NOMINATION OF CORCOVADO NATIONAL PARK

AND CAÑO ISLAND BIOLOGICAL RESERVE

FOR INCLUSION IN THE WORLD HERITAGE SITE LIST

UNDER THE WORLD HERITAGE SITE CONVENTION

FEBRUARY 2003

SUBMITTED BY THE GOVERNMENT OF COSTA RICA

1.IDENTIFICATION OF THE PROPERTY

a. Country

Costa Rica

b. State, Province, or Region

Province of Puntarenas, cantons of Golfito and Osa; located in the Osa Peninsula in the extreme Southwest of Costa Rica (Figure 1).

c. Name of Property

1) Corcovado National Park (Corcovado) and
2) Isla del Caño Biological Reserve (Isla del Caño)

Isla del Caño is located offshore approximately 17 km west from the coast of Corcovado National Park. Although these two protected areas are physically separate and have distinct legal status (see part 4(b), below), both properties are under essentially the same management regime (see part 4(d) below) and share ecological characteristics and relationships. Thus, for the purposes of this application and World Heritage Site status, Isla del Caño is considered a part of Corcovado National Park.

d. Exact location on map and indication of geographical coordinates to the nearest second

The geographical coordinates of Corcovado National Park are: 8°25'55" to 8°44'00" N and 83°24'50" to 83°45'00" W.

The geographical coordinates of Isla del Caño Biological Reserve are: 8°42'4" N and 83°53'20" W.

e. Maps and/or plans showing boundary of area proposed for inscription and of any buffer zone

The National Geographic Institute of Costa Rica (*Instituto Geografico Nacional*) of Costa Rica has published topographical maps of the entire country based on Lambert coordinates, available at 1:50,000 and 1:200,000 scales. The Llorona,

Sierpe, Madrigal, and Golfo Dulce sheets contain the entire area of Corcovado National Park (Annex 1). Figures 2 and 3 show Corcovado National Park and Isla del Caño Biological Reserve and their surrounding areas.

f. Area of site proposed for inscription (ha) and proposed buffer zone (ha)

Corcovado National Park: 47,757 terrestrial ha (MINAE and SINAC 1999) and 5,375 marine ha (this marine area encompasses 500 meters of seaward extension from the coastline of the Park).

Isla del Caño Biological Reserve: 320 terrestrial ha and 5,800 marine ha.

2. JUSTIFICATION FOR INSCRIPTION

a. Statement of Significance

Often shrouded in mist, the densely forested slopes of Corcovado National Park look like an impenetrable fortress of trees. Indeed, it is only within the last 30 years that scientists and visitors have come to fully appreciate the enormous beauty and scientific knowledge hidden within this lush forest. **Corcovado National Park and the associated Isla del Caño are the most significant remaining areas of lowland Pacific tropical rainforest in Central America**. Corcovado's location between the ocean and high mountain ranges has created an extraordinary array of biodiversity and endemism. This exceptional international resource is of outstanding universal value in terms of science, conservation potential, and natural beauty. The area clearly fulfills the criteria for a World Heritage Natural Property under paragraph 44(a)(ii), (iii), and (iv) of the Operational Guidelines. Although each of these three criteria is discussed independently below, the unique biological and aesthetic attributes of the park are interrelated. Thus, there is some overlap between these discussions. **Designating Corcovado as a World Heritage Site will help insure the protection of an extraordinary national park into perpetuity and will assist future conservation efforts within the Osa Peninsula, surrounding areas, and Costa Rica in general.**

b. Justifications for Inscription

44(a)(ii): Corcovado is an outstanding example of significant on-going ecological and biological processes

1) Corcovado is an isolated zone of biological diversification and endemism. Many distinct species races and populations of plants, insects, and birds exist only in Corcovado National Park and the Osa Peninsula. Biologically, Corcovado is like an island due to its isolation by dry forests along the Pacific coast and by high mountains further inland (Gilbert 1999). The historical isolation of this area,

which was a separate island until millions of years ago, has contributed to speciation within Corcovado. **Unless the habitats in Corcovado and surrounding forests are preserved, important mechanisms of future biodiversity creation will be lost**. In addition to endemic species, there are some species with distinct subspecies on the Atlantic and Pacific sides of Costa Rica that recombine genes in mountain passes between these areas, providing the opportunity for genetic exchange and further biological diversification. Subspecies of Atlantic zones are less local and less unique to Costa Rica than those within the Osa Peninsula and in Corcovado (Gilbert 1999). This situation is unique in Central America, and found in only a few areas of South America (Gilbert 1999).

2) Scientists are still recognizing new and unique biological processes that occur in the Corcovado area. Biologists recently discovered that Golfo Dulce, located just east of Corcovado, is a calving area for both northern and southern Pacific populations of humpback whales (*Megaptera novaeangliae*) (see Acevedo 1995). This circumstance is very rare, and may prove essential for the preservation of genetic diversity of this species. These whales pass through the protected waters of Corcovado National Park and the Isla del Caño. Recently the highly endangered harpy eagle (*Harpia harpia*) believed to be locally extinct in Corcovado National Park since 1989, was confirmed to still exist in the Park or to have returned (Eliecer Arce, Personal Interview, 2002). Corcovado and the Osa Peninsula contain extremely high species diversity. Biologists estimate that the area contains approximately 10,000 species of insects, at least 2,418 species of plants, 700 species of trees, 140 species of mammals, 367 species of birds (Stiles 1983), 117 species of amphibians and reptiles (Scott et al. 1983), and 40 species of freshwater fish (MINAE & FPN 1999). An estimated 49 species of trees in the area are in danger of extinction, at least 12 of which are endemic to Costa Rica (MINAE & FPN 1999). In addition, the Osa Peninsula is the home of an endemic species of bird (*Habia atrimaxillaris*) and 17 endemic subspecies of birds (MINAE & SINAC 1999). Corcovado also contains the most significant populations of large endangered mammals such as jaguars (*Felis onca*), pumas (*Felis concolor*), ocelots (*Felis pardalis*), white-lipped peccaries (*Tayassu pecari*), and tapirs (*Tapirus bairdii*) on the Pacific coast of Central America. In addition to endangered mammals, there are relatively large populations of endangered birds in Corcovado including scarlet macaws (*Ara macao*) and the great curassow (*Crax rubra*). Preservation of Corcovado's rich biological resources will allow future recognition and understanding of the complex natural processes that characterize this ecologically unique area.

44(a)(iii): Corcovado contains superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance

1) Corcovado is one of the most outstanding examples of tropical rainforest worldwide in terms of tree size and diversity. The forest within Corcovado

exemplifies the classic cathedral-like rainforests with very large trees and an open understory. Well-known botanist Alwin Gentry explained in a letter that his study site within the Park had more tree species of large size than any other Central American Site (Gentry 1988). One trail located in the Llorona plateau, contains awe-inspiring examples of tree species such as *Vantanea barbourii* that grow as high as 65 m (Hartshorn 1983).

2) Corcovado and Isla del Caño encompass the interaction between rainforest and ocean in an undisturbed setting. Clear unpolluted rivers drain from primary rainforest into mangrove estuaries and into open sea. Significant estuarine environments exist at the mouth of the Sirena, Corcovado, and San Pedrillo rivers. Large sharks swim into the mouths of rivers in search of food during high tide. Jaguar populations achieve high densities by taking advantage of marine resources such as sea turtles. At Salsipuedes point, located along the southern Pacific coast of the park, coral reefs exist just meters from rainforest. Visitors walking from the Leona ranger station to Sirena Biological Station can enjoy the sublime contrast between pristine beaches and lush, green rainforest. The proximity of Sirena Biological Station to both the beach and the forest allow visitors and scientists to explore the unique interaction between marine and terrestrial environments.

Similarly, Isla del Caño's waters contain extensive, well-preserved coral reefs that visitors can appreciate while snorkeling or diving. In addition, visitors can ponder the meaning of the mysterious stone spheres, created by ancient indigenous peoples, which remain scattered throughout the island. The relative accessibility of the island by boat from San Pedrillo or Bahia Drake creates opportunities for future research of the interaction between terrestrial and marine ecosystems as well as opportunities for aesthetic appreciation of the island's biological and archaeological resources.

(44)(iv): Corcovado contains significant natural habitats for in-situ conservation of biological diversity and species in danger of extinction

1) Corcovado is the last remaining large tract of lowland rainforest in the Pacific Coast of Central America (Blake 1992). The forests of the Corcovado basin and the Llorona plateau are unique along the Pacific lowlands in Mesoamerica, most of which are too dry for such forests (Gilbert 1999). The isolation and distinctiveness of Corcovado's forests increase its value for comparative studies with other rain forests. As a result of the biological diversity and relatively intact state of the area, Corcovado and the rest of the Osa Peninsula ranks above all Pacific lowland rain forests in the Americas as a global priority for conservation (Gilbert 1999).

2) Corcovado contains unusually high habitat and species diversity. Within a relatively small area of less than 50,000 ha, Corcovado contains at least thirteen

major ecosystems including the following: 1) inter-tidal (both rocky and sand), 2) mangroves, 3) lagoon with floating herbaceous vegetation, 4) herbaceous swamp, 5) palm swamp, 6) swamp forest, 7) low forest on poorly drained alluvium, 8) forest on well drained terraces and alluvial plains, 9) forest on undulating plateau, 10) forest on low broken hills, 11) forest on low steep hills, 12) mountainous forest, and 13) cloud forest (Vaughan 1979). Detailed studies of the vegetation of Corcovado will most likely yield at least 25-30 discernible vegetation associations (Hartshorn 1983). One study by Holdridge et al. (1971) illustrates that upland forest is characterized by the complete absence of dominance by one particular species (Hartshorn 1983). Studies have indicated that in some areas as many as 169 species of large plants (159 species of trees; 10 species of vines greater than 10 cm) can occur in one hectare (Soto 1992). The extremely high level of species and habitat diversity increases the opportunities for *in situ* conservation in terms of number of species preserved relative to the area protected.

3) Corcovado contains large areas of undisturbed habitat that allow large mammals and birds to maintain significant populations. Large mammals such as tapir, peccary, and jaguar are able to maintain significant populations. Such species impact forest structure and are symbols of successful conservation. A neotropical forest is not "pristine" without them (Gilbert 1999). A neotropical conservation area such as Corcovado that supports healthy populations of large animal fauna has great regional and global significance for *in situ* conservation efforts. Corcovado is also identified as one of the most important sites for the conservation of reptile species such as Central-American caiman (*Caiman crocodilus*) and crocodiles (*Crocodylus acutus*) (Vaughan 1981). Because this fauna is protected within Corcovado, and supported by other protected areas throughout the Osa Peninsula (see part 4(c), below), **Corcovado is at the top of conservation priorities in Central America** (Gilbert 1999).

4) Corcovado is an outpost of South American species in Central America. Corcovado and the Osa Peninsula contain species, genera, and even families of plants and animals that have populations nowhere else in Central America (Hartshorn 1983; Gilbert 1999). One example of this phenomenon is the tree *Caryocar costaricensis*, the only representative of its family north of the Panama-Colombia border (Gentry 1988). Similarly, the largest populations of carton nesting ants (*Azteca orita*) and squirrel monkeys (*Saimiri oerstedii*) in Central America are found in Corcovado (Janzen 1983). These populations are important

resources for preserving genetic biodiversity among populations in both Central and South America. Similarly, potential comparative studies of Central and South American populations may yield biological insights that can be used to improve existing *in situ* conservation efforts.

5) Corcovado presents unique opportunities for the study of large neotropical animal populations and development of conservation biology strategies. Few neotropical forest regions are relatively accessible to visitors, possess field stations, and also support populations of large mammals living in natural home ranges. Sirena Biological Station in Corcovado provides an opportunity, one of the few in the Americas, to study viable populations of large animals (Gilbert 1999). Other biological stations do not contain sufficient areas of intact forest for these studies. Corcovado and the Osa Peninsula may provide the best hope for understanding the ecology of large animals. This knowledge is critical for developing effective long-term conservation and management strategies.

6) Designation of Corcovado as a World Heritage Natural Property will influence future leaders in conservation science in the Americas. Graduate student researchers from many countries including Mexico, Panama, Puerto Rico, Colombia, Peru, Brazil, and Venezuela have conducted projects at Sirena in the last 10 years. Despite the rustic nature of the facilities, substantial research has been achieved. For example, Boinski's research on squirrel monkeys (*Samiri oerstedii*) near Sirena (1986) has been fundamental for understanding the characteristics of the species necessary for conservation and management efforts. This example illustrates the level of scientific knowledge that can be achieved even in a low-budget setting. **Sirena Biological Station may become a realistic model for developing countries to follow for achieving effective research and conservation strategies with limited financial resources**. Designation of Corcovado as a World Heritage Natural Property will reflect international recognition of Costa Rica's active role in research and conservation and will contribute to future research and conservation efforts worldwide.

c. Comparative Analysis

1) Corcovado's unique biological characteristics are inherently valuable and make it one of the most important research locations worldwide. Many biological research areas are important primarily because they posses well funded, heavily used research stations and large databases of information. It is often the "added value" of previous research that distinguishes these areas, rather their characteristics as biological "hotspots." In contrast, Corcovado's extreme biological diversity and heterogeneity distinguish it from other sites. One well-known biologist, Dr. Larry Gilbert of the University of Texas, explained, "The diversity of ecological systems found on the Osa [Peninsula] is not exceeded by any area of comparable size on earth" (1999). Corcovado has been compared to the Galapagos Islands in terms of its uniqueness, a fact that illustrates the inherent

scientific research value of Corcovado (Gilbert 1999). Furthermore, because of nearly 30 years of research at this site, Corcovado possesses the "added value" of extensive baseline data and species lists (Annex 2). In sum, Corcovado represents one of the world's most important sources for future knowledge about rainforest ecosystems and the conservation of biological diversity.

