

PP 1000-1001
10-26031

Wildlands conservation in Central America

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SUMMARY

1 Conservation efforts in Belize have been oriented towards tiny wildlife sanctuaries for bird-watching on the mainland and protecting seabird rookeries on small mangrove islands. Half-Moon Caye National Monument protects one of the few true coral atolls in the Western Caribbean. Although representative forest ecosystems are not protected, the low population pressure and the emphasis on pine exploitation do not yet pose serious threats to the broad-leaved forests.

2 In 12 years, Costa Rica has developed a model system of twenty-two functional national parks and equivalent reserves. Though close to its goal of protecting 10% of the country, the Costa Rican National Park Service is having difficulty consolidating the national parks system due to numerous private land-holdings (23% of the parks area) and the very serious national economic problems. Costa Rica's part of the Friendship International Park (La Amistad) has recently been declared a biosphere reserve by UNESCO.

3 El Salvador's few conservation units have been seriously degraded by population pressures and the current civil war. Montecristo National Park contains the only significant forest remaining in the country, but the park suffered from uncontrolled logging and slash and burn agriculture long before this civil war.

4 Guatemala has established sixteen national parks since 1955, but only four meet the recommended international criteria. The Tikal World Heritage Site is the most significant conservation unit in Guatemala; most of the other conservation units are non-functional 'paper parks' (e.g. Río Dulce) or too small to effectively protect critical habitats or populations (e.g. Quetzal biotope). Terrorism and civil warfare have greatly reduced the government presence in conservation units. Guatemala's conservation efforts continue to suffer from the assassination of Mario Dary, the country's leading conservationist.

5 In the past few years Honduras has made impressive progress in conservation, highlighted by establishment of the Río Plátano Biosphere Reserve. Río Plátano is the most significant conservation unit in northern Central America, particularly because of its pristine nature and large size.

6 After the 1979 revolution, Nicaragua's new government created a National Park Service (SPN) to administer the two existing national parks. SPN is actively evaluating thirty-five wildlands for conservation potential and designation as conservation units.

7 Panama's national parks and equivalent reserves cover nearly 12% of the country; however, most of the conservation units are merely 'paper parks'. The remote Darién World Heritage Site remains intact because of its inaccessibility, but construction of

the Pan-American Highway to the Colombian border would seriously threaten the integrity of an area that might be the most biologically rich in the world.

INTRODUCTION

Central America has served as a great mixing ground for the floras and faunas of North and South America. Tracks of puma and jaguar overlap in Honduras' Río Plátano biosphere reserve. Northern hemisphere conifers (pines, firs, spruces and cedars) extend as far south as Lake Nicaragua, but oaks dominate the high-elevation Talamanca forests of Costa Rica and Panama. Paramo—low, shrubby vegetation above tree-line that dominates the northern Andes—has its northernmost extension on Costa Rica's highest peak.

Central American forests are the habitats of a great diversity of tropical birds, mammals, herps and invertebrates (Moser 1975). Many so-called North American migratory birds spend more time in these tropical forests than in their brief northern summer habitat. Recent studies indicate that a surprising number of local bird species migrate altitudinally. Yet Central America's forests are being cut at a combined rate of not less than 300 000 ha year⁻¹ (Table 1). Except for sparsely populated Belize, the other six countries have less than 45% of their land still in natural forests (MacFarland & Morales 1981). With human population growth averaging 3.0% for the region, Central America's population will nearly double by the year 2000. The inexorable advance of the agricultural frontier into the shrinking forests leaves little time—certainly no more than this decade—to establish protected conservation units. The current political strife in northern Central America and the severe economic problems buffeting the region make it difficult for government agencies responsible for national parks and equivalent reserves to protect the existing parks. How will they be able to add new conservation units and to consolidate the national conservation system?

This paper offers a country-by-country overview of the status of national parks and equivalent reserves. The latter include biological reserves, wildlife refugia, biosphere reserves, as well as those multiple-use areas, world heritage sites and natural

TABLE 1. Features of Central American countries

	Area*	Population 1977-78	Remaining wildlands*	1978 minimum rate of deforestation*	Protected area* (%)	Number of conservation units
Belize	22 975	140 000	19 500	50	0.36 (0.002)	2
Costa Rica	51 000	2 044 300	16 000	600	4327 (8.48)	22
El Salvador	21 156	4 310 000	200	--	30 (0.14)	2
Guatemala	108 889	6 531 000	32 000	750	988 (0.91)	6
Honduras	112 088	2 954 000	44 000	600	4410 (3.93)	5
Nicaragua	148 000	2 346 000	66 000	400	173 (0.12)	2
Panama	77 082	1 798 000	26 000	500	8609 (11.8)	7
Total	541 190	17 423 300	203 700		18 537 (3.43)	46

* Area in km².

2

monuments that protect significant natural ecosystems. Comments on biological and ecological aspects are kept to a bare minimum in this paper; however, pertinent literature references are included. The listing of national parks and equivalent reserves (Table 2 and Fig. 1) follows, where possible, the numeration of IUCN (1981).

REGIONAL SYNTHESIS

Central America's forty-six national parks and equivalent reserves cover 18 537 km², or about 3.5% of the region. About three-quarters of these conservation units have been established since 1970. Except in Belize, each country's early efforts focused on national parks. Only in the past few years have some countries established other types of conservation units, such as biological reserves, wildlife refugia and natural monuments. The early predilection for national parks is understandable and even justifiable, given the strong international recognition associated with national park status. If park consolidation and effective protection are achieved, a protected area can be reclassified to a more appropriate type of conservation unit.

In general terms, each country has an adequate legal base for conservation. Most conservation units have been established by presidential decree, thus they can be abrogated by another decree or simply ignored by the next president. Nevertheless, presidential interest in conservation can produce marvellous results, as shown by Costa Rica's impressive advances in conservation during the administrations of Daniel Oduber (1974-78) and Rodrigo Carazo (1978-82). Costa Rican law stipulates that a conservation unit established by presidential decree can only be changed by a two thirds vote of the Legislative Assembly.

Consolidation of conservation units is the most serious problem facing Central America's national parks and equivalent reserves. It is easy to promulgate a presidential decree, but it is much more difficult to implement the decree establishing a conservation unit. Consolidation means that boundaries must be established and maintained on the ground; privately-owned land should be expropriated; non-indigenous occupants need to be moved to new lands outside the unit; the biota must be protected from hunters and poachers; the area should be zoned for use; and a management plan developed. Failure to consolidate a conservation unit not only permits the destruction of biota and natural resources that were supposed to be protected, but it has the more insidious effect of inculcating disrespect for conservation. The all-too-common occurrence of 'paper parks' in Latin America, where a declared park is occupied by hundreds of squatters practising slash-and-burn agriculture, makes it nearly impossible to consolidate such parks. Ineffective government efforts to avoid 'paper parks' pose serious threats for other conservation units that may be still intact due to inaccessibility.

