization front is moving rapidly from Rio Indio to Miguel de la Borda and Coclé del Norte as a result of a new road being built by the government, while to the

Cordillera from the Pacific side. Already hundreds of peasants have cleared extensive tracts of forest in the headwaters of Donoso's most important watershed (Rio Coclé del Norte).

This colonization front, which is advancing over the Central Cordillera and downstream towards the Caribbean coast of Donoso, has been greatly facilitated by the infrastructure provided by the Coclesito project. This is a directed colonization project, sponsored by the National Guard, that is intended to open the Atlantic coast to settlement. The Coclesito project itself involves mostly campesinos from the province of Coclé. Within the last two months, the National Guard completed cutting a preliminary trail for the eventual construction of a road between Coclesito and Belén.

### Metropolitan Region

Within this region the areas that have experienced the most serious deforestation, as a result of the spread of extensive grazing, are the watersheds of the Canal (formed by the Gatún and Alajuela lakes) and the Bayano dam that produces hydroelectric power. Deforestation has been very extensive in both the Gatún and Alajuela watershed areas, while in the Bayano dam's watershed the presence of the Cuna Indian Reservation around the newly formed lake has been an effective barrier to the expansion of the cattle front but has not prevented excessive logging and forest clearing for agricultural purposes.

### Oriental Region

In the eastern region of Panama the greatest threat to existing areas of tropical forests is the construction of the Interamerican Highway that serves as the main penetration route for the settlers into the headwaters of the Rio Bayano and into Darién itself. Large tracts of burnt and cleared forest are found along the highway corridor from Canitas in the Chepo province to Santa Fe in Darién province. The migrant peasants are moving in the tracks of the highway construction equipment. It appears that the majority of these households are either "Santenos" or "Herreranos", people from the Azuero peninsula. In the case of the "Santenos", these families appear to be arriving from other former colonization fronts that are now expelling population. Some of the households along the route have already participated in two and even three earlier fronts. These families have sold their properties in the old fronts hoping with the acquired cash to obtain larger land tracts in this new frontier.

Most children in the frontier seem to be undernourished, somewhat yellowish and thin, and show all the signs of the enormous sacrifice and the toll taken by the harsh conditions of any newly opened front.

### 3. Small Farmers and Colonization

An Agricultural Sector Assessment document (AID, 1969) identifies the small farmer situation as one of the most critical socio-economic problems of the country, if not the worst. It was estimated that 89% of Panama's rural population is living in poverty conditions, with per capita annual incomes of \$304 or less. Furthermore, over 16% of the total rural population was classified as living under conditions of "extreme poverty" with annual per capita incomes of less than \$160. The geographic distribution of this poverty is closely correlated with areas of most extreme resource base degradation and thus is concentrated in the provinces of Veraguas, Panamá, Chiriquí and Colón. The higher incidence of extreme poverty is found in the Veraguas province with 61% of its population classified as extremely poor.

According to various surveys done by the GOP, bilateral and international institutions alike, most of the rural poor are engaged in subsistence agriculture, have no legal title to the land they work, receive no institutional credit nor technical assistance, and utilize very rudimentary production methods. The illiteracy rate is almost 50%, housing and health conditions are extremely poor, and malnutrition is widespread. A shifting agriculture pattern, oftentimes associated with extensive pastoral land uses is common, particularly in the Azuero Peninsula and Darién. Certain cultural groups, such as the "Santenos" that come from the Azuero Peninsula area, especially around Chitré and Los Santos, are well known for their extremely destructive land use pattern of cut and burn agriculture with an almost absolute disdain for the worth of trees and forest cover. This small farmer-rural poor complex is the direct source of many of the problems of rural to urban emigration, spontaneous colonization and deforestation of the marginal hinterlands and natural resource (particularly soil, water, forest and wildlife) degradation.

Improper land use reflected in degraded farm and pastureland throughout western Pacific Panama and the new agricultural frontiers (i.e., Darién, Colón, etc.) is generally an expression of the exploitation of marginal lands and great pressure on the land's resources.

To better understand the reasons why extensive grazing is unable to provide the peasants with a sound basis for economic growth, one must examine the productive system of the campesinos as a whole. According to Heckadon (1980) campesinos from Panama's interior such as the Santenos make their livelihood by practicing a mixture of subsistence 'roza' farming (slash and burn agriculture) that provides them with their basic foodstuffs, particularly the key grains such as rice, corn and beans. Grazing on the other hand provides the household with cash to purchase the increasing number of manufactured goods and services that have become indispensable needs of the peasants. While technologically the peasants' productive system has evolved very slowly, the socio-economic conditions under which the system operates have changed radically in the last decade.

Within his small frontier property, the campesino responds to these new conditions by expanding both his subsistence and commercial activities, which causes a rapid deterioration of the natural resources at his disposal, particularly the soils. When the soil fertility in cleared tropical forest areas has been depleted, it cannot sustain the production of the basic foodstuffs upon which peasants depend. Once subsistence agriculture becomes infeasible, qualitative changes begin to adversely affect the social organization of the households. The agricultural crisis "has a direct impact on nutrition and employment for the campesino household" (Heckadon, 1978). Extensive grazing is unable to make up for the loss of subsistence agriculture. The breakdown of subsistence agriculture in the regions of colonization is linked to the destruction of the wet tropical forests themselves. (Heckadon, 1978). When this occurs there also begins a breakdown of local peasant society, signaled by concentration of land by fewer owners and the emergence of a new class of landless peasants. Emigration from the area follows shortly afterwards.

There is a strong emigration pressure from the Central provinces outward toward the hinterlands. Poor Santenos will continue colonizing new lands in search for a better existence and will likely be spreading traditional faragua pastures throughout all those colonization fronts open to them in the country. Unfortunately, the drier agricultural frontier is rapidly coming to an end and what confronts them is generally a wetter and much more hostile environment. Here traditional faragua systems will meet with less success and cropping to grass "turn around" times will be even shorter. Traditions and land use patterns will have to be changed quickly and for hundreds of campesino families if massive amounts of human suffering and environmental degradation are to be avoided in the near future.

In the wetter life zones, which now constitute the bulk of the remaining lands of Panama, permanent crops and forestry land uses represent stable and sustainable systems under these adverse environmental conditions. In other cases, it is simply a question of safeguarding forest protection lands, controlling spontaneous colonization and providing alternative employment opportunities for the rural poor.

In addition to land degradation and erosion problems, another major danger is represented by the extension of grazing lands, particularly into the eastern portion of Panama. "Aftosa" (foot and mouth disease) is a very real and imminent danger if the "Tapón del Darién" (the Darién Gap) is opened up into Colombia. The environmental implications of aftosa are clearly described in the environmental impact statement developed for the Interamerican Highway (U.S. Department of Transportation, 1976, and R. Goodland, 1977).

#### 4. Inter-Ethnic Relationships

For centuries, Panama's wet tropical forests have been inhabited by minority groups such as Indians and Blacks. These groups have adapted well to their local habitats and as a rule, their productive practices are ecologically sound. Given the long standing physical isolation of their traditional habitats, these minority groups have remained somewhat outside of the country's social and political mainstream. However, their geographic and cultural isolation will be largely broken by an extensive governmental road building program planned for the 1980's.

Besides facilitating communications and reducing the costs of transport, these roads will accelerate the penetration of "interiorano" colonists into the wet tropical forests of the Caribbean and Darien regions. This will bring the colonists into closer contact with the minority groups who live in these forested areas.

Both Indians and Blacks have cultural patterns that are distinct from those of the interiorano campesinos. Furthermore, the land use patterns of these minority groups are ecologically sounder than those of the "interiorano" peasants, who above all are interested in transplanting their extensive grazing system into the wet forests. If future conflict situations arise between the traditional forest dwelling minorities and the "interiorano" peasants for possession and use of the land, the GOP will most likely favor the latter.

The issue of the critical role of the state in favoring the cattle rearing settlers of the "interior" above other ethnic groups with different cultural and productive practices was foreseen several years ago in a still largely ignored monograph published by the then Dirección General de Planificación de la Presidencia. The two principal authors of this document (Heckadon y Herrera) stated: "At the national level the colonists from the 'interior' belong to the cultural group that historically has been politically dominant. As part of the dominant group, they will in all probability assume an attitude of domination towards other groups within the area both in a cultural, economic and political sense. . . ." ".Consciously or unconsciously state programs favor those groups that belong to the so called national culture, to the detriment of the rights of other cultural groups. When in critical periods the rights of the latter groups are considered, the government starts from the premise that substantial parts of the indigenous culture will have to be eliminated as if these different cultural systems could not be fitted into the existing models of economic development. Thus, seldom is there a meeting of interests between those of the Indians and other national groups, especially those sectors that determine national policy.

"The colonists, for example although they are a marginal group of a lower social class within the dominant national society, are aware of being part of this society; they have developed a political awareness and this experience gives them sufficient self-confidence

that allows them to transform themselves, faster than any other cultural group, into an effective political pressure group."

Today, in both the Costa de Arriva and Costa de Abajo sections of Colón, the local Black communities feel themselves at a loss when faced with the penetration of the ranching settlers. The "costenos", who have seldom engaged in fencing land or burning it to transform it into pastures, feel that they cannot count on the support of either the national or provincial authorities when conflicts arise with the settlers. There is a substantial degree of truth in this because most of the upper echelons of the National Guard are of "interiorano" stock, who are thoroughly convinced that minority groups such as the Blacks of the Caribbean coast are lazy and not real cultivators. This prejudice towards rural cultural groups that are not interioranos permeates the whole of the central government. For most of the leadership of the central government, the "Conquista del Darién" involves more than the economic imposition of grazing - it is a cultural conquest as well.

##### 5. Road Construction

The government of Panama has carried out an extensive program of construction of a network of primary and secondary roads in the most populous sections of the country. Indeed, Panama is one of the most advanced of the Central American countries with respect to its access infrastructure (road and highways). Many of the problems the GOP still faces in this respect, however, have to do with the highly disproportionate concentration of population and economic, social, political and cultural activities in the Metropolitan-Panama City-Colón corridor in contrast to the relatively forgotten rural areas. The rural portion of the country, in general, has a widely dispersed population in a large number of small settlements with a relatively low level of physical and economic integration. One notable exception to this rule is the integrated and fairly advanced province of Chiriquí. This situation in the rural areas has led to low income, underemployment, out-migration of the more productive segment of the population to urban centers and the metropolitan area, and a dependence on subsistence and low-technology methods of production.

The spine of Panama's highway system is the Interamerican Highway, which extends from the Costa Rican border to the Darién Province. West of the Canal, the road is paved to the border; however, much of the road east of the Canal is gravel surfaced. As of 1976, the road network had effectively linked most of the major urban centers and rural zones of highest agricultural productivity. As the network was constructed, tertiary roads running to small rural communities located off the main roads were not built. Each community was left to its own devices to build connecting links. Usually the result was a trail created on an ad hoc basis by foot and horse traffic. Later, some of these trails were widened and graded for use of motorized traffic during the dry season. But many still remain little more than cart trails. Because these roads have no

provision for drainage and the soil is easily eroded, the wheel tracks act as drainage ditches, the ruts deepen and the entire road may soon take on the appearance of an eroded gully. Also, the development of these tertiary roads is generally a function of spontaneous rural colonization, which is largely undirected and unplanned. Politicians, government officials and decision makers generally respond to population pressures rather than any rational technical criteria for road improvement.

A total of 7,774 kms. of roads were inventoried in 1976 in an AID/GOP (MOP) study (Aid Rural PP, 1978). Approximately 23% were gravel surfaced while 45% were earth surfaced. Approximately 65% of the earth surfaced roads were considered in poor condition.

Since the mid-1960's and increasingly since 1968, rural areas have received increased attention from the government. Development policy has been primarily directed towards raising the living standards of the rural poor (small farmers) and integrating them into the political life and economy of the nation. Clearly one of the major constraints to increased income and provision of social services for small farmers is the lack of all weather access roads to rural marketing and service centers. Major projects contemplated for the next 5 years or that are already in the process of construction include:

Oriental Region:

1. Darién Interamerican Highway - segment Santa Fe - Yaviza; still under construction.
2. Road from Carti to Tupile (or Llanos - Chepo) - from the Interamerican Highway north to the Comarca de San Blas coastline; under construction.
3. Road from Santa Fe to La Palma to Garachine.

Metropolitan Region:

4. Penonomé - Colony Highway
5. Coastal road west from Colón to Cocle del Norte.

Central Region:

6. Penetration roads associated with the Coclesito colonization project.
7. Santiago - Soná - Tolé Highway.

Occidental Region:

8. Gualaca - Changuinola Highway, opening up Bocas del Toro province.

9. Road to Cerro Colorado Project.

10. Penetration road from Cerro Colorado to Bisira area (Laguna de Chiriquí).

All of these roads (with the exceptions of 7 and 9) are characterized by being penetration roads that will open up forested and undeveloped lands. Although all of these roads are potentially dangerous because of the spontaneous colonization that they are likely to promote, in most cases on marginal lands, the Darién and the Gualaca - Changuinola Highways are of particular concern because of the important forest and hydrologic resources that they will subject to deforestation and degradation impacts associated with land use changes. No special precautionary measures are being taken in the case of those projects in construction (i.e., cases 1, 2, 5, 6, 9) nor are there any indications of the requirement of measures to avoid environmental degradation in those projects projected to be initiated in the near future (i.e., 3, 4, 7, 8, 10). Furthermore, there is no institution currently capable of, nor active in controlling colonization pressures associated with such projects.

C. Panama's Development Strategy

Panama's focus on equity-based rural development coincides with most other bilateral and international assistance policies and is generally consistent with AID's legislative mandates.

The overall strategy that has emerged to address these goals, however, is frequently counter-productive and in conflict with sound environmental/economic development principles. One of the three principal goals of this strategy is "incorporating the hinterland and especially the more backward rural areas - into the political, economic and social mainstream of the nation" (AID, 1969). The encouragement of colonization, the granting of land titles and the provision of improved infrastructure (roads, drinking water and electrification, etc.) and social services all in more remote and often marginal areas not only sacrifices the small farmer, but gives rise to medium- and long-term environmental damages of serious consequences to the general public. If this "conquista" occurs spontaneously and without adequate studies, planning and governmental controls over land use (as is occurring in Darién and many parts of the Atlantic Slope), the results will be disastrous. The current agricultural and rural development policy, noble and ambitious in its intent, is environmentally dangerous and economically counter-productive on a medium and long-term basis. Environmental constraints and integral development potentials must be recognized and incorporated into this policy and planning process to permit success.

In addition, a myopic focus on improving the lot of the small farmer has other dangers inherent in it. The assurance of overall national agro-sector economic efficiency and solvency is critical given Panama's current balance of payment problems. Also, the potentials of the manage-

ment of other non-traditional resources (forests, fisheries, hydroelectric power, etc.) must be considered in relation to this agricultural sector policy, and trade-offs should be made where other potential uses are greater than those afforded by agriculture. "Ecodevelopment" must be the basis for national and regional planning rather merely than the small farmer and his farm.

Currently, Ministry of Planning and Economic Policy (MPPE) and GOP policies also are promoting a broad regionalization and balancing of the socio-economic development of the country. A misconception commonly derived from this policy is that the implementation of infrastructure (agriculture, etc.), must go with the "development" of the hinterland. There seems to be little appreciation for the fact that some regions should probably remain essentially "undeveloped". In this state they would be in Panama's best interests. A good example of this is the Chanquinola and Teribe watersheds which could best be utilized for hydro-power development and protected against colonization and forest clearing. Also, the development of large engineering projects such as highways, Cerro Colorado, the interoceanic canal, the oil port and hydroelectric dams must be viewed and evaluated with the context of their contributing or inhibiting these broader environmental and ecodevelopment goals.

One of the major constraints in defining an ecological approach to development is the lack of ecological awareness and understanding among Panama's political and economic leadership. Heckadon (1980) states:

"There still prevails an ideology of development which is ecologically short-sighted that views the tropical forests as a symbol of underdevelopment and as a resource which in its natural state does not render any economic benefits to the country. This ideology proposes the substitution of the tropical forests and the utilization of the soil for other uses. This substitution of the forests is euphemistically called 'the integration of the jungle into the national economy'. To achieve the integration of the last areas of tropical forests different measures are being taken crystallizing in around strategies known as the 'Conquest of the Atlantic' and the 'Conquest of Darién'."

#### D. Assessment of Panama's Awareness and Commitment to the Environment

The significance of Panama's environmental deterioration has been largely subordinated to the short-run interests of finding immediate solutions to its economic and social problems. The term "environmental crisis" has not entered the vocabulary of the general public or politicians yet.

However, the extent and severity of the country's destruction and degradation of its natural resource base has probably reached the point where recognition of a real crisis is inescapable in the near future. The disparate relationships between economics, politics and environment quality will be better understood in terms of their interdependences by

the majority of Panama's inhabitants as the effects of major environmental problems begin to be felt. Clearly, there are signs that the stability and productivity of some ecosystems are being significantly threatened. Examples include: overfishing and destruction/contamination of white shrimp estuarine habitats; overgrazing and loss of soil fertility in the Pacific Cordillera uplands and coastal foothills; and depletion of surface and ground water supplies as a result of uncontrolled deforestation in the Metropolitan, Central and Occidental regions.

To a great extent Panama's environmental problems are a reflection of its economic, social and political dilemmas. Stimulated by rapid population growth, imbalanced spacial distribution, and increased pressure of more people requiring more goods and services, the GOP has responded by encouraging the use of traditional technologies and hasty adoption of new ones without proper regard for their appropriateness or suitability, in the in the country's major development frontiers -- Darién Colon and Bocas del Toro provinces. The ensuing environmental problems are basically of two types: (1) the effects of natural resource loss or deterioration; and (2) the effects of economic development.

The first of these problems poses the greatest challenge to Panama's immediate and long-term economic stability. Out of desperation, ignorance or simple mismanagement, human demands and abuses upon the environment are allowed to exceed its absorptive capacity. When environmental stresses exceed critical threshold points, the productivity of these systems begins to fall. Not only is the quality of life threatened, but the ability to sustain both human and animal lives becomes endangered as well. The principal victims of these events are the poor, who are most directly dependent upon the environment for their basic needs. Their state of physical impoverishment is often the prime factor in their own undoing. Recovery from this type of problem is achieved usually through a long gradual rehabilitation program to restore the reproductive capacities of damaged systems.

The second type of environmental problems comes from the negative effects of developmental activities such as construction of access roads, dams, irrigation systems, housing developments, industrial facilities, etc. In many cases, the direct construction impacts of development projects may have only limited, short-term adverse effects on the immediate environment where they are located. However, if appropriate environmental management systems do not exist or operate effectively, the use and operation of these "development improvements" may cause serious damage to the environment from air and water pollution, noise, residual waste disposal or interference with the life cycle of some critically important biological communities. Because Panama's limited concern for the environment has not been translated into environmentally sensitive integrated planning and design of its major development projects, the worst potential adverse impacts are occurring. Regrettably, many environmental problems arising from development initiatives could be mitigated by taking appropriate precautionary measures at minimal additional costs.

## 1. General Public Understanding

Presently, the issues of environmental quality and conservation of scarce resources are not broadly supported nor perceived by the general public in Panama as vital concerns in their lives. Only a relatively small number of individuals or localized environmental interest groups exist throughout the country. These "environmentalists" are oriented primarily to the preservation of natural resources -- establishment of national parks, and wildlife habitat and species protection. However, this environmental focus needs to be broadened to embrace a much larger concept of the fragile relationship between man and his natural resource base. Panamanians have not grasped this connection and consequently have not elevated the topics of environmental protection and sustained utilization of natural resources to the forefront of public discussion and debate. On the contrary, the mass media portrays man's relationship to remote unsettled areas such as Darién, Bocas del Toro and the Atlantic coastal region between the Gulf of San Blas and Punta Rocón in terms of the "conquistas" of the frontiers. Given Panama's rapid population growth and its few remaining natural resource reserve areas, public attitudes must be changed. The "desertification" of the Azuero Peninsula and massive out-migration of Santenos attest to the economic, social and political costs associated with the misuse and destruction of natural resources in the central region of Panamá. To prevent the recurrence of this disaster in other areas will require a fundamental change in attitude by the general public and governmental officials. The joint efforts of public and private-sectors are vitally important in the battle for rational use of non-renewable and renewable natural resources and protection of environmental quality.

## 2. GOP Commitment

In the absence of broad public awareness and political support for increased attention to natural resource conservation and environmental protection concerns, the GOP economic development priorities, strategies and plans reflect the fact that environmental affairs do not rank among Panama's top national priorities. In response to a combination of economic, social and political conditions, the GOP has focused its primary attention on the issues of employment generation, agricultural production, education, and social services. It is clearly evident that its national development plans reflect the adoption of economic priorities weighted in favor of maximization of investments in the short-term with minimum control mechanisms to govern the type of land use, intensity of use, or the geographic location of development projects.

The potential dangers of these policies can be seen in the GOP's new lands settlement and development strategies, which are focused on three primary geographic fronts -- the north coast of the Atlantic, Bocas del Toro, and Darién. The migration of Santenos with traditional lifestyles of slash and burn agriculture and cattle grazing from the Azuero Peninsula into these fragile wetland forests

raises serious questions about the economic and environmental suitability as well as cost-effectiveness of these land uses. Past experience in the Central and Metropolitan regions of Panama environmentally sensitive areas have not been successful in the long-run. In addition, they have caused serious deterioration of the natural resource base. In the wetter Atlantic lowlands soil degradation may be expected to occur much more quickly because of higher erosion and leaching potentials. Unless these forested areas are managed differently, the use of traditional agricultural practices in these critically sensitive areas will cause serious loss and damage to their tropical soils. Once depleted, substantial public investments will be required in the future to restore their productivity.

Despite the political leadership's limited understanding of the intricate relationships between natural resource conservation, economic development and ecological systems, the sudden awareness of the existence of an environmental crisis would not be sufficient to remedy Panama's predicament. To effectively reverse the accelerated destruction of the natural resource base upon which the country's future rests requires a thorough understanding of the capabilities and limitations of the different ecological life zones and the cause and effect relationships of man's utilization of the natural resources. Serious institutional and human resource deficiencies present major obstacles to achieving rational natural resource management and environmental protection.

### 3. Actions Facilitating Uncontrolled Settlement

Governmental agencies contribute both directly and indirectly to the colonization of the country's remaining wet tropical forests. Their participation in the different settlement fronts may be one of direct physical participation as in the case of the National Guard's Cocolito project, in which the military constructed roads, built houses, and brought in volunteers to cut down the forest. Most frequently, the government plays an indirect role such as when the Ministry of Public Works constructs a new road to link isolated communities, thus facilitating access into formerly isolated and sparsely populated forested areas.

One of the major contradictions of official actions is that governmental institutions are working in opposition to each other on matters relating to the use and protection of the tropical forests. For example, RENARE, a branch of the Ministry of Agriculture, tries with limited personnel and financial resources to protect certain watersheds from the ravages of deforestation, while the Banco de Desarrollo Agropecuario (Agricultural Development Bank-BDA) facilitates the expansion of cattle grazing in these same watersheds by granting easy credits to producers. The BDA Ministry of Agricultural Development, itself part of the Ministerio de Desarrollo Agropecuario, sees its function in a narrow commercial sense of making available 'soft' credit to qualified borrowers to start or expand grazing operations irrespective of location or environmental implications of these actions. In the case of the Colón province, the BDA has extended \$2 million in credit this year for agricultural production.

Ninety percent of this amount was assigned to the grazing sector, and the remainder to crop production such as coffee and cacao, which are more suited to the wet tropical conditions than extensive cattle grazing.

#### 4. Conclusions

The main threat to Panama's remaining reserves of wet tropical forests lies in the ongoing process of colonization, particularly that involving the "interiorano" peasants (mainly from the provinces of Los Santos, Herrera and Chiriquí) whose main economic orientation is towards extensive cattle production for the internal market.

It is quite feasible that within the next two decades Panama will exhaust most of its forest reserves, given the intensity of colonization and the vast scale in which the tropical forests are being transformed into pasturelands. However, when the colonization of the remaining forests of the Caribbean coast and Darién has been completed, most of the peasant settlers will be no better off economically. This is due to the nature of extensive grazing, a system that achieves low productivity at the highest possible ecological costs. Some of the main factors behind the rural exodus are: 1) the demographical revolution that has led to greater pressure on natural resources and increased ecological deterioration; and 2) the sharp increase of peasant dependency on cash commodities and thus, their participation in market economics. All of these have been taking place within the framework of an unjust agrarian land tenure system.

Colonization, the expansion of the cattle front and other productive activities that are causing serious ecological deterioration are also facilitated by the actions of national institutions (public and private) and international lending agencies. Most of these institutions today are carrying out development schemes without any or minimal environmental considerations to guide their actions.

#### E. Recommendations

Based on the previous discussion, the following recommendations are made to the Government of Panama:

- ° Re-examine the policy toward colonization and management of Panama's wet typical forests and establish a policy based on ecological principles;
- ° Review and modify the present road building program of the Ministry of Public Works to prevent and minimize adverse impacts upon the environment. Halt construction of secondary roads in the Oriental region until proper environmental and settlement procedures are developed;
- ° Take corrective measures such as reforestation in the province of Colón, especially in the districts of Colón, Portobelo, and Chagres;

- ° Discharge extensive cattle grazing in Donoso and Santa Isabel by suspending all credit and prohibiting conversion of forested areas to pastures. Encourage planting of permanent crops such as coffee and cacao as well as improved management of existing tropical tree species;
- ° Secure and protect the rights of minority groups inhabiting areas of wet tropical forests which are subject to colonization and deforestation;
- ° Develop and implement specific environmental education programs for the public. Develop programs such as the following:

- Improve science curricula for primary and secondary students including support of teacher training, and re-orientation and production of educational materials such as textbooks, films, classroom demonstration and experimental kits, and teachers' manuals;
- Develop new interdisciplinary programs for environmental and natural resources studies at the university level and allocate the funds necessary for exploratory workshops, seminars and symposiums to develop and implement such programs. Encourage interdisciplinary faculty groups to establish research groups or an institute of experts capable of solving Panama's major problems at the local, regional, and national levels;
- Increase the general public's awareness of significant environmental and natural resource problems in Panama and foster an understanding of their potential implications through the use of the following:

Exhibits, demonstration projects and display materials shown in museums, schools, plazas, etc;

Special documentary educational television and radio programs;

Publication of newspaper and magazine articles on critical issues and concerns;

Promotion of community action programs such as reforestation, water conservation, park and street beautification, monitoring wildlife movements, and recycling of waste products.

- Establish an Environmental Coalition of non-governmental environmental groups in Panama to coordinate and support all relevant public planned programs and activities. Such a group can be an effective tool in raising the environmental consciousness of the various public audiences reached by each group.

### CHAPTER III. FOREST RESOURCES

#### A. Summary

#### B. Resource Base

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CHAPTER III      FOREST RESOURCES

A. Summary

The forest environment in Panama can be described most easily by using the Holdridge Life Zone classification system (see Figure 2, p.16. Of the twelve Life Zones found in Panama, four have the most importance: Tropical Moist, Tropical Wet, Premontane Wet and Premontane Rain. These four forest types cover 75% of the country. The cuipo tree dominates more than 10,000 square kilometers (km<sup>2</sup>) of forest in eastern Panama. Other important forest types are dominated by a single species such as cativo along the Rio Chucunaque, oréy around the Laguna de Chiriquí, and mangroves on coastal deltas. Little is known about the forests of the wet Atlantic lowlands or the mountainous superhumid areas.

Panama's forest cover decreased from 70% of the country in 1947 to 50% in 1974. Current rough estimates of forest cover are 40-45%. Estimates of important forest types vary considerably, ranging from 4,200 to 9,650 km<sup>2</sup> of cativo forests and 1,990 to 5,056 km<sup>2</sup> of mangroves. Advancing agricultural frontiers are destroying vast areas of forest along the Interamerican Highway, in the Atlantic lowlands of the Metropolitan and Central regions, and on the upper Pacific slopes of the western Cordillera.

The timber industry is based on only a handful of species, with cativo contributing approximately 50% of the logs. Panama's forests also make significant indirect contributions; for example, the mangrove swamp areas serve as breeding grounds for the white shrimp, while natural forests in mountainous watershed areas help to conserve water and regulate its flow.

Substantial differences in several estimates of land-use capability in the Darien suggest that there is less land suitable for agriculture in Panama than previously believed. The amount of deforested and degraded lands indicates that the agricultural conquests of the Darien and the Atlantic lowlands are doomed because most of the soils cannot sustain permanent agriculture. Reforestation totaling 4,500 hectares (ha.) is a small token compared to annual deforestation exceeding 50,000 ha. The Dirección General de Recursos Naturales Renovables (RENARE) is involved with three ambitious projects which will reforest a total of 38,500 ha. over a five year period.

Although RENARE is responsible for all aspects of renewable natural resources and was founded upon adequate legislation, it has been rather ineffective to date. Despite inadequate funding during the 1970's, RENARE accumulated a substantial staff. RENARE's passive management of natural resources, however, is attributed to an ineffective administration.

Other problems involving the forestry sector include: a poorly conceived forest concession system; complete absence of silviculture and forest management; lack of up-to-date information on forest utilization and conversion; poor timber utilization; degraded soils; and unreliable soil capability and land-use data based on classification systems that overestimate land suitable for agriculture.

## B. Resource Base

### 1. General Description

The physical and biological characteristics of the forests of Panama are best understood in the context of the Holdridge Life Zone classification system (Holdridge 1947, 1967, 1978; Holdridge et al. 1971). The Life Zone system is a bioclimatic classification of potential vegetation using two independent climatic variables, mean annual rainfall and bio-temperature (Fig. 2). A Holdridge Life Zone with certain climatic conditions will have a characteristic forest of distinctive structure that will be similar to forests anywhere in the world where the same climatic conditions exist. Local differences in forest structure caused by soils, drainage, or atmospheric conditions are recognized as distinctive ecological associations within a Life Zone. The Life Zone system is not dependent upon floristic relations or knowledge. Most species occur in more than one Life Zone, yet a species' geographic limits often coincide with Life Zone boundaries. The Life Zone system has been widely used in tropical America; hence it provides a useful means of comparing Panama's vegetation, environmental problems and productive potential to other tropical areas.

Life Zones in the extensive lowlands of Panama are determined primarily by rainfall regimes. The movement of tropical air masses from the Pacific and sub-tropical air masses from the Atlantic produce two distinct rainfall regimes: (1) The Pacific rainfall regime predominates on the Pacific side of Panama, producing a monsoon-type alternation of a seven-month rainy season with a five-month dry season. The dominance of northeasterly tradewinds from December to March in combination with the mountainous backbone of Panama produces a pronounced rain-shadow effect throughout most of the Pacific region. The severity of the rainless season is greatly increased by the drying effect of the moistureless winds descending over the hot lowlands. The mid-elevation rainy areas in the Serranía de Maje, Serranía de Pirre and Sierra de Jungurado are in part due to orographic lifting of moisture-laden southeasterly tradewinds during June to August and greatly weakened northeasterly tradewinds during December to March. These differences from western Panama produce a more intense rainy season and a much weaker "dry" season on the Pacific near the Colombian border. (2) The narrow Caribbean slope and lowlands have a distinct regime of two rainfall maxima and two minima; the former in June-July and November-December and the less rainy periods in September-October and February-March.

The short "dry" seasons have sufficient rain so that, in effect, dry periods stressful to natural vegetation seldom occur.

Twelve Life Zones occur in Panama (Table 1), with four Life Zones covering more than 75% of the country (Tosi 1971). Tropical Moist Life Zone predominates over the Pacific lowlands, extending from the Costa Rican border almost to the Colombian border. Only in the low Metropolitan region does the Tropical Moist Life Zone extend across the Isthmus to the Caribbean coast. Tropical Moist Life Zone also occurs as coastal bands in San Blas and around the Laguna de Chiriquí (Bocas del Toro).

Table 1

DISTRIBUTION OF HOLDRIDGE LIFE ZONES IN PANAMA (TOSI, 1971)

<u>Life Zone Type</u>	<u>Area, Km<sup>2</sup></u>	<u>% of Country</u>
1. Tropical Dry	5,630	7.44
2. Tropical Premontane Dry	2,070	2.74
3. Tropical Moist	24,530	32.43
4. Tropical Premontane Moist	2,400	3.17
5. Tropical Wet	10,900	14.44
6. Tropical Premontane Wet	15,200	20.09
7. Tropical Premontane Rain	9,975	13.19
8. Tropical Lower Montane Moist	9	0.01
9. Tropical Lower Montane Wet	1,378	1.82
10. Tropical Lower Montane Rain	2,370	3.13
11. Tropical Montane Wet	3	.004
12. Tropical Montane Rain	<u>1,185</u>	<u>1.57</u>
TOTAL	75,650	100.00

Tropical Wet and Premontane Wet Life Zones are usually found at elevations higher than Tropical Moist, or in wetter coastal areas. The most extensive area of Tropical Wet Life Zone occurs in the Caribbean lowlands of the Central region. The Promontane Rain Life Zone occurs along the western cordilleras, on the Serranía del Darién, Serranía de Pirre, Sierra de Jungurado, and Serranía de Maje, plus a few other areas on the Azuero Peninsula and highest parts of the Lago de Alajuela watershed.

The driest areas (Tropical Dry and Premontane Dry Life Zones) occur in a broad arc bordering the Bahía de Parrita. Small areas also occur east of Panama City and on Punta Garachiné. These dry areas apparently are related to nearby upwelling of cold water.

## 2. Major Forest Types

### a. Cuipo

Cuipo-dominated forests cover about 10,000 km<sup>2</sup> of the Tropical Moist lowlands in the Oriental region of Panama. Many other tree species are associated with cuipo, Cavanillesia platanifolia (Bombacaceae), but it is the huge and abundant cuipo that dominates the Darién lowlands. Large cuipo trees may reach 40 m. in height on a bole 2 m. in diameter, with a proportionately small crown towering over other associated tree species. Various studies indicate cuipo occupies 39-60% of the timber volume (Donaldson 1963; Golley et al. 1975; Falla 1978a). The exceptional size and abundance of cuipo has attracted numerous attempts to find commercial uses for its wood. Cuipo wood is very light like balsa, but unusually weak. L.R. Holdridge likens cuipo to an overgrown vegetable. Detailed tests of cuipo wood for a variety of products, including paper and fiberboard, have been unsuccessful (Rankin 1963). It should be tested for cattle fodder.

### b. Cativo

Cativo forests are pure or nearly pure stands of Prioria copaifera (Caesalpinaceae) that occur on alluvial flats inundated occasionally with fresh water, but with adequately-drained soils. Cativo forests occur most frequently along major rivers, such as those feeding into the Golfo de San Miguel. Lamb (1953) reported pure cativo stands on the banks of the Rio Balsas. More recent studies along the Rio Chucunaque indicate cativo-dominated forests extend about 1 km. along each side of the river (Donaldson 1963, Anonymous 1978). Also, cativo occurs in mixed forests on better-drained soils farther from rivers, as well as in the Mora oleifera forests inundated daily by brackish water. Cativo forests occur in the Bocas del Toro lowlands and are reported to occupy 4,000 ha. on Isla Coiba (Falla 1978a).

c. Mangroves

Mangrove forests occur on both coasts of Panama, but are much more extensive on the Pacific estuarine deltas due to the appreciably greater tidal flux on the Pacific coast than in the Caribbean. The red mangroves, Rhizophora brevistyla and R. mangle (Rhizophoraceae) are overwhelming dominants in the mangrove forests, generally forming pure stands. The black mangrove Avicennia germinans (Avicenniaceae), and Pelliciera rhizophorae (Theaceae) are occasional tree associates in the mangrove forests.

d. Oréy

Oréy forms pure stands in brackish swamps around the Laguna de Chiriquí in Bocas del Toro. These forests of oréy (Campnosperma panamensis, Anacardiaceae) probably have the highest stocking of timber known in the Tropics, with average volumes of 382 m<sup>3</sup>/ha. for boles greater than 40 cm. in diameter and 716 m<sup>3</sup>/ha. for all boles larger than 10 cm. in diameter (Falla 1978a). Such impressive volumes of oréy timber and its fiber suitability offer considerable potential for a pulp and paper industry (Holdridge et al. 1958).

e. Tropical Wet Forests

A forest inventory of the Donoso district of the northern Central region found adequate quantities of excellent timber trees such as Dialyanthera otoa and Virola spp. (Myristicaceae), Carapa guianensis (Meliaceae), Miquartia guianensis (Olacaceae), Aspidosperma magalocarpon (Apocynaceae) and Sacoglottis sp. (Humiriaceae).

f. Other Forest Types

The remaining forests of Panama, especially in the super-humid mountainous regions, are very poorly known. Except for the above-mentioned Donoso district, even the tropical wet lowlands along the Caribbean coast from Bocas del Toro to San Blas are also incompletely known. Tropical oaks of several species (Quercus spp., Fagaceae) are conspicuous of Lower Montane Wet and Rain Life Zones in the western Cordillera. The Montane Rain Life Zone on Volcan Barú is dominated by huge oaks (Q. costaricensis).

C. Status of Forests

At the time of Spanish exploration of the Pacific lowlands of Panama in the early 1500's, a considerable indigenous population

practiced shifting cultivation over extensive areas extending from eastern Darién as far west as present-day Santiago (Sauer 1966). Corn was the principal crop grown by the Indians. Despite substantial differences in the subjective estimates sent to the Spanish Crown as to the size of the indigenous populations and the amounts of land under cultivation, it is widely accepted that fields and young secondary vegetation were far more prevalent than undisturbed forest in the Pacific lowlands of eastern and central Panama. The striking present-day (modern) dominance of these regions by cuipo has led some authors (e.g. Budowski 1965; Bennett 1968) to attribute cuipo's success to large-scale abandonment of land following decimation of the indigenous peoples by the Spanish. This interpretation claims the cuipo-dominated forests are nearly 500-year old secondary forests; however, this is not supported by recent studies of tropical forest dynamics nor by the potential of cuipo (See Hartshorn 1978, 1980, for a more complete review).

Standley's (1928) remarks about collecting in good "jungle" near Chorrera indicate that it is safe to assume that practically all of Panama in the Central region should have supported forests, for no evidence has been found in the literature for the occurrence of extensive natural savannas in Panama.

The earliest estimates of forest cover in Panama (Table 2) indicate the paucity of forests in Coclé, Herrera and Los Santos provinces more than 30 years ago. Garver (1947) estimated 70% of the country (not including the Canal Zone) to be in forest.

Falla (1978a) reports country-wide estimates of forest cover between 1950 and 1974 (Table 3). The 1970 data are considered to be the most accurate because they are derived from country-wide forest inventories carried out by the Food and Agriculture Organization of the United Nations (FAO) in 1970 and 1971. Falla's 1974 estimate was derived by adjusting forest boundaries observed during aerial reconnaissance flights. The data in Table 3 yield annual deforestation rates ranging between 0.5 and 1.0%, yet Falla (1978b) reports the agricultural frontier advanced 2.7% per year during the early 1970's. It was impossible to verify either figure; however, since the agricultural frontier advances at the expense of forests in Panama, it seems the latter figure may be closer to reality. Projection of an intermediate per annum rate of deforestation at 1.5% from the 1970 estimate yields 29,254 km<sup>2</sup> or 38% of the country with forest cover in 1980. Dirección de Recursos Naturales Renovables (RENARE) and FAO foresters think the actual forest cover is around 45% of the country. It is instructive to note that the two most completely forested provinces of Panama (Bocas del Toro and Darién) have a combined surface area of 25,889 km<sup>2</sup> or 34% of the country.

Table 2

AMOUNT OF FORESTS IN PANAMA IN 1947 (Garver, 1947)

<u>Province</u>	<u>km<sup>2</sup></u>	<u>% of Province</u>
Bocas del Toro	8,650	95
Coclé	1,150	30
Colón (+ San Blas)	6,900	95
Chiriquí	3,850	40
Darién	15,350	99
Herrera	200	15
Los Santos	1,100	30
Panama	10,400	90
Veraguas	4,850	40
TOTAL	52,450	70

\* Does not include the Canal Zone.

Table 4

SEQUENTIAL ESTIMATES OF FOREST AREA IN PANAMA

<u>Year</u>	<u>km<sup>2</sup></u>	<u>%</u>	<u>Source</u>
1947	52,450	70	Garver 1947
1950	52,445	68	Falla 1978a
1960	45,000	58	Falla 1978a
1970	40,816	53	Falla 1978a
1974	39,000	50	Falla 1978a

The uncertain status of Panama's forests is further exemplified by the considerable differences in the estimates of cativo, oreý and mangrove forests in Panama (Table 4). Falla's estimate of 965 km<sup>2</sup> of cativo forests for the entire country seems too high, since the cativo forests in Rocas del Toro and on Isla de Coiha are minor in comparison with Darién. No explanation is given for the grossly different estimates of mangrove forests given by Falla (1978a,b).

Table 4

AREA ESTIMATES OF FOREST DOMINATED BY SINGLE SPECIES IN PANAMA

<u>Region (Source)</u>	<u>Area Coverage (km<sup>2</sup>)</u>		
	<u>Cativo</u>	<u>Orey</u>	<u>Mangrove</u>
1. East of Canal Zone (Donaldson 1963)	387	--	1,040
2. Darién (Anon. 1978)	457	--	337
3. Entire Country (Falla 1978a)	--	625	5,056
4. Entire Country (Falla 1978b)	965	760	1,990

An attempt was made to obtain satellite images for purposes of updating the data on forest area and rates of deforestation, but only a few cloud-free images are available for the western region of the country (see Map 1 and 2 in the rear of this report). Field observations by both land and low-level flights indicate several active fronts of deforestation. In the Darién, agriculturalists continue to advance up the principal valleys and lower slopes (e.g., Rios Sambu, Balsas, Tuirá and Sabanas). Large-scale clearing is occurring along the entire length of the Interamerican Highway between Bayono and Yaviza. Even on the steep slopes on the northern Norte. The remaining forests south of this area are being severely squeezed by aggressive deforestation radiating from Coclesito. This forest cutting extends over the continental divide between Cerro Flores and Cerro Colorado. Appreciable slash-and-burn agriculture is claiming forests in the lower valleys and slopes of the Rios Teribe and Chaguinola in Bocas del Toro.

4. Forest Ecosystem Functions

As implied in the previous section, forests play a critical role in watershed protection. Virtually all of the country

has potential evapotranspiration (PET) ratios less than 1.0, indicating total annual rainfall exceeds potential evapotranspiration (Tosi 1971). Excess rainfall is the source of the many rivers originating in the mountains of Panama. The super-humid regions such as Premontane Rain and Lower Montane Rain Life Zones have PET ratios less than 0.25, indicating that natural vegetation uses less than one-fourth of the moisture available. Those substantial excesses of water not only provide the life-supporting moisture in the lowlands during the long dry season, but also have tremendous erosive capabilities. Natural vegetation, particularly forest, is the most effective cover protecting mountainous soils from erosion. The sponge-like absorptive capacity of forest soils plays a significant role in moderating extremes, whether in minimizing rainy season floods or maximizing dry season discharge into streams. Cloud forests are believed to glean amounts of condensation water from moisture-laden clouds far in excess of the actual rainfall, hence cloud forests straddling the continental divide are crucial to maintaining dry season stream flow. Watersheds are treated in more detail in a separate section of this report.

