DRAFT

Environmental Profile

of

EL SALVADOR

prepared by the

Arid Lands Information Center
Office of Arid Lands Studies
University of Arizona
845 North Park Avenue
Tucson, AZ 85719

National Park Service Contract No. CX-0001-0-0003
with U.S. Man and the Biosphere Secretariat
Department of State
Washington, DC

March 1982

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THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE
Department of State, IO/UCS
WASHINGTON, D. C. 20520

An Introductory Note on Draft Environmental Profiles:

The attached draft environmental report has been prepared under a contract between the U.S. Agency for International Development (AID), Office of Forestry, Environment, and Natural Resources (ST/FNR) and the U.S. Man and the Biosphere (MAB) Program. It is a preliminary review of information available in the United States on the status of the environment and the natural resources of the identified country and is one of a series of similar studies now underway on countries which receive U.S. bilateral assistance.

This report is the first step in a process to develop better information for the AID Mission, for host country officials, and others on the environmental situation in specific countries and begins to identify the most critical areas of concern. A more comprehensive study may be undertaken in each country by Regional Bureaus and/or AID Missions. These would involve local scientists in a more detailed examination of the actual situations as well as a better definition of issues, problems and priorities. Such "Phase II" studies would provide substance for the Agency's Country Development Strategy Statements as well as justifications for program initiatives in the areas of environment and natural resources.

Comments on the attached draft report would be welcomed by USMAB and ST/FNR and should be addressed to either:

James Corson
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Washington, D.C. 20520

OR

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Office of Forestry, Environment, and Natural Resources
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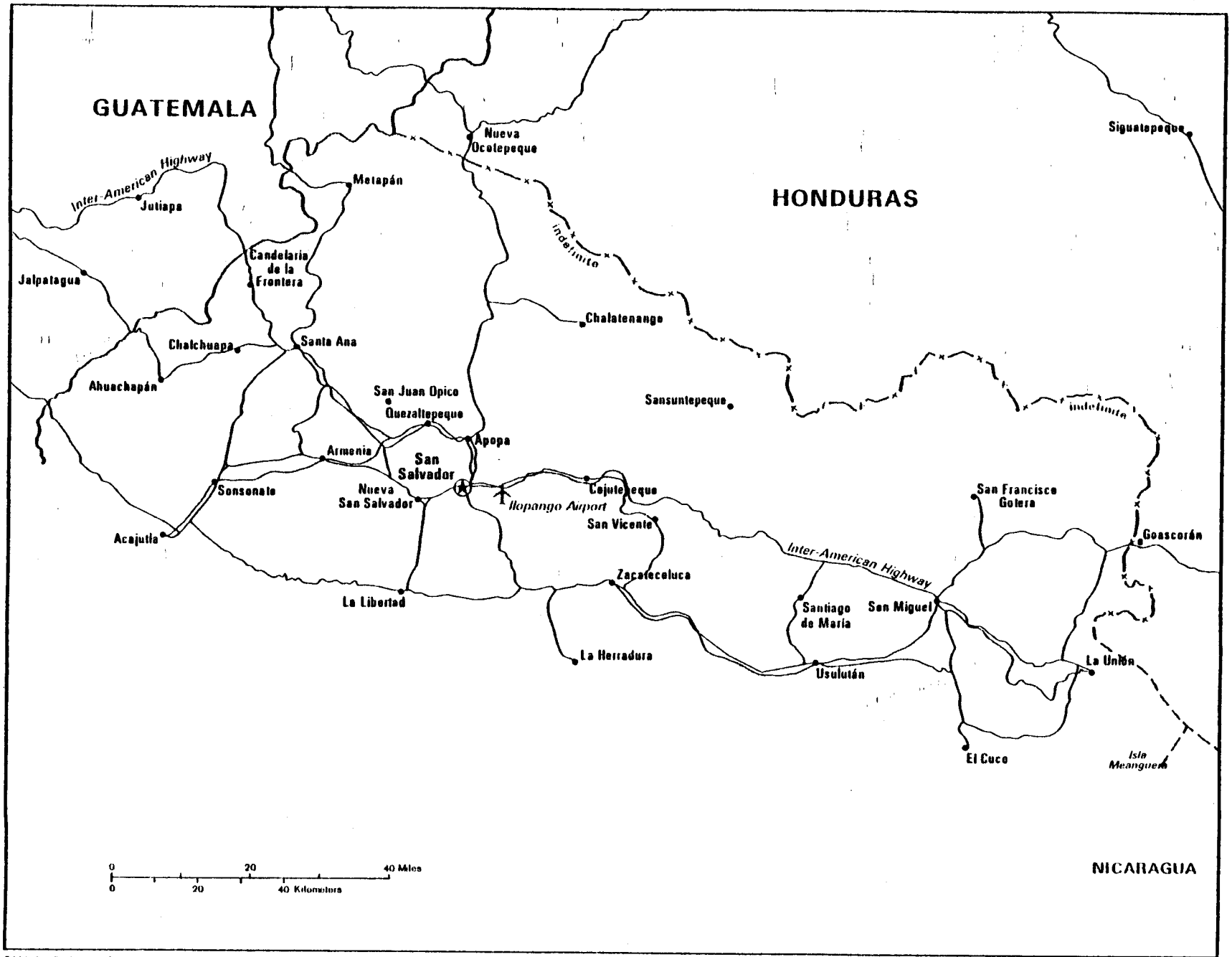
El Salvador



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Lambert Conformal Projection
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SUMMARY

El Salvador is Central America's smallest and most densely populated country. It also has the highest proportion of rural inhabitants and among the lowest per capita income. According to U.S. AID (1980) sources, the majority of Salvadorans are hungry, illiterate, infested with parasites, malnourished, poorly housed, underemployed, and have little opportunity for self-improvement. There is also high illiteracy, a chronic housing shortage and a higher percentage of labor underutilization in the agriculture sector than anywhere else in the Western Hemisphere. Coupled with this dismal social and economic situation are environmental problems of enormous magnitude, including almost complete deforestation, massive soil erosion and loss of soil fertility, siltation threatening hydropower developments, large-scale extinction of flora and fauna, diminishing groundwater resources, deteriorating water quality, and widespread health-threatening environmental pollution.

El Salvador's economy traditionally has been based on agriculture; the majority of the most fertile land is owned by a privileged minority. This sector has emphasized cash crops for export, formerly indigo and coffee, now cotton, sugarcane, coffee, and, to a lesser extent, cattle. By contrast, subsistence food crops, grown primarily by the land-poor, or land-less, and on the poorest and most marginal soils, have been inadequate to feed El Salvador's burgeoning population, which is now expected to double within 20 years. This imbalance of land ownership, and extensive (rather than intensive) use of the land by the wealthy minority, combined with overpopulation, an energy-poor natural resource base, misuse and destruction of natural resources, and festering social and economic problems are viewed as major factors contributing to the ruinous environmental situation found in El Salvador today. Major civil disorder now disrupts or threatens to disrupt almost every facet of Salvadoran life. As a result of these problems, more than 35,000 people have been killed since 1979 and no progress on any environmental issues is expected until civil order is restored and economic and political conditions are stabilized.

The most important environmental problems in El Salvador are:

1) Deforestation. This is probably El Salvador's most serious environmental problem, not only because it represents the loss of a major natural resource, but also because it has led to many other serious environmental problems. Although forests once covered more than 90 percent of the country, less than 15 percent of the forest cover remains and most of this is highly degraded. Less than 2 percent is believed to be undisturbed. Commercial forestry has vanished. This once valuable resource has been burned and wasted -- a process encouraged by cultural traditions, inappropriate land tenure laws, a lack of economic

incentives, uncontrolled population growth, and inequitable ownership of land. Reforestation efforts have been almost nonexistent.

2) Soil Degradation. This is one of the major consequences of deforestation, and has been markedly accelerated in El Salvador by the fragility of Salvadoran soils, steep terrain and reckless cultivation of marginal areas. Soils over large sections of the northern mountains have been irreversibly destroyed by erosion, gully formation and laterization. Soil loss or damage also has been extensive in the volcanic coastal cordillera, although coffee plantations with a forest overstory have provided a substantial buffer in portions of this zone. Soil loss or damage in El Salvador is believed to represent a serious threat to any meaningful economic recovery of the agriculture sector.

3) Loss of Water Quality. Water quality is already a serious environmental problem and will become increasingly serious in the future. The problem stems from a variety of complex and interrelated factors including deforestation, soil erosion, and environmental pollution. River water pollution threatens drinking water supplies; deforestation and lack of watershed management is leading to depleted groundwater supplies and uncontrolled flooding.

4) Loss of Native Flora and Fauna. The loss in this category is incalculable. Almost all economically important species are now extinct, and there is little hope for successful reintroductions because forest remnants are highly fragmented and subject to constant human pressure. Even populations of once common species may eventually disappear because forest and woodland reserves are now very small and isolated. This may result in limited gene flow and may eliminate the "buffering" effect from perterbations that populations enjoy in large refugia.

5) Environmental Pollution. This is a problem that now permeates almost every facet of Salvadoran life. It includes toxic chemical buildup in soil, livestock, humans and ecological foodchains, and urban waste disposal associated with urban centers, overpopulation, and resettlement. A beleaguered economy, civil strife, lack of governmental legislation, inability to enforce existing laws, and public ignorance are only a few of the factors that permit environmental pollution to continue increasing at an alarming rate.

1.0 Introduction

This draft environmental profile summarizes information available in the United States on the natural resources and environment of El Salvador. The report reviews the major environmental problems of El Salvador and the impact of the development process upon resources and the environment. This draft report represents the first step in developing an environmental profile for use by the U.S. Agency for International Development (U.S. AID) and Salvadoran government officials. The next step in this process should be a field study to evaluate the information presented here, to obtain additional information, and to define the issues, problems, and priorities in greater detail. This entire process should help provide direction in future efforts to deal with the management, conservation, and rehabilitation of the environment and natural resources.

The information and interpretations in this report are preliminary and are not intended to attain the detail and accuracy required for development planning. The report represents a coperative effort by the Man and the Biosphere (MAB) project staff of the Arid Lands Information Center (ALIC). Sections 2.1 (geography), 2.2 (population) and the research for Section 2.3.1 (land use background) were prepared by James R. Silliman; the remaining setions were completed by Steven L. Hilty. The report was edited by Anna Elias-Cesnik. The resources of ALIC, the University of Arizona Library, and the cooperation of James Corson, AID/MAB Project Coordinator, and other AID personnel are gratefully acknowledged.

Comments on the attached draft report would be welcomed by USMAB and DS/ST and should be addressed to either:

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2.0 General Description

2.1 Geography [1]

Located on the Pacific slope of Central America between 13° and 14°30' north latitude, El Salvador is the smallest Central American nation and the only one without a Caribbean coast. El Salvador's area, amounting to just over 21,000 square km, forms a rough rectangle bordered to the west and north by Guatemala, to the north and east by Honduras, and to the south by the Pacific Ocean. The only islands of significant size are off the southeast coast in the Gulf of Fonseca. Most of the country consists of volcanic uplands of moderate elevation, which are an eastward extension of the southern highlands of Guatemala.

2.1.1 Land Forms

The complex topography of El Salvador, shown in Figure 1, can be divided into five general landform categories: 1) coastal plains; 2) coastal ranges; 3) interior valley; 4) Pacific volcanic chain; and 5) northern mountain ranges.

Coastal Plains. Along the Pacific coast are two areas of low-lying coastal plains, composed of alluvial deposits, spits, and mangrove swamps. One coastal plain, at the western end of the coast and surrounding the port town of Acajutla, is an eastward extension of the Guatemalan coastal plain. The second plain from the central to east-central coast, surrounds the lower reaches of the rivers Jiboa, Lempa, and Grande de San Miguel. Altogether, coastal plains occupy about 10 percent of El Salvador's area.

Coastal Ranges. The coastal plains are interrupted in two areas by coastal ranges. One range, just west of La Libertad, separates the two coastal plain regions described above, while the second range occupies the easternmost coastline. These ranges are built up from Pliocene volcanic rocks, but contain only a few recent volcanos.

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[1] Sources: American University. 1979.
Brooks and Candy. 1981.
Osborne. 1956.
U.S. OFDA. 1980.
Weyl. 1980.

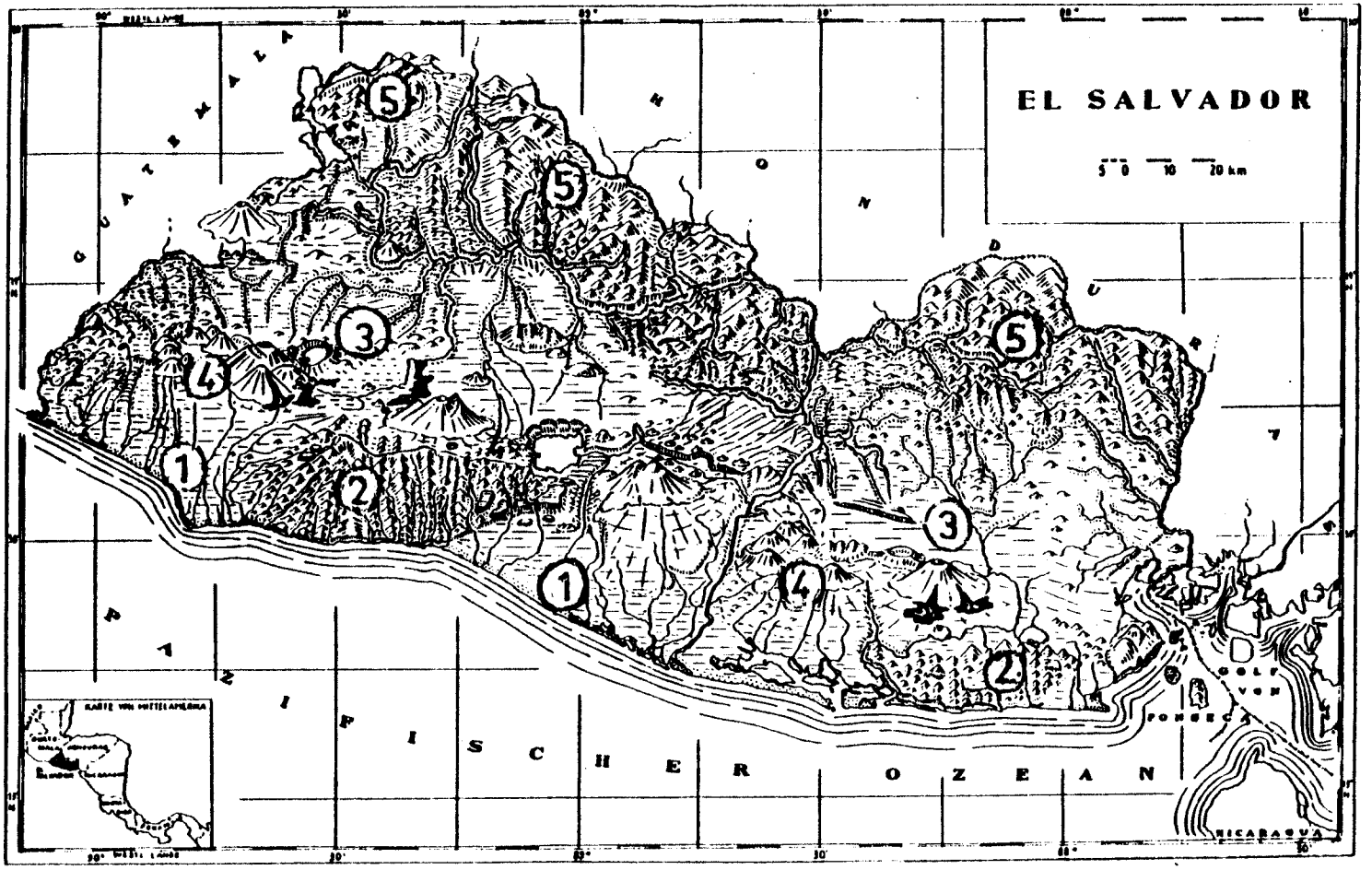

Figure 1. Landforms. 1) Coastal Plains; 2) Coastal Ranges; 3) Interior Valley; 4) Pacific Volcanic Chain; 5) Northern Mountain Ranges

Source: Weyl. 1980.

Interior Valley. North of the Pacific volcanic chain and surrounding several outlying volcanos is the interior valley, a heterogeneous area composed of low intermountain basins. The largest of these basins surrounds the Rio Lempa north of the capital city of San Salvador; another surrounds the Rio Grande de San Miguel near Lake Olomega in the southeast. The Inter-American Highway passes through the interior valley region, which contains most of the major cities and towns. Elevations in this area range from 400 m to 800 m. San Salvador's elevation is just over 600 m. The interior valley covers about 25 percent of the country.

Pacific Volcanic Chain. Just inland of the coastal ranges lies a more or less continuous chain of volcanic cones running the length of the country. This volcanic chain includes most of the recent and active volcanos in El Salvador (Section 2.1.2), and the highest peaks in the south, such as Santa Ana (2,381 m), San Vicente (2,173 m), and San Miguel (2,132 m). The Pacific volcanic chain is often grouped with the coastal ranges as one large southern mountain chain. The average elevation of this entire southern highlands area is about 1,200 m and occupies about 30 percent of the country.

Northern Mountain Ranges. Mountain ranges north of the interior valley and extending along the northern border are built up of Tertiary volcanics, plutonic rocks, and, in the far northwest, sediments. Only a few scattered recent volcanos are present. The northern mountain ranges include the highest elevations in El Salvador, averaging from 1,500 to 2,000 m. The country's highest point, 2,730 m, is reached at Cerro El Pital on the northwestern border with Honduras. The northern mountains cover about 15 percent of El Salvador.

2.1.2 Volcanos and Seismic Activity

According to Weyl (1980), there are 180 volcanos of various sizes and ages in El Salvador. However, most of these are extinct, and only about 20 are large enough to be mentioned by general texts (e.g., U.S. OFDA 1980; Encyclopaedia Brittanica 1979). The distribution of volcanos in El Salvador is shown in Figure 2; 17 of the most important volcanos are listed in Table 1.

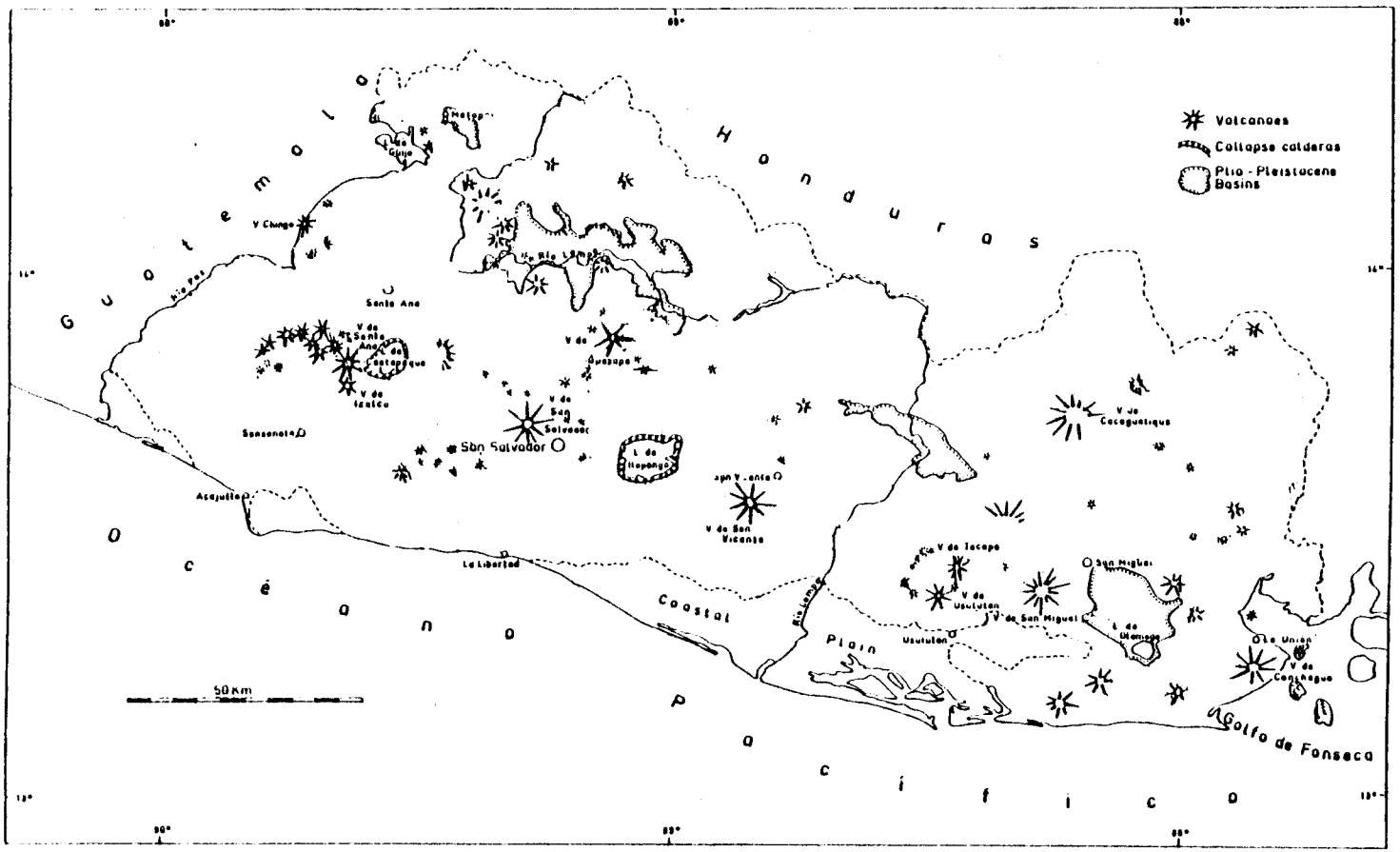

Figure 2. Distribution of Volcanoes

Source: Weyl. 1980.

Table 1. Major Volcanos, Northwest to Southeast

Name	Coordinates North	Coordinates West	Elevation (M)	Status
Cerro Grande de Apaneca	13°50'	89°49'	1,854	Extinct
Laguna Verde	13°54'	89°47'	1,851	Extinct
Cerro Los Naranjos	13°52'	89°41'	1,984	Extinct
Santa Ana (Ilamatepec)	13°51'	89°38'	2,381	Active[1]
Izalco	13°49'	89°38'	1,965	Active
Cerro Verde	13°50'	89°37'	2,024	Extinct
San Marcelino	13°48'	89°35'	1,324	Active
San Salvador (Quezaltepeque)	13°44'	89°17'	1,967	Active
San Vicente (Chichontepeque)	13°77'	88°51'	2,173	Active
Tecapa	13°30'	88°33'	1,592	Active
Usulután	13°25'	88°28'	1,453	Extinct
Chinameca	13°28'	88°20'	1,228	Active
San Miguel (Chaparrastique)	13°26'	88°16'	2,132	Active
Conchagua	13°17'	87°50'	1,250	Extinct
San Diego	14°17'	89°29'	780	Extinct
Guazapa	13°54'	89°07'	1,438	Extinct
Cacaguatique	13°45'	88°12'	1,500	Extinct

[1] "Active" refers to any historical activity.

Source: Weyl. 1980.

Only eight volcanos have shown significant activity in historic times (Table 1):

Santa Ana. Violent eruptions in 1576, 1847 and 1880; mild eruptions in 1904 and 1937; fumarolic activity until 1955.

Izalco. Formed since 1770 by very frequent eruptions, last major eruption in 1926; known as "Lighthouse of the Pacific" for the visibility of its flares from offshore.

San Marcelino. Eruptions in 17th century and in 1722 (?).

San Salvador. Crater lake drained in 1917 by seismic disturbance and eruption, with formation of small cinder cone and lava flow.

San Vicente. Active fumaroles and solfataras.

Tecapa. Active fumaroles and solfataras.

Chinameca. Active fumaroles and solfataras.

San Miguel. Frequent eruptions since 1586; major eruption in 1787 formed lava flow now called La Malpaicera; last major eruption in 1844.

The principal zone of earthquakes in Central America lies along the Pacific coast and coincides with the zone of recent volcanic activity. Both volcanic and seismic activity in El Salvador are caused by movements of two plates of the earth's crust which meet along this zone: The Cocos Plate to the west, and the Caribbean Plate to the east. Figure 3 summarizes seismic activity during the last 300 years in El Salvador and adjacent nations lying on the active zone. The capital city of San Salvador was destroyed by a major earthquake in 1854, and has suffered several smaller earthquakes since then. The most recent earthquake of importance occurred on May 3, 1965. This earthquake caused the death of 110 people, left 91,000 people homeless, and caused damages amounting to $35 million. In 1951, another serious earthquake at the town of Jacuapa left 1,000 people dead.