2) Corcovado is among the most biologically important protected areas in Central America (MINAE & FPN 1999). Previous studies indicate that Corcovado National Park is, in many respects, the most important wilderness area protected in the country (FPN 1999). One third of all tree species known to exist in Costa Rica are found in Corcovado and the surrounding Osa Peninsula (FPN 1989). One half of the endangered plants in Costa Rica can be found in the Osa Peninsula (Bixby *et al*. 1999). Similarly, Corcovado contains a large number of endangered animal species. The largest population of scarlet macaws in Costa Rica is in Corcovado. Large herds of white-lipped peccaries, a species that has almost disappeared from Pacific coastal areas, are frequently observed in the park. Current efforts to improve the management of surrounding areas within the Osa Peninsula and develop an extensive biological corridor within the Osa Peninsula and a management plan for the Golfo Dulce (see part 4(d), below) will further distinguish Corcovado from other conservation areas worldwide. Thus, **Corcovado is unique among other natural properties, both in the country and worldwide, and is worthy of recognition as a World Heritage Natural Property**.

d. Integrity

44(b)(ii): Corcovado's relatively large size and the fact that it contains necessary elements of natural processes provide one of the best hopes for the long-term conservation of ecosystems and the biological diversity in Central America

1) Corcovado National Park presents one of the best opportunities in the Americas to maintain an array of terrestrial, marine, and freshwater ecosystems in one site. The fact that at least one entire watershed is contained in the park helps insure the integrity of the hydrological systems necessary for maintaining freshwater and terrestrial habitats. Similarly, with regard to marine ecosystems, the area contains impressive coral reefs, such as those near Salsipuedes Point and the waters surrounding Isla del Caño. Corcovado also contains seagrass flats, mangroves, and other adjacent terrestrial ecosystems that help regulate nutrient and sediment inputs into the reef. The pristine nature of the terrestrial habitats contributes to the uniqueness of freshwater and marine habitats in the park. The size of Corcovado and its unique interface between terrestrial, marine, and freshwater environments allows the maintenance of high levels of biodiversity.

2) Corcovado contains the key elements for a healthy rainforest system. Corcovado contains a variety of elevations ranging from sea level to 745 masl.

Similarly, the soils range from very poor to rich (Soto 1992). One scientist has noted that the unusually high soil quality in some areas may be responsible for the extremely large trees in Corcovado (Gentry 1988). The contrast between the heavily forested areas of the park and the more open areas, such as those surrounding Lake Corcovado (see description in part 3(a), below), provides opportunities for succession and other natural ecosystem changes. The high level of both macro – and micro – habitat diversity of the forest ecosystems in Corcovado has contributed to the unusually high level of species diversity in Corcovado. Thus, Corcovado's forest ecosystems contain the elements necessary to maintain natural processes and allow long-term conservation of biodiversity.

44(b)(iii): Corcovado is of outstanding aesthetic value and includes areas that are essential for maintaining the beauty of the site

1) Corcovado presents unique aesthetic opportunities. Corcovado National Park offers the most extensive hiking along pristine beaches and rainforest trails in Costa Rica. Wildlife is abundant; opportunities for visitors to easily observe wildlife in its natural habitat are unmatched in Central America (Baker 1996). Sightings of endangered animals such as squirrel monkeys, tapirs, and peccaries are common. Flocks of scarlet macaws fly overhead along the beaches and trails. At high tide visitors gather on the banks of Rio Sirena to watch the large sharks and crocodiles that cruise the inshore waters. Hikers can bathe in crystal clear mountain streams such as Rio Claro, just minutes from Sirena Biological Station. In addition, there are numerous waterfalls, such as the impressive Llorona, a 35 m waterfall that cascades directly onto the beach.

2) Corcovado is the most accessible area of large rainforest in the Americas. A two-hour ride by four-wheel-drive taxi from Puerto Jimenez is easily arranged for those who hike into the park through the Leona entrance. Flights from Puerto Jimenez and San Jose are relatively inexpensive and provide access to the Park for less mobile individuals. While Corcovado is very accessible as far as wilderness areas are concerned, it is less visited by casual tourists than areas such as Manuel Antonio National Park. The fact that Corcovado is located in the far southwest of the country and that there is a time commitment involved in visiting the interior of the Park tends to limit the number of visitors. This minimizes the human impact on the park and contributes to the unique social dynamic among park visitors.

44(b)(iv): Corcovado contains habitats for maintaining the most diverse fauna and flora characteristics of the biographic province and ecosystems under consideration

1) Corcovado contains a variety of habitats including those critical for the survival of viable populations of wildlife. There are a variety of terrestrial, marine, and freshwater ecosystems and at least 25-30 vegetation associations within the park

(See part 2(b), above). These various habitats support a number of species of plants and wildlife, including a number of animals that are globally endangered, including jaguars, tapirs, and peccaries. The fact that Corcovado contains significant populations of large predators such as jaguars and puma reflects the overall ecosystem integrity of the area.

2) Existing and future management efforts insure the integrity of habitat functions within the park. In order to maintain Corcovado's healthy populations of fauna and flora, it is necessary to insure that essential ecosystem functions are occurring within protected habitat. Management activities such as facilitating the education and active involvement of nearby communities in protection efforts help to minimize poaching, illegal resource extraction, and other activities that degrade the ecological function of habitats on the edge of the park. Corcovado is currently located near a network of protected areas including Piedras Blancas National Park and Terraba-Sierpe National Wetlands. In addition, efforts are underway to establish a permanent and extensive biological corridor to link the numerous protected areas throughout the Osa Peninsula. This corridor will help preserve the long-term viability of populations within Corcovado National Park by expanding available habitat and facilitating genetic exchange among different populations (see part 4(d), below).

44(b)(v): Corcovado has a developed management plan and is currently improving management plans for the surrounding areas in the Osa Peninsula

Since the creation of Corcovado National Park in 1975, the Costa Rican government has developed several management plans for the park. In the 1980's a large influx of gold miners into Corcovado threatened the integrity of the park (See Janzen *et al*. 1985), the Costa Rican government took action evicting the miners (*oreros*), while at the same time working to minimize the social impacts of this move. The discussion of management (see part 4, below) illustrates the evolutionary nature of management efforts in Corcovado National Park and describes some current efforts to improve the effectiveness of conservation efforts in the surrounding areas, such as the Golfo Dulce.

44(b)(vi): Corcovado has adequate long-term legislative, regulatory, and institutional protection as well as adequate spatial characteristics and boundaries

1) Corcovado has been the site of innovation regarding protection and resource management. The government of Costa Rica has invested a very high level of resources in the management of the area, a level of expenditure only surpassed by its investment in the much larger Guanacaste Conservation Area (MINAE & FPN 1999). In addition, Corcovado has been the site of innovation regarding national parks management. In 1985, Corcovado was the first Costa Rican National Park to establish an office off park grounds in nearby Puerto Jimenez, the largest town in the Osa Peninsula. The relocation of the office allowed the Park's

administrators to better respond to the management needs of the park and to initiate community outreach activities. This decision reflected a realization on the part of the National Parks Service that effective management required participation of communities, local governments, and indigenous groups (MINAE & FPN 1999).
This new approach led eventually to the concept of decentralized conservation areas and the integration of managed buffer zones and biological corridors, co-management, payment for environmental services through forest protection incentives, and alliances with indigenous groups and local non-governmental organizations. In all of these areas, Costa Rica has been an innovator and a world leader.

2) Efforts are underway to improve management and conservation of the areas surrounding Corcovado National Park. As discussion of management indicates (see part 4(d) below), a number of governmental and non-governmental organizations have been very active in developing new conservation strategies within the Osa Peninsula. These organizations are currently planning to improve the management of both protected and unprotected areas in the Osa Peninsula and to establish an extensive biological corridor to link the numerous public and private conservation areas located throughout the peninsula. Similarly, efforts are underway to obtain protection for the Golfo Dulce. In addition, these organizations have been using a stakeholder process to build the consensus necessary for more comprehensive conservation programs. **Designation of Corcovado National Park as a World Heritage Natural Property will help catalyze future conservation efforts. Such efforts might eventually lead to designation of the entire Osa Conservation Area as a UNESCO Biosphere Reserve**.

44(b)(vii): Corcovado is among the most important site for the conservation of biological diversity in Central America

Corcovado is Costa Rica's most biologically important lowland protected area (MINAE & FPN 1999). As discussed above, Corcovado has an **unusually** high level of biological diversity, provides essential habitat for a number of endemic and endangered species, and has enormous potential for long-term *in situ* conservation within Central and South America. The high level of scientific interest in Corcovado National Park (see bibliography in section 7(c)) illustrates the outstanding biological characteristics of the area and the global importance of preserving it. Corcovado's extraordinary scientific and aesthetic value, as well as its overall ecosystem integrity and the precedent of conservation efforts in the surrounding areas, make it appropriate for designation as a World Heritage Natural Property.

3. DESCRIPTION

a. Description of the property

Corcovado National Park

Corcovado National Park encompasses 45,757 terrestrial ha and 5,375 marine ha and contains a variety of ecosystems including forests, beaches, coral reefs, and mangrove and freshwater swamps. Corcovado includes the entire drainage of the Corcovado plain, a sediment-filled embayment between Punta Llorona and Punta Salsipuedes that extends 5-10 km inland. The Corcovado plain covers about 10,000 ha ringed with steep and broken uplands on three sides and the Pacific Ocean on the southwest. Intense geological weathering has produced a topography of narrow ridges, long and steep slopes, and a drainage network that dominates practically all of the uplands except for an undulating plateau in the northwest part of the park.

The climate of Corcovado is hot, humid, and rainy. Although no weather station exists in the park, vegetation patterns suggest that the Corcovado plain receives an average annual rainfall between 3,000 and 3,800 mm, while the tropical wet forest uplands receive more than 4,000 mm (Hartshorn 1983). However, the annual rainfall in the high interior could be as high as 5,000 to 6,000 mm (Hartshorn 1983). The average mean temperature of the Park is approximately 27° C (MINAE & SINAC 1999).

The unique topography and weather patterns of the park have led to the development of at least thirteen major ecosystems within Corcovado (see part 2(b), above). These ecosystems support an array of plant and animal life, which is described in more detail below.

Corcovado is distinguished from other areas in Central America and worldwide by the variety and uniqueness of its flora. Approximately one third of the trees in Costa Rica can be found in the Corcovado area, including one-half of the endangered trees in the Country (Bixby *et al*. 1999). It has been estimated that there are 4,000 to 5,000 vascular plant species in the Osa Peninsula (Herrera-MacBryde *et al*. 1997). The lowlands of southern Costa Rica are the only wet forests still extant on the Pacific side of Central America. The abundant rainfall coupled with a short three-month dry season seems to be ideal for tree growth, which helps explain why the Corcovado has the most impressive forests in Central America (Hartshorn 1983).

Corcovado's forests exemplify the popular conception of the tropical rain forest, with a multitude of species, very tall trees, spectacular buttresses, large woody lianas, and abundant herbaceous vines. Holdridge *et al*. (1971) report that the most outstanding feature of their study site in the Osa Peninsula is the extreme height of the forest; they encountered 22 species over 50 m tall, five species that exceeded 60 m, and one, *Minquartia guianensis,* that reached 73 m (Hartshorn 1983). Possibly the largest tree in Central America, an example of *Ceiba pentandra* measuring 80 m tall, 3 m in diameter, and with 10 m tall buttresses, occurs on the Corcovado plain (Boza and Boniall 1978).

Lake Corcovado is one of Corcovado's notable hydrological features, and encompasses approximately 10 km near the center of the park (Naranjo 1993). An extensive floating mat of herbaceous vegetation, dominated by a *Pennisetum* sp., surrounds the relatively small, open-water section of the lagoon (Hartshorn 1983). As the depth of water decreases, more heterogeneous vegetation is rooted in the muck soil. The slightly higher natural levees of the streams feeding the lagoon support a large stand of *Inga vera*. Surrounding the herbaceous swamp is an extensive area dominated by the Yolillo palm (*Raphia taedigera*) estimated by Vaughan (1979) to vary between 200 and 1,500 m in radius. The Yolillo palm forms mono-specific stands in areas receiving appreciable floodwaters for a few months each year. The *Raphia* swamp dries out during the dry season to the stage that it is relatively easy to walk on the mucky swamp soil. The vegetation outside the *Raphia* swamp takes on the appearance of typical swamp forests with large, well-buttressed canopy trees, stilt rooted sub canopy trees, and a fairly open understory of abundant palms (Hartshorn 1983).