Forests play an important role in nutrient conservation. The characteristic shifting cultivation pattern of one or two years of cropping followed by ten to fifteen years of fallow is entirely dependent upon the nutrient accumulation capability of secondary forest. Short-term cropping exploits the nutrient capital accumulated by forest during the fallow period. Shifting cultivation like that practiced by the Chocoes people in Darien is an ecologically sound form of land use on soils that cannot sustain continuous or permanent agriculture. Without forest cover or regeneration, restocking of nutrients does not occur, resulting in considerable soil degradation and greatly diminished fertility.

Many soils in the Pacific lowlands of the Central region have low productivity. Site degradation occurs more quickly in the wetter Atlantic lowlands because of heavy rainfall which causes erosion and leaching. Soil capability and land-use potential are treated in a separate section of this paper. Forests also make important contributions to regional and global climate, tending to moderate climatic extremes. Forests are able to ameliorate or lessen local abuses such as pollution and contamination. These aspects also are treated in a separate section of this report.

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## 5. Direct Economic Role of Forests

Forests provide direct contributions to the Panamanian economy, estimated by Falla (1978a) at 2.0-2.2% of GNP. Timber, is the primary forest product. Between 1965 and 1975 forest exploitation produced an annual average of 225,000 m<sup>3</sup> of logs valued at \$3.18 million (Falla 1978a). Seventy-five percent of the logs went into sawn lumber and the remainder into plywood. The construction industry utilizes 65-85% of the sawn lumber. The national wood market grew at an annual rate of 4.6% between 1965 and 1975.

From 1960 to 1975 cativo has supplied roughly 50% of the logs in the national market, with about 75% of the cativo logs coming from the Darien. Cativo is used primarily as core stock for plywood and to a lesser extent as face veneer and form lumber. Quality woods such as caoba (mahogany, Swietenia Macrophylla, Meliaceae) and cedro amargo (Spanish cedar, Cedrela mexicana, Meliaceae) have diminished greatly in quantity from their post-World War II importance to where they provided only 10% of the timber used in 1974. According to Falla (1978a), 94% of the logs marketed in 1976 were supplied by only five species: cativo, espave (Anacardium excelsum, Anacardiaceae), amargo (Vatairea sp., Fabaceae), cedro espino (Bombacopsis quinatum, Bombacaceae) and zapetero (Hieronyma oblonga, Euphorbiaceae). Espave, amargo and cedro espino are components of the cuipo forest in the Oriental region. Zapetero comes from the tropical wet forests of the northern Central region.

Garver (1947) lists 47 saw timber species. Twenty years later only 30 species were used (Falla 1978b). Although FAO identified 300 potentially commercial timber species, the national market accepts only 50 species (Anon. 1979). The dominance of the national market by so few species means logging operations are very costly and inefficient. Considerable quantities of good wood are bypassed in the logging of a few species. This would be acceptable silviculturally if the forests were controlled, protected and managed for a sustained yield of timber. Although the advance of the agricultural frontier is an important source of timber, considerable volumes of non-harvested timber are burned by colonists. Falla (1978b) estimates 75% of the timber felled by colonists is not harvested. The restricted national market is in part due to the opening of substantial forest along the Interamerican Highway and a rapid "creaming" of the preferred species. Now that the highway has reached Yaviza and the development of penetration roads slows, the next few years should see increasing acceptance of other species.

Mangrove forests contribute both directly and indirectly to the Panamanian economy. Red mangrove bark is a major source of tanning for the tanning industry. Although no such industry

exists in Panama, 1,841 tons of bark were exported to Costa Rica in 1974 (Falla 1978a). General impressions indicate mangrove bark harvesting and export have increased substantially since 1974. Because of concern about the irrational harvest of mangrove bark, the governor of Chiriquí Province recently decreed a halt to mangrove exploitation starting in 1981. However, there is interest in establishing a tanning industry in eastern Chiriquí.

The most important function of mangrove forests is as breeding grounds for the white shrimp, keystone of Panama's shrimp export industry. Destruction of mangrove forests will have definite repercussions on the shrimp industry, already beset with over-fishing problems.

No reliable data exist in Panama on the consumption of firewood and charcoal, however FAO estimates Panama's 1975 consumption of firewood to be 1,450,000 m<sup>3</sup>, equivalent to 0.86 m<sup>3</sup> per capita (Falla 1978a). Increasing costs of petroleum derivatives have undoubtedly increased campesino dependence on and use of firewood. Sources of firewood are becoming scarce on the deforested Pacific part of the Central region.

Another significant secondary forest product is wood for fence posts. Although certain species are used as "living fences", Falla (1978a) estimates 110,000 m<sup>3</sup> of wood are used per year for new fence posts. Forests also are the source of numerous secondary products such as balata (chicle), rubber, fruits, and wild game that are insignificant to the national economy but are important to the economy of individual families living in forested areas.

## 6. Projected Utilization Of Forest Resources

Falla (1978b) attempts to project the national demands for wood products from 1975 to 2005 based on low and high rates of growth in the demand. His 30 year low-high growth projections are 431-531% for wood, 234-345% for wood pulp, 310-310% for fence posts and 0-0% for firewood. His logic for predicting a constant demand for firewood is not explained. Falla uses two alternative hypotheses to project the change in land use: (1) the historical advance of the agricultural frontier at 2.7% per year; and (2) substantially reduced rate of advance at 0.3% per year as a consequence of agro-technological advancements. The former model projects the land cleared for agriculture to expand from 18,690 km<sup>2</sup> (1975) to 41,450 km<sup>2</sup> (2005), which would reduce Panama's forests to 11,000 km<sup>2</sup> by 2005. The latter model would reduce forests to 36,200 km<sup>2</sup>, but the assumption of a technological fix for Panama's agriculture (including cattle) seems too farfetched to merit consideration. Falla (1978b) concludes

that an intermediate 1.5% rate of advance of the agricultural frontier would deforest about 10,000 km<sup>2</sup> by 2005. He suggests that heterogeneous forests and cativo forests will each supply about one-third of the national market over the next thirty years.

## 7. Soil Capability and Land-Use Potential

The rapid expansion of the agricultural frontier, estimated to have averaged 2.7% per year between 1950 and 1975 (Falla 1978a), suggests at least two possible explanations: (1) Panama has ample lands suitable for agriculture that have only begun to be opened by colonization in the past few decades; or (2) Panama's existing agricultural lands are so poor that small farmers are abandoning their land to move onto virgin lands. These are, of course, just two extreme views of complex phenomena spanning a broad spectrum of multiple causes. Nevertheless, widespread adherence to and support for the agricultural conquest of the Atlantic and the Darién suggests the former belief (#1 above) is most commonly held. Panama's rapidly expanding agricultural frontier is a result of interrelated causes much more complex than a simple frontier mentality or the availability of good soils. Worn-out and degraded soils in the western Pacific lowlands in combination with high population growth rates and the consolidation of small farms into extensive rangeland have forced the emigration of Santenos and Chiricanos to those new frontiers. The sociological aspects of the agricultural frontier and extensive cattle ranching are dealt with in a separate section of this report.

Plath (1979) recently updated Armuelles' 1969 map of land-use potential for the entire country (Table 8, p. 134). According to Plath's classification system, 18% of Panama should be in protection forests, 43% has potential for production forestry, and 35% has potential use for agriculture; the 35% of potential agricultural lands consists of 9.1% suitable for intensive agriculture, 20.4% suitable for extensive agriculture, and 5.6% suitable for very extensive agriculture. Comparing Plath's figure of 35% of the country suitable for agriculture with a rough estimate of 55-65% of the country already deforested leads to the inescapable conclusion that the agricultural frontiers are advancing into areas largely incapable of supporting sustained agriculture. For a complete discussion of soil capability and land use potential, see the Soil and Water Resources section of this report.

## 8. Reforestation

In spite of rampant deforestation exceeding 50,000 ha. per year, and the abundance of degraded lands in the western Pacific lowlands, reforestation efforts have been few. According to RENARE

and FAO officials, tree plantations totaled 4,500 ha. in 1979. The plantations are mostly Pinus caribaea and are largely in the La Yeguada area. It has been reported that several hundred hectares of teak (Tectona grandis) planted near Puerto Armuelles by the Chiriquí Land Company have been felled and burned by agricultural colonists.

RENARE is sponsoring three ambitious reforestation projects: (1) the U.N. World Food Program plans to plant 8,000 ha. of trees in four-year period; (2) the AID Panama Canal watershed project calls for planting 10,500 ha of trees plantations in five years; and (3) an Interamerican Development Bank (IDB) project plans 20,000 ha of commercial tree plantations over the next five years along the highway between Santiago and Tole.

## C. RESOURCE MANAGEMENT

### 1. GOP Institutions

The Dirección General de Recursos Naturales Renovables (Directorate General for Renewable Natural (Resources) (RENARE) is wholly responsible for the administration, delimitation, inventory, protection and utilization of Panama's forest resources. A dependency of the Ministerio de Desarrollo Agropecuario (Ministry of Agricultural Development-MIDA), RENARE's forestry objectives are:

- a) to obtain public recognition that forest resources have enormous long-term importance for Panama and that immediate means need to be adopted to protect and to develop the forest resources;
- b) to establish a broad-based National Forest Service with administrative breadth and full authority and adequate budget to develop the forest resources of the country;
- c) to delineate and set aside as forest patrimony those zones in the public domain that in actuality have more value for forestry uses, by means of being identified for the production and the protection of different renewable natural resources;
- d) to broaden the inventory and development of public forests;
- e) to assist and to orient owners and businessmen in the timber industry in order to guarantee the satisfactory protection and inventory of privately held forest lands;
- f) to foment the forest products industry to guard the long-term productive potential of the forest resources;

- g) to maximize forest production in the most important forests, with the objective to fill the internal demand in the short-term and to export additional material;
- h) to train qualified personnel in forest sciences for government and for industry;
- i) to execute programs of forestry action in order to generate employment and raise incomes by means of cooperative programs among loggers and through promotion of reforestation;
- j) to establish an applied research program.

## 2. Administration

The Dirección General de Recursos Naturales Renovables (RENARE) is organized into separate departments for forestry, watersheds, soils, agrometeorology, national parks and wildlife, programming and evaluation, and administrative affairs. A regional RENARE office is maintained in each of the ten provinces. Overall national responsibility lies with a director, who is assisted by one sub-director.<sup>1</sup> Major reorganizations of RENARE were proposed by FAO in 1973 and by AID in 1979, but nothing has been changed to date. The central offices of RENARE were recently moved to a former Canal Zone school in Paraiso.

As a dependency of MIDA, RENARE's policy, direction, control and budget must be approved by the Minister of Agriculture and the Ministry's central offices in Santiago. The regional offices of RENARE also fall under the aegis of MIDA's regional officers. Dealing with the decentralized MIDA offices in Santiago and the cumbersome regional arrangement with MIDA limits RENARE's ability to effectively program and execute projects.

The Directorate has been severely limited by meager budgetary appropriations from MIDA. Through most of the 1970's RENARE received roughly \$600,000 for annual operations. Only in 1979 did RENARE's budget increase substantially because of government obligations to the Canal watershed project. In 1977, RENARE had 144 permanent employees and an additional 105 on contract. By 1979 the number of employees nearly doubled (Appendix F). The forestry department accounted for about two-thirds of all RENARE personnel in 1977.

Formal forestry education is non-existent in Panama. A University of Panama forestry curriculum was abandoned several years ago. Although RENARE is experiencing difficulty finding qualified professionals in natural resources, the absence of a national forestry school is not as

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<sup>1</sup>Note: Despite numerous attempts, it was impossible to obtain an interview with the director of RENARE to discuss Panama's forestry sector with him.

critical as one may suppose. Presently RENARE has 23 students receiving specialized training in natural resources in seven foreign countries. If the competent, young professionals in RENARE such as Ing. Tomás Vasquez are representative of the students studying in foreign countries, then RENARE has a bright future. The diversity of training received by Panamanian foresters in foreign countries could have a positive impact on RENARE's approaches to natural resource problems and projects. In the future, there is a need for natural sciences curricula, in Panamanian schools, including forestry, if the country is to meet long-term needs for qualified personnel.

### 3. Legislation

The basic forestry law as decreed (No. 39) on 29 September 1966, created the Forest Service and established objectives and jurisdiction, general forestry regulations, prevention of forest fires, control of forest diseases and pests, protection of water and soils, exploitation regulations, forestry development, national forestry fund and the entities for applying the law. However, the regulations governing decree No. 39 were never presented, so there is considerable legal and bureaucratic confusion concerning RENARE's administration of natural resources. Decree No. 23 on 30 January 1967 regulates slash and burn agriculture in rural zones, but it is completely ignored. In 1969, decree No. 80 created the Ministry of Agriculture, Commerce and Industry, including the national directorate of Renewable Natural Resources.

In 1972, RENARE was organized by means of resolution No. 395. MIDA was created by law No. 12 on 12 January 1973, which also reiterated RENARE's responsibilities. Law No. 55 passed in 1973 affected RENARE's sources of funding by stipulating that timber cutting fees go to the municipalities.

Other decrees have created official forest reserves for protective purposes, such as the Bayano watershed (Decree No. 117, 15 November 1973), Darién protection forests along the Colombian border (Decree No. 84, 8 May 1972), or reserved 8 km each side of the Interamerican Highway in Darién for directed colonization (Law No. 71, 20 September 1973).

### 4. Forestry Projects

Panama has an exceptionally rich source of information on the major forest resources, including reports from several decades ago (e.g. Pittier 1918, Cooper 1928, Cooper 1928, Garver 1947, Lamb 1953, Holdridge and Budowski 1955, Holdridge et al. 1958, Donaldson 1963, Mayo 1965). From 1966 to 1972, FAO carried out a major and multi-faceted forestry project under the general title "Forestry Demonstrations and Forest Inventories." FAO staff and consultants produced 18 technical reports that form the core of basic information about Panama's forest resources. Foresters from RENARE conducted the forest inventory of the Darien for the OAS project (Anon. 1978).

Current forestry projects include: (1) a U.N. World Food Program initiated in 1979 that provides food in return for planting trees; (2) an FAO 30-month project to strengthen RENARE's forestry department; (3) a 6-month FAO mini-project to rationalize forest utilization with the opening of the Darién; and (4) RENARE in collaboration with the Instituto de Recursos Hidraulicos y Electrificación (IRHE) and AID plans to manage an 800 ha. forest for use as an energy source. The FAO program directed by Ing. Elmo Montenegro includes a strong silvicultural component. Ing. Arturo Romero has just completed a field census and analysis of all plantations and species trials established by the first FAO project. Romero's results should be very useful for reforestation and agroforestry projects planned for Panama. If the FAO program to strengthen RENARE's forestry department gets off to a good start, it will probably be renewed for several additional years. Consultants to FAO are preparing reports on colonization, forest utilization and the potentials for using cuipo wood. Newspapers recently reported the signing of an agreement between RENARE and the Centro Agronomico Tropical de Investigación y Enseñanza (CATIE) of San José Costa Rica, to develop tree plantations for firewood, but candidate areas have not yet been selected.

## 5. Major Problems

### a) Institutional Administration

Though it is easy to blame RENARE's weaknesses on financial constraints, lack of qualified personnel, and the policy control of MIDA, these difficulties seem to be present in many national forest services in tropical America. RENARE is founded upon an adequate set of laws and has ample legal jurisdiction to manage, develop and conserve Panama's renewable natural resources. That RENARE has accomplished so little suggests it lacks an effective administration. Although RENARE has started to grow in capability and in personnel due to the AID and FAO institutional building programs, strong and competent direction still is essential. The Directorate decidedly needs a committed and effective administration if it is to carry out a successful program of managing Panama's renewable natural resources.

### b) Forest Concessions

Forest Concessions Decree No. 39 explicitly states RENARE's obligations to establish three classes of forests (production, protection and special) on national forest lands. Despite an FAO report (Deveraux 1973) proposing 13 production forests, five protection forests and six special forests covering 48,010 km<sup>2</sup> (62% of the country) not a single production forest has been legally established. Panama's timber industry depends upon forest concessions granted by RENARE, exploitation permits to private land-holders and unpredictable spot purchases from agricultural colonization. The concessions are for a one to two year period permitting the concessionaire to exploit the timber on small areas (200-1000 ha.) of the government land.

The consequences of such short-term concessions is that the concession-holder is only interested in maximizing profitable timber exploitation and doesn't even think about a future second harvest, let alone the long-term management of the forest for a sustained yield of timber. This type of concession arrangement might be

acceptable if a strong forest service oversees the exploitation and follows up with silvicultural treatments and forest management as part of a regional production policy. But RENARE's supervision of concessions is negligible and forest management is non-existent. RENARE does have a valid argument against concession fees going to the municipalities, but it is doubtful that money alone would improve the exploitation and management of de facto production forests. Under the present system of short-term, small concessions, the timber industry has a justified but shortsighted reason for ignoring forest management. A classic situation exists where private industry would not do anything about sustaining the basic resource of the industry, while the government agency legally responsible for the resource also does nothing except grant logging concessions. Meanwhile the natural resource continues to be depleted and becomes more costly and difficult to renew.

A state-controlled corporation such as is operating the Bayano watershed might be a potential mechanism to rationally manage the forest resources of a region. Although the Bayano Corporation's forestry practices were not reviewed, airplane observations indicated considerable logging activity and some active slash-and-burn agriculture within the Bayano watershed. Bayano Corp. has one forester (seconded from RENARE) and no forest management plans for the critical watershed. Another alternative would be for RENARE to greatly expand (to at least 5,000 ha) and lengthen (to a minimum of 20 years) the concessions and to strictly supervise and control harvesting techniques, management plans and silvicultural treatments used by private concessionaires. This latter set of requirements is beyond the present capabilities of RENARE. An alternative partial solution is proposed in the following section on recommendations.

### c. Silviculture and Forest Management

As implied in the preceding section, forest management is non-existent in Panama. Silvicultural programs for cativo and red mangrove are urgently needed. How the government agency responsible for renewable natural resources can ignore two species that have such an important role in the national economy is beyond comprehension. Apparently RENARE takes comfort in the fact that the estimates of area in cativo forests have been following an increasing trend over the past 10 years even though cativo exploitation shows the same trend. It does appear that cuipo forests increase in area while they are being heavily exploited, however.

#### d. Forest Utilization and Conversion Data

Despite a substantial number of reports on Panamanian forests and the forestry sector, the latest available data are no more recent than 1975 and some have not been updated in more than a decade. Attention has been drawn in several sections of this report to substantial discrepancies in the multiple estimates of a particular resource, e.g. areas of mangrove forests and of cativo forest, which suggests that single source estimates must be viewed with considerable caution.

RENARE has largely ignored the importance and necessity of accurate and up-to-date statistics in the administration of newable natural resources. Some modest up-dating of imported forest products is being done, but RENARE's forestry department has been relying on the substantial documentation produced by the 1966-1972 FAO project and has only recently awakened to the need for up-date information on forest products, exploitation and utilization.

Neither RENARE nor any of the collaborating international donors have plans to assess the status of forests and the rate of deforestation in Panama. Even though RENARE acknowledges significant deforestation is occurring, it joins the media and conservationists in placing the blame on uncontrolled agricultural colonization. The Directorate seems to prefer to be a passive bystander rather than exercise its broader legal responsibilities to protect Panama's natural resources.

#### e. Timber Utilization

Panama's timber industry traditionally has been based on the utilization of a small number of species to meet national demands for wood and wood products. If the literature is to be believed, the timber industry's acceptance of species decreased slightly in the past three decades. Low species utilization from heterogenous tropical forests is based on cultural preferences, local availability, uncontrolled exploitation, and the lack of appropriate wood technology. There are numerous examples of a tree species having a highly preferred status in one country, whereas a neighboring country considers the same species a second-rate wood. Studies by FAO in Panama indicate about 300 tree species have commercial potential.

The poor species acceptance by Panama's timber industry is not representative of the pattern in other Central American countries (excluding the pine-rich countries of Honduras and Guatemala), where local markets are rapidly accepting new timbers. The unchanging Panama situation is most likely due to the rapid opening of the Darién via the Interamerican Highway. Vast areas of virgin forest became accessible in the past decade, permitting an adequate

supply of preferred logs. Forest exploitation along the newly-opened sections of the highway are restricted to "high-grading" of the few preferred species. Now that the highway has reached Yaviza and secondary road construction is occurring slowly, the flow of premium timbers should decrease appreciably. As scarcity and inaccessibility drive up the prices of the preferred species, the national market should begin to accept new species. Wood technology studies and information can play a key role in facilitating entrance of lesser known woods into national markets. Although RENARE is the appropriate agency for wood technological information, it has done nothing in the area since the FAO project terminated in 1972. The new FAO project will include a wood technologist to work on some of Panama's potential timber species.

f. Rehabilitation of Degraded Soils

Deforested lands considered unsuitable for agriculture or pasture are estimated to cover between 10,000 km<sup>2</sup> (Falla 1978a) and 18,000 km<sup>2</sup> (Mayo Mendez in Anon. 1979). Mayo Mendez' estimate is equivalent to 23% of the country. The majority of the degraded soils occur in the Pacific Central region, including most of the Azuero Peninsula. Because of the dearth of natural vegetation in the region, and the socio-cultural nature of the human population, it is completely unrealistic to depend on or even consider natural vegetation for soil rehabilitation. The only realistic possibility for soil rehabilitation is through reforestation. At least 50% of the degraded soils could be rehabilitated with commercial tree plantations. On degraded soils designated as protection areas, such as watersheds, the natural vegetation should be allowed to recover, rather than reforested with costly tree plantations that may not be as effective as natural secondary vegetation.

g. Soil Capability and Potential Land-Use

Existing information on soil capability and potential land-use suggests only 35% of Panama's soils are suitable for agriculture. That estimate is based, however, on an inappropriate classification system that overestimates the agricultural potential of tropical soils. A comparison of three different land-use capability classification systems used in the Darién (Table 9, p. 133) found substantial differences in the estimates of lands suitable for intensive agriculture, improved pastures, production forests and protection forests. Considering the high erosion potential of most Panamanian soils, the more conservative classification system should be used throughout Panama.

The most serious problem lies with government's complete inability to use soil capability information to guide agricultural development and rationalize land use. The GOP has made no serious effort to organize and direct colonization of agricultural lands nor attempted to prohibit colonization of lands not suitable for agriculture.

## D. Recommendations

### 1. Government of Panama

- Reorganize RENARE to incorporate more effective leadership for administering national use and conservation of Panama's renewable natural resources.
- Establish national and community production forests with legal and institutional capability and commitment necessary to provide administration, technical management and protection.
- Initiate experimental forest management projects in the major forest types, specifically cativo, red mangrove, orèy, cuipo and mixed wet forests of Bocas del Toro, with actual or potential commercial importance. Emphasis should be given to developing compatible multiple uses of the resources, while maximizing biomass production from the forests.
- Give highest priority to silvicultural programs for cativo and red mangrove that will demonstrate effective management techniques for ensuring sustained yields and continued ecosystem functioning of these two important resources.
- Encourage and initiate innovative research on ways to utilize cuipo wood. One suggestion is to test partially hydrolyzed cuipo wood as cattle fodder.
- Update forest industry and resource statistics. Special effort should go into a deforestation monitoring program that could be carried out by the competent cartographic section of RENARE. The accumulation, compilation, analysis and maintenance of forestry sector statistics could be the responsibility of a special section of RENARE.
- Conduct detailed independent analysis of Panama's forest concession system with the specific objective of resolving the present situation that ignores future productivity, or lack thereof, of the forest resource.
- Stress plantation forestry and agroforestry in areas requiring rehabilitation of degraded soils.
- Rationalize land use, particularly in areas threatened by the advancing agricultural frontier, by using more accurate and appropriate soil capability data and large-scale maps of potential land use.
- Direct colonization in the Atlantic and Darièn provinces to prevent destruction of natural resources, and restrict colonization in areas unsuitable for agriculture. Develop colonization efforts that include forest farming and other alternatives to slash and burn agriculture and cattle grazing.

- ° The Government of Panama must bring under control the chaotic destruction of natural resources by the so-called conquests of the Atlantic and the Darién. Orderly and directed colonization of suitable soils is needed in place of the wanton, disorganized and ill-conceived agricultural colonization that now typifies Panama's agricultural "frontiers". Colonists are now advancing onto lands less suitable for agriculture than the lands they left, hence they will soon be on the move again. The longer the government of Panama ignores the ecological limitations of the "frontiers", the more drastic and costly will be the consequences.

## 2. Potential AID Projects

### a) Deforestation Update

The most recent accurate data on Panama's forests are from 1970, when forests were estimated to cover 40,816 km<sup>2</sup>, equivalent to 53% of the country. Current guesses by RENARE and FAO officials are that roughly 40-45% of the country remains in forests. The inexorable advance of Panama's agricultural frontier suggests deforestation may be occurring more rapidly than forestry officials suppose. Yet neither RENARE nor collaborating international agencies have any plans to determine how much forest remains in Panama or to document present rates of deforestation.

Accurate and up-to-date information on Panama's forests are essential to the development of realistic programs for the management, utilization, the protection of forest resources. Without good base data, RENARE can only guess or ignore natural resource problems and their potential solutions.

AID should support a short-term study (2-3 months) to update the status of Panama's forests and the rates of deforestation. The interpretation of satellite imagery and conventional aerial photography should be accompanied by a strong effort towards on-the-ground verification. Detailed data should be obtained on special forest types of major commercial importance or potential, such as cativo, mangrove and orey. Accurate maps of remaining forests should be produced and all data should be summarized according to the regional development framework used by the Ministry of Planning and Economic Policy (MPPE).

The proposed study will require technical assistance of a tropical forest ecologist to guide the interpretative work and ground verification, as well as provide overall direction to the study. The proposed study should be done in collaboration with RENARE and possibly with the Instituto Geografico Nacional (IGN).

### b) Forest Colonization Pilot Project

Panama's soil degradation problems and human demographic trends preclude any possibility of slowing the rapidly advancing agricultural frontier. Nor is there any evidence of willingness or capability on the part of government agencies to control and direct

colonization. The only hope for saving some of Panama's forest resources is by redirecting colonization away from the traditional slash/burn/pasture approach to a more rational utilization of the forest resources.

AID should support a five-year forest colonization pilot project based on a "forest farming" concept. Forest colonization would be based on management of natural forests for sustained yield of timber. The production forest could be cooperatively owned and managed by colonist families living in nuclear settlements, or each colonist could receive a 50-75 ha. parcel of the production forest.

The forest colonization pilot project should be located in virgin tropical wet forest, e.g. in the Atlantic lowlands, because of naturally high timber stocking and rapid natural regeneration. Selection of the pilot area and development of colonization plans must be based on detailed forest inventories, land-use capability classifications and forest management plans. Controlled colonization must be accompanied by infrastructural development.

The pilot project will require substantial technical assistance in tropical forest management, natural forest silviculture, sociology and integrated rural development. The proposed pilot project could become a successful model for rationalizing land-use by slash and burn colonists.

International and national agencies have traditionally viewed agricultural colonization of humid tropical lowlands as a way to relieve population pressure and aid national development. But the fragile soils of the wet tropics will not support sustained agriculture. It is time for agricultural development planners to look at tropical forests as productive and renewable natural resources. If we do not come up with viable systems to combine natural forest productivity and colonization pressure we are ensuring the demise of tropical forests.

CHAPTER IV. AQUATIC RESOURCES

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## CHAPTER IV. AQUATIC RESOURCES

### A. Summary

Panama has one of the most diverse coastlines found in Central America. The Pacific Coast is characterized by irregularity, fine quartz sand and mud beaches, and large mangrove-dominated estuaries. The continental shelf area is broad with a gradual slope. Strong northerly winds combined with tidal and counter-clockwise currents result in upwelling of older, nutrient-rich bottom waters. Temperature, rainfall, salinity and upwelling combine to determine the abundance and distribution of the areas aquatic resources.

The Caribbean coast is characterized by quartz sands near areas of coral reefs with mud beaches in areas near river mouths. The continental shelf is narrow, widening only in the Bocas del Toro region. Oceanic currents along the Caribbean coast are part of the Equatorial current moving to the west and north. Coastal areas outside the influence of the Panama Canal locks are less subject to variation in both temperature and salinity than the Gulf of Panama waters.

Community diversity and composition vary greatly between the two coasts, with the Pacific rocky shores dominated by barnacles and oysters while molluscs are absent from similar areas in the Atlantic. Mangroves are present on both coasts although they are more abundant on the Caribbean coast.

The primary marine resources of economic importance to Panama are shrimp, herring, anchovy, and lobster. Of the seven groups of shrimp fished, six are found in the Pacific. The shrimp resource of greatest economic significance is the white shrimp, which inhabits nearshore waters averaging 7-20 meters in depth. Larvae of the white shrimp are carried into estuarine areas where they pass through several juvenile stages. White shrimp appear to have been overfished since 1968 when the number of boats reached a high of 232. The other shrimp resources, including red shrimp and Titi shrimp, appear to be underexploited.

Herring and anchovy are used locally and for fish meal and oil exports. These resources appear to be underutilized. Anchovies are found in greater abundance at the mouth of estuaries, which may be related to increased food supply in those areas. The lobster fishery in Panama is of secondary importance, with most fishing on an artisanal level. Lobster populations appear to be confined to rocky zones such as Isla Perla and San Carlos along the Pacific coast. The Caribbean coast spring lobster fishery accounts for 90% of the total lobster landings. Potential fishery resources in Panama are Pacific sharks, tuna, pink shrimp and red snapper, although a greater potential exists in the more efficient utilization of presently exploited stocks.

Other important aquatic resources in Panama are marine minerals, river fisheries, freshwater shrimp, and culture exotic fish species in ponds.

## B. Resource Base

### 1. General Description

Few countries in the world compare with Panama in diversity of coastline. The Pacific coast, extending approximately 1500 km in length, is characterized by its irregularity, fine quartz sand and mud beaches interspersed with igneous extrusions, and large mangrove-dominated estuaries. With the exception of the southern Azuero Peninsula and the western-most point of Bahia de Charco Azul, the continental shelf area (200 meter isobars) is broad with a gradual slope. Oceanic currents in the Gulf of Panama move in a counterclockwise direction with tidal currents superimposed on the permanent current either accentuating or alternating with this current, depend on the tide (NOAA/EDS 1978). Tides are semi-diurnal with a maximum spring range of 6 meters (Glynn 1972). Salinities vary with the season and proximity to shore reaching 18-20 parts per thousand (ppt) near the Canal locks during the rainy season though off-shore ranges are more characteristic of open ocean.

Temperature variations may be extreme and abrupt though seasonally predictable. The dry season resulting from the movement southward of the Intertropical Convergence Zone. It is characterized by strong prevailing northerly winds. These winds transport surface layers offshore, which are and it is replaced by the colder nutrient rich bottom waters. This process is known as upwelling. Upwelling may result in 12°C drops in ambient water temperature in a 24-hour period (Glynn 1972). Nutrient enrichment and the associated phytoplankton blooms have been described by numerous authors (Forsbergh 1963, Smayda 1966, Kwiecinski, et al 1975). Upwelling is continued to the Gulf of Panama as the alternating effect of Cordillera Central on northerly winds blocks surface transport of waters in the Gulf of Chiriquí. Rainfall in the Pacific averages 178 cm/year (Area Handbook 1972). These physical parameters play a major role in the abundance and distribution of the area's living resources.

In contrast to the Pacific coastline, the Caribbean coast has fewer major physiographic features and extends only an estimated 800 km in length. Beaches are composed primarily of quartz sands with carbonates dominating near major areas of coral reefs while mud beaches are confined mainly to the areas immediately adjacent to river mouths. The continental shelf is narrow (5-35 km in width), widening only in the Bocas del Toro region. The oceanic current along the Caribbean coast is a continuation of a component of the Equatorial current moving to the west and north (Mariners Tables, 1976). A coastal countercurrent, however, often occurs averaging

between .05-1 knots per hour (NOAA/EDS 1978). Tidal range is narrow (maximum .05 meters) and mixed, thus less predictable than Pacific tides (Glynn 1972). Despite the greater rainfall that occurs on the Caribbean coast (250 cm), coastal areas outside the influence of the Canal locks are subject to less variation in both temperature and salinity than the Gulf of Panama waters (CICAR 1976).

Community composition and diversity differ significantly between the two coasts. On Pacific rocky shores the high and mid-tide levels are dominated by barnacles and oysters while molluscs are absent from the same zones in the Atlantic (Glynn 1972). While large fleshy algae exist at lower tidal levels in the Caribbean, filamentous algae, bryozoans and hydroids dominate in the Pacific (Glynn 1968). In a study contrasting sandy beach communities Dexter (1972) found the Pacific communities had approximately 6 times the density of individuals, 9 times the biomass and 3 times the number of species.

Mangroves are present on both coasts and are comprised of 8 species divided among 4 genera (Rabinowitz 1975). Lugo and Snedaker (1961) described the Panamanian mangrove forests as inordinately large in biomass per hectare, which they attributed to their location out of the hurricane belt. Mangrove associated communities on the Pacific are greatly reduced in comparison with Caribbean communities which is attributed to longer exposure during low tides (Glynn 1972).

The differences in community composition and diversity continue into the shallow sublittoral zones. Earle (1972) described grass beds dominated by Thalassia, Halodule to a depth of 10 meters and Syringodium and Halophida as more characteristic of deeper subtidal areas. In the Pacific, however, Panamanian flora was described as poor. Similarly, whereas coral composition from the Caribbean side of Panama has been described as one of the richest in the area, the Pacific fauna on all taxonomic levels was described as an impoverished Indo-Pacific fauna (Porter 1972).

## 2. Status of Panama's Marine, Freshwater and Coastal Zone Aquatic Resources

### a. Marine Resources

#### 1) Marine Fish and Shellfish

The fishing industry, dominated by the shrimp and fish meal companies, represents a major sector in the Panamanian export economy. Fish product exports in 1977 totaled an estimated 203,250 tons valued at \$45.8 million dollars or 4% of the GNP. (Estatistica Pesqueras 1977), derived primarily from Pacific waters.

## 2) Shrimp Resources

In 1978 shrimp landings totaled 5,235 metric tons representing a value of \$27.6 million dollars (Estadística Pesqueras 1977). The industry, which began in the late 1940's, currently is comprised of six shrimp processing and packaging plants, five of which are located in the new government port facility of Vacamonte and the sixth in Puerto Pedegral near David. The shrimp fleet consists of 290 boats of which 264 at present are licensed to fish.

The primary shrimp grounds are found in the Gulf of Panama to Darién region, shallow areas adjacent to the island of Coiba, and the Gulf of Chiriquí. Boats are capable of fishing for periods of up to two weeks over the entire Pacific coast.

Of the seven groups of shrimp fished from the two coasts six are found in the Pacific. The shrimp resource of greatest economic significance, the white shrimp, includes the three species, Penaeus vannamei, P. stylirostris and P. occidentalis of which the latter dominates most catches (Bullis and Klíma, 1972, D'Croz, et al. in press). These shrimp inhabit nearshore waters averaging 7-20 meters in depth (Obarrio 1959). Though spawning activity has been documented throughout the year, peak periods occur during the months November-December (Masters 1956, Obarrio 1959). Larvae, largely through passive transport by tidal and wind-driven currents, are carried into estuarine areas where they pass through several juvenile stages. Highest densities are observed during the months of March-May (D'Croz et al 1976). There appears to be a high degree of tolerance to variations in salinity as juveniles occur in all parts of the estuary (D'Croz, personal communication). The life cycle is completed during the spring months when young adults return to parent stocks. Strong currents and the narrow shelf of the southern Azuero Peninsula would appear to maintain at least two separate white shrimp populations (Gonzalez, personal communication), although there is little evidence of this.

Of the remaining shrimp resources, red shrimp (P. brevivirostris) and Titi shrimp, (Protrachypene precipua, Iphopenaeus riveti) both represent significant exports. The former is fished further off shore in deeper waters, while the latter is often found associated with the white shrimp species.

As a result of the importance of the white shrimp resource, fairly detailed records are maintained. This data is based on samples from company landings. The fishery is at present a closed one limited to 264 boats and fishing activity is banned during the months of February to March. It is timed

to coincide with the migration of young adults back to parent stocks. Despite these efforts at stock management, white shrimp appear to have been overfished since 1968 when the number of boats reached a high of 232 resulting in successive reductions of catch per unit effort (Gonzalez personal communication). Present calculations indicate that a reduction of approximately 80 boats would be required at current fishing intensity to return stocks to maximum sustainable yield levels. No further constraints on the fishing of stocks appear evident though licenses cannot be transferred upon departure from the fishery for any reason. While no evidence of overfishing of red shrimp exists, data indicate that the resource may be at or near maximum sustainable yield (MSY) levels (Gonzales personal communication). The other remaining shrimp resources appear underexploited, though demonstrating this is difficult as only total catch records are maintained. Other problems currently facing the fishery include rising fuel prices, illegal fishing of young shrimp in estuaries (San Miguel, Parita and Chiriquí) and the detrimental effect unabated mangrove destruction is having or will have on white shrimp populations.

### 3) Herring And Anchovy Resources

Exploitation of the herring and anchovy (anchoveta) resource first began at an industrial scale to serve the needs of the U.S. tuna fishery for live bait fish during the 1930's and 40's (Bullis and Klima 1972). The two stocks principally harvested are the anchoveta Cetengraulis mysticetus and thread herring Opisthenema libertate, the former dominating landings. After meeting local market demand (30% of total production) fish meal and oil exports amounted to an estimated 26,500 metric tons (132,500 metric tons live wt.) valued at \$8 million (FAO 1976). It appears the resource may be underutilized as both Baycliff (1966, 1969) and Forbergh (1969) estimated the potential yield in the Gulf of Panama to be in the order of 140-250,000 tons annually. The present utilization of this source began in the mid 1950's (Fong, personal communication). Currently, there are only two plants operating though a closed plant is reportedly nearing reopening in the fall. Each plant utilizes a fleet composed of a mixture of company, government and individually-owned boats. There are approximately 30 purse seiners in the day fishery focused in the Bahía de Panama and Bahía de Parita. When the fishing is poor in these waters, boats venture as far as Las Armuelles and Bahía de San Miguel.

The anchovies spawn principally in November-December and move offshore during the juvenile stages (Baycliff 1966). In April and May the young move back on shore feeding off the extensive mud flats occurring throughout the Gulf to a depth of 10 meters (Bullis and Klima 1972). Principal prey species include dinoflagellates, diatoms and bottom detritus. The

greater abundance of anchoveta at the mouth of estuaries may be related to increased food supply though there is presently little evidence to support this conclusion (D'Crox, personal communication). There is little management of the fishery. As there are only two companies at present harvesting the resource, there is common agreement when to initiate and terminate fishing activities (based on the first appearance of adults and gravid females respectively). Records of landings are reported to the Department of Marine Resources.

#### 4) Lobster Resources

Though high in value per unit weight, the Panamanian lobster fishery is of secondary importance in comparison with the shrimp and fishmeal industries. The fishery is artisanal in nature on both coasts. The Caribbean coast fishery, based on the spiny lobster (Panulirus argus), accounted for 90% of the estimated 76 metric tons landed in 1975 (NOAA/ NMFS 1977). Of this amount 27 metric tons were exported to the U.S. The major lobster grounds on the Caribbean side include all of San Blas and the Bocas del Toro regions. On the Pacific side, lobster populations are confined to rocky zones such as Isla Parida, San Carlos and areas adjacent to Bahía de Muertos.

The fishery in Bocas del Toro is seasonal, coinciding with lobster migration to the rocky shores of the Laguna de Chiriquí in February to May (NMFS 1977). In contrast, the Pacific fishery is exploited year round. When not consumed in the immediate local market, lobsters are collected until enough quantities exist to justify flying them to Panama City. The San Blas Indians export their own lobster directly to the U.S. market through Panama.

At present, there are no restrictions on lobsters landings. Records are not maintained and landings represent only estimates. Based on personal observations and interviews in the Panama fish market, the Pacific lobsters P. gracilis and P. inflatus, if not over-exploited, are certainly mismanaged. There is little evidence to base any judgment on the state of the Caribbean populations; however, estimates of a potential production of 200 metric tons/year have been calculated (Butler and Pease 1965).

#### 5) Potential Fishery Resources

Based on FAO-sponsored exploratory fishing surveys from the period 1972-1975, three new shrimp species appear to have possibilities for development. Two deep-water Pacific species, the Fidel (Solenocera agassizii) and cabezon (Heterocarpus vicarius) shrimps, were found between 50-200 fathoms with highest densities collected from the shelf edge (Giudicelli 1978). A third species, the Caribbean pink shrimp (P. duorarum), was found throughout the continental shelf

with highest concentrations in the 15-30 meter range. Major impediments facing the harvesting of the Pacific species are: the small number (20-35) of boats projected to harvest MSY (Giudicelli 1978); resistance of fishermen to learning required new techniques, cost in gear replacement; and increased fuel costs associated with fishing deep-water species. The primary problem facing the exploitation of the pink shrimp is the limited seining area resulting from the presence of coral reef and rock outcroppings in Caribbean waters.

In addition to exploitation of new shrimp stocks, the following were identified by Giudicelli as potential fisheries:

Pacific Sharks - possibly capable of supporting a fishery at the artisanal level.

Pacific Long Line Operation - potential exists for sustaining low levels of exploitation for tuna and tuna-like resources in pelagic waters.

Caribbean Artisanal Fishery - possible development opportunities for shelf edge fisheries of shark, pink shrimp and red snapper.

A second area for potential expansion exists in Panama's fisheries through more efficient utilization of presently exploited stocks. Currently, trash fish and high value fish such as flounder and snapper trapped in shrimp seines are discarded which often results in high rates of mortality. This represents a resource that if not suitable for the export market could be sold locally. A second non-utilized resource exists in the discarding of shrimp heads at sea before being landed. Among other uses, shrimp heads can be processed for fish meal and fertilizers.

## 6) Marine Minerals

Panama appears to have put little emphasis on marine mineral exploration. Government policy on mining endeavors is a mixed one, with participation both in joint ventures and in granting private concessions with compensation clauses.

The principal marine mineral extracted in Panama has been sand for use as a construction aggregate. The Bahia de Chame is the traditional source of sand. It is transported to Panama City by boat. At present, there are two companies

extracting an estimated 94,000 yd<sup>3</sup>/year of sand from the area (Departamento de Recursos Minerales 1978).

There are no producing oil wells in Panama, although concessions have been granted to several companies (subsidiaries of Texaco Gulf) for exploration on the continental shelf and adjacent slope region in an area extending from the Golfo de los Mosquitos to Cabo Tiburon. Exploratory wells are planned for next year (Esquivel, personal communication). At present, a joint U.S.-Panama-owned oil transshipment terminal (Petroterminal de Panama, S.A.) exists near Puerto Armuelles. Its purpose is to tranship Alaska crude oil to small oil tankers capable of transiting the Canal.