The inclusion of privately-owned lands within the boundaries of a conservation unit presents another obstacle to consolidation, largely because of government disinterest (e.g. El Salvador's Montecristo) or difficult economic conditions. The Costa Rican tradition of private land ownership is reflected in the estimate that 23% of the country's protected wildlands is still in private hands. As money became available, the

TABLE 2. National Parks and equivalent reserves in Central America

Conservation unit	Year of creation	Area (ha)	Elevations (m)	Biogeographic province	Ecological life zones*
Belize					
(1) Guanacaste Park Wildlife Sanctuary	1975	21	50	8.01.01	Sm
(2) Half-Moon Caye Natural Monument	1928-78	15	0-2	8.01.01	Sm
Costa Rica					
(1) Chirripó National Park	1975	43 700	1220-3819	8.16.04	TLMr, TMr, TSAr
(2) Corcovado National Park	1975	41 469	0-750	8.16.04	Tw, TPw, TPr
(3) Braulio Carrillo National Park	1978	32 000	500-2900	8.16.04	TPw, TPr, TLMr, TMr
(4) Tortuguero National Park	1970	18 947	0-299	8.16.04	Tw
(5) Rincon de la Vieja National Park	1974	11 700	640-1916	8.16.04	TPw, TPr, TLMr
(6) Santa Rosa National Park	1971-80	21 500	0-319	8.16.04	Td, Tm
(7) Hitoy-Cerere Biological Reserve	1978	9045	300-1025	8.16.04	Tm, TPw
(8) Carara Biological Reserve	1978	7600	10-638	8.16.04	Tm, Tw
(9) Volcan Poas National Park	1971	4000	1600-2708	8.16.04	TLMw, TLMr, TMw, TMr
(10) Isla de Coco National Park	1978	3200	0-634	8.43.13	TPr
(11) Monteverde Cloud Forest Reserve	1972	3100	1200-1870	8.16.04	TPw, TPr, TLMw, TLMr
(12) Volcán Irazú National Park	1955	2400	2900-3432	8.16.04	TMw, TMr
(13) Cahuita National Park	1974	1700	0-10	8.16.04	Tm
(14) Cabo Blanco Strict Nature Reserve	1963	1172	0-355	8.16.04	Tm
(15) Manuel Antonio National Park	1972	690	0-100	8.16.04	Tw
(16) La Selva Biological Station	1953	1362	35-200	8.16.04	Tw, TPw
(17) Islas de Guayabo, Negritos, Pájaros, Biological Reserves	1973	12	0-100	8.16.04	Td
(18) Barra Honda National Park	1974	2295	20-575	8.16.04	Td
(19) Rafael Lucas Rodríguez Wildlife Refuge (Palo Verde)	1978	7523	3-230	8.16.04	Td
(20) Palo Verde National Park	1980	2440	3-200	8.16.04	Td
(21) La Amstad International Park	1982	211 602	200-3549	8.16.04	Tw, TPw, TPr, TLMw, TLMr, TMr, TSAr
(22) Tapanti Wildlife Refuge	1982	5200	?	8.16.04	TPr
El Salvador					
(1) Montecristo National Park	1979	1990	1600-2418	8.16.04	SLMw
(2) Laguna Jocotal Wildlife Refuge	1978	1000	100	8.16.04	Sm

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TABLE 2 (cont.)

Conservation unit	Year of creation	Area (ha)	Elevations (m)	Biogeographic province	Ecological life zones*
Guatemala					
(1) Tikal World Heritage Site	1955/79	57 600	200-250	8.01.01	Sm,Sw
(2) Rio Dulce National Park	1955	24 200	0-1267	8.01.01	Sm,SLMw
(3) Lago Atitlán National Park	1955	13 000	1562	8.21.04	SLMm
(4) Volcán Pacaya Natural Monument	1963	2000	1300-2600	8.21.04	SLMw
(5) Quetzal Conservation Biotope	1977	1000	1580-2348	8.21.04	SLMw
(6) El Rosario National Park	1980	1030	?	8.01.01	?
Honduras					
(1) La Tigra National Park	1980	7571	1360-2290	8.21.04	Sm,SLMm
(2) Rio Plátano Biosphere Reserve	1980	350 000	0-1326	8.16.04	Sm,Sw,SLMw
(3) Lago de Yojoa Multiple Use Area	1971	34 628	600-2744	8.21.04	Sw,SLMw,SMw
(4) Cusuco National Park	1959/80	15 000	0-2270	8.21.04	Sm,Sw,SLMw
(5) Bay Islands National Park	1960/80	33 800	0-413	8.16.04	Sm
Nicaragua					
(1) Volcán Masaya National Park	1979	5500	100-635	8.16.04	TPm
(2) Saslaya National Park	1971	11 800	200-1650	8.16.04	Sw,SLMw
Panama					
(1) Altos de Campana National Park	1977	4816	250-1034	8.02.01	Tm,TPw
(2) Volcán Barú National Park	1976	14 322	1544-3475	8.16.04	TLMw,TLMr,TMw,TMr
(3) Portobelo National Park	1976	17 364	0-979	8.02.01	Tw,TPr
(4) Darién World Heritage Site	1981	597 000	0-1500	8.02.01	Tm,Tw,TPw,TPr,TLMr
(5) Soberanía National Park	1979	22 000	20-200	8.02.01	Tm,Tw,TPw
(6) Barro Colorado Natural Monument	1923/79	5400	26-171	8.02.01	Tm
(7) La Amistad International Park	Proposed	200 000	200-3550	8.16.04	Tw,TPw,TPr,TLMr,TMr

* Ecological life zones: Td = Tropical dry, Tm = Tropical moist, Tw = Tropical wet; TPm = Tropical Premontane moist, TPw = Tropical Premontane wet, TPr = Tropical Premontane rain; TLMw = Tropical Lower Montane wet, TLMr = Tropical Lower Montane rain; TMw = Tropical Montane wet, TMr = Tropical Montane rain; TSAr = Tropical Subalpine rain; Sm = Subtropical moist, Sw = Subtropical wet; SLMm = Subtropical Lower Montane moist, SLMw = Subtropical Lower Montane wet; SMw = Subtropical Montane wet.