In addition to Lake Corcovado, the Park contains a variety of freshwater ecosystems. Some of the larger rivers include Rio Madrigal, Rio Claro, Rio Sirena, Rio Corcovado, and Rio Llorona. In addition, there is an extensive network of smaller streams and brooks. Mangroves occur in association with the tidal estuaries of the Llorona, Corcovado, and Sirena rivers. These environments support an array of birds and aquatic life.

The wildlife in Corcovado National Park and the surrounding Osa Peninsula is as abundant and varied as its plant life. The park contains important populations of large wild vertebrates, several of which are in danger of extinction in Costa Rica and globally. These include tapirs, jaguars, pumas, ocelots, white-lipped peccaries, and possibly giant anteaters. It is estimated that Corcovado and the Osa Peninsula contains 375 species of birds (18 of which are endemic), 124 species of mammals (more than 50 are bats), 40 species of freshwater fish, approximately 8,000 species of insects (Mansour 1995), 71 species of reptiles and 46 species of amphibians (Soto 1992). The species recorded in this area represent between 30% and 50% of the species known to exist in Costa Rica. As further biological research is conducted these numbers of species will most likely continue to grow. The large inventory of plant and animal species is one indicator of the complexity of the ecosystems within Corcovado.

Isla del Caño

Isla del Caño is located about 17 km off the Pacific coast at the north end of Corcovado National Park and is clearly visible from the shore. The island is approximately 320 ha in area; it forms a rough triangle 3-km long and 2-km wide at the base. The island is a heavily forested rock mesa about 100-m high dissected by small ever-flowing creeks. The beaches are sand and rock and lack mangroves due to the high-energy environment. The upland part of the island contains undisturbed rainforest, while the triangle's apex contains various ages of secondary growth following clearing for banana plantations, an aborted airstrip, and some cultivated areas. The slopes down to the sea contain undisturbed vegetation similar to that on the sea-facing cliffs of northern Corcovado National Park.

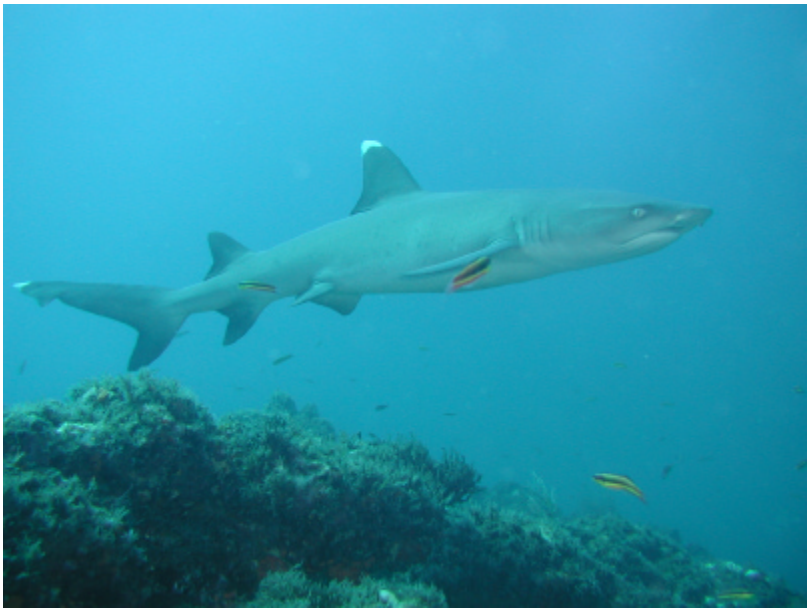
The climate of the island is characterized by high precipitation; the mean annual rainfall for the zone is 5150 mm annually (Guzman & Cortez 1989). The rainy season is from May to December, and the peak of precipitation is in October. The dry season is from December to April. The temperature in the island is very consistent ranging between 26-27° C, and there is almost always 100% relative humidity.

Like most islands, species richness is lower than on the mainland and a few species are the most abundant. In terms of plant species, 158 species of vascular plants and ferns exist on the island. The area is characterized as humid tropical forest, and the majority of the species are perennials (FPN & SINAC 1999). The tree species vaco (*Brosimum utile*), aguacaton (*Ocotoea ira*) and pilon (*Hieronima alchornioides*) dominate the upper strata of the forest while the juco (*Trema micranta*) and rubiacea (*Penhagoa gymnopoda*) dominate the underbrush. The abundance of the vaco in the center of the island suggests the possibility of its introduction by the Quepos and Cotos Indians for religious reasons (Wille 1987).

Thus, the vegetation associations on the island have archaeological as well as ecological significance. There is little vegetation along the periphery of the island, due to the abruptly steep terrain.

There are a total of 69 species of animals known to exist on the island. These include 31 species of birds, 4 species of amphibians, 9 reptiles, and 5 species of mammals. In terms of insects, there are 5 species of beetles, 4 of butterflies, 2 of moths, and 7 species of bees. Notable species include the "four eyed fox" (*Philander opossum*), the endangered tepezcuintle (*Agouti paca*), a large rodent), and the important pollinating hummingbird, *Amazilia tzacatl*, (MINAE & SINAC 1999).

The waters surrounding Isla del Caño contain five fringing coral reef flats, ranging in size from 0.8 to 4.2 ha. (Guzman & Cortes 1989). Nineteen species of corals and 60 mollusks have been identified in the coral reefs near the island. The dominant coral species is *Porites lobata*, which is resistant to environmental fluctuations, has a high rate of wound recovery, and is subject to low-level predation (Gomez & Cortez 1989). In addition, there are a number of fish species that occupy this ecosystem. This ecosystem is one of the healthiest and best-preserved reefs in the Costa Rican Pacific coast. The coral reefs surrounding Isla del Caño are comparable to the best-developed reefs in Panama, Colombia, and the Galapagos (Guzman & Cortes 1989). These unique marine environments have been targeted as being some of the most important for conservation in the country (MINAE & SINAC 1999).



Isla del Caño also merits special attention for its cultural resources. Archaeological relics including a number of large stone spheres and pottery shards are scattered throughout the island. One study conducted by Finch and Honetschlager (1982) revealed at least 17 archaeological sites. It appears that ancient people used the island exclusively for funerary purposes. Despite incidents of exploitation of these resources by grave robbers (*huaqueros*), there are still a number of remaining relics that have aesthetic and archaeological value.

b. History and development

Corcovado National Park

The creation of Corcovado National Park was the result of a national and international campaign in the 1970's to save the biological resources of the Corcovado Basin from imminent threats posed by both agricultural settlers and an international timber and development company, *Osa Productos Forestales.* The creation of the park was also a means to defuse serious and escalating conflicts between settlers and the company. The exceptional biological wealth of Corcovado was recognized in the previous decade, and the campaign for the creation of the park was waged principally by biologists working in the area and the Costa Rican National Parks Service, with the active support of international conservation organizations. The establishment of the park required the expropriation of a large portion of the holdings of *Osa Productos Forestales* and the resettlement of small farmers onto other lands. The creation of Corcovado National Park was a milestone in the history of conservation in Costa Rica and the world because it marked the explicit recognition of conservation as a priority in the nation's development process. This commitment was demonstrated by the very difficult governmental decision to favor conservation over competing economic uses and to allocate the large amounts of scarce public funds necessary to create the park.

The 1980s were marked by economic crisis throughout Costa Rica, and the southern zone was severely affected. A particularly heavy blow to the economy of the region was the abrupt decision of the United Fruit Company to abandon its plantations in the area, a decision that posed challenges for conservation. The sudden loss of employment by thousands of workers resulted in the migration of a great number of these workers to ecologically delicate lands throughout the area. Many attempted to earn a living by farming independently or mining for gold. The southern portions of Corcovado National Park were severely threatened by both gold mining and hunting (See Janzen *et al*. 1985). Although there had previously been a small number of traditional miners in the areas of Corcovado, as many as 1,000 miners entered the park and severely threatened the ecological integrity of this area. The Costa Rican government responded to this threat by evicting the miners. Although this was successful in conservation terms, it was also highly controversial. A number of displaced gold miners marched on the

capital of San Jose and won significant monetary compensation from the government.

This episode with the miners offered important lessons for the Costa Rican government regarding the management of protected areas in Corcovado and Costa Rica in general. The invasion of Corcovado made it clear to the administrators of the National Park System that the value of National Parks was neither well understood nor greatly respected by local communities. The incident with the miners illustrated that some believed that the resources in the park could and should be exploited in times of need. In an effort to educate local communities as to the value of Corcovado National Park, as well as to improve relations with inhabitants of nearby communities, the National Parks System opened the first field office outside the borders of a national park, in Puerto Jimenez. This move began the process of decentralization, education, and increased community involvement that now characterizes the management of Costa Rican National Parks.

Isla del Caño

According to the artifacts that remain, Isla del Caño was used by various groups of humans. It is believed that the island was used as an ancient cemetery by societies of the Chiriqui between 700 and 1500 BC (MINAE & SINAC 1999). There is some evidence that suggests permanent occupation by other indigenous groups, perhaps the Quepos or Brunkas (MINAE & SINAC 1999). In 1519 Juan de Castañeda visited the island and named it Isla del Caño. Later, grave robbers (*huaqueros*) visited the island. In 1935 there was an attempt to inhabit the island's west side and to introduce agriculture onto the island. In 1940, a banana company built a lighthouse, which was in service until 1961. Some history books describe several failed attempts to build an airstrip on the island. In 1976, the Government authorized the National Park Service to administer the island. Originally annexed as an addition to Corcovado National Park on September 30, 1976 by executive decree N°6385, Isla del Caño was legally established as a Biological Reserve on February 24, 1978 by law N°6215.

c. Form and date of most recent records of site (see description of plans, section 4(f), below)

- 1979: "Master Plan for management and development of Corcovado National Park"
- 1988: "Management and Development plan for Corcovado National Park" and "Management and development plan for Isla del Caño Biological Reserve"
- 1992: "Rapid Ecological Assessment"
- 1994: "Protection plan for the Osa Conservation Area"

- 1995: “Management plan for Corcovado National Park and Isla del Caño Biological Reserve”
- 1999 “Work Plan for Corcovado National Park and Isla del Caño Biological Reserve: Plan Towards the New Millennium.”
- Yearly: annual operational plan

d. Present state of conservation

Historically, the forests and high biological diversity of the Osa Peninsula have been protected by the difficulty of access to the area. As a result, in 1990 approximately 70% of the forests in the Osa Peninsula were primary forests (Carillo *et al*. 2000). Since the creation of Corcovado National Park in 1975 and the Isla Del Caño Biological Reserve in 1978, the government of Costa Rica has invested a significant amount of funds into the management and protection of the area. This investment is reflected in the actual state of the natural resources in the Corcovado area. Corcovado protects populations of species that are threatened in the rest of their range of Costa Rica and Central America. For example, Corcovado National Park is probably the area that contains the largest populations of jaguars and peccaries in Costa Rica (Soto 1992). Within Corcovado many of these populations are biologically viable as a result of the healthy ecosystems within the Park. However, there is also consensus among biologists that large species of mammals (particularly cats) are threatened unless biological corridors are consolidated to enable genetic interchange with other populations of the same species (Soto 1992).

The Golfo Dulce Forest Reserve and the Guaymi de Osa Indigenous Reserve form the terrestrial perimeter of Corcovado National Park, and act as a buffer zone, while strong currents and high waves limit access by sea.

Presently, five ranger stations exist within Corcovado and the Isla del Caño, as well as two patrols that cover the entire peninsula. The greatest threats to Corcovado are clandestine hunting and mining within the borders of the park, together with the fragmentation of forests outside, which could biologically isolate the park and its fauna. In addition, the Park does not receive sufficient financial support from the government to cover its operating costs, and much of the income that the park itself produces is dispersed throughout the Conservation Areas System nationwide. The greatest threats to the Isla del Caño include illegal fishing, the loss of archaeological artifacts, and damage caused to corals by recreational divers (see part 5(a), below).

The infrastructure possessed by these areas is very good compared with other national parks in the country, but it is deteriorating and requires significant investment in maintenance and renovation. The Los Patos ranger station must be rebuilt, and the effective management of the park will require the construction of a new station in the northern sector of the park (or in the nearby community of Rancho Quemado) to address problems posed by hunting in that area. Another pressing challenge is to increase income produced by Corcovado National Park – primarily through entrance fees and services to tourists and researchers – and to insure that this income is retained for the management of the Park. Sirena Biological Station has great potential, but requires significant investment in improving its research facilities. In addition, the Management Plans of Corcovado and the Isla del Caño – while very good – must be updated.

Presently, work is being done to improve conservation in the buffer zones and biological corridors surrounding the park (Figure 4). Many landowners have formed private reserves, and some receive financial incentives from the government in the form of payments for environmental services. An intensive effort is underway to resolve a long-standing land tenure conflict in the area of the Golfo Dulce Forest Reserve, which has caused much friction over the years between landowners and governmental conservation efforts. Efforts are also being undertaken to resolve tenure disputes in the Guaymi Indigenous Reserve. Work is also being done to increase environmental awareness and involve local communities in protection efforts. Finally, a major fundraising effort is underway to help finance activities in Corcovado National Park and surrounding areas.

e. Policies and programs related to the preservation and promotion of the property

Area de Conservacion Osa (ACOSA), together with the organizations that make up the Osa Biological Corridor Coalition (see part 4 (d), below) and the Costa Rica-USA Foundation, are undertaking an international campaign to raise awareness as to the importance of Corcovado, Isla del Caño, and surrounding areas, and to seek financing for their consolidation and long-term conservation. These efforts include the formation of a trust fund for the management of the protected areas of ACOSA, including Corcovado and the Isla del Caño. Designation of Corcovado and Isla del Caño as a World Heritage Site will greatly assist these efforts.