#### 7) Coral Reefs

Coral reefs represent one of the most diverse habitats found in the marine environment. Panamanian coral reefs have been identified on both sides of the Isthmus, though their distribution is much better known on the Pacific coast. The Caribbean side has greater diversity in both corals and associated communities, in contrast to the Pacific corals where diversity is limited to 20 species. Where reefs do occur they are shallow and generally dominated by Pocillipora (Porter 1972). As a result of drastic reductions in temperature associated with seasonal upwelling in the Gulf of Panama, the greatest coral development occurs in the Occidental region, specifically the Secas Islands, Contreras group, Bahía Honda and Parida Island near the Chiriquí River mouth (Glynn, personal communication). To a lesser extent, coral communities occur near Taboga, Taboquilla, and the Pearl Islands group (Glynn 1972).

Forty-nine stony corals are known to occur on the Atlantic side (Porter 1972). Major known areas of development are the leeward side of the San Blas Islands, Isla Grande, Galeta Point, and a small area on the exposed islands of Boca del Toro (Lessios, Robertson, personal communication, personal observation). Coral development has been described as comparable to other areas in the Caribbean (Porter 1972).

#### 8) Islands

The islands of Panama appear to represent one of the major underutilized resources in the near coastal zone. By one estimate (Handbook 1975) there are approximately 1,600 islands in Panamanian possession with the majority found on the Pacific side. These islands range from emergent rocks to Coiba with an area of approximately 10,000 km<sup>2</sup>. Panama is fortunate to have unique island grouping as beautiful,

pristine, and diverse as the coral reef-fringed San Blas islands, the mangrove islands in the Bocas del Toro area, the igneous exposed Secas and the Contreras groups with their unique Eastern Pacific coral development, and the Perlas providing nesting sites for pelicans, cormorants and several endangered bird species.

b. Coastal Zone Resources

1) Mangroves

Mangrove forests are found along both the Pacific and the Atlantic coasts of Panama. They are very important as spawning habitat for many commercially important brackish water and marine fish species such as corvina and robalo. Some relation may exist also between the abundance of the anchovy c. mysticetus, important to the country's fish meal and oil industry, and proximity to mangrove estuaries. Mangroves are especially important to the various shrimp species found in Panama. The white shrimp, Penaeus occidentalis, passes to juvenile stage in estuaries from March to May (D'Croz et al, 1976). At least six other shrimp species have been found in mangrove waters as well (D'Croz and Kwiecinski, in press). Mangroves also act as buffers to tropical storms as well as terrestrial runoff. Major areas of mangrove on the Atlantic are the lowlands along the Rio Changuinola (Changuinola), lowland areas adjacent to the Laguna de Chiriquí (Chiriquí Grande) and the Golfo de San Blas (Comarca de San Blas). On the Pacific side major stands are found in a zone extending from La Boca de Los Espinos (Alajuela) to Boca de Pajaroncito (Sona), the Golfo de Montijo (Rio de Jesus, Montijo), a range between the Rio de Cana and Tonosí (Tonosí), Bahía de Parita (Aguadulce) and throughout the Bahía de Panama to the Golfo de San Miguel.

Based on a proposal to eliminate the mangrove areas near Juan Diaz to provide for Panama City's expansion, D'Croz and Kwiecinski (in press) calculated the approximate economic loss in fish and shellfish production resulting from habitat destruction. The estimated value was \$94,629/km/yr or \$1.1 million/yr for the proposed area of development.

2) Mudflats

Mudflats represent the feeding grounds for the adult herring and anchovy stocks in Panama. Major areas of mudflats include Bahía de Parita, Bahía de Chame, Bahía de Chorrera, Bahía de Bigne, Bahía de Panama, and the Golfo San Miguel. Mudflats are very limited in number on the Caribbean, sum-

summarily found in areas immediately adjacent to river mouths.

### 3) Coastal Zone Minerals

At the local level, sand is harvested from the beaches along both coastlines in Panama. This practice is so widespread that the Direccion de Recurso Minerales (Directorate of Mineral Resources) defers to local town mayors on regulation of the resource. In practice, however, there is no regulation. A second use of sand has been for the extraction of magnetite ore. The Japanese-owned company Hierro Panama mined large quantities up until 1971 from the berms behind Nueva Gorgona. Besides the rusting equipment scattered throughout the area, the berm pits still remain as left. Other areas of concern in or adjacent to the coastal zone with potential quantities of mineral that would warrant their commercial exploration are (Direccion de Recursos Minerales):

<u>Location</u>	<u>Region</u>	<u>Mineral</u>
Punta Cahuita - Punta Mona	(Changuinola)	Magnetite Ore
Lagartito - Las Tablas Abajo	(Guarare)	Magnetite Ore
Punta Chame - Boca del Rio Hato	(Chame-Anton)	Magnetite Ore
Peninsula Valiento	(Chiriqui Grande)	Coal
Chiriqui Grande	(Chiriqui Grande)	Coal
Isla Popa	(Chiriqui Grande)	Coal
Salmoneta	(Sona)	Aluminum
Bahia Honda	(Sona)	Molybdenum

### 4) Other Important Resources

Two examples of other important coastal resources and their critical habitat are: 1) the turtle beaches located in western Bahia de Charco azul, southeastern Azuero Peninsula, Golfo de Parita and Golfo de la Mosquitos; and 2) habitat in the Bahia de Chiriqui and the Rio Changuinola area utilized by the endangered manatee, Tricheus marinus.

### c. Freshwater Resources

Panama has few natural lakes. Rapidly flowing streams and rivers are primary characteristics of Panama's freshwater habitat. The larger river systems are found in the watersheds of Bahia de San Miguel and Golfo de Chiriqui where broad and gently sloped drainage basins exist. On the Caribbean side, however, the rivers are shorter in extent and feed directly into the sea.

## 1) River Fisheries

River fisheries as a source of protein in Panama have generally been of secondary importance. Despite Templeton's (1969) description of freshwater fish as a significant food resource in southeastern Panama, food preferences of the people inhabiting the region are for marine fish and shellfish. Templeton estimated that the Cunas of the San Blas region derive 30% of their protein from marine origin. In the Occidental region Young (1971) indicated that fish still perform an important role as a food source for populations living near rivers. Fishing activity as in the Oriental region seems to be highest during the dry season when streams are low and clear.

Traditional fishing techniques include the use of spears, hand lines, traps, poisons, and gunpowder. These latter two methodologies have resulted in serious depletion of fish populations (Young 1971) and possibly, sterilization of entire streams (Goodyear, personal communication).

## 2) Fresh Water Shrimp

In addition to the freshwater fish resource, several species of freshwater shrimp (Macrobrachium sp.) occur in streams in the Interior. Harvesting occurs primarily with the use of basket and cloth traps (Adams 1957).

## 3) Exotic Fish Species

The introduction of exotic fish species to Panama has a long history. The first record of fish introduction was the Barbadian Guppy Girardinus poecillodes sponsored by the Panama Canal Company for mosquito control (Le Prince and Orenstein 1926). Though introduced into what is now Gatun Lake, the species apparently failed to adapt. This attempt was followed by two other attempts in 1917 and 1925 to introduce the largemouth bass, bluegills, and crappies which met with similar fates (Hildebrand 1938). Rainbow trout were successfully introduced into the Rio Chiriquí Viejo in 1925. They occupy streams at altitudes above 5,000 feet with little apparent negative impact to the environment (Richardson, personal communication). In 1967 the "Peacock Bass" Chichla Ocellaris, was introduced into Gatun Lake. Introduction was attributed to an accidental overflow from an artificial recreational fish pond which led to the Chagres River (Zanet and Paine 1973). As this high level piscivore spread throughout the lake and its tributaries, populations of various prey species were reduced, which resulted in effects in lower trophic levels. A similar occurrence took place in Lake Atitlán in 1958 with the introduction of the largemouth bass and

black crappie. Within 15 years local native populations and the black crappie were decimated by the voracious bass (Zanet and Pain 1973). Exotic fish introduction has continued to the present with the introduction by the Panama Canal Company of a high-level herbivore, the Chinese carp (Ctenopharyngodon idella), as a biological control for the freshwater plant Hydrilla.

As a result of GOP interest, the National Directorate for Aquaculture (DINAAC) was established in 1976. With partial support from AID approximately 30 community ponds and 175 family ponds have been constructed. Ponds are stocked with sterile hybrid of Tilapia, which is beneficial both in having a faster growth rate and preventing establishment of natural populations. As DINAAC continues to expand, future projects will include fish introduction of Tilapia in Lake Alajuela and construction of a shrimp hatchery in Punta Chame.

At least one freshwater shrimp culture company is experimenting with an introduced species Macrobrachium. The Directorate expressed interest in the species as a candidate for culture programs, noting its previously known life cycle and fast growth rate. However, it must be cautioned in light of its antecedents that introduction of this species may, if not carefully controlled, result in eventual displacement of one or more of the native shrimp species.

A similar attempt, with possibly much greater environmental consequences, occurred in the shrimp mariculture field: Agromarina applied for and was granted permission to import an exotic species of marine shrimp. The species after completion of laboratory experiments was destroyed (Rodriguez, personal communication). Though apparently carefully controlled, one must consider the potential impact release of the species might have had on native shrimp populations. Given the importance of resident stocks, the question of the adequacy of existing safeguards must be addressed.

In the former case, the species was brought to Panama without any notification of relevant authorities. The species was allowed into the country solely on the basis of permission from the quarantine authorities. In the latter case, requests were submitted to the Department of Marine Biology in the Dirección de Recursos Marinos. The request was reviewed and granted though limitations were placed on the quantity of shrimp allowed into the country. There appears to be no coordination of activities between experts to review such requests other than on an ad hoc basis. Possibly of greater significance, coordination of activities between a panel of experts and quarantine personnel still appears to be lacking.

## C. RESOURCE MANAGEMENT

### 1. Government of Panama Institutions

At present there exists no defined policy for the management of Panama's marine, freshwater and coastal zone resources. Regulatory authority governing the use and development of these resources is spread out over a number of government ministries and agencies with little evidence of coordination among them. Conflicts normally are resolved through the formation of interagency committees directed to resolve specific problems on a case-by-case basis. Once a consensus is achieved, recommendations are made to the relevant ministries whose approval is required before they become policy. The government agencies with major roles in marine, freshwater and coastal zone resources management are:

#### a. Ministerio de Comercio e Industria (MICI) (Ministry of Commerce and Industry)

This Ministry of Commerce and Industry was created with the signing of Decreto de Gabinete (cabinet decree) No. 145, June 8, 1969. Its mandate is to plan, organize, direct and enforce those activities that facilitate the creation, development, and expansion of the country's industrial sector.

In addition to the internal planning, administrative, and budgetary components, MICI is composed of several elements responsible for policy execution, of which three have jurisdiction over aquatic resources, including:

#### Dirección General de Recursos Minerales (Directorate General of Mineral Resources)

Upon approval of Decreto Ley (Legal Decree) 23, 1963, the Código de Recursos Minerales (Code of Mineral Resources) was established. Authority extends to all classes of mineral deposits and their exploitation. Jurisdiction extends over the mainland, continental shelf, seabed and islands. The Directorate is also responsible for negotiation and financing of the development and exploration and exploitation of mines and oil and gas reserves.

#### Dirección General de Recursos Marinos (Directorate General of Marine Resources)

This agency was created in June, 1969 with the signing of Decreto 145. Situated in the Ministry of Commerce and Industry its mandate is to prepare, direct and supervise a national program for the development of the fishing sector. This includes economic, social and administrative aspects of the sector as well as the participation in the investigation, explanation and conservation of Panama's living marine resources.

Autoridad Portuaria (Port Authority)

This body was created in 1974 with the signing of Ley Law 42. Situated in the Ministry of Commerce and Industry, the Port Authority's mandate is to plan, promote and coordinate the development of the country's port system. Critical areas of jurisdiction include those over construction of any port or marine installation on the bottom, beaches and banks of the Nation's rivers, estuaries and ocean. This jurisdiction includes any part of the national territory covered by the seas extending to a line 10 meters above high tide. Any activity taking place in this area requires permission from the Port Authority.

There does not exist any environmental review component within MICI. The only two departments that administer natural resources directly are Marine Resources and Mineral Resources. Both have their own "in-house" capabilities to assess possible environmental impact of proposed or ongoing programs. As they are both regulatory in nature norms can be set to limit detrimental impact to the environment before granting licenses. Given the problems observed in overfishing of certain fish stocks and lack of control of illegal beach sand extraction, one must question the effectiveness of implementation of existing environmental standards.

The mandates of the remaining bodies in MICI are largely ones of advocacy or monitoring. The conflict between unrestrained economic growth and environmental deterioration would seem to indicate that a comprehensive review process for programs and projects initiated by private or public entities would be in order.

b. Ministerio de Desarrollo Agropecuario (MIDA)  
(Ministry of Agricultural Development)

MIDA supervises all aspects of agriculture in Panama, including fishery resources. Two agencies within the ministry are of particular importance:

Dirección General de Recursos Naturales Renovables (RENARE)  
(Directorate General of Renewable Natural Resources)

This agency was formed as part of the Ministry upon approval of Ley 12 in January, 1973. Its responsibilities are to complete an inventory of the country's forests, regulate and supervise the exploitation of the states forests and reforest excessively exploited areas. The Directorate's jurisdiction, as it relates to the coastal zone, is the role it occupies in management of mangroves and surface waters entering estuarine areas.

Dirección Nacional de Acuicultura (DINAAC)  
(National Directorate of Aquaculture)

This government program for aquaculture development was created in 1978 and placed under the Ministry of Agricultural Development. This agency's objectives are to promote aquaculture pro-

sectors. Up to the present, the center's major activity has been directed toward pond aquaculture. However, plans are currently being formulated to expand into mariculture, focusing primarily on shrimp culture.

## 2. Administration

To illustrate how these various institutions interface and how policies are formulated, a specific problem still in the process of resolution is outlined below. The problem concerns the use of estuaries. The basic issues are (1) where and to whom is jurisdiction delegated; (2) what regulations exist and how are they implemented; and (3) what effects, if any, will these activities have on the estuary and white shrimp resource.

One significant cause of the problem is attributed to the granting of a 20-year concession to Agromarina de Panama (Ralston-Purina) in 1974 to develop approximately 6,000 hectares of salt flats for the purpose of shrimp mariculture. A second legal concession was authorized for Panlangosta in April, 1979 to develop 124 ha. of salt flats over a period of 10 years. These grants were authorized by the Ministerio de Hacienda y Tesoro (Ministry of Finance) with the approval of the Port Authority. Though it is unclear to what degree these two legalized activities spurred other private interests to enter the field, by November 1979 it was apparent that a largely uncontrolled movement into the field was underway. By February, 1980, 14 requests for permission to initiate development were before the Port Authority with 9 additional requests submitted between that time and the present. The problem became significant when it was documented that in the majority of cases, development activities were already occurring and that possible alternation or destruction of the respective mangrove areas might be involved (Autoridad Portuario 1980).

The problem became even more complex with involvement by additional governmental bodies. Officially RENARE had yet to formulate a position in regards to the issue (Diaz, personal communication) though concern was expressed with the potential impact on the area's water and mangrove resources. The Port Authority recommended that a freeze be placed on all activity based on, among other justifications, the possible impact proliferation of shrimp mariculture activity might have on their nation's shrimp industry and ultimately on the new \$40 million port facility at Vacamonte (Leon, personal communication). Also, the Dirección de Recursos Marinos was in favor of some form of limitation on taking juvenile white shrimp as it related to impact on the natural shrimp populations. Finally, DINAAC, whose mandate is to encourage and promote artificial rearing of aquatic animals, was generally a proponent of this activity (Pretto, personal communication).

There is legislation for the protection of the mangroves (Ley 12, 1973), regulation of the use of water (Ley 12, 1973), and management of the nations fisheries (Decreto 17, 1959), but there is, at present

no other legislation regarding the use of the salt flats and a loop-hole exists in regard to mangrove alternation or destruction.

Although individual entrepreneurs held legal title to the land, they were acting illegally until official permission to develop the salt flats or alvinas was obtained from the Port Authority. In addition, legislation may not be applicable to individuals holding clear title to mangrove areas prior to passage of legislation (Rodrigues, personal communication): It appeared that the relevant government bodies were not certain as to who held titles, what lands were involved, and when the titles were acquired.

The problem was addressed by the formulation of an intergovernmental committee in February, 1980. The committee, in turn, formed subcommittees to develop working papers from which a consensus could be reached. Upon agreement an announcement was issued in May requiring that: (1) only enterprises measuring 100 ha. or less be allowed to collect shrimp from natural areas, while larger companies must purchase shrimp from hatcheries; (2) all present illegal operations be frozen at their present size; and (3) the Port Authority coordinate the permitting process. A meeting at the ministry level has been announced to consider these recommendations and attempt to formulate legislation.

As might be expected, the illustration above is only one example of a host of problems for which no coordination mechanism exists for adequate and effective resolution of problems.

### 3. Existing Relevant Legislation

The following compilation of relevant legislation must be prefaced by two caveats. First, no central depository of national laws exists in Panama but rather documents are dispersed among the separate ministries and legislative offices. Thus, a comprehensive review within the given time allotment was impossible. Second, much of what was considered "insignificant" legislation for the purposes of this document (the yearly establishment of fishing moratoriums) has been deleted.

#### a. Marine Resources

- |                  |        |  |
|------------------|--------|--|
| ° Decreto Ley 23 | (1963) | Created Dirección General de Recursos Minerales.   |
| ° Decreto 145    | (1969) | Created Dirección General de Recursos Marinos to prepare, direct and supervise a national program for the development of the fishing sector. |

° Ley 42 (1974) Created Autoridad Portuaria to plan, promote, and coordinate the development of the country's port system.

b. Jurisdiction

° Ley 58 (1958) Defined Panama's territorial sea as extending to 12 miles.

° Ley 31 (Art 1) (1967) Extended Panama's jurisdiction to 200 Nautical miles including air space territorial sea, and continental shelf areas.

c. General Fisheries

° Decreto 17 (1965) Defines marine fauna as a renewable resource that belongs to the State though allowance is made for its exploitation by individuals by right of occupation with certain limitations: the Executive Branch maintains the right to regulate the fishery (Art. II), establish prohibitions (Art.28), and require fish licenses (Art.50).

° Decreto 210 (1965) Prohibits the fishing in nursery grounds (estuaries and mangroves).

- ° Decreto 162 (1966) Fishing activity is regulated throughout the territory.
- ° Ley 5 (1967) To facilitate pending fishery measures inspections of landings and boats shall be allowed.
- ° Decreto 202 (1968) It is prohibited for boats exceeding 10 gross tons to fish inside the 12 mile limit and in certain specified areas.
- ° Decreto Ejecutivo 71 (1971) Formed national commission of fish
- ° Decreto Ejecutivo 50 (1977) Modifications of basic fishing regulations.
- ° Decreto Ejecutivo 192 (1976) Modifications of basic fishing regulations.
- ° Decreto Ejecutivo 369 (1976) Modifications of basic fishing regulations.
- d. Shrimp
  - ° Ley 33 (1961) Shrimp processing plants with a value exceeding 50,000 B. may own their respective fleets, not to exceed 5 licenses.
  - ° Decreto 49 (1969) It is prohibited to import boats to be used in the shrimp fishery.

° Decreto 162	(1966)	Measures were established to guarantee the optimal utilization of under exploited shrimp species until net mesh criteria could be established.
° Decreto 13	(1967)	Shrimp boats exceeding 20 gross tons that have neither a license or request for renewal may not sell their catch.
° Decreto 14	(1970)	Seasonal closure of fishery.

#### 4. Marine, Freshwater and Coastal Zone Projects

Several major projects embarked upon by the Panamanian government over the last 10 years have clearly demonstrated its commitment to the development and maintenance of the sector. Some of these projects are described below as follows:

##### a. Proyecto Pesquero

At present there are 13 cooperatives in Panama, 10 located on the Pacific coast and the remaining three on the Caribbean side. Fish production at the cooperative level is currently directed only to meeting local market demand.

Giani (1977) estimated that of approximately 3,000 fishermen employed in the fishing sector 1,188 participated at the artisanal level. Approximately one-half of all artisan level fishermen were found in the province of Panama followed by Coclé, Colón, Chiriquí and Veraguas provinces with approximately 100-150 each.

The subsistence fishermen are scattered along both coasts and use dugouts or cayucos which are 10-20 feet in length, usually without motors. The commercial fishermen category is composed of approximately 10 purse seiners and numerous motor-powered cayucos measuring between 20-35 feet. Fishing activity is directed toward pelagic species dominated by corvina, jurel, sierra and robalo.

Proyecto Pesquero, funded and administered jointly by the Banco Interamericano de Desarrollo (Inter-American Development Bank-BID), Banco de Desarrollo Agrícola (Bank of Agricultural Development), and Banco Nacional (National Bank) consists of three elements: construction of new shrimp boats and purse seiners

to replace aging boats in the fleet, a project to aid existing and create new fishing cooperatives and the initiation of an oyster mariculture program in Bocas del Toro. The major components of the fleet modernization program are: construction of 26 shrimp and purse seiners to replace older wooden hull vessels; providing assistance for the construction and use of the new boats; and providing funds for transferring, processing and packaging facilities for the new fishing port of Vacamonte.

Through loans provided by the World Bank, six new cooperative projects were sponsored in 1976 to add to the already existing seven cooperatives. The objectives of the Proyecto Cooperativo were to: augment production and modernize equipment in present and newly formed coops; create an employment estimated at 450 new jobs; establish a modern and expedient system of commercialization of fish; and lower the need to fish at subsistence levels.

Proyecto Ostra was initiated three years ago in Bocas del Toro. The current staff consists of 2 biologists and a Cuban technician. The project's focus is to examine the feasibility of mariculture of the mangrove oyster in the islands of the region.

b. Puerto Vacamonte

As control of the Panama Canal reverts to the GOP, the country's importance as a major port center is rapidly being elevated. Besides the modern large facilities at Cristóbal, Balboa and Vacamonte, secondary ports exist at Almirante, Bocas del Toro, Portobelo and La Bahia de las Minas on the Atlantic side, and Puerto Armuelles, Pedegral, Aguadulce and La Palma on the Pacific Coast (Atlas 1975). Future proposed port sites on the Atlantic coasts of Panama are Punta Robalo, Calovebora and Coclé del Norte. Three port sites are presently being proposed for the Pacific side - an area above Bajos de la Iglesia on the Río Sabana, Puerto Mensabo and a port near Las Lajas to serve Cerro Colorado.

Panama's newest fishing port, Puerto Vacamonte, was opened in April, 1980 completing a four-year project at a cost of approximately \$40 million. Though initially planned as a tuna port, at present it serves five of the country's six shrimp processing and packaging companies. Facilities include two shrimp fleet unloading jetties, two service jetties, synchrolift and ship repair yard as well as complete facilities to serve the international tuna fleet. Future construction of tuna processing and packaging facilities as well as development of a national fleet is being considered.

## 5. Problems and Constraints

Several problems and constraints appear to have significance for future development in Panama's marine, freshwater and coastal zone aquatic resources. Among these are the following:

### a. Large-scale Destruction of Mangrove Areas

Large-scale clearing of mangrove areas is prevalent throughout Panama. This is best illustrated in the development of the Punta Chame resort complex (see Appendix c) and urban expansion witnessed east of Panama City.

Other sources of direct mangrove destruction include harvesting bark for export to Costa Rica for tanning (primarily occurring near David); for firewood and charcoal (apparently prevalent throughout Panama); and for use as construction scaffolding (observed in the Colón area).

Potential indirect sources of impact to mangrove communities include: contaminant build-up associated with large agricultural activity such as bananas (Bocas del Toro, Puerto Armuelles), rice (David), cane (east of Juan Diaz), urban areas (David, Panama City and Juan Diaz) and major site-specific operations (oil transshipment at Puerto Armuelles), and future mine tailings associated with copper extraction at (Las Lajas). To conclude, one must mention that water diversion, levy construction, saline water discharge, and shrimp removal activities associated with shrimp mariculture may be detrimental to adjacent mangrove areas. This is an area in urgent need of further study.

### b. Island Habitat Destruction

Groups of islands on both sides of the Isthmus are suffering from slash and burn cultivation. Though still confined to isolated locations, burned areas were observed on mangrove cays in Bocas del Toro and islands in the Las Secas and Las Perlas groups. Through several islands in the latter group are privately owned, it would appear that most of the activity was caused by squatters.

### c. Sectoral Constraints

The following list of constraints by sector is based on an intensive four-week research in Panama. The list emphasizes the major current issues of each sector.

Though individual cases may be cited where increased human, technical or financial assistance would alleviate the immediacy of the specific problem, the inadequacy of administration

appears to be of much greater significance. Failure in administration is a result of a host of factors many of which are inherent in the socio-cultural-political fabric of Panama today. Since these issues are outside the scope of the present paper, primary stress has been placed on the more manageable problems such as lack of coordination between administrative units, policy formulation and the sharing of monitoring and enforcement responsibilities. It has been a major theme throughout the paper that administrative capabilities need to be strengthened before use of the various forms of assistance, both local and international, can be utilized effectively.

### 1) Marine Resources

The shrimp and anchovy stocks represent the major marine resources presently utilized and are significant components in Panama's export economy.

Critical habitats for the two resources are estuaries and mudflats.

The mainstay of the industry, the white shrimp, has been exploited beyond maximum sustainable yield (MSY) for 12 years resulting in gradual stock depletion and reduction in catch per unit effort. Further pressure on stocks will result as vital habitat continues to be destroyed. The red shrimp stocks may be at or near MSY. The lobster stocks appear to be overexploited or mismanaged. Statistics for other stocks are incomplete or absent, and their condition has not been assessed.

### 2) Coastal Zone Resources

There is no defined administrative or regulatory mechanism to address coastal zone management issues; and existing legislation is vague, creating "grey" areas between various jurisdictional boundaries.

Existing "loopholes" in present legislation provide for legal use and abuse of the coastal zone by individuals, and where legislation exists, enforcement is minimal.

### 3) Freshwater Resources

Exotic species introduction has had a long and sometimes disastrous effect on Panama's lakes and streams. There are indications that rather than examine the feasibility of culturing native species, introduced species are preferred, and no effective and consistent review procedure appears to exist to assess the potential for environmental impact of introduced species on natural populations.

## D. RECOMMENDATIONS

### 1. Recommendations to the Government of Panama

The following recommendations are listed by sector.

#### Marine Resources

- ° Remove fishing pressure on heavily fished stocks by:
  - diverting some or all government and privately-owned boats to fishing underexploited stocks;
  - providing incentives for company and individual boat conversions, such as duty waivers on imports, free technical workshops, and fuel subsidies to fish off-shore stocks;
  - increasing the closed season;
  - utilizing present resources more effectively;
  - marketing fish by-catch associated with shrimp and purse seiners; and
  - examining alternative uses for shrimp heads including their use as fish meal by the local industries.
- ° Provide for complete statistics through increases in budget and field technicians and establish permanent office at Vacamonte;
- ° Examine feasibility of conversion of an older boat in the fleet to serve for exploratory fishing surveys;
- ° Implement legislation and controls of under size lobster harvesting; and
- ° Develop capabilities to monitor critical habitat and fish product quality.

#### Coastal Zone Resources

- ° Establish a part-time committee drawn from public, private and academic sectors to administer coastal zone activities with power of consent required for initiation of any project with potential for coastal zone impacts. Budget and permanent technical and administrative staff should be provided.

- Halt all further illegal development activities within the coastal zone through coordination of enforcement activities in the respective ministries;
- Initiate a coastal zone characterization study program to include at least the following;
  - mapping efforts to include coastal type and extent analysis;
  - account of present utilization including physical activities located in the zone and impacts from use of adjacent lands; and
  - documentation of owner and definition of title rights.
- Formulate a coastal classification system from which to base management decisions (see Appendix C);
- Provide advisory and coordination capabilities to include:
  - definition of areas of jurisdiction among government agencies,
  - coordination of respective ministries' policies,
  - review and advise on such relevant issues as:
    - oils spill contingency plans (Petroterminal)
    - critical habitat destruction (Punta Chame)
    - beach access (Punta Chame - San Carlos area).
- Provide a focal point of review and approval for proposed upland development activities identified as having impacts on the coastal zone.

#### Freshwater Resources

- Form or expand the mandate of an existing multi-disciplinary committee to include RENARE, DINAAC, Dirección de Recursos Marinos and the University to act as a review and consent mechanism for exotic species introduction programs;
- Encourage utilization of existing natural resources by:
  - directing research to examine the feasibility of culturing native Macrobrachium species;
  - initiating re-stocking efforts in depopulated rivers, streams and artificial lakes;

- ° Continue research in the area of induced biological controls (i.e., sterile hybrids); and
- ° Examine the feasibility of artificially raising and marketing such native alternative marine stocks as conch, turtle and mangrove oysters.

In addition to the above specific recommendations it is also recommended that the Government of Panama form a committee for more effective coastal zone management.

d. Proposed Committee for Management of the Coastal Zone

This proposed new entity need not be highly sophisticated; rather, it must be both administratively feasible and relevant to Panamanian conditions. The concept of intergovernmental committees is not a new one. However, an interdisciplinary committee with a separate budget, permanent staff with participation from government, academic and private sectors is a rarity. The justification of this recommendation rests on the complex nature of the coastal zone itself; the ineffectiveness of the present system of management; and the belief that though the human resources exist in Panama to formulate and participate in a high quality program, they are dispersed through public and private sectors. Therefore, some highly qualified persons may not be available on a permanent staff of professionals to perform the administrative tasks.

The most sensitive issue will be the actual role of the Committee. Rather than act in just an advisory role to the various ministries, it is felt that the Committee should participate in both policy formulation and coordination between ministries. This role is particularly important since no one ministry has the total capability to deal with the variety of complex issues in coastal zone management.

To achieve this level of authority would require the full support of the respective ministries. One possible mechanism to obtain this support would be the appointment of current high level administrators to the Committee with responsibilities over some aspect of the coastal zone. This has an additional advantage of providing access at the ministry level through which the committee could pass recommendations and policy initiatives. Additional membership should include representatives from intensive coastal zone users such as fishing and land development sectors. Finally, the academic sector could provide technical expertise such as the environmental implications of various proposed projects. At the idea paper level it is futile to continue the detailing of administrative schematics. Nevertheless, one additional idea would be the creation of a permanent technical staff to work with its administrative counterpart. This would be advantageous in the compiling and synthesizing of information required to make sound management decisions.

## 2. POTENTIAL AREAS FOR AID INVOLVEMENT

### a. Environmental Education Programs

Panamanian fishing cooperatives are some of the best organized in Central America and have recently expanded to 13 upon receipt of a \$650,000 loan from the World Bank. One possible area AID might consider is education programs at the cooperative level and the inclusion of an environmental component in the already existing programs or new program development focused on relevant environmental issues. The problems currently faced at the industry level stem from ineffective management, largely a result of limited resources (financial and human), lack of appreciation for the need of stock management by the fishing community, and no enforcement capabilities. Though outside AID's traditional areas of involvement, some participation in the former two issues may be warranted. Workshops both technical for the fishery manager technician (management strategies, fishery statistics, etc.) and non-technical (need for fishery management) for the fisherman would be advantageous.

Financial and possibly technical assistance could be utilized by the Departamento de Recursos Marinos to develop fishery management plans to regulate stocks.

### b. Pilot Research Project on Non-and Under-Utilized Resources

AID could provide the framework for more effective utilization of presently harvested resources and support pilot projects to identify alternative markets and determine the economic feasibility for use of such "non-utilized" resources as shrimp heads and shrimp by-catch.

### c. Technical Assistance in the Coastal Zone

If the proposal coastal zone management committee is formed, AID could provide technical assistance to its members. Examples of areas of possible participation include: 1) lending technical assistance to a much needed coastal zone characterization program; and 2) sponsoring interdisciplinary workshops to facilitate dialogue and provide a basis for an integrated approach to solving problems in the zone.

### d. Aquaculture Project

Of the three areas outlined in this paper, AID's principal involvement and success has been in the field of pond aquaculture. While AID's involvement in fresh water culture appears bright, caution is advised before embarking in the mariculture field. Despite some success in the culture of shrimp at the industrial level its feasibility has not yet been proven at the small pond stage. It is estimated that a minimum of 20 ha. would be required to produce shrimp at a competitive price (Pretto,

personal communication.) Operations of this size would require a cooperative approach and represent a significant departure for AID from past involvement at the family managed pond level. Finally, the full ramifications of shrimp mariculture activity on the estuarine ecosystem is still unclear. As pointed out earlier this may not only signify immediate habitat destruction but have possible long-term negative impacts on the shrimp industry. Since this has become a volatile issue in Panama, it is advisable that AID minimize involvement in shrimp mariculture in the near future. Less traditional mariculture species with either existing or potential markets include the mangrove oyster, turtle hatcheries (suitable both for repopulation and export activities) and development of hatchery capabilities for Caribbean conch.

Continued participation in fresh water monoculture and polyculture efforts seems well advised though more thorough examination of the full environmental implications of species introduction is warranted. Panama has the expertise to judge these implications but has failed to utilize them in the past.

Emphasis should be placed on the feasibility of using sterile hybrids rather than reproductively viable exotic populations for pond culture. A second area to be studied is the utilization of native populations for aquaculture purposes, the most attractive being one or more of several species of the freshwater shrimp Macrobrachium that occur in Panama.

## CHAPTER V. WILDLIFE RESOURCES AND NATIONAL PARKS

### A. Summary

### B. Resource Base

1. General Description
2. Major Wildlife Resources
3. National Parks and Reserves
4. Resource Utilization

### C. Resource Management

1. Government of Panama Institutions
2. Administration
3. Legislation and Law Enforcement
4. Personnel
5. Public Relations and Extension
6. Major Problems

### D. Wildlife Management Recommendations

1. Recommendations to the Government of Panama
2. Potential Projects for AID Involvement

## CHAPTER V WILDLIFE RESOURCES AND NATIONAL PARKS

### A. Summary

Panama is a tropical country with distinct dry and rainy seasons caused primarily by the tradewinds. The northeast trades drop their moisture on the Caribbean slopes of the Central Cordillera and build up again over the Pacific savannas. These trades occasionally cause an upwelling on the Gulf of Panama and bring cold, nutrient-rich bottom waters to the surface where they provide excellent feeding conditions for fish, birds, and sea mammals. Above 1000 meters, cooler temperatures prevail, and organisms differ greatly from those found in the humid and dry tropical lowlands.

The country's wildlife is composed of species endemic to North and South America, although the fauna is predominantly neotropical. Three of the four major bird migration routes between the two Americas converge in Panama. A wide variety of habitats exists in the country, ranging from islands and coral reefs to mangrove forests and mudflats along the coastlines. The wildlife found in Panama are among the most studied in the tropics in regard to animal taxonomy and possible animal ecology.

Throughout the forested areas of Darien and the Atlantic provinces, indigenous tribal communities continue to hunt game animals for food, especially the peccary, tapir, iquana, squirrels, rodents, deer and all bird species except scavenger species. Indians also use turtles and turtle eggs for food. There is some commercial exploitation of wildlife in Panama, such as parrots and macaws collected to be sold as pets, primates captured for biomedical research, and big cats such as the ocelot and jaguar killed for their skins. Turtles, iquanas, frogs and crocodiles are sold as well in the international market. Although many species have a good economic potential, there is little management of these resources and little effort to monitor populations and enforce existing laws.

Panama has a wide variety of existing and proposed national parks. A common problem to several such parks is colonization within park boundaries. Another difficulty with two parks, Volcan Barú and the international park, La Amistad, is that their boundaries are arbitrarily drawn at the 1,800 meter contour line, which does not include the vertical transition zones leading to the parks themselves. Several parks harbor important species; for example, the forest of Volcan Barú National Park harbor the only quetzal population in Panama.

Wildlife conservation and management in Panama is the responsibility of RENARE's Department of Wildlife and National Parks. The Department's wide mandate is presently the responsibility of seven professionals and 25 guards in the field. The Department does not have an overall resource development plan nor a listing of priority areas for development and for research. The only operational wildlife project is a sea turtle protection project begun in 1975.

## B. RESOURCE BASE

### 1. General Description

The Isthmus of Panama displays a unique diversity of life zones. Its climate is essentially tropical, except for the cooler conditions found in the western and eastern highlands. The seasonal variability in precipitation characteristic of most tropical lowland climates results in a distinct alteration between dry and rainy seasons. However, seasonal variations are enhanced by geographic conditions, and organisms inhabiting the different ecosystems exhibit variations within species. Ridgely (1976) points out that the trade winds are the main cause for the annual cycle of dry and rainy seasons. The northeast trades, typical for the dry season, drop their moisture on the Caribbean slopes of the Central Cordillera and build up again over the Pacific savannas where they further desiccate an area already suffering from lack of rain and systematic removal of the water-retaining vegetation. The same trades occasionally cause an upwelling in the Gulf of Panama where warm surface water is replaced by cool, nutrient-rich subsurface water masses, thereby creating excellent feeding conditions for birds, fish and sea mammal alike. At elevations above 1000 meters temperatures drop progressively, resulting in floristic and faunistic compositions distinctively different from the humid and dry tropical lowlands.

Panama encompasses the southernmost part of the Central American Isthmus which connects the two Americas. In zoogeographical terms, it has served as an extremely important land bridge between organisms developing in North and South America. The country's fauna is composed of species endemic to the northern and southern part of the continent. Due to climatic conditions, however, the fauna is predominantly neotropical. Three of the four major migration routes of migratory birds between the two Americas converge in Panama. The country provides migrants with important staging, breeding and seasonal living space (Mendex, 1979).

Ridgely (1976) points out that Panama provides an excellent opportunity to see within a short distance a variety of unspoiled and accessible tropical habitats. Panama has a great potential for outdoor recreation and wildlife-based tourism. The Pacific and Atlantic coastlines, the many attractive islands, the numerous coral reefs, and the diversity of mainland life zones in a vertical and horizontal transition and readily accessible by road, sea or air. Conservation problems in the country are increasing. The rapid rate of forest destruction, the abuse of watersheds and the contamination of waterbodies and estuaries are areas of critical concern (see section in this report on forestry, watershed management, marine resources and pollution). These problems are the direct result of population pressures, aggressive and undirected colonization, the lack of synecological understanding of natural systems, and the lack of a multidisciplinary national planning effort based on sound land use capability classifications.

## 2. Major Wildlife Resources

### a. Reviews of Research Efforts

Panama is one of the best known countries in the neotropics with regard to animal taxonomy and possibly animal ecology. As indicated by Ridgely (1976), the birdlife in Panama has been systematically studied for over a century. The same author gives an excellent account of scientists who made contributions to the scientific knowledge of birds (introduction to "Birds of Panama", Ridgely, 1976). Detailed ecological and behavioural investigations as well as systematic collections of specimens were greatly enhanced through the establishment of the Barro Colorado Research station in the Canal Zone in 1923. This research station has hosted several world-reknowned ornithologists and since being placed under the auspices of the Smithsonian Institution, it has provided local scientists and students the opportunity to conduct original scientific research. In 1968 the Panama Audubon Society was founded. It has done excellent promotion work for the country's birdlife, and fostered specific studies. Since its creation the Gorgas Memorial Laboratory has made major contribution to the knowledge of Panama's avifauna, culminating in the excellent book by Dr. E. Mendez on "Las Aves de Caza de Panama" (1979). Prolific local scientists operating from the University of Panama, and the extension branch in David continue the series of important research programs.

Since Goldman's classic book on "Mammals of Panama" (1920), much additional information on mammals in Panama has been collected. The relevant literature has been reviewed by Dr. C. Handley, Jr. (1966) in his introduction to the "Checklist of the Mammals of Panama" which can be considered the most comprehensive publication on mammal taxonomy for the Republic. Scientific field parties from the Smithsonian Institution have greatly contributed to the academic knowledge of the mammalian fauna. However, the mammalian fauna is generally less well known and understood than the avifauna in Panama. The state of knowledge for amphibians and reptiles is even less developed.

Wildlife-related scientific research in Panama has had a clearly autecological orientation. This approach is difficult to justify in the light of declining animal populations and increasing environmental destruction. Future emphasis should be placed on synecological research which addresses more complex issues and requires multidisciplinary involvement. The lack of funds for field work at the universities may be the direct result of the classic autecological research approach. The demand for baseline studies for land use development programs will dramatically increase within the near future. Public agencies and private industry will have to make more funds available for feasibility and baseline studies leading to environmental impact assessments and statements. This can provide the academic

community with the opportunity to provide technical assistance and at the same time help students get field research experience. It would also be very useful for the management of animal species with geographic ranges that cross national boundaries if the concerned nations could share research results. This would be useful especially for those species with a high economic potential such as sea turtles and crocodiles.

Research findings and management experience from other countries which are applicable to Panamanian conditions could prevent overlap and assist in the identification of research gaps. The successful breeding and management projects of crocodilian species in Columbia, Peru, Brazil and Bolivia may serve as an example and the most impressive breeding success of sea turtles in Surinam as another. The management of primates in connection with management of forest reserves as found in Peru could be applicable to the Republic of Panama, and may serve as a classic model for a good multiple land use form which provides attractive economic revenues without environmental stress.

b. Current Status of Wildlife

Little research information is available on the status of most species in Panama although it is known that a large number of mammal and bird species have decreased drastically in recent years. The most severe impacts on wildlife habitats occur all along the Pacific slopes and lowlands of the continental divide from the Costa Rican border to the Canal.

With the exceptions of the Los Santos lowlands and a few upper watersheds, forest habitats have been substantially destroyed. The same applies to the Pacific side of the Metropolitan region with the exception of the Canal Zone and the area from Colón to Portobelo. Forest destruction continues in the Oriental region where it is confined mainly along the new Interamerican Highway extending from Chepo to Santa Fé. Despite increasing population expansion and the occurrence of widespread destruction as high as the continental divide, large tracts of forests along the Costa Rican border and the Atlantic slopes are still in their original state. However, the intrusion of settlers into the bottomlands of Bocas del Toro and the coastal zone from Cocolé del Norte to Portobelo and parts of the Gulf of San Miguel give reason for major concern. The oriental region is considered the least affected through colonization and land use changes. Darién is still covered by extensive areas of forest habitats, which provide excellent living conditions for wildlife populations.

Although the mangrove forests and mudflats along the Pacific coast are under heavy pressure, they are still productive, but protection efforts will have to be intensified to maintain their continued ecological productivity. Panama's islands have received little protection efforts to date; most of them will be threatened soon if not protected adequately. This applies,

in particular, to Coiba Island and the Gulf of Bocas del Toro. Some of the Pearl Island Archipelago receives increasing pressure from farmers and colonizers.

Excessive sport hunting in the Occidental and Metropolitan regions is responsible for sharp decline in game populations there. The liberal and indiscriminate use of pesticides and explosives for fishing in mangrove estuaries and rivers is causing serious damage. Commercial poaching and exploitation of economically valuable animal species such as turtles, reptiles, macaws and other pet birds and in particular spotted cats are of primary concern in the Oriental Region.