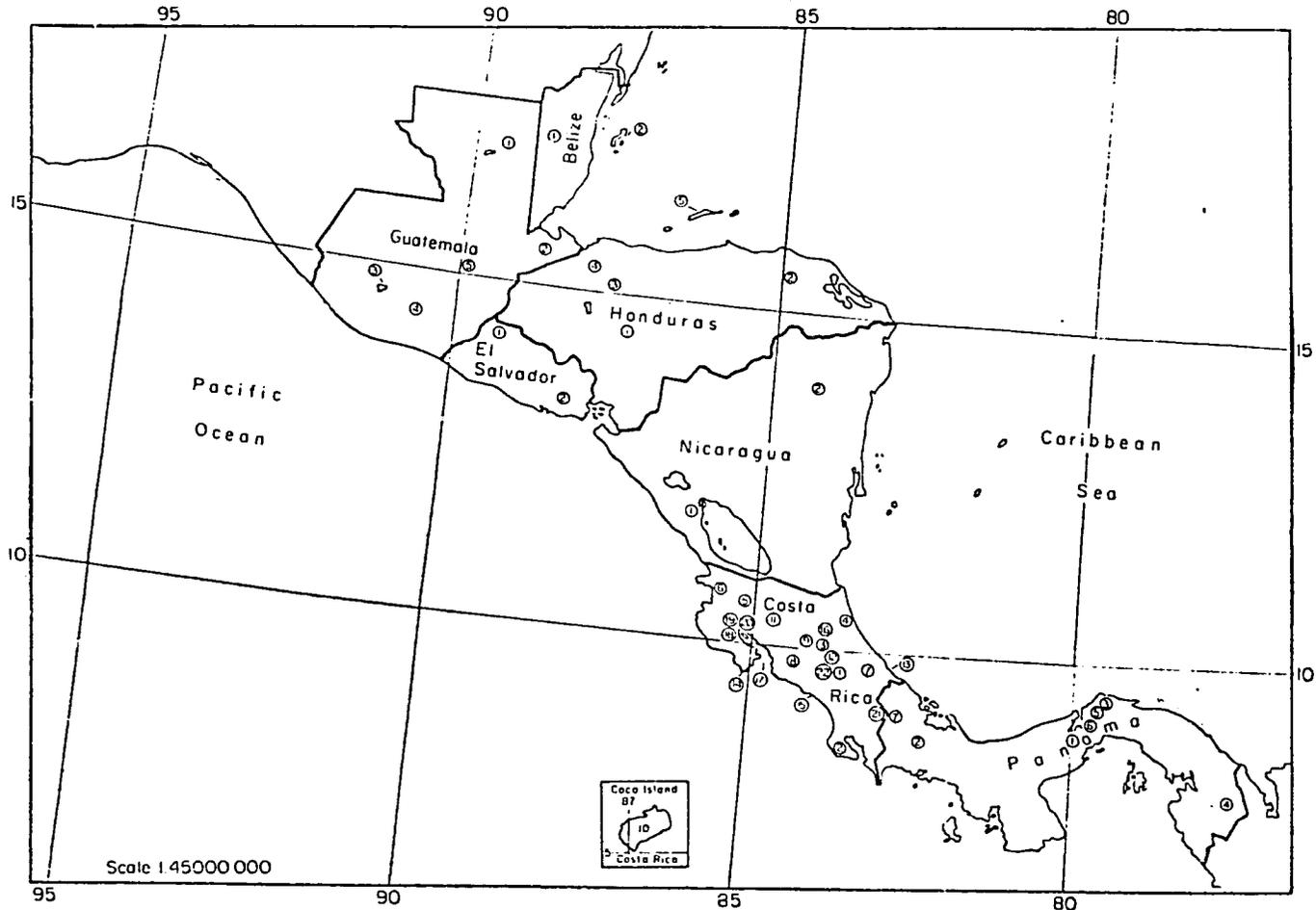


FIG. 1. National Parks and equivalent reserves in Central America (see Table 2 for information on each conservation unit).

9

SPN purchased key parcels, but the current economic debacle has seriously slowed the consolidation programme. In two recent cases, La Amistad and the Braulio Carrillo-La Selva corridor, the government has tried to avoid expropriation by segregating privately-held lands into a Protection Zone, where changes in current land use are prohibited.

The lack of ecological and cadaster surveys *prior* to legal establishment of a conservation unit has also hindered the consolidation process. Office-drawn boundaries often include operational farms, yet omit critical habitats or unique ecosystems. On an independent evaluation of Costa Rica's national parks and equivalent reserves, boundary modifications were recommended for two-thirds of the conservation units (CCT 1982). La Amistad International Park is the first case in Central America where ecological and cadaster field studies preceded legal establishment of a conservation unit.

Other than in Costa Rica, the sparse information available on established conservation units makes it difficult to assess their representativeness. The biogeographic provinces (see Table 2) used by IUCN are ecologically meaningless in Central America. For example, flora and fauna species overlap is probably less than 10% between Honduras' Río Plátano biosphere reserve and Costa Rica's Chirripó or Corcovado national parks, yet they occur in the same biogeographic province according to the IUCN classification system.

Estimates of major ecological life zones represented in each conservation unit (Table 2) suggest that subhumid and humid life zones are poorly represented in protected areas of Central America. This is not surprising since these humidity provinces are preferred for agriculture and human inhabitation, with a long history of natural resources degradation. The subhumid Pacific lowlands of Central America have very few conservation units due to the general absence of forests. Similarly, the dry highlands of northern Central America have few functional conservation units because of centuries of human use.

Private organizations have played critical roles in helping Central American countries establish and consolidate conservation units. Most obvious is the financial support of international or foreign conservation groups to government conservation agencies, as well as to private biological reserves. Although space does not permit the long listing of all the private donor organizations, they deserve much credit for donations that, more often than not, made the critical difference in the successful consolidation of several conservation units.

Worldwide concern about tropical deforestation has prompted a much more active participation of USAID in Central American conservation. AID's Central American portfolio includes grants to the Costa Rican Association for the Conservation of Nature (ASCONA), a loan to the Panama government to rehabilitate the Panama Canal watersheds, a loan to the Costa Rican government for conservation of natural resources, and country environmental profiles. The U.S. Nature Conservancy is helping the private Costa Rican National Parks Foundation raise funds for land acquisition (Barnard 1982). RARE (Rare Animal Relief Effort) is supporting a conservation education programme in eleven primary schools in Costa Rica, that

complements ASCONA's public education efforts. CATIE's program in wildlands conservation is partially supported by the Rockefeller Brothers' Fund.

In the face of burgeoning populations and rampant deforestation, precious little time remains to add new conservation units or to consolidate existing national systems. Ecological evaluations of existing and potential units, such as has been completed in Costa Rica and is in progress in Nicaragua, are urgently needed in Panama, Honduras and Guatemala. The convulsive political situation and horrendous economic problems of most of the countries make it extremely difficult to maintain the conservation *status quo*. Even though responsible government institutions need strengthening and national conservation systems should be expanded and consolidated, the Central American governments simply lack the resources to accomplish their conservation goals. This is truly a critical decade for conservation in Central America. Yet in times of crises, the importance of education is often forgotten. Public education is crucial to the growth of environmental awareness and support for conservation. Without support of the general public, few national parks and equivalent reserves of Central America will survive into the twenty-first century.