In addition, Corcovado and the Isla del Caño receive a great deal of international attention from the scientific community. Corcovado, and in particular Sirena Biological Station, is renowned among tropical biologists for its setting, its abundance of wildlife, and its great diversity of species and ecosystems.

Finally, the governmental Costa Rican Tourism Institute (ICT) as well as the numerous private tourism operators in the Osa Peninsula are promoting the great importance of Corcovado and the Isla del Caño as conservation sites both nationally and internationally. This helps produce income and support for conservation efforts both directly (through the payment of entrance fees) and indirectly (through the strengthening of the local nature tourism-based economy, increased donations to support conservation, etc.).

4. MANAGEMENT

a. Ownership

Corcovado National Park and Isla del Caño Biological Reserve are property of the Republic of Costa Rica.

b. Legal status

Corcovado National Park was established by Executive Decree N° 5357-A on October 24, 1975. It was enlarged, also by Executive Decree on two occasions: by Decree N° 6385-A on September 30, 1976, and by Decree N° 11148-A on February 5, 1980. Both decrees and the status and boundaries of the Park were ratified by Law N° 6794 on August 25, 1982 (Annex 3).

Isla del Caño was initially included as an addition to Corcovado National Park by Decree N° 6385-A on September 30, 1976, and was legally established as Isla del Caño Biological Reserve by Law N° 6215 on March 9, 1978.

Both Corcovado and Isla del Caño are located within the Osa Conservation Area (ACOSA), which was established by Executive Decree N° 20790-MIRENEM, in November 1991. The National System of Conservation Areas (SINAC) was created as a part of the Biodiversity Law, N° 7788, on April 23, 1998. This law ratified the prior decree of conservation areas throughout the country and provided a nationwide legal and administrative framework for the operation of conservation areas.

c. Protective measures and means of implementing them

Under the title "General Rules," the "Management and Development Plan of Corcovado National Park" (1988) sets forth the following protection methods and guidelines:

In the park, it is prohibited to cut trees, extract plants or any other plant product, hunt or capture marine, riverine or terrestrial wildlife or collect any of their products or wastes, collect or extract objects of historical or archaeological

interest, introduce plants or domestic or exotic animals, land on beaches without a permit or fly over the area at low altitude, take stones or sand, cause fires, introduce cattle and carry guns, except for Park Guards on duty.

Similarly, Article 8 of the Law of the Creation of the National Park Service, N^{o} 6084, August 17, 1977, prohibits the following activities within national parks:

1) Cutting trees and removing plants, or any other forest product. Hunting or capturing wild animals, collecting or extracting any of their products or parts.
2) Hunting sea turtles of any species, collecting or removing their eggs or any other products.
3) Scratching, marking, staining, or causing any other damage to plants, equipment or facilities.
4) Engaging in sport, industrial or small-scale fishing, except in the case cited in Article 10.
5) Collecting or removing corals, shells, rocks, or any other marine product.
6) Collecting or removing mineral rocks, fossils or any other geological product.
7) Carrying guns, harpoons or any other instrument that can be used as a hunting weapon.
8) Introducing exotic animals or plants.
9) Cattle ranching activities.
10) Causing any type of environmental pollution.
11) Removing stones, sand, gravel or similar products.
12) Feeding animals.
13) Building electric or telephone lines, sewer systems, roads or railways.
14) Developing any type of commercial, agricultural or industrial activities.

In addition, the “Management and Development Plan of Corcovado National Park” (1998) and the “Management and Development Plan of the Isla del Caño Biological Reserve” (1998) establish zoning for each of the areas and detail the permitted uses of each zone. This zoning has been strictly enforced, notwithstanding limitations posed by the lack of human and financial resources.

Enforcement measures include patrolling areas within and along the perimeter of Corcovado National Park and Isla del Caño Biological Reserve. Information from monitoring efforts, scientific research, and reports on possible hunting or mining sites is used to determine patrol routes and timing.

Efforts are underway to increase the human and financial resources available for management and protection. An international fundraising campaign is currently being organized by ACOSA, the Osa Biological Corridor Coalition, and the CR-USA Foundation. A specific goal of this campaign is the creation and consolidation of a trust fund for the protected areas of ACOSA to ensure resources to improve both short and long-term management

Efforts are also being made to extend environmental protection beyond the limits of Corcovado by involving local communities in conservation and protection activities. These efforts are centered primarily in the area of the Golfo Dulce Forest Reserve, which serves as a buffer zone and biological corridor for the park. Activities being coordinated by the Osa Biological Corridor Coalition, ACOSA, and other local organizations include environmental education; the forming, training and equipping of volunteer committees to assist in protection of forests and wildlife; identification and consolidation of key sites for protection; promotion of incentives and legal strategies for conservation of forests on private lands; the resolution of land tenure conflicts; and assisting local communities in the development of economic activities consistent with conservation.

d. Agencies with management authority

Corcovado National Park and the Isla del Caño Biological Reserve are under the management of the Administration of Corcovado National Park. This administration is responsible for the technical and operational management of these areas, as well as for their protection and conservation. In turn, this administration is under the direction of the Area de Conservacion Osa (ACOSA).

ACOSA comprises all public and private lands within the Cantons of Osa, Golfito, and Corredores, including lands within and outside the limits of designated natural protected areas. This regional conservation area reflects the governmental decision to create a National Conservation Areas System (SINAC), which includes the entire national territory in eleven decentralized regional conservation areas. SINAC is an agency of the Ministry of Environment and Energy (MINAE).

Other agencies and organizations cooperating with Corcovado National Park and the Isla del Caño Biological Reserve include the following:

Ministry of Public Security: The Ministry of Public Security and the Ministry of the Environment and Energy (MINAE) have signed an agreement whereby the former agrees to participate in environmental protection, including protected areas throughout the country. Pursuant to this agreement, the Ministry of Public Security has assisted with the eviction of miners in Corcovado National Park in the mid 1980s (see part 3(b), above) and with the control of hunting activities. In

addition, a protocol to this agreement has been negotiated between ACOSA and the Costa Rican Coast Guard to increase protection of coastal and marine resources in ACOSA, including the waters of Corcovado National Park and the Isla del Caño.

Local Committee of the Osa Conservation Area (CLACOSA): The Biodiversity Law established local committees, comprised of representatives of local communities, as consultative bodies for each of Costa Rica's conservation areas. This committee provides the opportunity for local communities and ACOSA to work together to develop and implement conservation plans. In ACOSA, this local committee is subdivided into three regional sub-committees, one of which is for the Osa Peninsula.

Osa Biological Corridor Coalition: A Coalition comprised of ACOSA and eight local, national, and international conservation organizations is working to establish a permanent biological corridor in the Osa Peninsula and surrounding areas linking public and private protected areas in the Osa Peninsula. It is also cooperating with fund raising efforts to consolidate the protected areas of ACOSA.

The current member organizations of the Coalition are the following:

- Fundación Corcovado
- Fundación Cecropia
- Fundación TUVA
- Fundación Neotrópica
- Centro de Derecho Ambiental y de los Recursos Naturales (CEDARENA)
- Instituto Nacional de Biodiversidad (INBio)
- The Nature Conservancy (TNC)
- Conservation International

Natural Resources Vigilance Committees (COVIRENAS): These committees are organized community volunteer groups trained to cooperate in environmental education and the prevention and reporting of illegal hunting and logging.

National Parks Foundation (FPN): This private foundation cooperates with SINAC in fundraising and administration of funds. Funding administered by the FPN is used to acquire lands and equipment for protected areas and to pay staff salaries.

Corcovado Foundation: This non-government organization has cooperated with ACOSA by hiring park rangers and acquiring and administrating donations for Corcovado National Park.

CR-USA Foundation: The Costa Rica – United States of America Foundation for Cooperation has supported the administration of Corcovado National Park through donations (channeled through non-government organizations) to cover pressing needs within Corcovado National Park. These have included funds for the clearing and maintenance of park trails and boundaries, the posting of signs, and the acquisition and maintenance of equipment.

Corcovado Campaign: This is a joint fundraising initiative of CR – USA Foundation and conservation groups of the Osa Biological Corridor Coalition. The specific objectives of the campaign are: 1) establish a trust fund for the protected natural areas of ACOSA (including Corcovado National Park and Isla de Caño Biological Reserve), 2) fund land purchases in Piedras Blancas National Park, and 3) support the consolidation of Biological Corridors.

National Biodiversity Institute (INBio): INBio is conducting an inventory of marine and terrestrial species in Corcovado National Park and the Isla del Caño Biological Reserve. INBio has also created ecosystem maps for all of ACOSA, including Corcovado and Isla del Caño (Figure 5, Table 1). INBio has also cooperated with the training of ACOSA personnel on administration and fund management. INBio has also helped Corcovado National Park by providing resources for making signs and brochures, as well as for training and buying equipment.

Municipalities of Osa, Golfito and Corredores: These local governments hold important responsibilities for the administration of natural resources outside protected areas. In particular, municipalities play a very important role in regulating development in the coastal zone.

National University of Costa Rica (UNA): The Regional Wildlife Program of the UNA has cooperated extensively in research and monitoring activities within Corcovado National Park. The data obtained from this research is used by the Park administration to plan biodiversity conservation strategies.

Organization of Tropical Studies (OTS): This consortium of Unites States and Latin American universities regularly holds part of its post-graduate programs in Sirena Biological Station. Many researchers from member universities conduct research in Corcovado.

University of Texas at Austin: The University of Texas has cooperated with Corcovado National Park in the construction of the laboratory at Sirena Biological Station through promotion of research activities and the donation of equipment, tables, shelves, and a small library.

e. Level at which management is exercised and names and addresses of responsible persons for contact purposes

The management of Corcovado is based in the park and at administrative offices in the nearby town of Puerto Jimenez, within the framework of SINAC's decentralized administration. The person directly responsible for both the operation and technical management of Corcovado and Isla del Caño is the administrator of these areas, Mr. Eliécer Arce-Guevara. Mr. Arce acts under the direction and with the support of the Lic. Luis Barquero-Barrantes, Chief of the Osa Peninsula Sub-region of ACOSA, and of Oscar Zúñiga-Guzmán, the Director of ACOSA. The ACOSA Director works with the support of a Technical Committee, composed of ACOSA Program Coordinators, the finance director, the area's legal advisor, and the Administrators of each of ACOSA's protected areas. The Technical Committee supervises the technical elements related to management of ACOSA and its protected areas.

Addresses:

Mr. Eliecer Arce
Administrator, P.N. Corcovado, R.B. Isla del Caño
Telephone: (506) 735-5036, 735-5580
Fax: (506) 735-5076
e-mail address: egarce@costarricense.cr

Lic. Luis Barquero
Chief, Peninsula sub-region of ACOSA
Telephone: (506) 735-5036, 735-5580, 735-5581
Fax: (506) 735-5076
E-mail address: lubarba@minae.go.cr

Ing. Oscar Zúñiga
Director, ACOSA
Telephone: (506) 741-1146, 741-1173; Cellular (506) 392-4225
Fax: (506) 741-1136
E-mail address: o.zuñiga@costarricense.cr

f. Agreed plans related to the property

Corcovado National Park and Isla del Caño Biological Reserve have had several management plans over the years. This fact reflects the adaptive approach to management within these areas. The existing management plans include necessary measures for protection, operation, and implementation of these areas.

- In 1979, the first comprehensive management plan, the "Master Plan for Management and Development of Corcovado National Park" was written.

- In 1988, the "Management and Development Plan for Corcovado National Park" and "Management and Development Plan for Isla del Caño Biological Reserve" were prepared. Both of these plans are still in use, and the Park's administration has complied with the proposed objectives and zoning (Annex 4).

- In 1994 the "Protection Plan for the Osa Conservation Area" was created, and the system of patrols set forth in this plan is still in use.

- In 1995, the "Management Plan for Corcovado National Park and the Isla del Caño Biological Reserve" were made by the University of Costa Rica's Program for Environmental Studies. Although this plan contains much valuable information about Corcovado and the Isla del Caño, its operational section was not validated by ACOSA, and thus the plan was never implemented.

- In 1999, Corcovado National Park's administration developed a "Work Plan for Corcovado National Park and Isla del Caño Biological Reserve: Plan Towards the New Millennium." This document summarizes the conservation status of both these protected areas and addresses potential threats to conservation. It has served as an important guide for the administrators of these areas in recent years (Annex 4).

- Annually, Corcovado National Park and Isla del Caño Biological Reserve have operational plans for the year that delineate proposed activities, the expected results, persons in charge of each activity, the timeline for the execution of each activity, and the necessary funds and their corresponding sources (Annex 4).

g. Sources and levels of finance

Table 2. Sources of finance for Corcovado National Park and Isla del Caño Biological Reserve, 2002.