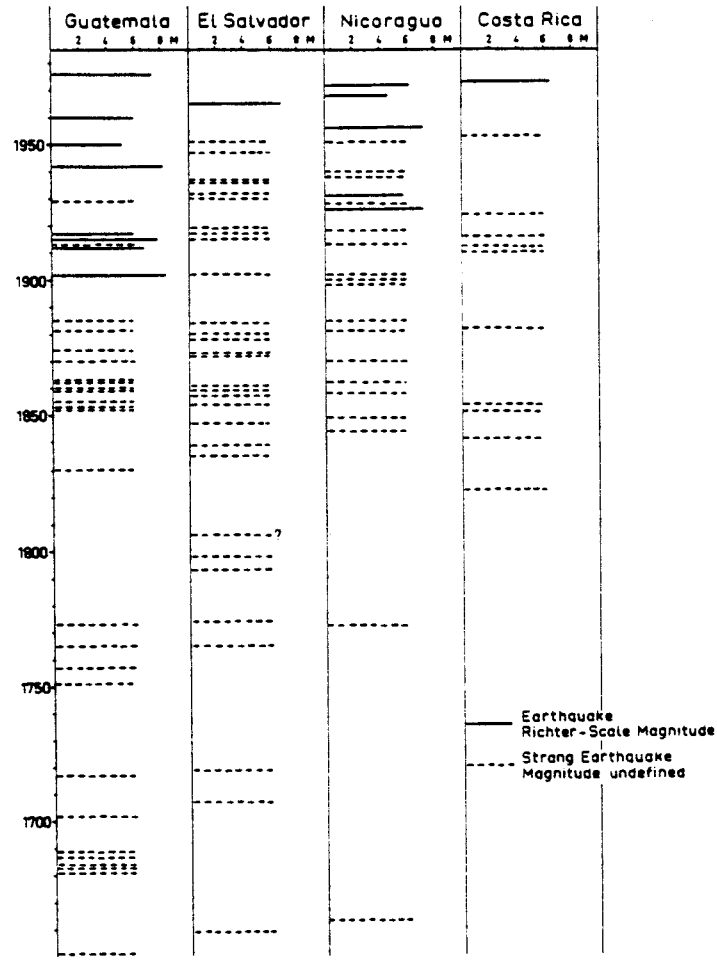

Figure 3. Central American Earthquakes, 1650 - 1980

Source: Weyl. 1980.

2.1.3 Rivers and Lakes

The Rio Lempa (Figure 4) is the major river of El Salvador and is the longest river in Central America. It stretches 254 km from its headwaters in the rugged hills near Esquipulas, Guatemala, to its mouth on the Pacific coast of El Salvador. The Rio Lempa enters El Salvador on the northwestern border with Honduras, flows south about 50 km, then eastward for 130 km across the northern edge of the interior valley, and finally cuts southward to the Pacific coast. The Lempa was dammed in 1954 at the 5 de Noviembre hydroelectric dam southeast of Chalatenango, but the reservoir is rapidly filling with sediment; another hydroelectric dam is under construction at Cerron Grande, 17 km upstream (Goodland 1973). The Lempa floods in many places during the wet season, but during the dry season many sections are almost dry. The river is navigable only for short, disconnected stretches; the longest navigable stretch is about 40 km for shallow-draft vessels. Other major river systems (Osborne 1456) include the Rio de Paz in the west (56 km), the Rio Jiboa in the south-central region (70 km) and the Rio Grande de San Miguel in the east (72 km).

Besides the artificial lake behind the 5 de Noviembre Dam on the Rio Lempa, El Salvador is dotted with 22 natural lakes, either in volcanic craters or intermontane basins. The largest of these lakes is Lago de Guija on the northwestern border with Guatemala. Its surface covers about 300 square km. The second largest lake is Lago de Ilopango (75 square km), just east of San Salvador. It fills a crater of volcanic origin. In 1880, a volcanic island formed on the center of Lago de Ilopango; it is now 50 m high (Osborne 1956). Other major lakes are Contepeque (40 square km), in western El Salvador, south of Santa Ana, and Olomega (18 square km) in the southeast, which drains into the Rio Grande de San Miguel (Goodland 1973).

2.2 Climate [2/]

Because El Salvador is small and compact, is exposed entirely to the Pacific coast, and does not have extreme

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[2] Sources: American University. 1979.
Daugherty. 1974.
U.S. OFDA. 1980.

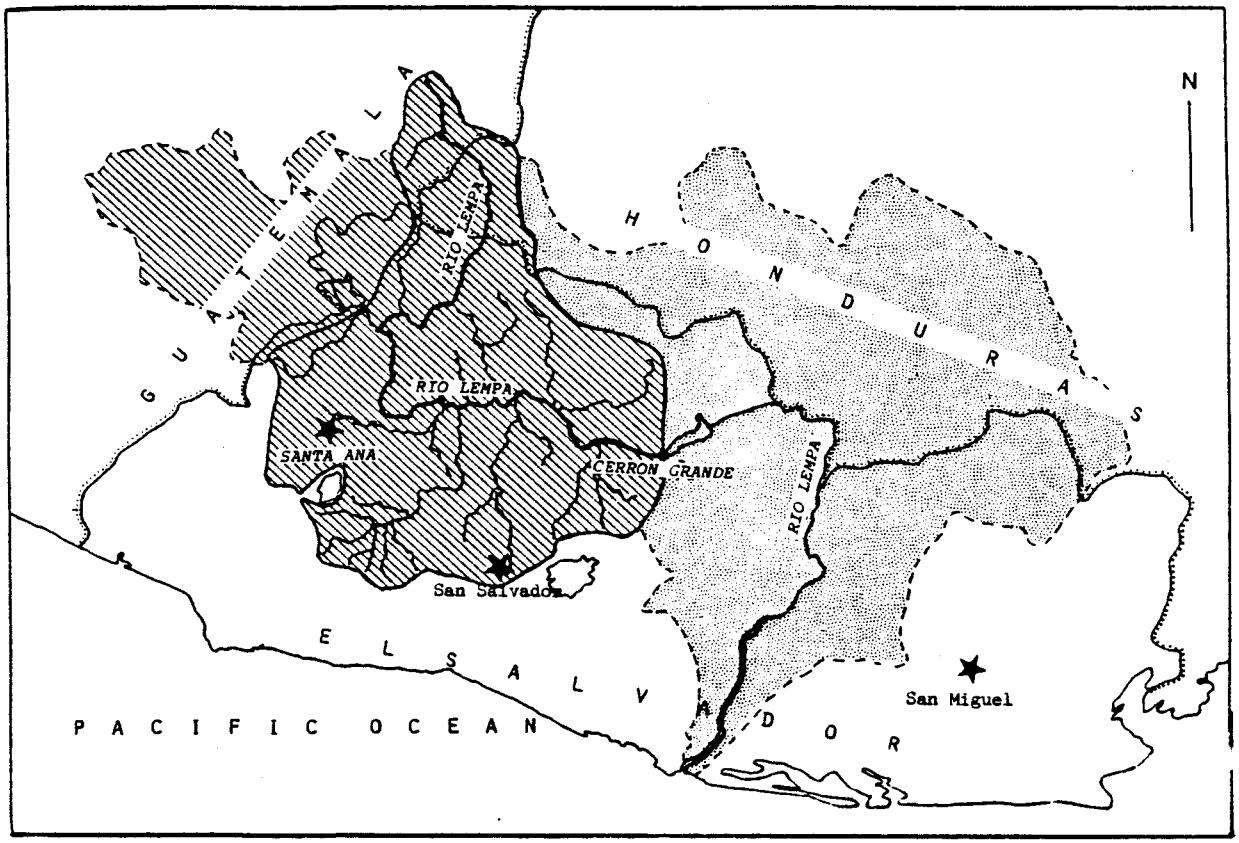

Figure 4. Rio Lempa Watershed (shaded area). Diagonal Striping = Watershed above Cerron Grande Dam; unmarked = remaining watershed

Source: Goodland. 1973.

variations in elevation, its climate is relatively uniform. The rainy season lasts six months, from May to November, when about 90 percent of the total annual precipitation falls. Average annual rainfall varies from 1,500 to 2,000 mm, with heaviest rainfall on the coast, and drier conditions in the northern mountains (Table 2). The wettest months are June, July and September, when persistent overcast brings heavy rains lasting for several days or even weeks.

Temperature varies more directly with elevation. The average annual temperature at the port town of Acajutla (elevation 5 m) is 26.8°C, while Santa Ana (elevation 725 m) averages 22.8°C (Table 3). Seasonal variation in temperature is not extreme. The coldest winter months, December and January, are just 2°C or 3°C cooler than the warmest summer months at the end of the dry season in April and May (Table 3).

El Salvador is rarely subjected to damaging tropical storms. It is protected from hurricanes arising in the Gulf of Mexico, and Pacific storms generally pass northward and offshore to the west. In 1969, one hurricane struck the southwest coast doing damage estimated at $1.6 million (U.S. OFDA 1980). Occasional gales of high-pressure polar air blow down from the north, causing minor damage to crops and habitations.

2.3 Population

2.3.1 Cultural and Historical Background 3/

At the time of the Spanish conquest, the area that is now El Salvador was inhabited by the Pipil, a tribe of nomadic Nahuatl people originally from Mexico. About 3,000 B.C., the Nahuatl migrated into Central America, and the Pipil tribe settled in present-day El Salvador and in small areas of Honduras and Nicaragua. Although not as advanced as the Maya, the Pipil had a relatively well-developed culture related to that of the Aztecs. Primarily an agricultural people, the Pipil also built a number

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3 Sources: American University. 1979.
Browning. 1971.
U.S. Dept. of State. 1981.

Table 2. Average Monthly and Annual Rainfall at Selected Stations (mm)

Station	Elevation (m)	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Metapan	465	36	0	.	1	50	180	300	250	240	310	170	20	10	1,530
Santa Ana	645	34	.	.	.	70	210	330	330	320	370	190	30	.	1,850
Izalco	380	12	0	.	1	60	250	320	350	350	440	350	60	10	2,190
Sonsonate	225	51	.	.	.	50	190	340	300	300	360	300	30	.	1,870
Acajutla	5	52	.	.	.	50	170	300	280	260	320	270	40	.	1,690
Ateos	470	28	.	.	.	60	160	280	290	270	300	150	30	.	1,540
San Andrés	475	20	.	.	.	60	200	290	340	270	390	160	40	.	1,750?
Santa Tecla	955	25	.	.	.	50	160	330	330	310	320	240	40	.	1,780?
San Salvador	700	55	.	.	.	50	190	320	320	300	340	230	40	.	1,790?
Ilopango	615	19	.	.	.	50	180	290	370	300	370	260	30	.	1,850?
Cojutepeque	800	39	.	.	.	40	200	380	390	350	370	260	50	.	2,040
Chorrea del Guayabo	190	14	.	.	.	80	260	360	380	320	350	240	50	.	2,040
San Vicente	425	39	.	.	.	40	210	360	360	340	390	280	50	.	2,030?
Zacatecolucal	170	39	.	.	.	40	250	400	350	340	470	360	60	10	2,280?
Santa Cruz Porrillo	30	35	.	.	.	30	180	300	280	260	350	280	50	.	1,730
Usulután	70	37	.	.	.	20	90	360	300	280	400	350	60	.	1,860
San Miguel	105	35	.	.	.	20	200	300	250	250	370	290	40	.	1,720
Olomega	65	39	.	.	.	20	210	300	220	230	410	320	40	.	1,750
Cutuco	5	39	.	.	.	30	250	360	190	240	450	330	50	.	1,900

A period (.) indicates less than 10 mm.

Source: Daugherty. 1974.

Table 3. Average Monthly and Annual Temperatures at Selected Stations (°C)

Station	Elevation (m)	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Acajutla	5	12	25.8	26.5	27.3	28.3	28.0	27.0	26.9	26.9	26.4	26.4	26.4	25.9	26.8
Santa Cruz Porrillo	130	17	26.1	26.5	27.4	28.1	27.9	26.8	26.9	26.8	26.3	26.1	26.1	25.9	26.7
San Miguel	105	6	26.2	27.0	28.3	28.9	28.3	26.6	26.9	26.9	26.9	25.6	25.6	25.6	26.8
Chorrera del Guayabo	190	11	26.5	27.7	28.9	29.2	27.8	26.1	25.8	26.0	25.5	25.8	25.9	26.0	26.8
Izalco	380	11	23.4	23.8	24.8	25.4	25.0	24.3	24.6	24.6	24.0	24.1	24.0	23.7	24.3
San Andrés	475	18	22.6	23.5	24.7	25.6	25.2	24.4	24.2	24.4	24.0	23.6	22.8	22.2	23.9
Ilopango	615	10	22.1	22.7	23.7	24.4	24.0	23.1	23.1	23.2	22.8	22.7	22.2	21.8	23.0
San Salvador	700	15	21.9	22.6	23.7	24.4	23.9	23.0	22.9	23.1	12.6	22.5	22.2	21.8	22.0
Santa Ana	725	8	21.6	22.5	23.5	24.3	23.9	22.9	23.0	23.1	22.7	22.5	21.9	21.4	22.8
Santiago de Maria	930	9	21.3	22.0	22.8	23.2	22.8	22.0	22.5	22.6	21.7	21.6	21.4	21.2	22.1
Santa Tecla	955	19	19.5	20.1	21.1	21.9	21.8	21.3	21.4	21.7	20.9	20.7	20.2	19.6	20.8
Los Andes	1,700	4	14.6	16.0	16.8	17.8	17.6	17.2	17.0	17.0	16.8	15.6	14.8	14.4	16.3

Source: Daugherty. 1974.

of large urban centers, some of which developed into contemporary cities, such as Sonsonate and Ahuachapán. The Pancho Indians, a small tribe living today in Panchimalco near San Salvador, are thought to be direct descendents of the Pipil.

Although the Pipil formed the major group in El Salvador at the time of the Spanish conquest, two other groups, the Pokoman and the Lenca also were present. The Pokoman were settled in the northwest, while the Lenca were located north and east of the Rio Lempa. The Pokoman, derived from the Maya, were more advanced than the Lenca, but both groups probably were influenced by cultural interchange with the Pipil and with each other (Browning 1971).

The first attempt by the Spanish to conquer the area failed in 1524 when forces led by Pedro de Alvaro were defeated by Pipil warriors in a major engagement at Cuscatlán, the Pipil capital near present-day San Salvador. In 1525, de Alvaro returned and finally succeeded after a long and difficult struggle, delivering the district to the control of the Captaincy General of Guatemala, where it remained until 1821. After independence from Spain was won in 1821, El Salvador formed a number of unstable alliances, first with Mexico and the remaining four Central American countries, and later, with just the Central American states, as the Federal Republic of Central America. When the federation was dissolved in 1838, El Salvador was declared a sovereign, independent republic.

El Salvador's history as an independent state has been marked by numerous revolts and military coups. Summarizing the first sixty years following independence, American University (1979) comments: "Discounting minor revolts, disorders, and confrontations, which occurred almost continually, [the first sixty years of the Republic were marked] by a number of major disruptions that often upset stability and created an atmosphere of political chaos." After a period of relative stability from 1900 to 1930, the election of military dictator General Hernández Martinez began an era of military involvement in government affairs. Every president since Hernández Martinez has been an army officer, with the exception of one provisional executive who served for four months.

Aside from internal turmoil, El Salvador also has been involved in frequent confrontations with the neighboring states of Guatemala and Honduras. Brief wars with Guatemala occurred in 1875, 1885, 1890 and 1906. The latter confrontation was undertaken in alliance with Nicaragua. There was war with Honduras in 1899, and again in 1969. The 1969 war often is referred to as the "soccer war" because it began after riots broke up a soccer game between the two countries. The 1969 war is particularly important because its roots lay in the environmental problems of land scarcity, overpopulation, and natural resource distribution in El Salvador (Durham 1979). The central issue was the treatment of 300,000 Salvadoran farmworkers who had emigrated to Honduras from overcrowded El Salvador in search of land and jobs. After five days of war, during which Salvadoran troops penetrated up to 29 km into Honduras and 3,000 to 4,000 people died on both sides, the Organization of American States effected a cease-fire. A peace treaty followed in October 1980.

Political conditions in El Salvador continue to be unstable. A military coup in October 1979 established the Revolutionary Junta of Government (JRG), currently led by President José Napolean Duarte. Opposition to the junta formed in 1980 from both the left (Unified Revolutionary Directorate or DRD) and the right (Democratic Revolutionary Front or FDR), and led to an outbreak of civil war. The country continues to be in a state of civil unrest today, and the outcome of the present hostilities is not clear.

As with the 1969 war with Honduras, the fundamental causes of the present conflict are as much environmental as political, stemming from the problems of resource distribution in an overcrowded land.

In modern El Salvador 89 percent of the people are Mestizo (mixed Spanish and Indian descent); 10 percent are pure Indian; and 1 percent are Caucasian. Spanish is spoken by virtually everyone, although Indians also may speak Pipil, a Nahuatl dialect. Roman Catholicism is the dominant religion. Culturally, most Salvadorans are "Ladinos," a term implying a mixture of Hispanic and Amerindian customs. There are a few affluent, land-rich families at the apex of the social system who generally trace their lineage from the original

Spanish colonists. However, the majority of Salvadorans are "hungry, illiterate, infested with parasites, malnourished, poorly housed, underemployed, and generally subsist from day to day with little opportunity to improve their lot in life" (U.S. AID 1980).

2.3.2 Population Growth and Distribution [4]

El Salvador's population growth over the last several decades has been exceptionally fast (Table 4, Figure 5); it is often cited as an extreme case (e.g., U.S. AID 1980). During the 1960s the annual population growth rate climbed to almost 3.5 percent, one of the world's highest. This phenomenal growth can be traced directly to a lowered death rate in a society with a continuing high birth rate. Immigration contributed practically nothing to population growth.

There is some evidence that the rate of population growth has begun to slow during the last decade. U.S. OFDA (1980) reports a decline in the crude birth rate from 50 per 1,000 in the 1960s to 39 per 1,000 by 1977, and a drop in the average annual growth rate to 2.9 percent during 1970-1977. However, growth rates are reported to remain high in rural areas (U.S. OFDA 1980).

Figures reported for population growth during the last decade must be viewed with caution because there is considerable variability between and even within sources. The last reliable national census appears to have been in 1971; sources are fairly consistent in reporting a population of about 3,555,000 for that year. Estimates after 1971 are less certain. For example, U.S. OFDA (1980) gives a mid-1978 estimate of 4.3 million, a figure that translates to an average annual growth rate of 2.75 percent during the 7 years following 1971. The World Bank (1981) gives a mid-1979 population of 4.4 million, and an annual growth rate of 2.9 percent for 1970-1979. On the other hand, U.S. Department of State (1981) estimated a considerably higher mid-

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[4] Sources: Browning. 1971.
Durham. 1979.
U.S. Department of State. 1981.
U.S. OFDA. 1980.
World Bank. 1981.

Table 4. Population Growth of El Salvador 1570-1978

Year	Estimated Population	Average Annual Growth Rate in the Interval
1570	77,000	
1778	146,700	0.31%
1807	200,000	1.07
1855	394,000	1.42
1878	554,800	1.50
1892	703,500	1.71
1930	1,436,900	1.90
1950	1,859,500	1.30[a]
1961	2,523,200	2.81
1971	3,555,800	3.49

[a] Reduced growth rate caused by rebellion of 1932, with 17,000 deaths.

Source: Durham. 1979.

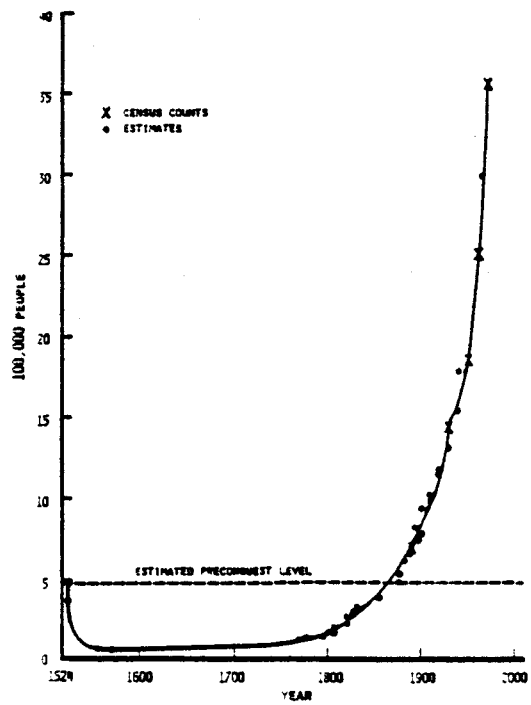


Figure 5. Population Growth, 1524 - 1971

Source: Durham. 1979.

1979 population of 4.67 million, reflecting a likewise higher annual growth rate of 3.47 percent during essentially the same period.

The rapid population growth caused by high birth rates during the past several decades has led to a proportionately younger and more dependent population (Table 5). The proportion of the population of working age decreased from 55 percent in 1950 to 51 percent in 1975 (U.S. OFDA 1980).

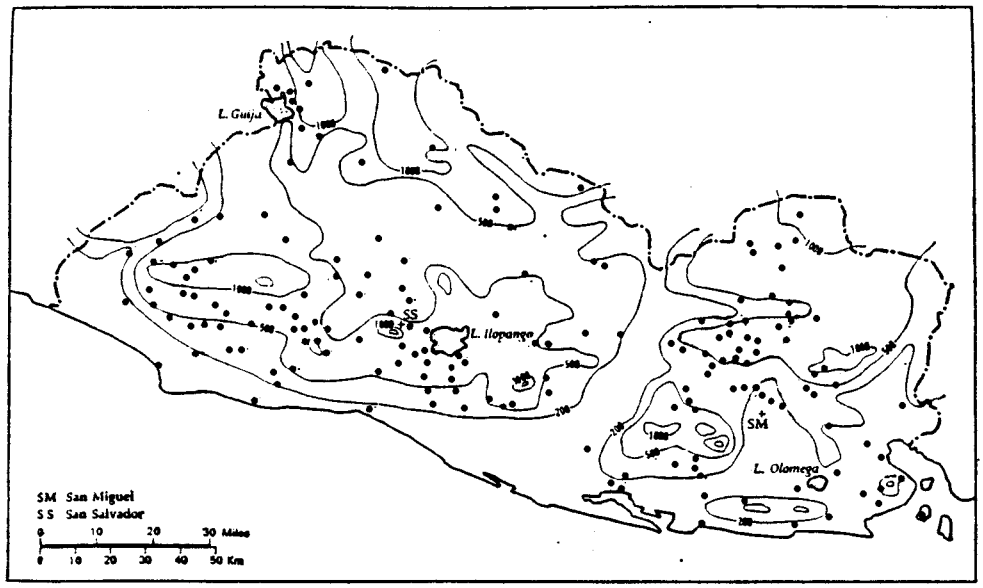
Another consequence of population growth within the limited area of El Salvador is high population density. Current estimates range from 205 individuals per square km (U.S. OFDA 1980) to 218 per square km (U.S. Department of State 1981), the highest on the mainland American continent and second only to Haiti in the Western Hemisphere. The geographic distribution of indigenous populations was relatively even at the time of the Spanish conquest (Figure 6). Modern population distribution patterns continue similarly, although there is some local variation (Figure 6). Population densities are lowest in the rural departments of the Chalatenango, Cabanas, and Morazan Mountains in the north (Table 6). Densities are highest in the central corridor connecting the urban centers of Santa Ana in the west and through San Salvador to San Miguel in the east. Due to the advent of cotton farming and malaria control, the coastal lowlands which were formerly sparsely populated, now support 19 percent of the rural population.

The urban population, 22 percent of which lives in San Salvador, amounts to 41 percent of the total population (World Bank 1981). In 1960, the urban population comprised less than 38 percent of the total population, indicating that urban populations have grown faster than rural populations. Durham (1979) conservatively estimates the rate of rural migration to the cities to have increased from 2.96 per 1,000 during 1930-1950, to 5.06 per 1,000 during 1950-1961, and to 5.81 per 1,000 during 1961-1971. As of the 1971 census, El Salvador had 43 towns and cities with populations greater than 5,000 (U.S. OFDA 1980); the three largest cities were San Salvador (565,000 in the metropolitan area), Santa Ana (98,400) and San Miguel (62,000).