By region, the more specific areas of concern are the following:

#### Occidental Region

Especially threatened are the upper watersheds of Volcan Barú, which are subject to heavy pressure from agricultural encroachment. The cloud forests of the Volcan provide shelter to possibly the best quetzal population of Panama. If records for the endangered bush dog from this region can be verified, the species should be protected effectively. The same applies to the giant anteater. Little work has been done on manatees which are still reported in the Rio Chanquinolo and Rio Coclé del Norte areas (Mandez, 1970). Manatees are also known to inhabit the Sixaola River in Bocas del Toro province. However, numbers of manatees are extremely low in Panama primarily due to hunting. If research and protection programs were designed, international funding for their implementation could possibly be available throughout the World Wildlife Fund (WWF).

The Swans Cay Islands in the Gulf of Bocas del Toro host the last known colony of tropic birds (Phaethon aethereus) in Panama, and needs protection (Dr. R. Smith, STRI). The best coral reefs in the Pacific are found around Islas Secas. Presently, the islands receive no protection, although they are ideally suited for a marine island national park. The Barqueta turtle beach along the Pacific and the Bastimentos beach in Bocas del Toro need intensified protection and research efforts. In addition, the exploitation of Dendrobatis frogs from the Bocas del Toro islands should be assessed and regulated. Chiriquí offers an excellent opportunity for the Dirección de Recursos Naturales Renovables (RENARE) to cooperate with local hunting clubs which are very much interested in actively participating in wildlife management.

#### Central Region

The destruction of mangrove forest for the creation of monoculture pasture and "alvinas" needs to be controlled. Mangrove destruction poses a threat to shorebirds and in particular to breeding heron colonies in the Gulf of Parita. The excessive exploitation of turtle eggs in Isla de Coua should be stopped

through better enforcement. The impact of pesticides in the mudflats of the Gulf of Parita must be investigated. The mudflats are most important for migratory waterfowl.

Coiba Island is Panama's best habitat for the Scarlet Macaw (Ara macao), which once ranged over the Pacific slope east to the Canal Zone. It is rapidly decreasing in number as a result of forest destruction and the taking of young from nests to be kept as pets or sold as cagebirds (Ridgely, 1976). If the status of the island's penal facility is changed, it will be subject to intensive development and settlement pressures. Protection status for the island should be a high priority.

#### Metropolitan Region

The land pressure for residential expansion or agriculture and ranching activities is extremely high. The remaining forest habitats, mangroves, and the lake require intensified protection effort.

The beaches on the point of Puerto Chame, which used to be famous for breeding turtles, are under heavy pressure through housing development. If not intensively protected the beaches will be destroyed. An airstrip has been constructed on the point, covering part of the turtle breeding groups. The yellow crocodile in the Canal Zone is still heavily poached and needs protection. The mangrove forests at Punta Chame and within the Bay of Panama are rapidly disappearing. The iguana populations of the Famenco and Perito Islands in the mouth of the Canal have been almost exterminated due to excessive hunting.

Increasing real estate activity and forest destruction on Tabogo poses real threats to the world's largest brown pelican colony. The release of striped bass (Chichla speciosa) into Lake Gatún indicates the potential negative effects of introducing exotic species into Panama. Gatún Lake was famous for its bird life before the introduction of this exotic species. Now, many bird species which formerly preyed on abundant phytophagous fish populations have disappeared from the lake. In addition, tern, herons, egrets, kingfishers, teals and many other species are gone. In their place the hydrilla plant has grown and reached pest proportions. As part of the Archipelago Las Perlas, Pacheca Island should be protected against catastrophic fires set regularly by iguana hunters. In addition, the fires have a detrimental effect on the extensive colonies of seabirds such as frigate birds and neotropical cormorants. Several other islands of the Archipelago host good colonies of blue and brown footed boobies, egrets, and pelicans. The proposed national park in this area should be decreed and Pacheca declared a wildlife sanctuary.

### Oriental Region

The spontaneous colonization along the Interamerican Highway causing wildlife habitat destruction should be controlled. Law enforcement should be intensified to control the illegal, commercial exploitation of wildlife throughout the Darien province. Emphasis should be placed in the region on the cultural protection of indigenous communities, which depend in varying degrees upon wildlife resources for their livelihood.

The heavy exploitation of green sea turtles by coastal Cuna Indians along the Caribbean estuary of San Blas needs to be brought under control. The use of the turtles for meat protein and eggs should be restricted to only subsistence utilization. Commercial marketing should be launched to investigate the use of Playa Muerta by sea turtles. The beach locally called "Tortuguero" is said to have an abundance of the species.

#### c. Endangered Species

In January of 1980 a resolution listing 82 animal species in danger of extinction and in need of urgent protection was prepared by RENARE for Panama (See Appendix D). This list was proposed as an addendum to the Washington Convention and possible for inclusion in the International Union for the Conservation of Nature and Natural Resources (IUCN) Red Data Book on endangered species. Although this may be considered an important effort for the conservation of wildlife in the country, it does not seem to be a practical or feasible approach.

First, there is no evidence that the majority of the listed species are in danger of extinction, using internationally defined evaluation and status assessment criteria. Some species are "vulnerable" or "rare" but not threatened. If this list is submitted in its present form to international protection groups, its approval is rather doubtful. Nevertheless, if it is used to enforce international laws and control traffic of live specimens, hides and furs leaving Panama, it may be of some value.

Secondly, there is little value in preparing a long list of endangered species if there is no conceptual plan for species management. There is an urgent need to identify where, when, and how to effectively manage and protect the species. If the status of a species is not properly researched and the causes for population declines not adequately documented, there will be little hope for protection.

#### d. International Assistance

The Smithsonian Institution is the principal agency providing continuing assistance in the areas of academic research and graduate training through its Smithsonian Tropical Research

Institute (STRI). Recently it expanded its activities into public education and conservation extension efforts. The Centro Agronomico Tropical de Investigaciones y Ensenanza (CATIE) provides experts to assist RENARE in the production of management and operational plans for existing and proposed national parks. Wildlife and park matters are described in the United Nations Food and Agriculture Organization (FAO) Forestry Sector Analysis (1978). No other action has been taken or is planned. Small donations from WWF, RARE, the Nature Conservation Society and others have provided some input, primarily for national parks and autelological short-term studies. The International Society for Animal Protection enabled the rescue of animals displaced by the filling of the Bayano dam.

### National Parks and Reserves

#### a. Definition

At the second World Conference on national parks (Washington, 1972) the following definition of a National Park was accepted and passed by the assembly:

"A National Park is a relatively large area: (1) in which one or several ecosystems are little altered through exploitation as human settlements, where faunistic and floristic resources, geomorphological sites and habitats are the special scientific, educational and recreational interest, or which contain a landscape of outstanding natural beauty; (2) for which the highest authority of the nation takes the necessary steps to prevent or eliminate the exploitation or occupation of the area as soon as feasible and for geomorphological or aesthetic aspects which justify the area's nomination as a National Park; (3) for which visitor use is provided under specified conditions, for educational, cultural, recreational or inspirational purposes."

Since its first formulation, this definition has been considerably amplified and modified. The most pertinent alterations can be summarized as follows: 1) minimum recommendable size should be 10,000 hectares; and 2) watershed protection and other goods and services provided to the public can play a crucial role in the justification of the protection effort.

Viewed from these perspectives, Panama's existing and proposed national parks may not meet required international standards. Non-compatible land use forms are frequently found in existing or proposed park areas.

The status of national parks in the country, their major functions for public use, and the conservation of their resources for the future is little understood or appreciated. Consequently, little effort has been spent on their administration

and management. The country has received international assistance for the identification of areas suitable for national parks (FAO, 1973) and for the elaboration of management and "operational plans" (CATIE, FAO, 1977 to present). From FAO's survey from 1973, eight areas were identified as suitable for national parks. However, comparing the location and area covered by existing and proposed parks with the ecological map of Panama, it would appear that major ecosystems and life zones are quite underrepresented. Ironically, most parks are located in the highlands. The tropical moist forest, which covers 32.4% of the country's surface, and which is the predominant ecosystem, is hardly represented in these designated potential national parks areas. A fraction of the tropical moist forest is found in proposed Fronterizo Park, and a larger area in the proposed Bocas del Toro Park. The same applies to the premontane wet forest type which covers 20.1% of Panama.

Besides national parks three other protection categories exist: (1) forest reserves; (2) biological reserves; and (3) indigenous reserves. Biological reserves fall within the jurisdiction of RENARE's Department of National Parks and Wildlife, forest reserves are administered by RENARE's Division of Forestry and indigenous reserves are "managed" by the Ministry of the Interior.

#### b. Analysis of National Parks

The National Parks movement in Panama commenced with the establishment of Altos de Campana National Park in 1966. In 1968, the Department of Wildlife and National Parks was created, primarily to administer Altos de Campana. Between 1966 and 1974, no additional parks were established. The second national park of Portobelo was declared in 1975, possibly as a follow-up to the recommendations made by the FAO team in 1973.

In the following, the major objectives of each existing and proposed park are identified and critical constraints analyzed. The most pertinent information on existing and proposed parks are summarized in Table 5 including their legal status, principal objectives, size and location by province.

##### 1). Altos de Campana National Park

This national park contains 5,000 hectares and was established by decree in 1966. It was covered originally by good stands of premontane rain forest and tropical wet forest. The park received very little administrative support or attention until 1975 when a management plan was formulated under the auspices of the regional FAO office. This management plan was never implemented but served as a basis for an "operational plan", formulated with

Table 12

## BACKGROUND ON NATIONAL PARKS AND RESERVES

NAME	LEGAL STATUS DECREE OR LAW	CATEGORY	PRINCIPAL OBJECTIVE	SIZE (HECTARES)	PROVINCE
Altos de Campana	D-No. 35(28.4.77)	National Park	Climate, cloud forest, watersheds	4,800	Panama-Colon
Volcan Baru	D-No. 40(6.76)	National Park	Geology, flora, fauna, watersheds	14,322	Chiriqui
Portobelo	L-No. 91(22.12.76)	National Park	Historic sites, terrestrial and marine resources	7,364	Colon
La Libertad	pending	National Park	Biological potential historic, cultural	22,000	Panama-Colon
Alto Darien	D-No. 84 (8.5.70)	Protection Forest	Protection of forest " against aftosis (hoof and mouth disease)	780,000	Darien
Fronterizo	pending	National Park	Cultural, Ecology watersheds, Indigenous	475,000 (Port of Alto Darien)	Darien
Bocas del Toro	proposal	National Park (Marine)	Marine resources island habitats	21,750	Bocas del Toro
Islas de las Perlas	proposal	National Park Marine/terrestrial	Marine resources colony breeding, bird species, tourism	10,200	Panama
La Amistad	proposal	National/International Park	Fauna, flora, geology, watersheds	125,000	Bocas del Toro/Chiriqui
Isla Canon	pending	Biological Reserve	Turtle protection	15,000	Los Santos

the assistance of CATIE in 1979. There is little doubt that the principal objective for the establishment of the park was its very pleasant cool climate within a short driving distance of the capital. These characteristics may have been its downfall. At present approximately twenty families live within the park boundaries and many other residential structures have been constructed for recreational weekend use by wealthy Panamanians from the capital. In addition, 2,000 hectares or 40% of the park's total area are being used as cattle range and for other agriculture purposes. The pressure to use the park for other purposes is increasing and large areas of its original forest cover have been destroyed. Shifting cultivation inside the park boundaries is still common. The park also hosts a forest nursery to provide seedlings for reforestation projects in the Canal Zone. This is another noncompatible use which does not conform to international criteria for national parks.

Presently, the park has one administrator and three guards charged with its control. These personnel are poorly equipped and all patrolling has to be done on foot, which seriously limits the efficiency of control and enforcement. Some effort had been made by the park administrator to begin an environmental awareness campaign in peripheral communities outside Altos de Campana. While public support is increasing it has had little positive impact overall. Plans exist to expand the park to the northeast to include the watersheds of Río Ciri and Río Churra. This additional area would add 3,000 hectares to the Park.

The Smithsonian Institute has expressed interest to establish a botanical institute inside the park to serve scientists and for public education. Considering the constraints on the park and the little support it receives from GOP agencies and officials, it may be necessary to place the area into a different administrative category. Since it has high recreational value with regards to climate, this use form could be enhanced in the form of a "national residential restricted recreation reserve." Guidelines for the protection of watersheds originating within the park's boundaries should be developed in order to effectively stop the forest destruction. For these reasons it may be justified to remove the area from Panama's national parks list. However, this needs careful study before such drastic steps are taken.

## 2) Portobelo National Park

Portobelo National Park was established in 1975 by presidential decree. Its original 20,000 hectares were covered by a wet tropical forest in excellent condition. Its primary objectives were the protection of the well-preserved colonial fortification, its fauna and flora, and the fine coral reefs along its coastline. Several endangered animal species were reported in the park.

The construction of the road connecting Colón with Portobelo brought in a flood of colonizers who immediately occupied and destroyed major park areas for cattle ranching and other agricultural uses.

As a result the limits of the park were adjusted in 1979 to exclude the colonized zones. The park's land area has decreased to a total of 10,000 hectares. Although the human population is concentrated in the coastal zone, the pressures on the park continue. At present, no human settlements are found within the park but there is no buffer zone to prevent hunting and poaching activities. The area is controlled by two guards with little support, operating from the village of Portobelo. An operational plan, which was formulated for the park, is in the initial implementation phase. The park has an administrator with insufficient technical and financial support.

Because of its vicinity to the capital, its historic sites and good wildlife resources, Portobelo National Park's development should be given high priority. Effective control by a good corps of guards is a prerequisite to safeguarding its resources. The Panamanian Institute of Tourism (IPAT) has entered an agreement with RENARE to assist in the implementation of the operational plan. IPAT has offered to develop beaches and other infrastructure, including the historic sites, for the establishment of tourism in the park.

### 3) Volcan Barú National Park

Volcan Barú was founded by decree in 1976. Its major objective is the protection of its unique geology. With an elevation of 3,478 meters Barú is Panama's highest mountain. The boundaries include important watersheds covered with mature forests, and follow the 1800 meter contour line. The forests are inhabited by the only quetzal population of Panama. The park is administered by one technician located in RENARE's David office and controlled by one guard. The volcanic soils of the park area's lower slopes are the most productive agricultural lands in Panama. Poor agricultural practices, indiscriminate burning, and forest destruction in watersheds up to the summit of Volcan Barú have caused severe erosion and loss of important wildlife habitat. The destruction is particularly severe along the southern and eastern slopes. Soils in these areas are highly erodible. Farms with and without title and "Rights" are found inside the park's boundaries. The pressure of agricultural land encroachment is particularly severe. A maintenance road has been constructed to the highest point of Volcan Barú to provide convenient access to the radio transmitting tower erected on the crest of the mountain. The road facilitates access for illegal colonizers who occupy the land and remove the existing forest cover, thus posing a severe threat to the unique faunal communities located in the park's upper ecosystems. Colonization pressure threatens the caldera watershed.

An agreement was signed with CATIE to produce a management plan for the park within the next year. Due to the unfortunate adoption of the 1,800 meter contour line as the park's boundary, many life zones found in the vertical transition zones are not protected. In addition, the park needs more guards for protection and infrastructure development for wildlife-based tourism and outdoor re-

creation. A well-designed tourism program could be an economic alternative to intensive agricultural use of the highlands and provide strong arguments for more intensified protection.

Consideration should be given to adjusting park boundaries to encompass a broader range of life zones, to exclude occupied lands, and to extend the park to the northwest to join with the proposed international park La Amistad.

#### 4) Proposed International Park La Amistad

The international park La Amistad, to be established along the border with Costa Rica, is still in a proposal stage. Its total area is projected to cover 120,000 hectares of lower montane rain forests. The park is seen as a last stronghold for all wildlife resources endemic to the Occidental region. Because of its inaccessibility the forests and wildlife are considered pristine. The park would protect major watersheds important to the lowlands of Bocas del Toro province. La Amistad would join with Costa Rica's park and thereby provide a major complex of protected lower montane forests.

The major constraint on the proposed park is the arbitrary, illogical proposal to adopt the 1,800 meter contour line as its boundary. This is contrary to all ecological principles and may greatly reduce the park's value if officially approved. It is imperative to include vertical transitional lifezones and ecosystems down to the wet tropical lowland forests. It is well known that ecotones (areas where two different life zones merge) provide larger species diversity in flora and fauna than each life zone in itself. An arbitrarily established boundary line may cut important seasonal or daily migration routes of larger mammal species with extended home ranges and distinct, seasonal distribution thus, preventing effective protection of these resources. Therefore, it is strongly recommended that new boundaries be established which take these concerns into consideration.

The major management objective of the park should focus on protection. No infrastructure should be developed until the effective conservation of the area can be assured. The park's present inaccessibility may be its greatest protection asset.

#### 5) Bocas del Toro

As described in FAO's survey report for potential sites suited as national parks (1973), the Bocas del Toro Archipelago provides one of the most attractive zones of Panama with regard to scenic beauty and recreational potential. It consists of numerous islands of all dimensions with unique life forms. The diversity ranges from true inundated mangrove islands to islands with tropical moist forests. The multitude of sandy beaches provide excellent breeding habitat for sea turtles. The forests are inhabited by a unique avifauna with several threatened species, and the only population of tropic birds in Panama located in this area. As mentioned in a different context, amphibians, mammals and reptiles

in these islands have developed interesting racial variations which still need to be studied to be better appreciated.

Slash and burn agriculture is practiced on some of the islands to a limited extent, but pressure is mounting and the danger of colonization increasing. It is strongly recommended to speed up the long process of obtaining a protective decree for the proposed Bocas del Toro park. A management plan should be formulated to enhance recreational and wildlife-based tourism. The economic potential of this area to support wildlife related tourism is unquestionable. Consideration should be given to the establishment of Panama's first joint marine/terrestrial island park. International financial assistance for preparation of a management plan should be readily obtainable. It is suggested that a fund raising proposal for submission to WWF International be prepared. The proposed size of the park is 21,750 hectares.

#### 6) Proposed National Park Islas de las Perlas

The Archipiélago de Las Perlas is not only of outstanding scenic beauty but known for its richness in colonies of breeding seabirds. The coral reefs and coasts of the numerous islands in the archipelago draw increasingly more local and international visitors.

Presently, no protection for the proposed national park's 10,200 hectares is provided. The destruction of seabird colonies through indiscriminate burning by iguana hunters is well known on Pacheco Island. Similar destructive activities take place on many other islands, but are not yet documented. It is critical that Panama create a national park and a combination of marine and terrestrial ecosystems within the Archipiélago area as one of Panama's best examples of Pacific island habitats. In conjunction with the national park, a protection program should emphasize the conservation of major breeding colonies, especially for frigate birds, boobies and neotropical cormorants.

Tourism to the islands ought to be more strictly regulated and preferably guided by well-trained naturalists. The cooperation of IPAT should be obtained to ensure the compatible development of tourist programs and related infrastructure improvements.

A presidential decree should be obtained as quickly as possible to legalize boundaries and prevent further destruction of the islands. A project proposal should be prepared for international fundraising assistance. Again, WWF would be a good potential source for financial and technical support.

#### 7) Proposed National Park Fronterizo

For a detailed description of the resources and objectives of this proposed 475,000 hectares national park along the border with Colombia, attention is directed to the management plan produced as a joint effort by FAO, CATIE and Panamanian technicians. Its boundaries are well defined, include large parts of the rugged Pacific

shoreline and all major ecosystems characteristic of Darién. However, the boundaries still remain to be legalized by decree. Within the proposed park's boundaries, family groups of indigenous tribal communities are found. To a substantial extent, they have been able to preserve their original ecosystems due to the splendid isolation of this vast pristine forest, which is connected with the Alto Darién protection forest extending all along the border to the Atlantic. The protection of this immense area was endorsed by the Government as a buffer zone against hoof and mouth disease common to Colombia, but not yet known in Panama. For the same reason, it may be logical to postpone the construction of the last link of the Interamerican Highway in Panama.

A unique feature of the park, which has not been mentioned in the literature, its great evolutionary potential for producing new life forms and/or special ecological adaptations. Geologic erosion results in a multitude of landslides and successional plant community development. The rugged terrain characterized through deep cuts and gorges provides a wide range of specific habitats which undoubtedly offer interesting opportunities to plant and animal species for behavioral and possibly physiomorphological adaptations.

Although a voluminous management plan was prepared for La Fronterizo it has proven to be infeasible to implement. CATIE, in cooperation with RENARE, has formulated a provisional operational plan to initiate some limited development. If the park's boundaries are legalized and effectively protected, the status of the area is considered excellent as long as no access is provided. Although the value of tourism programs for the justification of a park and as an economic alternative is readily appreciated, tourism is not recommended for La Fronterizo at this time. The effort would be quite costly and offer only limited returns. Special attention needs to be focused on controlling the scale and types of commercial wildlife exploitation now occurring in the area.

#### 8) Proposed Park La Libertad

La Libertad, located in the Canal Zone, presents a striking contrast to its peripheral areas. "As part of its Canal defense policy, the U.S. Government has for years carefully restricted the number of private individuals allowed to settle and farm within the zone's limits. Because of this exclusionary policy, much of the Canal Zone remains in tropical forest cover. It is now a virtual island of forest in the midst of generally cleared countryside." (citation page 12, Ridgely, 1976). Meanwhile the situation has changed and the proposed Park La Libertad is administered by RENARE. The Libertad park covers an area of approximately 22,000 hectares which forms part of the Canal's watershed management project (a total of 326,225 hectares.) The park's bird life is internationally known and draws large numbers of tourists. The fauna still is represented by many species such as jaguars and other spotted cats, tapir, peccaries, and others. Several endangered species are encountered within the park. The manatee has vanished and the yellow crocodile is still heavily poached.

La Libertad may be considered the most accessible neotropical park and the best developed of its kind in Central America. Its potential for environmental education, and wildlife-based tourism is unmatched. If administered and developed according to its management plan, this park could become the model project of RENARE's Department of Wildlife and National Parks for all of Panama.

Summit Gardens, which serves as RENARE's wildlife and national parks headquarters, encompasses an area of 120 hectares within la Libertad park. Seventy hectares are occupied by a zoo, botanical garden, and infrastructure buildings. The establishment of a visitors center is planned for this area. Summit Gardens is a short distance from Panama City and can be reached by train or auto. Although its educational potential has not been fully attained, annual visitor numbers exceed 50,000 persons. A concerted effort is being made by the park's administration to capitalize on this opportunity in cooperation with the Smithsonian Institute and CATIE.

However, the park does face some serious problems. A threat is posed by farmers who try to enter and settle within its boundaries. Poaching still is not under control in its southern extension because of lack of access. The park is controlled by only four guards, who are occasionally assisted by the National Guard. More guards are desperately needed for efficient protection. La Libertad is administered by a director, sub-director, one administrator and one extension specialist. Sixteen permanent laborers are employed for maintenance operations.

#### 9) Summary Observations on National Park and Reserves

As can be seen by the previous discussions, national parks in Panama are beset by problems.

Not all of these problems can be solved or attacked at once. However, there are many actions which can be taken that do not necessarily require additional manpower or funds. If implemented they could greatly enhance Panama's national park development. Suggested initiatives include: 1) intensify efforts to achieve presidential decrees for all proposed parks, 2) identify priority areas for protection; 3) develop better interdepartmental relationships and closer cooperation with the tourist industry and mass media; and 4) develop a sensitivity in management personnel for what is feasible and which activities should be postponed based on the establishment of priorities.

With the exception of CATIE and the Smithsonian, little use has been made of international assistance programs. Efforts in this area need to be intensified.

An attempt should be made to rapidly develop the most suitable marine/terrestrial parks of the Pearl Islands and Bocas del Toro, and embark on a well-designed tourist program in a joint effort with the Panamanian tourist agency (IPAT) and other GOP agencies.

In addition, RENARE should review all existing and proposed national parks to assess whether they meet international standards. It would

be advisable to maintain their current legal status until a more appropriate classification system has been defined and is legally established in Panama. Categories such as "ecologic reserves", "wildlife sanctuaries", "recreation areas", and "biosphere reserves" have been introduced successfully to other countries of the region. There is no reason why some of them should not be applicable to Panama; however each category must first be defined and its objectives agreed upon. For example, an "ecological reserve" may be an excellent protection category for small-sized areas with unique ecological features, such as mangrove forest communities and coral reefs. This category should emphasize systems interrelationships, food chains and unique energy flows.

Another category, "wildlife sanctuaries", may be used for crucial nesting habitats on small islands or on the mainland. Wildlife sanctuaries in Panamá might include the Gulf of Parita, Taboga, Pacheco, etc.

The proposed protection system would help to maintain sufficiently high levels of genetic variability within populations to prevent species extinction. For example, if only the Darién and the La Amistad park areas were to be protected without protecting other areas in the Central region, there would be a minimal likelihood of genetic interchanges between the two areas. According to many wildlife management specialists, it is considered essential from both an evolutionary and a pragmatic point of view to protect both small and large areas dispersed throughout the country.

Other areas that should be protected are the numerous islands along the Pacific and Atlantic coastlines that have developed radical life forms.

#### 4. Resource Utilization

##### a. Use of Wildlife by Indigenous Tribes

Wildlife as source of meat protein, income, and hunting in general plays an important role in the life of Panama's tribal communities. Although extensive socio-anthropological research has been done for all the country's tribes, much remains to be known about the cultural and social status of successful hunters to adequately understand and appreciate the role of wildlife within tribal territories. Presently GOP policy regarding indigenous people is vague. Although several reserves have been created to allow for specific cultural development, reserve boundaries have been repeatedly altered by the government at will.

Reserves are continually shrinking and communities have been displaced in favor of development projects such as Cerro Colorado.

The Guaymi Indians are found in the mountainous regions and provinces of Bocas del Toro, Chiriquí, and Veraguas. Their economy is based on subsistence agriculture, although hunting still has some significance for families living in remote areas. The principal animals hunted are squirrels, rodents, deer, peccary,

iguana and tapir. The Guaymi also hunt all bird species for food except scavenger species. Fishing also is practiced but is restricted to the dry season. These Indians use firearms for wildlife hunting and explosives, pesticides and indigenous poisons to harvest fish.

The Cuna Indians live in small communities along the upper portion of the Rio Bayano and Chucunaque, and along the Colombian border. These Indians derive 7.2% of their total food intake from game and 6.3% from fish.

Hunting plays a major role in their cultural and social life. Wildlife is abundant throughout their territories particularly the dry season. Game meat is the usual daily dish for all families. Most frequently hunted are: Dasyprocta punctata, Tayassu tajacu, Iguana iguana, Penelope purpurascens, Crax rubra, Sciurus spp., Amazona autumnalis, Tapirella bairdii. Deer species are rarely taken because they are "tabu" for women's diets (Torres de Arauz, 1975). After agriculture, hunting is the most important subsistence technology. Small caliber rifles and shotguns are in common use. Dogs are increasingly used for hunting. Surplus meat is smoked and salted and either stored or sold to coastal Indians.

The majority of the Cuna Indians are found along the San Blas coastal zone. The major game species hunted by the San Blas Cunas are Tayassu tajacu, Penelope purpurascens, Dasyprocta punctata, and Tapirella bairdii. Game meat is bought from the Cunas who live in jungles and transport smoked and salted meat to the coast for sale. The carey turtle's meat and eggs are utilized by these Indians from April to August. Fishing commonly takes place during the dry season, and hunting at the end of the dry season.

The territory of the Choco Indians ranges from the lower Rio Bayano to Darien. Depending upon the location, hunting is the Choco's major occupation and game meat contributes greatly to their diet. According to Torres de Arauz, about 5.9% of their diet consists of game meat and 7.6% consists of fish and molluscs. The Chocos are famed for their hunting skills, but also for their destructive influence on wildlife. Apparently more is hunted than can be used. The use of firearms have almost completely replaced conventional weapons.

The most frequently hunted species are:

<u>Tayassu tajacu</u>	<u>Tay pecari</u>
<u>Tapirella bairdii</u>	<u>Mazame americana</u>
<u>Cuniculus paca</u>	<u>Iguana iguana</u>
<u>Ateles sp.</u>	<u>Ramfostus sulfuratus</u>
<u>Saguinus geofroy</u>	<u>Pionus nestrus</u>
<u>Cebus Capucinus</u>	<u>Penelope purpurascens</u>
<u>Sciurus sp.</u>	<u>Amazona autumnalis</u>
<u>Nasua narica</u>	<u>Crax rubra</u>

Reptiles are highly valued for their eggs (Torres de Arauz, 1975). The ethnic group of "Negros Mestizos" and "Afro Colonials" (ap-

proximately 22,000) inhabit the gulf of Darién but are found also within many flood plains in Darién. Economically, they are the most important group in the Oriental region. Agriculture is their primary food source and game meat complements their diet. They generally spend little time on hunting and are rather indiscriminate in game consumption. Iguanas are hunted for commercial use and so are spotted cats and other animals with valuable skins. The skins are smuggled across the Columbian border where they are marketed.

The colonists who are found in increasing numbers in the Oriental Region come from western Panama, especially from Chiriquí, Herrera, Los Santos and Veraguas provinces. Their diet and economy is based primarily on agriculture. Game meat contributes only 1.2% to their diet (Torres de Arauz, 1975). They carry rifles and shotguns at all times. They dislike penetrating the forests and thus concentrate their hunting efforts along rivers and artificial forest openings.

b. Commercial Utilization

Panama's fauna offers excellent opportunities for commercial exploitation. However, ruthless habitat destruction and uncontrolled taking of animals have led to stock depletion and dangerously low population densities. All commercial operations are officially banned, but poaching continues. To date RENARE has not pursued any commercial programs and there are no plans for such programs in the future. Export statistics are scanty and do not reflect the full magnitude of trade with live specimens, skins and other animal products. It is believed that the actual export quantities far exceed official records. This can be substantiated by figures obtained from the Commission responsible for wildlife rescue from the Bayano Dam (FAO report, 1978). The Commission discovered the existence of 8 import/export firms dealing exclusively with live specimens and animal products; further, 50 persons and companies were listed doing occasional business. Within the past few years the eight companies exported several million dollars worth of specimens and skins. Figures from one company are as follows:

Birds:	109,000 (Parrots, Macaws, etc.)
Mammals:	1,396 (Primates, Ocelots, etc.)
Reptiles:	150 (Boas, etc.)
Skins:	180 kg. (Ocelot skins)

Fur and skin trade are very difficult to control in Panama. Large quantities of the poached products leave the country via Colombia. Prices paid to native hunters in Panama vary from \$5 to \$30 per skin for a small fur bearer. Prices obtained abroad are disproportionately high; the value of a jaguar fur on the U.S. "black market" is as high as \$3,500. The trade with live specimens of primates for biomedical research is lucrative and well worth the risk to organized poachers. According to Dr. Rand from the Smithsonian Institute a new export market recently has been developed for the trade of pet frogs. The genus Dendrobatis spp. is has become a lucrative export item. The frog has developed dis-

tinct variations (possibly subspecies) on the numerous islands of Bocas del Toro. Each island has its own unique color variations. At present, officials are not yet aware of the potential danger of overexploitation of this species or the risk of losing unique population variations due to accidental release. Very little is known about the extent of commercial utilization of sea turtles. Although some efforts have been made by the RENARES to control turtle beaches, enforcement is poor and the control totally insufficient.

Until 10 years ago, iguanas were hunted commercially in Panama. RENARE introduced a law prohibiting the marketing of the species and imposed a closed season. The latter is ignored, but the marketing law is enforced to some degree.

In summary, many species have a good economic potential; but sound management is needed to identify species and area-specific harvest rates, to monitor populations and to enforce or modify corresponding laws.

c. Sport Hunting

The National Parks and Wildlife Department of RENARE has the legal authority to issue hunting permits. In 1980 hunting was closed for all species except the family of Columbiformes (doves, pigeons, etc.). This hunting restriction was imposed because of stock depletions and enforcement problems with related bag limits.

With the exception of the Metropolitan and Occidental regions, sport hunting in Panama has been insignificant in the past. However, according to environmental protection groups from Chiriquí, game animals have been eliminated almost all along the Pacific side of the continental divide extending from the Costa Rican border to the Panama Canal. However, hunting pressure in Chiriquí still continues at an extremely high rate. Organized sport hunting parties have been reported on the Atlantic slopes of the Cordillera. These relatively virgin areas are the last habitat for all major big game species found in western Panama. The construction of the road to San Blas could have detrimental effects on wildlife if sport hunting is not properly controlled.

The total ban on sport hunting does not seem to be a reasonable management decision. It is felt that in modern society there is still a place for this type of recreational activity. It is the devotion of sport hunters in industrialized nations which has greatly contributed to species protection and management; furthermore, hunting clubs have been advocates of nature conservation programs. A hunting society can be a very powerful lobby, especially through membership of influential citizens. Means should be found to form and invite hunting clubs to actively participate in the management of the country's wildlife resources. A total ban on hunting not only antagonizes enthusiastic sportsmen, but is also extremely difficult to enforce.

d. Wildlife-Based Tourism

Panama offers to the traveler and naturalist the unique opportunity to reach tropical habitats within relatively short distance. A list of attractive locations for naturalists is provided by Ridgely in the appendix to his "Guide to the Birds of Panama" (1976). Very little can be added to his detailed descriptions of localities of specific interest to the birdwatcher and wildlife photographer. The most central location to enjoy unspoiled tropical wildlife is the Canal Zone within easy driving distance from the capital. The Canal Zone has probably the most extensive, readily accessible lowland forest in Central America. Many of the larger mammals and a rich diversity of birds easily can be observed from roads and trails, especially on Barro Colorado Island, where protection from hunters is provided. The pipeline road and Madden forest are internationally famous for their bird life and have drawn thousands of tourists from all over the world. It may be one of the best tourist attractions in the entire country. Panama's avifauna consists of 883 known species, of which 127 are long distance migrants. According to Ridgely, at certain times of the year (autumn and spring migrations), migrant passerines constitute a conspicuous element in the Panamanian avifauna. "Migrant ducks, though limited in species, are in the aggregate more numerous than all the interesting waterfowl put together (Ridgely, 1976).

Little attention has been paid to island habitats. The large breeding colonies of many seabird species on the Pearl Islands and numerous other islands along the Pacific coast have good tourist potential. The opportunity offered by Taboga Island to observe brown pelicans from strategic positions may be unmatched. The breeding colonies on the island host thousands of birds and are within walking distance and accessible from the tower road.

Although no statistics on wildlife-based tourism in Panama are available, income from tourism adds considerably to the GNP. Little effort has been made by GOP agencies to capitalize on this income source. If adequately developed, well-programmed, and promoted, wildlife-based tourism (including underwater photo-safaris to exploit the spectacular marine life found around the numerous coral reefs) potentially could become one of the country's major sources of foreign exchange.

C. Resource Management

1. Government of Panama Institutions

Dirección de Recursos Naturales Renovables (RENARE)

RENARE'S Department of Wildlife and National Parks is responsible for the management and conservation of wildlife resources and national parklands. The Department's legal authority encompasses environmental planning and management of the country's flora, wildlife, and national parks.

At present the environmental planning and flora sections exist only on paper. Because the Department's mandate for wildlife and national parks is sufficiently broad in scope and is extremely limited in its administrative capabilities, it is recommended that these paper responsibilities be deleted.

However, considering the importance and potential of a wildlife-based tourist industry, it may be appropriate to create within the Department a "Division of Outdoor Recreation". Its principal responsibility might be to plan, elaborate and enhance tourism and related extension and public promotional work. It could be an important link to tourist agencies, civic environmental groups, and others interested in environmental protection. It might assume the responsibility for interdepartmental planning, program coordination, and communications.

The Department's wide mandate is presently the responsibility of 7 professionals assisted by 25 guards in the field. The professionals include the parks administrators. There is little communication of between field personnel and headquarters. The educational backgrounds the professional staff clearly lack relevancy and no in-service training is provided. Limited career incentives quickly dampen enthusiasm and technical performance.

## 2. Administration

The Department's policy is presently under revision and was not discussed in detail with the Department's staff. However, it is suggested that the policy has to be applicable over time and cover all areas of responsibility. Policies tend to be vague if not supported by a strong framework of long- and short-term objectives. The policy has to conform with the national development policy concept and RENARE's policy guidelines. At present, the Department lacks a conceptual development plan to cover constraints and opportunities.

A conceptual development plan forms the basis for all long and short-term programs. It is recommended that RENARE or the Department develop such a plan. The plan should rank projects and identify priorities. Objectives should be sufficiently flexible to allow for adjustments. The conceptual development plan should identify the strategy to be adopted to meet the objectives. As long as this crucial plan is lacking, the Department will continue its uncoordinated approach with little hope for increases in budget and manpower.

The Department's only operational wildlife project concentrates on sea turtles. Started in 1975, its main objective was the protection of all species. Two major breeding sites were identified as Islas de Canal and Isla de Bastimentos in the province of Bocas del Toro. Efforts were and are being made to protect the loggerhead and the east pacific green turtles being, in these areas. Each site is controlled by a poorly equipped guard who has to control many miles of beach and fights a losing battle against poachers and fellow villagers. The present use of "viveros" for protective incubation of turtle eggs and the consecutive release of hatchlings into the sea may decrease the infant and egg mortality by some degree but is insufficient to enhance turtle

populations. The project is not coordinated with the internationally funded Central American sea turtle program. It is strongly recommended to revise the project and incorporate the known turtle beaches of Barqueta, Portobelo, Punto Chame, and the Playa Muerto in Darién. Some effort should be made to obtain more reliable information on turtle breeding and distribution along the extensive coastline of Comarca de San Blas.

The Department's participation in the rescue of 3,641 animals from the Bayano Dam was an action-oriented program, and apparently quite successful. Several new project ideas include the following: (1) a project on crocodile fusco in the coral zone to explore captive breeding potential; (2) a project of captive breedings of Ara spp. for export; (3) captive breeding of unas for release and repopulation of the Central region; and (4) the creation of fauna reserves (heron colonies on Chitré, Isla Pacheca, etc.).

### 3. Legislation and Law Enforcement

The existing laws for wildlife resources and national parks are outdated, not comprehensive and inadequate to protect the resources and meet the diversified demands of the public. The legislation needs to be reviewed to reflect the status of knowledge and integrated within the total framework of general resource management legislation. Special consideration should be given to philosophical basis of these laws. Legislation has to be practical and enforceable. It is strongly recommended to create "positive" and not "prohibitive" laws. Positive laws invite the public's active participation for the management of resources and stimulate public involvement in enforcing laws. Prohibitive legislation as presently found in Panama has the tendency to antagonize user groups and may actually jeopardize the resources which it is intended to protect. Active public support could be achieved by developing close relationships with civic conservation groups, hunting clubs, presenting courses for hunters, and through the creation of a nucleus of honorary wildlife or environmental inspectors. Effective conservation requires public support.

Legislation should reflect the Department's policies and objectives. However, the best legislation is of little value if it is not enforced. Presently, the "guardabosques" (forest guards) are charged with enforcement. Their only training is a 2-month course to familiarize them with first aid, weapon handling, laws and their authority. Areas of responsibility cover wildlife, flora, forests and water.

The most significant shortcomings with the current law enforcement system are:

- ° Poor training;
- ° No equipment or vehicles for control;
- ° Areas of control too large to expect efficiency;
- ° Little recognition by the public;

- ° No use of uniforms or other means to demonstrate authority; and
- ° Wages extremely low and no incentives provided for excellence of service.

#### 4. Personnel

Currently, the education of professionals working in resource related fields is provided by the faculty of Natural Sciences of the University of Panama with an extension branch in David. Of 400 students registered per year for a "biology program," approximately 20 successfully complete their undergraduate studies. Although the biology training seems to have a high standard, there are few job opportunities for the young graduates. Most of them go into high school teaching, some continue as assistants at the University and very few are absorbed by RENARE or other GOP agencies. Career opportunities in private enterprise are almost nonexistent.

In meetings with the University staff the need for a graduate school was recognized. Graduate training is presently only available abroad. Interest was also expressed in designing curricula with an "ecological" orientation, providing students with a wider range of optional courses.

The only school for training of forest and agro-technicians is located in Aguadulce. It is a technical school for intermediate level training with a strong agronomy orientation.

Forestry programs which were established a few years ago by the University were terminated for lack of job opportunities.

It is strongly recommended that a permanent training center be created for enforcement personnel with one to two year training programs. It should be the responsibility of the center to provide the enforcement officer with a broad basis of technical knowledge to effectively carry out his function. The establishment of such a center should be synchronized with the design for careers for the successful participants. Each province should be subdivided into control areas to be headed by an enforcement officer. The enforcement mandate should cover all environmental protection aspects. Special courses could be provided by the same center for park and wildlife officers who may require some more specific knowledge. The number of personnel needed at present and the near future would justify the maintenance of this type of training center.

#### 5. Public Relations and Extension

Even though a section for public relations was established in 1979 by RENARE, it is not operational today. It is believed that the dissemination of informative materials and close cooperation with the public may be far more beneficial to the conservation of Panama's resources than day-to-day administrative office work and occasional project management. An excellent opportunity for public education exists through La Libertad National Park, which enjoys a very high visitor quota. Well-designed nature trails, an expansion of the zoo with focus on endemic fauna, guided wildlife tours, and slideshows, could be of tremendous public educational value.

The recent establishment of an Office for Conservation and Environmental Education within the Smithsonian Institute appears to be a step in the right direction. The Institute enjoys good financial support and has embarked upon interesting programs such as the establishment of a film library, slideshows depicting environmental issues and the preparation of a radio series on Panama's parks.

#### 6. Summary of Major Problems

The major problems affecting wildlife conservation and management in Panama are: 1) lack of an overall wildlife management development plan, with priorities and objectives identified; 2) lack of manpower and skilled personnel; 3) lack of comprehensive, enforceable, up-to-date legislation; 4) lack of funds; and 5) lack of strict law enforcement.