Source	Salaries	Operation
National Park fund	$70.000	$8.500
Ordinary budget	$145.000	
President's fund	$32.800	
Corcovado fund		$110.000
INBio-SINAC project		$10.900
CR-USA Foundation		$72.500
Corcovado Foundation	$10.300	
Total	$258.100	$201.900
• Grand Total	$460.000	

Source: Ministry of Environment and Energy (MINAE), 2002.

In order to increase available financial resources and facilitate the more effective administration of Corcovado National Park, a Trust Fund for the Protected Areas of ACOSA will soon be created and consolidated within the framework of the Campaign for Corcovado mentioned above.

In addition, plans also exist to promote the self-sufficiency of Corcovado National Park by improving Sirena Biological Station and the services it provides to researchers and visitors.

Improved management will generate profits to help cover operating costs and finance other programs within the park.

Also, a small trust fund (the President's Fund) was established in the National Parks Foundation in 1998 to cover the salaries of a number of park guards.

h. Sources for specialization and training in conservation and management techniques

The personnel of Corcovado National Park and Isla del Caño receive specialized training which is continuously being updated. Training includes the following topics: mountain orienteering, patrol systems, conservation biology, natural history, first aid, and wildlife monitoring. Similarly, the personnel of Isla del Caño Biological Reserve receive diving lessons to enhance their ability to monitor and protect the island's coral reefs.

i. Infrastructure for visitors and statistics

Corcovado National Park and Isla del Caño Biological Reserve have adequate infrastructure for their operation, unlike the majority of protected areas in Costa Rica. For example, Sirena Biological Station includes an airstrip and is able to generate sufficient revenue from research and tourism activities to cover the operating costs of the station. Among the challenges to be addressed in the short-term management of Corcovado National Park is the reconstruction of the Los Patos ranger station, the possible re-location of the El Tigre ranger station and the construction of the new Los Planes ranger station.

Visitation to the Corcovado area increased at an annual rate of 80-90% in the 1990s when mining activities decreased. Tourism has become an important source of financial support for Corcovado and Isla del Caño. Of the visitors to Corcovado, 20-30% were Costa Ricans and 70-80% were foreigners, mainly from the United States and Germany.

The statistics for Corcovado National Park visits for the years 1982-2001 are included in annex 5.

Corcovado National Park and Isla del Caño Biological Reserve have great potential to promote an economy based on ecologically-sustainable tourism in the Osa Peninsula, thereby establishing the basis for the future economic development of the area (MINAE & FPN 1999). By involving the community in the conservation of natural resources, the administration of Corcovado and Isla del Caño and its many collaborators are creating a legacy of conservation while insuring that local communities will experience the benefits of an increase in tourism revenue.

Description of infrastructure:

Table 3. Infrastructure available in the Operation Centers of Corcovado and Isla del Caño, June 2002.

Ranger Station (Puesto)	Toilets	Employees rooms	Beds for visitors	Showers	Offices	Con-ference room	Kitchen and dining room	Laboratory
Pto. Jiménez	10	10	0	4	12	1	1	0
Sirena	17	6	32	15	2	3	1	1
Los Patos	4	4	4	2	1	0	1	0
La Leona	3	3	10	3	1	0	1	0
El Tigre	2	6	0	2	1	1	1	0
San Pedrillo	4	4	0	5	1	0	1	0
Casa Geología	2	2	6	2	0	0	1	0
Isla del Caño	4	3	2	3	1	0	1	0
Total	46	38	54	36	19	4	8	1

*Corcovado***:**

Corcovado National Park contains the five following ranger stations, the features of which are described below:

- **Sirena:** Camping area with a capacity for 40 persons; Operations Center with an area of 80 m^2; Research Station composed of two laboratories 70 m^2 each, with a storage room, study rooms and a library, and can lodge 15 researchers; a 250 m^2 hostel with a capacity for 20 tourists; a conference room 70 m^2; a dining room with a capacity for 30 persons; and 4 showers and toilets. Access is by land, air, or sea. By land, access is on foot since there are no roads to the station. There are trails connecting Sirena Biological Station and the La Leona, Los Patos, and San Pedrillo ranger stations. There is an airstrip for small aircraft (maximum capacity of five passengers).

- **San Pedrillo:** Visitor quarters (that were funded by Global Environment Facility); housing for park guards; storage room; camping area for 30 tents. Access is possible only on foot or by sea.

- **La Leona:** Housing for park guards; kitchen and dining room; camping area for eight tents (approximately fifteen people).

- **El Tigre:** Station with capacity to lodge 10 persons; access is by gravel road.

- **Los Patos**: Housing for park guards; camping area; access is only possible on foot.

Isla del Caño:

The existing infrastructure is a ranger station of approximately 120 m^2, a cement platform, and a picnic table in the beach area. Access is only possible by boat. Diving is allowed in three areas, and fishing is prohibited within the limits of the Reserve.

j. Site management plan and statement of objectives

The "Management and Development Plan of Corcovado National Park" and "Management and Development Plan of Isla del Caño Biological Reserve" are attached in annex 4.

The "Management and Development Plan of Corcovado National Park" states the following objectives:

- Insure the conservation and protection of a sample of the only "very humid tropical forest" life zone in the Pacific of Costa Rica and Central America and allow the normal development of natural processes within the life zone.

- Insure the physical integrity of marine ecosystems in such a way so that the protection and conservation of the natural resources within them is guaranteed.

- Protect and conserve the cultural resources of the region where the Park is located, and facilitate the analysis and scientific interpretation of these resources.

- Promote and contribute to the sustainable development of the buffer zone, in order to insure the protection and conservation of the natural and cultural resources in the Corcovado area.

- Develop environmental education and interpretation programs both for the residents of the surrounding areas and for the general public.

- Protect and conserve flora and fauna for the aesthetic, educational and recreational benefits they offer.

- Insure the conservation of genetic diversity found in Corcovado for future use as medicines (medicinal plants), agriculture (plants to obtain hybrids resistant to plagues, etc.).

- Encourage scientific research in Corcovado and its buffer zones, and guide neighboring communities towards the sustainable development of resources.

The "Management and Development Plan of Isla del Caño Biological Reserve" has the following objectives:

- Strict protection of the flora and fauna, coral formations, and existing marine ecosystems in a 3-km radius around the island.
- Strict protection of archaeological sites, stone spheres, and other archaeological objects of great cultural value that are located on the island.
- Promote scientific research on the existing natural resources on the island.
- Offer recreational opportunities to national and foreign visitors through regulated visits. These visits should be oriented towards scientific tourism and should consider the capacity of the public use areas of the island.
- Offer opportunities for the interpretation of the ecological, cultural, and aesthetic value of Isla del Caño.

k. Staffing levels (professional, technical, and maintenance)

Corcovado and Isla del Caño currently have 36 staff members, located in Puerto Jimenez (the administrative center for the two protected areas) and the six ranger stations that serve as operational centers: Leona, Sirena Biological Station, Los Patos, El Tigre, San Pedrillo, and Isla del Caño. Two patrols composed of park guards monitor the whole of Corcovado, and three park guards are stationed permanently in Isla del Caño. There is a strong need to increase the personnel in order to operate the park more efficiently. The number of park guards is expected to increase to 10 per station to strengthen the protection of natural resources and the control of human activities within the park.

Table 4. Corcovado National Park and Isla del Caño Biological Reserve personnel, June 2002.

Administrator	Director of Park Guards	Tourism Director	Park Guards	Boat Captain	Heads of patrols	House-keeping
1	1	1	12	1	2	1

Drivers	Security officers	Finance manager	General Services	Warehouse manager	Heads of operational centers	Para-taxonomists
2	1	1	2	1	6	4

5. FACTORS AFFECTING THE PROPERTY

a. Development pressures

Corcovado National Park

Although its designation as a National Park affords Corcovado the maximum legal protection available in Costa Rica, some illegal activities within the park continue to occur. The main threats to biodiversity and ecosystems within Corcovado National Park are hunting, gold mining, and the potential biological isolation of the park due to development outside the Park boundaries.

- Hunting

There is no data as to the exact number of hunters who enter the park illegally, although it is known that hunting occurs. Mostly, the hunting that occurs is not subsistence hunting, but rather is undertaken for sport by persons from outside of the Osa Peninsula. However, some subsistence hunting is practiced by the indigenous people of the Guaymí reserve on the outskirts of Corcovado National Park. The northern areas of the park are the areas of greatest hunting activity. A proposal exists to construct an additional ranger station in this section of the park, which would allow park rangers to better control and stop illegal hunting within the park as well as the transportation of carcasses and meat (Eliecer Arce, Personal Interview, 2002). Similarly, as discussed above, there are increasing efforts to foster a sense of stewardship and cooperation with neighboring communities, including active participation by COVIRENAS in patrols carried out by ACOSA. Such efforts will help decrease illegal hunting by inhabitants of these communities as well as encourage the reporting of illegal activities undertaken by individuals from outside the region.

- Mining

Mining has been one of the main environmental problems in this area because miners hunt as well as disturb and destroy the forest (Janzen 1985, Carrillo *et al.* 2000). In the past, there were as many as 1,000 miners in Corcovado National Park. As a result of efforts on the part of the Costa Rican government, these miners were evicted (see part 3(b), above). Nevertheless, it is estimated that there

are still approximately 40 individuals mining within the park. The relatively large size of the Park and the limited number of park guards available to patrol for mining activity make it difficult to completely eradicate this problem. As practiced in Corcovado, mining activity can negatively impact river ecosystems due to sedimentation, which in turn negatively affects marine life. In addition, the cutting of trees and other vegetation and unauthorized subsistence hunting by miners does occur.
ACOSA is increasing its efforts to patrol the park to stop these activities. Also, community education efforts are underway to discourage mining and to encourage the reporting of illegal activities.

World Heritage status can help the Park obtain funds to hire additional personnel, purchase equipment, and expand community education efforts. This status will also place a greater obligation on the government to redouble its efforts to stop this activity.

- *Forest destruction and fragmentation in surrounding areas*

Outside Corcovado, there is still a loss of ecosystems associated with deforestation (See Sanchez-Azofeifa *et al*. 2001). This activity, if not curtailed, will eventually lead to the biological isolation of populations within Corcovado National Park. As discussed above, efforts are currently underway to develop a comprehensive conservation program for the Osa Peninsula, undertaken by a coalition of local, national and international conservation organizations, who are working with local communities. This plan would involve the establishment of a permanent biological corridor linking public and private protected areas throughout the region. This biological corridor will insure the mobility of populations of animals and thus facilitate genetic exchange among populations. In addition, the project will encourage the sustainable use of the forest resources in the Osa Peninsula. The area is also becoming increasingly important as an area for ecotourism. Corcovado National Park is the major attraction for a developing ecotourism economy in the Osa Peninsula that is becoming a pillar of the future economic development of the area (MINAE & FPN 1999), a fact that is now widely recognized by local communities. Community stewardship of natural resources is a legacy that is self-perpetuating and will be transmitted by the people of the Osa Peninsula to other areas as well.

Isla Del Caño

- *Illegal commercial and sport fishing*

Commercial fishing for conch, lobster, and other fish is diminishing the natural populations of these animals, despite low prices for fish caught in the region. In addition, there have been reports of illegal sport fishing within the protected limits of the island. A lack of resources and the relative isolation of the island from the

next closest ranger station at San Pedrillo has limited the ability of ACOSA to curtail these activities. As in the case of illegal hunting on the mainland, World Heritage status could help the Park secure resources including personnel, equipment, and boats. Efforts are underway to encouraging the education and stewardship of the resources of the island by nearby communities such as Bahia Drake. Many of the inhabitants of Bahia Drake rely on income from tourism, including boat tours of Isla del Caño. Encouraging tour operators to assume an active role in monitoring and reporting illegal fishing in the surrounding waters will help deter and reduce illegal fishing. Also, as mentioned above, a strong partnership between ACOSA and the Coast Guard for protecting the marine resources of the region is developing.

- *Recreational diving and snorkeling*

Although there are established public-use rules for recreational diving, some disturbance of the marine ecosystem could occur. For example, some fragile coral reefs could be damaged by divers' fins and by individuals standing on the corals. The main problem is the lack of control of underwater activity, which depends on the goodwill of the guides and individual divers. Increased funding could allow the installation of buoys delineating approved dive sites and allow the construction of signs that explain appropriate diver conduct. Educating guides regarding the fragility of reefs and the importance of preserving the reefs for both environmental and economic reasons should encourage stewardship and improve diver behavior.

- *Loss of archaeological artifacts*

In addition, there have been problems associated with the loss of archaeological resources from the island. Visitors and collectors have been illegally removing relics from the island. As with the case of illegal fishing and other types of visitor impacts, increases in personnel, resources, and education will help minimize this threat to the island's unique archaeological resources.

b. Environmental pressures

There are currently no records of any major sources of pollution within Corcovado National Park. Although in the past widespread mining activity threatened ecosystem integrity by degrading water quality and causing sedimentation, this activity has been largely curtailed and the ecosystem is recovering. While there have been no studies regarding the affect of global climate change on the park, large forested areas such as Corcovado National Park and the surrounding Osa Peninsula are important sites for carbon sequestration and will likely play an increasingly important role in stabilizing the global climate.

c. Natural disasters and preparedness

In general, natural disasters do not pose a major threat to the future integrity of Corcovado National Park. Although tropical storms and hurricanes can have an impact on coastal environments, these ecosystems have evolved to naturally respond to such impacts, and this area is well south of areas of major hurricane and tropical storm activity.