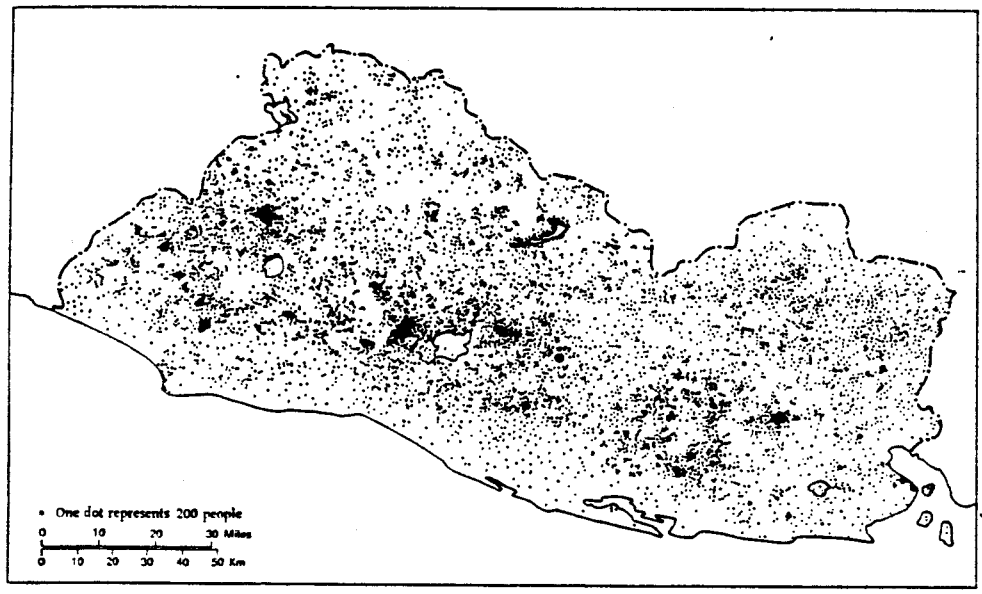
Table 5. Population by Age Groups. 1971 Census

Age Groups	Total Pop.	Male Pop.	Female Pop.
0 - 4	597,307	300,678	296,629
5 - 9	581,597	296,365	285,232
10 - 14	471,787	241,719	230,068
15 - 19	359,588	175,330	184,258
20 - 24	296,212	143,311	152,901
25 - 29	230,125	109,384	120,741
30 - 34	199,711	99,080	100,631
35 - 39	186,109	90,687	95,422
40 - 44	151,115	74,454	76,661
45 - 49	121,771	58,998	62,773
50 - 54	98,286	47,725	50,561
55 - 59	70,009	33,863	36,146
60 - 64	67,924	33,825	34,099
65+	123,107	57,771	65,336
Total	3,554,648	1,763,190	1,791,458

Source: U.S. OFDA. 1980.



Distribution of Indian Villages, 1550



Population Distribution, 1950

Figure 6. Patterns of Population Distribution, 1550 and 1950

Source: Browning. 1971.

Table 6. Population Distribution, 1978

Department	Population (1000s)	Density (per sq km)	Growth Rate 1950-1971
Ahuachapan	215.7	174	3.06
Cabanas	151.6	137	2.52
Chalatenango	196.0	97	2.36
Cuscatlan	176.0	233	2.54
La Libertad	345.8	209	3.31
La Paz	216.7	177	3.04
La Union	272.9	132	3.39
Morazan	175.5	121	2.30
Santa Ana	379.7	188	2.44
San Miguel	380.8	183	3.03
San Salvador	856.6	967	4.40
San Vicente	178.2	151	2.70
Sonsonate	287.4	235	3.28
Usultan	349.3	164	2.87
El Salvador Total	4,182.2	199	3.14

Source: U.S. OFDA. 1980.

2.3.3 Health [5]

Although health conditions in El Salvador are improving, as indicated by a decline in the crude death rate from 17 per 1,000 in 1960 to 9 per 1,000 in 1979 (World Bank 1981), most Salvadorans are still in poor health. Coughing, malnourishment, and diarrhea are so common they are accepted as a routine part of life (U.S. AID 1980). The number one cause of death is enteritis and other diarrheal diseases (Table 7). These gastrointestinal diseases affect children most seriously; the infant mortality rate in 1977 was 59 per 1,000 , more than six times the world average (U.S. OFDA 1980). Rural people receive proportionately less health care than urban residents and have higher infant mortality rates and lower life expectancies than city people.

In large part, the poor health of Salvadorans is due to unsanitary and overcrowded living conditions. Forty-seven percent of the population do not have household running water; 85 percent lack plumbing facilities. Of the 261 urban municipalities, 205 do not have garbage disposal facilities. In rural areas, 69 percent of the population is not supplied with water and 83 percent is without latrines. Crowded living conditions throughout the country are indicated by average population densities of 120 or more inhabitants per square km in all but one of the 14 departments (Table 6). The population density of the urban department of San Salvador exceeds 960 inhabitants per square km. About 63 percent of the population of San Salvador lives in overcrowded mesones, once-comfortable dwellings abandoned by their owners and now rented out as separate rooms (UNEP 1976). Another 13 percent of San Salvadorans live in shanty towns constructed from scrap materials. These are located on land regarded as unsuitable for ordinary urban development because of flooding, uneven terrain, or proximity to pollution sources. The high densities and poor sanitary conditions of El Salvador's human settlements make it difficult to control endemic and epidemic disease. Some of the most frequent diseases are syphilis, gonorrhea, meningitis, measles and diphtheria.

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[5] Sources: UNEP. 1976.
U.S. AID. 1980.
U.S. OFDA. 1980.
World Bank. 1981.

Table 7. Major Causes of Mortality, 1970 and 1975

Rank	Cause	1970 No.	1970 %	1975 No.	1975 %
1	Enteritis and other diarrheal diseases	6,262	17.8	4,339	14.0
2	Accidents and acts of violence	2,627	7.6	3,645	11.0
3	Other digestive diseases	2,345	6.7	785	2.4
4	Bronchitis, emphysema and other similar diseases	1,261	3.6	1,322	4.0
5	Pneumonia and bronchopneumonia	1,004	2.9	1,054	3.3
6	Dysentery and amebiasis	990	2.8	80	0.2
7	Influenza	744	2.1	424	1.3
8	Malignant tumors	708	2.0	780	2.4
9	Cerebral vascular disease	606	1.7	679	2.1
10	Avitaminosis and other similar diseases	567	1.6	561	1.7
11	Anemias	---	---	537	1.6
--	Ill-defined disease	10,379	29.6	9,090	28.4
--	Other causes	7,636	21.7	8,680	27.0
	Total	35,129*	100.0	31,986**	99.4

* Total number of deaths medically certified is 35.3%
** Direccion General de Estadisticas y Censos.

Source: U.S. OFDA. 1980.

Inadequate nutrition, although not frequently a direct cause of death, is a major factor contributing to poor health. The main problem is insufficient caloric intake; 20 percent of the general population and 74 percent of Salvadoran children under 5 years of age are affected. Low income families, especially, suffer from insufficient food intake. Rural populations, particularly in marginal agricultural areas have worse caloric deficiencies than populations in urban areas. Other widespread problems are vitamin A deficiencies and anemias caused by iron and folate deficiencies in infants, adolescents, and lactating women (U.S. OFDA 1980).

Health care services are provided by the Ministry of Health and Social Services and the autonomous Social Security Institute. These services have had some successes. Crude death rates have declined steadily, and the average life expectancy has increased from 59 to 63 years since 1977. Vaccination programs for preventable diseases (measles, diphtheria, tetanus, whooping cough, polio and tuberculosis) are available. Family planning services have increased the acceptance of contraceptives by 34 percent of married women. However, health care services primarily aid urban populations (U.S. OFDA 1980), and Ministry of Health facilities generally are overcrowded and poorly administered (U.S. AID 1980). Many poor people bypass government services by going directly to local pharmacies where minimally trained personnel diagnose illnesses and prescribe drugs. Government malaria-control programs, in operation for 20 years, have had little effect, and 3.8 million Salvadorans continue to live in areas where malaria is endemic or hyper-endemic (U.S. OFDA 1980). There is a shortage of trained health personnel, particularly in rural areas. In 1976, the public health system provided just one doctor to 3,779 persons, and one mid-level nurse to 4,000 persons.

2.4 Land Use

2.4.1 Background and Trends

The most significant historical trend in El Salvador's land use has been the conversion of forest land to farmland, coupled with agricultural use of increasingly marginal lands. In 1807 the estimated forest cover was 60 to 70 percent of the total surface area (Durham 1979); by 1900 forest

cover had dropped to 10 percent and it declined further to 8 percent by 1946 (Durham 1979). In 1916, El Salvador's land was described as follows (Durham 1979): "Salvador presents a view that reminds us of a large and well-kept garden, with every available piece of land, even at the highest levels, being under cultivation." In 1946 it was common to see hillsides with slopes as steep as 45 degrees completely stripped of native vegetation and planted in corn or other annual crops. The amount of land under cultivation continued to increase dramatically until about 1961, but thereafter declined sharply. As can be seen from Table 8, between 1961 and 1971 only about 7,000 ha of land were converted to crops or pasture. This was a drop of more than fivefold from the 1950 to 1961 period and represents a lack of land left to convert, rather than a lack of demand. In fact, demand for and occupation of marginal land increased because of rapid population growth (Section 2.3.2) and greater use of the most productive land for cash export crops such as cotton, coffee and sugarcane. Increased emphasis on cash crops has occurred primarily on larger farms. As a result subsistence farmers have been displaced into ever more marginal lands thus further reducing production of basic foods such as maize, rice and beans (Durham 1979).

This shift in agriculture began in the 1950s. As can be seen in Figure 7, there has been a steady decline in basic food crop production and a corresponding increase in the importation of basic food crops. Food crop importation peaked in the 1960s.

2.4.2 Land Use Patterns and Causes of Land Scarcity

Figure 8 shows that during the period 1935 to 1971 total agricultural production of all principal crops kept up with population increase. This suggests the food production imbalance that developed during the 1950s and 1960s, discussed in Section 2.4.1, was not due to the expansion of agriculture to some physical limit. Rather, there were priorities in the production of some agricultural products over others. Also, it suggests large increases in some products for export were realized at the expense of domestic food supplies. Food crops lagged in production because they were less profitable than crops grown for export. By 1960, export crops, principally coffee, cotton, and sugarcane, accounted for almost 42 percent of the total area

Table 8. Distribution of Agricultural Land

Year	Total[1] Hectares Under Cultivation	Temporary Crops	Permanent Crops	Improved Pastures	Native Pastures & Woodlands
1950	924,670	391,050	153,220	174,881	205,510
1961	986,778	493,495	159,662	104,434	229,187
1971	932,716	488,436	163,499	112,737	- 168,044

[1] Total land area 2,098,000 ha.

Source: U.S. AID. 1980.

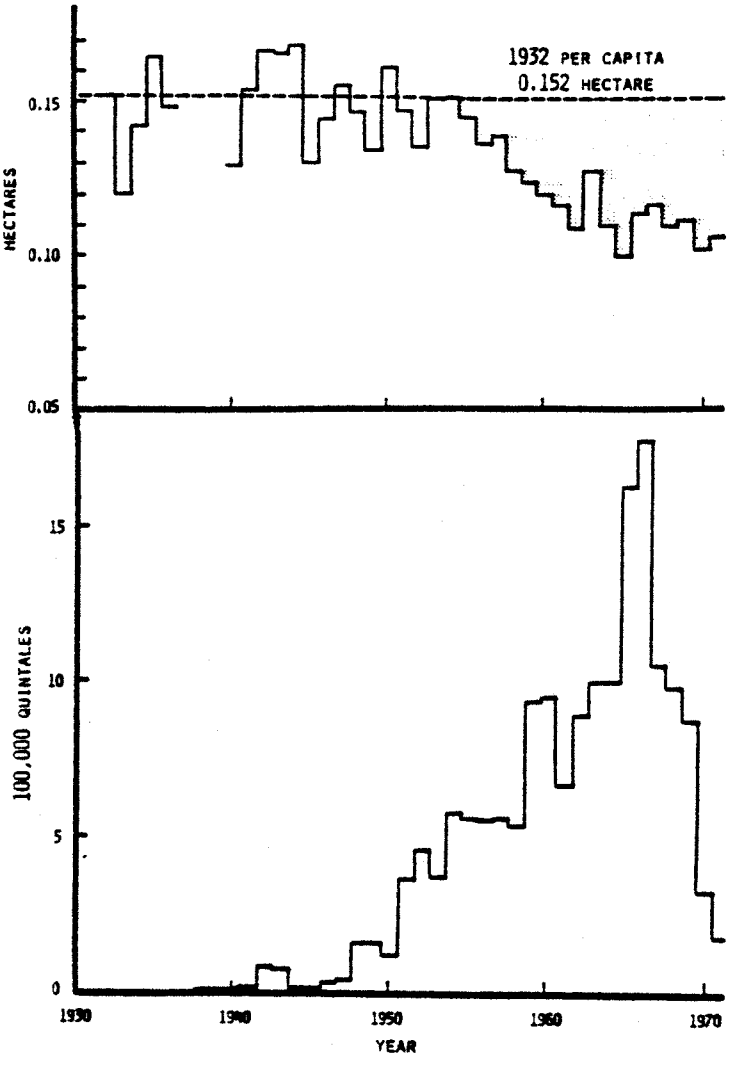

Figure 7. Per-Capita Farmland in Basic Food Crops, 1932 - 1971 (top) and Imports of Basic Food Crops, 1932 - 1971 (bottom). 1 Quintal = 100 kg.

Source: Durham. 1979.

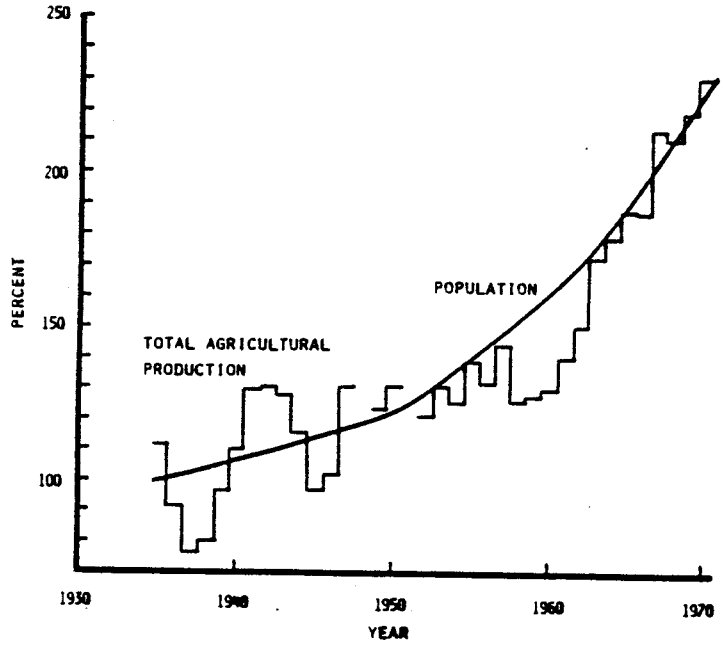

Figure 8. Population Growth and Total Agricultural Production, 1935 - 1971. Agricultural Productions Based on Yearly Kilogram Production of Maize, Rice, Beans, Sorghum, Coffee, Cotton and Export Sugar.

Source: Durham. 1979.

cultivated in major crops. Thus one of the most important factors leading to food scarcity and land pressure appears to be the allocation of large proportions of land to cash crops rather than to domestic food crops.

Although cotton and sugarcane contributed substantially to the displacement of basic food crop production, expansion of the coffee industry was the most dramatic. By 1966, crop land committed to coffee production expanded to about 140,000 ha, second in area only to maize (165,754 ha) (Durham 1979).

Because most of the coffee is grown at elevations above 500 m, the growth of the coffee industry has played a major role in the exploitation of highland regions. Durham (1979) believes that expansion of the coffee industry and other cash export crops has been as important as population growth in the destruction of El Salvador's forest cover. An example of the competitive exclusion of maize (basic food crop) by coffee (cash export crop) is shown in Figures 9 and 10. The area distribution of major commercial agriculture is shown in Figure 11. Cultivated areas of sorghum in Central America are shown in Figure 12.

The shift to cash crops has had other important consequences in addition to creating a food shortage. Most of the cash crops are produced on farms of large landowners who own most of the flattest and most fertile land. As shown in Figure 13, almost 50 percent of all the farmland is concentrated in the hands of less than 2 percent of the landowners. According to Durham (1979) up to 46 percent of the land on the large farms may be used for pasture, and fully 32 percent of the land classified as under cultivation on these farms is actually fallow (ESDGEC in Durham 1979, p. 51).

In El Salvador, where the population is very dense and growing rapidly one might expect all but the poorest soils and the steepest slopes to be fully cultivated. But, because of the land ownership distribution the reverse occurs. The poorest soils and steepest slopes are the most intensely cultivated for food. Large estates, which comprise most of the land, are usually underutilized or are used for the production of export crops rather than domestic food crops.

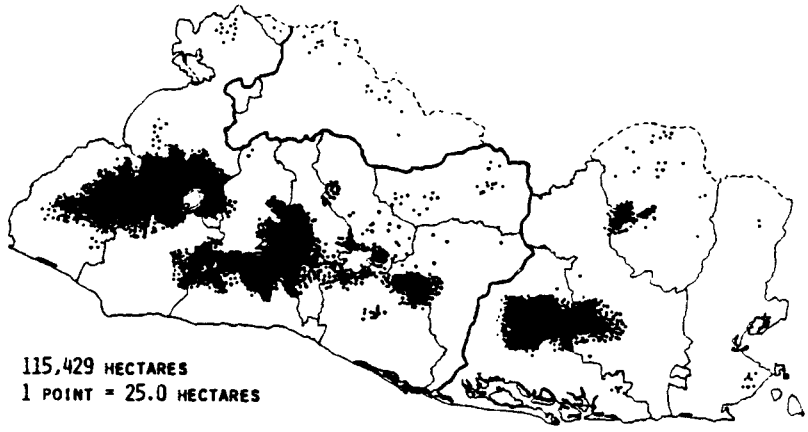

Figure 9. Principal Coffee Growing Areas, 1950

Source: Durham. 1979.

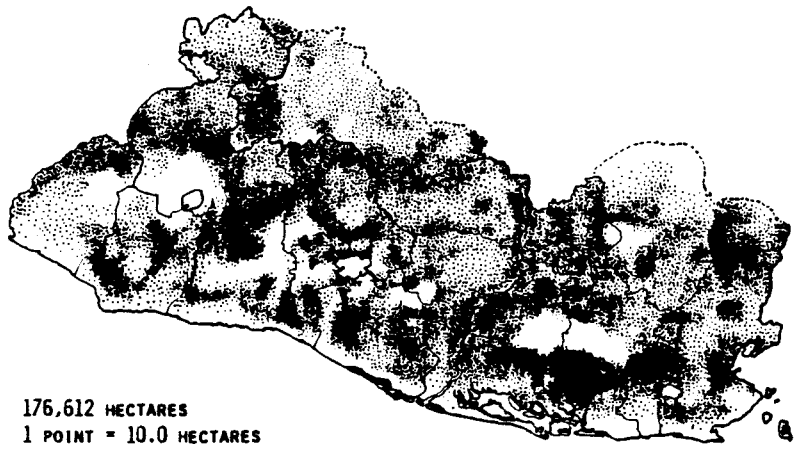

Figure 10. Principal Maize Growing Areas, 1950

Source: Durham. 1979.

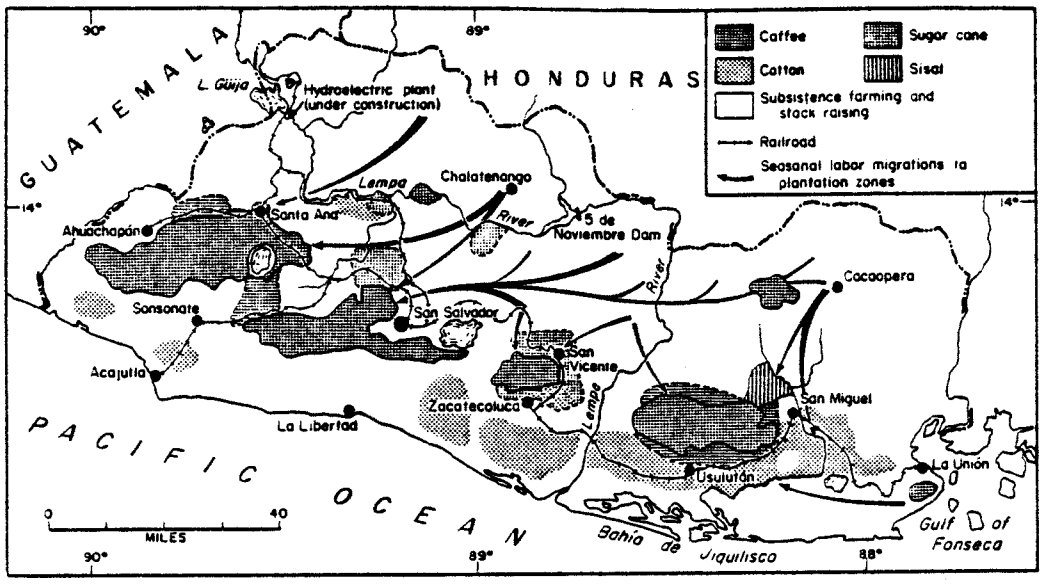

Figure 11. Areas of Commercial Agriculture

Source: West and Augelli. 1976.

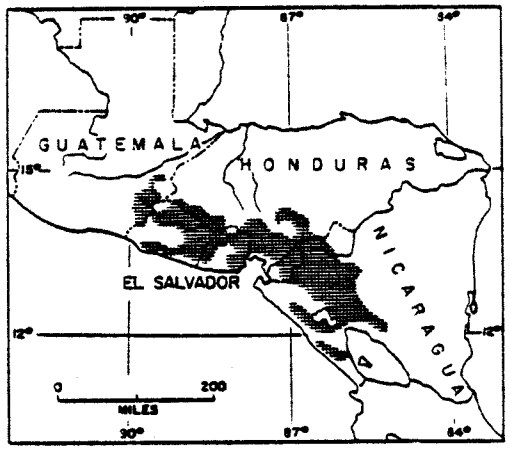

Figure 12. Areas of Grain Sorghum Cultivation in Central America

Source: West and Augelli. 1976.

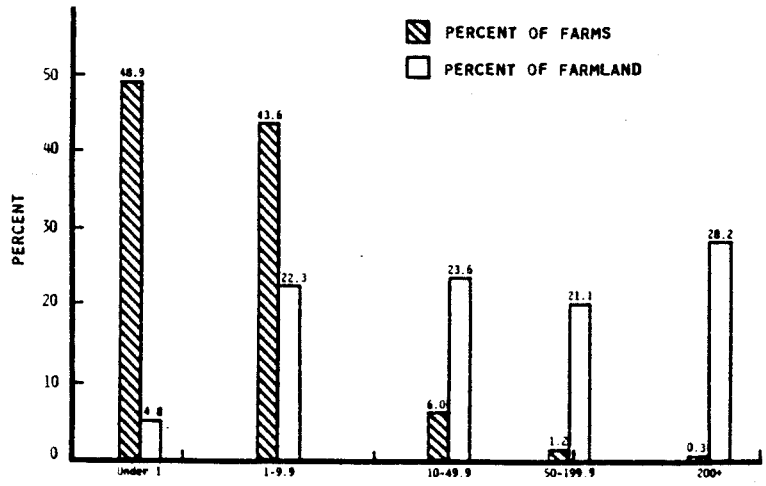

Figure 13. Farm Size Distribution, 1971.

Source: Durham. 1979.

The change to cash crop export farming has been accompanied by a gradual reduction in size of the holdings of small landowners. In the early colonial era, sprawling haciendas rapidly displaced communal Indian village holdings during the indigo boom. In 1881 the government abolished the traditional communal land system. As a consequence of this and the ensuing bureaucratic procedures for issuing lawful titles, large numbers of peasants and Indians lost their land. Expansion of the coffee industry augmented this process because small traditional land parcels were unsuitable for profitable coffee cultivation. Consequently many small land units were consolidated although portions of them often laid fallow. During the Depression of the 1930s larger land parcels were consolidated further. It is estimated that at that time 28 percent of the coffee holdings, primarily those of small owners, changed hands (Durham 1979). From the Depression until World War II, coffee prices remained low. This encouraged diversification in agricultural exports and led to increased production of cotton, sugarcane and other products raised primarily for export. The expansion of more profitable export crops caused further displacement of small landholders onto more marginal lands and resulted in excessively intense use of steep slopes and poor soils for basic food crops. This in turn led to erosion, severe soil depletion, deforestation, and other types of environmental degradation.

From 1950 to 1971, the number of small, traditional farms (less than 2 ha) increased by 82 percent and their total cultivated area expanded from about 83,000 ha to 151,000 ha. During the same period, pasture and woodland declined by about 100,000 ha; land in annual crops increased correspondingly. According to land capability standards, the estimated amount of land in annual crops in 1978 exceeded the recommended level by more than 200,000 ha. This increasing pressure for land has resulted in: 1) higher purchase and rental prices; 2) greater numbers of small farms; 3) decreased average size of small farms; 5) rapid expansion onto hillsides and marginal land; and 5) increasing insecurity of tenure in the small farm sector (U.S. AID 1980).