#### D. Wildlife Management Recommendations

##### 1. Recommendations to The Government of Panama

Throughout this section, recommendations have been made on specific issues. The following recommendations summarize those made previously and place them in order of priority;

- ° Provide a functional institutional structure with legally supported authority and a clearly defined wildlife management mandate;
- ° Design a country-wide wildlife management and conservation development plan;
- ° Formulate a clear and comprehensive set of policies and objectives that addresses long and short-term needs and problems and identifies the most practical strategies to achieve these objectives;
- ° Train enforcement personnel to effectively carry out their tasks, and increase their total numbers;
- ° Prepare a species checklist for mammals, birds, and the most prolific amphibians and reptiles. Specify the status of each listed species;
- ° Design, in close cooperation with the University, a country-wide research program to complement the development plan. Establish a priority index for research topics, placing emphasis on synecological investigations. Research should be done by universities or consultants rather than RENARE;
- ° Develop action-oriented pilot projects which promise practical results. Investigate the economical potential of certain wildlife species and initiate commercial projects. Prior to exploitation, collect biological/ecological data needed for sustained yield management. Species suitable for intensive management may be turtles, iguanas, crocodiles, pet frogs and other pet amphibians, and cage birds. Encourage the participation and financial involvement of interested entrepreneurs;

- Develop a model project for the demonstration of economically-attractive wildlife land use management concepts. Coiba Island may be a suitable location where forest could be managed for the production of highly-prized primates and, if feasible, macaws;
- Utilize the findings of environmental impact assessments and monitoring programs in developing and planning new wildlife-related projects;
- Evaluate guidelines for the identification of land use forms compatible with parks and wildlife conservation and management;
- Establish within RENARE a special section for wildlife and national park-based "outdoor recreation". This group should be responsible for developing wildlife and national park-oriented tourist programs in close collaboration with tourist agencies; enhancing interdepartmental communication; and developing good public relations campaign and techniques to disseminate information on the agency's programs and activities;
- Provide a countrywide network of "honorary" wildlife inspectors to assist in management and monitoring activities on a provincial level;
- Make use of existing research, exploitation and intensive wildlife management experiences from other countries in the region such as turtle breeding in Surinam; crocodile farming in Colombia, Brazil and Bolivia; forest primate management in Peru; and capybara farming in Venezuela.

The following are recommendations on a regional basis for national parks and reserves:

#### Occidental Region

- Exclude non-compatible land use from Volcan Barú and intensify protection effort for quetzals;
- Adjust boundaries of the proposed La Amistad national park to include ecologically important vertical transition zones.

#### Central Region

- Improve the conservation status of Coiba Island; initiate multiple use projects (wildlife/forestry);
- Protect the Secas Islands and adjacent coral reefs;
- Protect heron colonies east of Aguadulce and possibly establish a wildlife sanctuary to permanently protect nesting sites;
- Revise and redesign the turtle project of Islas de Cana.

### Metropolitan Region

- Develop La Libertad National Park as a model park for the country; promote tourism and design an integrated public education program;
- Select a more suitable protection category for the Altos de Campana National Park and provide more efficient watershed protection for the benefit of the capital;
- Develop protection projects for mangroves and turtle beaches of Punta Chame;
- Intensify cooperation with IPAT for development of the Portobelo National Park;
- Create a wildlife sanctuary for pelican colonies on Taboga Island and promote IPAT's participation in wildlife-based tourism;
- Declare Pacheco Island a wildlife sanctuary to protect major breeding colonies of prolific seabirds;
- Declare Pearl Island a national park by decree and find assistance for preparation of a management plan.

### Oriental Region

- Protect wildlife and forests as crucial living space for and place emphasis on the indigenous tribal communities;
- Ensure the legal status of the Alto Darién National Park and obtain boundaries as described in the park's management plan.

## 2. Potential Projects For AID Involvement

- Assist in developing a country-wide conceptual wildlife management development program and set up a framework for formulating management principles for existing wildlife reserves. Establish an order of priority for projects and set up an action plan. Design one pilot project such as a sea turtle breeding project to test resources and management principles. A sea turtle project could incorporate research information already available in the Central American region;
- Assist the National Parks Division of RENARE with management of wildlife resources in National Parks and in developing a framework for the identification of new areas to be managed for wildlife resources. Provide training in wildlife management for RENARE staff;

- ° Support the agreement between RENARE and CATIE of reevaluating the present National Parks and wildlife reserve system. Revise existing operational plans for important parks such as Alto de Campana and advise on selection of new areas to be converted into parks, especially fragile areas such as Coiba Island, Las Perlas, and Bocas del Toro.

## CHAPTER VI. SOIL AND WATER RESOURCES

### A. Summary

### B. Resource Base

1. Water Resources
2. Soil Resources

### C. Resource Management

1. Government of Panama Institutions
2. Non-government Institutions
3. Administration
4. Legislation
5. Soil and Water Resources Projects
6. Major Problems

### D. Recommendations

1. Recommendations to the Government of Panama
2. Potential Projects for AID Involvement

## A. Summary

Panama's climate is characterized by a dry season with uniform temperatures and high humidity and a wet season with heavy rainfall. The wet season is governed by the position of the Inter-Tropical Convergence Zone, which is the buffer zone between the north and south trade winds. During the wet season heavy showers may occur daily, with the broken topography dictating rainfall distribution. Annual rainfall ranges from 1,100 millimeters (mm) on the eastern coast of the Azuero Peninsula to more than 5,500mm in scattered areas on the Atlantic mountain slopes.

Panama can be divided into 51 major basins or drainage units, of which 18 are found along the Atlantic slopes and 33 along the Pacific slopes. The rivers of the Atlantic slope all flow directly into the Caribbean, while those on the Pacific flow either into the Pacific Ocean directly or into tributaries of larger rivers that discharge into it. Generally rivers in the country are short and steep, with their courses perpendicular to the coastlines.

Runoff in Panama responds rapidly to precipitation, especially during the wet season when soil moisture is maintained at a high level by frequent rainfall. Erosion and flooding are common problems throughout the country, especially along the Atlantic northern slope. Although intense rainfall is common, destructive floods are relatively rare.

Little work has been done on groundwater resources in Panama except for the Azuero Peninsula. There are some problems with groundwater supplies for municipal and irrigation needs in that area, partially because of a decreased flow in the rivers and general drought conditions. This is thought to be caused by deforestation and pasture degradation.

There is generally good solid data and mapping information for the Pacific slopes of the country and the Atlantic slopes of Colón province; however, large gaps exist in information for other areas. Panama has very little good, flat lands suitable for mechanized agriculture; the best soils are found in the alluvial lowlands of Chiriquí. The highland volcanic soils of the Volcan Barú area produce most of the vegetable crops for the country. It is estimated that Panama has less than 20,000 hectares of highly productive and mechanized soils, which is only 3% of the country's total surface area.

Several different land and soil use capability classification systems have been used to describe Panama. Estimates of land use capability have been based on systems developed for temperate climate conditions, and therefore are not adequate for identifying Panama's resources. It appears that all systems used to date overestimate the amount of land suitable for agriculture in the Darién.

Panama has some of the most severe soil erosion and degradation problems of tropical soils in Latin America. Over the years there has been little emphasis on soil conservation in Panama, but recently the Dirección de Recursos Naturales Renovables (RENARE) has included soil conservation and management as one of its responsibilities.

## B. Resource Base

### 1. Water Resources

Panama can be divided hydrographically into 51 major river basins or drainage units, many of which are presently under study for different water resource development purposes. The Institute of Hydraulic Resources and Electrification (IRHE) (1979) provides detailed information and characterizes each basin according to its area and pertinent precipitation and runoff values (Figure 11).

The hydrogeographic nature of the country is distinguished by distinct Atlantic and Pacific slope drainages. The rivers of the Atlantic side are numerous, generally of high surface runoff in relation to total water balance values, and are grouped into 18 different catchment areas, all of which flow directly into the Caribbean Sea. The two most western of these catchment areas, the Rio Sixaola and the Rio Teribe, are international and share parts of their drainage networks with Costa Rica. The Pacific slope, also with a dense drainage network, is divided into 33 basins that all flow directly into the Pacific Ocean or tributaries of larger river systems that discharge into it.

Panama's climate is characterized by a dry season with uniform temperatures and high humidity and a wet season with generally heavy rainfall. As in most tropical environments, temperature is directly related to elevation above sea level. Thus both micro-climate conditions and rainfall change drastically with changes in relief. During the dry season, which varies in length from one area to another, precipitation is normally not sufficient to satisfy evapotranspirational losses.

#### a. Precipitation

In the Metropolitan region the rainy season begins in May and ends in November, with a brief 15-to-30 day dry interval normally occurring sometime during July-August. The Atlantic coast is generally wetter with a more evenly distributed rainfall pattern, and the Pacific has relatively less rainfall distributed in a more pronounced wet-dry regime.

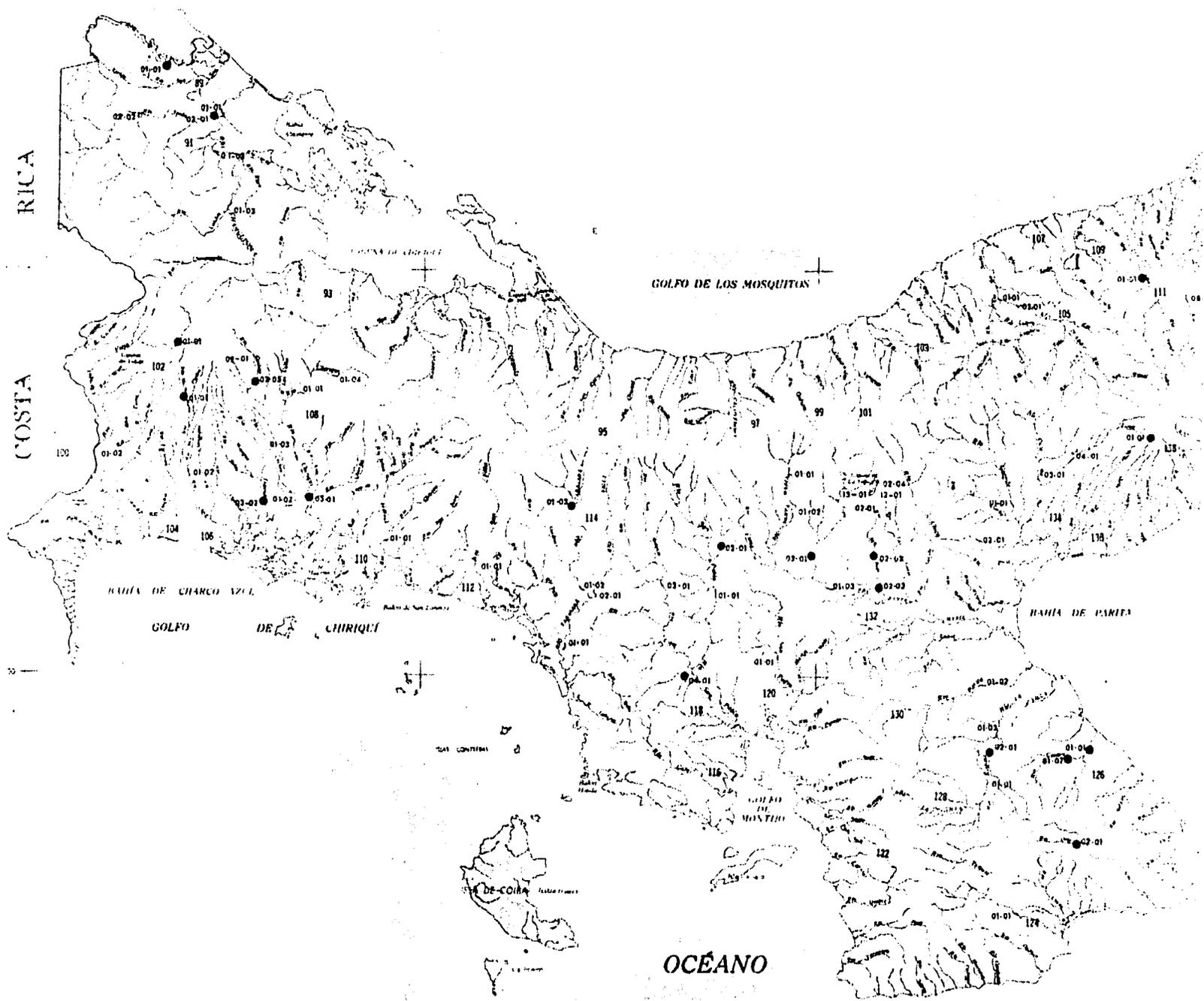
The presence of the wet season is governed the position of the "Inter-Tropical Convergence Zone (ITC)". This is the buffer zone between the north and south trade wind belts. The passage of the ITC over Panama is indicated by high relative humidity, low variable winds and frequent convectional-type rainfall.

Heavy showers may occur daily as the surface air is warmed and upward movement takes place. The broken topography results in variable orographic influences and uneven intensity and rainfall distribution. General cold front storms, called "nortes" in Panama, sometimes occur during December with the arrival of a mass of cold air from the north, and occasionally cause unusually heavy and prolonged periods of rainfall.

Rainfall is influenced by many factors which include prevailing winds, topography, exposure, location with respect to land and

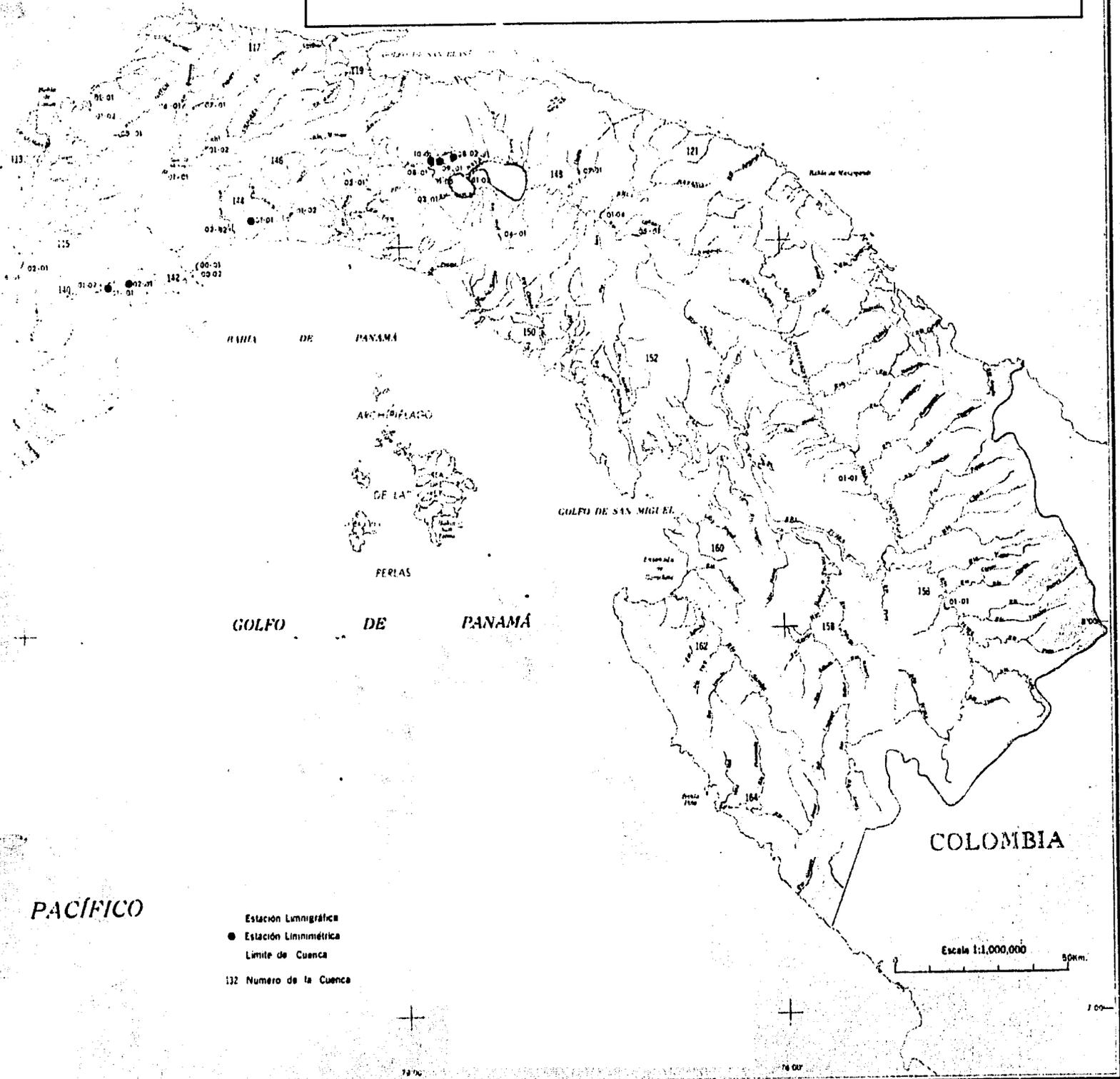
MAR

COSTA RICA



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# FIGURE 11 DELINEATION OF MAJOR WATERSHEDS



125A

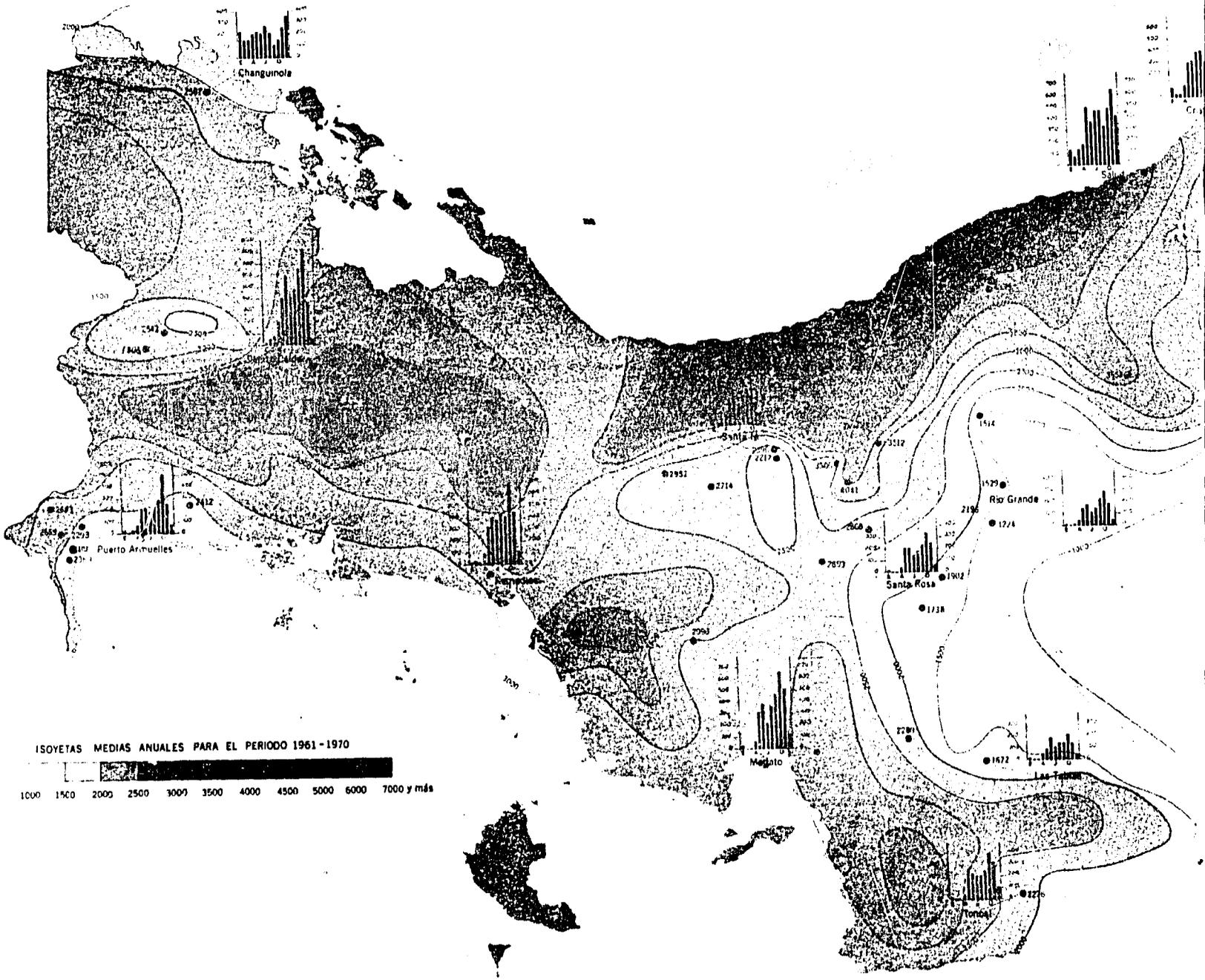
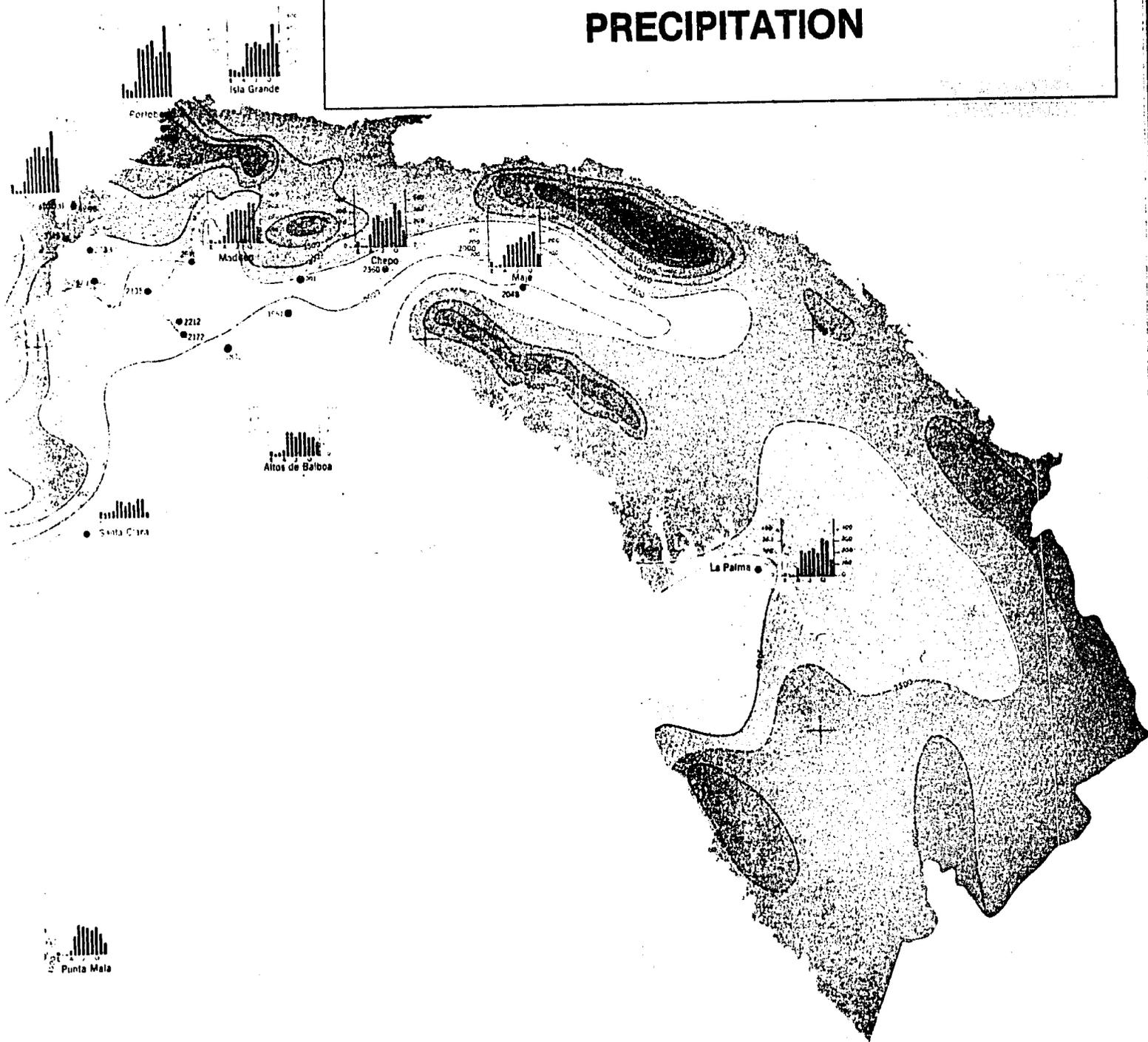


FIGURE 12  
PRECIPITATION



water masses, and other factors which affect the precipitation frequency, intensity, and seasonal distribution. In considering precipitation over a large area, it is necessary to subdivide the area into zones of approximate meteorological homogeneity. The Ecological Life Zones map of Holdrige (1970) on page 16 in a general way depicts climatic variability over the country and gives a good idea of moisture regimes especially for isolated areas where direct hydrometeorologic data is missing.

Several zones in Panama have distinct precipitation characteristics. One of particular hydrologic importance is that of the montane cloud forests. Vegetative characteristics indicate areas of superhumid conditions and sometimes wind effects and cloud moisture interception. Where cloud moisture, or "bahareque", occurs in association with forest vegetation, positive effects and likely with respect to water yield and more even flow regimes, characteristics which can be very important to most types of water resource development.

Annual rainfall maxima exceed 5,500 mm in scattered pockets of the Atlantic slope, and rainfall minima have been recorded at around 1100 mm on the eastern coast of the Azuero Peninsula. Annual precipitation accumulations and their geographic distributions are shown in Figure 12. It is estimated by IRHE that the total annual volume of precipitation that falls over the country in an average year is 233,760 million cubic meters, translatable to an average surface depth of 3.0 meters. Additional information is available for evapotranspiration rates, wind velocity, relative humidity, evaporation and air temperature for selected stations throughout the country. Much of this information is summarized in the Registry of Rural Lands and Waters of Panama (Catastro Rural de Tierras y Aguas de Panama - CATAPAN), 1970.

b. Surface Water Runoff and Stream Flow

Runoff in Panama responds to precipitation, especially during the long wet season when soil moisture is maintained at a high level by frequent rainfall. For some watersheds, especially those impacted by improper land use and soil degradation, short, intense storms cause daily flood peaks with troughs that drop nearly to base flow. Although intense rainfall is common, destructive floods are relatively rare. Flooding may occur several times a year, but the high water seldom lasts more than a few hours, as intense protracted precipitation is uncommon. Erosion and flooding problems, predominantly on the Atlantic northern slope, are caused by the medium to high intensity storms (sometimes up to 5 days in length) called "nortes". Although most of the precipitation that falls over the country comes from short duration thunderstorms and orographic phenomena, the less frequent "nortes" dump large quantities of water over entire wet-to-saturated watersheds and thereby cause record floods.

TABLE 6  
AVAILABLE WATER RESOURCES

Large	River	Basins	Area km <sup>2</sup> x 10 <sup>3</sup> c/	Precip. m m	Runoff m m	Ce	Normal m <sup>3</sup> /s	Runoff Dry m <sup>3</sup> /s a/	95% m <sup>3</sup> /s	Subter. Waters Assured Yield m <sup>3</sup> /s b/
<u>Total for Nation</u>			75.65	3094	1902	0.62	4570		681	105
<u>Total Atlantic Watershed</u>			22.52	3745	2567	0.68	1834		342	14
II	87 - 91	Sixaola, Home Creek, Changuinola	3.66	3450	2271	0.66	263	220	53	3
JJ	93 - 103	Guarumo, Cricam., Calov., Verag.	7.55	4506	3287	0.73	790	671	118	11
KK	105 - 115	Cocle, Miguel de la Borda, Indio, Chagres	7.65	3376	2263	0.67	548	466	148	--
LL	117 - 121	Mandinga and others	3.67	3236	2013	0.62	234	199	24	--
<u>Total Pacific Watershed</u>			53.13	2819	1621	0.57	2732		339	91
MM	102 - 108	Chiriqui Viejo, Chico, Chiriqui	4.49	3454	2487	0.72	356	278	71	41
NN	110 - 124	Fonseca, Tabasara, San Pablo, San Pedro, Tonosi	11.70	3369	2301	0.68	853	648	85	15
OO	126 - 134	La Villa, Parita, Sta. Maria Grande and others	9.67	2156	1164	0.54	355	270	36	19
PP	136 - 140	Anton, Caimito and others	2.22	2152	1085	0.50	76	61	38	6
QQ	142 - 146	Juan Diaz, Tocumen and others	1.20	2552	1500	0.59	57	48	6	2
RR	148	Bayano	4.63	2747	1666	0.61	250	212	25	--
SS	150 - 162	Congo, Tucuti, Chucunaque, Tuirra, Sambu	19.21	2781	1293	0.47	786	68	79	8

Notes: a/ Dry year recurring every 10 years.

b/ Estimated with 35% recoverable infiltration calculated on the basis of area and infiltration rate for each cuaternary material.

c/ Does not include the islands.

Source: IRHE, April 1976.

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Slopes are generally adequate for good drainage and the channels are well developed by frequent peak flows. Some record floods are documented, however, such as the ones that hit Boquete on the Rio Caldera in 1969 and 1970, or the flood of the coastal watershed of Rio Abajo in 1979, both of which caused substantial material damages and loss of human life.

The larger rivers derive much of their flow from upland areas which have steep slopes and shallow soils. As might be expected from this type of watershed, base flow recessions are continuous without a definite "leveling off". Many of the smaller headwater streams are intermittent having no flow during the dry season,--particularly those in dry to moist life zone areas of low rainfall and a pronounced dry season on the Pacific Slope, and those having watersheds at low elevations. The Central provinces are most strongly affected by both these torrential and highly seasonal runoff regimes.

Of Panama's 51 major rivers 18 are located on the Atlantic slope and 33 on the Pacific slope. The Rio Teribe-Changuinola basin, which occupies a large percentage of the province of Bocas del Toro, is an international watershed with part of the headwaters of the Rio Teribe extending over into Costa Rica. Generally the rivers of the country are short and steep with their courses oriented perpendicular to the coast lines. The most important rivers in terms of runoff discharge are Chiriquí Viejo, Chiriquí, San Pablo, Changuinola, Santa Maria, Cocle del Norte, Chagres, Bayano, Tuirá and Chuquenaque (See Table 6).

#### c. Groundwater Resources

Little work has been done on groundwater resources in Panama with the exception of exploratory work done in the Pacific slope of the Central province, in the Azuero Peninsula. This is an area in most critical need of groundwater evaluation work. Low annual and dry season precipitation superimposed on high evapotranspiration rates combine to create a critical need for groundwater supplies, especially for municipal and irrigation water supplies. In addition, decreased baseflow of the rivers and general drought conditions of the watersheds occur throughout this region. This is caused in part by deforestation and pasture degradation effects that compound a naturally "dry" climatic condition. This phenomena is applicable to the Gulf of Parita region, where towns such as Chitré, Los Santos, and Anton are located.

Well registration programs, reconnaissance study of aquifers and exploration based on tectoliner analysis has been done to a limited degree. Water quality information is also available for this groundwater evaluation area (CATAPAN, 2970 and IDAAN documents).

#### 2. Soil Resources

There is generally good soil data and mapping information for the CATAPAN study area which covers most of the Pacific slope of the country from the border with Costa Rica through Chepo, east of Panama City,

plus the Atlantic slopes covering most of Colón province (See Appendix 6). Within this study area, semi-detailed soils information is available for parts of Veraguas, Divisa, Las Tablas, Coclé, western Panama and Central Colón Provinces. These soils were also mapped for land use and land capability. Additional soils information is now available for the Darién region from the OAS regional development study (1978). Large gaps exist in soils information, however; those extensive areas without soils inventories include the provinces of Bocas del Toro (with the exception of the banana lands of the Changuinola area), the Atlantic slope of Veraguas, western Colón and the eastern third of Panama which mostly encompasses the Río Bayano basin.

Panama has very little good, flat lands suitable for mechanized agriculture or cattle raising. The best soils are found in the alluvial lowlands of Chiriquí. The highland volcanic soils of the Volcan Barú area (Chiriquí) are also excellent with respect to fertility and production capability, but due to their moderate to steep slopes and an almost complete lack of conservation practices, are actively suffering from accelerated erosion. These soils, because of their exceptional microclimatic conditions, produce most of the vegetable crops of the Republic. Preliminary reports also suggest that the bottomlands of the Rio Chucunaque, Balsas and Tuirá basins in the Darién are of similar capability, but more detailed studies of bio-climatic factors i.e., tropical wet life zone and heavy rainfall might prove that these soils are subject to important limitations. It has been liberally estimated that Panama has less than 20,000 hectares of highly productive and mechanizable soils, i.e. only 3% of the country's total surface area.

a. Soil Classification and Land Use Capability

The CATAPAN survey delineated soil units on 1:20,000 maps, but most of the original samples and data have been lost. Panama has spent considerable money on soil classification but has not yet succeeded in creating within the government a nucleus of competent soil surveyors and scientists trained in soils taxonomy and management techniques.

The OAS sponsored project, "Integrated Development of the Darién" (Anon., 1978) conducted detailed soil surveys of the entire Darién. Unfortunately, the USDA-SCS 9-class system was used to categorize soil capability and land-use potential. Though the USDA-SCS system was developed for temperate zone soils, it has been frequently used, often under AID auspices, to classify tropical soil capability. The USDA-SCS soil capability system consistently overestimates the capability of most tropical soils to support sustained agriculture because it does not give appropriate recognition to potential surface erosion and nutrient leaching following conversion to nonforest uses.

Furthermore, the USDA-SCS soil capability system is oriented to modern technological uses of the land that are seldom applied in tropical regions. The eight classes are too general for practical application and numerous restrictions in a particular class are in fine print and nearly always ignored.

The OAS soil capability study of the Darién reflects the questionable agricultural bias of the USDA-SCS system and its overgeneralized recommendations (Table 7). The purported capability of Class V and VI soils for permanent crops, pastures and forest exploitation offers no real insight or guidance on rational use of those soils. The legend caption that Class VII soils are "marginal for agriculture" is testimony to the inappropriateness of the USDA SCS soil capability system for tropical regions.

TABLE 7

OAS SOIL CAPABILITY AND RECOMMENDED USES FOR DARIEN PROVINCE (Anon., 1978)

<u>Capability Class</u>	<u>Km<sup>2</sup></u>	<u>%</u>	<u>Recommended Uses</u>
II	116	0.71	Intensive crops
III	761	4.65	Intensive crops
IV	287	1.75	Intensive crops
V	422	2.58	Permanent crops, pasture, forestry
VI	3,937	24.05	Permanent crops, pasture, forestry
VII	5,961	36.41	Marginal for agriculture
VIII	4,888	29.86	Protection forests

TABLE 8

## POTENTIAL LAND-USE IN PANAMA BY REGIONS AND PROVINCES (Plath, 1979).

	A G R I C U L T U R E			F O R E S T R Y			FRESH WATER	T O T A L
	Intensive	Extensive	Very Extensive	Production	Mangrove	Protection		
<u>Western</u>								
Bocas del Toro	419(6)	680(4)	44(1)	7,469(23)	234(12)	--	72(2)	8,918
Chiriqui	2,529(36)	1,273(8)	1,169(27)	432(1)	389(19)	2,966(21)	--	8,758
Subtotal	2,948(42)				623(31)	2,966(21)	72(7)	
<u>Central</u>								
Veraguas	274(4)	3,062(19)	797(19)	4,053(12)	282(14)	2,619(19)	--	11,087
Herrera	116(2)	899(6)	446(10)	327(1)	40(2)	599(4)	--	2,427
Los Santos	135(2)	1,649(10)	278(6)	1,091(3)	111(5)	606(4)	--	3,867
Cocle	380(5)	1,642(10)	307(7)	1,050(3)	203(10)	1,453(10)	--	5,035
Subtotal	905(13)	7,249(46)	1,828(43)	6,521(20)	636(31)	5,277(38)	--	22,415
<u>Metropolitan</u>								
Western Panama	34	654(4)	480(11)	879(3)	83(4)	498(4)	--	2,628
Eastern Panama	574(8)	2,012(13)	5	2,888(9)	347(17)	2,468(18)	370(34)	8,664
Western Colon	66(1)	460(3)	159(4)	1,816(5)	--	--	--	2,501
Eastern Colon	34	460(3)	40(1)	1,194(4)	8	21	--	1,757
Canal Zone	--	311(2)	256(6)	355(1)	13(1)	26	470(43)	1,431
Subtotal	708(10)	3,897(25)	940(22)	7,132(22)	451(22)	3,013(22)	840(78)	16,983
<u>Eastern</u>								
San Blas	65(1)	529(3)	240(6)	2,252(7)	24(1)	96(1)	--	3,206
Darien	2,318(33)	2,165(14)	60(1)	9,201(28)	291(14)	2,599(19)	169(16)	16,803
Subtotal	2,383(34)	2,694(17)	300(7)	11,453(35)	315(16)	2,695(19)	169(16)	20,009
<b>Country Total</b>	<b>6,944(100)</b>	<b>15,793(100)</b>	<b>4,281(100)</b>	<b>33,007(100)</b>	<b>2,025(100)</b>	<b>13,951(100)</b>	<b>1,081(100)</b>	<b>77,082</b>
<b>Country Percentage</b>	<b>9.01</b>	<b>20.49</b>	<b>5.55</b>	<b>42.82</b>	<b>2.63</b>	<b>18.10</b>	<b>1.40</b>	<b>100</b>

\*Data are in square kilometers with column percentages in parentheses.

It is especially instructive to compare the potential land use of soils of Darién based on three different classification systems (Table 9). As mentioned above, the OAS Study used the USDA SCS system. Plath (1979) gave detailed land-use potential figures for the country as a whole (Table 8). Plath's system was developed with modifications of the USDA-SCS system. Tosi's system was developed in Peru, where it has been officially adopted by the Peruvian government as a basic criterion for selecting areas for colonization and agricultural projects. It has been used to classify land-use capability in Paraguay (Hartshorn 1977), the Colombian Choco (Tosi 1976) and several areas in Costa Rica (Centro Científico Tropical 1968; Tosi 1980). Tosi's system was used to classify potential land-use in the Darién as part of a brief ecological study for OAS (Dickinson et al. 1977) that was not included in the OAS final report (Anon. 1978).

Analysis of Table 9 reveals several substantial differences among the three systems: (1) soils potentially usable for intensive agriculture are estimated at only 3% of the Darién by Tosi, whereas OAS estimated 6.9% and Plath estimates 8.4%; (2) the OAS estimate of soils suitable for improved pastures (10.9%) is three times greater than Tosi's estimate; (3) Tosi considers 15.1% of the Darién as most suitable for agroforestry or traditional shifting cultivation, while OAS and Plath classify comparable percentages of land as suitable for permanent crops; (4) both Tosi and Plath classify more than 60% of the Darién as suitable only for production forestry, whereas OAS estimates only 43%; (5) Plath's estimate of area requiring protection forests (5.7%) is less than one-third the OAS and Tosi estimates.

TABLE 9

COMPARATIVE ANALYSIS OF POTENTIAL LAND-USE OF THE SOILS OF DARIEN PROVINCE.  
USING THREE DIFFERENT CLASSIFICATION SYSTEMS.

Land Use	<u>OAS</u>	<u>PLATH</u>	<u>TOSI</u>
	(Anon. 1978)	(Plath 1979)	(Dickinson, et al 1977)
	<u>Km<sup>2</sup> (%)</u>	<u>Km<sup>2</sup> (%)</u>	<u>Km<sup>2</sup> (%)</u>
Intensive Agriculture	1,164(7.1)	1,406(8.4)	499(3.0)
Improved Pastures	1,848(11.3)	913(5.4)	644(3.8)
Permanent Crops	2,513(15.4)	2,225(13.2)	174(1.3)
<b>Subtotal: Typical Agriculture</b>	<b>5,525(15.4)</b>	<b>4,544(27.0)</b>	<b>1,317(7.8)</b>
Agroforestry or Shifting Cultivation	--	--	2,546(15.1)
Production Forests	4,255(26.0)	8,990(53.5)	10,123(60.1)
Limited Production Forests	2,897(17.7)	1,845(11.0)	--
Mangroves	367(2.2)	291(1.7)	--
<b>Subtotal: Production Forests</b>	<b>7,519(45.9)</b>	<b>11,126(66.2)</b>	<b>12,669(75.4)</b>
Protection Forests	3,328(20.3)	965(5.7)	2,817(16.7)
<b>TOTAL</b>	<b>16,372(100)</b>	<b>16,803(98.9)</b>	<b>16,803(100)</b>

Even though the OAS estimate of Darién soils suitable for agriculture is four times lower than previous official estimates (Duisberg 1976), Tosi's estimate of soils suitable for agriculture is only 20-25% of the OAS and Plath estimates (Table 8). The estimates by OAS and Plath may still overestimate the amount of land suitable for agriculture in Darién. In view of Plath's comparative overestimate of agricultural and land and underestimate of protection forests in the Darién, his country-wide estimates for these two classes must be questioned. Plath (1979) fails to classify the rugged Talamancas in Bocas del Toro as protection forests, yet IRHE considers the Changuinola watershed to have the greatest hydroelectric potential in the country.

As suggested earlier, soil erosion is one of the primary limiting factors of sustained agricultural use of many tropical soils. The highly eroded soils of the Pacific lowlands of the Central region are a major source of regional degradation and impoverishment. The potential for severe soil erosion portends grave consequences for the agricultural conquest of the Atlantic and the Darién regions.

In another under utilized OAS study, Duisberg (1976) states that the erosion potential of the Darién soils is so enormous, that uncontrolled agricultural colonization will cause an ecological disaster in the Golfo de San Miguel due to a manifold increase in sedimentation. Duisberg was so concerned about the potential soil erosion problems of the Darién, that he recommended two alternatives: (1) postponement of completion of the Interamerican Highway to Yaviza until essential basic data on soil capability and erosion potential could be gathered and analyzed; or (2) completion of the highway accompanied by strict enforcement of laws on land use, a data gathering project, and the directed colonization on lands of low erosion risk. Duisberg's (1976) report was not included in the OAS final report (Anon. 1978) and his warnings and recommendations have been ignored by GOP officials.

b. Soil Fertility

There are soils laboratories at Santiago de Veraguas, at the University of Panama (both in Panama City and in David), and RENARE is starting a soils laboratory of its own. The laboratory at Santiago, the largest and of greatest capacity, is not being used to full potential and could be developed to serve the needs of soil classification as well as soil fertility. Much of the initial impetus of this soils laboratory formation resulted as a by-product of a North Carolina State project.

c. Soil Conservation

Panama has some of the most severe soil erosion and degradation problems of tropical soils in all of Latin America. Most consultants visiting the country have commented on these problems (Phelan, 1975; Martini, and others). Many people involved in

natural resource management and the agricultural sector of the country are aware of the problems and are quite articulate about them. However in the field of soil conservation there are hardly any technicians working on a day-to-day basis. During the CATAPAN studies, 25 Panamanian agronomists were trained as soil surveyors; today few if any of these men are still working in soil conservation or management in Panama. Even if existing soil specialists could be pooled among the government agencies, there are not enough trained personnel to address the number of existing problems, let alone the new agricultural frontiers. Most of Panama's existing soil technicians are now being employed to combat the serious deforestation, erosion and sedimentation problems which threaten the Panama Canal watershed.

There was a soil management and conservation project initiated in Panama during the 1940's - 50's by the "Servicio Inter-Americano de Cooperación Agrícola en Panama". Most of the work that was done then, however, apparently has been lost. Panama's only existing soil conservation effort outside the Canal watershed is a small soil conservation project for the highland volcanic soils of Chiriquí province (principally Boquete, and to a lesser degree Cerro Punta). French mission support in the form of two soil specialists (on loan to RENARE) has been in operation for over a year now and success is apparent. Local farmers are anxious to change traditional ways, and they are beginning to recognize the need for soil conservation practices. Unfortunately, this mission is scheduled to complete its work at the end of 1980, and there is an urgent need for its continuity. This is one of the few encouraging developments in the field of soil conservation for the whole country.