STATUS OF CENTRAL AMERICAN NATIONAL PARKS AND EQUIVALENT RESERVES

Belize

The British administration created several small Crown Reserves and entrusted the administration of these bird sanctuaries to the Belize Audubon Society. The oldest, Half-Moon Caye Wildlife Sanctuary, was set aside in 1928. Seven Crown Reserves are tiny mangrove islands less than 2 ha in size and not described in the listing of national parks and equivalent reserves. The mangrove islands serve as rookeries for roseate spoonbills (*Ajaia ajaja*), wood storks (*Mycteria americana*), great egrets (*Egretta alba*), cormorants (*Phalacrocorax olivaceus*), boat-billed herons (*Cochlearius cochlearius*), anhingas (*Anhinga anhinga*), cattle egrets (*Bubulcus ibis*), white ibis (*Eudocimus albus*), reddish egret (*Dichromanassa rufescens*), tri-colored herons (*Hydranassa tricolor*), brown boobies (*Sula leucogaster*), white-crowned pigeons (*Columba leucocephala*) and magnificent frigatebirds (*Fregata magnificens*).

The colonial government created ten Forest Reserves totalling about 420 000 ha (18% of the country); however, they are considered reserves primarily for timber exploitation. Protection efforts focus on control and prevention of fires in the pine forests.

(1) *Guanacaste Park Wildlife Sanctuary*

The dominant feature of this park is a huge guanacaste tree (*Enterolobium cyclocarpum*). The 21 ha bird sanctuary was decreed in 1975 with tenure assigned by a conditional free grant to the Belize Audubon Society. The sanctuary is fenced and is used principally for bird watching.

(2) *Half-Moon Caye National Monument*

Half-Moon Caye bird sanctuary was converted to a National Monument in 1982 by the newly independent Belizean government. It is a 15 ha coral sand cove at the south-eastern end of Lighthouse Reef, one of the few true coral atolls in the Caribbean Sea. The western half of the island is a thriving rookery for the white phase of the red-footed booby (*Sula sula*) as well as for the magnificent frigatebird. Despite clear legal status as a wildlife sanctuary, Half-Moon Caye and the smaller island rookeries suffer from nest raiding by local fishermen for eggs and young birds. The Belize Fisheries Department is administratively responsible for Half-Moon Caye National Monument.

Costa Rica

Since the establishment of the National Park Service (SPN) in 1970, Costa Rica has made truly remarkable progress in conservation. Twenty-two national parks and equivalent reserves cover 8.47% of the country, one of the highest percentages of any country in the world. In contrast to many Latin American countries, Costa Rica's national parks and equivalent reserves are functional conservation units; each has on-site administrative and guard personnel. Management plans exist for most of the conservation units. SPN is responsible for all national parks and public biological reserves and through an intraministerial agreement with the Forest Service, the SPN administers two protection zones contiguous to national parks.

Two wildlife refuges, Palo Verde and Tapantí, are administered by the Wildlife Department (DVS). Two well-known private biological reserves are important components of the conservation system: Monteverde Cloud Forest Reserve is owned by the Tropical Science Center and the La Selva Biological Station is owned by the Organization for Tropical Studies.

Many of Costa Rica's conservation units are described and beautifully illustrated in the books by the first SPN director (Boza 1978; Boza & Mendoza 1981). Considerable ecological information on the biota of Santa Rosa, Palo Verde, Corcovado, La Selva and Monteverde also exists (Janzen 1983).

(1) *Chirripó National Park*

The highest peak in Costa Rica, several lakes of glacial origin and extensive paramo vegetation are the principal features of this national park in the central Cordillera de Talamanca. The Chirripó paramo is the northernmost occurrence of the high-altitude, shrubby vegetation that dominates the northern Andes. A fire set by visitors in March 1976, burned about 90% of the paramo. Post-fire recovery is being documented by a team of ecologists from the National University (UNA).

(2) *Corcovado National Park*

Many visitors consider Corcovado to be the gemstone of Costa Rica's system of national parks and equivalent reserves. Corcovado's lowland wet forests are the most

spectacular I have seen in the tropics. The park includes entire watersheds of several rivers that flow onto the 10 000 ha Corcovado plain before interrupting the 19 km of pristine beach. Endangered large mammals such as white-lipped peccary, giant anteater, tapir and jaguar are well-represented in Corcovado. SPN is having considerable difficulty controlling the activities of independent gold miners in the rugged interior of the park.

(3) *Braulio Carrillo National Park*

This major national park is partly a consequence of a proposed highway through the rugged Cordillera Volcánica Central. Conservation opposition to construction of the San José-Guápiles highway played a major role in the establishment of Braulio Carrillo National Park. Extending from the peak of Volcán Barba (2900 m) down to 500 m on the Caribbean slope, Braulio Carrillo offers an exceptional altitudinal transect through three superhumid (potential evapotranspiration ratio <0.25) ecological life zones.

Dr G. Stiles of the University of Costa Rica has found that a substantial proportion of the bird species in Braulio Carrillo are altitudinal migrants that spend part of the year in the Sarapiquí lowlands. To protect lowland habitat for altitudinal migratory species from Braulio Carrillo and to provide a forest corridor between the park and La Selva (see (16) below) the government decreed a 6000 ha protection zone to be administered by the SPN. The narrow protection zone (2-5 km wide) may be a minimum forest corridor between Braulio Carrillo and La Selva, but it is probably too small to support the numerous altitudinal migrants from Braulio Carrillo that require lowland forest for part of their yearly cycle.

With financial assistance from USAID, the SPN is actively preparing management plans and interpretative programs to capitalize on the considerable traffic expected on the San José-Guápiles highway. Uncontrolled construction of the highway right-of-way has devastated slope forests and dumped thousands of tons of sediments into two major rivers. But the most serious problem for Braulio Carrillo is a substantial number of private holdings within the park that the SPN lacks funds to purchase.

(4) *Tortuguero National Park*

Isolated low hills, extensive swamp forests, coastal lagoons and a long stretch of sandy beach comprise this extremely wet national park that is world-famous as the primary nesting area of the endangered green turtle (*Chelonia mydas*). Three decades of research by Dr Archie Carr and collaborators at Tortuguero have generated much greater understanding of sea turtle biology (see Carr 1976), as well as providing the impetus for establishment of Tortuguero National Park. In spite of legal protection and guards, turtle hunting, both on-shore and just off-shore, and egg-collecting are still problems in the park.

(5) *Rincón de la Vieja National Park*

The relatively low, isolated volcanic massif of Rincón de la Vieja in the Cordillera de

Guanacaste is the principal park feature. The park also has critical watershed functions, with thirty-two rivers and sixteen intermittent streams originating in the park. The Pacific slope drainages form the headwaters of the Río Tempisque, the principal river of the monsoonally dry Guanacaste lowlands.

(6) *Santa Rosa National Park*

Not only is Santa Rosa the most important historic site in the country, but it is the largest conservation unit in the seasonally dry lowlands of northwestern Costa Rica. Santa Rosa includes the recent 11 600 ha Murcielago addition; however, the two are separated by 13 000 ha of private land. These intervening lands have been recommended for inclusion in Santa Rosa National Park (CCT 1982) and consolidation of all three blocks into one conservation unit is a top priority of the newly-formed National Parks Foundation.