2.4.3 Forest Land-Use Patterns 6/

As discussed in Section 2.3.1, forest land in El Salvador decreased from more than 90 percent to 8.3 percent in 1946 (Bourne in Durham 1979). Today forests cover only about 2 percent of the land. Deforestation has been faster and more complete than in any other Central American country. There has been essentially no land-use policy with respect to forest lands, and no attempt has been made to use the wood or wood products. The absolute disregard for future heritage, and preservation of this valuable resource base is vividly illustrated by Lafarrière as he rode through the hills south of Lake Ilopango in the dry season in 1860, "We were surrounded by fire on all sides ... fields of grain were being burnt over and parts of the forest were being burnt also to clear them so that the mountains around us seemed to be illuminated and glowing red .... the smoke enveloped us while we travelled to such an extent that it was difficult to breathe or even to see clearly." Deforestation has resulted in massive gullies, loss of soil nutrients, landslides, silting of dams, and reduction of water tables.

2.4.4 Land-Use Planning and Policy

The history of El Salvador is marked by a lack of any cognate land-use policy or planning. In 1973 the Legislative Assembly approved the Forestry Law and restructured the forestry and animal service to implement a new land-use policy. There appears to be little hope for success given the virtually complete degradation of the Salvadoran environment at the present, especially in light of the current economic, social and political instability. Additional information on environmental plans, related legislation, and governmental infrastructures can be found in Section 4.4 and Tables 25 and 26.

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6 Sources: Browning. 1971.
Durham. 1979.

3.0 Environmental Resources

3.1 Geology and Soils

3.1.1 Geology

With the exception of the extreme northern part of the country, El Salvador's geology is volcanic. Almost all of the country is located within Tertiary and Quaternary volcanic formations, and is thus comparatively young. The volcanic chain, which parallels the Pacific coast, contains several active volcanos, and forms part of the volcanic chain that stretches from southern Mexico and Guatemala to northern Costa Rica.

According to Weyl (1980), El Salvador can be divided into the following morphological-geological units (see also Section 2.1.1).

Coastal Plains. Coastal plains occur in the west and central part of the country and are made up primarily of alluvial deposits.

Coastal Ranges: This zone includes the Tacuba, Bálsamo and Jucurán Ranges (including the Pacific volcanic chain). These ranges are volcanic rocks of the Pliocene Bálsamo Formation (below). Beds and peneplains that dip gently toward the coast in the Bálsamo Range are partially covered with thick red soils.

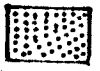
Interior Valley. This is a heterogeneous region geologically. It consists of low mountainous topography with more or less eroded extinct volcanos and the alluvial basins of the Metapán, Lempa, Titihuapa, and Olomega Rivers. Along the southern part of the valley there is a chain of Pleistocene volcanos; some are still active.

Northern Mountain Ranges. This region includes Monte Cristo, Los Esesmiles and the region around Chalatenango and the Río Torola. It is built up primarily of Tertiary volcanics of the Chalatenango and Morazán Formations, Plutonic rocks, and in the region of Metapán, Cretaceous - Lower Tertiary sediments.

The stratigraphic sequence of El Salvador begins in the northern border of the country with Mesozoic beds (Figure 14), and adjacent or on top of these are the Jurassic-Cretaceous red rock beds. Above

Figure 14. Surface Geology

Quaternary Alluvium: Marine Sediments Along the Coast



Paleocine, Eocene and Miocene Sedimentary Rocks (incl. Some Upper Cretaceous); Mainly Marine Sediments; Terrestrial Sediments in Small Intermontane Basins

Mesozoic Sedimentary Rocks (Mainly Volcanic Activity Related to the Middle American Volcanic Cones; Pumice-Filled Basins; Ignimbrite Flows and Laharaic Deposits

Tertiary Volcanic Rocks (Upper Miocene to Pliocene); Lava Flows, Tuffs, Ignimbrite and Lacustrine Volcanic Sediments

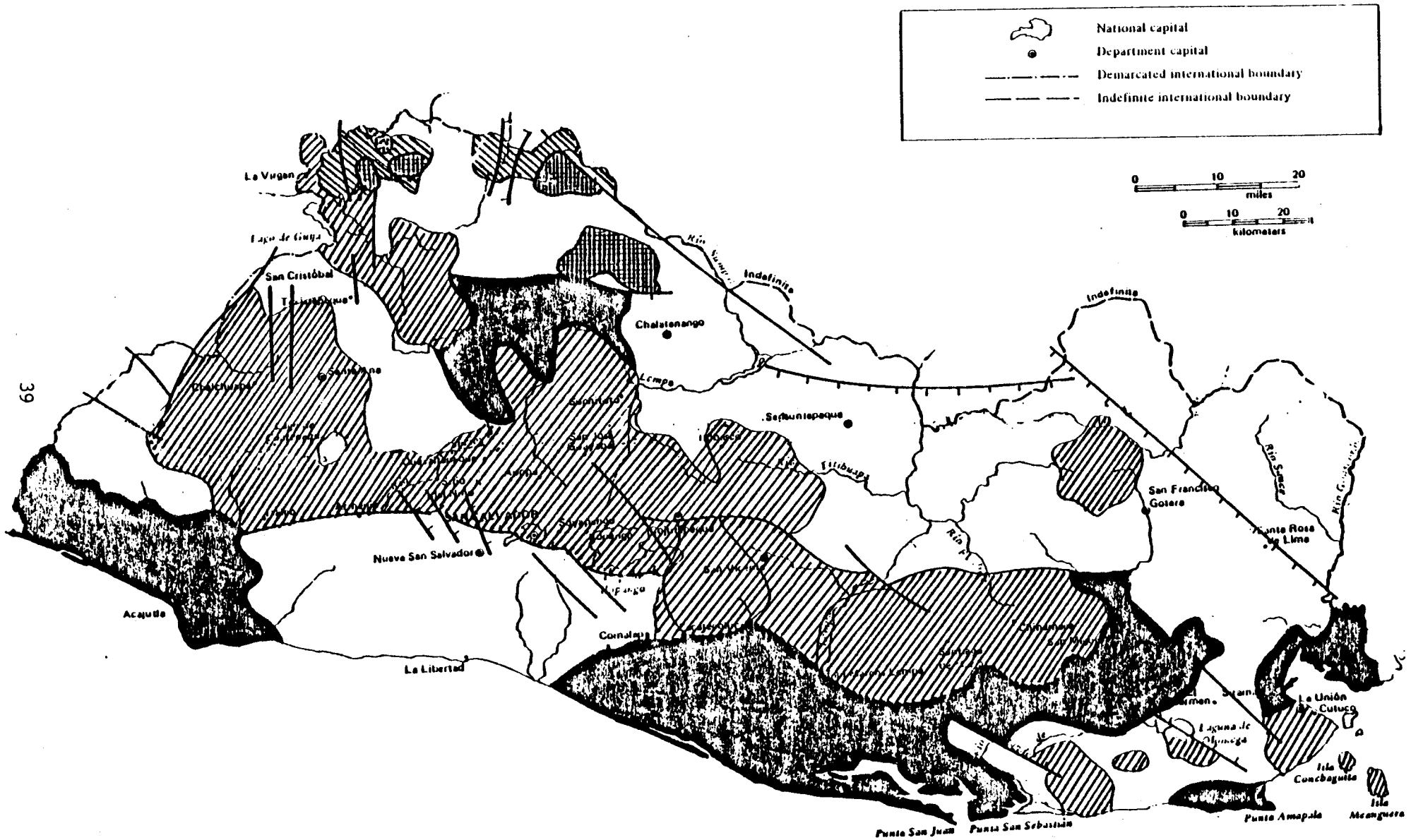
Cretaceous and/or Tertiary Intrusive Rocks; Mainly Grandiorite and Granite

Normal Faults, Barbs Indicate Downthrown Block

Faults, Undifferentiated

Source: Arbingast et al. 1979.

Surface Geology



these are limestones and marls, and higher still are Upper Cretaceous - Lower Tertiary conglomerates, sandstones and intercalated volcanics. The most recent zones of the Tertiary and Quarternary are predominantly terrestrial volcanics, as discussed in the preceding section. Further stratigraphic details can be obtained from Weyl (1980).

The geological structure of El Salvador is determined by several fault systems (Figures 14 and 15). The most important one is the main west-east (WE) fault that extends from the Guatemala border to the northern edge of the Olomega Basin. This fault largely corresponds to the large intramountain basin (central depression) that passes through the basins of Coatepeque and Boquerón, Lago Ilopango, northwest of Tecapa and beneath the Santa Ana Mountains and east of San Miguel (see Figure 14).

The second major fault system strikes north-west/south-east (NW/SE) and determines the position of a number of volcanic eruption centers. This system includes the intramontane basins that lie along the line of extension of the Nicaragua Depression. These basins include the Olomega, Río Titihuapa, Río Lempa, and Metapán. They are filled primarily with fluviatile and limnic sediments (Weyl 1980).

3.1.2 Soils 7/

There is a large body of literature dealing with soils, soil classification and potential soil uses in El Salvador. A few of the more important papers include Bourne (1949), Bourne et al (1946), DeKoninck (1944), FAO (1964), Lahud (1944), OAS (1974), Rico (1963, 1964), and Holdridge (1959). A bibliography of soil studies in El Salvador may be found in Orvedal (1978).

The soils of El Salvador are diverse and largely volcanic. Some are extremely fertile although highly susceptible to erosion. Alluvials and lateritic soils also exist, characterized by their great fragility when exposed to sun, heat and humidity. The destruction of soils in El Salvador probably has been one of the most serious consequences of deforestation. As the protective

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7 Source: FAO-UNESCO Soil Map of the World. 1975.

Figure 15. Major Fault Lines. Fault through Central Depression (top) and through Extension of Nicaraguan Depression (bottom)

Source: Weyl. 1980.

forest cover was lost, erosion began to occur and has resulted in deep gullies and ravines that now characterize large areas of the countryside.

Eutric Nitosols are probably the most widespread soils in El Salvador although Vitric Andosols predominate in the volcanic central region and Dystric Cambisols are common along the northern border of the country. Vitric Andosols are suitable for growing many kinds of crops and with the addition of phosphates are probably the most important soils economically in El Salvador. These soils can also be irrigated to great advantage. Each of the eight major soils is discussed briefly below and their distribution is shown in Figure 16.

Eutric Nitosols. These are relatively deep soils with good drainage and high natural fertility. They are usually of volcanic origin. Under traditional farming, adequate productivity is achieved with a wide variety of crops. Eutric Nitosols erode easily, which frequently leads to rapid losses of productivity.

Eutric Gleysols. These are soils of the flat or nearly flat coastal zone. They are low in fertility, have slow internal drainage and are difficult to use in traditional agriculture. These soils are used primarily for rice or rough pasturage.

Vitric Andosols. These soils are well represented in El Salvador and are probably more widespread than shown in Figure 16. Because of their volcanic origin they are among the most productive soils in El Salvador.

Mollic Andosols. Similar to the previous soil group, these soils are moderately productive but erode easily and require phosphatic fertilizers for sustained yields. They are limited to a few volcanic zones in El Salvador.

Chromic Cambisols. These soils occur primarily in the extreme eastern portion of the country and are found where the parent rocks are calcareous and contain volcanic minerals in the form of tuff. Crop yields are moderate. Five- to eight-year resting periods between crops often are required.

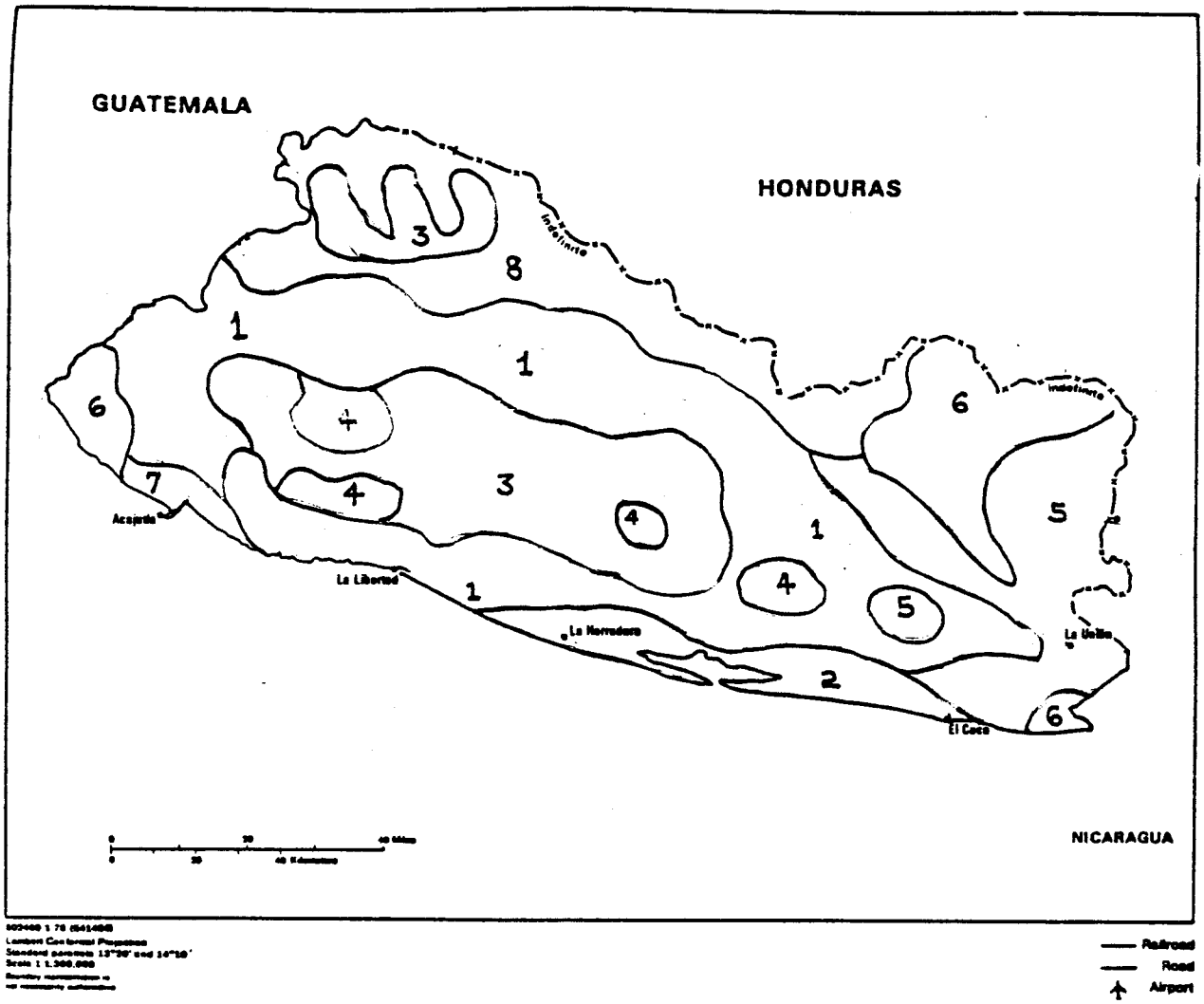

Figure 16. Distribution of Major Soil Groups:

1) Eutric Nitosols
2) Eutric Gleysols
3) Vitric Andosols
4) Mollic Andosols
5) Chromic Cambisols
6) Eutric Regosols
7) Pellic Vertisols
8) Dystric Cambisols

Source: FAO-UNESCO Soil Map of the World. 1975.

Entric Regosols. These soils occur in three widely scattered areas. In coastal areas, these are the only soils that have sufficient drainage for productive subsistence agriculture. Irrigation can improve yields but soluble salts may build up in the root zone. In the highlands, these soils occur near active volcanic vents where there are freshly deposited cinders, scoria, and coarse volcanic sand that has not had time to weather.

Pellic Vertisols. These soils are limited to a small coastal area in El Salvador. They are characterized by an abundance of clay, consequently they swell in the rainy season and become very sticky. In the dry season they shrink and become very hard and fissured. Arable farming can be carried out only during a brief period when the soil is neither too wet nor too dry. Rice and livestock production are the most satisfactory forms of land use on these soils.

Dystric Cambisols. These are soils derived from silicaceous rocks (e.g., granite, quartz, diorite, quartz, sandstone) in mountainous regions with a high annual average rainfall (>3,500 mm). These soils are almost wholly unsuitable for traditional agriculture because they are shallow, low in fertility, and usually cover steep rugged terrain. With proper management they are suitable for tree crops such as cacao and coffee.

3.1.3 Minerals, Mining and Fossil Fuels [8]

Mineral resources are small but varied; they include gold, silver, copper, iron ore, sulphur, mercury, lead, zinc, salt and lime. At the San Cristobal Mine about 500 tons of gold- and silver-bearing ore are processed each day. The only other gold mine of importance, the San Sebastian Mine, also operates a 100 ton per day cyanide mill. The San Sebastian mine, at Santa Rosa de Lima, is in an area where further geological exploration is planned.

Canadian Javelin Ltd. expanded its Monte Cristo gold mine to 200 tons per day during 1981. Ore is mined

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[8] Sources: Ledbetter and Mittleman. 1979.
Quart. Econ. Review. 1980b.

nearby at several small underground mines and is trucked to the mill. The company is also exploring the old Divisadero silver-gold mine.

Several old mines were reopened and sampled during 1981. Bruneau Mining Company examined the El Dorado Gold Mine, which last operated in 1953. Ricardo Kriete reopened and sampled the old Gigante silver-gold mine in 1981.

There are no known petroleum or coal deposits. Although the government has invited foreign oil companies to explore for oil in Salvadoran territory there has been no response because of political instability in the country. Arpel and the Colombian state oil company, however, have offered technical assistance to El Salvador and have already carried out some exploratory work. Refinería Petrolera Acajutla SA, which is owned by Esso (65 percent) and Shell (35 percent), operates a 14,000 barrel per day (b/d) refinery at Acajutla. Its $1 million expansion program included an asphalt plant completed in January 1973. Currently crude oil for refining is imported from Venezuela but attempts are being made to replace this import with cheaper Mexican oil.

3.2 Water Resources

3.2.1 Hydrographic Systems

El Salvador is drained by four major river systems. A fifth region includes seven smaller rivers, all of which drain the short Pacific coastal cordillera (region 5 on Figure 17). The Rio Lempa is the largest and most important river in El Salvador. It is also the longest river system in Central America. Its watershed covers nearly two-thirds of the country (Figure 17, Table 9). Four tributaries of the Rio Lempa, the Rios Sucio, Torola, El Jine and Titihuapa, form important subbasins of their own. All rivers draining El Salvador flow toward the Pacific Ocean.

Most rivers in El Salvador are navigable for only short distances. The Rio Lempa, the largest, is also navigable for only short distances. The longest navigable stretch is about 40 km for shallow draft vessels. Most of the northern portion of the Rio Lempa flows through mountains where it is navigable only in short discontinuous sections.

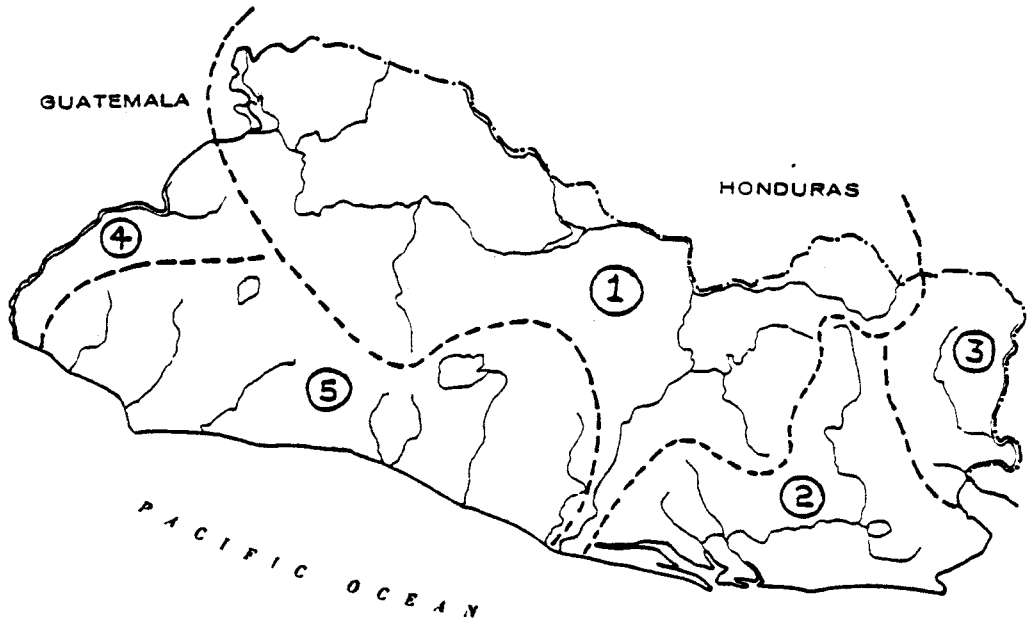

Figure 17. Major Surface Drainage Basins:

1) Rio Lempa
2) Rio Grande de San Miguel
3) Rio Goascoran
4) Rio Paz
5) Rio Grande de Sonsonate - Rio Jiboa and others

Table 9. Monthly Discharge of Selected Rivers

River and discharge	Station	Basin area km²	Mean monthly discharge, m³/s												Year	Period of record
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		
Paz	La Hachadura	795	12.5	12.1	11.7	13.5	16.8	50.2	48.7	43.3	47.2	35.8	19.4	15.0	27.2	1962-66[1]
Sonsonate	Sensunapan	219	2.0	2.0	2.0	3.7	5.8	9.3	8.9	10.3	14.2	8.7	4.3	2.1	6.1	1959-66[2]
Banderas	Carretera Litoral	433	1.6	1.2	1.4	2.0	5.1	14.1	16.4	13.0	18.5	11.7	7.2	2.9	13.3	1961-66[3]
Jiboa	Carretera Litoral	229	4.2	3.7	3.3	3.2	3.9	6.9	10.3	13.5	14.8	12.5	8.1	6.3	7.6	1961-66[4]
Lempa	San Marcos	18,000	69.2	59.8	65.5	60.3	131.0	545.0	943.0	616.0	1,104.0	691.0	171.0	75.1	377.5	1961-66[5]
Torola	Osicala	760	7.8	7.2	6.0	7.5	24.9	80.1	51.7	50.8	159.0	81.7	16.1	8.6	40.1	1962-66[6]
Aceihuate	Junta Lempa	709	5.6	5.4	4.3	5.1	9.9	15.2	25.1	18.0	23.3	18.7	3.7	3.4	11.5	1962-66[7]
Sucio	Mouth	843	4.4	4.1	4.2	4.1	7.1	16.8	37.5	26.5	41.4	20.2	9.2	6.3	15.2	1961-66[8]
Suquiapa	Tecachico	308	5.2	5.1	5.0	5.1	5.9	8.7	11.1	9.2	11.9	8.3	6.7	5.7	7.3	1961-66[9]
Grande San Miquel	Vado Marin	2,027	7.6	7.6	8.0	8.5	11.7	30.4	44.7	26.8	77.7	77.5	24.9	8.5	27.8	1959-66[10]
Sirama	Sirama	329	0.3	0.2	0.2	0.2	2.8	15.1	9.2	5.3	20.2	8.6	2.7	0.4	5.4	1961-66[11]
Goascoran	Goascoran	1,750	3.7	2.5	1.9	2.2	28.5	64.8	66.0	36.3	93.6	79.4	19.6	6.1	33.7	1962-66[12]

Maximum flows and month:

1) 389.1 (Jun.)
2) 253.0 (Sep.)
3) 285.0 (Sep.)
4) 99.3 (Sep.)
5) 3,516.0 (Sep.)
6) 992.0 (Sep.)
7) 187.2 (Sep.)
8) 271.0 (Sep.)
9) 133.6 (Jul.)
10) 284.0 (Jul.)
11) 720.6 (Jun.)
12) 670.0 (Sep.)

Source: van der Leeden, 1975.

Further complicating navigation, the river frequently floods during wet seasons and is nearly dry in many sections during dry seasons.

Two other river systems drain small portions of the east and west. The Rio San Miguel drains a low-lying eastern section and the Rio Paz drains a small western area along the border with Guatemala. There are several small lakes in the central valley (see Section 2.1.3). None are important waterways for transportation but several are important water sources for irrigation.

The numerous lakes and lagoons that are scattered throughout the volcanic basin of the country constitute important habitats for migratory birds and could have great recreational potential. These lagoon ecosystems in El Salvador now are threatened by increasing pollution and poor management of the natural resources surrounding the watersheds. Most are now repositories for soil eroded from surrounding slopes, and for various toxic chemicals used in agriculture.

3.2.2 Surface and Groundwater 9/

Water resource data currently available for El Salvador are based on information collected by CEPAL or Lemus in van der Leeden (1975). Surface drainage and groundwater discharge data are available for most major river basins. Suspended sediment loads, an important item in countries like El Salvador where most of the natural forest cover has been destroyed, do not seem to be inventoried.