Because of the difficulty of obtaining counterparts, the OAS soils team that worked in the Darién did not train and consolidate any Panamanian soils specialists to continue its work. A private company of Panamanian technicians (PRESA) was formed and under contract with the government carried out secondary studies in more detail along the Interamerican Highway corridor using the new taxonomy.

In general, over the years there has been very little emphasis on soil conservation in Panama. Until recently, there were almost no specialists working in the field. In recent years the Dirección de Recursos Naturales Removables (RENARE) of MIDA has grown and now includes soil conservation and management as one of its units. However, with only a handful of individuals working in the entire field of soils and enormous problems and demands, they are severely limited in what they can accomplish.

## C. Resource Management

### 1. Government of Panama Institutions

#### Instituto de Investigación Agropecuaria de Panamá (IDIAP)

The Instituto de Investigación Agropecuaria (Agricultural Research Institute) is a semi-autonomous agency affiliated with the Ministerio de Desarrollo Agropecuario (Ministry of Agricultural Development-MIDA). Founded in 1975, the Instituto has a Department of Agricultural Sciences, which includes a soils group. This group is in charge of fertilizer field trials for soil fertility studies and of soil analyses, which are done both as a service to the farmer and for research needs. The soil analyses are done at IDIAP's soils laboratory. The laboratory does physical and chemical analyses of approximately 5,000 soil samples per year.

#### Dirección de Recursos Naturales Renovables (RENARE)

The Dirección de Recursos Naturales Renovables (Directorate of Renewable Natural Resources) is the official agency for natural resources management and conservation. It has four principal technical divisions of which one is important for soil conservation and watershed management. The Department of Watershed Management and Soil Conservation is responsible for soil classification, conservation and management as well as land use. However, the total budget is inadequate for RENARE's needs and responsibilities, and there are few qualified personnel available. As of 1978, there were only three professionals in soils within RENARE.

#### Instituto de Recursos Hidráulicos y Electrificación (IRHE)

Hydrologic and meteorologic records in Panamá are collected by the Instituto de Recursos Hidráulicos y Electrificación (Institute of Hydraulic Resources and Electrification), the Panama Canal Company, the Chiriquí Land Company, Ingenio Ofelina, MIDA, the U.S. Air Force and a number of other smaller organizations. These institutions, with the exception of IRHE, collect special purpose records only for their own operations. The Hydrometeorology Department in IRHE is the largest and most important of the hydrometeorologic data collection organizations in Panamá. It collects the records needed for most of the important planning activities in the Republic especially with respect to water resources development.

Stream flow records in the Republic of Panamá outside the Canal Zone are collected by IRHE and those in the Canal Zone or immediately adjacent to it are collected by the meteorologic and hydrologic branch of the Panama Canal Company (PCC).

As of 1979, IRHE had gauged and collected records from 67 permanent stream gauging stations, 62 of which were automatic systems. In addition selected water quality data was obtained for 26 different rivers for the 1976-77 period.

### Comisión de Reforma Agraria

During the years 1964-68 this office was closely connected to the program "Catastro Rural de Tierras y Aguas" (Registry of Rural Lands and Waters) under which the major agricultural areas of the country were mapped (CATAPAN, 1970). The project was financed by \$2.4 million dollar AID loan plus a 2 million dollar GOP counterpart contribution AID loan. All soils maps and photomosaics produced in this program are now held and distributed through the Comisión de Reforma Agraria (Agrarian Reform Institute). The analytical data logically should be with the Soils Laboratory of IDIAP, but it may have been lost because of frequent changes in personnel and a change in location. In spite of that fact, a great deal of valuable material remains from the project. However, all the soils specialists trained in the project have left the field.

At present, the Agrarian Reform Institute has no units of soils specialists. However, it has done some practically oriented soils evaluation and land capability evaluation in connection with the establishment of "asentamientos".

### Dirección Nacional de Catastro

Property maps are maintained by the Dirección Nacional de Catastro, Ministerio de Hacienda y Tesoro, (Bureau of National Records, Ministry of Lands & Treasury) in Panama City. These were originally produced for the Catastro Rural between 1964 and 1968. While the Dirección Nacional de Catastro does not do any soils work or have any soils personnel, its photomosaics delineating farms at large scales can be very helpful to soil scientists working at the farm or local level.

### Proyecto Darién

This project was initiated by the GOP with OAS assistance in late 1974, in order to plan the development of the Darién area. It was recognized that the area would open to planned or spontaneous settlement once the final link of the Inter-American Highway between the Darién and Panama City was connected.

A soils study and a 1:250,000 map to the level of suborders of the taxonomy was made by an OAS consultant was made. This was based on only slightly more than 50 samples, most which were near rivers. Nevertheless, it represents important new knowledge at less than a reconnaissance level of detail. A land capability map was also prepared at a level of 1:250,000. These maps were in part on small scale radar imagery since the Darién has never been completely covered by aerial photography. A determination of soil and ecological erosion hazards was also made. Erosion is quite serious because of the rough topography, high rainfall and other conditions peculiar to the Darién.

## 2. Nongovernmental Institutions

### University of Panama

The University of Panama has a Department of Soils consisting of two soil scientists, plus a third scientist from the school of Agronomy.

About 20 agronomists graduate each year, of whom 5 or 6 specialize in soils. A thesis is required for graduation and at times involves fertility trials, mostly on the university farm. The soils department is primarily engaged in research related to specific crops.

### Programa Mundial de Alimentos (PMA)

A cooperative World Food Program project has been initiated by RENARE and the UN/FAO forestry mission, and their work is promoting rural development, soil conservation and agro-forestry in the central region of Panama.

## 3. Administration

Water control and use in Panama is still in the initial stage of development and only primary projects have been constructed on an individual basis. Water supply, except for seasonal shortages and in critical areas (i.e., the Central Provinces), is generally adequate. Overall water resource planning has not yet become as essential and critical as it is in more populous countries and drier regions of the world. As yet, there is, in reality, no strict regulation of the use of water, although the desirability of such control is recognized and organizations for that purpose exist, i.e. IDAAN, RENARE, and the National Council of Water Resources.

Good coordination among organizations is essential to efficient soil and water resource development and conservation; cooperation is currently very poor as is the effectiveness of the official coordination body, the "Consejo Nacional de Aguas" (National Council of Water Resources). No coordinating entity exists for land use with the exception of a small number of regional corporations, the majority of which are extinct, ineffective or highly permissive of improper land use.

## 4. Legislation

The legal body affecting the use and conservation of soil and water resources is cumbersome and conflicting. Several different studies indicate the need to modernize the existing land and water laws as well as to develop new legislation relating specifically to soil and water conservation and watershed management.

## 5. Soil and Water Resources Projects

The largest and most important water use project in Panama is the Panama Canal system which controls the water in the Chagres and Pedro Miguel watersheds. The hydrology of the Canal is outside the scope of this paper and no description of it is given other than limited data on the two hydroelectric plants in the Canal Zone. More details concerning the technical and environmental aspects of the Panama Canal Project are covered in the recent AID Watershed Management Project Paper Document (1978). Within the structure of this, the Canal AID/GOP Watershed Project is currently receiving much attention as a pilot integral watershed management effort and as part of an institutional building effort for RENARE.

Another major project is the proposed Sea Level Canal. At present, the Canal is still in the proposal stage. If and when it is funded, there will be a detailed environmental impact assessment of the project before construction begins.

## 6. Major Problems

The basic goals of the Government's new regional development and agricultural sector policies are "to improve the quality of life of the campesino through increasing his income, offering greater employment opportunities, increasing agricultural production and incorporating him into the market economy, and to move toward a more equitable distribution of the benefits of development."

The overall strategy that has emerged to address these goals, however, is often in conflict with sound environmental and economic development principles. Some of the problems associated with such policies are the following:

### Improper Land Use

The misuse of water and related land resources and subsequent soil erosion problems are very common in populated upland watershed areas, predominantly in the Pacific slope provinces of the Central, Occidental and Metropolitan regions of Panama. As a result, water supply and water quality problems have become acute in certain parts of the country (especially in the Pacific Central provinces) over the last decade with serious economic and health consequences. Improper land use frequently leads not only to local resource degradation, but also, to off-site and indirect impacts that are costly and detrimental to third parties and frequently in the general public.

### Lack of Protection for Municipal Watersheds

Throughout the country cities, towns, and small rural populations administer their own surface water resources, frequently with little assistance and technical know-how from institutions such as IDAAN.

Decreasing dry season flows and poor water quality because of agrochemical contamination and sedimentation are common problems that threaten the potential utilization of many critical watersheds.

### Erosion of Agricultural Soils

Soil erosion is a prevalent problem over almost the entire agricultural zone of the country, but the highland volcanic soils of Chiriquí Province located around Volcan Barú are probably the soils most seriously affected in the entire country. Boquete on the east and Cerro Punta to the northwest combine to produce an estimated 60% of the total commercial vegetable crops produced in the country. Other notable products of the area are coffee and flowers. The Boquete Valley forms part of the Rio Caldera head-waters which is site for the Estrella-Los Valles hydroelectric project. The Rio Caldera is well known for its torrential precipitation regime, high sediment loads, and floods which in past years have caused considerable property damage and even loss of lives in the village of Boquete.

Highly erodable soils, high intensity rainfalls and an almost complete ignorance of basic soil conservation measures by most of the farmers have the combined effect of causing tremendous soil losses estimated to be in some cases from 1600 to 2000 metric tons per hectare per year. Preliminary work done by two French soil conservation specialists in cooperation with RENARE indicate that on soils of moderate slopes the adaptation of some rather simple practices, including the management of the vegetative cover, the use of deep plows rather than rototillers (which produce a compacted layer) and the use of contour cultivation and drainage ditches, will solve most of the basic problems. Other soils, on slopes too steep for agricultural uses, should be changed over to permanent crops or reforested. The French mission is unfortunately coming to a close toward the end of 1980 and there is an urgent need for refinancing and project continuity. RENARE currently is not capable of taking over and successfully continuing this important project, which is just "taking off" and seeing tremendous farmer support.

## D. Recommendations

### 1. Recommendations to the Government of Panama

To assist the GOP in attaining its development goals and base their development actions on a stable socio-economic system and sustainable resource base, the following set of general principles and recommendations are presented:

- ° Develop an integrated approach to Panama's soil and water resources management and conservation. This can best be achieved on a watershed basis because of the tremendous importance that water resource planning has on the country's national growth and development;

- ° Protect watersheds of areas that are important for hydroelectric, municipal and industrial water supplies and where environmentally sensitive or physically hazardous conditions negate other alternative land uses. Protection is called for in most of the mountain cloud and rainforest areas of the country. Examples of watersheds that should be in the protection category are: (1) Changuinola; (2) Teribe; (3) Cerro Azul and highland area to the east of the Canal Zone; and (4) all the watersheds along the Atlantic slope of the Golfo de los Mosquitos and Comarca de Sar Blas;
- ° Initial integrated, multiple-use watershed development where agriculture, forestry, road construction, urbanization and other land uses should be combined according to land use capabilities;
- ° Train professionals in watershed planning and soil and water conservation and management. A lack of professionals and technicians in the environmental sciences is a major obstacle to planning and implementation of development projects in the field;
- ° Initiate and carry out applied research on Panama's national resource management and conservation problems;
- ° Develop an environmental assessment capability within key planning institutions. Make use of environmental assessments and impact statements required by multinational and binational institutions and international development banks for projects they fund;
- ° Survey Panama's watersheds to identify initial areas, determine priorities, and provide data for sound management plans;
- ° Develop education and extension programs in rural areas to make small farmers more aware of conservation principles. The structure provided by the regional university centers, the "Ciclos Basicos" and the MIDA Regional Centers would probably meet the needs, if adequate personnel and resources were available;
- ° Establish a policy or procedure to finance watershed management and protection work. Charges should be placed upon major water uses, and the resulting funds used for watershed projects;
- ° Provide incentives in critical erosion areas to carry out some of the soil and water conservation practices that have little direct and immediate benefit to the landowner, or that are needed for regional or off-site protection, i.e., flood control, gully and torrent control, stream bank protection, etc. These incentive programs can be effectively implemented through a watershed/soil conservation district approach. The most urgent soil conservation needs of the country are in the volcanic uplands of Chiriquí province where the majority of the nation's horticultural crops are produced.

2. Potential Projects for AID Involvement

Based on the recommendations made above, suggested areas for AID participation include the following:

- ° Provide technical and financial assistance for the management and protection of municipal water supplies through a mini-watershed programs. Such a project could and should be coordinated with the on-going AID/GOP Alternative Energy Sources Project within the micro-hydro component;
- ° Support RENARE's soil conservation and natural resource management programs through various means, including funding of IDIAP's research projects on problems of soil and rangeland management;
- ° Continue integrated, multiple-use watershed development planning and management projects such as that detailed in the AID Agriculture Sector assessment of 1968;
- ° Provide training programs for natural sciences professionals abroad and support environmental education programs aimed at training rural farmers in soil and water conservation practices.

CHAPTER VII. WATER, AIR AND SOLID WASTE POLLUTION

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5. Conclusions

D. Recommendations

1. Recommendations to the Government of Panama

## CHAPTER VII. WATER, SOLID AND SOLID WASTE POLLUTION

### A. Summary

The quality of water resources in Panama is influenced by the different land use activities that occur within individual watersheds, and the climatic and geological characteristics of the area in which the flows originate. In places where precipitation is scarce, water quality is more susceptible to human activities.

In a study done by the Department of Hydrometrology of the Institute of Hydraulic Resources and Electrification (IRHE), none of the 61 rivers studied had concentrations of contaminants that would limit their use as water supply sources. This study did not look at bacteriological contaminants, however. Of the four zones studied, the Azuero Peninsula had the lowest water quality containing the highest levels of suspended and dissolved solid waste, nitrates, nitrites and chlorides. Although no basic studies have been done on subsurface water, the extensive use of septic tanks suggests that these waters are being polluted. Another source of pollution that has received little attention is the massive application of herbicides, pesticides and fungicides in farming areas and the addition of nutrients from detergents and fertilizers from domestic, industrial and agri-industrial uses. In the Metropolitan Region, uncontrolled land use has resulted in deforestation and increased sedimentation in rivers which further reduces the availability and quality of water.

Sewage in Panama rarely receives adequate treatment before it is discharged into streams, rivers, ravines, swamps and vacant lands. Part of the effluent from Panama City is discharged through a collection system directly to the coastal waters, while part is discharged into natural drainage canals or ditches which flow through the city, creating health hazards. These canals and ditches are used for garbage disposal as well, which often clogs canals and results in flooding nearby streets. Other sewage is disposed of through septic tanks which are inadequate and permit leaking of nutrients into subterranean waters.

The continuous passage of ships through the Panama Canal results in discharges of varying amounts of crude oil and its derivatives into the water. Occasionally there are considerable oil spills such as the one which occurred in 1968 at the northern entrance to the canal.

There have been few studies investigating the air quality of Panama. The Metropolitan region is the only one with a concentration of emission sources including automobiles, thermoelectric generators, factories, and shipping. Concentrations of sulphur are near to the maximum acceptable levels. Gaseous emissions associated with copper mining are derived from different processes, such as blasting, floatation, rewashing and smelting. Smelting emissions include sulphur anhydride, arsenic, antimony, bismuth, cadmium and other compounds present in the mineral itself.

Solid wastes in Panama are primarily from household activities. In urban areas refuse is collected by the Department of Sanitation and dumped in sanitary landfills. These dumps, however, are not properly

sited nor maintained. In rural areas solid wastes are either disposed of individually or their collection and disposal is the responsibility of local boards or councils.

## B. Resource Base

### 1. WATER

#### a. General Description

The volume of average annual rainfall in Panama has been estimated to be 233,760 million cubic meters, which is equivalent to an average rainfall of 3,000 mm. The Atlantic slope receives approximately 83,930 million cubic meters (36%), and the Pacific slope, 149.830 cubic meters (64%), estimated on the basis of an average precipitation rate of 3,740 and 2,820 mm, respectively (Report on Water Resources in Panama, 1976).

According to studies on water quantity it has been determined that the average surface flow of the rivers on both slopes is 4,570 cubic meters per second, 60% of which drains toward the Pacific Ocean, and during a dry year with 1/10 annual recurrence, the flows vary between 76% and 85% of the normal amount. Low water flows occur during the months of January, February, and March and are estimated to be 15% of the average, representing approximately 681 cubic meters per second.

The estimated yield of subterranean water in the country is around 105 cubic meters per second, a resource which may be considered very valuable for the regions of low precipitation (Azüero, Chitré, Aguadulce, Las Tablas, Rio Hato, etc.)

The degree of water availability determines the possibilities for development of a region or country. In Panama, given its topographical conditions, the basins of the Pacific slope are larger and possess a greater hydraulic potential in absolute terms. However, as a result of climatic conditions the basins which drain into the Caribbean are those which possess the highest singular resources with an annual uniform distribution and without water deficit restrictions during the dry season.

#### b. Water Quality

The quality of Panama's water resources is significantly influenced by the different land use activities that occur within individual watersheds. Likewise, climatic and geological characteristics of the area in which the flows originate contribute to its final quality. These characteristics affect each water body's capacity for dilution, addition, absorption and conveyance of contaminants. Taking into consideration these variables, it is expected that in places where precipitation is scarce, water quality will be more susceptible to human activities. Not until the early 1970's were any basic studies done which would provide

preliminary understanding of the physical-chemical characteristics of the waters which flow through Panama. Because the country's economic development has been mainly oriented toward services and agricultural activities and only a limited amount of secondary manufacturing industries, the water quality has not suffered any significant deterioration, except in a few exceptional cases.

In a study performed by the Department of Hydrometrology of the Instituto de Recursos Hidraulicos y Electrificación (IRHE) (Muschett 1977) on the physical and chemical qualities of 61 rivers in the country, none of the rivers had concentrations of the parameters analyzed that would limit their usage as water supply resources. However, bacteriological characteristics were not examined in this study, and since a number of the rivers leave domestic discharges of raw or partially treated sewage, there may be contaminants in the rivers that preclude their use for domestic purposes.

Of the four zones studied, the Azuero Peninsula possessed waters of the lowest quality, containing the greatest concentrations of suspended and dissolved solid wastes, hardness, and nitrates, nitrites and chlorides.

Panama still lacks basic studies which would permit an assessment of the quality of subterranean waters and their potential uses. However, the extensive use of septic tanks, many of which are located near wells or high groundwater levels, suggests that subterranean waters are being polluted. This suspicion is strengthened by the physical characteristics of Panamanian soil, which are generally clayey and have limited absorption capacity.

Another potential source of pollution which has received little attention is the massive application of herbicides, pesticides and fungicides in farming areas, and the addition of nutrients from detergents and fertilizers associated with domestic, industrial and agri-industrial uses.

In the first four months of 1980, Panama imported 64,880 kg. and 66,475 liters of insecticides, herbicides and fungicides and 4,569 tons of fertilizer. The recent statistics on detergents (1975) shows Panama sold 6,995 tons of detergents (Panama Ministry of Health and Bureau of Statistics and the Census, 1978). It is expected that a substantial amount of these products reaches surface water sources or percolates into subterranean waters. These discharges are eventually conveyed to environmentally sensitive estuaries or mangrove swamps and consequently pose serious dangers to human health as well as aquatic plant and animal communities. It is worthy to note that 19% of Panama's exports in 1975 consisted of shrimp, which spend the most sensitive phase of their life cycle (larval phase) in mangrove swamps (Colorado School of Mines Research Institute, April 1977).

c. Regional Analysis of Water Quality

Metropolitan Region

Residential water consumption in the Metropolitan region is concentrated in Panama City and Colón. Water consumption in the region is quite high, averaging 698 gallons (2,650 liters) per connection per day. (IDAAN, 1979). This suggests that there is a rapid rate of water loss in public transmission systems. In addition, 61.3% of household connections are not metered; those without meters generally use greater quantities of water.

The quality and quantity of water in the region is affected by the amount of vegetative cover in important river basins. In the Metropolitan region river basins have been deforested for farming and livestock purposes. As a consequence of uncontrolled land use the amount of sediment in the rivers is substantially increased, thus threatening to reduce the length of their useful life. If this trend continues unabated the availability of water to satisfy demands will be further limited. Likewise, due to the deforestation of the Río Caimito basin, the source of water for the city of La Chorrera, the turbidity of the water has risen dramatically, increasing the cost of water treatment (Frederick, 1980).

Sewage in Panama rarely receives adequate treatment before it is discharged into nearby streams, rivers, ravines, swamps and vacant lands. In the case of Panama City and Colón part of the effluent is discharged through a sewage collection system to the coastal waters without any treatment. Another part of the effluent is discharged into natural drainage canals or ditches which flow through the cities, creating parts of contamination. Finally, a small portion of the cities' total effluent is partially treated in septic tanks prior to discharge. Because this region is the most densely populated in the country and 75% of all industrial establishments are concentrated here, the commulative effects of the effluent discharges on water quality has been quite detrimental. The bodies of water most affected are Río Matasnillo, Río Carundu, Río Matías Hernandez, Río Abajo and Río Juan Díaz. Of these, the Río Matasnillo is the most polluted with clearly septic conditions and high concentrations of sulphur anhydride ( $\text{SO}_2$ ) in solution, nitrates, phosphates and high turbidity (Muschett, 1977 and Tecnipan-Hazansaw, 1976).

These rivers drain into the Bay of Panama where the contaminants are diluted. These discharges, together with another 13 coming from the sewers serving Panama City and 11 from combined liquid wastes, have affected the composition and quality of the Bahía de Panama (Bay of Panama). Fecal coliform bacteria concentrations reach 160,000 per 100 cubic centimeters. Organic contamination, however, shows rather low concentrations; this is attributed to dilution of the discharges by tidal action. Nonetheless, if the current practice of effluent disposal without treatment persists, future problems of anaerobism, foul odors and toxic gas emissions could rise. It was estimated that in 1976-77 the daily discharge

of contaminants to the Juan Diaz River was 1,700 kg of DBO, 2,270 kgs of suspended solid waste and 860 kgs of nitrogen total, but if liquid discharges are not treated the same parameters for the year 2,020 will be 31,200, 30,800 and 8,300 kgs., respectively.  
(10)

The Tecnipan-Hazansaw analysis of the Bahía de Panama's waters near Panama City did not include a determination of insecticide, pesticide or heavy metal concentrations. It must be assumed that they exist in trace concentrations in this region.

Another source of potential contaminations to the Bahía de Panama are solid waste disposal sites. Water leached from the City's solid waste disposal site near Rio Abajo is loaded with organic acids and possibly toxic compounds. These conditions are attributed in part to the site's low elevation, minimal cover spread over the solid waste, high rainfall concentrations and proximity to the Bay. Coincidentally, one of the highest concentrations of coliform bacteria in the waters of the Bay was found in the area off-shore from the disposal site.

The continuous passage of ships through the Canal, many of which are carrying petroleum and unloading operations at the Colón refinery cause continuous discharges of varying amounts of crude oil and its derivatives into the water. Due to the diversity in type and size of the ships, it is difficult to estimate the size of this discharge. However, there have been considerable oil spills in this area such as the one which occurred on December 13, 1968 at the northern entrance to the Canal.

Also, eight miles off shore from Panama City on the island of Taboguilla, a fish meal plant produces 70,000 tons of fish meal and fish oil per year. The effluent from this operation which has a high organic content, is discharged into the waters around the island (Jaime Diaz, RENARE). It is estimated that the discharge from this site is equivalent to that of a population of 1.75 million persons.

### Occidental Region

The Occidental region includes the provinces of Bocas del Toro, one of the greatest farm and livestock producers of the country, and Chiriquí, the third largest in population. In addition the Occidental region has the largest capacity petroleum unloading port (Puerto Armuelles), a sugar plant (Alanje), and two hydroelectric power plants (La Estrella and Los Valles).

Because this region receives the largest amount of rainfall in the country (maxima exceed 7,000 millimeters per year) and has a relative low level of industrial development in absolute terms and only limited need for irrigation, it enjoys a considerable water surplus over actual quantities demanded. Therefore, there is no shortage of water foreseen in the near future. The current

demand for water supplies is approximately 0.35 m<sup>3</sup>/sec (92 gallons per second GPS), for the city of David (supplied by the Rio Mazagua) and 0.05 m<sup>3</sup>/sec (13 GPS) for Puerto Armuelles (supplied by the Rio San Bartolo). The water for the city of Changuinola is obtained from subterranean fountains.

Water demand for agriculture is satisfied by annual rainfall with no need, therefore, to utilize surface water. Industry located outside the urban perimeter is supplied by subterranean water.

As in the rest of the country, effluent generated by the development of various human activities does not receive adequate treatment prior to being discharged into receiving water bodies.

In the Occidental region the large volumes of water which flow in the rivers have great contaminant dilution capacities. However, there are water quality problems in sections of some tributaries caused by their limited flows and/or flow velocities.

As a consequence of the advanced deforestation of the upper parts of the Chiriquí province, water quality has deteriorated because of the conveyance and deposition of sediments. These problems have been of special concern at the water treatment plant of the city of David, located on Rio Mazagua.

In the city of David, there is a very critical situation with respect to the disposal of treated and untreated sewage. Due to the fact that the sewer system of the City has not been enlarged since it was constructed some 40 years ago, more than half of its population is not connected to the sewage collection system. The unserved areas discharge their effluent into open ditches, inoperative septic tanks or latrines which do not meet minimum sanitation conditions. This area includes Dolegita, El Retiro and other neighborhoods (Heckadon, February 1980). The sanitation situation is further complicated by the fact that the channels which flow through the City are also used to dispose of garbage. Thus the channels are frequently obstructed, producing flooding of the streets and lots adjacent to or near the channels.

The province of Chiriquí contributes 35% of the country's total agricultural production and almost 90% of its horticultural production. These significant levels of production currently require intensive cultivation practices, including extensive use of pesticides, herbicides, fungicides and fertilizers. The uncontrolled discharge of these compounds into the environment is doubtlessly producing accumulations in plants, soil, rivers, estuaries and marine species. To date, there have been no basic studies to suggest the exact concentration of these compounds.

However, some statistics are known about the sugar cane industry. In the Victoria plant it was necessary to add 15 lb/hectare year of powdered herbicide (Gesapa, Karmex) and 2 liters of liquid 2,4-D (Idalia Rodriguez, 1980). In the case of a 4,500 hectare

Alanje plantation, 30,645 kg of powdered herbicide and 9,000 liters of liquid herbicide are used each year. For control of pests which are specific to sugar cane, products such as Aldrin, Endrin and compounds of copper and mercury are utilized in varying amounts (Jules Ledea, 1980). Synthetic fertilizers (12-24-12 and 18-9-21) are used in amounts varying between 800 to 1000 kg. per hectare for the stock which is renewed at the rate of 25-30% per year. This application rate of fertilizers is on the order of 750 tons per year. It is reported that 19,313 tons of inorganic fertilizer are applied each year in the province of Chiriquí (J.E. Illueca, 1977).

Other discharges are those known as "fresh waters" generated by the production of sugar. Because of their high organic content, large quantities of oxygen are consumer in the receiving water, causing the disappearance of aquatic life in sections of the river affected. The same effect has been observed in the Boquete area from the discharge of coffee bean husks. This, in turn, affects the turbines of the IRHE hydroelectric power plants (Tovar, 1980).

In Chiriquí province, about 7 kilometers south of the city of Puerto Armuelles, near Punto Piedra on the Bahía Charco Azul, there is the newest and largest petroleum unloading terminal in the country (500,000 barrels/day).

In unloading petroleum, spills occur as a result of the cleaning of tanks and loose pipe valves and joints, pumps, hoses and ventilation tubes. The water used to clean the tanks is sent inland to a gravity separation system. The treated water from this system is discharged into the sea and the petroleum recovered is disposed of separately. The efficiency of the petroleum removal by these units, under the best conditions, is on the order of 60%. Thus, approximately 200 barrels of petroleum are discharged during each cleaning operation.

Petroleum, which is lighter than water, floats and inhibits the passage of light from the sun, thus reducing or inhibiting primary production. Also, because of its aromatic compounds, it is highly toxic for aquatic life, especially for eggs and larvae. If oil discharges continue, over the long-term there is serious danger to the abundant marine resources in the vicinity of the terminal.

The future mining complex of Cerro Colorado deserves special consideration. The possible effects on the environment have been discussed in other studies (Colorado School of Mines Research Institute, 1977; Illueca, 1977; SEASPA, 1979). However, it has not been possible to state precisely the magnitude of the project's potential physical impacts on the environment. No consideration has been given to byproducts which will be generated during the operations such as the acid waters originating from the runoff

rainfall on uncovered mineral material, nor have available documents mentioned the control measures that are to be taken in order to mitigate the potential negative impacts from those byproducts. Typical concentrations of elements, present in effluents from Copper processing are presented in Table 10, page 155.

The start-up of the Cerro Colorado mining complex may require the enlargement of the sugar cane area for the production of alcohol, a basic raw material for the preparation of the several chemical compounds utilized in the processing of copper.

### Central Region

The Central region includes the provinces of Veraguas, Los Santos, Coclé and part of Colón (west of Indio River). The most important population centers in this region are Santiago, Chitré-Los Santos, Aguadulce, Penonomé, Anton and Las Tablas.

This region encompasses broad areas under cultivation, the most important being the cultivation of sugar cane (Plantations of La Victoria and La Estrella) and vast zones of livestock production. Rainfall fluctuates between 7,000 mm per year on the Atlantic coast of Veraguas and Colon, and 1000 mm, the lowest in the country, along the coast of the Gulf of Panama (Parita Gulf).

Because of the low annual rainfall in the zone, during the summer the amount of precipitation is insufficient to meet even household needs. Under these circumstances the water supplies systems of the cities of Penonomé, which is supplied by 7 wells, with a total demand of 0.023 m<sup>3</sup>/sec (6 gallons per second), and Aguadulce, which is supplied by 8 wells with a total demand of 0.027 m<sup>3</sup>/sec (7 GPS), only function partially during the summer period. Contributing to this situation is the high incidence of deforestation, particularly in the province of Los Santos. Severe water shortages have imposed serious limitations on the development of this region. Consequently, it has forced the inhabitants of the area to migrate to other regions of the country, particularly the Panama City-Colón corridor.

In the water quality study cited earlier (Muschett, 1977), it was observed that the waters of the rivers of the Azuero Peninsula (Tonosí, Oria, Guarare, La Villa, Parita and Escota) were those which had the lowest water quality index of the 51 rivers studied. This is attributed primarily to the fact that the dilution capacity of the rivers in the Central region are smaller than for any other region of the country.

Among the principal causes of the deterioration of the region's water quality are the numerous discharges of raw sewage and partially treated effluent from septic tanks. Though these discharges are small the effects are quite significant due to the limited dilution capacity of the receiving bodies of water.

In the city of Santiago there exists a critical situation with respect of the collection of sewage. More than half of Santiago's population (65%) is not connected to the existing sewerage collection system (Heckadon and Garcia, February 1980). Their sewage wastes are discharged into open ditches, septic tanks (frequently inoperative) or latrines such as those used in the neighborhoods of Don Bosco, San Martin and El Paraiso. Santiago's environmental health conditions are made worse by the indiscriminant disposal of garbage in narrow sewage-laden stream channels. This practice causes their obstruction and leads to breeding of mosquitos, rodents and other pests.

The industrial discharges of contaminated water, originating from sugar cane plants, have caused on more than one occasion the disappearance of aquatic life and massive fish deaths. Complaints have been registered by working fishermen regarding the La Victoria plant which discharges effluent into the Santa Maria River.

In the case of the La Estrella plant, problems have been experienced with the discharge of contaminated water into the Bahia de Parita, a primary shrimp cultivation area. These waters have shown a high biochemical demand for oxygen, producing a high rate of shrimp mortality (Preto, May 1980).

Just as in the Occidental region, the agro-industrial crop of sugarcane, which for the La Victoria plant amounts to 10,000 hectares, require the application of 68,000 Kg. of powered herbicide and 4,000 tons of fertilizers per year, in addition to unknown quantities of pesticides.

#### Oriental Region

The Oriental region includes the province of Darien and the Comarca de San Blas. Because of the region's limited development there exists no source of data which would be sufficient for the purposes of evaluating the status of its water quality. However, it can be stated that the region possesses abundant water resources, the majority of which are as yet only slightly altered by human activity, with the exception of Rio Bayano. A dam was built on the Rio Bayano for the purposes of generating hydroelectric power. The Bayano power plant makes use of the flow of 176 m<sup>3</sup>/sec to generate 150 MW of power. Apart from this engineering work, there are no other major uses of water because the region's population centers are small and agriculture relies on rainfall which reaches maxima of 6000 mm and minima of 2000 mm annually.

Herbicides are used in the reservoir and rivers behind Bayano Dam for the control of aquatic weeds. For this purpose a broad leaf selective herbicide is used (2,4-d Dimethyl Amin) in concentrations of 1.28 Kg/hectare. Paraquat (Gramoxone) is also used in concentrations of 0.28 Kg/hectare. These applications are made every three months. To date the effects that these chemicals may be having on aquatic fauna is not known.

## 2. Air

### a. General Description

There have been few studies investigating the status of air quality in Panama, probably because the perception of any serious problem is practically non-existent. However, it is known that in the Metropolitan region there are localized problems relating to the presence of bad odors and suspended dust.

Of the four regions of the country, the Metropolitan region is the one which contains the greatest concentration of emission sources constituted by the number of cars in circulation, thermo-electric generators, passage of shipping and factories. This makes the Metropolitan regional more susceptible to air pollution. However, studies carried out by the Department of Environmental Health of the Ministry of Health in collaboration with the Pan-american Health Office between 1977 and 1978 showed that concentrations of sulphurous anhydride were far less than the maximum safe permissible levels of  $80 \text{ ugr/m}^3$ , \* and that suspended particles exceeded slightly (for short periods of time) the maximum permissible safe level of  $75 \text{ ugr/m}^3$  (Cuevas, May 1980).

A later study (Guerra, April 1978) Corroborated the initial results, and concluded that "...air quality in Panama City, with respect to sulphurous anhydrides, is not a problem...". However, the same conclusion cannot be reached with respect to particulates which are quite near to the maximum acceptable level of concentration.

As industrial activity intensifies, problems relating to deterioration of air quality may be expected. Proof of this statement lies in the foul smelling emissions which originate from fish flour plants, mainly in the cases of Tabuguilla which affects Panama City, Puerto Caimito and Chorrera. These emissions have, in other countries, caused respiratory problems for large sectors of the population.

Gaseous emissions associated with copper mining are derived from different processes. When blasting, large quantities of dust may be emitted into the atmosphere, unless precautions are taken such as wetting of the mineral when loading trucks. The floatation process (concentration) per se does not create dust problems, but this cannot be said of rewashing done in yards, after the water in contact with the atmosphere has evaporated. Preventative steps should include spreading binding compounds over the surface of the yards, landscaping or wetting of the surface. Due to the climatic conditions of the area, wetting of the surface may be necessary only during dry summer periods.

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\* Two sampling stations were set up; one at the University and the other in the building of the Panamanian Anthropological Museum. Maximum concentrations found were  $30 \text{ ugr/m}^3$  at the Museum station.

Smelting generates substantial gaseous emissions because of the high temperatures required for copper processing. These emissions contain As, Pb, Cd and other compounds present in the mineral. It is also common to encounter sulphurous anhydride SO<sub>2</sub> emissions in the smelting of copper. Table 11 shows that the amounts of SO<sub>2</sub> emissions into the atmosphere fluctuate between 290,000 and 360,000 tons annually, depending on the process used. This is based on the Colorado School of Mines projected production of 170,000 tons of copper per year. Procedures for controlling and reducing these discharges include gravitational collectors, cyclones and electrostatic precipitators in which retention efficiency reaches 99.7%. A quantity of gas may be utilized for production of sulphuric acid which is required in the processing, even though the SO<sub>2</sub> concentration is not always high enough to make this economically attractive.

### 3. Solid Wastes

#### a. General Description

In this section, solid waste refers to solid byproducts of household activities and to the byproducts of industrial activities in each of the four regions of Panama.

#### Metropolitan Region

According to statistical data, the production of refuse in the Metropolitan region which reaches the site of final disposal is 0.75 kgs/per person per day, even though it is assumed that the gross volume generated is on the order of 1.00 kgs per person per day (Tello, November 1978). The total amount which reaches the site of final disposal is 426 metric tons per day, with an estimated volume of 1,600 m<sup>3</sup>/day (Treatment of Urban Wastes, January 1977). This figure is for November 1978. Currently it is assumed that the figure is 625 tons.

Refuse is collected and transported by the trucks of the Department of Sanitation in three daily shifts totalling 73% of the daily volume. The rest is transported directly in private vehicles.

Panama City's solid waste disposal site is located on 44 hectares near Rio Abajo, on land that used to be a mangrove swamp.

In the Metropolitan region there is another area for dumping refuse produced in the former Canal Zone. This dump is located at a site known as "Red Tank" adjacent to a broad area for harnessing surface water to be conveyed to the Miraflores Water Purification Plant (Tello, November 1978). It is known that current practices of sanitary filling are adequate, but no data was obtained showing the number of collection vehicles, Institute of National Aqueducts and Sewers, (IDAAN) employees, personnel in the fill area (under Canal authorities) or the total daily volume.

TABLE 10

TYPICAL CONCENTRATIONS OF ELEMENTS  
PRESENT IN EFFLUENTS FROM COPPER PROCESSING\*

(PERCENTAGES)

Elements	Burners	Shaker Ovens
Copper	5.2	2.9
Iron	6.6	1.6
Lead	7.6	30.5
Zinc	1.7	8.3
Arsenic	43.0(a)	25.7(a)
Antimony	5.3	3.0
Bismuth	0.4	1.11
Cadmium	---	0.71

(a) Only when present in concentrate.

TABLE 11

AMOUNTS OF SO<sub>2</sub> PRODUCED IN COPPER SMELTING PLANT

Primary Copper Smelting	gr. SO <sub>2</sub> /kg of metal
If Toaster used	
Toasters	325 - 675
Reverberator Furnaces	150 - 475
Converters	975 - 1075
If no toasters used	
Reverberator Furnaces	275 - 800
Converters	850 - 1800

\* Source: Nelson, Varner and Smith, 1977.

The City of Colón efficiently employs the method of sanitary filling for its refuse disposal. The collection service is offered to 95% of the City's population with 8 compactor trunks and two dump trucks (data as of November 1975).

During a visit to the Panama City dump it was observed that there were improper or inadequate practices of final waste disposal. The main cause is insufficient earth cover for the refuse. This is due to the fact that the cover material (turf) is scarce and must be brought in from outside of the area. It was also noted that there are no controls on the amounts of refuse conveyed by vehicles, because there are no scales at the access point to the dump. The sole control is on the number of Department of Sanitation vehicles, but not on the private ones.

#### Occidental and Central Regions

The collection, conveyance and final disposal of solid wastes in the cities of the country's inland regions are the responsibility of the municipal councils which, due to the shortage of economic resources, offer intermittent and unreliable service. Refuse collection occurs normally two or three times a week, though there are places where the collection is once a week. The practice of final refuse disposal usually takes the form of an open air dump site which is conducive to the proliferation of different pests and contamination by leaching of the soils and pollution of surface and subterranean waters.

#### Oriental Region

There is little information on solid waste production or disposal in the Oriental region of Panama.

#### b. Cerro Colorado Copper Mine Wastes

The quantity of solid wastes to be generated by exploitation of Cerro Colorado is equivalent in weight to 122 times the solid wastes generated by the population of the entire country. These wastes originate from the processes of concentration and smelting of copper. They may be expected to contain chemical compounds and metallic elements in the form of silicates (Fe, Ca, Mg, and Al). Due to these characteristics they should be disposed of properly to avoid unnecessary significant impacts to the environment. Disposal of wastes directly into the Río San Félix should be avoided.

In addition, it must be made certain that neither the effluent or the runoff from the rewash yards reaches the river through surface or subsurface drainage without having first been neutralized and their content of metals in solution and toxic compounds (Arsenates, Cyanate) analyzed. Unless this is done, the important marine fishery resources of the region may be seriously affected,

and in the worst of cases, may even disappear. When constructing the rewash yards, the slope or grade of the walls should prevent the rewash from escaping into the river in the case of breakdown by seismic tremors.

## C. Resource Management

### 1. Government of Panama Institutions

#### Institute of National Aqueducts and Sewers (IDAAN)

The Institute of National Aqueducts and Sewers (IDAAN) was established as an autonomous State agency by Law 98 of December 29, 1961. The law charged the IDAAN with all functions relating to planning, research, design, management, construction, inspection, operation, maintenance and utilization of the aqueduct and sewerage systems in Panama. The agency was also charged with authority to prepare, or authorize the preparation of all plans for public works, and for all the autonomous entities insofar as systems of sewerage or aqueducts is concerned. The IDAAN is also responsible for approving all plans for private works in accordance with its standards.

Nearly 100% of the urban population is served with potable water by IDAAN, while only 62% of the rural population is covered. However, IDAAN only serves communities of more than 500 inhabitants, while the Bureau of Environmental Health serves all smaller settlements.

#### Bureau of Environmental Health (DSA)

The Bureau of Environmental Health (DSA) is under the Directorate of Health of the Ministry of Health, as provided by the Ministerial Directive of January 7, 1975. Formerly the Department of Sanitary Engineering (Decree 75 of February 27, 1969), the DSA has been developing several successful programs for environmental improvement such as construction of rural aqueducts, drilling of wells improvements in rural housing, inspection and control of sanitation and industrial health, and collecting and disposing of solid wastes, a responsibility which now falls exclusively on the Department of Urban Sanitation under the IDAAN.

The Bureau is responsible for constructing water supply aqueducts for communities of 500 inhabitants or less. Under the DSA's 1978-1982 plan, it will build 75 aqueducts and 250 wells per year. Of the almost 700 aqueducts in the country, more than 500 have been built with financial support from AID (Five-Year Development Plan, 1978).

The DSA is also responsible for the control and conservation of air quality in Panama. In 1977 the DSA, in conjunction with the Pan-American Health Organization, initiated a continuing monitoring program for air quality under the Panamerican Standardized Air Quality Monitoring system (RED PANIARE) intended to evaluate suspended particle

concentrations and SO<sub>2</sub> concentrations at three key points in Panama City. After ten continuous months of monitoring, the program was suspended because the mobil support unit went out of operation, and since that time, air quality monitoring has been stopped.

## 2. Other Agencies

In addition to the two agencies listed above, there are others associated with the utilization of Panama's water resources. These institutions are the Directorate of Renewable Natural Resources (RENARE) of the Ministry of Agricultural Development, whose functions include those of administration and fiscal control of the use of bodies of water, supervision and control of the grants and permits in effect, and preservation of water quality through supervision of the discharge of all types of used waters.

The Institute of Hydraulic Resources and Electrification (IRHE), whose purpose is to plan, increase, diversify and rationalize the generation, transmission and distribution of electric energy in the entire country (Office Decree No. 235 of July 20, 1969) executes electrification plans and affects the exploitation of the nation's hydroelectric resources.