Due to the very wet nature of the forests within Corcovado, the potential for damage from forest fires is minimal. There has never been problems with forest fires reported in the park.

A major earthquake in the region could cause deforestation of steep slopes, as occurred in the Talamanca range in eastern Costa Rica as a result of a major earthquake in 1992. However, as with rare serious storms, tremors and earthquakes are part of the evolutionary process of the ecosystems of the Osa Peninsula.

d. Visitor, tourism pressures

In the last 12 years visitation to the Corcovado has increased significantly. This visitation reflects the increasing international recognition of the beauty and uniqueness of Corcovado National Park. As discussed above, the large area of the park (over 54,000 ha of marine and terrestrial property) as well as its remoteness

compared to other parks minimizes visitor impact on natural systems. Rustic facilities, such as unpaved trails and very basic accommodations in the ranger stations (*puestos*), further reduce the impact of visitors on wildlife behavior patterns. In addition, a study of the impact of human visitation on the natural systems and wildlife of Corcovado National Park is currently underway. The findings of this study will help improve the management of visitation in order to insure that the Park is not adversely affected.

e. Number of inhabitants within site, buffer zone

With the exception of park staff, there are no permanent inhabitants within Corcovado National Park or the Isla del Caño (Eliecer Arce, Personal Interview, 2002). The estimated population on the Osa Peninsula is 12,000 people (a density of less than 7 people/km^2). This population is located primarily within several larger population centers (Puerto Jimenez, Cañaza, La Palma, Bahia Drake), but it is also dispersed throughout the Osa Peninsula in smaller settlements and isolated farms (Carrillo *et al*. 2000).

f. Other

The buffer zone of Corcovado is the Golfo Dulce Forest Reserve, which surrounds the park along most of its terrestrial boundary. Although the Golfo Dulce Forest Reserve is also a protected area, it has different management objectives. Corcovado National Park and Golfo Dulce Forest Reserve share the same general ecological characteristics of the Osa Peninsula. However, in Corcovado National Park all resource extraction is prohibited, while in Golfo Dulce Forest Reserve the development of certain sustainable commercial activities is permitted. Golfo Dulce Forest Reserve was created as a multiple use area for the production of water, timber, wildlife, forage, and recreation, and was designed to minimize negative impacts on natural resources (Thelen and Dalfelt 1979). However, a lack of active management has led to deforestation and threats to wildlife (Eliecer Arce, Personal Interview 2002; Carrillo *et al*. 2000). Currently, much of the Golfo Dulce Forest Reserve is being included in the Osa Biological Corridor Project, which is taking a more comprehensive and active approach to the management and protection of the area. This should greatly increase the level of protection for wildlife and natural resources.

6. MONITORING

a. Key indicators for measuring the state of conservation

One of the main indicators of the state of conservation efforts in Corcovado National Park is the size of populations of keystone species. Monitoring the state of the populations of large mammals, such as jaguars, peccaries and tapirs, shows that conservation efforts within the park have been considerably effective in protecting biodiversity. Research projects that have monitored mammal populations in the park have shown that overall mammal abundance has remained relatively stable since 1990 (Carrillo *et al*. 2000). A comparative study between the abundance of groups of species in the park and outside the park showed that the state of conservation of species within the park is better due to the effectiveness of patrol efforts to combat illegal hunting within the park.

Another important indicator of success of conservation programs is the monitoring of the level of illegal mining, hunting, and poaching activities. For example, one study funded by the World Wildlife Federation (see Janzen 1985) highlighted the serious problem with miners in Corcovado National Park in the early and mid-1980s and spurred the Costa Rican government to take appropriate action to evict the miners (see part 3(b), above).

Although Corcovado National Park safeguards wildlife, some species have large territory requirements and need to be able to range outside the Park's borders. Thus, the level biological connection of Corcovado National Park to other protected areas is another indicator of the state of conservation of the Park. The establishment of a permanent biological corridor in the Osa Peninsula would facilitate wildlife movement throughout the area and increase the long term survival of species inhabiting the park by increasing migration rates, diminishing the probability of genetic bottle necking, and allowing the continuity of natural ecological processes.

b. Administrative arrangements for monitoring property

Monitoring is necessary to assess whether the management actions within protected areas are achieving the goals described above in part 4(j). The administration of Corcovado and Isla del Caño has included a regular system of monitoring of the ecological process and cultural features in its annual operations plan. Currently, park guards patrol Corcovado and Isla del Caño regularly. The guards use information generated from scientific research, as well as observations of the locations of hunters and miners, to plan effective monitoring and management activities. Monitoring and vigilance are expected to improve in the near future with the increase of personnel and funds. There is a plan to systematize the information obtained from the monitoring activities so it can be processed and transformed into a format more conducive to effective decision-making.

c. Results of previous reporting exercises

Many scientific studies have been carried out in Corcovado National Park documenting the state of conservation (see bibliography of scientific literature, section 7(c)). These include research on the different species of wildlife in the park, studies of animal and plant ecology, and population monitoring efforts. One very comprehensive study is the "Rapid Ecological Assessment" (1992). It gives an overview of the state of plants, insects, marine resources, amphibians, reptiles, birds, mammals, and geological information within the Osa Peninsula. An inventory of the terrestrial and freshwater environments was begun in this study and the inventory has been continued by individual scientists and by the National Biodiversity Institute (INBio) through the efforts of its parataxonomists and the related eco-map project.

Several graduate studies have been done in the Park studying the general ecology of keystone species (Carrillo 2000, Campero 1999; Foerster 1998; Chinchilla 1994; Altrichter 1997). These studies have examined issues such as the minimal areas needed to maintain populations of peccaries and jaguars, the potential of forest habitats to support different species, diurnal and nocturnal behavior of jaguars. This last study brought about a change in the Park administration's rules that prohibited tourists from walking on the beach at night in order to avoid conflicts with jaguars and turtles (Carrillo 2000). This example illustrates the intimate relationship between research, monitoring, and conservation decisions within Corcovado National Park. Other studies with important conservation implications include the evaluation of diet and relative abundance of several species within the park (Chinchilla 1994); activity patterns, home range size and habitat utilization of tapirs (Foerster 1998); and variability and genetic structure of peccaries (Campero 1999). The close relationship between research and monitoring has contributed Corcovado's status as one of the best-protected regions in Costa Rica. As a result, the Park has been receiving increasing international recognition. For example, the Wildlife Conservation Society has described Corcovado National Park as one of the most important sites for jaguar conservation in the Americas (Carrillo, Personal Interview, 2002). **Designation of Corcovado National Park as a World Heritage Natural Property will bring further international recognition, help secure funding to improve existing conservation programs, and will result in the increased scientific attention necessary for effective, long-term conservation.**

7. DOCUMENTATION

a. Photographs, images, maps, and video/film (see annexes 1-10)

- Topographic maps, scale 1:50,000, Carate, Sierpe, Llorona, Golfo Dulce, Madrigal (Annex 1).

- Flora and fauna species lists (Annex 2).
- Maps of zoning, vegetation, life zones, buffer zones, neighboring protected areas, etc. (Annex 6)
- CD-Rom with maps of the area (Annex 6).
- Satellite image of the area (Annex 7).
- Aerial photographs (Annex 8).
- Video "Corcovado: un lugar para todos", UNED (Annex 9).
- CD-Rom with photographs of the area (Annex 10).

b. Copies of property management plans and extracts of other plans relevant to the property

See annex 4.

c. Bibliography

Literature Cited

Acevedo, A. 1995. First records of humpback whales including calves at Golfo Dulce and Isla del Coco, Costa Rica, suggesting geographical overlap of Northern and Southern hemisphere populations. *Marine Mammal Science*. v. 11, no. 4. p. 554-560. 1995.

Altrichter, M. 1997. Estrategia de alimentación y comportamiento del chancho cariblanco *Tayassu pecari* en un bosque húmedo tropical de Costa Rica. M.Sc. Thesis, Heredia: Universidad Nacional. p.97.

Arce, E. 2002. Administrator Corcovado National Park, Personal Interview. June 15-18.

Baker, C.P. 1996. *Costa Rica Guidebook*. Moon Publications, Inc, Chico, California.

Blake, B. 1992. *The new key to Costa Rica*. Publicaciones en ingles, S.A. San José, Costa Rica.

Boinski, S. 1986. The ecology of squirrel monkeys in Costa Rica. Ph.D. Dissertation, The University of Texas at Austin.

Boza, M.A. 1992. *Parques Nacionales de Costa Rica*. INCAFO, S.A., Madrid, Spain.

Boza, M.A. and Bonialla, A. 1978. *Los parques nacionales de Costa Rica*. INCAFO, S.A., Madrid, Spain.

Campero, H. 1999. Variación y estructura genética dentro y entre grupos de chanchos de monte (*Tayassu pecari*) en el Parque Nacional Corcovado, Costa Rica. M.Sc. Thesis, Heredia: Universidad Nacional. p. 78.

Carrillo, E. 2000. Ecology and conservation of white-lipped peccaries and jaguars in Corcovado National Park, Costa Rica. Ph.D. Dissertation, University of Massachusetts. p. 131.

Carrillo, E., G. Wong, and A. Cuarón. 2000. Monitoring mammal populations in Costa Rican protected areas under different hunting restrictions. *Conservation Biology* 14(6): 1580-1591.

Chinchilla, F. 1994. La dieta del jaguar (*Panthera onca*), el puma (*Felis concolor*), el manigordo (*Felis pardalis*), (Carnivora, felidae), y dos métodos de evaluación de su abundancia relativa en el Parque Nacional Corcovado, Costa Rica. M.Sc. Thesis, Heredia: Universidad Nacional. p. 50.

Finch, W.O. and Honetschlager, K. 1982. Preliminary Archaeological Research, Isla del Caño. *Journal of the Steward Anthropological Society*. Vol. 14 (No. 1-2)- 189-206.

Foerster, C. 1998. Ecología de la danta centroamericana *Tapirus bairdii* en un bosque húmedo tropical de Costa Rica. M.Sc. Thesis, Heredia: Universidad Nacional. p.82.

(FPN) Fundacion Parques Nacionales. 1989. *The Corcovado 2000 Project*.

Gilbert, L.E. 1999. *Global Importance of Corcovado Park and Surrounding Conservation Zone of the Osa Peninsula, Costa Rica: A Biological Perspective*.

Guzman, H.M. and Cortez, J. 1989. Coral Reef Community Structure at Caño Island, Pacific Costa Rica. *Marine Ecology*, 10 (1): 23-41.

Hartshorn, G.S. 1983. *In:* Janzen, D.H. (ed.) 1983. *Costa Rican Natural History*. University of Chicago Press, Chicago.

Holdridge, L.H. *et al*. 1971. *Forest Environments in Tropical Life Zones: A Pilot Study*. Pergamon Press, New York.

Janzen, D.H. (ed.) 1983. *Costa Rican Natural History*. University of Chicago Press, Chicago.

Janzen, D.H., R. Dirzo, G. Green, J. Romero, F. Stiles, G. Vega, and D. Wilson. 1985. *Corcovado National Park: a perturbed rainforest ecosystem*. Report. World Wildlife Fund, Washington, D.C.

Janzen, D.H. *et al*. 1998. *Area de Conservacion Guancaste: Nomination for Inclusion in the World Heritage List of Natural Properties.* Submitted by the Government of Costa Rica.

Mansour, J. (ed.) 1995. *Parks in peril source book*. The Nature Conservancy: America Verde Publications.

MINAE & FPN. 1999. Short-Term Measure for Corcovado National Park: Managing Biodiversity in the Heart of the Osa Conservation Area (A proposal presented to the Global Environment Facility by Ministry of the Environment and Energy of the Republic of Costa Rica and the National Parks Foundation). Puerto Jiménez, June.

MINAE & SINAC. 1999. *Plan de trabajo para el Parque Nacional Corcovado y la Reserva Biológica Isla del Caño: Plan Hacia el Nuevo Milenio*. September.

Naranjo, Eduardo Jorge. 1993. Abundancia, Uso de Hábitat y Dieta del Tapir (*Tapirus bairdii*) en el Parque Nacional Corcovado, Costa Rica. M.Sc. Thesis, Universidad Nacional, Heredia, Costa Rica.

Rosero, Luis *et al*. 1999. Bosque y Población en la Península de Osa. Seminario Internacional "La población del Istmo al fin de milenio" Jaco, Costa Rica. October 20-22.

Scott, N.J., Savage, J.M. & Robinson, D.C. 1983. *In:* Janzen, D.H. (ed.). *Costa Rican Natural History*, University of Chicago Press, Chicago. p 367-74.

Soto, R. 1992. Evaluación Ecológica Rápida de la Península de Osa. Fundación Neotrópica, Programa Boscosa. Península de Osa. Costa Rica.

Stiles, F.G. 1983. *In*: Janzen, D.H. (ed.) 1983. *Costa Rican Natural History*, University of Chicago Press, Chicago.

Thelen, K.D. and A. Dalfelt. 1979. *Políticas para el manejo de las áreas silvestres*. Editorial Universidad Estatal a Distancia, San José. Costa Rica.

Vaughan, C. 1979. *Plan Maestro para el Manejo y Desarollo del Parque Nacional Corcovado, Peninsula de Osa Costa Rica*.