During a normal year total surface water runoff to the Pacific Ocean is estimated at 18,953 million cubic meters, and total groundwater discharge is estimated at 2,313 million cubic meters. In addition, 17,200 million cubic meters is estimated to be lost due to evapotranspiration (Table 10). Total water usage in 1980 was estimated at 251 cubic meters per second, of which the largest proportion is consumed for hydropower. Most of the remainder is used for irrigation. In 1980, public water supply and industry usages were estimated to be only 7 cubic meters per second (2.8 percent). Estimates

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9 Sources: U.S. AID. 1980.
van der Leeden. 1975.

Table 10. Water Balance Summary

Element	Annual mm	Annual volume of water million m^3
INFLOW		
Precipitation	182	36,367
River inflow from other countries (Rio Lempa Basin)	24	4,841
Total	206	41,208
OUTFLOW		
Total runoff	95	18,953
Direct runoff	(75)	(15,088)
Base flow	(19)	(3,865)
Ground water discharge to sea	12	2,313
Total evapotranspiration	86	17,200
of ground water	(3)	(696)
of precipitation	(83)	(16,504)
Total	193	38,466

Source: van der Leeden. 1975.

of water usage in 1970, and projected usage in 1980 and 1990 for selected river basins are shown in Table 11. These values suggest greatly increased water usage at a time when water systems are becoming increasingly polluted, when water available for human consumption is limited, and when erosion of watersheds and siltation in rivers are increasing the difficulty of constructing and operating hydroelectric power plants. Currently, 8 percent of cultivated land is irrigated but it is hoped that this will be increased substantially in the future. Water pollution is discussed further in Section 4.3.1.

El Salvador's total surface water supply is abundant but is highly seasonal and somewhat unequally distributed. There is great variation in surface runoff between the dry season and wet season (Table 9); the flow of many rivers decreases manyfold during the driest months. Likewise, surface runoff is higher along the coast where rainfall is greatest, and much less in the extreme northern mountains where rainfall is markedly lower.

3.2.3 Urban and Rural Water Quality

Water quality and supply are particularly acute problems in rural areas of El Salvador. Currently water supply systems reach only 31 percent of rural areas (these sources are often not safe) and 87 percent of urban areas. Sewage disposal systems are available to only 15 percent of rural areas and 38 percent of rural areas. This clearly suggests that, in a country where 60 percent of the population is rural (U.S. AID 1980), the majority of the population does not have access to safe water.

Attempts to improve water quality have been particularly discouraging. Despite legislation requiring purification treatment of fresh water used for human consumption, the problem of enforcement has been very difficult.

It is believed that because of water pollution, a shortage of safe drinking water is one of the most serious environmental problems facing San Salvador in the short term, and a problem that many other urban centers will face in the longer term. Groundwater also is being polluted because of untreated sewage and infiltration of toxic chemicals, thus presenting a serious obstacle to water resource planning. A great amount of groundwater is already toxic, preventing its use for

Table 11. Present and Projected Water Demand (Million Cubic Meters per Year)

River basin	Irrigation	Hydropower	Public water supply and industry	Total water demand	Irrigation	Hydropower	Public water supply and industry	Total water demand	Irrigation	Hydropower	Public water supply and industry	Total water demand
	1970				1980				1990			
Lempa and Jiboa to Grande de San Miguel	10.07	116.07	3.02	129.42	33.02	158.06	5.72	197.62	176.00	279.00	8.84	463.84
Paz	–	0.01	0.13	0.23	7.06	0.1	0.22	7.92	23.06	0.01	0.34	24.04
Between Paz and Sonsonate	–	–	0.03	0.03	–	–	0.05	0.05	7.03	–	0.08	7.38
Sonsonate	10.04	1.02	0.14	11.74	13.04	1.02	0.27	14.87	15.03	1.02	0.41	16.91
Between Sonsonate and Jiboa	0.06	–	0.21	0.81	0.06	–	0.37	0.97	24.05	–	0.55	22.05
Grande de San Miguel	1.08	0.03	0.15	2.25	29.01	0.03	0.26	29.66	59.00	0.03	0.39	59.69
Goascoran and others	0.01	–	0.12	0.22	0.01	–	0.22	0.32	8.02	–	0.33	8.53
Total	23.60	117.3	3.80	144.70'	84.0	160.20	7.11	251.31	313.09	280.60	10.94	605.44

Source: van der Leeden. 1975.

either human consumption or irrigation. In addition to losses of ground and surface waters due to pollution, there has been a serious loss related to deforestation. This appears likely to lead to a permanent decrease in groundwater supply, as well as greater surface loss due to uncontrollable flooding.

3.3 Energy Resources

El Salvador has an estimated hydroelectric energy resource base of slightly less than 1,500 megawatts (MW), which is far in excess of current production though still much below that of estimated potentials for other Central American countries. Because of degraded conditions of many Salvadoran watersheds, hydroelectric potential may be considerably less than this estimate in El Salvador. Cinco de Noviembre and Cerro Grande, on the Upper Rio Lempa, are the largest installed hydroelectric power plants currently in use.

By contrast, geothermal development in El Salvador is the most advanced in Central America. One third of El Salvador's non-hydroelectric generating capacity is now geothermal (60 MW) and is likely to increase significantly. According to Mitre (1980), El Salvador could have between 70 percent to 90 percent of the total installed geothermal capacity in Central America by 1990 if political events permit. A geothermal power plant using a condensing turbogenerator of 30 MW capacity was installed in the Ahuachapan field in 1975. Costs per kilowatt hour for geothermal power production have been more expensive than hydroelectric power production; however, half of the costs have been for equipment to dispose of geothermal brine. The damaging environmental effect of hot water and mineral discharge has not been assessed.

There are no proven oil resources in El Salvador and no oil shales have been identified. Likewise, there are no known commercially exploitable reserves of coal. Because almost no forests remain in El Salvador, forest biomass resources in El Salvador are insignificant.

One remaining biomass resource, bagasse, has not been exploited extensively but may offer potential. Sugarcane bagasse already is used to provide electrical energy in sugarcane processing plants. It is believed that there are substantial untapped reserves from the large Salvadoran sugarcane industry. Other crop residues, such as those from coffee and bananas also represent a potential energy resource.

Current energy use in El Salvador is primarily derived from imported petroleum (about 55 percent); geothermal energy and non-commercial fuels such as wood and bagasse account for much of the remainder (MITRE 1980).

3.4 Vegetation

3.4.1 Vegetation Communities

The natural vegetation of El Salvador was greatly altered by human activity even before 1800, and was almost completely destroyed by 1900. Consequently, most of the natural vegetation was destroyed before it could be inventoried or studied by botanists. There are only a few botanical studies dealing with plants or plant communities of El Salvador. These include Guzman (1925), Choussy (1926-1932), Lauer (1954a, 1954b), Stanley (1924), Stanley and Calderon (1925, 1941), and Daugherty (1974). These studies have been derived primarily from remnants and relicts of the former natural vegetation.

The original vegetation is believed to have been primarily forest which can be grouped into three principal plant formations; two are characteristic of lowland regions from sea level to 1,000 m above sea level, one is typical of highland areas above about 1,000 m. According to Holdridge (1967) terminology, these forests are: 1) Tropical Dry Forest (including mangroves); 2) Tropical Moist Forest; and 3) Premontane Wet Forest (Cloud Forest). In addition, one important plant association, pine-oak, was probably widespread in isolated patches in the highlands (Figure 18). Along some rivers in drier zones, Gallery Forest (an edaphic climax) was probably common and mangroves are still widespread along the coast. A brief description of each plant formation is given below along with the general distribution of some more common species.

Mangroves. Mangroves are confined to zones of salt or brackish water and often form dense evergreen forests. In El Salvador they occur most extensively around Bahia de Jiquilisco. Other localities include the Estero de Jaltepeque, Barra de Santiago and around the Gulf of Fonseca. Mangroves encircle the Gulf of Fonseca and form an extension of a much larger mangrove zone in Nicaragua and Honduras. A few isolated mangrove islands also occur elsewhere along the coast. The three primary species of mangrove in El Salvador are red mangrove

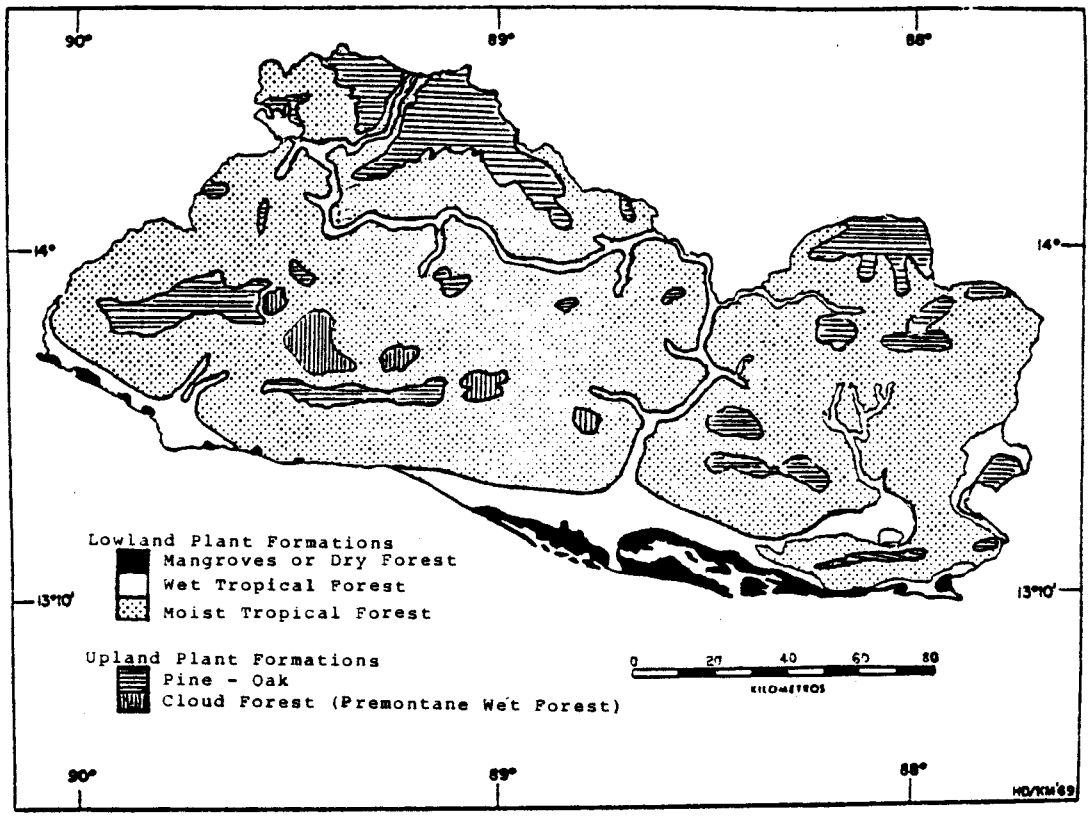

Figure 18. Probable Distribution of the Original Vegetation

Source: Daugherty. 1974.

(Rhizophora mangle), black mangrove (Avicennia germinans) and white mangrove (Laguncularia racemosa). Two other salt-tolerant trees common as peripheral associates to mangroves are Conocarpus erecta and Hippomane mancinella.

Moist Tropical Forest. This forest type occurs primarily along the zone inland from mangroves (Figure 18); it also is believed to have formerly occurred on the moister floodplains of the larger rivers, such as the Rio Lempa and Rio Grande de San Miguel and around Laguna de Olomega. Moist Tropical Forest also previously occurred in the watersheds of Lago Zapotilán and Lago Guija. These forests grew primarily on alluvial soils where soil moisture was relatively high year-round and where rainfall was relatively heavy. Compared to forests of wetter regions, such as the Caribbean slope of Central America, Moist Tropical Forests are more open, less luxuriant, contain fewer species and have a greater number of deciduous trees. Some characteristic trees of Moist Tropical Forests in El Salvador are listed in Table 12.

Tropical Dry Forest. Tropical Dry Forest was probably the most widespread forest in El Salvador, originally covering approximately 90 percent of the country. It is also the most characteristic vegetation formation of the Pacific coast of Central America. Plant species (Table 13) are similar to those occurring on the Pacific slope of Guatemala and Nicaragua. Rainfall averages from 1,500 to 2,000 mm over most of the region where Tropical Dry Forest formerly occurred in El Salvador. This places the vegetation on the wetter end of a scale from Dry Forest to a Dry-Moist Transition.

Gallery Forest. Gallery Forest is an edaphic (soil) climax forest that occurs along the edges of rivers where soil moisture is high. It may be classified as Tropical Moist Forest following Holdridge (1967) terminology. Some common trees of this zone include ceiba (Ceiba pentandra), Guanacaste tree or Donacaste (Enterolobium cyclocarpum), fig (Ficus spp.) and volador (Terminalia obovata).

Pine-Oak Woodland. The pine-oak association is widespread, although irregularly distributed, in the highlands of the coastal volcanos and the

Table 12. Characteristic Trees of Moist Tropical Forest in El Salvador

Scientific Name	Commom Name
Chlorophora tinctoria	mora
Brosimum terrabanum	ojushte
Castilla gummifera	hule
Myroxylon balsamum	bálsamo
Ceiba pentandra	ceiba
Terminalia obovata	volador
Ficus spp.	amate
Enterolobium cyclocarpum	conacaste
Pithecellobium saman	carreto
Swietenia spp.	caoba
Cedrela spp.	cedro
Sideroxylon tempisque	tempisque
Bombax ellipticum	barrigón

Source: Daugherty. 1974.

Table 13. Characteristic Trees of Tropical Dry Forest

Scientific Name	Common Name
Poeppigia procera	memble
Piptadenia constricta	quebrado
Gliricidia sepium	madrecacao
Lonchocarpus spp.	chaperno
Cedrela spp.	cedro
Cordia alliodora	laurel
Tabebuia chysantha	cortés amarillo
Tabebuia donnel-smithii	cortés blanco
Tabebuia pentaphylla	maquilishuat
Luehea candida	bonete
Bursera simaruba	jiote
Bimaruba glauca	aceituna
Swietenia spp	caoba
Calycophyllum candidissimun	salamo
Cochlospermum vitifolium	tecomasuche
Myroxylon balsamun	bálsamo

Source: Daugherty. 1974.

interior mountains. This plant association is dominated by 12 species of oak and one species of pine (Pinus oocarpa). P. oocarpa also is widespread in the highlands elsewhere in Central America south to Nicaragua. Other species that occurred, at least formerly, in the pine-oak association include Perymenium spp., Cedrella mexicana, Clethra vulcanicola and Nectandra sinuata. Liquidumbar styraciflue also occurs in pine-oak associations where the soil is richer.

Premontane Wet Forest (Cloud Forest). Generally found at elevations above 1,800 m, Premontane Wet Forest is particularly well developed in the northwestern region in Montecristo and El Pital, but also can be found in limited areas on Volcan Santa Ana, Volcan San Salvador, and Volcan San Vicente. The only Premontane Wet Forest remaining is at Montecristo. Areas of Premontane Wet Forest are characterized by annual rainfall in excess of 2,000 mm, high humidity (often as a result of fog and cloud cover) and an abundance of epiphytic growth on the limbs and branches of trees. Bromeliads, orchids, ferns and mosses abound and usually cover almost every available bark surface.

At the highest elevations, and in zones of markedly poor soil, Pinus oocarpa occurs in relatively pure stands. It is possible that these stands are not naturally-occurring but have invaded following selective cutting of oak, and massive soil ersosion, and loss of soil fertility. According to Stanley (1924) pine highland stands of Pinus oocarpa appear to have expanded in area between the 19th and early 20th centuries. Stands of pine now grow in the most badly degraded and eroded highland areas, which were formerly used for pastures and subsistence agriculture.

Savanna or Grassland. Grassland is now widespread in El Salvador. Its presence appears to be due to a long history of cutting, burning, and pasture and subsistence agriculture, which have allowed grasses to invade. Grasslands are now widespread in areas of both high and low precipitation, although formerly there was little or no natural grassland in El Salvador.

According to Daugherty (1974) the long history of cutting, burning and subsistence agriculture

activity in El Salvador has resulted in a significant alteration of the remaining vegetation. The species composition of many woodland tracts is now almost permanently altered as a result of an endless cycle of cutting and burning followed by regrowth. Some important shrubs and trees of regrowth zones are listed in Table 14. Most of these species are fast-growing trees that produce lightweight lumber of low quality and that are of limited commercial potential.

3.4.2 Forest Resources and Timber Exploitation

El Salvador has the smallest land area of any Central American country and it has also preserved a much smaller proportion of its forest reserves. Formerly almost the entire country was forested. The coastal plain was covered with mangroves and evergreen forest, and more than 90 percent of the interior was deciduous forest. Oak and pine forest predominated at elevations from 800 to 1,800 m and cold, damp cloudy forests occurred above 1,800 m.

Seventy percent of the country may still be suitable for forestry or forest protection but currently only 3 percent of the total area is being used for productive forestry; most of the remaining fragments of forest are in the extreme northern part along the Honduran border. Virtually no undisturbed forest lands remain in El Salvador, and almost all of the remnants are in a regrowth stage or disclimax.

El Salvador imports about 90 percent of its wood at a value of 9.3 million colones annually. A small portion of these wood products are used to produce furniture, paper and other products for export, at a value of about 1.7 million colones. Thus an annual deficit of 7.6 million colones exists in this subsector. By the end of this decade this deficit could be four of five times greater. Wood use in El Salvador is estimated as follows: 70 percent for construction, 12 percent for furniture, and 18 percent for other uses (such as fuelwood for cooking).

In the mid-1970s the Salvadoran government attempted to restore some of the country's forests. Activities were begun to protect and restore 80,000 ha of pine plantations and mangroves. Because of the severe balance-of-payments deficit and protracted civil strife during the last two to three years, it is unlikely that reforestation projects

Table 14. Principal Trees and Shrubs of Forest and Woodland Regrowth Zones

Scientific Name	Common Name
Caesalpinia criostadrys	pintadillo
Caesalpinia coriaria	nacascolo
Mimosa tenuiflora	carbón
Acrocomia vinifera	coyol
Byrsonima crassifolia	nance
Apeiba tibourbou	peine de mico
Curatella americana	Chaparro
Combretum criathum	chupamiel
Tabernacimontana donnel-smithii	cojón
Psidium spp.	guayabo
Crescentia alata	morro
Crescentia cujute	jícaro
Acacia hindsii	izcanal
Acacia farnesiana	espino blanco
Hylocereus spp.	pitahaya
Nopalea cochenillifera	nopal
Gliricidia sepium	madrecacao

Source: Daugherty. 1974.

now receive significant support. Despite the military junta's claim to the contrary, guerrillas now move freely over at least a third of the country (Ariz. Daily Wildcat 1982), including areas in the Departments of Chalatenango and Morazán in the north and northeastern part of the country where some of the last remnants of forest occur.

The most important trees used in furniture construction include Tabebuia, Cedrela, Gliricidia, Cordia and Miroxylon. Large numbers of Miroxylon also have been used for railroad ties. Other trees of the Moist Tropical Forest zone that have been selectively cut for various purposes include Pithecollobium, Chlorophora tinctoria, Ceiba pentandra, Enterolobium cyclocarpum and Terminalia obovata.

Pine and oak forests, originally the second most widespread plant formation in El Salvador, for the most part have been destroyed. Only scattered remnants have escaped cutting or burning. Many trees have been cut for construction and for firewood, even in a small zone protected by FAO in northern Metapán.

In the central part of the country coffee plantations have replaced the pine and oak forests. The most common overstory tree shading coffee is Inga, formerly a common tree of humid tropical forests in El Salvador.

3.5 Fauna and Conservation

3.5.1 Mammals

Seven mammals indigenous to El Salvador are listed by the IUCN Red Data Book (1978) and the U.S. Department of Interior (1979) (Table 15). According to Daugherty (1974), at least four mammals, Jaguar (Panthera onca), Howler Monkey (Alouatta palliata), Central American Tapir (Tapirus bairdii) and Giant Anteater (Myrmecophaga tridactyla) are extinct in El Salvador; the other three mammals, Ocelot (Felis pardalis), Margay (F. wiedii) and Jaguarundi (F. yagouaroundi) are considered endangered. Given the almost complete loss of habitat and great environmental disturbance everywhere, it is likely that only the Jaguarundi still survives in El Salvador.

Table 15. Vertebrates Listed by the U.S. Department of Interior (1979) and the IUCN Red Data Books (1966, 1969, 1975, 1978)

Scientific Name	Common Name	Status	
		IUCN	U.S. Dept. Interior
MAMMALS			
Panthera onca	Jaguar	X	E
Felis yagouaroundi	Jaguarundi	?	E
Felis wiedii	Margay	X	E
Alouatta (villosa) palliata	Howler Monkey	X	E
Felis pardalis	Ocelot	X	E
Tapirus bairdii	Central American Tapir	X	E
Myrmecophaga tridactyla	Giant Anteater	X	E
BIRDS			
Pharomachrus mocinno	Resplendent Quetzal		E
REPTILES			
Crocodylus acutus	American Crocodile	X	E
Chelonia mydas	Green Sea Turtle	X	E
Eretmochelys imbricata	Hawksbill Sea Turtle	X	E
Caiman crocodilus fuscus	Central American Caiman	X	
AMPHIBIANS/FISH			
None			

X = listed by IUCN; E = endangered (U.S. Dept. of Interior 1979).

As suggested by Daugherty (1974) and the sources in Table 16, the status of mammals is much worse than suggested by the IUCN Red Data Book (1978) and the U.S. Department of Interior (1979). From a list of 32 species, eight are believed extinct in El Salvador, nine more are considered endangered, and another eight are listed as rare or very rare and local. The list does not consider the many species of bat, small rodents, insectivores, and other forest or woodland dwellers that are threatened or already extirpated (Appendix I). The absence of these species from the IUCN, Federal Register, and Daugherty's list reflects a lack of information on populations and distributions of these less known species. Many species eventually may be listed when information becomes available or when they are brought to the attention of conservationists.

Literature on mammals in El Salvador is scattered, seldom comprehensive, and often out-of-date. Some of the more important sources include Guzman (1883), Stanley (1924), Hall and Kelson (1959), Bennet (1968), Nietschman (1972), Daugherty (1974), IUCN (1978) and Hall (1977). Because of limited coverage, taxonomically and geographically, several of these references are of limited use in conservation planning.

The future for conservation of mammals in El Salvador is grim. Almost all of the large species, or ones of potential economic importance, are already exterminated or critically endangered. Further, most could not even be reintroduced at present because of lack of forest habitat, and because introductions would probably face immediate exploitation from humans. For the near term, and in the absence of a dramatic change in the social, economic and cultural bases that favor viewing the land as a renewable natural resource, there is little hope for improvement.

3.5.2 Birds

Except for Dickey and van Rossen's (1938) extensive work, there has been relatively litle interest in Salvadoran birds. This may be attributed to the fact that even as early as the turn of the 20th century, more than 90 percent of the natural vegetation was destroyed, leaving little incentive for field work. Consequently much of our present knowledge of the avifauna and its distribution is based on work in adjacent countries with similar

Table 16. Status of 32 Mammals

Scientific Name	English Name	Spanish Name	Status
MARSUPIALIA			
Didelphis marsupialia	Southern Opossum	Tacuazin	Common
Chironectes minimus	Water Opossum	Tacuazin de Agua	In danger of extinction
Marmosa mexicana	Mexican Mouse Opossum	Tacuazin-raton Mexic.	In danger of extinction
PRIMATES			
Ateles geoffroyi	Geoffroy's Spider Monkey	Mono Arana	In danger of extinction
*Allouatta palliata**	Mantled Howler Monkey	Mono Aullador	Exterminated
EDENDATA			
Myrmecophaga tridactyla	Giant Anteater	Oso Hormiguero	Exterminated
Temandua mexicana	Tamandua	Tamandua	Exterminated
Dasypus novemcinctus	Nine-banded Armadillo	Cusuco de Nueve Bandas	Locally common
LAGOMORPHA			
Sylvilagus floridanus	Eastern Cottontail	Conejo Montes	Locally common
RODENTIA			
Sciurus variagetoides	Variegated Squirrel	Ardilla Gris	Rare
Sciurus deppei	Deppe's Squirrel	Ardilla Roja	Rare and ver local
Coendu mexicanus	Mexican Porcupine	Puerco Espin	In danger of extinction
Agouti paca	Agonti	Tepescuintle	Rare
Rattus rattus	Black Rat	Rata	Abundant
CARNIVORA			
Canis latrans	Coyote	Coyote	Very rare and local
Urocyon cinereoargenteus	Gray Fox	Gato de Monte	Fairly common
Nasua narica	Coatimundi	Pezote	Fairly common and local
Mustela frenata	Long-tailed Weasel	Comadreja	Fairly common
Eira barbara	Tayra	Tayra	Exterminated
Spilogale putorius	Eastern Spotted Skunk	Zorrillo Moteado	Rare
Mephitis macruoura	Hooded Skunk	Zorillo Encapuchado	Very rare
Conepatus mesoleucus	Eastern Hog-nosed Skunk	Zorrillo	Rare
Lutra annactens	River Otter	Nutria del Rio	Rare
Panthera onca	Jaguar	Jaguar, Tigre	Exterminated
Felis concolor	Mountain Lion	Puma	Exterminated
Felis pardalis	Ocelot	Tigrillo (Ocelet)	In danger of extinction
Felis wiedii	Margay	Tigrillo (Gato Margay)	In danger of extinction
Felis yagouarondi	Jaguarundi	Gato Zonto	In danger of extinction
PERISSODACTYLA			
Tapirus bairdii	Central American Tapir	Tapir	Exterminated
ARTIODACTYLA			
Tayassu tajacu	Collared Peccary	Cuche de Monte Collar	In danger of extinction
Odocoileus virginianus	White-tailed Deer	Venado de Cola Blanca	In danger of extinction
Mazama americana	Red Brocket	Venadito Rojo	Exterminated

* No definite El Salvador record but doubtless occurred formerly (Hall 1977).