Nancite beach is one of the principal nesting sites of the Pacific ridley sea turtle (*Lepidochelys olivacea*). Uncontrollable fires sweeping through dry, rank grasses are the major problem confronting Santa Rosa National Park.

(7) *Hitoy-Cerere Biological Reserve*

This little-known biological reserve is nestled in the rugged Caribbean foothills of the Cordillera de Talamanca. It is bordered on three sides by the Estrella, Talamanca and Telire Indian Reserves.

(8) *Carara Biological Reserve*

When the government expropriated the vast Hacienda Coyolar for agricultural colonization, the extensive forests were segregated to form the Carara Biological Reserve. It is the only large block of primary forest remaining on the lower slopes of the central Pacific region. The area is very rich biologically because it is in a transitional region between the southern perhumid life zones and northern subhumid life zones. Excellent accessibility from the Coastal Highway suggests reclassification to national park status (CCT 1982). Easy access to most of the reserve borders during the dry season facilitates illegal hunting, the principal problem affecting Carara wildlife.

(9) *Volcán Poás National Park*

This active volcano in the Cordillera Volcánica Central just north-west of the capital, San José, is the most visited of Costa Rica's national parks. A recent government loan from the Central American Bank for Economic Integration (BCIE) funded major improvements in tourist facilities, including visitors' centre, restaurant and a paved highway.

(10) *Isla de Coco National Park*

This oceanic island lies about 500 km south-west of the Costa Rican mainland. In

contrast to the Galapagos Islands, Coco is extremely wet, with annual rainfall of about 7000 mm. The Coco Island finch (*Pinaroloxias inornata*) is closely related to the famed Darwin's finches of the Galapagos. Sizeable feral populations of domestic pigs and cats are the principal problem on Coco Island.

(11) *Monteverde Cloud Forest Reserve*

Straddling the low Cordillera de Tilarán in north-central Costa Rica, the Monteverde Reserve is an exceptional cloud forest laden with epiphytes and mosses. Monteverde has good populations of the resplendent quetzal and the endemic golden toad (*Bufo periglenes*); legitimately-identified feathers have been found of the oilbird (*Steatornis caripensis*). The private Monteverde Cloud Forest Reserve is owned and administered by the Tropical Science Center, a Costa Rican association involved in the conservation and rational use of natural resources in the tropics.

(12) *Volcán Irazú National Park*

The oldest of Costa Rica's national parks and equivalent reserves, Irazú functions exclusively as a tourist attraction. Volcanic eruptions in 1963–65 destroyed the vegetation near the summit and most of the rest of the park is used for agriculture or pasture. Because of the tourist attraction and the absence of significant natural ecosystems in the park, it has been proposed (CCT 1982) that Irazú National Park be joined with the nearby Ricardo Jiménez Oreamuno Recreational Area (Prusia) in a National Recreational Area.

(13) *Cahuita National Park*

This small park on the Caribbean coast includes 1100 ha of degraded terrestrial habitats and 600 ha of sea to protect Costa Rica's only coral reef that is about 6.5 km long and 300 m offshore. Unfortunately, the coral reef has deteriorated badly and shows considerable mortality, apparently caused by sedimentation. Because of its smallness and popularity with tourists, Cahuita should be re-classified to a National Recreation Area (CCT 1982).

(14) *Cabo Blanco Strict Nature Reserve*

The Cabo Blanco Reserve at the tip of the Nicoya peninsula was established in 1963 as a private reserve by Olof Wessberg. The nearby island of Cabo Blanco is a major rookery for frigatebirds and pelicans. Cabo Blanco is now administered by the SPN as a biological reserve.

(15) *Manuel Antonio National Park*

Manuel Antonio is the smallest of Costa Rica's national parks, but includes some of

the more beautiful Pacific beaches. It is very popular for recreation and tourism, hence status as a National Recreation Area would be more appropriate (CCT 1982). Pollution from nearby houses and the town of Quepos and sedimentation are affecting the marine component of the park.

(16) *La Selva Biological Station*

La Selva was owned by Dr L. R. Holdridge from 1953 to 1968 when he sold it to the Organization for Tropical Studies (OTS). Nearly three decades of research activities have made La Selva a renowned site. The U.S. National Research Council recommended La Selva as one of four tropical sites for long-term ecological research (NRC 1980). The recent purchase by OTS of an adjoining property will permit expansion of research activities into ecosystem processes and applied fields. The OTS is actively collaborating with the National Parks Foundation to raise funds to consolidate the Protection Zone corridor to Braulio Carrillo National Park (see (3) above).

(17) *Isla de Guayabo, Negritos, Pajaros Biological Reserves*

Three small rocky islands in the Nicoya gulf serve as sea-bird rookeries, especially for brown pelicans (*Pelecanus occidentalis*), magnificent frigatebirds, brown boobies (*Sula leucogaster*) and anhingas. These islands would be more appropriate as a wildlife refuge.

(18) *Barra Honda National Park*

Intricate and extensive limestone caverns are the primary feature of Barra Honda. All the land is privately owned, with the consequence that terrestrial habitats are severely degraded. Since the park does not contain important ecosystems or biota, Barra Honda should be reclassified as a National Monument.

(19) *Rafael Lucas Rodriguez Wildlife Refuge (Palo Verde)*

Extensive seasonal lagoons on the Tempisque floodplain attract thousands of migratory waterfowl in the dry season to the Palo Verde refuge. The Forest Service's Wildlife Department (DVS) administers the Palo Verde refuge and has an active research program on several waterfowl species. Palo Verde Wildlife Refuge also includes one of the least disturbed blocks of dry forest remaining in north-western Costa Rica.

(20) *Palo Verde National Park*

Bordering the Palo Verde Wildlife Refuge on the south, this national park was reduced to about 25% of its original size due to the government's financial inability to

expropriate the large private holdings in the park. Seasonal lagoons remain in the park, but severe financial problems have hindered SPN consolidation of the park and protection of the waterfowl. The Palo Verde National Park should eventually be integrated into the Palo Verde Wildlife Refuge.

(21) *La Amistad International Park*

Friendship International Park extends along the Cordillera de Talamanca east from Chirripó National Park to the Panama border, where it is supposed to join Panama's component of this binational park. Costa Rica's Amistad Park covers about 192 000 ha, extending down to 900 m on the Pacific slope and 200 m on the Caribbean side. The 19 602 ha Las Tablas Protection Zone is considered part of Amistad, even though it was legally established as a separate unit because the lands are privately owned.

Amistad National Park includes seven of the twelve ecological life zones in Costa Rica and is estimated to contain at least two-thirds of the country's vertebrate fauna. The very large size of the park and its exceptional ecological diversity make Amistad potentially the most important conservation unit in Central America.