Vaughan, C. 1981. *Parque Nacional Corcovado: Plan de Manejo y Desarrollo*.

Wille, Alvaro. 1987. *Corcovado, Meditaciones de un biólogo: un estudio ecológico*. Editorial Universidad Estatal a Distancia. San José, Costa Rica.

A**dditional Literature Involving Corcovado National Park**

Ammerman, L. K. 1992. *A dietary analysis of phyllostomid bats from Corcovado National Park, Costa Rica*. Vol. 3 No. 5. University of Texas at Austin.

Bello y Bello, B. 1997. Biologia de las dispersion de las Marantaceas en dos selvas tropicales de Costa Rica: interacciones con hormigas.

Billington, H. L., Thomas, C. D., & Gilbert, L. E. 1990. Variation in stage-specific mortality patterns of a specialist herbivore on different host plant clones. *Functional Ecology* 4: 721-725.

Boggs, C. L. 1979. Resource allocation and reproductive strategies in several heliconiine butterfly species. Ph.D. Dissertation, Univ. of Texas at Austin.

Boggs, C. L. 1981. Selection pressures affecting male nutrient investment at mating in heliconiine butterflies. *Evolution* 33: 931-940.

Boinski, S. 1979. *Wet season cebid interspecific contacts in Corcovado National Park, Costa Rica.* Vol. 1 No. 2. University of Texas at Austin.

Boinski, S. 1985. Status of the squirrel monkey *Saimiri oerstedi* in Costa Rica. *Primate Conservation* 6: 15-16.

Boinski, S. 1986. The ecology of squirrel monkeys in Costa Rica. Ph.D. Dissertation, The University of Texas at Austin.

Boinski, S. 1987. Birth synchrony in squirrel monkeys (*Saimiri oerstedi*): A strategy to reduce neonatal predation. *Behav. Ecol. Sociobiol.* 21: 393-400.

Boinski, S. 1987. Habitat use by squirrel monkeys (*Saimiri oerstedi*) in Costa Rica. *Folia primatol.* 49: 151-167.

Boinski, S. 1987. Mating patterns in squirrel monkeys (*Saimiri oerstedi*): Implications for seasonal sexual dimorphism. *Behav. Ecol. Sociobiol*. 21: 13-21.

Boinski, S. 1988. Sex differences in the foraging behavior of squirrel monkeys in a seasonal habitat. *Behav. Ecol. Sociobiol*. 23: 177-186.

Boinski, S. & Fowler, N. L. 1989. Seasonal patterns in a tropical lowland forest. *Biotropica* 21: 223-233.

Boinski, S. & Fragaszy, D. M. 1989. The ontogeny of foraging in squirrel monkeys, *Saimiri oerstedi*. *Anim. Behav*. 37.

Boinski, S. & Newman, J. D. 1988. Preliminary observations on squirrel monkeys (*Saimiri oerstedi*) vocalizations in Costa Rica. *Am. J. Primatol*. 14: 329-343.

Boinski, S. & Scott, P. E. 1988. Associations of birds with monkeys in Costa Rica. *Biotropica* 20: 136-143.

Boinski, S. & Timm, R. M. 1985. Predation by squirrel monkeys and double-toothed kites on tent-making bats. *Am. J. Primatol*. 9: 121-128.

Chai, P. 1986. Field observations and feeding experiments on the responses of rufous-tailed jacamars (*Galbula ruficauda*) to freeflying butterflies in a tropical rainforest. *Biological Journal of Linnean Society* 29: 161-189.

Chai, P. 1987. Patterns of prey selection by an insectivorous bird on butterflies in a tropical rainforest. Ph.D. Dissertation, The University of Texas at Austin.

Chai, P. 1988. Wing coloration of free-flying neotropical butterflies as a signal learned by a specialized predator. *Biotropica* 20: 20-30.

Chai, P. 1990. Relationships between visual characteristics of rainforest butterflies and responses of a specialized insectivorous bird. Pp. 31-60. *In*: Wicksten, M. (eds.). *Adaptive Coloration in Invertebrates*. Galveston, Texas A & M University Sea Grant College Program.

Chai, P. & Srygley, R. B. 1986. Associations of flight pattern and thermal biology of butterflies to their palatability. *Am. Zool*. 26: 98 Abstract.

Chai, P. & Srygley, R. B. 1990. Predation and the flight, morphology, and temperature of neotropical rainforest butterflies. *Am. Nat*. 135: 748-765.

Chloe, J. C. & Timm, R. M. 1985. Roosting site selection by *Artibeus watsoni* (Chiroptera: Phyllostomidae) on *Anthurium ravenii* (Araceae) in Costa Rica. *J. Tropical Ecol*. 1: 241-247.

Colwell, R. K. 1985. A bite to remember. *Natural History* 4: 2-8.

Condon, M. A. & Gilbert, L. E. 1988. Sex expression of *Gurania* and *Psiguria* (Cucurbitaceae): Neotropical vines that change sex. *Amer. J. Bot*. 75: 875-884.

Condon, M. A. & Gilbert, L. E. 1990. Reproductive biology and natural history of neotropical vines *Gurania* and *Psiguria*. Pp. 150-166. *In*: Bates, D., R. W. Robinson, & C. Jeffrey (eds.). *Biology and Utilization of the Cucurbitaceae*. Ithaca, NY, Cornell University Press.

Constanz, G. D., Bussing, W. A., & Saul, W. G. 1981. Freshwater fishes of Corcovado National Park, Costa Ric. *Proc. Acad. Nat. Sci*. 133: 15-19.

Deinert, E.I., J.T. Longino, and L. E. Gilbert. 1994. Mate competition in butterflies. *Nature* 370:23-24.

Delprete, P. 1991. *Results of the collecting expedition at Sirena Station (Corcovado National Park, Costa Rica).* Vol. 3 No. 9. University of Texas at Austin.

DeVries, P. 1978. An annotated list of the butterflies of Parque Nacional Corcovado during the dry season. *Brenesia* 14-15:47-56.

DeVries, P. 1987. Butterflies of Costa Rica and their natural history. Princeton, Princeton University Press.

DeVries, P. J. 1983. Checklist of butterflies. Pp. 654-678 in Janzen, D. H. (eds.). Costa Rican Natural History. Chicago, University of Chicago Press. DeVries, P. J. 1986. Hostplant records and natural history notes on Costa Rican butterflies (Papilonidae, Pieridae and Nyymphalidae). *J. Res. Lep*. 24: 290-333.

DeVries, P. J., Kitching, I. J., & Vane-Wright, R. I. 1985. The systematic position of *Antirrhea* and *Caerois*, with comments on the classification of the Nymphalidae (Lepidoptera). *Syst. Ent.* 10: 11-32.

Dixon, M. T. 1991. *A survey of the bat community of Sirena, Corcovado National Park, Costa Rica*. Vol. 3 No. 6. University of Texas at Austin.

Dixon, M. T. & Ammerman, L. K. 1991. A survey of the bat community of Corcovado National Park, Costa Rica. Abstract No. The University of Texas at Austin.

Duckett, C. N. 1987. The natural history of an undescribed Neotropical flea beetle (Coleoptera: Chrysomelidae: Alticinae), and its relationship to oviposition in the butterfly, *Heliconius hewitsoni*, and to other local alticines. M.A. Thesis, The University of Texas at Austin.

Duckett, C. N. 1987. *A practical key to the Passiflora-associated Alticinae of Sirena and some Co-mimics.* Vol. 2 No. 5. University of Texas at Austin.

Duckett, C. N. 1989. Natural history of *Pedilia* sp. A and its interactions with other herbivores of *Passiflora pittieri*. *Entomography* 6: 381-389.

Gastreich, K. R. 1991. *The nonpollinating wasps of Ficus insipida at Corcovado National Park, Costa Rica*. Vol. 3 No. 8. University of Texas at Austin.

Gilbert, L. E. 1980. Food web organization and the conservation of neotropical diversity. Pp. 11-33. *In:* Soule, M. & B. Wilcox (eds.). *Conservation Biology*. Sunderland, Sinauer.

Gilbert, L. E. 1982. The coevolution of a butterfly and a vine. *Sci. Am.* 247: 110-121.

Gilbert, L. E. 1982. Contributions of research on neotropical butterflies to ecology. *In*: (ed.), Congreso Latinoamericano de Entomologia, Maracay, Venezuela:

Gilbert, L. E. 1982. Oviposition by two *Heliconius* species: Comments on a paper by Dr. A. Young. New York Entomological Society 90: 115-116.

Gilbert, L. E. 1983. *Anguria* and *Gurania* (Rain-Forest Cucumber). Pp. 190-191. *In*: Janzen, D. H. (eds.). *Costa Rican Natural History*. Chicago, University of Chicago Press.

Gilbert, L. E. 1984. The biology of butterfly communities. Pp. 41-54. *In*: Vane-Wright, R. & P. Ackery (eds.). *The Biology of Butterflies*. New York, Academic Press.

Gilbert, L. E. 1991. Biodiversity of a Central American *Heliconius* community: Pattern, process, and problems. Pp. 403-427. *In*: Price, P. W., T. M. Lewinsohn, G. W. Fernandes, & W. W. Benson. (eds.). *Plant-Animal Interactions: Evolutionary Ecology in Tropical and Temperate Regions*. New York, Wiley.

Gilbert, L. E. 1993. An evolutionary food web and its relationship to tropical biodiversity. In: *Animal-Plant Interactions in Tropical Environments* (eds.) W. Bartholott, C.M. Naumann, K. Schmidt-Loske, and K.-L. Schuchmann. pp. 17-28. Bonn:Zoologisches Forschungsinstitut und Museum Alexander Koenig.

Gilbert, L. E. Manuscript. A new twist in the interaction of moths and spiders: The case of *Eudulophasia* (Geometridae, Edulini).

Gilbert, L. E., Forrest, H. S., Schultz, T. D., & Harvey, D. J. 1988. Correlations of ultrastructure and pigmentation suggest how genes control development of wing scales of *Heliconius* butterflies. *J. Res. Lepidoptera* 26: 141-160.

Gilbert, L.E. 1995. *Heliconius* "Longwing"--The Ultimate Rainforest Butterflies. *American Butterflies*.

Gill, F. B. 1987. Ecological fitting: use of floral nectar in *Heliconia stilesii* Daniels by three species of hermit hummingbirds. *Condor* 89: 779-787.

Gill, F. B. 1988. Effects of nectar removal on nectar accumulation in flowers of *Heliconia imbricata* (Heliconiaceae). *Biotropica* 20: 169-171.

Gill, F. B. 1988. Trapline foraging by hermit hummingbirds: competition for an undefended, renewable resource. *Ecology* 69: 1933-1942.

Gill, F. B., Mack, A. L., & Ray, R. T. 1982. Competition between hermit hummingbirds Phaethorninae and insects for nectar in a Costa Rican rain forest. *Ibis* 124: 44-49.

Gray, J. 1980. Colonization of *Passiflora* vines by adult flea beetles (Coleoptera: Chrysomelidae, Alticinae) in Corcovado National Park, Costa Rica. Vol. 1 No. 7. University of Texas at Austin.

Greig, N. 1984. *The biology and distribution of the Piper community at Parque Nacional Corcovado*. Vol. 1 No. 17. University of Texas at Austin.

Greig, N. 1991. Ecology of co-occurring species of neotropical *Piper* (Piperaceae): Distribution, reproductive biology, and seed predation. Ph.D. Dissertation, The University of Texas at Austin.

Greig, N. & DeVries, P. J. 1986. Observations on the diurnal gregarious roosting of *Ocalaria* sp. (Noctuidae) in Costa Rica. *J. Lep. Soc*. 40: 124-126.

Guda, N. 1994. Interspecific interactions in a neotropical anuran community. Course Report.

Herwitz, S.R. 1977. The regeneration of selected tropical wet forest tree species in Corcovado National Park, Costa Rica. M.A. Thesis, University of California, Berkeley.

Hillman, P. E. 1969. Habitat specificity in three sympatric species of *Ameiva* (Reptilia: Teiidae). *Ecology* 50: 476-481.

Horvitz, C. C. 1991. Light environments, stage structures and dispersal syndromes of Costa Rican Marantaceae. Pages 463-485. In. C. Huxley and Cutler. (eds.) *Ant-plant interactions*. Oxford University Press. Oxford.

Horvitz, C. C. and J. LeCorff. 1993. Spatial scale and dispersion pattern of ant- and bird-dispersed herbs in two tropical lowland rain forests. Vegetatio 107/108: 351-362. In T.H. Fleming and A. Estrada (eds.). *Frugivory and seed dispersal: evolutionary and ecological aspects.* Kluwer Academic Publishers. Belgium.

Huston, M. and L.E. Gilbert. In press. *Ecosystem function of biodiversity: consumers and secondary production. in Diversity and Processes in Tropical Forest Ecosystems*. G.H. Orians, R. Dirzo, and J.H. Cushman (eds.) Springer-Verlag, Berlin.

Johnson, S. 1994. Interactions of White-Faced Capuchins (*Cebus capucinus*) with Sympatric Primates. Course Report.

Kernan, C. N. 1992. Epiphyte and canopy ecology in Corcovado National Park, Costa Rica. Ph.D. Dissertation, The University of Texas at Austin.