Sources: Daugherty (pers. obs. 1968-69; 1974)
J. Serrano (pers. comm.)
Guzman. 1883.
Standley. 1924.

habitat and drainage, and where the natural vegetation has not been extensively degraded.

Studies of limited scope that treat Salvadoran birds are Cooke (1941), Marshall (1943), and Rand and Traylor (1954). Several reference works covering birds in El Salvador and other areas of North and Central America include Davis (1972), Eisenmann (1955), Hellmayr (1924-1949), and Ridgway and Friedmann (1901-1950). Two important works on birds in adjacent countries are Monroe (1968) on Honduras, and Land (1970) on Guatemala. Several studies such as those of Blake (1958), Edwards (1972), and Peterson and Chalif (1973) on Mexico, and Alvarez del Toro (1971) on Chiapas, Mexico, are valuable to workers in El Salvador.

Dickey and van Rossem (1938) list 446 species of birds for El Salvador, and Marshall (1943) added several others. No El Salvadoran bird is listed by the IUCN Red Data Book (1966). (1979 list not available.) The U.S. Department of Interior lists only one, the Resplendent Quetzal (Pharomachrus mocinno), and it probably survives only in the extreme northwest in Montecristo National Park. But these data do not accurately reflect the current status of birds in El Salvador because almost certainly a large number of species are critically endangered there. The birds in Table 17 represent a partial list of species that formerly occurred in El Salvador, and are now believed by the author to be either extinct or critically endangered. The status of a much larger list of species given in Appendix I is uncertain; however, many are likely to be threatened, endangered, or extirpated.

There are no species of birds endemic to El Salvador. Several species of the pine and pine-oak highlands are restricted to a small area from southern Mexico to El Salvador or Honduras; therefore, the loss of habitat, even in an area as small as the highlands of El Salvador, is significant. Species in the pine and pine-oak highlands include: Fulvous Owl (Strix fulvescens), Amethyst-throated Hummingbird (Lampornis amethystinus), Green-throated Mountain-Gem (L. viridipallens), Garnet-throated Hummingbird (Lamprolaima thami), Blue-throated Motmot (Aspatha gularis), Black-capped Swallow (Notiochelidon pileata), Bushy-crested Jay (Cissilopha melanocyanea), Black-throated Jay (Cyanolyca pumilo), Unicolored Jay (Aphelocoma unicolor),

Table 17. Birds Recorded in El Salvador Whose Current Status May be Endangered[1] or Extirpated[2]

Common Name	Scientific Name	Elevational Zone	Habitat Status
Great Tinamou*	Tinamus major	Lowlands	Forest
Boat-billed Heron[1]	Cochlearius cochlearius	Lowlands	Swamp
Jabiru	Jabiru mycteria	Lowlands	Marsh
Fulvous Whistling-Duck	Dendrocygna bicolor	Lowlands	Marsh
Muscovy Duck	Cairina moschata	Lowlands	Marsh-Swamp
King Vulture	Sarcoramphus papa	Lowlands	Forest Semi-open
Black-collared Hawk	Busarellus nigricollis	Lowlands	Swamp
Ornate Hawk-Eagle[2]	Spizaetus ornatus	Lowlands	Forest
Great Curassow[2]	Crax rubra	Lowlands	Forest
Crested Guan[2]	Penelope purpurascens	Lowlands-Highlands	Forest
Spotted Wood-Quail*	Odontophorus guttatus	Highlands	Forest
Maroon-chested Ground-Dove	Claravis mondetoura	Highlands	Forest
Scarlet Macaw[1]	Ara macao	Lowlands	Forest Semi-open
Yellow-headed Parrot[2]	Amazona ochrocephala	Lowlands	Forest
Spectacled Owl	Pulsatrix perspicillata	Lowlands	Forest
Black-and-white Owl	Ciccaba nigrolineata	Lowlands	Forest
Resplendent Quetzal	Pharomachrus mocinno	Highlands	Forest
Collared Aracari[1]	Pteroglossus torquatus	Lowlands	Forest

*No records for El Salvador. Perhaps formerly occurred but now exterminated.

Source: Hilty (speculation based on known habitat preference and habits).

Rufous-browed Wren (Troglodytes rufociliatus), Blue-and-white Mockingbird (Melanotis hypoleucus), Rufous-collared Robin (Turdus rufitorques), and Black Thrush (Turdus infuscatus).

Most birds of lowland moist and dry forests are more widespread in distribution, although this area also has suffered serious habitat loss along much of the Pacific slope of Central America. Many of the bird species in this area (Table 17) may no longer occur in El Salvador.

The loss of virtually all of El Salvador's natural forest is of particular concern because the area of Mexico and Central America south to western Panama and the northern Caribbean region, serves as the wintering ground for most migrant land birds that breed in North America. These migrants winter over a land area far smaller than their breeding range, and it has been shown that most north temperate migrants winter in forested zones (Keast and Morton 1980). Consequently, as deforestation proceeds, the amount of habitat available to these birds for wintering ground is reduced each year.

This trend can be appreciated fully when El Salvador, which comprises only about 5 percent of the Central American land area (excluding Mexico and Panama), but has lost more than 95 percent of its forest cover, is viewed against alarmingly similar trends in neighboring countries. For example, in Guatemala estimates of forest remaining vary from 33 percent to 59 percent; less than 20 percent of the original forest remains in the southern half of the country (Cooley et al. 1981). In Nicaragua forest cover is probably less than 60 percent (Hilty 1981) and in Costa Rica forest dropped from about 75 percent in 1940 to less than 31 percent in 1977 (Silliman 1981b). If these trends continue it is clear that wintering areas available for North American breeding migrants will be severely impacted, or will ultimately disappear. Tropical deforestation is clearly of global concern, having economic implications that have not even begun to be appreciated.

3.5.3 Amphibians and Reptiles

The U.S. Department of Interior lists three species of reptiles for El Salvador (1979). One of these, the American Crocodile (Crocodylus acutus), is listed by the IUCN Red Data Book (1975).

The Red Data Book also lists one additional species, the Central American Caiman (Caiman crocodilus). No amphibians are listed by either source. But because of almost countrywide environmental degradation, these lists primarily reflect a lack of information rather than the current status of reptiles and amphibians in El Salvador.

Two species of sea turtles listed by the U.S. Department of Interior (1979) suffer persecution, to a greater or lesser degree, throughout their broad range. It is not known if these turtles (Table 15) now breed in El Salvador or if they bred there in the past.

Relatively little work on reptiles and amphibians in El Salvador appears in the literature. The lists in Tables 18 and 19 are from Mertens (1952a, 1952b) in Daugherty (1974).

3.5.3.1 Status of IUCN Listed Crocodilia in El Salvador

Caiman crocodilus fuscus (Central American Caiman).
Status: Scarce or even extinct over large areas of range. Causes of decline are over-exploitation for hides, catching young for export as pets to U.S., sale of stuffed hatchlings and juveniles, and habitat loss. Hide industry mainly affects those over 80 cm in length.
Habitat: Freshwater but will enter brackish and salt water.
Conservation measures taken: Total prohibition of export of living animals and skins (IUCN 1976).

Crocodylus acutus (American Crocodile).
Status: Critically endangered throughout range. Formerly occurred from southern Florida and the Greater Antilles and on both coasts of central Mexico south to northern Colombia and western Ecuador.
Habitat: Brackish and salt water, occasionally fresh water.
Conservation measures proposed: as in previous species (IUCN 1976).

3.5.4 Fish

Several studies summarize the freshwater ichthyofauna of El Salvador, or treat specific drainage basins or taxa of fish. Two of the

Table 18. List of Reptiles

TESTUDINES

Kinosternon cruentatum
Staurotyphus salvinii
Geoemyda pulcherrima
Pseudemys ornata
Eretmochelys imbricata
Cheloniia mydas

LORICATA

Caiman crocodilus
Crocodylus acutus

SAURIA

Coleonyx mitratus
Gonatodes fuscus
Phylladactylus eduardofischeri
Anolis crassulus
Anolis cupreus
Anolis heterophoiidotus
Anolis lemurinus
Anolis sericeur
Basiliscus vittatus
Corytophanes percarinatus
Ctenosaura similis
Iguana iguana
Sceloporus malachiticus
Sceloporus squamosus
Sceloporus variabilis
Lepidophyma smithii
Barisia moreletii
Ameiva undulata
Cnemidophorus deppii
Cnemidophorus sackii
Gymnophthalmus speciosus
Lygosoma assatum
Lygosoma cherriei
Mabuya mabouya

SERPENTES

Leptotyphlops phenops
Constrictor constrictor
Loxocemus bicolor
Coluber mentovarius
Coniophanes fissidens
Coniophanes piceivittis
Conophis pulcher
Dryadophis dorsalis

SERPENTES

Drymarchon carais
Drymobius margaritiferus
Elaphe triaspis
Enulius flavitorques
Geophis fuivoguttatus
Imantodes gemmistratus
Lampropeltis doliata
Leptodeira annula
Leptodeira rhombifera
Leptodrymus pulcerrimus
Ninia sebae
Oxybelis aeneus
Oxybelis fulgidus
Pliocercus elapoides
Rhadinaea godmani
Rhadinaea montecristi
Rhadinaca pinicola
Rhadinaea zilchi
Scolecophis atrocinctus
Sibynophis albonuchalis
Spilotes pullatus
Stenorrhina freminvillii
Tantilla armillata
Tantilla brevicauda
Thamnophis sauritus
Trimetopon posadasi
Trimorphodon biscutatus
Tropidodipsas carri
Micrurus nigrocinctus
Agkistrodon bilineatus
Bothrops godmani
Bothrops nummifer
Bothrops ophryomegas
Crotalus durissus
Trimeresurus godmani

Source: Daugherty. 1974.

Table 19. List of Amphibians

GYMNOPHIONA
Gymnopis mexicana
CAUDATA
Magnadigita engelhardti
Oedipina salvadorensis
SALENTIA
Eleutherodactylus rhodopis
Eleutherodactylus rugulosus
Engystomops pustulosus
Leptodactylus labialis
Leptodactylus melanonotus
Bufo canaliferus
Bufo coccifer
Bufo marinus
Bufo valliceps
Agalychnis moreletii
Hyla baundinii
Hyla euthysanota
Hyla modesta
Hyla robertmertensi
Hyla salvadorensis
Hyla stafferi
Plectrohyla guatemalensis
SALENTIA
Rana macroglossa
Rana pipiens
Hypopachus aquae

Source: Daugherty. 1974.

earliest works are Meek (1908) and Hildebrand (1925), the latter treating the entire republic. Other more recent works include Miller (1955, 1966), Boseman (1956) and Myers (1960).

The native freshwater fish fauna of El Salvador is depauparate and reflects the low species diversity throughout Central America from the Isthmus of Tehuantepec to eastern Panama. The 30 species of freshwater fish in El Salvador (Daugherty 1974) are representative of the region (Table 20). None of these species are listed by the U.S. Department of Interior (1979) or the IUCN Red Data Book (1969), although, as with other vertebrate taxa, this probably reflects a lack of information rather than the current status of these species. Because of widespread stream pollution and siltation it is probable that some of the more sensitive species, or those of restricted distribution, may be threatened. No information was found on the ichthyofauna of the several large freshwater lakes of El Salvador.

3.5.5 Marine Fisheries

Shrimp fishing is the most important marine industry in El Salvador. After coffee and cotton, shrimp is the most important export. According to Moss (1971) the government rigidly limits the total shrimp fishing fleet to 68 trawlers, although some believe that the shrimp fishery could support a greater sustained yield, and hence a larger fleet. Other marine fishing, which is mostly incidental to shrimp fishing, accounts for a total catch of 2,000 to 2,700 metric tons (1965-1967), which is about 30 to 50 percent of the annual shrimp catch (5,000 to 7,300 metric tons).

Per capita consumption of fish in El Salvador, reported to be 0.8 kg annually (0.2 gm per person daily), is exceptionally low, especially for a country with a long coastline (U S. Department of Agriculture 1964 in Moss 1971).

3.5.6 Inland Fisheries

El Salvador possesses about 20 principal lakes, one-third of the lakes have areas in excess of 1 sq km. Most are of volcanic origin and, consequently, have rather small drainage basins and low productivity.

With respect to fisheries, the Rio Lempa is the largest and most important river, although

Table 20. List of Freshwater Fish

Scientific Name	Spanish Name
CHARACINAE	
Astyanax fasciatus	Plateada, Sardina
Roeboides salvadoris	Plateada, Sardina, Alma Seca, Ulumina
ARIDAE	
Aruis taylori	Bagre, Catfish
PIMELODIDAE	
Rhamdia guatemalensis	Filin, Catfish
CYPRINODONTIDAE	
Profundulus guatemalensis	Bagre, Catfish
Profundulus punctatus	Chimbola
Mollienesia sphenops	Chimbola
POECILUDAE	
Priapichthys letonai	Chimbola
Priapichthys fosteri	Chimbola
Anableps dovii	Cuatro-ojo
Pseudoxiphophorus bimaculatus	
Poecilistes pleurospilus	
Poeciliopsis turrubarensis	
FAMILY (?)	
Thyrina guija	Pepesca, Manjuda
MUGILIDAE	
**Mugil cephalus*	Liebre, Ancha, Liza
Agonostromus monticola	Tepemechin, Chimbera, Liza
CENTROPOMUS	
**Centropomus nigrescens*	Robalo
**Centropomus robalito*	Robalo
**Centropomus pectinatus*	Robalo

* Marine or brackishwater species.

Table 20. List of Fresh Water Fish (continued)

Scientific Name	Spanish Name
CICHLIDAE	
Cichlasoma nigrofasciatum	Burro, Achiba, Chamarra, Chincoyo, Conga, Mojarra
Cichlasoma macracanthus	Mojarra
Cichlasoma meeki	Mojarra Negra, Mojarra Plateada
Cichlasoma trimaculatum	Guapote, Mojarra, Istatagua
Cichlasoma motaguense	Guapote, Mora, Pando
ELEOTRIDAE	
Gobiomorus maculatus	Guvina
Eleotris picta	
**Dormitator latifrons*	
GOBIIDAE	
Sicydium gymnagaster	
Awaous banana	
Gobionellus microdon	

Sources: Hildebrand. 1925.
Boeseman, 1956 *in* Daugherty, 1974.

relatively little is known of total fish production, quantity of harvest, relative abundance by species or economic value of the fishery. Other rivers that contribute to the total fishery resource are the Ríos Paz, Jiboa, Grande de San Miguel, Goascoran, Torola and Sumpul (Figure 19). The remaining rivers, primarily coastal, are short (25-35 km), have very low volume during the dry season and are unimportant to the inland fishery industry.

The freshwater lakes and rivers in El Salvador support a relatively small number of fish species. A partial list of the most important commerical and subsistence freshwater fishery species is given in Table 21. Species of the Rio Lempa are given in Table 22. None of these species reach very large size. An attempt by the Ministry of Agriculture and Livestock to improve quality and quantity of the fishery has been made by introducing a number of exotic fish species.

The largest lakes, their areas, number of introduced (non-native) species present, and most important commercial species are shown in Table 23. In most cases, where introductions have occurred, these species (especially Cichlasoma) are now the most important commercially harvested fish. In Lago Coatepeque, freshwater crabs (Pseudothelphusa magna) are an important fishery product and a major source of revenue. Lago Olomega is by far the most productive for its size; the 1957 harvest, 110 kg per ha, is many times that harvested from other lakes.

In most lakes and rivers, gill nets, cast nets or hook and line are used; gill nets are favored by those that can afford them. Except for bans on the use of poisons, dynamite or home-made explosive devices, there are no restrictions on the type of fishing gear used or on the size of the fish taken. Fishing activities may be carried out year-round and no licenses are required.

Inland Fisheries and Aquaculture. Most of the information in this section is based on Moss (1971) and therefore does not reflect progress during the past decade. Before this period the government-operated Santa Cruz Porrillo Fisheries Station was the only fishery in El Salvador. This facility lacks trained personnel, adequate pond facilities, a deep well to ensure adequate water supply, and a cold-storage facility. Throughout El Salvador there is a need for basic information to improve

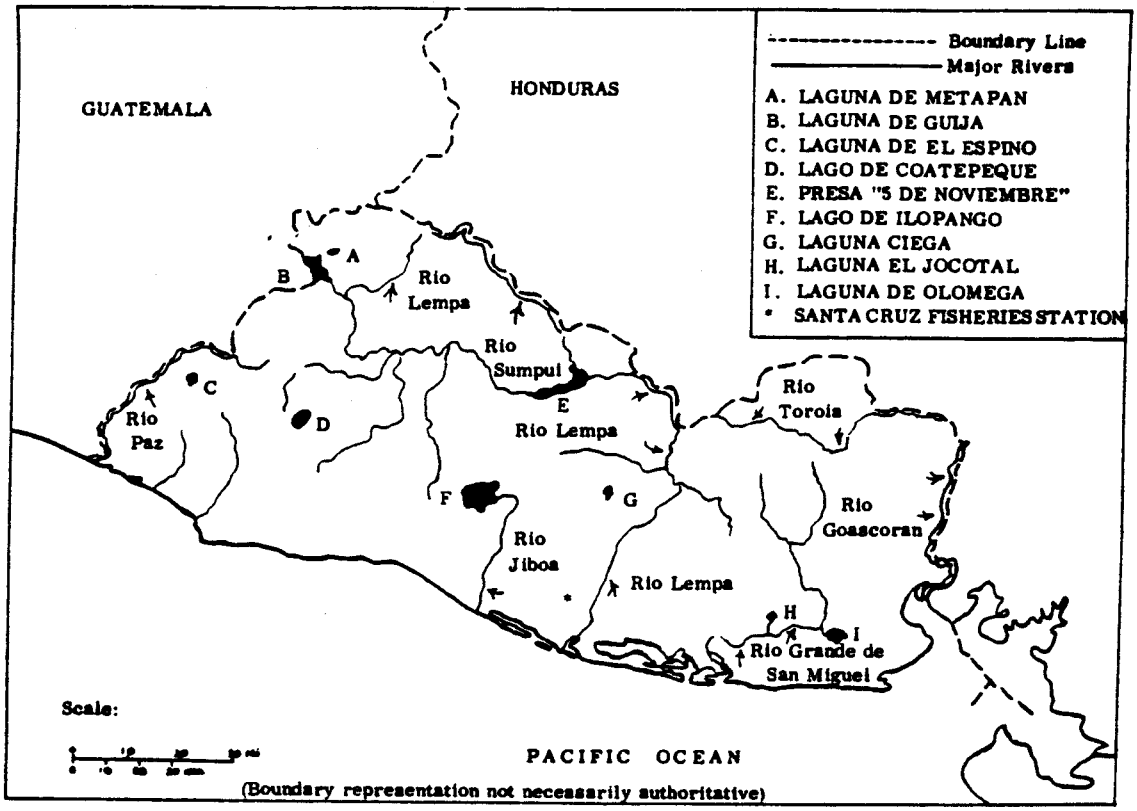

Figure 19. Map of Principal Lakes and Rivers Important to Fisheries

Source: Moss. 1971.

Table 21. Distribution of Important Native and Introduced Freshwater Fish and Crustaceans

Scientific Name	Common Name	Distribution[1]
Native Fish and Crustacean Species		
Cichlasoma macracanthrum	mojarra	O,G,I,A
C. trimaculatum	guapote	O,G.I
C. motaguense	guapote	O,G,I,C
C. nigrofasciatum	burra	Most lakes and rivers
Poecilia sphenops	chimbolo	O,G,I,A,C,E
Poeciliopsis turrubarensis	chimbolo	O,G,I,A,C,E
Roeboides salvadoris	sardina	O,G,I,A
Rhamdia guatemalensis	juilin	O,G,I,A
Astyanax fasciatus	plateada	O and most rivers
Dormitator latifrons	sambo	J and most rivers
Arius guatemalensis	bagre	O,G,I,A
Synbranchus marmoratus	anguila	O,C, and most rivers
Pseudothelphusa magna	cangrejo (crab)	C,G
Macrobrachium tenellum	camaron (prawn)	G,I and some rivers
Introduced Fish Species		
Cichlasoma managuense	guapote tigre	O,G.I,A,C,E
C. dovii	guapote blanco	A
C. guttulatum	mojarra azul	C
Tilapia mossambica	tilapia negra	G,I,A,C,E
Tilapia nilotica[2]	tilapia blanco	Santa Cruz Fisheries Station
Cyprinus carpio	carpa	Santa Cruz Fisheries Station
Micropterus salmoides	lobina negra	I,A

1. O = Laguna de Olomega; G = Lago de Guija; I = Lago de Ilopango; A = Laguna de Apastepeque; C = Lago de Coatepeque; E = Embalse 5 de Noviembre (reservoir); J = Laguna de Jocotal

2. Although commonly called T. nilotica at the station, this fish appeared to be T. aurea.

Source: Moss. 1971.

Table 22. Partial List of Fish and Crustacean Species Occurring in the Río Lempa

Scientific Name	Common Name
Freshwater Species	
Cichlasoma macracanthum	mojarra
C. trimaculatum	guapote
Arius guatemalensis	bagre
Rhamdia guatemalensis	julin
Astyanax fasciatus	plateada
Roeboides salvadoris	sardina
Poecilia sphenops	chimbolo
Poeciliopsis turrubarensis	chimbolo
Anableps dovii	cuatro ojos
Marine or Brackishwater Species	
Lutjanus novemfasciatus	pargo
Centropomus nigricans	robalo
C. robalito	robalete
C. pectinatus	robalo
Mugil cephalus	lisa
Menticirrhus undulatus	corbina
Promicrops itaiara	moro
Dormitator latifrons	sambo
Symbranchus marmoratus	anguila
Crustaceans	
Pseudothelphusa magna	cangrejo
Macrobrachium olfarsi	cacarico
M. acanthurus	camaron

Source: Moss. 1971.

Table 23. Fishery Statistics for the Five Largest Lakes in El Salvador

	Area sq km	Watershed sq km	Introd. Fish Species	Most Important Commercial Species	Approximate No. Full-time Fishermen
Ilopango	70.5	204	Cichlasoma managuense	C. managuense	200
			Tilapia mossambica	T. mossambica	
			Micropterus salmoides[1]	C. macracanthum	
Guija	44.1	1,989	Tilapia mossambica	Tilapia	300
			C. managuense	C. managuense	
			C. dovii[1]	Arius guatemalensis	100
Coatepeque	25.0	63	C. guttulatum	C. guttulatum	200 (part-time)
			Pseudothelphusa magna (Fresh-water crab)	Crab	
Olomega	18.6	252	C. managuense	C. managuense (Formerly Astyamax, Poecilia and Arius)	-----
San Juan	10.6	38	-----	-----	-----

[1] Did not survive.

management and use of the fishery resources. An effective farm pond fisheries program could provide a significant source of animal protein in inland areas where protein intake is low. Before significant progress in the inland fisheries program can be achieved, it is imperative that fishery personnel be trained in aquaculture and fishery management (Moss 1971).

Government Divisions Responsible for Fisheries. Marine fishery activities in El Salvador are directed by the Section for Fisheries and Maritime Activities under the Ministry of Economy. Inland fisheries programs are directed by the Ministry of Agriculture and Livestocks. The Fisheries Section carries out various research and extension projects.

3.5.7 National Parks, Protected Areas and Conservation

El Salvador is the smallest, most densely populated and most industrialized country in Central America. Between 90 percent and 95 percent of the land is under cultivation. Consequently, with less than three percent of the country still forested there are very few natural areas remaining in El Salvador. Most of the remnants of natural vegetation are under strong pressure for exploration and usually are extensively disturbed (La Bastille 1979).

Despite this sobering environmental picture in El Salvador, the country's national park service, the Unidad de Parques Nacionales y Fauna Silvestre, was continuing to move ahead with plans for the establishment and protection of several areas before the 1979-1982 civil strife. Four national parks have been established and are receiving some form of official protection, including one above La Libertad that was scheduled for establishment in 1978 (Prance and Elias 1977, La Bastille 1978). Each of these parks is discussed below and is shown on the map in Figure 20. A partial list of the flora and fauna of Parque Nacional Montecristo is given in Appendix III.