There is currently no agency in the country responsible for taking steps intended to avoid the dangers of pollution of sea waters. However the national Port Authority, through its Office of General Counsel, has drafted a bill which would establish a Department for the Prevention of Marine Pollution, whose purpose would be to prevent the contamination of the territorial seas, coasts and swamps, whether it be by hydrocarbons and their derivatives, chemicals or toxic substances or materials which endanger human health and marine flora and fauna.

Mining installations receive authorization for such use from the Bureau of Mineral Resources of the Ministry of Industry and Commerce (MICI).

The Ministry of Public Works (MOP) has within its other activities, "...to grant aqueduct and hydroelectric rights."

There are also municipal councils which have among their functions the maintenance of the purity of water, the provision of water and sewer service, and the management and conservation of the natural resources of the municipality.

The Advisory Council for Water Resources (CCRH) is an advisory organ of the Department of Water of the MIDA for all questions concerning planning and scheduling of usage, conservation and control of water. It was established by Executive Order No. 70 of August 27, 1973.

Finally, there are the Development Corporations (Bayano, La Victoria, CODEMIN), which have direct and almost absolute control of the water resources within their areas of development.

It is noted that there exists a large number of autonomous and semi-autonomous government agencies which decide on the use to be given to the waters which concern them. This broad spectrum of public and semi-

public institutional involvement gives rise to conflicting actions between these groups. Because institutional mandates are not well-defined by law, this has caused agencies not to take initiatives thinking that certain actions pertain to the mandate of another agency. While Panama abounds in the number of agencies responsible for the protection or use of its water resources, the coordination and strengthening of these agencies with respect to human and financial resources has not been carried out. This state of affairs is the greatest limitation on the efficient, rational and sustained management of water resources in Panama.

### 3. Legislation

There are a great number of laws which cover all aspects of the use and exploitation of water resources. However, the majority of these laws are not accompanied by regulations which facilitate their application. For example, the General Water Law is rather complete regarding procedures to be followed for the utilization of water resources, but it lacks regulations which could classify the bodies of water into categories according to their practical uses, such as irrigation, production of fish, and water transporation. As long as bodies of water remain unclassified, the requirement that "...used water, once it is returned to the river must have the same characteristics as when it was extracted" is meaningless. Vague performance standards are practically impossible to fulfill in all cases, as well as uneconomical and unnecessary. Because of the limited number of available personnel, inspection for compliance with the laws cannot be achieved and the purpose of the laws is thus not fulfilled.

Air quality legislation includes the following:

- Article 88 of the Sanitation Code, established by Law 66 of November 10, 1947, referring to location of industry.
- Decree No. 71 of February 26, 1964, approving rules for location of industries.
- Decree No. 226 of October 2, 1969, relating to diesel vehicle emissions into the atmosphere.
- Mayoral Decree No. 6 of May 4, 1970, regulating particulate material transport.
- Decree No. 56 of February 15, 1971, barring incineration of garbage in the capital.

Although these laws exist, as yet there is no Panamanian agency identified to enforce them.

### 4. Major Problems

The availability and quality of water resources is already a factor limiting the process of development in the Metropolitan region. Deforestation of the river basins in this area is considered to be the

main cause of the deterioration of the water quality and quantity. On the eastern side of the Azuero Peninsula, in the Central region, water resources are already a limiting factor in the region's development due to scarce rainfall and advanced stages of deforestation. Future prospects are difficult to judge and complicated by the limited availability of groundwater which has contributed to conflicts over usage of available water supplies.

In the Oriental region water resources are abundant and the quality of water has been only slightly altered. The region's water resources will be a limiting factor to development during the upcoming decade.

The deterioration of water quality in Panama is principally associated with the organic discharges coming from residential household, agro-industrial and food-processing industrial activities. However, it is quite possible that there exist significant levels of pollution caused by pesticides and herbicides given their intensive use in the Central and Occidental regions.

The organic forms of pollution are largely of a localized nature and could be cleaned up in a relatively short time once the discharges are collected and properly treated. The extent and severity of Panama's sewage pollution are attributed to the common practice of discharging raw or partially treated wastes indiscriminantly into nearby receiving bodies or water. Also, existing treatment systems consist mainly of septic tanks and due to defects in design, lack of maintenance and low absorption capacity of the soil, they do not function effectively. This problem is common in all of Panama's population centers, especially Panama City, Colón, David, Santiago, Chorrera, Penonomé, Chitré and Los Santos.

In the case of the pesticides and herbicides, it is probable that there are significant concentrations over large areas of the country. Furthermore, it is also possible that they may be damaging marine resources. The regions most likely affected are the Occidental and Central regions where most of Panama's farming, livestock, and agroindustrial activities are centered. The probable extent and severity of pesticide and herbicide impacts on human and natural ecological systems could not be determined because of the scarcity of quantitative information on this topic.

Other problems that limit effectiveness of Panama's agencies to deal with water, air and solid waste pollution are the following:

° Lack of Sufficiently Trained and Qualified Personnel

Of 500 employees in the Bureau of Environmental Health, only 10% are supervisors or mid-level supervisors, and only 0.8% are engineers. The lack of engineers capable of designing aqueducts is a serious problem, resulting in use of designs that are not adapted to particular sites and which may cause significant negative impacts on the environment.

- ° The Institute of National Aqueducts and Sewers employs 37 engineers (2.0% of the total work force), of which less than 10 are sanitary engineers. Mid-level managers account for only 0.8% of the work force, which is clearly inadequate for completion of projects. Nevertheless, IDAAN has surpassed the goals established in the Ten-Year Health Plan signed in 1972.

The Sanitation Department of the City of Panama, which is administered by IDAAN, does not employ even one sanitary or civil engineer capable of providing guidance on final disposal of refuse.

- ° Lack of Appropriate Technology

Many of the systems of water storage, pumping and distribution found in Panama are based on out-of-date designs and have problems with leakage. Simple latrines are used that frequently have odor problems and while there are improved latrine designs which would require only minor changes to eliminate these types of problems, little work has been done in this area. Sewage disposal continues to rely on septic tanks even though there are favorable conditions for other solutions such as oxidation pools in the country. Sanitary landfill sites can be found which are not subject to leaching and have sufficient cover material nearby. Most of these problems are exacerbated by the lack of personnel with relevant training.

- ° Economic Constraints

Recent rises in the price of fuel have cut back the transportation available for solid waste collection, transport of building materials and personnel for aqueducts, and inspection visits by supervisory personnel. Refuse collection resources are used inefficiently; about 80% more is spent per ton of refuse in Panama than necessary (Tello, 1978). In the inland areas the economic resources for collection and disposal of solid wastes are more critical. All of the interior cities use open dumps because it is the least costly method and does not require technical expertise.

## 5. Conclusions

Judging from statistical data and visits to certain sites, extensive pollution of Panama's water resources does not exist, except in localized areas. Localized pollution is primarily organic in origin and therefore, susceptible to rapid recovery as soon as the causes are removed or cleaned up.

It is highly probable that in the Occidental and Central regions environmental changes may have taken place because of the extensive utilization of pesticides, herbicides and fertilizers. These changes could be causing accumulative effects in aquatic species and organisms which are among Panama's most important resources.

The principal water pollution problems in the Metropolitan region are attributed to discharges of raw sewage into streams and ditches which flow through the city and discharge into the Bay of Panama.

Deficiencies of a technical nature have been observed in the design and location of Panama's few existing sewerage treatment facilities. The facilities also lack any maintenance operations, which further complicates design problems.

Except in Panama City, disposal of solid wastes does not result in serious pollution problems, even though the techniques of disposal are inadequate in most cases.

Air pollution levels in the places for which information is available (two sampling stations in the capital) are low with respect to SO<sub>2</sub>, but somewhat higher for suspended particulate matter, (though still in concentrations which are lower than those recommended as maximum safe limits).

Unless due precautions are taken in the form of appropriate control measures, damage foreseen from the Cerro Colorado Copper Mine will exceed by several orders of magnitude the most critical impacts seen to date in the country, and if not avoided or reduced these potential effects may lead to irreversible damages.

#### D. Recommendations

##### 1. Recommendations to the Government of Panama

The following are recommendations to the Government of Panama for preventing and handling pollution problems in air and water resources and from solid wastes.

- ° Review and delineate the responsibilities assigned to the agencies related to the environment, particularly in the areas of water, air, and solid waste pollution in order to clearly define them avoiding duplication of efforts.
- ° Classify water flows into categories according to their current use and potential use, in order to be able to legislate and regulate them in an economical fashion and in accordance with their ecological characteristics.
- ° Establish and maintain a current register of household and industrial discharges entering into the different bodies of water in the country.
- ° Formulate regulations and guidelines for enforcement of those laws which currently lack them (e.g., General Water Law, Pesticide Utilization Law).

- ° Require that all major development projects include an environmental impact component that should be prepared according to a prescribed set of standards. Require that its findings and conclusions be incorporated into any subsequent project planning, design and implementation.
- ° Provide incentives and aid to those students interested in sanitation engineering or related environmental sciences in order to meet the country's present and future technical manpower needs.
- ° Promote development of short courses (which include an evaluation report) on design techniques for personnel of the agencies responsible for providing water and sewerage services, placing special emphasis on systems which are appropriate for the different climatic regions of the country.
- ° Strengthen environmental control and monitoring activities in the areas of greatest population and in all places where there are industries which pose potential dangers to the environment.
- ° Strengthen interagency and intra-agency coordination and communication.
- ° Promote the establishment of an Environmental Data Bank in the country with the prime purpose of centralizing all information about research, theses, legislation and related studies either in existence or in preparation.
- ° Create a "social awareness" of pollution the problems in environment and their importance at all levels of population in Panama. Utilize the country's public schools, universities and existing training systems such as the National Training System for Panamanian Public Administration (SINAP) the National Training Council, the Central Training Officer, the Institutional Training Officer (OIA), municipal and community boards and grassroots environmental groups.
- ° Investigate the use of pesticides, herbicides and fertilizers and initiate appropriate control measures to prevent the occurrence of any serious problems from their use.

## CHAPTER VIII. MINERAL AND ENERGY RESOURCES

### A. Summary

### B. Resource Base

1. Minerals
2. Energy
3. Alternative Energy Sources
4. Current Energy Use
5. Future Energy Development
6. Energy Growth Projections

### C. Resource Management

1. Government of Panama Institutions
2. Major Problems

### D. Recommendations

1. Recommendations to Government of Panama

## A. SUMMARY

Mining activities and mineral exploration occur on a small scale in Panama. There is some drilling for petroleum but to date no economically extractable quantities of oil or gas have been found. There is some mining for gold and beach sands, and there are plans to develop the Cerro Colorado open-pit copper mine in the near future.

The primary energy resources used in Panama are petroleum, biomass, and hydroelectric power. The use of petroleum accounted for 77% of the total energy consumed in 1977, while hydroelectricity accounted for only 8% and non-commercial sources (firewood, bagasse, coffee wastes) accounted for 16%. Future energy demands will rely heavily on the development of Panama's considerable hydroelectric potential, estimated at 1500 MW. Panama is also promoting rural electrification through the use of mini-hydroelectric power plants and other alternative energy sources.

## B. RESOURCE BASE

### 1. Minerals

In most cases, mining activities and mineral exploration occur on a small scale in Panama, and the associated environmental impacts are localized and dependent upon the exploitation process. The most important mineral resources in Panama are the following:

#### a. Petroleum

Crude oil drilling and offshore drilling-right concessions in Panama are concentrated in the Caribbean coast from the Golfo de los Mosquitos to the Colombian border. To date, on-shore exploratory wells have failed to show any economically extractable quantities of oil or gas. The offshore potential for crude oil is undetermined. Significant environmental dangers exist from the handling of petroleum products at both the 100,000 barrel per day refining facility at Colón and the petroleum port at Charco Azul in Chiriquí. The potentially dangerous contamination impacts of spills and effects on marine resources and coastal areas are discussed in other sections of this report.

#### b. Gold

Some gold extraction and exploration is now occurring from placer deposits in river systems, principally in the Darién. Important associated impacts relate to sedimentation and disturbance of riverine and river bank environments. Since the activity is limited in its extent, this type of mining is currently of minor concern.

#### c. Beach Sands

Certain beach areas of the country are being or have been exploited for beach sand as a construction material or source of

ferrous mineral. The impacts of such massive extractions are dangerous not only from the point of view of coastal stability and beach dynamics, but also because of indirect impacts on mangroves, beach vegetation and marine organisms that depend on these habitats. More detailed information with regard to these activities, especially in the Punta Chame area where considerable coastal degradation is occurring, is provided in the marine fisheries section of this report.

d. Cerro Colorado - Copper Mining

The Cerro Colorado open-pit copper mining project is the largest scale development project to affect Panama since the Panama Canal, and potentially the most dangerous. This project is of enormous economic importance to Panama, but if adequate environmental and human protection precautions are not taken it could turn into one of the largest ecological disasters in the Central American region. It is the feeling of the team that although the potential impacts of the project have been fairly well identified (P. Galindo, 1980), they have not been adequately addressed. Because of the extreme environmental, economic and political sensitivity of this project, it is imperative that the Government of Panama take all feasible environmental protection measures required to minimize or avoid unnecessary negative environmental impacts.

2. Energy

Considering all major energy resources, including hydroelectric, geothermal, oil and gas, coal, wind, solar and biomass resources, only hydroelectric and biomass development appear to have possibilities in the near future for power generation in Panama. Although there are hot springs areas at Cerro Pando and Agua de Salud, only surface testing has been done for potential geothermal energy sources. Wind and solar resources exist and could be developed in the future, but limitations exist (lack of data, technology and qualified personnel) that make it unlikely that Panama will be able to depend upon these energy sources in the near future. In summation, the most encouraging energy prospects are hydroelectric and biomass power generation.

a. Biomass

Biomass resources include wood, bagasse, and coffee waste. Recent estimates by the consultant team indicate that somewhat less than half (47-49%) of Panama's land area is still forested. Currently an AID/Instituto de Recursos Hidraulicos y Electrificación (IRHE) Alternative Energy Project Component in cooperation with RENARE contemplates the generation of electricity (120 KW) starting in May, 1981, from a wood-burning plant in Yaviza based upon a 2000 Ha reforestation/plantation rotation project. This is the first public commercial scale project in biomass energy production to be developed in Panama.

b. Hydroelectric Power

There were eleven hydroelectric plants operating in the Republic of Panama as of September, 1979. Location, construction and production capabilities of these projects are shown in Table 12.

The two largest facilities in the Metropolitan region, Madden and Gatún, are operated from storage reservoirs maintained as part of the water supply of the Panama Canal. The other projects of the system are "run-of-the-river" types which consist of a gated intake structure in the flow of the river, a supply canal leading to the head of the penstock and power units. There is no storage, and operation of this type of plant depends of the day-to-day flow of the river.

The effect of these projects on the flow in their respective rivers is variable depending upon the availability of water for the power project in relation to downstream uses, the period of the water year, project design and other factors. The plants at Boquete, Caimito, Macho de Monte and Rovira return the water to the same river from which it is diverted, and therefore have little effect on stream flow. The plant at Caldera takes its water from Río Caldera and discharges it into Río Cochea. The Estrella Los Valles project takes water from Río Caldera and diverts it into the Río Los Balles, both of which are tributaries of Río Chiriquí. Serious erosion and sedimentation problems exist around around the regulating reservoir of this project and require stabilization work to protect the temporary storage provided by the reservoir. Also, sedimentation at the diversion-intake structure of Río Caldera is accelerating, pointing out the need for a more adequate protection of the upper catchment. Plants Dolega I and Dolega II discharge Río Cochea water into Río David. The amount of control on the supply of water in these rivers is not important during the wet season when ample flow is available, but it becomes appreciable during the dry season when flows are low and the amount diverted represents a large part or all of the available river flow.

The La Yeguada hydroelectric project, using water diverted from Río San Juan, consists of a storage reservoir, a regulating reservoir, and a power system. The regulating reservoir at El Flor will, in an average year, utilize most of the flow in Río San Juan. Erosion problems around the reservoir have been partly arrested by a joint RENARE-IRHE reforestation project.

The largest existing hydroelectric project in the Republic is the Bayano project on Río Bayano. This project, which became operative in 1976, controls the flow of Río Bayano with a concrete main dam and earthen saddle dam. The reservoir impounds approximately  $4,000 \times 10^9$  cubic meters of water. When fully developed, the project will produce 150,000 kilowatts from five units.

TABLE 12

## HYDROELECTRIC PROJECTS IN PANAMA

Name	River	Location		No. of units	Rated low output	Rated flow (m <sup>3</sup> /sec)	Rated head (m)	Year of construction	Remarks
		Lat.	Long.						
Boquete	Boquete	8°46'	82°26'	1	250	.91	33.5	1946	72 kw unit in plant but not connected.
Caimito Caldera	Caimito Caldera	8°54' 8°43'	79°46' 82°27'	2	5,040	7.14	90.0	1955	Discharges into Rio Cochea. Carries base load for system.
Dolega I	Cochea	8°34'	82°25'	2	870	2.34	41.6	1937, 1947	Discharges into Rio David. Usually standby.
Dolega II	Cochea	8°34'	82°25'	2	2,230	6.36	41.5	1964	Discharges into Rio David.
Gatun Laguna de La Yeguada	Gatun Lake San Juan	9°00' 8°27'	79°35' 80°52'	2	22,500 6,000				
Macho Monte	Macho de Monte	8°41'	82°36'	1	770	1.02	68.0	1970	
Madden	Chagres	9° 3'	79°37'		24,000			1938	
Rovira	David	8°38'	82°29'	1	160	.62	55.0	1909	Poor condition.
Bayano	Bayano	9°11'	78°51'	3	72,000		55.0	1972-76	Delay in putting into operation because a dry water year and other effects. Seriously criticized for its adverse environmental impact.
La Estrella	Caldera							1969-78	Installed capacity 420

TABLE 13

## CURRENT AND FUTURE WATER USAGE FOR GENERATION OF HYDROELECTRIC POWER IN PANAMA

LARGE BASINS	BASINS	RIVERS	PROJECT	WATER USAGE, (m <sup>3</sup> /s)					
				1975		1980		1990	
				TOTAL	NOT REPEATED	TOTAL	NOT REPEATED	TOTAL	NOT REPEATED
<u>Total for Nation</u>				115.4	67.7	338.0	278.8	421.0	348.8
<u>Total Atlantic Watershed</u>				104.3	58.3	104.3	58.3	187.3	128.3
II <u>a/</u>				--	--	--	--	83.0	70.0
	91 <u>a/</u>	Teribe I	Teribe I	--	--	--	--	70.0	57.0
	91 <u>a/</u>	Teribe II	Teribe II	--	--	--	--	13.0	13.0
KK				104.3	58.3 <u>c/</u>	104.3	58.3	104.3	58.3
	113	Gatun Lake	Gatun	46.0	--				
	115	Chagres	Madden	58.3	58.3				
<u>Total Pacific Watershed</u>				11.1	9.4	233.7	220.5	233.7	220.5
MM				9.7	8.0 <u>b/</u>	56.3	43.1 <u>b/</u>	56.3	43.1
	106	Macho Monte	Macho Monte	0.7		0.7	0.7	0.7	0.7
	108	Caldera	Caldera	3.6		--	--	--	--
	108	Conchea	Dolega I	1.2		1.2	--	1.2	--
	108	Conchea	Dolega II	3.4		3.4	3.4	3.4	3.4
	108	David	Rovira	0.3		--	--	--	--
	108	Qda. Grande	Boquete	0.5		0.5	--	0.5	--
	108	Chiriqui	Fortuna	--		24.0	24.0	24.0	24.0
	108	Caldera-Los Valles	Estrella-Los Valles	--		26.5	15.0	26.5	15.0
00	132	San Juan	La Yeguada	1.4	1.4	1.4	1.4	1.4	1.4
RR	148	Bayano	Bayano	--	--	176.0	176.0	176.0	176.0

Notes: a/ International Basin; values for Panama only.

b/ Dole I and Boquete projects use the same water as others further down river.

c/ The Gatun Central Plant uses the same water as the Alhajuela Plant.

Source: IRHE. Report on Water Resources in Panama. April 1976.

As of 1979, the total national installed capacity of Panama's combined energy systems (hydroelectric, thermal, and diesel) was 479 MW, of which 208 of these were supplied by hydroelectric projects. Table 13 details current and future water use for potential hydroelectric development schemes. Currently, there are two major hydroelectric projects in construction. The Los Valles project is a second state utilization of the waters of "La Estrella" project, in addition to the captured discharge of the Rio Los Valles. This project will drop its waters to the Rio Chiriquí and in so doing generate a projected maximum of 48 MW. The Fortuna Hydroelectric project is also located in the province of Chiriquí (along with Estrella-Los Valles) some 35 kilometers to the north of David. Its design is based on a large cement-covered rock dam 60 and 100 meters high in its two successive stages and will eventually generate an estimated 170 MW of energy. An impact statement was developed for the project by the Gorgas Institute (IRHE, 1977).

### 3. Alternative Energy Sources

Since 1979, IRHE, in cooperation with AID by means of an \$825,000 grant for an Alternative Energy Sources project, has been developing alternative energy sources including biomass, biogas and solar applications. This project is oriented toward solving energy shortage and cost problems of low income rural families and communities, and includes the construction of mini-hydro plants. An estimated 40 sites throughout rural Panama will be developed for the installation of small turbine plants. This new program is viewed as an advancement in appropriate technological applications and will need concerted efforts in the area of community education and watershed management if these projects are to be successful.

### 4. Current Energy Use

The total energy consumption in Panama in 1977 was 88,966 terajoules, of which petroleum accounted for 77%, hydroelectricity 8%, and non-commercial sources, 16%. This total excludes 59,736 terajoules of petroleum products refined in the country, 80% of which are sales of bunker fuel to ships using the Panama Canal.

Historically, Panama has depended more than any other Central American country on thermal generation of electricity. Until 1976, hydroelectric power constituted less than ten percent of public sector installed capacity and contributed a similar share of gross electricity generation. In that year the 150 MW Bayano plant opened and installed hydroelectricity jumped tenfold, reaching 166.1 MW or 35.7 percent of total capacity. By the following year, hydroelectric generation accounted for 23 percent of total capacity. In 1978 gross hydroelectric generation reached 71.8 TWh, or 48.0 percent of the country's electricity output.

Partially as result of Panama's relatively greater reliance on thermal (petroleum based) generation, the average price of electricity to consumers is the highest in the region, 5.8 cents/KWH in 1976 and 7.4 cents/KWH in 1978. As of 1977, an estimated 30.1 percent of total consumption of petroleum went to the generation of electricity. All public service electricity generation and distribution with the exception of the former Canal Zone is the responsibility of IRHE.

Panama imports and refines more than twice its internal needs of petroleum products, making this section the largest in Central America and a substantial contributor to the national GDP. The Texaco refinery in Colon has suffered a reduction in productivity in recent years, falling from a high of 29.2 million barrels of crude oil in 1975 to a low of 16.9 million barrels in 1978. This drop reflects a drastic curtailment in the availability of Ecuadorian crude and has resulted in a weakening of the country's foreign exchange position and diminished the refinery's contribution to the total economy.

According to the 1970 census, 45 percent of the population (predominantly rural poor) or 600,000 people utilized fuelwood, primarily for home cooking and lighting but also for small industry. IRHE is completing studies and a survey on fuelwood use in the rural section which will provide more reliable data and indicate the critical role that fuelwood use plays. Preliminary results indicate that 650,000 people (39 percent of the population) continue to depend in 1980 on fuelwood for daily energy needs. The alarming rate of deforestation in the country and the scarcity of fuelwood sources, especially in the tropical dry and moist life zones of the Pacific Slope (in the Provinces of Coclé, Herra, Los Santos, Veraguas and eastern Chiriquí), make this rural energy problem extremely critical.

##### 5. Future Energy Development

To meet an anticipated 7.4 percent annual growth rate between 1980 and the turn of the century, Panama is undertaking an extensive construction program of electricity generating facilities. As in most Central American countries, Panama is emphasizing the development of its considerable hydroelectric power resources, estimated a minimum to be 2500 MW based on dam site evaluations. However, IRHE projections of installed capacity and generation vary greatly.

The major factor influencing Panama's future energy development is the proposed Cerro Colorado copper mining project. It is estimated that Cerro Colorado would require an average of 1,510 GWH of electricity annually, with a peak load of 148.5 MW. To accommodate this demand, IRHE would have to raise its gross generation by 12 percent by the year 2000 (7,662 to 8,549).

IRHE has defined four options for electricity generation growth over the next twenty years, two options with Cerro Colorado and two options

without (IRHE, 1979). All options assume the IRHE will expand generating capacity at (250MW) in 1983 and Bayano (70MW) in 1984. In any case, IRHE will construct hydroelectric dams on the Changuinola River (264 MW and 306 MW) and on the Teribe River (237MW) sometime after 1986, although the exact timing will vary with the option selected.

One major goal of Panamanian electric sector policy is to increase the scope of rural electrification. With more than half of its population currently served by electricity, the country is farther ahead towards this goal than any other country in the region except Costa Rica. However, rural electrification is very expensive. Instead of integrating the small isolated systems into the national grid, IRHE plans, with AID/IDB support, to introduce minihydro and, later, other alternative sources.

## 6. Energy Growth Projections

Future energy requirements in Panama have been estimated by MITRE (1980), based upon data from IRHE sources, to average 7.4 percent per year through the year 2000, giving a total generation need of 7,921 GWH (excluding Cerro Colorado consumption). These energy growth projections imply a substantial increase in petroleum products consumption from 68,062 terajoules in 1977 to 142,682-207,986 terajoules in the year 2000 (4.1-6.2 percent annual increase in petroleum demand). In addition, it is assumed that noncommercial energy consumption will grow at a rate equal to population growth (2.05 percent per annum).

A final energy analysis for the year 2000 requires an estimation of the resource energy mix needed to meet electric generation demands. The best electric sector supply balance information available shows that a very large expansion of hydroelectric power capacity in the order of 1,200MW, will have to take place (more than one half of the known development potential remaining in the country).

Thus future energy strategies for Panama do not leave many options open. Hydroelectric power sites will have to be developed to a maximum and considerable growth will have to occur in noncommercial energy sources (fuelwood, bagasse, and agricultural wastes). If the balance of payment situation is to improve, two basic strategies will have to be applied successfully to reduce petroleum product consumption to a minimum, namely: (1) oil substitution (by hydroelectric power); and (2) conservation (more efficient use of energy sources).

## C. RESOURCE MANAGEMENT

### 1. Government of Panama Institutions

#### Dirección General de Recursos Minerales

The Dirección General de Recursos Minerales (Directorate General for Mineral Resources) is part of the Ministry of Commerce and Industry. The Dirección publishes and makes available maps to the public at the Instituto Geografico Nacional (IGN) "Tommy Guardia" that indicate the location of minerals proexisting concessions and major concession requests for metallic minerals and petroleum. Information is also provided with respect to the company, type and class of exploration or exploratation, location and area of concession, and dates and other critical information about mining potentials and location of other materials such as non-metalic materials and ferilizers of alluvial areas, clay materials, sedimentary deposits and construction materials can be found in CATAPAN, 1970.

#### Instituto de Recursos Hidráulicos y Electrificación (IRHE)

The Instituto de Recursos Hidráulicos y Electrificación (Institute of Hydraulic Resources and Electrification - IRHE) is the primary agency concerned with the development of hydroelectric power and rural electrification. Most energy projects in the country fall under IRHE's auspices.

### 2. Major Problems

Panama has a moderately high hydroelectric power potential which is presently being exploited in a systematic and relatively efficient manner by IRHE. Hydroelectric energy is basic to the future development of the country and critical to the severe balance of payment deficit suffered, principally due to petroleum imports. Major problems in this field are related to watershed management, including sedimentation of existing structures, environmental impacts associated with impoundments, and advance watershed protection for future development of catchments. Based upon Panama's growth projections and its energy demands it is imperative to maximize the benefits of hydro-power development projects and continue with efforts to improve rural energy supplies. For hydroelectric project development, watershed protection is absolutely necessary to assure susstained and efficient project operation. Reforestation of degraded sites to control erosion with hydroelectric power (watershed) well as for the provision of non-commercial fuelwood supplies is necessary in watersheds such as the Canal watershed and Bayano. Protection of mini-hydro sites and multiple use sites (as portable water resources and perhaps community forests and recreational sites) would be a very worthwhile endeavor.

D. Recommendations

1. Government of Panama

The following recommendations to the Government of Panama are intended to help assure that environmental safeguards are incorporated into Panama's mineral exploitation and energy development activities:

- ° Require environmental assessments and/or impact statements for minerals exploration projects such as Cerro Colorado. Utilize the results in planning such projects to avoid negative environmental impacts in the project area;
- ° Sponsor an interagency investigation into potential land-use issues resulting from current patterns of mineral exploration, and extraction, and the concession-granting process. Particularly review impacts on wildlife, forested areas, indigenous settlements and marine resources;
- ° Initiate an active monitoring program on the potential environmental hazards associated with the handling of petroleum products at both the Colón oil refinery and the petroleum port at Charco Azul in Chiriquí. Solicit information from the appropriate agencies in other countries such as Mexico and Venezuela which have experienced oil spills and coastal contamination problems in recent years;
- ° Encourage the shift from petroleum-based energy sources towards renewable sources (including geothermal, mini-hydro, and rural fuelwood plantations) with increasing involvement in regional cooperative efforts such as the CATIE-ROCAP program;
- ° Evaluate the effectiveness of watershed management components of existing hydroelectrical power projects. Utilize the information compiled to strengthen such programs and to incorporate into the planning of future installations;
- ° Support the development of rural decentralized non-commercial biomass energy sources, through direct incentives and coordination of technical assistance provided by national, binational and international agencies. Assure that all activities in this area (community woodlots, conversion of agricultural wastes, etc.) be based on ecologically-sustainable production systems.

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## References

APPENDIX A

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APPENDIX B

Individuals and Environmental and Natural Resources Organizations

The individuals and organizations listed below were key contacts to members of the team. We wish to acknowledge their participation and contribution in this research effort. They represent the core of Panama's environmental expertise and will continue to play an important role in the country's future advancements in the environmental and natural resource fields.

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## APPENDIX C

A PROPOSED COASTAL CLASSIFICATION SYSTEM FOR PANAMA

The purpose of a coastal classification system is to determine the most suitable balance between preservation and utilization of the zone's resources. A common system of classification in frequent use today divides the zone into three broad categories: (1) preservation; (2) development, and (3) conservation uses. Criteria for classification are not well defined, thus, some flexibility is required in their specific application. Areas of preservation include "critical" or "vital" habitats where little disturbance can be tolerated. These typically include estuaries, coral reefs, nesting sites, and critical habitats for endangered species. If these sites are exposed to development pressures extreme precautions are required, usually signifying high cost and generally unsuccessful co-existence. A second area of possibly reduced flexibility includes parts of the zone required for major development projects. In some cases required utilization may be based on such relatively irresistible forces such as discovery of high value mineral deposits or space needed for rapidly expanding urban populations. Major problems for the decision maker arise when one area of the zone falls within both categories. Finally, conservation areas are those best utilized in some form of multiple use program.

I. Preservation AreasA. Mangroves

Mangroves are a designation for tree species capable of tolerating periodic inundation of salt water. They occur in tropical and subtropical regions. Their role in the coastal zone is both significant and complex. Mangrove areas act as buffers from both tropical storms, (hurricanes) and terrestrial runoff (contaminants), provide critical habitat to many economically important brackish and marine fish species as well as waterfowl and reptiles, and are a source of primary productivity.

Starting seaward, mangrove zonation begins with the red mangrove Rhizophora of which two species occur on the Pacific and one on the Atlantic coast of Panama. This genera gradually gives way to the black mangrove Avicennia which, progressing gradually inland, is replaced by the white mangrove Laguncularia. (Rabinowitz 1975.) These latter two genera rarely occupy single stands. A fourth genera Pelluiera also has been described as present in lowlying areas bordering estuary banks.

Major areas of occurrence on the Atlantic side are the lowlands along the Rio Changuinola (Changuinola), lowland areas adjacent to the Laguna de Chiriquí (Chiriquí Grande), and Golfo de San Blas (Comarca de San Blas). On the Pacific side major stands were observed in a zone extending from La Boca de Los Espinos (Alajuela) to Boca de Pajaroncito (Sona), the Golfo de Chiriquí, Golfo de Montijo (Rio

de Jesus, Montijo), a range between Rio de Chiriqui (San Felipe Tomos), Bahía de Parita (Aguadulce) and throughout the Bahía de Panama to the Golfo de San Miguel.

The role of the mangroves in Panama's fisheries has been relatively well documented. *Parachanna occidentalis*, the species of white shrimp accounting for 64-97% of all white shrimp landings (D'Croz et al, in press), pass the juvenile stages in estuaries, mainly during March to May (D'Croz et al, 1976). Use of the estuaries by the other two species (*P. stylirostris* and *P. vannamei*) also have been documented during August-September and September to December periods, respectively (D'Croz et al, 1976, D'Croz et al, in press). Though it is not known how significant these areas are to the other species of shrimp found in Panama's Pacific waters, at least six other species have been observed in mangrove waters (D'Croz and Kwiecinski, in press). A correlation may exist between abundance of the anchovy, *Engraulis mordax*, important to the country's fish meal and oil industry, and productivity of mangrove estuaries. This may be attributable to high nutrient concentrations associated with mangroves (D'Croz, personal communication). Finally, these areas provide habitat for juveniles of commercially important fish species such as jacks, *Caranx* and *Micropogonias*.

Based on a proposal to eliminate the mangrove areas near Bahía Parita to provide for Panama City's expansion, D'Croz and Kwiecinski (in press) calculated the approximate economic loss in land and shellfish production resulting from associated habitat destruction. The estimated value was \$94,629/km<sup>2</sup>/yr or \$1.1 million/yr for the proposed area of development.

## B. Coral Reefs

Coral reefs represent one of the most diverse habitats found in the marine environment reaching their greatest development in tropical and subtropical latitudes. Their vertical range extends from emergent species during low tide to deep water species. The diversity, density, and extent, however, occurs in the shallow zone. This habitat nurtures a diversity of organisms known in no other ecosystem. Despite their often extensive development, coral reefs are intolerant of contaminants, high or prolonged rates of sedimentation, and drastic or prolonged changes in salinity and temperature conditions.

Panamanian coral reefs have been identified on both sides of the Isthmus, though distribution is much better along the Pacific coast. The Caribbean side has greater diversity in both corals and associated communities, in contrast to the Pacific side where diversity is limited to 20 species. Where reefs do occur they are highly degraded and generally dominated by *Pocillopora* (D'Croz, 1977). As a result of drastic reductions in temperature and other conditions existing in the Gulf of Panama, the greatest coral outcrops are found in the Occidental region, specifically the Santa Fe Islands, Comandante group, Bahía Honda and Florida Island near the Chiriquí River mouth (D'Croz, personal communication). To a lesser extent, coral communities occur

near Taboga, Toboquilla, and the Pearl Islands group (Glynn 1972). Forty-nine stony corals are known to occur on the Atlantic side (Porter 1972). Major known areas of development are the leeward side of the San Blas Islands, Isla Grande, Galeta Point, and a small area on the exposed islands of Boca del Toro (Lessios, Robertson, personal communication, personal observation). Coral development has been described as comparable to other areas in the Caribbean (Porter 1972).

#### C. Mud Flats

Muds flats are not normally considered critical habitats in coastal type designations but they do warrant it in this case. As previously mentioned these areas represent the feeding grounds for the adult herring and anchovy fish stocks in Panama. Given the importance of the industry to the Panamanian fishing sector, these areas should be given special consideration. Major areas include Bahía de Partia, Bahía de Chame, Bahía de Chorrera, Bahía de Bique, Bahía de Panamá, and the Golfo de San Miguel. Mudflats appear to be very limited in number on the Caribbean. They are limited primarily to those areas immediately adjacent to river mouths.

#### D. Islands

Islands are unique environments that are difficult to fit into the strategies of development presently in use on the mainland. Their limited carrying capacity, isolation, often unique range of habitats and species diversity, and finally their special esthetic value require a much more critical and sometimes unique application of management strategies.

The islands of Panama appear to represent one of the major under-utilized resources in the near coastal zone. By one estimate (Handbook 1975) there are approximately 1,600 islands in Panamanian possession with the majority found on the Pacific side. These islands range from emergent rocks to Coiba with an area of approximately 10,000 km<sup>2</sup>. Panama is fortunate to have unique island groupings as beautiful, pristine, and diverse as the coral reef fringed San Blas islands, the mangrove islands in the Bocas del Toro area, the igneous exposed Secas and the Contreras groups with their unique Eastern Pacific coral development, and the Perlas providing nesting sites for pelicans, cormorants and several endangered bird species.

Signs of abuse of this resource have already been documented and confirmed during site visits. Isla Grande near Nombre de Dios on the Atlantic side is already suffering from weekend excursions of "colonites" leaving little to the local inhabitants other than solid waste. Several cays in the Bocas del Toro group are suffering from slash and burn cultivation similar to that observed on the mainland. This was observed also on the Las Secas and Perlas Islands. Diez (1979) described the deterioration in both air and water quality as a result of the fish meal plant situated in Taboquilla.

Critical Areas	Habitat Destruction																									
	Agriculture	Cut/Burn	Bark Stripping	Charcoal	Const. Materials	Fire Wood	Mariculture Ponds	Urban Mining	Contaminant Sources	Urban	Agriculture	Oil Pollution	Erosion Related	Runoff	Mariculture Ponds	PAJOR PROJECTS	La Estrella - Fortuna	Cerro Colorado	Bayano	Teribe - Changuinola	Road Development	Bocas del Toro	San Blas	Darien		
<b>Mangroves</b>																										
<u>Atlantic</u>																										
Rio Changuinola	(x)	(x)	(x)	(x)	x		(x)			(x)										(x)		(x)				
Laguna de Chiriqui	(x)	(x)	(x)	(x)	x					(x)																
Colon - Puerto Pilon	(x)	(x)	x	x	x		x			(x)																
Golfo de San Blas	(x)																									
Bahia de Mesargandi	(x)			(x)	(x)	(x)																				
<u>Pacific</u>																										
La Boca de los Espinos - Boca de Pajaroncito	x	x	(x)	x						(x)	(x)	(x)	(x)							(x)	(x)					
Golfo de Montijo	(x)	(x)	(x)	x																						
Rio de Cuna - Tonosi	(x)	(x)	(x)	x																						
Bahia de Parita	x	(x)	(x)	x	x					(x)				x												
Punta Chame	x	(x)	(x)	x	x			(x)		(x)				x												
Bahia de Panama	x	(x)	(x)	x	x		x			(x)				x												
Golfo y Rios de San Miguel	(x)	(x)	(x)	x																					(x)	
<b>Coral Reefs</b>																										
<u>Atlantic</u>																										
Bocas del Toro																										(x)
Galata Point										(x)	(x)															(x)
Golfo de San Blas																										(x)
Islas de San Blas																										(x)
<u>Pacific</u>																										
Isla Parida										(x)	(x)										(x)	(x)				
Islas Secas										(x)	(x)										(x)	(x)				
Islas Pajaros										(x)	(x)										(x)	(x)				
Islas Contreras										(x)	(x)										(x)	(x)				
Bahia Honda																										
Islas Las Perlas																										
Coliba																										
<b>Mud Flats</b>																										
<u>Pacific</u>																										
Golfo de Montijo																										
Bahia de Parita										(x)	(x)															
Punta Chame										(x)	(x)															
Bahia de Panama										(x)	(x)															
Ensenada de Garacimo										(x)	(x)															
<b>Islands</b>																										
Bocas del Toro	x																									
Isla Grande	x																									
Islas Secas	x																									
Islas de Las Perlas	x																									
Islas de San Blas																										(x)
<b>Other</b>																										
<u>(Turtle Beaches)</u>																										
<u>Atlantic</u>																										
Golfo de los Mosquitos																										
<u>Pacific</u>																										
Bahia de Charcoal Azul																										(x)
Rio Morcones - Rio Salado																										(x)
<u>(Nesting Sites)</u>																										
Isla Pacheco	(x)																									

x Observed or cited impacts

(x) Potential for, or present unknown impact

In the Perlas group areas near the Hotel Contadora located on Isla Contadora have suffered from souvenir hunting by tourists. Due to their relative inaccessibility many of the islands until recently have been protected from developmental pressures common to the mainland. As these areas become more accessible however, a well planned and controlled strategy for their protection and utilization is required.

#### E. Other critical areas

This includes areas that are critical for their diverse assemblage of animals. Two examples of these areas are: 1) the turtle beaches located in western Bahia de Charco Azul, southeastern Azuero Peninsula, Golfo de Parita and Golfo de los Mosquitos; and 2) habitat in the Bahia de Chiriqui and the Rio Chanquinola area utilized by the endangered manatee Trichechus manatus. A matrix designed to show present and potential environmental impact for the critical areas of Panama is presented on page C-4.

## II. Areas of Development

Developmental activities affecting the coastal zone may be best envisioned as either short-term (10-20 years) area-specific projects or long-term processes such as population shifts, erosion and sedimentation. In the former case, the role of the decision maker may be a critical one in deciding when and how projects are to be developed and where and to what degree a specific project may disturb adjacent areas. In the latter case, however, when the "national needs" as articulated by the politician require major long-term commitments to development, the role of the administrator may be relegated to a passive one with emphasis directed on ameliorating potential environmental impacts.

Two examples of past project or area-specific development sites where disregard for environmental considerations were apparent include:

- A. Sand extraction of magnetite ore by the Japanese company Hierro Panama near Nuevo Gorgonia. Despite cessation of activities approximately nine years ago, the berms behind the beach have never recovered; and
- B. Fish meal and oil plants located in Taboga and Puerto Caimito surrounded by "dead zones" as described by Diez (1979) in Taboga and observed in Puerto Caimito.

Two specific land development projects help place resource management issues in proper perspective:

### 1. Punta Chame Project

Punta Chame is a resort development located approximately 1 1/2 hours from Panama City, on the tip of the Punta Chame Peninsula. The project envisions development of one-half of the company's 5,000 acres as sites for ten hotels, a golf course, marina, yacht club, and condominium con-

struction. In addition, 450 acres reserved for "parks, lakes and wildlife preserves" already have been transformed from a mangrove dominated estuary into an artificial lake by closing off the entrance to the sea. At present, the remaining southeastern portion of the estuary is being drained and locals are being allowed to harvest the remaining stands of mangroves. This destruction of a major portion of critical habitat resulted from possession of a title to land predating new legislation preventing mangrove destruction and a developer's disregard for sound ecocodevelopment principles. In this particular case, the best recommendation would have been to move the development project further back off the point and provide carefully planned access roads to beach areas.

## 2. Juan Diaz Project

The Juan Diaz area, east of Panama City, has been subject to recent intensive urban development pressures resulting in widespread loss of wetlands and mangroves despite existing laws to protect these areas. As a result of the critical state of affairs, a meeting took place involving all the relevant public institutions from which evolved the delineation of a mangrove zone between Río Matia Hernandez and Río Tapia of approximately 1200 ha. Within this area all further development has been prohibited and present users must meet newly formulated pollution standards. Measures were adopted to regulate inland uses within the Río Juan Diaz watershed that potentially could impact the mangrove areas. A second resolution that recognizes the importance of the wetlands behind the mangrove zone requires the use of water treatment facilities for urban development in the area and the use of adequate water drainage systems to prevent soil erosion.