(22) *Tapanti Wildlife Refuge*

Practically no information is available on this new conservation unit administered by the DVS. It is near the Río Grande de Oroqui at the northern end of the Cordillera de Talamanca, and it includes one of the major watersheds supplying the Río Macho and Cachi hydroelectric power plants.

El Salvador

The smallest country in Central America, El Salvador is the antithesis of Belize. El Salvador has the region's highest population density (Table 1) and is nearly completely deforested. No information is available for two national parks (Cerro Verde and Deininger) administered by the National Institute of Tourism (INSTU). Implementation of agrarian reform is purported to have tripled the number of protection units, but it is extremely doubtful that any unit can be protected during the current warfare.

(1) *Montecristo National Park*

El Salvador's last major remnant of primary forest is in this mid-elevation national park at the international border convergence with Guatemala and Honduras. The two principal forest types are oak-dominated cloud forest and oak-pine to 2100 m. Several threatened and endangered animal species are reported to occur in the park; however, the native wildlife has probably been seriously decimated by war and use of the Montecristo region by anti-government forces. Although managed and protected by the National Parks and Wildlife Service (DIGERENARE), Montecristo National Park has not been legally established and the majority of the land is privately owned.

Most of the lower slopes were deforested for subsistence agriculture prior to the creation of the park.

(2) *Laguna Jocotal Wildlife Refuge*

Laguna Jocotal is a eutrophic lake situated at the base of Volcán San Miguel. The refuge was established in 1978 to protect local and migratory waterfowl; however, it still lacks legal protection. The lake-shore vegetation is severely degraded and the lake tributaries carry pesticides used in the neighbouring cotton fields. About 300 families live along the lake margin, of whom 120 subsist on fishing in Laguna Jocotal.

Guatemala

Guatemala made an impressive start to conserve wildlands with the establishment of ten national parks in 1955. By 1973, sixteen national parks had been created, but only four meet international criteria for national parks (Godoy 1982): Tikal, Río Dulce, Atitlán and Pacaya. The auspicious start in 1955 is attributable primarily to the conservation of tourist attractions such as the Mayan ruins at Tikal. National parks and equivalent reserves are administered by various government agencies. Tikal is administered by the National Archaeology and History Institute (INAH), while Río Dulce is assigned to the Institute of Tourism (INGUAT). The National Forestry Institute's (INAFOR) Department of National Parks and Wildlife has legal responsibility for national parks and equivalent reserves, but has yet to develop protection and management programmes in any park. INAFOR's conservation priorities focus on recreational areas. Due to government disinterest in conservation, concerned biologists at the University of San Carlos formed a Center for Conservation Studies (CECON) in 1976, which led to the establishment of the University Biotope for the Conservation of the Quetzal. CECON has established three other biotopes and is considering five other possibilities (Godoy 1982).

The escalating violence between government and guerrilla forces has turned many wildlands into free-fire zones, relegating most conservation units to the status of 'paper parks'. Continued violence has drastically reduced tourism to Guatemala.

(1) *Tikal World Heritage Site*

The Tikal National Park, created by government decree in 1955, was reclassified in 1979 as a World Heritage Site in recognition of the Mayan temples, pyramids and stelae. The extensive forests have an abundance of mahogany (*Swietenia macrophylla*), chicle (*Manilkara achras*) and ramón (*Brosimum alicastrum*), possibly a consequence of Mayan silviculture to increase the abundance of these useful trees. The Tikal forests are reported to contain the following endangered or threatened animal species: giant anteater (*Myrmecophaga tridactyla*), ocelot (*Felis pardalis*), jaguar (*F. onca*), Baird's tapir (*Tapirus bairdii*) and crocodile (*Crocodylus moreletii*). Although some illegal hunting occurs within the protection areas, the principal problem is theft of archaeological items.

(2) *Río Dulce National Park*

Created in 1955 by presidential decree, Río Dulce National Park is a classic 'paper park'. It includes the Sierra de Mico, Lago Izabal and the Río Dulce, but most of the land is privately-owned and exact boundaries have never been fixed. In the absence of protection and management by INGUAT, deforestation and hunting are rampant. The same endangered or threatened animal species listed for Tikal are also reported for the Río Dulce National Park; however, it is unlikely that viable populations of large animals can survive in the park without complete protection from hunting and human encroachment. Several small settlements and the town of Livingston occur within the national park, and nickel mining is planned. Given the unlikelihood that the Río Dulce National Park can become a functional conservation unit, the area should be reclassified.

(3) *Lago Atitlán National Park*

The 1955 presidential decree that established Lago Atitlán National Park protects the 130 km² lake, but not the shoreline nor adjoining land. Rapid and uncontrolled development along the shore, particularly of summer homes, is causing serious erosion and pollution problems. The lake supports a small population of the endemic Atitlán grebe (*Podylimbus gigas*).

(4) *Volcán Pacaya Natural Monument*

The active Pacaya volcano was recognized as a natural monument by a 1963 presidential decree. Although a master plan for management and protection was prepared (Anon. 1974), it has not been implemented. The natural forests have been severely affected by volcanic activity (two major forest fires in the past 15 years) and subsistence agriculture. Many of the 100 families living near the volcano intensively cultivate corn on the upper slopes and use the highlands for pasture. Wildlife is scarce due to continuous hunting pressure. As in the case of Río Dulce National Park, the Volcán Pacaya Natural Monument is not a functional conservation unit.

(5) *Quetzal Conservation Biotope*

In 1977 the municipality of Salama, Baja Verapaz, donated about 900 ha of cloud forest to the University of San Carlos to establish a conservation unit for the resplendent quetzal (*Pharomachrus mocinno*), Guatemala's national bird. University of San Carlos' biologists have actively participated in biological inventories and research and development plans for the Quetzal Conservation Biotope (e.g. Dary & Ponciano 1980). Although hunting is common in the region, the biotope is now well protected. It is questionable if 900 ha of primary forest is sufficiently large to support a viable population of quetzals, hence the plans to enlarge the biotope to about 3000 ha should be strongly supported.

(6) *El Rosario National Park*

No information is available for this small (1030 ha) park in the Petén that was created by presidential decree in 1980.

Honduras

In the past 4 years Honduras has made great progress in conservation, with the creation of a national protected wildlands system, new national parks and Central America's first biosphere reserve. The General Directorate for Renewable Natural Resources (DIGERENARE) in the Ministry of Natural Resources is responsible for national parks and equivalent reserves. The Honduran Forest Development Corporation (COHDEFOR) has an active programme in watershed protection for Lake Yojoa and Cusuco. COHDEFOR controls the nationalized forest industry and forest reserves; however, since the latter are for timber exploitation they are not considered here as conservation units.

(1) *La Tigra National Park*

Created in 1980, this park includes the higher elevations of San Juancito mountains that are the source of potable water for the capital, Tegucigalpa. A master plan for protection and public use of the park is being implemented. Minor problems include lack of adequate patrolling and enforcement, as well as agricultural encroachment along the boundaries.