National Parks

Montecristo. (2,000 ha) Montecristo is the most important cloud forest remaining in El Salvador. It adjoins the Guatemala-Honduras border in the extreme northwest; 1,800 to 2,400 m elevations are reached at Cerro Miramundo (2,394 m) and Cerro Brujo (2,140 m). The flora and fauna are representative of Premontane and Montane Wet

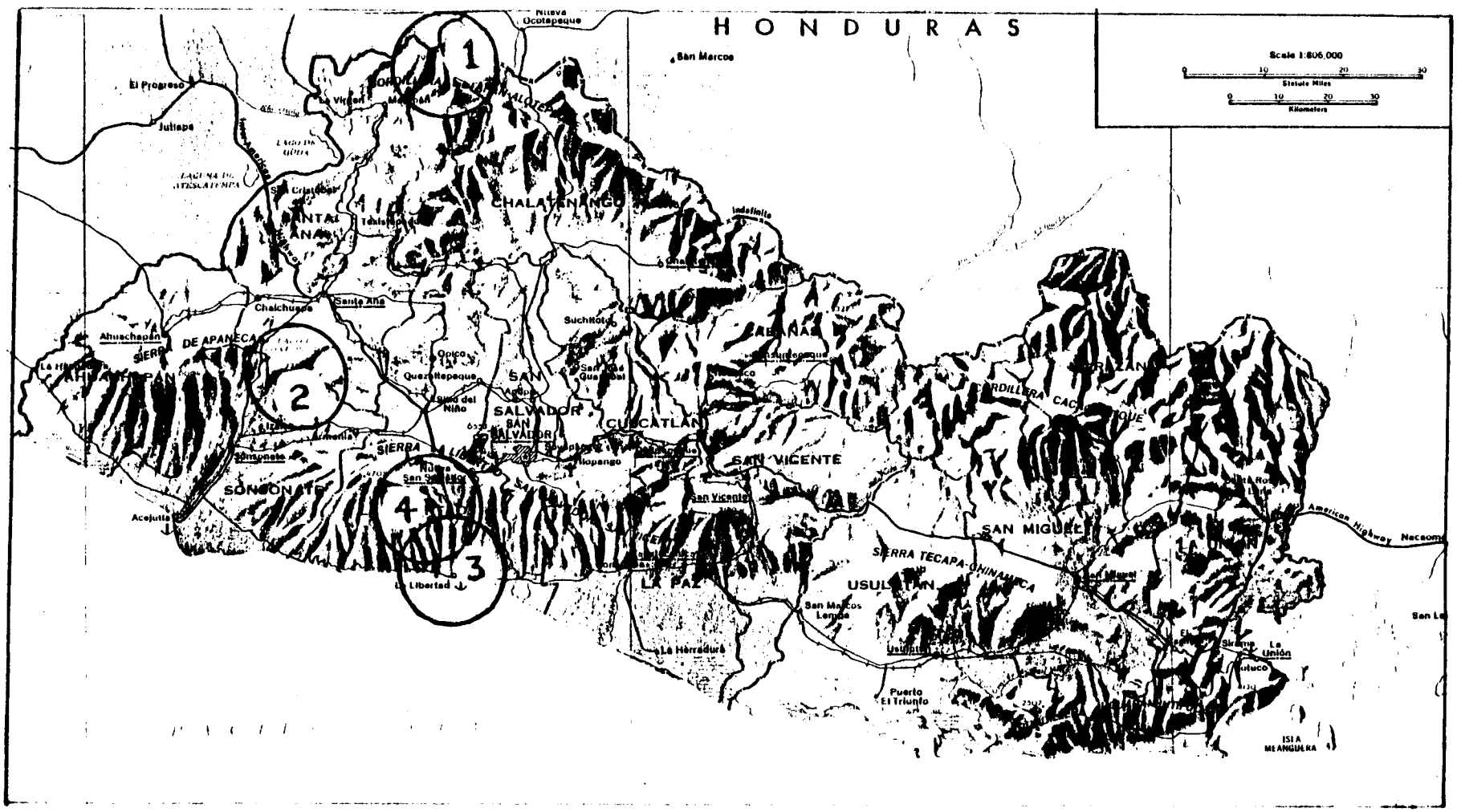

Figure 20. Location of National Parks; 1) Montecristo; 2) Cerro Verde; 3) Deneger; and 4) Thermopolis(?)

Forest. Situated within an extensive region of broken mountains, most of Montecristo is still covered with primary forest. Attractions include a population of Resplendent Quetzals and more than 200 species of orchids (at least one-fourth are endemic to El Salvador). Because the Park in El Salvador is contiguous with a larger forested area in adjoining Honduras and Guatemala, an attempt to establish a tri-national frontier park has been made. It is not known if all three countries have entered into a formal declaration on the status of this park.

Cerro Verde. (Size uncertain) Cerro Verde includes portions of Cerro Verde, Volcán de Izalco and Lago Coatepeque, and is on an escarpment overlooking Volcán des Escalo. Primarily cloud forest, the area is now heavily disturbed. Also, there was formerly extensive pine-oak woodland above about 1,800 m. Souvenir hunters and collectors frequently poach plants, especially orchids, epiphytes and tree branches, which are then sold for Christmas trade in cities. There is a tourist hotel in the park.

Deneger. (Size uncertain) Deneger is located on the coast near La Libertad. It was formerly subjected to extensive disturbance, including farming and wood cutting for many years. The construction of a road within the park also has caused extensive damage. It is hoped that with protection the area will recover. Because of disturbance and lack of natural habitat the park does not now conform to international definitions of "a national park."

Thermopolis. (Size uncertain) Thermopolis is a new park that was to have been established in 1978 in the mountains above La Libertad. It is an old forest composed primarily of a legume, Balsam de Peru (Myroxylon perierae). No current information on this park was available.

Several other parks have been identified by Daugherty (1974). These areas suffer to a greater or lesser degree from human disturbance. Table 24 lists each park with its most probable classifications.

La Bastille (1978) discusses two other areas of interest. Lago Jocoto is a very shallow, eutrophic, 1,000-ha lake in the Department of San Miguel in

Table 24. Classification of Proposed and Established Areas for a System of National Parks and Equivalent Reserves. Areas With an Asterisk are Officially Designated National Parks. A Fourth National Park, Thermopolis, is Not Shown in This List.

	PARQUE NACIONAL	RESERVA BIOLOGICA	SANTUARIO DE AVES	RESERVA DE FAUNA SILVESTRE	AREA DE REGENERACION	RESERVA FORESTAL	BOSQUE NACIONAL	RESERVA BIOLOGICA ESCOLAR	MONUMENTO NATURAL	MONUMENTO HIST/NAT.	AREA NACIONAL DE REC	TURICENTRO
* PARQUE NACIONAL DE MONTECRISTO	X											
Bosque nebuloso 2000 metros		X										
Periferia del bosque nebuloso 1700-2000 m				X								
Mac San José-Los Planes hasta 1700 m.					X							
Hacienda San José									X			
PARQUE NACIONAL DE SAN DIEGO	X											
Selva de San Diego					X							
Volcán de San Diego							X					
Bocana del Rio Angue			X									
Islas del Lago de Guija				X								
Lago de Guija y Laguna de Metapán										X		
Igualtepeque									X			
Iglesia de Metapán									X			
VOLCAN DE SAN SALVADOR	X											
El Picacho							X					
El Boquerón												X
Turicentro de Los Chorros												X
Cuenca Hidrográficas de Los Chorros		X										
Laguna de Chanmico			X									
Las lavas del Volcán de San Salvador							X					
* PARQUE NACIONAL DE CERRO VERDE	X											
Cerro Verde												X
Volcán de Izalco							X					
Lavas de Izalco				X			X					
Selva de Izalco		X										
Cráter del Volcán de Santa Ana 1800 m.							X					
Lago de Coatepeque										X		
Isla del Lago de Coatepeque		X		X								
Lado sureño del Lago de Coatepeque					X							
Lado norte del Lago de Coatepeque						X						
* PARQUE NACIONAL DE DEININGER	X											
Zona 1 - (enfrente)										X		
Zona 2 - (tierras bajas)				X								
Zona 3 - (tierras altas)					X							
NANCUCHINAME												
La selva		X										
Periferia de la selva (100 metros)				X								

Source: Daugherty. 1974.

Table 24, continued

	PARQUE NACIONAL	RESERVA BIOLOGICA	SANTUARIO DE AVES	RESERVA DE FAUNA SILVESTRE	AREA DE REGENERACION	RESERVA FORESTAL	BOSQUE NACIONAL	RESERVA BIOLOGICA ESC.	MONUMENTO NACIONAL	MON. HIST. / CULT.	AREA NAC. DE REC.	TURICENTRO
BAHIA DE JIQUILISCO	X											
Los manglares (al oeste del Puerto El Triunfo)						X						
Los manglares (al este del Puerto El Triunfo)		X										
Isla Tortuga		X										
La periferia de los manglares (1 Km)				X								
Isla El Arco (playa)		X								X		
Playa El Espino												
LA ZONA DE SAN MIGUEL												
Colinas de Jucuarán						X						
La Selva "Tierra Blanca"		X										
Volcán de San Miguel							X					
Las lavas del Volcán de San Miguel							X					
El bosque de robles del Volcán		X										
Laguna El Jocotal			X									
Laguna de Olomega			X									
Islas de la Laguna de Olomega		X										
Pantanos de la Laguna de Olomega			X									
Quelepa									X			
Minas de El Divisadero									X			
EL GOLFO DE FONSECA												
El Volcán de Conchagua							X					
La selva sureña del Volcán		X										
La selva este del Volcán				X								
Los manglares del Golfo		X										
Isla Meanguera (parte sureña)		X		X								
Isla Meanguerita		X		X								
Los Farallones			X									
Isla Martín Pérez				X								
Isla Icla				X								
Playa El Tamarindo										X		
LA SELVA DE PERQUIN		X										
EL LAGO DE ILOPANGO	X											
El lago y periferia										X		
Las islas y la peninsula		X										
Las faldas colindantes						X						
BARRA DE SANTIAGO	X											
Los manglares		X										
La playa										X		
La costa interior del estero										X		

southeastern El Salvador. The area has attracted attention because of large numbers of native and migratory waterbirds that use the lake and wetlands. It is considered to be the richest freshwater area in El Salvador. All four species of resident Central American ducks, including the rare Masked Duck (Oxyura dominica) occur on the lake, as well as a large number of north temperate breeding migrants that "winter" there, primarily between October and April. Herons, egrets, various rails and coots, anhingas, blackbirds, and crocodiles are also resident.

Although Lago Jacotal was formerly a favorite waterfowl hunting area, the Park Service recently closed the area to hunting and, according to La Bastille (1979), has enforced the ban. However, as a result of extensive pesticide use in the surrounding drainage basin, the lake is now subject to extensive chemical contamination, a far more difficult problem to control. Large fish- and bird-kills have already occurred during the rainy season and the Park Service has been making a strong effort to improve lake management. La Bastille (1978) has recommended that the area be made part of an international system of wildlife reserves. El Imposible Forest is named for a difficult mountain pass. More than 300 species of trees are known from this 4,000 ha forest, more than any other comparable area in El Salvador. Many of the epiphytic plants are reported to be distinct from those of Montecristo. The region may be the last reservoir in El Salvador for several species of large mammmals such as the Tayra, Two-toed Anteater and Ocelot. Because the forest has been privately owned and access has been difficult, it was largely overlooked by scientists until 1975; however, it has been exploited extensively by hunters for decades. Species such as the large cats, White-tailed Deer, Collared Peccary and probably Great Curassow no longer occur. More recently, efforts have been made to cut the forest and convert the region into coffee plantations. In 1978 money was allocated by the government to purchase and to protect El Imposible Forest. Several forest guards have already been stationed there to divert illegal squatters and to prevent timber cutting (La Bastille 1978).

3.5.8 Non-Governmental Conservation Agencies 10/

There have been relatively few private scientific and educational institutions active in conservation and environmental issues in El Salvador. This lack of interest, especially by large international conservation organizations such as the World Wildlife Fund (WWF) and the International Union for the Conservation of Nature and Natural Resources (IUCN) probably derives from the fact that almost no natural areas of importance have survived to the last quarter century. The following is a brief description of two non-government agencies that have been active in El Salvador.

National Ecology Commission. This is a private organization composed of persons from academic, business, industrial, professional, and government sectors. The National Ecology Commission organizes seminars and symposiums and regularly sponsors programs aimed at stimulating regional interest in environmental matters. The Commission has collaborating biologists and ecologists who perform research on national environmental problems. The Commission has attempted to promote ecology and environmental awareness in primary and secondary schools and to provide interdisciplinary techno-environmental courses at the university level.

Centro Agronomico Tropical de Investigación y Ensenañza (CATIE). Originally founded and funded by the Organization of American States (OAS), CATIE is a non-profit, scientific and educational association. It now receives support from a number of international conservation organizations and other U.S. and international agencies. CATIE's scope of operations is international but its primary focus is Central America. The organization is based in Coast Rica, where its operation and influence have been most extensive. The Wildlands and Watershed Unit of CATIE has played a particularly important role in encouraging establishment of national parks and reserves, including a pilot park in each Central American country. During the establishment of Parque Nacional Montecristo, the Wildlands and Watershed Unit provided equipment and training.

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10 Source: La Bastille. 1978.

4.0 Environmental Problems

This section reviews environmental problems in El Salvador. The major environmental problems confronting El Salvador are similar to those of neighboring Latin American countries but are now even more chronic and intractable because of greater industrialization, a far higher population density and a government plagued with major civil disorder. The most serious problems include deforestation, soil conservation, water conservation, environmental pollution, and human resettlement.

4.1 Role of Land Scarcity, Overpopulation, Culture and Economics in Deforestation

Almost all of the natural vegetation of El Salvador was once forest, ranging from dry woodland in the central interior, to wet cloud forests, at higher elevations in the interior mountains and coastal volcanos. Today less than 2 percent of the original forest remains. Forest destruction by early settlers was so thorough that even by the beginning of this century 90 percent of the forestland was lost. Today there is little undisturbed land left. Destruction has touched virtually all indigenous natural habitats and has resulted in extinction of more than 20 mammalian taxa and accelerated erosion of an estimated 77 percent of the land area (Durham 1979).

Many of the environmental problems that plague El Salvador can be traced to overpopulation, and to social patterns and political events that created unequal access to land and other resources on local and national levels. Overpopulation is an important contributor to El Salvador's current environmental plight. El Salvador's population density is more than five times as great as any mainland country in the Western Hemisphere, and is more densely populated than India, an acknowledged standard of comparison (Durham 1979). Less well known but equally important to the current environmental problems are unfortunate political and social events that allowed a minority to accumulate and control more than half of all agricultural land in the country, and almost all of the flattest and most fertile land (see Section 2.4.1). These events thrust an ever expanding population onto more marginal, less productive land that was cleared and farmed intensively for subsistence food crops.

These trends were further accelerated by economics which also have played an indirect, although important, role in deforestation in El Salvador. Land accumulated by large haciendas was kept fallow or used to produce cash crops for export. As a result, the most intensive land use--the

production of subsistence foods such as rice, beans, and maize--is carried out in the least suitable localities. This trend, aggravated by population growth and an increase of the land-less or land-poor, has placed extreme pressure on the remaining areas that are least suitable for agriculture. According to Durham (1979), without significant land-redistribution programs and more intensive use of the more productive land, El Salvador will have to depend increasingly upon imported food to support its growing population.

Interestingly, recent U.S. supported land and economic reforms undertaken by President Duarte have done little to alleviate the plight of the poor. Many former landowners contend that by nationalizing the biggest farms and redistributing the land among less fortunate peasants, Duarte wrecked the country's efficient and productive agriculture. They claim that land redistribution has made everyone poorer, and has sharply reduced much-needed commodity exports upon which the government depends heavily for revenue (Schuster 1982).

Cultural factors also have played a role in deforestation. In El Salvador, as in Costa Rica (Silliman 1981b) and most other Latin American countries, the original Spanish colonists regarded tropical forest as a hostile environment. This attitude has persisted to the present, and as a result, the natural vegetation is repeatedly cut and burned until ultimately no woody regrowth is possible. This attitude is even reflected in the vocabulary of rural people who often refer to natural vegetation as "monte" or untamed forest, while "bosque" (forest) is reserved for tree plantations (Silliman 1981b).

4.2 Consequences of Deforestation

4.2.1 Soil and Water Quality

As a result of massive deforestation, El Salvador has lost a significant portion of its capacity for storing groundwater. Also, extensive soil erosion has led to landslides, gully formation, loss of soil nutrients, siltation of rivers and dams, reduction of water tables, and frequent flooding of rivers. The lowered water table has been particularly noticeable on Volcán San Salvador, which provides San Salvador with all of its drinking water.

The most dramatic consequence of deforestation has been the destruction and loss of soil. El Salvador's soils are largely volcanic and fertile but extremely susceptible to erosion. Consequently,

loss of natural vegetation from steep slopes has resulted in dramatic geomorphological changes such as extensive ravine and gully formation. In flatter river valleys, soils are largely alluvium. In non-volcanic mountains of the north, lateritic type soils predominate. The latter are highly fragile and when exposed to erosive processes, undergo loss of fertility, and fundamental and irreversible changes in composition.

Soil erosion is most extensive in the northern mountain region (Cordillera Norte), including the lower slopes of Montecristo in the extreme northwest. Formerly covered with deciduous forest or mixed pine-oak woodland, the region is now almost 100 percent deforested. Soil cover is now impoverished or eroded, often exposing bare rock. Vegetative regrowth is now shrubby and xerophytic.

The volcanic central mountains have escaped some of the soil degradation that characterizes the north because of coffee cultivation. Nevertheless, soil loss throughout the country has been significant and has caused serious problems. The dependable supply of safe drinking water is one of the most immediate problems. With deforestation, the hydrologic cycle has been greatly accelerated, water absorption by soil has been poor and groundwater replacement has diminished. Another serious environmental consequence of deforestation has been the greatly accelerated rate of siltation of the principal hydroelectric dam, Cinco de Noviembre, on the Río Lempa. The siltation has markedly reduced energy production capabilities and has negatively impacted energy-dependent industry and human settlement. Water available for irrigation also has been reduced. Because of the decreased productivity of the Cinco de Noviembre hydroelectric plant, the Salvadoran government is constructing another hydroelectric plant on the Cerrón Grande in the upper Río Lempa basin. This new project will require greatly improved watershed management if the Cinco de Noviembre Dam experience is to be avoided.

4.2.2 Loss of Native Flora and Fauna

El Salvador, for its small size, formerly had a surprisingly diverse flora and fauna (see Sections 3.3 and 3.4). However, destruction of native flora and fauna has been so extensive that there appears to be no hope of meaningful recovery. The primary cause of the loss of native fauna is simple

--deforestation, or degradation of habitat. In the case of economically important species, over-exploitation is also a significant factor. Examples of the latter occur in the pet or skin trade, sport hunting, or when wildlife is used as a source of food.

Small steps have been taken to enforce wildlife and environmental legislation, to establish national parks and to implement reforestation of some areas in El Salvador. However, there is little likelihood that a century or more of selfish and thoughtless destruction of natural resources can be erased or even arrested. The remaining fragments of natural habitat are now "tiny islands" in a sea of bare or cultivated land and many of the small populations of plants and animals that remain may ultimately decline to extinction. This phemenoma has been demonstrated on Barro Colorado Island (Willis 1974; Willis and Eisenmann 1979) and at La Selva, Costa Rica (Stiles in Silliman 1981), and is being tested further in central Brazil by Thomas Lovejoy of the World Wildlife Fund. For many species recolonization is unlikely because reserves are isolated from larger reservoir areas and lack connecting corridors that permit gene flow and population exchange. As species are lost from these small islands of forest, they are unlikely to be replaced. This in turn sets in motion a chain reaction that gradually lowers the fitness of other species and leads to gradual dissolution of complex interrelationships established over millenia.

The loss of genetic diversity due to increasing fragmentation and isolation of forests and forest biota is incalculable. Already the diversity of these forests has provided man with a vast array of pharmaceuticals, plant products and hybrids that have propelled science and agriculture into twentieth century technology. It is likely that our understanding and use of this diversity has only begun.

The outlook for recovery of El Salvador's native flora and fauna is not hopeful. It is complicated by cultural resistance, economics, human overpopulation, a massive refugee problem, inefficient land use, and a system of land distribution that is in hopeless disarray. All of this is further complicated at present by bloody civil strife, paralyzing for an indefinite period of time, any constructive environmental progress that may have been made.

4.3 Environmental Pollution

4.3.1 Water Pollution

Water pollution, particularly in rural areas, is causing gastrointestinal disease and increasing infant mortality rate. The most prevalent source of water pollution is solid-waste discharge from coffee-processing plants. Other important sources of water pollution are untreated industrial and human wastes and toxic chemicals in irrigation runoff.

In several rivers that have been monitored the minimum sanitary standard of 4 parts per million (ppm) of dissolved oxygen is not met. Pollution increases markedly during the dry season when river levels are low and there is insufficient water for dilution. Most coffee-processing is carried out only during the dry season.

The most polluted rivers are those near urban and industrial areas or in coffee-processing areas. Untreated sewage pollutes the Ríos Acelhuate, Meteyate, Las Cañas and Urbina in the Department of San Salvador, the Río Suguiapa in the Department of Santa Ana, the Río Sucio in the Department of Quezaltepeque and its surroundings, and the Río Grande de San Miguel in the Department of San Miguel. In many areas lakes and dams are also being polluted by discharge from rivers. The most common lake water pollutants, boron, chloride and arsenic, are now present in varying levels in most of El Salvador's lakes. The water from Laguna de Coatepeque, which contains high levels of boron, is being used to irrigate the country's principal dairy-producing area, and may lead to serious health and environmental problems.

It is believed that the shortage of safe drinking water mentioned in Section 4.2.1 will eventually affect most of the country because of groundwater pollution. Much groundwater is already toxic and cannot be used for consumption or irrigation.

El Salvador has environmental laws regarding water quality. For example, the Irrigation and Drainage Law (Decree No. 153, 17 November 1970), which covers water pollution caused by sewage, requires purification treatment on all polluting establishments. However, such laws are often ineffective because they cannot be enforced.

Relocation of industrial establishments has been considered but no action is likely to be taken.

4.3.2 Toxic Chemical Pollution

The widespread and indiscriminate use of pesticides in agriculture is now a serious environmental problem. Prolonged use of DDT and organo-phosphated pesticides, which resist organic breakdown, has led to unacceptably high levels of these chemicals in both terrestrial and marine ecosystems. The cotton-growing areas of the coast are the most seriously contaminated agriculture areas in El Salvador. Both there and elsewhere dangerously high levels of DDT and other resistant pesticides have been detected in fish and shrimp, in the meat and milk of livestock, and in human mother's milk. Pesticide contamination of foods has had adverse economic effects. For example, consignments of beef exported to the United States have been rejected by the U.S. Department of Agriculture because of excessive pesticide levels in the meat. In 1976 about 500,000 pounds of El Salvador beef were rejected when levels of up to 95 ppm of DDT were found. That was 19 times higher than the U.S. maximum acceptable level of 5 ppm (U.S. AID 1979).

Human health problems created by pesticide poisoning are also increasingly common. According to U.S. AID (1979) between 1971 and 1976, 19,000 medically certified pesticide poisonings were reported in Central America, of which about 17,000 were in El Salvador and Guatemala. In Central America about 300 pesticide poisonings per 100,000 population occur annually, compared with about 100 per 60 million annually in the United States. Also, it is believed that in Central America, only a small percentage of the cases, the most acute exposures, are ever reported. Nothing is known about the effects or extent of chronic, low-level exposures on the population to pesticide-contaminated food and water.

Although the hazards of pesticide pollution are now more widely recognized, other types of agricultural pollution are becoming more common. The widespread use of fertilizers has resulted in nitrate and phosphate contamination of runoff waters, producing accelerated stream and lake eutrophication and groundwater pollution (U.S. AID 1979). Increased eutrophication due to fertilizer chemical runoff has become a serious problem in Lago de Olomega.

Many insect pests have become resistant to DDT, requiring the use of newer and even more toxic pesticides such as parathion and organic-phosphates. The widespread use of pesticides to control insect damage to agricultural crops also has contributed to the development of insect vectors of human disease that are resistant to chemical control. For example, malaria in El Salvador is now closely associated with cotton-growing areas along the coast where DDT and Propoxur have been used so excessively that they are no longer effective. In fact, because of recent increases in reported malaria, most programs are now aimed at control, with eradication viewed only as a possible long term goal.

4.3.3 Urban Pollution

Industrial, air and noise pollution are problems that, in one degree or another, are confronting or will confront El Salvador's major urban areas in the short term and rural areas in the long term. They are already considered serious in some large Central and South American cities. No information on these problems was available on El Salvador.