At present, there is a proposal solicited by the Ministerio de Vivienda from its own Dirección General de Desarrollo Urbano for a development strategy of the Juan Diaz area. The proposal presents a basic premise that the area will not be a high density area. The following land use categories have been suggested: 1) Ecological reserve (mangroves and wetlands); 2) Flood zones (forests and lakes), 3) Industrial zone; 4) Recreational Zone (lakes, parks); and 5) Residential zone (200 persons/ha). Among other considerations are the enforcement of water treatment standards, flood water control, solid waste treatment, and industrial development and pollution standards. (Dirección General de Desarrollo Urbano 1980).

Development and utilization of integrated approaches such as the one proposed above needs to be institutionalized. Only through the institutionalization process will the capabilities be developed to deal with the problems that will arise with the presently proposed long-term Panamanian government commitments. Those commitments with the most long-ranging impact on the coastal zone are the construction and opening of several roads in the Darién, Comarca de San Blas and Bocas del Toro regions. In summary, a mechanism must be established and functioning before these areas are made accessible to prevent the same unplanned developmental impacts evidenced on the Pacific coast.

## III. Conservation Areas

This category acts as a catch all for those remaining coastal areas that are not included in the former coastal use "types". The concept of multiple use is derived from the desire to achieve maximum use of the area without loss of

habitat or deterioration of surrounding environmental quality. Typical examples will include managed marinas, recreational beaches, and campsites.

In Panama two areas where increasing need for these types of zones will occur are to the east of Colón and west of Panama City. Weekend "colonites" travel as far as Isla Grande to pass the day or occasional weekend for recreation on Isla Grande's white sand beaches. Already pressures are beginning to be exerted on the islands' limited resources. A substantial accumulation of discarded solid waste is beginning to appear throughout the Island. No plans for the moment are being formulated to deal with the increased need for water, food, and waste treatment associated with increased recreational use of the Island. Similarly, to the west of Panama from Punta Chame to Golfo de Parita coastal areas progressively are being developed for weekend retreat houses. Problems are beginning to arise related to sewage treatment and beach access for locals. These do not represent serious problems as of yet, but will need to be addressed soon.

A second example includes Panama's islands and associated marine parks. Through careful selection and control some islands and underwater habitats can be developed as major tourist attractions (both local and international) without serious environmental degradation. Areas of special interest should include islands from San Blas, Bocas del Toro, Secas, and Perlas groups. Perhaps a grouping of Panamanian islands might be attractive to the national tourist bureau (IPAT) with representative selections from the country's diverse islands.

## Appendix D

PROPOSED LIST OF ENDANGERED SPECIES (RENARE, 1980)MammalsCommon NameScientific Name

Venado Corzo	<i>Mazama americana</i>
Cenado Corzo Chocolate	<i>Mazama gouazoubria</i>
Tapir or Macho del Monte	<i>Tapirus biardii</i>
Puerco Monte	<i>Tayassu pecari</i>
Saino	<i>Tayassu tajacu</i>
Conejo Pintado	<i>Agouti Paca</i>
Mamati	<i>Triechachus mamatus</i>
Leon or Puma Americano	<i>Felis concolor</i>
Tigre or Jaguar	<i>Felis onca</i>
Manigordo or Ocelote	<i>Felis pardalis</i>
Tigrillo or Margay	<i>Felis wiedii</i>
Tigrillo Congo	<i>Felis Yagouaroundi</i>
Poncho or Capibara	<i>Hydrochaeris hydrochaeris</i>
Perro de Monte	<i>Speothos venaticus</i>
Jujuna or Mono Nocturno	<i>Aotus trivirgatus</i>
Yerre or Mono Arana	<i>Ateles fusciceps</i>
Mono Nocturno	<i>Aotus bipunctuatus</i>
Mono Titi	<i>Saguinus geoffroyi</i>
Mono Colorado	<i>Ateles geoffroyi</i>
Mono Ardilla	<i>Saimiri oerstedii</i>
Mono Aullador	<i>Alouatta villosa</i>

Mammals (cont'd)Common Name

Mono Negro

Mono Cariblanco

Neque

Oso Caballo

Oso Homiguero

Tapacara Gato Balsa

Armadillo

Armadillo Rabo de Puerco

Gato de Mote

Gato Manglatero

Gato Manglatero

Nutria, Gato de Agua

Scientific Name*Alouatta villosa**Cebus capucinus**Dasyprocta punctata**Myrmecophaga tridactyla**Tamandua tetradactyla**Cyclopes didactylus**Dasypus novemcinctus**Cabassous centralis**Urocyon cincereoargenteus**Procyon cancrivorus**Procyon lotor**Lutra annectens*

BIRDSCommon Name

Guacamaya Azul Amarilla

Guacamaya Verde

Guacamaya Bandera or Escarlata

Guacamaya Roja

Lero Mono Amarillo

Guaquita

Gallito de Monte

Anade Real

Pata Crestudo

Pato Rabudo

Pata Cuchara

Pato Calvo

Pato Pechiblanco

Pato Collar

Pato Tigre

Torcaza, Paloma Cabeciblanca.

Tercaza Común

Paloma Escamosa

Tres-Peso-Son

Paloma Rojiza

Paloma Aliblanco

Paloma Rabiaguda

Paloma Morena

Paloma Cestarrique

Paloma Violacea

Scientific Name

Ara ararauna

Ara amibgua

Ara macao

Ara chloroptera

Amazona ochrocephala

Ara severa

Odontophorus gujanensis

Anas platyrhynchos

Sarkidiornis sylvicola

Anas acuta

Spatula clypeata

Mareca americana

Aythya affinis

Aythya collaris

Oxyura dominica

Columba leucocephala

Columba cayennensis

Columba speciosa

Columba nigrirostris

Columba subvinacea

Zenaida asiatica

Zenaida macroura

Geotrygen Lawrenc

Geotrygen cestari

Geotrygen violace

Birds (Cont.)

Perdiz de Arca

Perdiz de Rastrojo

Pavón y Pava Rubia

Pava Cimba or Roja

Paisana

Pava Negra or Nortena

Guichichi

Pato Real

Quetzal

Aguila Arpia

Perdiz Serrana

Gorra Azul

Halcón Peregrino

Tinamus major

Crypturellus soui

Crax rubra

Penelope purpurascens

Ortalis cinereiceps

Chamaopetes unicolor

Dendrocygna autumnalis

Cairina meschata

Pharemachrus mecinno

Harpia harpyja

Northecercus benapartei

Geotrygen chirique

Falco peregrinus

193

Reptiles and Amphibians

Tortuga Verde o Blanca

Rana Dorada

Tortuga Cabuama

Toruga Mulata

Caimán Aguja

Babilla

Tortuga Terrestre

Tortuga Carey

Tortuga Canal

Boa

Iguana

*Chelonia mydas*

*Atelopus varius zeteki*

*Caretta caretta*

*Lipidechelys olivacea*

*Crocodylus acutus*

*Caiman crocodilus fuscus*

*Geochelone (testudo) carbonaria*

*Eretmochelys imbricata*

*Dermochelys coriacea*

*Constrictor constrictor*

*Iguana iguana*

## Appendix E.

REGISTERED EXPORTATIONS OF ANIMAL PRODUCTS

YEAR	GROSS	NET	\$ VALUE FOB	OBSERVATIONS
1967	7.545	4.930	93.128	Carey, raw hides and skins for France, Italy and Japan.
1968	8.160	6.661	92.202	Carey, raw hides and skins for U.S.A., France, Italy and Japan.
1969	7.214	6.438	115.123	Carey, raw hides and skins for U.S.A., France and Italy.
1970	9.502	8.830	155.279	Carey, raw hides and skins for U.S.A., France and Italy.
1971	6.534	6.264	128.751	Carey, raw hides and skins for U.S.A., France and Italy.
1973	13.999	10.876	611.012	Carey only to Japan and Free Zone.
1974	8.894	6.749	252.670	Carey only to Japan and Free Zone.
1975	9.2381	7.130	239.888	Carey only to Japan and Free Zone.

Source: FAO, Forestry Sector Analysis 1978.

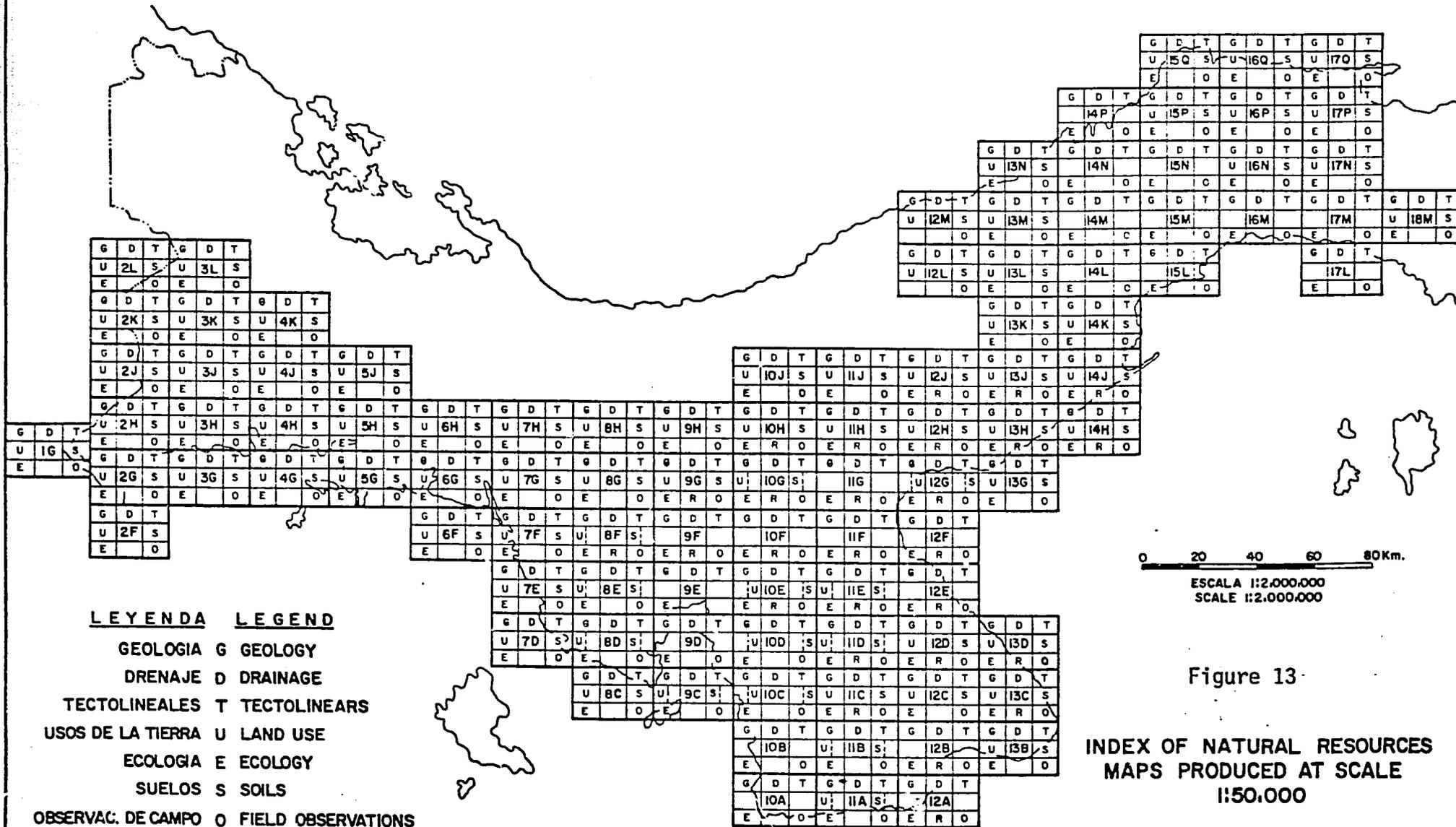
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## Appendix F.

## RENARE PERSONNEL IN 1977 AND 1979.

	<u>1977</u>	<u>1979</u>
Professionals	32	62
Technicians	48	139
Administrative support	28	80
Forest guards	25	57
Laborers	116	131
T O T A L	249	469

# REPUBLICA DE PANAMA



## LEYENDA LEGEND

- GEOLOGIA G GEOLOGY
- DRENAJE D DRAINAGE
- TECTOLINEALES T TECTOLINEARS
- USOS DE LA TIERRA U LAND USE
- ECOLOGIA E ECOLOGY
- SUELOS S SOILS
- OBSERVAC. DE CAMPO O FIELD OBSERVATIONS
- REGISTRO DE POZOS R REGISTERED WATER WELLS
- NUMERO DE HOJA 3G SHEET NUMBER

0 20 40 60 80km.

ESCALA 1:2.000.000  
SCALE 1:2.000.000

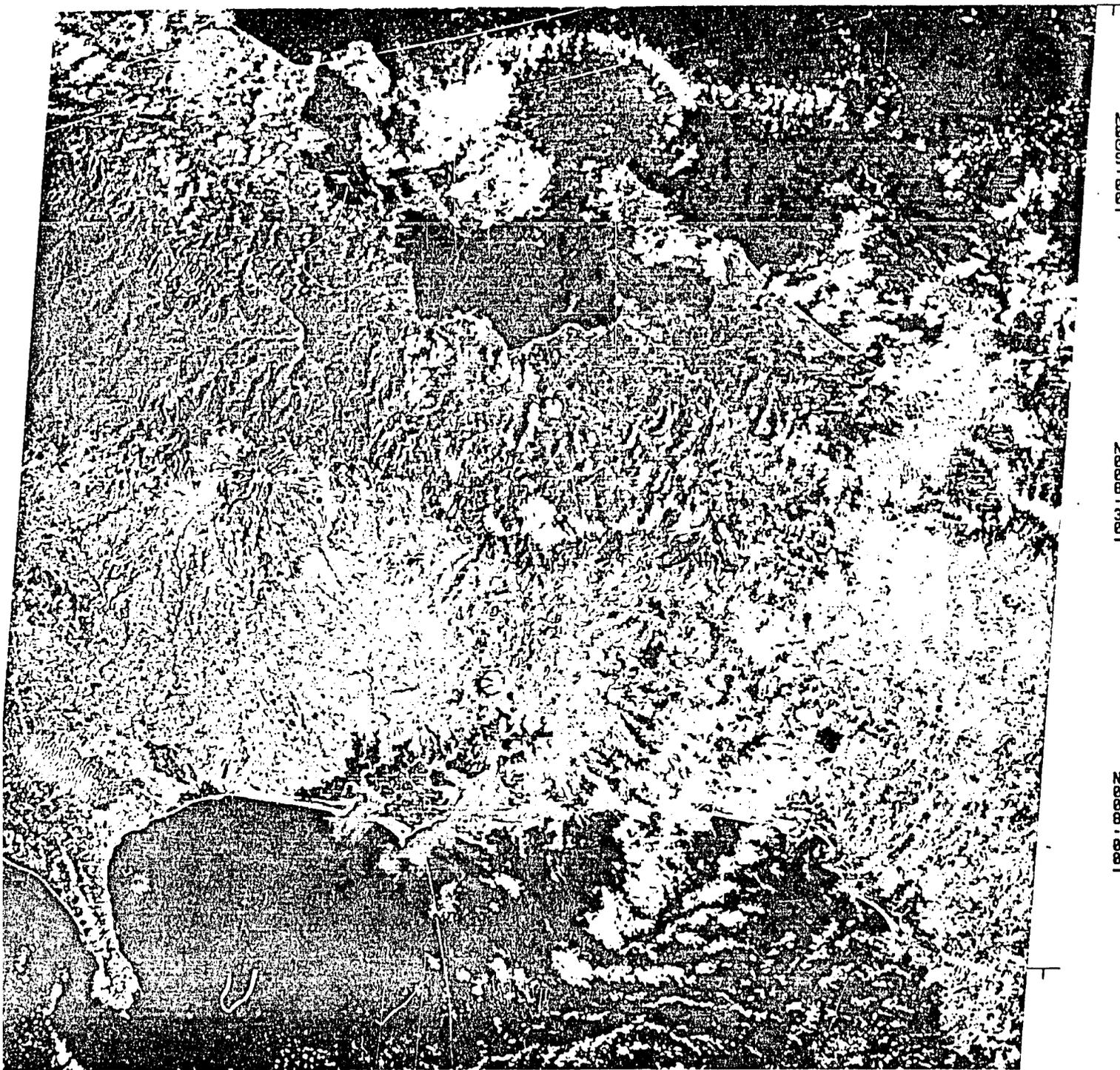
Figure 13

INDEX OF NATURAL RESOURCES  
MAPS PRODUCED AT SCALE  
1:50,000

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MAP 1

LANDSAT SATELLITE IMAGE OF WESTERN PANAMA



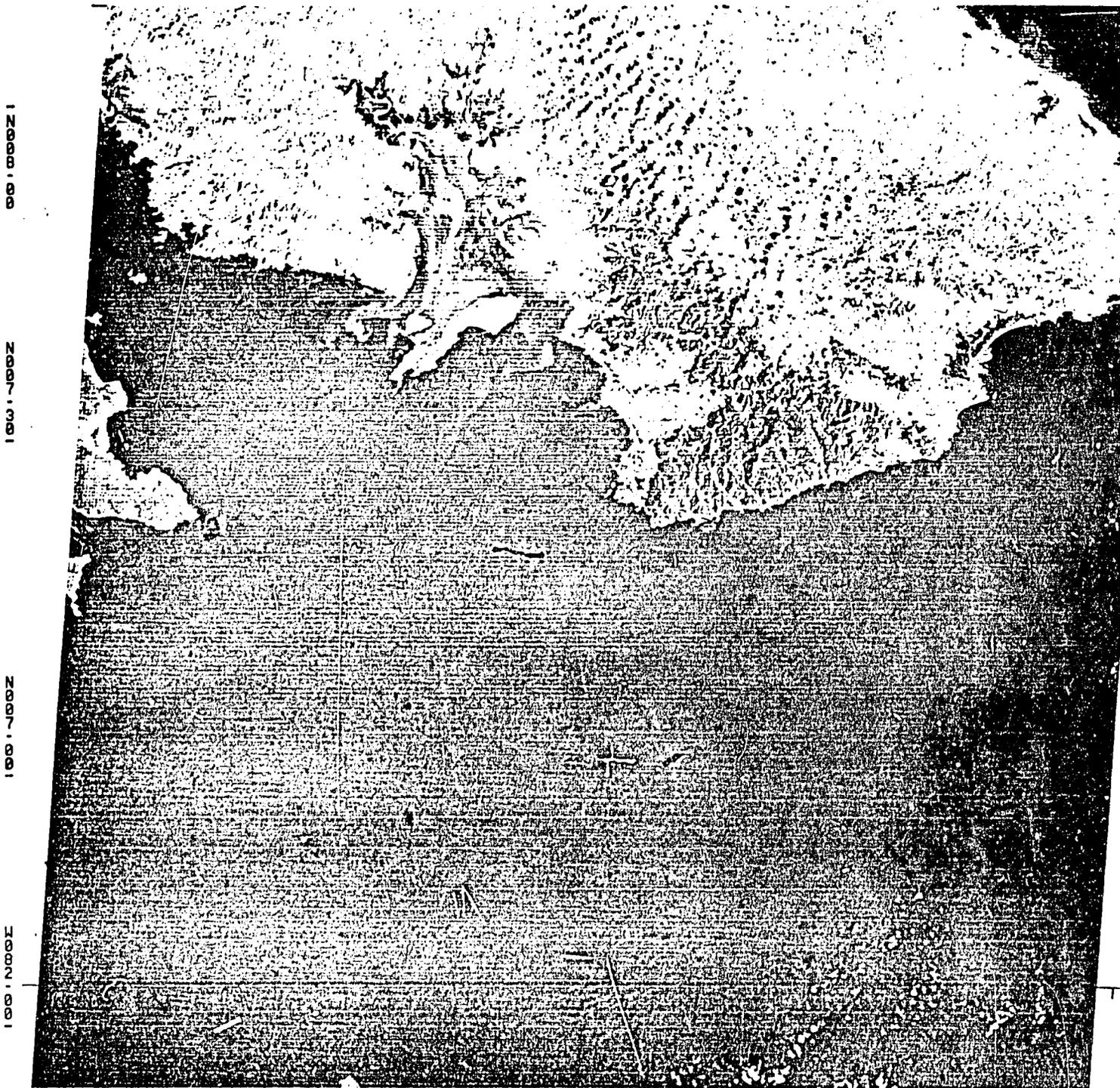
1000000  
1000000  
1000000

W082-301 W082-001  
30JAN79 C N08-39 W082-06 D014-054 N N08-38 W082-05 M 5 R SUN EL43 R124 SIS- P-N H2 NASA LANDSAT E-30331-15061-5

Landsat satellite image of western Panama (scale 1:1,000,000). Punta Burica can be seen at lower left and Laguna de Chiriquí and forested Bocas del Toro Province; the extensive mangroves near David; sedimentation discharge through the Bahía de Muertos; two extensive banana plantations north of Puerto Armuelles; and the prominent Volcán Barú

MAP 2

LANDSAT SATELLITE IMAGE OF SOUTHWESTERN AZUERO PENINSULA



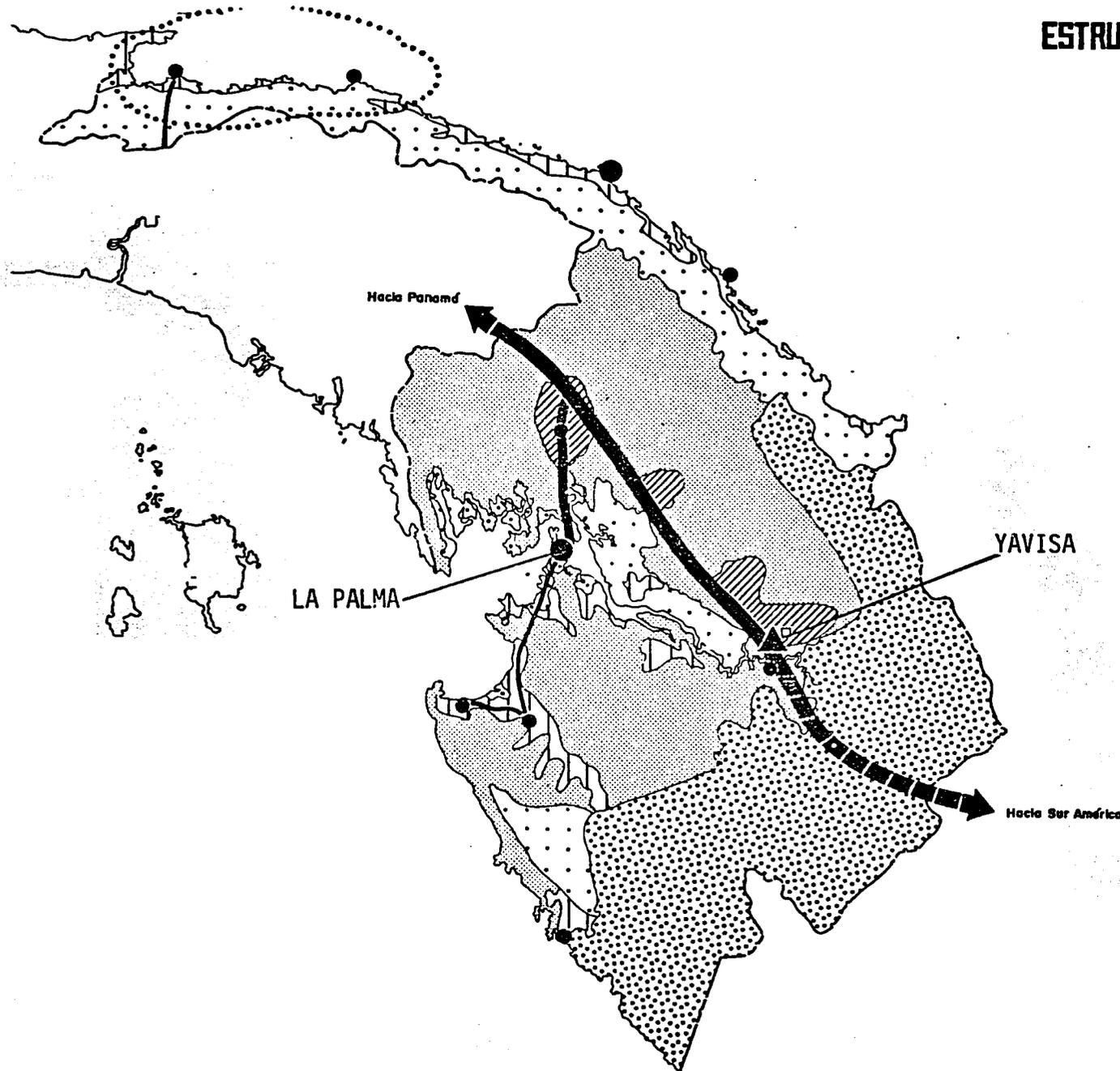
11JAN79 C N07-12/W000-58 D013-055 N N07-12/W001-00 M 5 W001-001 W000-301 W000-301  
R SUN EL42 A129 SIS- P-N H2 MASA LANDSAT E-30312-15005-5



Landsat satellite image of southwestern Azuero Peninsula (scale 1:1,000,000). Note the forest remnants on the southwestern part of the peninsula; mangroves east of Tonosí; and sedimentation discharged throughout the Golfo de Muertos.

# ESTRUCTURA ESPACIAL PARA EL AÑO 1990

Provincias Orientales: Darién y San Blas



### RED DE CENTROS URBANOS Y DE SERVICIOS

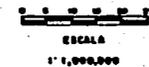
-  Principales Áreas Urbanizadas
-  Centros Nacionales y Regionales
-  Panamá
-  Primer Rango
-  Centros Sub-Regionales
-  Segundo Rango
-  Tercer Rango
-  Centros Locales
-  Cuarto Rango
-  Quinto Rango

### INFRAESTRUCTURA DE TRANSPORTE

-  Carretera de importancia Nacional.
-  Carretera de importancia Regional.
-  Carretera de importancia Local.
-  Puerto Internacional Principal.
-  Puerto de Cabotaje Principal.
-  Puerto de Pesca Internacional.
-  Aeropuerto Internacional de Pasajeros.
-  Aeropuerto de Carga.
-  Aeropuerto Interno Principal.
-  Terminal de Transporte Terrestre.
-  Canal de Panamá.
-  Terminal de Tránsito Petrolero.

### ACTIVIDADES ECONOMICAS

- Áreas Agrícolas**
-  Áreas de uso agrícola intenso.
-  Áreas de uso agrícola extensivo.
- Áreas Forestales**
-  Áreas de producción forestal.
-  Áreas de reforestación.
-  Parques nacionales y reservas forestales.
-  Otras áreas forestales.
- Industrias, Mina y Turismo**
-  Área Industrial.
-  Área Agroindustrial.
-  Mina de Carbón.
-  Principal Área Turística.

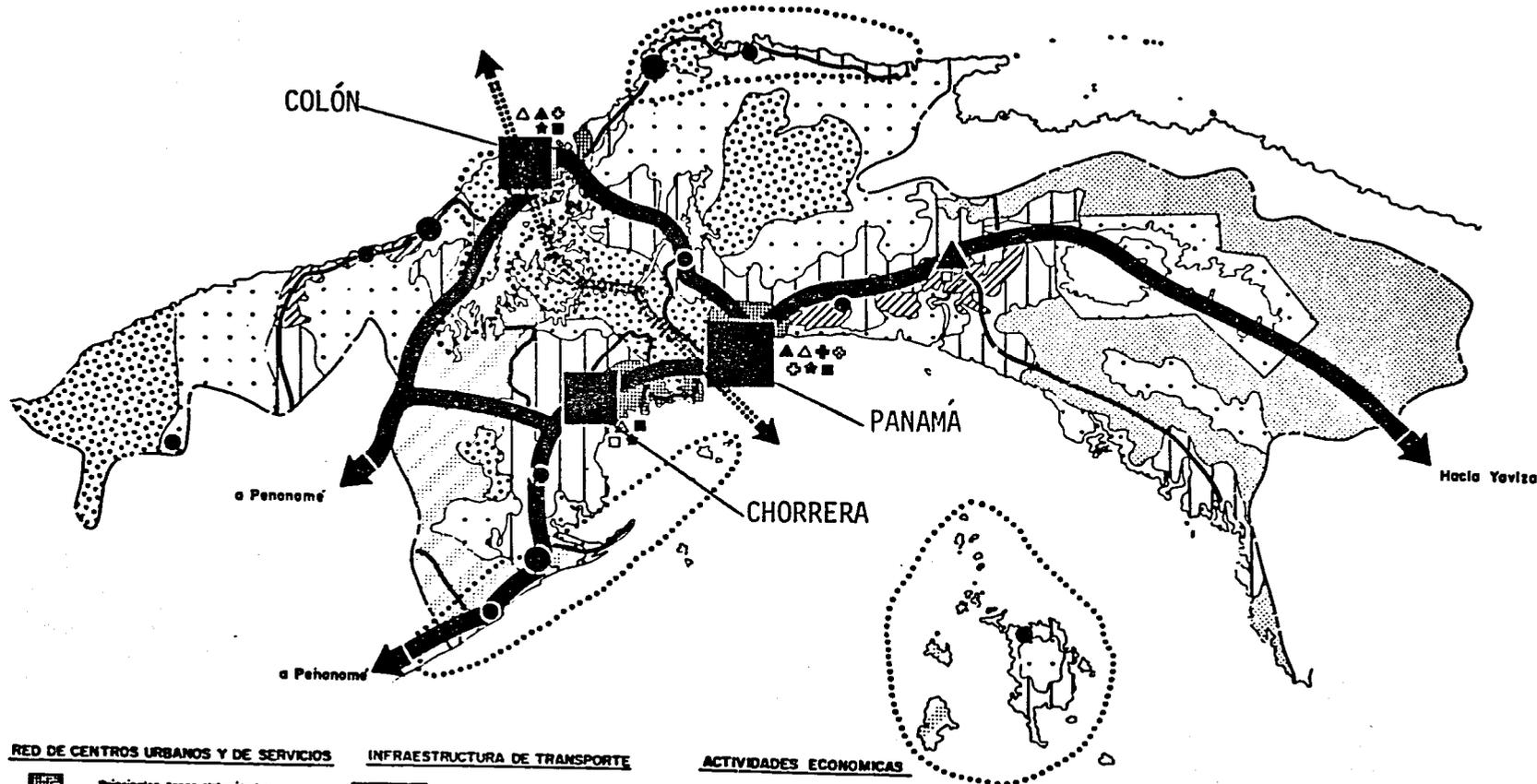


MAP 3

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# ESTRUCTURA ESPACIAL PARA EL AÑO 1990

Provincias Metropolitanas: Panamá y Colón



**RED DE CENTROS URBANOS Y DE SERVICIOS**

- Principales Áreas Urbanizadas
- Centros Nacionales y Regionales**
- Panamá
- Primer Rango
- Centros Sub-Regionales**
- Segundo Rango
- Tercer Rango
- Centros Locales**
- Cuarto Rango
- Quinto Rango

**INFRAESTRUCTURA DE TRANSPORTE**

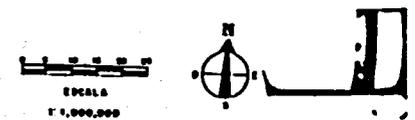
- Carretera de importancia Nacional.
- Carretera de importancia Regional.
- Carretera de importancia Local.
- Puerto Internacional Principal.
- Puerto de Cobalga Principal.
- Puerto de Pesca Internacional.
- Aeropuerto Internacional de Pasajeros.
- Aeropuerto de Carga.
- Aeropuerto Interno Principal.
- Terminal de Transporte Terrestre.
- Canal de Panamá.
- Terminal de Tránsito Petrolero.

**ACTIVIDADES ECONÓMICAS**

- Áreas Agrícolas**
- Áreas de uso agrícola intensivo.
- Áreas de uso agrícola extensivo.
- Áreas Forestales**
- Áreas de producción forestal.
- Áreas de reforestación.
- Parques nacionales y reservas forestales.
- Otras áreas forestales.
- Industrias, Minería y Turismo**
- Área Industrial.
- Área Agroindustrial.
- Mina de Oro.
- Principal Área Turística.

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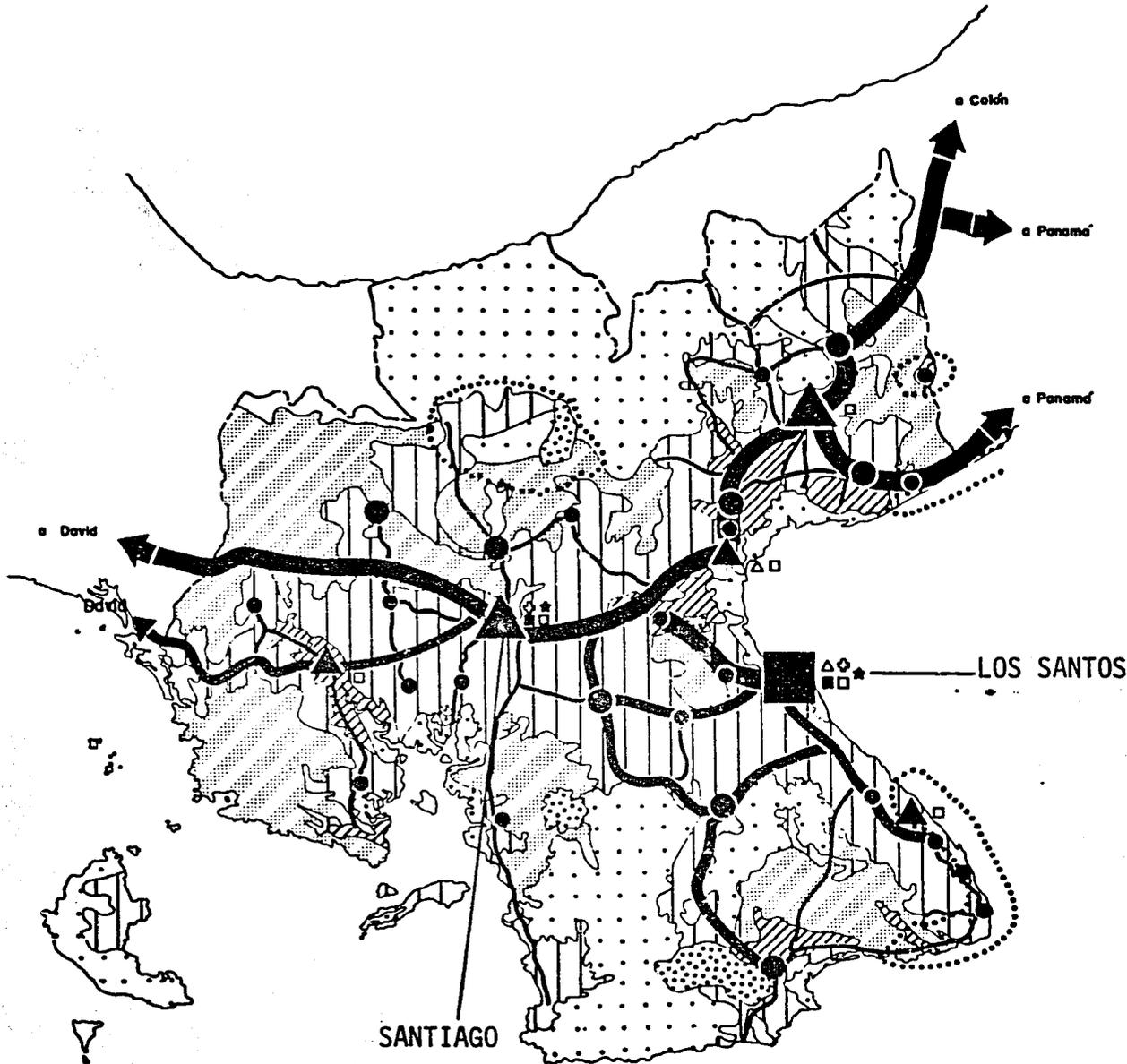
MAP 4



# MAP 5

## ESTRUCTURA ESPACIAL PARA EL AÑO 1990

### Provincias Centrales



#### RED DE CENTROS URBANOS Y DE SERVICIOS

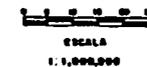
-  Principales Areas Urbanizadas
-  Centros Nacionales y Regionales
-  Primer Rango
-  Centros Sub-Regionales
-  Segundo Rango
-  Tercer Rango
-  Centros Locales
-  Cuarto Rango
-  Quinto Rango

#### INFRAESTRUCTURA DE TRANSPORTE

-  Carretera de importancia Nacional
-  Carretera de importancia Regional
-  Carretera de importancia Local
-  Puerto Internacional Principal
-  Puerto de Cabotaje Principal
-  Puerto de Pesca Internacional
-  Aeropuerto Internacional de Pasajeros
-  Aeropuerto de Carga
-  Aeropuerto Interno Principal
-  Terminal de Transporte Terrestre
-  Canal de Panama
-  Terminal de Traslado Petrolero

#### ACTIVIDADES ECONOMICAS

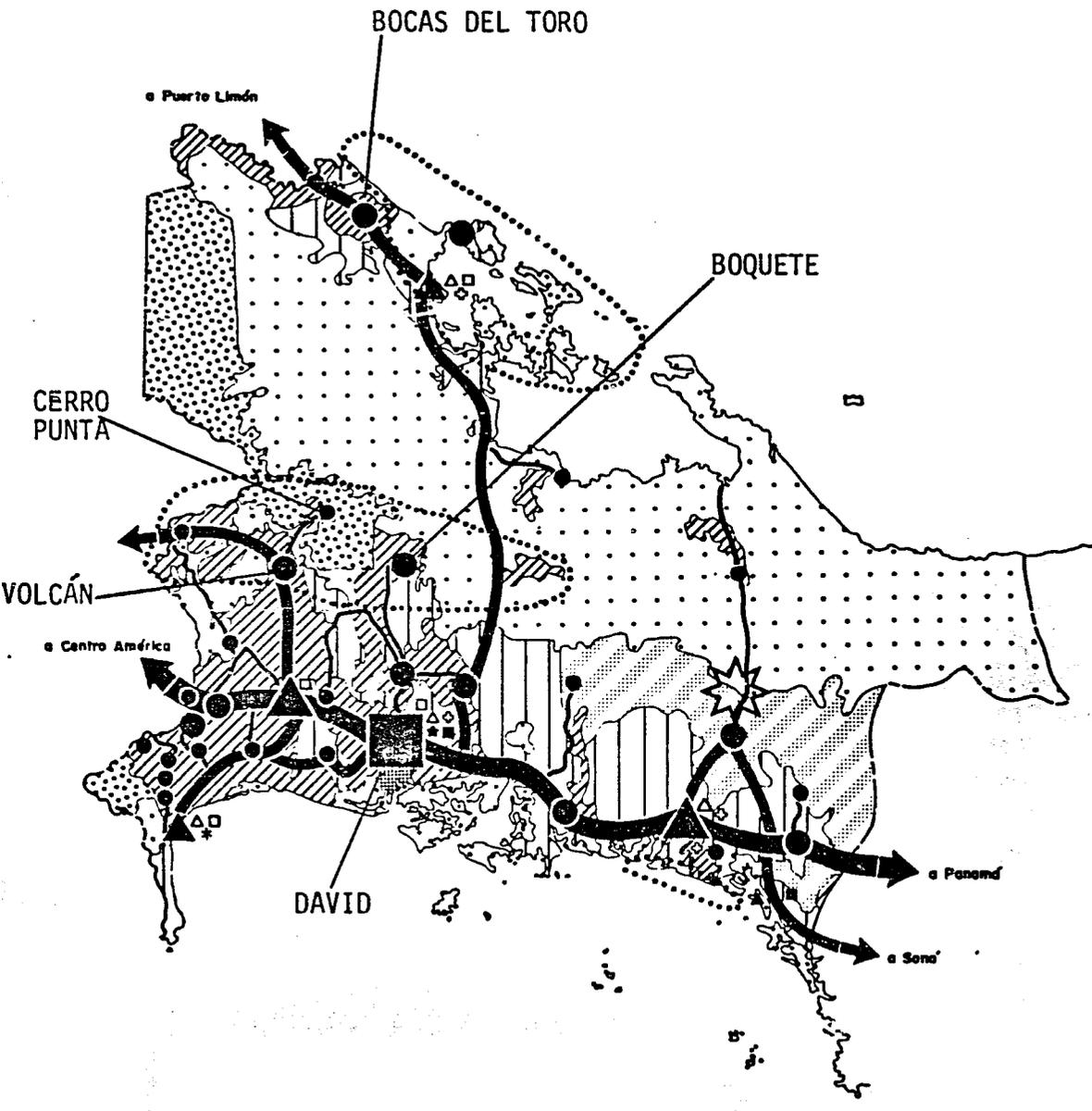
- Areas Agricolas**
  -  Areas de uso agricolo intensivo
  -  Areas de uso agricolo extensivo
- Areas Forestales**
  -  Areas de produccion forestal
  -  Areas de reforestacion
  -  Parques nacionales y reservas forestales
  -  Otras areas forestales
- Industrias, Mina y Turismo**
  -  Area Industrial
  -  Area Agroindustrial
  -  Mina de Cobre
  -  Principal Area Turistica



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# ESTRUCTURA ESPACIAL PARA EL AÑO 1990

Provincias Occidentales : Chiriquí y Bocas del Toro



### RED DE CENTROS URBANOS Y DE-SERVICIOS

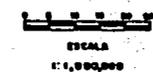
- Principales Áreas Urbanizadas
- Centros Nacionales y Regionales**
- Panamá
- Primer Rango
- Centros Sub-Regionales**
- Segundo Rango
- Tercer Rango
- Centros Locales**
- Cuarto Rango
- Quinto Rango

### INFRAESTRUCTURA DE TRANSPORTE

- Carretera de importancia Nacional.
- Carretera de importancia Regional.
- Carretera de importancia Local.
- Puerto Internacional Principal.
- Puerto de Cabotaje Principal.
- Puerto de Pesca Internacional.
- Aeropuerto Internacional de Pasajeros.
- Aeropuerto de Carga.
- Aeropuerto Interno Principal.
- Terminal de Transporte Terrestre.
- Canal de Panamá.
- Terminal de Tránsito Petrolero.

### ACTIVIDADES ECONOMICAS

- Áreas Agrícolas**
- Áreas de uso agrícola intensivo
- Áreas de uso agrícola extensivo
- Áreas Forestales**
- Áreas de producción forestal.
- Áreas de reforestación.
- Parques nacionales y reservas forestales.
- Otras áreas forestales.
- Industrias, Mina y Turismo**
- Área Industrial.
- Área Agroindustrial.
- Mina de Cobre.
- Principal Área Turística.



MAP 6

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