(2) *Río Plátano Biosphere Reserve*

A 1980 law changed the Ciudad Blanca Archaeological Reserve to the Río Plátano Biosphere Reserve, a vast area of approximately 350 000 ha in eastern Honduras. Major vegetation types include coastal mangroves, swamp forests fringing coastal lagoons, pine savannas, gallery forests and extensive mixed broad-leaved forests. In the absence of significant disturbance or hunting, this broad spectrum of habitats supports an impressive array of endangered species including manatee, jaguar, crocodile, giant anteater, harpy eagle, brocket deer and scarlet macaw. Two groups of Indians, the Paya and Miskito, also live in the reserve.

A management plan for the reserve has been prepared (Anon. 1980) and basic inventories of the natural and cultural resources have also been completed. DIGERENARE has received strong support from CATIE and WWF-UK helping to consolidate the Río Plátano Reserve. Not only is Río Plátano the first biosphere reserve in Central America, it is truly the most significant conservation unit in northern Central America. Except for the Tikal World Heritage Site all other conservation units in northern Central America are less than one-tenth the size of the Río Plátano Biosphere Reserve (see Table 1).

17

(3) Lago de Yojoa Multiple Use Area

The 79 km² Yojoa lake is the only large body of fresh water in Honduras, with the introduced largemouth bass supporting both commercial and sport fisheries. The Yojoa watersheds were declared as a forest reserve in 1971, but are now considered a multiple-use area (Betancourt & Dulin 1978) rather than a reserve for timber exploitation.

Despite full legal protection of the area, persistent problems include squatter invasions for subsistence agriculture, lake contamination from mining operations and fertilizer and pesticide runoff, and lack of control of the bass fishery.

(4) Cusuco National Park

The Cusuco Forest Reserve was decreed in 1959 and efforts are being made to convert the area to national park status. The Cusuco watersheds are the principal source of potable water for San Pedro Sula, Honduras' commercial centre. The municipality of San Pedro Sula maintains forest guards in the park and COHDEFOR has a fire control brigade stationed near the park. The surrounding area has been largely deforested for slash-and-burn agriculture and coffee growers are encroaching on the remaining mid-elevation forests.

(5) Bay Islands National Park

DIGERENARE has proposed converting the Guanaja Forest Reserve into the Bay Islands National Park, including the addition of about 10 000 ha of marine area and many beautiful coral reefs. The principal islands, Roatán, Guanaja and Utila, have been severely degraded and watershed destruction has reached a critical stage. Although the 1959 Fisheries Law declared coral reefs as protected areas, the Bay Islands' reefs have suffered considerable degradation. Numerous endemic wildlife races and species occur on the Bay Islands, but have greatly reduced populations due to habitat destruction. The Bay Islands lack effective enforcement of existing statutes protecting forests, wildlife and coral reefs.

Nicaragua

In 1980 the new government established the National Park Service (SPN) under the auspices of the Nicaraguan Institute of Natural Resources and the Environment (IRENA). Although only two conservation units existed prior to the 1979 revolution, the new government has initiated efforts towards a national system of protected wildlands. The SPN is evaluating thirty-five potential wildlands for classification as conservation units (Dilger & López 1982).

(1) Volcán Masaya National Park

This active volcanic complex lies only 20 km south-east of the capital, Managua.

12

Because of its attraction to local and foreign tourism, Nicaraguan dictator Anastasio Somoza was developing it as a showcase national park. Management and protection ceased during the recent civil war; after the revolution squatters invaded the national park that was closely identified with Somoza. These problems have been mostly solved by the new government; however, minor problems of firewood collecting and deer poaching persist. Detailed management and interpretative plans have now been implemented, so it appears that Nicaragua finally has a functional conservation unit.

(2) *Saslaya National Park*

This pristine park in the Zelaya hinterland has yet to be consolidated. Although protected so far by inaccessibility, the eastward expansion of the agricultural frontier will soon reach park boundaries. Protection and management will be necessary if Saslaya National Park is to be a viable conservation unit.

Panama

Panama has an impressive list of national parks and equivalent reserves, including the huge Darién World Heritage Site and part of the La Amistad International Park. Except for the Barro Colorado Natural Monument (BCNM) administered by the Smithsonian Tropical Research Institute, Panama's smaller parks have serious problems with squatter invasions, fire, hunting and general disrespect for conservation. The Renewable Natural Resources Directorate (RENARE) is the government agency responsible for administering Panama's national parks and equivalent reserves. RENARE's conservation efforts have been ineffective, in part due to weak leadership. Apart from BCNM, the best conservation effort in Panama is by the Cuna Indians in the autonomous Comarca de San Blas. But even their forests are coming under increasing pressure from non-Indian slash-and-burn agriculturalists and it is questionable that the Cuna can maintain their patrimony without more direct government help.

Panama has also declared eight forest reserves and two forest protectorates totalling some 300 000 ha: the former are primarily for timber exploitation, while the latter are supposed to be preserved as protection forests. Several key watersheds should be reclassified from forest reserves to hydrologic protection zones. Even though the critical Bayano watershed was classified as a forest protectorate, logging and slash-and-burn agriculture continue to destroy the native forests.

(1) *Altos de Campana National Park*

This park contains one of the watersheds contributing to Gatún lake and the Panama Canal. The xeric vegetation is caused by the shallow, porous soil and frequent fires set by local people. Forest cutting for agriculture, fire and hunting are serious problems that are increasing in the park.

(2) *Volcán Barú National Park*

The park extends from mid-elevation to the highest peak in the country. Although it is

all government land, squatters occupy about 15% of the park and some 500 families are estimated to practice subsistence agriculture within the park boundaries. Deforestation, fires and hunting in the park are increasingly serious problems.

(3) *Portobelo National Park*

Although this park contains over 17 000 ha, Portobelo Bay and the colonial ruins are the principal features. RENARE shares administrative responsibility with the Panamanian Institute of Tourism (IPAT). Approximately 5000 people live within the park boundaries, where they continue to convert forest to pasture, practising subsistence agriculture and hunting with impunity. Unless drastic action is taken soon, Portobelo will cease to be a viable conservation unit.

(4) *Darién World Heritage Site*

The Darién National Park established in 1980 was reclassified a year later to a World Heritage Site. This vast area is mostly undisturbed by man due to its inaccessibility; Cuna and Chocoe Indians practice traditional shifting cultivation on about 10% of the protected area. If the Pan-American Highway is eventually completed between Boca de Cupé and the Colombian border, the highway will bisect the conservation unit. RENARE's poor track record in conservation and the rapacious clearing and burning of forest along the recently opened Pan-American Highway to Yaviza do not augur well for the planned highway corridor through the Darién World Heritage Site.