4.3.4 Human Resettlement 11/

The resettlement of refugees coupled with an already acute housing shortage is a problem that could have significant negative impact on the environment in the future. Because of unequal access to land and a rapidly growing population many land-less and land-poor peasants fled to neighboring Honduras which had much undeveloped land. By 1969 it was estimated that more than 300,000 Salvadoran immigrants had settled in Honduras, mostly along the border between the two countries. Many were ultimately expelled from Honduras, creating political problems that culminated in the four-day soccer war between the two countries in 1969. It is believed, however, that as many as 40,000 immigrants remained in Honduras. Because of intense internal strife in El Salvador during the last two to three years, there are more than 180,000 Salvadoran refugees estimated to be living outside the country. The majority of

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11/ Source: Quart. Econ. Rev. 1981a, 1981b.

refugees now live in Mexico and Venezuela. A growing number also live in refugee and relief camps inside the Honduran border.

El Salvador has suffered a serious housing shortage for more than two decades. In the city of San Salvador alone, 75 percent of the population lives in illegal settlements, or mesones, most of which lack public services such as waste disposal and treated water. In most of the illegal shantytowns services are totally lacking and the danger of pollution is very high. In areas where these settlements develop, human wastes pollute the upper layers of groundwater. Groundwater often is the source of well water for human consumption.

The problem of human resettlement and inadequate housing, fueled by inadequate access to land, exploding population numbers, the soccer war and the present civil disorder, are believed to represent significant environmental pollution problems that are likely to become even more acute. Comprehensive human settlement policies should be established and implemented although the ultimate solutions to the problems will require political stability and economic prosperity on a national level.

4.4 Environmental Planning, Policy and Law

El Salvador does not have comprehensive national laws and a dominant institution for environmental management. Institutional capacity at the technical level to implement a national environmental plan exists but no initiatives have been taken. Lack of initiative at the national level in establishing a special organiziation for coordination and planning environmental matters is an important reason why a comprehensive land use and environmental policy does not exist. In place of such an organization the National Environmental Protection Committee was decreed on February 6, 1974. This committee has had very little effect in developing new environmental initiatives within the existing governmental framework. Probably the importance of designating an agency to deal with environmental problems has not been recognized in El Salvador, but more recently, events beyond governmental control appear to have overshadowed environmental problems.

Isolated policies exist within various governmental agencies but these do not yet come close to constituting a coordinated policy. Several laws enacted over the years

relate to critical environmental problems and are listed in Table 25. The institutional organizations, areas of environmental concern and their principal activities are shown in Table 26. Responsibility for various environmental matters is placed within existing ministries. The National Economic and Social Development Plan deals with the country's principal environmental problems. They were attempting to meet their objectives through agrarian reform, redistribution of income, active participation in labor, promotion of exports, reduction of imports, and reorientation of industry. Little progress appears to have been made, especially in light of the current civil disorder. Moreover, there is no provision that would promote or bring about rational use of resources or management of ecosystems.

Table 25. Laws Relating to Critical Environmental Problems

- Law for the Control of Pesticides, Fertilizees and Products for AGricultural Use. (Decree No. 315, Diario Oficial, No. 85, Vol. No. 239, 10 May 1973);

- The Sanitation Code and Addenda (for factories and industries);

- General Regulations on Safety and Hygiene in Work Centres. (Decree No. 7, Diario Oficial No. 27, Vol. 230, 9 May 1971);

- General Traffic Regulations, (Decree No. 13, Diario Oficial, No. 277 Vol. No. 141, 14 December 1946) of interest with regard to air pollution;

- Establishment of the National Environmental Protection Committee (Decree No. 18, Diario Oficial, Vol. No. 242, No. 25, 6 February 1974;

- Project for a Health Code, Department of Health. Refers specifically to sanitation of the urban and rural environment. This Code has not been enacted so far.

- The Irrigation and Drainage Law. (Decree No. 153, 17 November 1970, Diario Oficial No. 213, Vol. 229, 23 November 1970). Refers specifically to control of water pollution caused by sewage and to treatment of waste matter;

- General Regulations of the Irrigation and Drainage Law. (Decree No. 17, Diario Oficial No. 48, Vol. No. 238, 9 March 1973); and

- The Forestry Law. (Decree No. 268, Diario Oficial No. 50, Vol. 238, 13 March 1973). Refers specifically to forestation and reforestation, and protection of flora and fauna.

Source: UNEP. 1976.

Table 26. Government Agencies and Ministries and Areas of Responsibility in Environment

Field of Action	State Organization	Principal Activities
1. Air	Division of Environmental Sanitation, Ministry of Public Health and Social Welfare.	Environmental Pollution programme. Investigates outdoor atmosphere.
	National Department of Hygiene and Occupational Safety, Ministry of Labour	Control of Pollution of confined atmosphere (industrial)
	Department of Civil Engineering, School of Engineering and Architecture, University of El Salvador.	Studies on atmospheric pollution.
	Renewable Natural Resources, Ministry of AGriculture	Meteorological Service: - Supervises and investigates atmospheric processes, climatic and agro-climatic conditions and tidal movements. - Operates, maintains and expands the network of meteorological stations. - Collects, evaluates, processes, analyzes and publishes meteorological information. - Prepares weather forecasts. - Prepares climatic, agro-meteorological, hydro-meteorological and general studies of the country.

Source: UNEP. 1976.

Field of Action	State Organization	Principal Activities
2. Fresh Water	Division of Environmental Sanitation, Ministry of Public Health and Social Welfare	Investigation of pollution of lakes and rivers, and control of drinking water pollution.
	Department of Renewable Natural Resources, Ministry of Agriculture	Hydrological Service: 1. Determination of river volumes and flows - Daily variations in lake and river levels. - Silt in suspension - Physical and chemical quality information on river water 2. Hydrological and hydrogeological studies for research purposes 3. Hydrological forecasting 4. Collaboration with other organizations in the development of water resources.
3. Soil, Fauna and Flora	Department of Renewable Natural Resources, Ministry of AGriculture	Soil Conservation Service: - Surveying and classification of soils, inventory, evaluation, research and development with regard to soil resources. - Studies and projects for hydrographic river basin management.
	Department of Renewable Natural Resources, Ministry of AGriculture	Forestry and Wildlife Service: - Administration, inventory, evaluation and development of forest and wildlife resources. - Management of national and private forest resources. - Promotion of conservation, creation and administration of forest reserves, national parks and other reserves for the conservation of flora and fauna for the community benefit.

Field of Action	State Organization	Principal Activities
	Department of Renewable Natural Resources, Ministry of AGriculture	Fisheries Service: - Inventories and evaluates the natural wealth of the environment. - Inventories and protects aquatic flora and fauna using technical, scientific and legal means for the exploitation and rational use of these resources.
4. Non-Renewable Natural Resources	Geotechnical Research Centre, Ministry of Public Works	Evaluation of Mineral Resources: - Mineral resources zoning, evaluation and location studies. - Research and analysis services for obtaining necessary information on existing mineral deposits in order to programme their rational use.

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Appendix I

List of Mammals (excluding bats and marine species)

Scientific Name	English Name	Spanish Name
MARSUPIALIA		
Didelphis marsupialis	Southern Opossum	Tacuazin
Chironectes minimus	Water Opossum	Tacuazin de Agua
Metachirops opossum	Gray Four-eyed Opossum	Tacuazin-cuatro Ojos
Marmosa mexicana	Mexican Mouse-Opossum	Tacuazin-raton Mexicana
INSECTIVORA		
Cryptotis goodwini	Goodwin's Small-eared Shrew	Musaraña Guatemalteca de Orejas Pequena
Cryptotis parva	Least Shrew	
Cryptotis nigrescens	Blackish Small-eared Shrew	
PRIMATES		
Alouatta palliata	Mantled Howler Monkey	Mono Aullador
Ateles geoffroyi	Geoffroy's Spider Monkey	Mono Arana
EDENTATA		
Myrmecophaga tridactyla	Giant Anteater	Oso Hormiguero
Cyclopes didactyla	Two-toed Anteater	Hormiguero de Dos Dedos
Tamandua mexicana	Tamandua	Tamandua
Cabassous centralis	Central American Five-toed Armadillo	Cusuco de Cinco Dedos
Dasypus novencinctus	Nine-banded Armadillo	Cusuco de Nueve Bandas
LAGAMORPHA		
Sylvilagus floridanus	Eastern Cottontail	Conejo Montés, o Conejo Cola de Algodón
RODENTIA		
Sciurus variegatoides	Variegated Squirrel	Ardilla Gris
Sciurus deppei	Deppe's Squirrel	Ardilla Roja
Orthogeomys pygacanthus	Pocket Gopher (sp.)	Geomis de Bolsillo
Liomys salvini	Salvin's Spiny Pocket Mouse	Ratón de Bolsillo Espinoso
Heteromys desmarestianus	Desmarest's Spiny Pocket Mouse	Ratón de Bolsillo Espinoso
Oryzomys couesi	Coues' Rice Rat	Rata Arrocera
Oryzomys alfaroi	Alfaro's Rice Rat	Rata Arrocera
Oryzomys fulvences	Pygmy Rice Rat	Rata Arrocera Enana
Tylomys nudicaudus	Peter's Climbing Rat	Rata Trepadora
Ototylomys phyllotis	Big-eared Climbing Rat	Rata Trepadora
Nyctomys sumichrasti	Sumichrast's Vesper Rat	Rata Nocturna
Reithrodontomys sumichrasti	Sumichrast's Harvest Mouse	Ratón de Cosechas
Reithrodontomys fulvescens	Fulvous Harvest Mouse	Ratón de Cosechas
Reithrodontomys gracilis	Slender Harvest Mouse	Ratón de Cosechas
Reithrodontomys mexicanus	Mexican Harvest Mouse	Ratón de Cosechas Mexicano
Peromyscus bovlii	Brush Mouse	Ratón de Arbustos
Peromyscus mexicanus	Mexican Deer Mouse	Ratón Venado Mexicano
Peromyscus stirtoni*	Stirton's Deer Mouse	Ratón Venado
Baiomys musculus	Southern Pygmy Mouse	Ratón Enano del Sur
Scotinomys teguina	Alston's Brown Mouse	Ratón Pardo
Sigmodon hispidus	Cotton Rat	Rata del Algodón
Rheomys thomasi	Thomas' Water Rat	Rata de Agua

* Known only from east El Salvador and southwest Honduras.

Appendix I (continued)

List of Mammals (excluding bats and marine species)

Scientific Name	English Name	Spanish Name
RODENTIA		
Coendu mexicanus	Mexican Porcupine	Puerco Espin
Dasyprocta punctata	Agouti	Cotuza
Agouti paca	Paca or Spotted Cavy	Tepescuintle
CARNIVORA		
Canis latrans	Coyote	Coyote
Urocyon cinereoargenteus	Gray Fox	Zorro Gris or Gato de Monte
Bassariscus sumichrasti	Cacomistle	Cacomistle
Procyon lotor	Racoon	Mapache
Nasua narica	Coatimundi	Pezote
Potos flavus	Kinkajou	Micoleón
Mustela frenata	Long-tailed Weasel	Comadreja
Eira barbara	Tayra	Tayra
Galactis allamandi	Grison	Grisón
Spilagule putorius	Eastern Spotted Skunk	Zorrillo Moteado
Mephitis macroura	Hooded Skunk	Zorrillo Encapuchado
Conepatus leucorotus	Eastern Hog-nosed Skunk	Zorrillo
Lutra annectens	Southern River Otter	Nutria del Río
Felis onca	Jaguar	Jaguar or Tigre
Felis concolor	Mountain Lion	León, Puma
Felis pardalis	Ocelet	Tigrillo
Felis wiedii	Margay	Tigrillo
Felis yagouaroundi	Jaguarundi	Gato Zonto
PARISSODACTYLA		
Tapirus bairdii	Central American Tapir	Danta or Tapir
ARTIODACTYLA		
Tayassu tajacu	Collared Peccary	Cuche de Monte de Collar
Tayassu pecari	White-lipped Peccary	Cuche de Monte de Labio Blanco
Odocoileus virginiana	White-tailed Deer	Venado de Cola Blanca
Mazama americana	Red Brocket	Venadito Rojo

Sources: Daugherty. 1974.
Hall. 1977.
Hall and Kelson. 1959.

Appendix II

Birds of Uncertain Status

All have been recorded at least once in El Salvador; most are confined to highland pine, pine-oak, or cloud forest zones that have been largely eliminated in El Salvador.

White-breasted Hawk (Accipiter chinogaster). Pine-Oak and Cloud Forest from southern Mexico to Nicaragua.

White-bellied Chachalaca (Ortalis leucogastra). Dry Pacific slope lowlands from southern Mexico to western Nicaragua.

Black Penelopina (Chachalaca) (Penelopina nigra). Cloud Forests from southern Mexico to Nicaragua. Probably exterminated in El Salvador.

Buffy-crowned Wood Partridge (Dendrortyx leucophrys). Pine-Oak and Cloud Forest from southern Mexico to Costa Rica.

Singing Quail (Dactylortyx thoracicus). Pine-Oak and Cloud Forest from central Mexico to Honduras.

Ocellated Quail (Cyrtonyx ocellatus). Grassy understory of Pine-Oak Woodland from southern Mexico to Nicaragua.

White-faced Quail Dove (Geotrygon albifacies). Cloud Forest from southern Mexico to Nicaragua.

White-fronted Parrot (Amazona albifrons). Scrubby woodland of Pacific slope from western and southern Mexico to northwestern Costa Rica.

Fulvous Owl (Strix fulvescens). Pine-Oak and Cloud Forest in highlands from southern Mexico to El Salvador.

Emerald-chinned Hummingbird (Abeillia abeillei). Cloud Forest highlands from southern Mexico to northern Nicaragua.

White-eared Hummingbird (Hylocharis leucotis). Pine and Pine-Oak Woodland from extreme southwestern United States to Nicaragua.

Red-billed Azurecrown (Amazilia cyanocephala). Pine and Pine-Oak Woodland of highlands from eastern Mexico to Nicaragua.

Berylline Hummingbird (Amazilia beryllina). Pine and Pine-Oak Woodland from central Mexico to El Salvador and Honduras.

Amethyst-throated Hummingbird (Lampornis amethystinus). Cloud Forest and Pine-Oak woodland from central Mexico to El Salvador and Honduras.

Green-throated Mountain-Gem (Lampornis viridipallens). Pine-Oak Woodland and Cloud Forest from southern Mexico to northwestern El Salvador and western Honduras.

Garnet-throated Hummingbird (Lamprolaima rhami). Cloud Forest and Pine-Oak Woodland from southern Mexico to El Salvador.

Sparkling-tailed Hummingbird (Tilmatura dupontii). Woodland edge in highlands from central Mexico to Nicaragua.

Blue-throated Motmot (Aspatha gularis). Cloud Forest and Pine-Oak highlands from southern Mexico to El Salvador and Honduras.

Black-capped Swallow (Notiochelidon pileata). Highlands from southern Mexico to El Salvador, rarely western Honduras.

Bushy-crested Jay (Cissilopha melanocyanea). Wooded highlands of Guatemala to El Salvador and Nicaragua.

Black-throated Jay (Cyanolyca pumilo). Pine-Oak and Cloud Forest from southern Mexico to El Salvador and Honduras.

Unicolored Jay (Aphelocoma unicolor). Pine-Oak and Cloud Forest from southern Mexico to El Salvador and Honduras.

Rufous-browed Wren (Troglodytes rufociliatus). Pine-Oak and Cloud Forest from southern Mexico to El Salvador and Honduras.

Blue-and-white Mockingbird (Melanotis hypoleucus). Woodland borders in highlands from southern Mexico to El Salvador and Honduras.

Brown-backed Solitaire (Myadestes obscurus). Pine-Oak and Cloud Forest from northwestern Mexico to El Salvador.

Rufous-collared Robin (Turdus rufitorques). Cloud Forest and Pine-Oak Woodland from southern Mexico to El Salvador and western Honduras.

Black Thrush (Robin). (Turdus infuscatus). Pine-Oak and Cloud Forest from central Mexico to El Salvador.

Fan-tailed Warbler (Euthlypis lachrymosa). Forested highlands from Mexico to northwestern Nicaragua.

Golden-browed Warbler (Basileuterus belli). Pine-Oak and Cloud Forest from Mexico to El Salvador and Honduras.

Blue-crowned Chlorophonia (Chlorophonia occipitalis). Cloud Forest borders from southern Mexico to northern Nicaragua.

White-eared Ground-Sparrow (Melozone leucotis). Forest edges in highlands from southern Mexico to Costa Rica.

Black-headed Siskin (Spinus notatus). Pine and Pine-Oak Woodland from highlands of southern Mexico to Nicaragua.

Appendix III

Flora and Fauna of Parque Nacional de Montecristo

Table 1. Preliminary and Partial List of the Flora Known from the Montecristo Cloud Forest National Park

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FAGACEAE
- Quercus sapotaefolia
- Q. grandis
- Q. hondurensis
- Quercus spp

LAURACEA
- Nectandra globosa
- N. ambigens
- Persea popenoei
- Persea sp
- Phoebe acuminatisima

MELASTOMACEAE
- Leandra multiplinervis
- L. subseriata
- Miconia flavida
- M. glaberima
- Tococa parviflora

PAPAVE-RACEAE
- Rocconia arborea
- S. glaucifolia

COMPOSITAE
- Baccharis vacciniocides
- Eupatorium sp
- E. delecides
- E ruse
- Gnaphalium attenuatum
- Jungia ferruginea
- Lactuca intybacea
- Senecio petarioides
- S.santarosea

LEGUMINOSAE
- Galiandra grandiflora
- Dalbergia brownei
- Diphysa floribunda

PIPERACEAE
- Peperomia collocata
- P. tacana
- Piper luxii
- Cyanthes mexicana
- Alsophyla pruinata
- A. salvanii

ONAGRACEAE
- Fuchsia arborescens
- F. seleriana
- F. splendens

RUISIACEAE
- Rondeletia fufescens
- Relburnium bypocarpium

RUTACEAE
- Zanthocyllum harmsirum
- Z. melonastictum

SOLANACEAE
- Cestrum guatemalensis
- Solanum hispidum
- S. laurifolia
- S. nodum
- Solanda nitida

STYRACACEA
- Stvrox conterminum

VERBENACEAE
- Lippia alba
- L. myriocephala

HYMENOPHYLLACEAE
- H. polyanthos
- H. sieberi
- Trichomanes radicans
- T. robinsonii
- T. kunzeanum
- T. capillaccum
- T. braussii

POLIPODIACEAE
- Elaphoglosum hirtum
- E. firmum
- Asplerium harpeodes
- A. monanthes
- Polystichopsis denticulata
- Rhipidopteris peltata
- Cystopteria fragilis
- Thelypteris piloso-hispida
- Polippdium angustifolium
- P. carpinterae

HYMENOPHYLLACEAE
- Hymenophyllum trapezoidable
- H. maxonii var. angustius

VITTARIACEAE
- Vittaria filifolia
- Vittaria rostratum

SELAGINELLACEAE
- Selaginella huehetenanguensis

ORCHIDACEAE
- Aropphyllum alpinum
- Dichaea squarrosa
- Epidendrum brassabolae
- E. chloe
- E. celiare
- E. centropetalum
- E carolii
- E. cobanense
- E. difforme
- E. ibaguense
- E. ochraceum
- E. polyanthrum
- E. pseudopagmacum
- E. ramosum
- E. stanfordianum

BROMELIACEAE
- Tilandsia cryptopoda
- T. flabellata
- T lampropoda
- T. plumosa
- T. peiita
- T. ponderosa
- T. seleriana
- T. usneoides
- Catopsis natans
- Vriases cornus-cervi

ARACEAE
- Anthurium chlorocardium
- A. ranchoanum

POLIPODIACEAE
- P. cultuatum
- P. delitesens
- P. induens
- P. lanceolatum
- P. mortigañum
- P. plebeium

ORCHIDACEAE
- Govenia liliacea
- Habenaria entomatha
- Isochilus linearis
- Lepanthas edwardsii
- Liparis liliifolia
- Pleurothalis dolichopus
- P. ophiocephala
- Elleanthus capitatus
- E. laucheanum
- E. repens
- E. trachythece
- Goodyera repens
- Malaxis mexonii
- Maxiliria cucullata
- Oncidium oblongatum
- O. obryzatum
- Pleurothalis circumplexa
- P. doiichopus
- P. johnsonii
- P. pansamalae
- P. tuarokheimii
- Sobralis werocklei

CACTACEA
- Rhipsalis ranulosa
- Coreus sp. (?)

UMSELIFERAE
- Donnellsmithia guatemalensis
- Hydrocotile mexicana
- Saniculata liberta

Table 2. Cloud Forest Mammals of Montecristo Cloud Forest National Park

Scientific Name	English Name	Spanish Name
MARSUPIALIA		
Didelphis marsupialis	Southern Opossum	Tacuazin
Marmosa mexicana	Mexican Mouse-opossum	Tecuazin Raton Mexicano
INSECTIVORA		
Cryptotis nigrescens	Blackish Small-eared Shrew	Musaraña Orejas Pequeñas
PRIMATES		
(?) *Alouatta (villosa) palliata*	Mantled Howler Monkey	Mono Aullador
(?) *Ateles geoffroyi*	Geoffroy's Spider Monkey	Mono Araña
EDENTATA		
Cyclopes didactylus	Two-toed Anteater	Hormiguero de Dos Dedos
LAGOMORPHA		
Sylvilagus floridanus	Eastern Cottontail	Conejo Montés
RODENTIA		
Sciurus variegatoides	Variegated Squirrel	Ardilla Gris
Sciurus deppei	Deppe's Squirrel	Ardilla Roja
Coendu mexicanus	Mexican Porcupine	Puerco Espin
Dasyprocta punctata	Agouti	Cotuza
Agouti paca	Paca or Spotted Cavy	Tepescuintle
CARNIVORA		
Urocyon cinereoargenteus	Gray Fox	Zorro Gris
Bassariscus sumichrasti	Cacomistle	Cacomistle, Uyo
Procyon lotor	Racoon	Mapache
Nasua narica	Coatimundi	Pezote
Potos flavus	Kinkajou	Micoleón
Mustela frenata	Long-tailed Weasel	Comadreja
Eira barbara	Tayra	Tayra
Spilogale putorius	Eastern Spotted Skunk	Zorrillo Moteado
Mephitis macroura	Hooded Skunk	Zorrillo Encapuchado
Conepatus leuconotus	Eastern Hog-nosed Skunk	Zorrillo
(?) *Felis onca*	Jaguar	Jaguar
(?) *Felis concolor*	Mountain Lion	Puma
ARTIODACTYLA		
Tayassu tajacu	Collared Peccary	Cuche de Monte de Collar
Odocoileus virginianus	White-tailed Deer	Venado Cola Blanca
(?) *Mazama americana*	Red Brocket	Venadito Rojo

(?) indicates may no longer occur.

Source: Daugherty. 1974.

Table 3. Cloud Forest Birds of Montecristo Cloud Forest National Park

Scientific Name	English Name	Spanish Name
GALLIFORMES		
Penelopina negra	Black Chachalaca	Chacha Negra
COLUMBIFORMES		
Oreopeleia silvestris		Codorniz de Cara Blanca
Columba fasciata	Band-tailed Pigeon	Pichón de Cola Franjeada
STRIGIFORMES		
Strix fulvescens	Fulvous Owl	Buho Listado
APODIFORMES		
Atthis heloisa	Bumblebee Hummingbird	Colibri de Elliot
Lampornis amethystinus	Amethyst-throated Hummingbird	Cacique Guatemalteco
Lamprolaima rhami	Garnet-throated Hummingbird	
Colibri thalassinus	Green Violet-ear	
Aeronautes saxatalis	White-throated Swift	Vencejo de Garganta Blanca
TROGONIFORMES		
Pharomachrus moccino	Resplendent Quetzal	Quetzal
Trogon collaris	Collared Trogon	Trogon de Jalapa
CORACIFORMES		
Aspatha gularis	Blue-throated Motmot	Motmot de Garganta Azul
PICIFORMES		
Aulacorhyncnus prasinus	Emerald Toucanet	Tucan Verde
Dendrocopos villosus	Hairy Woodpecker	Carpintero Velludo
Lepidocolaptes affinis	Spot-crowned Woodcreeper	Picamaderos Aliado del Norte
PASERIFORMES		
Empidonax flavescens	Yellowish Flycatcher	Papamoscas
Troglodytes rufociliatus	Rufous-browed Wren	Reyezuelo Café Rojizo
Turdus plebejus	Mountain Robin	Senzontle Café de la Montaña
Cyanolea pumilo	Black-throated Jay	Chara de Garganta Negra
Diglossa baritula	Slaty Flower-Piercer	Pipi de la Montaña
Chlorospingus ophthalmicus	Common Bush Tanager	Tángara de la Maleza con Cabeza Gris
Atlapetas gutturalis	Yellow-throated Bush Tanager	Gorrión de Garganta Amarilla

Source: Daugherty. 1974.