Kernan, K. 1988. *Trees of Sirena Trails.* Vol. 2 No. 13. University of Texas at Austin.

Kernan, K., Delprete, P., Gilbert, L. E., Greig, N., & Westcott, D. 1986-93. *Plants of Corcovado Park*. No. University of Texas at Austin.

Kish, M. M. 1988. Pupal mating in *Heliconius* in Corcovado, Costa Rica. Vol. 2 No. 10. University of Texas at Austin.

Lanza, J. 1988. Ant preferences for *Passiflora* nectar mimics that contain amino acids. *Biotropica* 20: 341-344.

Lee, C. S., McCool, B. A., Moore, J. L., Hillis, D. M., & Gilbert, L. E. 1992. Phylogenetic study of heliconiine butterflies based on morphology and restriction analysis of ribosomal RNA genes. *Zool. J. Linn. Soc*. 106: 17-31.

Lemon, W.C. 1991. Foraging behavior of a guild of Neotropical vultures. *Wilson Bull*. 103: 698-702.

Longino, J. T. 1984. Shoots, parasitoids, and ants as forces in the population dynamics of Heliconius hewitsoni in Costa Rica. Ph.D. Dissertation, The University of Texas at Austin.

Longino, J. T. 1986. A negative correlation between growth and rainfall in a tropical liana. *Biotropica* 18: 195-200.

Longino, J. T. Manuscript. Behavior, distribution, and species richness of ants attracted to extrafloral nectaries of a Neotropical liana.

Longino, J. T. Manuscript. The population dynamics of *Heliconius hewitsoni* in a Costa Rican rainforest.

Lyons, J. & Schneider, D. W. Submitted. Factors influencing fish distribution and diversity in a small coastal river in southwestern Costa Rica. *Hydrobiologia*.

Mallet, J. 1984. Population structure and evolution of *Heliconius* butterflies. Ph. D. Dissertation, University of Texas, Austin, TX.

Mallet, J. 1986. Dispersal and gene flow in a butterfly with home range behavior: *Heliconius erato* (Lepidoptera: Nymphalidae). *Oecol*. 68: 210-217.

Mallet, J. 1986. Gregarious roosting and home range in *Heliconius* butterflies. *National Geographic Research* 2: 198-251.

Mallet, J. & Longino, J. T. 1982. Hostplant records and descriptions of juvenile stages for two rare species of *Eueides* (Nymphalidae). *J. Lep. Soc*. 36: 136-144.

Mallet, J., Longino, J. T., Murawski, D., Murawski, A., & Simpson de Gamboa, A. 1987. Handling effects in *Heliconius*: where do all the butterflies go? *J. Anim. Ecol*. 56: 377-386.

Mallett, J. and L.E. Gilbert. 1995. Why are there so many mimicry rings? Correlations between habitat, behaviour, and mimicry in *Heliconius* butterflies. *Biological Journal of the Linnean Society*.

Marcotullio, P. J. & Gill, F. B. 1985. Use of time and space by chestnut-backed antbirds. *Condor* 87: 187-191.

Marden, J. H. & Chai., P. 1991. Aerial predation and butterfly design: how palatability, mimicry, and the need for evasive flight constrain mass allocation. *Am. Naturalist* 138: 15-36.

Medina, M. C. 1992. Vertical stratification of Heliconiinae (Nymphalidae) in Sirena, Corcovado National Park, Costa Rica. Vol. 3 No. 18. University of Texas at Austin.

Meredith, C. 1989. Polyspecific associations of white-faced monkeys (*Cebus capucinus*) with double-toothed kites (*Harpagus bidentatus*), agoutis (*Dasyprocta punctata*), and peccaries (*Tayassu* spp.) (Proposal derived from 1989 course project.). Vol. 2 No. 15. University of Texas at Austin.

Miakado, M., Meinwald, J., & Gilbert, L. E. 1989. (R) - (Z,E) - 9,11-octadecadien-13-olide: An intriguing lactone from *Heliconius pachinus* (Lepidoptera). *Experientia* 45: 1006-1008.

Miakado, M., Meinwald, J., & Gilbert, L. E. Submitted. Z-9-Heneicosene, n-Heneicosane and Z-9-Tricosene: Possible pheromones for *Heliconius ismenius* (Lepidoptera).

Mitchell, P. & Schaefer, C. W. 1983. Food plants of the Coreoidea (Hemiptera: Heteroptera). *Ann. Entomol. Soc. Am.* 76: 591-615.

Mojica, C. L. 1991. An introduction to *Brachyrhaphis rhabdophora* and other poeciliids of Corcovado National Park, Costa Rica. Vol. 3 No. 10. University of Texas at Austin.

Murawski, D. A. 1986. Pollination ecology of a Costa Rican population of *Psiguria warscewiczii* in relation to foraging behavior of *Heliconius* butterflies. Ph.D. Dissertation, University of Texas, Austin, TX.

Murawski, D. A. 1987. Floral resource variation, pollinator response, and potential pollen flow in *Psiguria warscewiczii*. *Ecology* 68: 1273-1282.

Murawski, D. A. & Gilbert, L. E. 1986. Pollen flow in *Psiguria warscewiczii*: A comparison of *Heliconius* butterflies and hummingbirds. *Oecologia* 68: 161-167.

Nijhout, H. F., Wray, G. A., & Gilbert, L. E. 1990. An analysis of the phenotypic effects of certain color pattern genes in *Heliconius* (Lepidoptera: Nymphalidae). *Zool. J. Linnean Soc.* 40: 357-372.

O'Daniel, D. 1987. Seed dispersal and seed predation in two species of *Calathea* (Marantaceae) in a Costa Rican rainforest. M.A. Thesis, The University of Texas at Austin.

O'Daniel, D. 19?? Observations of seed dispersal and seed predation in two species of *Calathea* in a Costa Rican rainforest with descriptions of foraging behavior or avian visitors. *Brenesia*.

Odum, P. 1983. Observations on the natural history of two species of *Eurybia*, ant associated riodinid butterflies in Corcovado Park, Costa Rica. Vol. 1 No. 16. University of Texas at Austin.

Oliveira, E. G. 1991. Orientation of migrating *Urania fulgens* at La Sirena, Parque National Corcovado, Costa Rica. Vol. 3 No. 14. University of Texas at Austin.

Perry, G. 1995. The evolutionary ecology of lizard foraging: A comparative study. Ph.D. Dissertation. University of Texas at Austin.

Perry, G. 1999. The evolution of search modes: Ecological versus phylogenetic perspectives. *Am. Naturalist* 153:98-109.

Phillips, P. 1985. Sirena area land use history. Vol. 2 No. 1. University of Texas at Austin.

Phillips, P. 1989. The relationship of successional and primary tropical rain forests to color infrared photography. M.A. Thesis, The University of Texas at Austin.

Ray, T. 1980. *Syngonium oduberi* (Araceae): A new species from the Osa Peninsula of Costa Rica. *Aroideana* 3: 128-129.

Richards, P. & Williamson, G. B. 1975. Treefalls and patterns of understory species in a wet lowland tropical forest. *Ecology* 56: 1226-1229.

Schneider, D. W. & Frost, R. M. 1986. Massive upstream migrations by a tropical neritid snail. *Hydrobiologia* 137: 153-157.

Smiley, J. 1985. Are chemical barriers necessary for evolution of butterfly-plant associations? *Oecologia* 65: 580-583.

Smiley, J. & Gilbert, L. E. Manuscript. Habitat segregation in coexisting mimicry complexes.

Smiley, J. T. 1978. The host plant ecology of *Heliconius* butterflies in Northeastern Costa Rica. Ph.D. Dissertation, The University of Texas at Austin.

Smiley, J. T. 1978. Plant chemistry and the evolution of host specificity: New evidence from *Heliconius* and *Passiflora*. *Sci.* 201: 745-747.

Smiley, J. T. 1985. *Heliconius* caterpillar mortality during establishment on plants with and without attending ants. *Ecol.* 66: 845-849.

Smiley, J. T. & Wisdom, C. S. 1985. Determinants of growth rate on chemically heterogeneous host plants by specialist insects. *Biochem. Systematics and Ecol*. 13: 305-312.

Snow, A. A. 1982. Pollination intensity and potential seed set in *Passiflora vitifolia*. *Oecologia* 55: 231-237.

Srygley, R. B. 1991. The associations of palatability with flight, morphology, and thermal biology of Neotropical butterflies. Ph. D. Dissertation, The University of Texas at Austin.

Srygley, R. B. In press. Associations of mimicry and palatability with the flight-related morphology of heliconiine butterflies and their minics. *Evolution.*

Srygley, R. B. & Chai, P. 1990. Flight morphology of Neotropical butterflies: palatability and distribution of mass to the thorax and abdomen. *Oecologia* 84: 491-499.

Srygley, R. B. & Chai, P. 1990. Predation and the elevation of thoracic temperature in brightly-colored, neotropical butterflies. *Am. Nat.* 135: 766-787.

Srygley, R. B. & Dudley, R. 1993. Correlations of the position of center of body mass with butterfly escape tactics. *J. Exp. Biol.* 174: 155-166.

Sterrenberg, B. 1989. Soils and successional status around Sirena. Vol. 3 No. 1. University of Texas at Austin.

Sterrenberg, B. K. 1990. Nutrient availability during vegetational regrowth in a lowland tropical fainforest, Corcovado National Park, Costa Rica. M.A. Thesis, University of Texas at Austin.

Tangley, L. 1986. Costa Rica - test case for the neotropics. *Bio. Sci.* 36: 296-300.

Thomas, C. D. 1987. Behavioural determination of diet breadth in insect herbivores: the effect of leaf age on choice of host species by beetles feeding on *Passiflora* vines. *Oikos* 48: 211-216.

Thomas, C. D. Manuscript. Instantaneous accumulation of insect herbivores on introduced Passifloraceae plants.

Thompson, C., Bailey, M., O'Daniel, D., Barth, R. H., Damude, N., Fritz, B., Phillips, P., Thomas, C., & Swartz, M. 1982-1990. Birds observed around Sirena Biological Station, Corcovado National Park. No. University of Texas at Austin.

Thorne, B. L. 1982. Termite-termite interactions: Workers as an agonistic caste. *Psyche* 89: 1-2.

Todzia, C. A. 1981. *Floral biology of Mendoncia (Mendonciaceae) in Parque Nacional Corcovado, Costa Rica*. Vol. 1 No. 9. University of Texas at Austin.

Warkentin, K. M. 1995. Adaptive plasticity in hatching age: A response to predation risk trade-offs. *Proceedings of the National Academy of Sciences* 92: 3507-3510.

Westcott, D.A. 1991. Behaviour and social organization during the breeding season in *Mionectes oleagineus* (Aves, Tyrannidae). M.Sc. Thesis, The University of British Columbia, Vancouver.

Westcott, D. A. 1992. Intra- and inter-sexual selection: the role of song in a lek mating system. *Anim. Behav*. 44:695-703.

Westcott, D.A. 1993. Habitat characteristics of leks sites and their availability for the ochre-bellied flycatcher, *Mionectes oleagineus*. *Biotropica* 25: 444-451.

Westcott, D.A. 1994. Leks of leks: a role for hotspots in lek evolution? *Proceedings of the Royal Society of London* (Series B) 258:281-286.

Westcott, D.A. 1995. Lekking in the ochre-bellied flycatcher, *Mionectes oleagineus*. PhD Dissertation, The University of British Columbia, Vancouver.

Westcott, D. A. (1996). Lek locations and patterns of female movement and distribution in a Neotropical frugivorous bird. *Animal Behaviour*, in press.

Westcott, D.A. and J.N.M. Smith. 1994. Behavior and social organization during the breeding season in *Mionectes oleagineus*, a lekking flycatcher. *Condor* 96:672-683.

Wheelwright, N. T. & Wilkinson, G. S. 1985. Space use by a neotropical water strider (Hemiptera: Gerridae): Sex and age-class differences. *Biotropica* 17: 165-169.

Whittaker, P. L. 1979. *Notes on the satyrid butterfly populations of Corcovado National Park, Costa Rica.* Vol. 1 No. 3. University of Texas at Austin.

Whittaker, P. L. 1983. Notes on the satyrid butterfly populations of Corcovado National Park, Costa Rica. *J. Lep. Soc.* 37: 16-23.

Winemiller, K. 1983. An introduction to the freshwater fish communities of Corcovado Park, Costa Rica. *Brenesia* 21: 47-66.

Winemiller, K. & Morales, N. E. 1989. Comunidades de peces del Parque Nacional Corcovado luego del cese de las actividades mineras. *Brenesia* 31: 75-91.

Winemiller, K. O. 1982. *An introduction to the freshwater fish communities of Corcovado National Park, Costa Rica*. Vol. 1 No. 11. University of Texas at Austin.

Winemiller, K. O. 1990. Spatial and temporal variation in tropical fish trophic networks: Influence of ecology, math, and methodology on food web structure. *Ecological Monographs* 60: 331-367.

Zippin, D. B. 1992. *An introduction and key to the palm community of Corcovado National Park, Costa Rica*. Vol. 3 No. 20. University of Texas at Austin.

d. Address where inventory, records, and archives are held

Document center at Corcovado National Park's Puerto Jimenez office.