According to Dr A. Gentry of the Missouri Botanical Garden, the rain forests of the Darién and adjoining Colombian Chocó are extremely rich in plant species, possibly the most species-rich forests in tropical America. Although the flora and fauna of the Darién are still poorly known, the preliminary information on very high species diversity suggests that the Darién World Heritage Site probably includes more plant and animal species than any other conservation unit in Central America. Strictly from this biological perspective, consolidation of the Darién conservation area is absolutely essential, preferably before highway construction enters the area. World Wildlife Fund (U.S.) has been the principal foreign donor to help with park establishment and CATIE has been actively assisting RENARE with planning and operational development.

(5) *Soberanía National Park*

Created in 1979, this large park occurs along the east side of the Panama Canal and includes substantial areas of well-developed forest. The new park also encompasses several small settlements, as well as Summit Gardens. As U.S. influence in the Canal Zone waned in the 1970's, squatter invasions and poaching of wildlife and trees increased dramatically. RENARE is having great difficulty lessening these illegal activities that were well-established prior to the creation of the park.

(6) Barro Colorado Natural Monument

Several forested peninsulas in Gatún Lake were added to the famous Barro Colorado Island (BCI) in 1979 to become the Barro Colorado Natural Monument (BCNM). Under terms of the Torrijos-Carter Panama Canal Treaty, the Smithsonian Tropical Research Institute (STRI) is charged with management responsibility of BCNM until 1999. STRI is effectively protecting and managing BCNM.

BCI was set up as a preserve in 1923 for biological and ecological research. Over 55 years STRI has developed BCI as one of the premier tropical sites for basic research (Leigh *et al.* 1983). Long-term records enabled Willis (1974) to document a predicted loss of bird species attributed to the smallness (15.6 km²) of the island.

(7) La Amistad International Park

In 1979 Presidents Royo of Panama and Carazo of Costa Rica officially declared their intent to establish the Friendship International Park straddling the Cordillera de Talamanca of both countries. The boundaries initially proposed include about 200 000 ha in Panama; however, the Panama government did not follow through with park establishment prior to Royo's abrupt resignation in 1982. CATIE is actively assisting RENARE with planning in an attempt to bring to fruition the first binational park in Central America.

REFERENCES

- Anon. (1974). *Plan de manejo para el propuesto Monumento Natural Volcán Pacaya, Guatemala*. INAFOR FAO, Guatemala City.
- Anon. (1980). *Plan de manejo de la Reserva de la Biosfera, Río Plantano*. DIGERENARE CATIE, Turrialba, Costa Rica.
- Barnard, G.S. (1982). Costa Rica: Model for conservation in Latin America. *The Nature Conservancy News*, 32, 6-11.
- Bctancourt, J. & Dulin, P. (Eds) (1978). *Plan de uso multiple Lago de Yojoa (segunda fase), proyecto inter-institucional COHDEFOR, RENARE, CATIE, FAO, UNDP, Tegucigalpa, Honduras*
- Boza, M. (1978). *Los Parques Nacionales de Costa Rica*. INCAFO, Madrid.
- Boza, M. & Mendoza, R. (1981). *The National Parks of Costa Rica*. INCAFO, Madrid.
- Carr, A. (1967). *So Excellent a Fish: A Natural History of Sea Turtles*. Natural History Press, Garden City, N.Y., U.S.A.
- Centro Científico Tropical (1982). *Áreas potenciales para unidades de conservación de recursos naturales en Costa Rica*. Ministerio de la Presidencia, San José.
- Dary, M. & Ponciano, I. (1980). *Plan de manejo del Biotopo Universitario para la Conservación del Quetzal, Purullia, Baja Verapaz, Guatemala - un estudio introductorio con recomendaciones para manejo*. University of San Carlos.
- Dilger, F. R. & López, O.N. (1982). *Marco conceptual para la determinación de un sistema nacional de áreas silvestres protegidas en Nicaragua - SINASIP - SPN IRENA*. Managua.
- Godoy, J.C. (1982). *Situación actual del manejo de las áreas silvestres en Guatemala, específicamente los biotopos*. Seminario de la Ciencia Forestal y el Desarrollo del Trópico. CATIE, Turrialba, Costa Rica.
- IUCN (1981). *Conserving the Natural Heritage of Latin America and the Caribbean - The Planning and Management of Protected Areas in the Neotropical Realm*. Proceedings of the Eighteenth IUCN Commission for National Parks and Protected Areas, Morges, Switzerland.
- Janzen, D.H. (Ed.) (1983). *Costa Rican Natural History*. University of Chicago Press, Chicago.

- Leigh, E.G., Jr, Rand, A.S. & Windsor, D.M. (Eds) (1983). *The Ecology of a Neotropical Forest: Seasonal Rhythms and Longer-Term Fluctuations*. Smithsonian Institution Press, Washington.
- MacFarland, C. & Morales, R. (1981). *Plantación y manejo de los recursos silvícolas en América Central: Estrategia para una década crítica*. CATIE, Turrialba, Costa Rica.
- Moser, D. (1975). *Central America on Jungles*. Time-Life, New York.
- NRC (1980). *Research Frontiers in Tropical Biology*. U.S. National Academy of Science, Washington.
- Willis, E.O. (1974). Populations and local extinctions of birds on Barro Colorado Island, Panama. *Ecological Monographs*, **44**, 153-169.

develop an audio visual presentation on mangrove management, based on this *Handbook for Mangrove Area Managers*.

References

- Bina, R. T., R. S. Jara, and D. R. Rogue. (In press). Application of multi-level remote sensing survey to mangrove forest resource management in the Philippines. In E. Soepadmo (ed.), *Proc. Asian Symposium on Mangrove Environment: Research and Management*. Univ. Malaya, Kuala Lumpur, 25-29 August 1980.
- FAO. 1982. *Management and Utilization of Mangroves in Asia and the Pacific*. FAO Environment Paper No. 3. Rome.
- Galloway, R. W. 1982. Distribution and physiographic patterns of Australian mangroves. In B. F. Clough (ed.), *Mangrove Ecosystems in Australia: Structure, Function and Management*. Canberra: Australian National University Press.
- Hamilton, L. S. 1982. Understanding mangrove ecosystems Audiovisual Presentation, Gland, Switzerland: International Union for Conservation of Nature and Natural Resources, Commission on Ecology.
- Lal, P. N. (ed.) 1983. *Mangrove Resource Management*. Proc. of Interdept. Workshop, Suva, Fiji. Tech. Rept. No. 5. Fisheries Division, MAF, Suva.
- National Mangrove Committee, Philippines. 1980. Bakaan. Quarterly Newsletter. Ministry of Natural Resources, Manila.
- Natural Resources Management Center, Philippines. 1978. Mangrove forests: problems and management strategies. Likas-Yaman, *J. Nat. Resources Mgt. Forum* 1(3). Ministry of Natural Resources, Manila.
- Saenger, P., E. J. Hegerl, and J.D.S. Davie. (eds.) 1983. Global Status of Mangrove Ecosystems. Commission on Ecology Papers Number 3. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources. *The Environmentalist* 3(1983) Supplement No. 3.